"All the News That's Fit to Print"

The New York Times

LATE CITY EDITION

Weather: Rain, warm today; clear tonight. Sunny, pleasant tomorrow. Temp. range: today 80-66; Sunday 71-66. Temp.-Hum. Index yesterday 69. Complete U.S. report on P. 50.

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MEN WALK ON MOON

ASTRONAUTS LAND ON PLAIN; COLLECT ROCKS, PLANT FLAG

Voice From Moon: 'Eagle Has Landed'

EAGLE (the lunar module): Houston, Tranquility Base here. The Eagle has landed.

HOUSTON: Roger, Tranquility, we copy you on the ground. You've got a bunch of guys about to turn blue. We're breathing again. Thanks a lot.

TRANQUILITY BASE: Thank you.

HOUSTON: You're looking good here.

TRANQUILITY BASE: A very smooth touchdown.

HOUSTON: Eagle, you are stay for T1. [The first step in the lunar operation.] Over.

TRANQUILITY BASE: Roger. Stay for T1.

HOUSTON: Roger and we see you venting the ox.

TRANQUILITY BASE: Roger.

COLUMBIA (the command and service module): How do you read me?

HOUSTON: Columbia, he has landed Tranquility Base. Eagle is at Tranquility. I read you five by. Over.

COLUMBIA: Yes, I heard the whole thing.

HOUSTON: Well, it's a good show.

COLUMBIA: Fantastic.

TRANQUILITY BASE: I'll second that.

APOLLO CONTROL: The next major stay-no stay will be for the T2 event. That is at 21 minutes 26 seconds after initiation of power descent.

COLUMBIA: Up telemetry command reset to reacquire on high gain.

HOUSTON: Copy. Out.

APOLLO CONTROL: We have an unofficial time for that touchdown of 102 hours, 45 minutes, 42 seconds and we will update that.

HOUSTON: Eagle, you loaded R2 wrong. We want 10254.

TRANQUILITY BASE: Roger. Do you want the horizontal 55 15.2?

HOUSTON: That's affirmative.

APOLLO CONTROL: We're now less than four minutes from our next stay-no stay. It will be for one complete revolution of the command module.

One of the first things that Armstrong and Aldrin will do after getting their next stay-no stay will be to remove their helmets and gloves.

HOUSTON: Eagle, you are stay for T2. Over.

Continued on Page 4, Col. 1

VOYAGE TO THE MOON

By ARCHIBALD MACLEISH

PRESENCE among us,

wanderer in our skies,

dazzle of silver in our leaves and on our
waters silver,

O
silver evasion in our farthest thought—
"the visiting moon" . . . "the glimpses of the moon" . . .

and we have touched you!

From the first of time,
before the first of time, before the
first men tasted time, we thought of you.
You were a wonder to us, unattainable,
a longing past the reach of longing,
a light beyond our light, our lives—perhaps
a meaning to us . . .

Now
our hands have touched you in your depth of night.

Three days and three nights we journeyed,
steered by farthest stars, climbed outward,
crossed the invisible tide-rip where the floating dust
falls one way or the other in the void between,
followed that other down, encountered
cold, faced death—unfathomable emptiness . . .

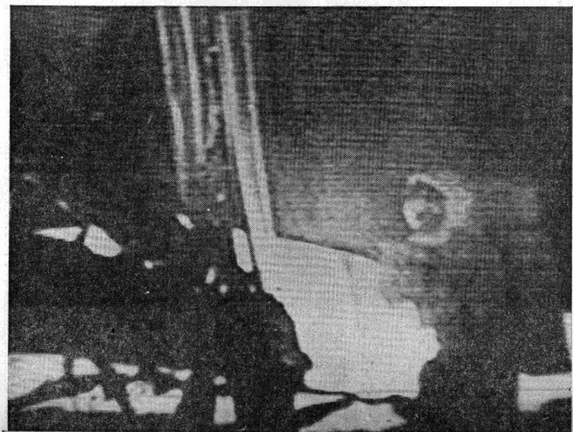
Then, the fourth day evening, we descended,
made fast, set foot at dawn upon your beaches,
sifted between our fingers your cold sand.

We stand here in the dusk, the cold, the silence . . .

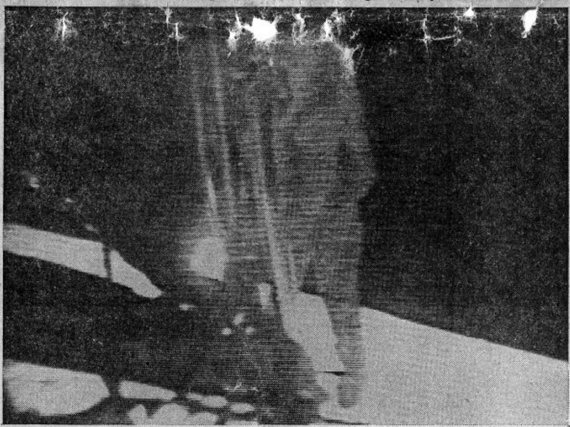
and here, as at the first of time, we lift our heads.
Over us, more beautiful than the moon, a
moon, a wonder to us, unattainable,
a longing past the reach of longing,
a light beyond our light, our lives—perhaps
a meaning to us . . .

O, a meaning!

over us on these silent beaches the bright
earth,
presence among us



Neil A. Armstrong moves away from the leg of the landing craft after taking the first step on the surface of the moon



The New York Times from C.B.S. News

Col. Edwin E. Aldrin Jr. climbing down the ladder. The television camera was attached to a side of the lunar module.

Associated Press

Mr. Armstrong, right, and Colonel Aldrin raise the U.S. flag. A metal rod at right angles to the mast keeps flag unfurled.

A Powdery Surface Is Closely Explored

By JOHN NOBLE WILFORD
Special to The New York Times

HOUSTON, Monday, July 21—Men have landed and walked on the moon.

Two Americans, astronauts of Apollo 11, steered their fragile four-legged lunar module safely and smoothly to the historic landing yesterday at 4:17:40 P.M., Eastern daylight time.

Neil A. Armstrong, the 38-year-old civilian commander, radioed to earth and the mission control room here:

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

The first men to reach the moon—Mr. Armstrong and his co-pilot, Col. Edwin E. Aldrin Jr. of the Air Force—brought their ship to rest on a level, rock-strewn plain near the southwestern shore of the arid Sea of Tranquility.

About six and a half hours later, Mr. Armstrong opened the landing craft's hatch, stepped slowly down the ladder and declared as he planted the first human footprint on the lunar crust:

"That's one small step for man, one giant leap for mankind."

His first step on the moon came at 10:56:20 P.M., as a television camera outside the craft transmitted his every moved to an awed and excited audience of hundreds of millions of people on earth.

Tentative Steps Test Soil

Mr. Armstrong's initial steps were tentative tests of the lunar soil's firmness and of his ability to move about easily in his bulky white spacesuit and backpacks and under the influence of lunar gravity, which is one-sixth that of the earth.

"The surface is fine and powdery," the astronaut reported. "I can pick it up loosely with my toe. It does adhere in fine layers like powdered charcoal to the sole and sides of my boots. I only go in a small fraction of an inch, maybe an eighth of an inch. But I can see the footprints of my boots in the treads in the fine sandy particles.

After 19 minutes of Mr. Armstrong's testing, Colonel Aldrin joined him outside the craft.

The two men got busy setting up another television camera out from the lunar module, planting an American flag into the ground, scooping up soil and rock samples, deploying scientific experiments and hopping and loping about in a demonstration of their lunar agility.

They found walking and working on the moon less taxing than had been forecast. Mr. Armstrong once reported he was "very comfortable."

And people back on earth found the black-and-white television pictures of the bug-shaped lunar module and the men tramping about it so sharp and clear as to seem unreal, more like a toy and toy-like figures than human beings on the most daring and far-reaching expedition thus far undertaken.

Nixon Telephones Congratulations

During one break in the astronauts' work, President Nixon congratulated them from the White House in what, he said, "certainly has to be the most historic telephone call ever made."

"Because of what you have done," the President told the astronauts, "the heavens have become a part of man's world. And as you talk to us from the Sea of Tranquility it requires us to redouble our efforts to bring peace and tranquility to earth.

"For one priceless moment in the whole history of man all the people on this earth are truly one—one in their pride in what you have done and one in our prayers that you will return safely to earth."

Mr. Armstrong replied:

"Thank you Mr. President. It's a great honor and privilege for us to be here representing not only the United States but men of peace of all nations, men with interests and a curiosity and men with a vision for the future."

Mr. Armstrong and Colonel Aldrin returned to their landing craft and closed the hatch at 1:12 A.M., 2 hours 21 minutes after opening the hatch on the moon. While the third member of the crew, Lieut. Col. Michael Collins of the Air Force, kept his orbital vigil overhead in the command ship, the two moon explorers settled down to sleep.

Outside their vehicle the astronauts had found a bleak

Continued on Pages 2, Col. 1

Today's 4-Part Issue of The Times

This morning's issue of The New York Times is divided into four parts. The first part is devoted to news of Apollo 11. and includes Editorials and letters to the Editor (Page 16). Poems on the landing on the moon appear on Page 17.

General news begins on the first page of the second part. The News Summary and Index is on the first page of the third part, which includes sports news, obituaries (Page 51) and transportation news and weather reports (Pages 50 and 52).

Financial and business news begins on the first page of the fourth part.

Following is the News Index for today's issue:

News Summary and Index, Page 35

Astronauts Land Module on Lunar Plain; Collect Rocks and Plant American Flag

Powdery Moon Surface Explored Around Craft

Continued From Page 1, Col. 8

world. It was just before dawn, with the sun low over the eastern horizon behind them and the chill of the long lunar nights still clinging to the boulders, small craters and hills before them.

Colonel Aldrin said that he could see "literally thousands of small craters" and a low hill out in the distance. But most of all he was impressed initially by the "variety of shapes, angularities, granularities" of the rocks and soil where the landing craft, code-named Eagle had set down.

The landing was made four miles west of the aiming point, but well within the designated area. An apparent error in some data fed into the craft's guidance computer from the earth was said to have accounted for the discrepancy.

Suddenly the astronauts were startled to see that the computer was guiding them toward a possibly disastrous touchdown in a boulder-filled crater about the size of a football field.

Mr. Armstrong grabbed manual control of the vehicle and guided it safely over the crater to a smoother spot, the rocket engine stirring a cloud of moon dust during the final seconds of descent.

Soon after the landing, upon checking and finding the spacecraft in good condition, Mr. Armstrong and Colonel Aldrin made their decision to open the hatch and get out earlier than originally scheduled. The flight plan had called for the moon walk to begin at 2:12 A.M.

Flight controllers here said that the early moon walk would not mean that the astronauts would also leave the moon earlier. The lift-off is scheduled to come at about 1:55 P.M. today.

Their departure from the landing craft out onto the surface was delayed for a time when they had trouble depressurizing the cabin so that they could open the hatch. All the oxygen in the cabin had to be vented.

Once the pressure gauge finally dropped to zero, they opened the hatch and Mr. Armstrong stepped out on the small porch at the top of the nine-step ladder.

"O.K., Houston, I'm on the porch," he reported, as he descended.

On the second step from the top, he pulled a lanyard that released a fold-down equipment compartment on the side of the lunar module. This deployed the television camera that transmitted the dramatic pictures of man's first steps on the moon.

Ancient Dream Fulfilled

It was man's first landing on another world, the realization of centuries of dreams, the fulfillment of a decade of striving, a triumph of modern technology and personal courage, the most dramatic demonstration of what man can do if he applies his mind and resources with single-minded determination.

The moon, long the symbol of the impossible and the inaccessible, was now within man's reach, the first port of call in this new age of spacefaring.

Immediately after the landing, Dr. Thomas O. Paine, administrator of the National Aeronautics and Space Administration, telephoned President Nixon in Washington to report:

"Mr. President, it is my honor on behalf of the entire NASA team to report to you that the Eagle has landed on the Sea of Tranquility and our astronauts are safe and looking forward to starting the exploration of the moon."

The landing craft from the Apollo 11 spaceship was scheduled to remain on the moon about 22 hours, while Colonel Collins of the Air Force, the third member of the Apollo 11 crew, piloted the command ship, Columbia, in orbit overhead.

"You're looking good in every respect," Mission Control told the two men of Eagle after examining data indicating that the module should be able to remain on the moon the full 22 hours.

Mr. Armstrong and Colonel Aldrin planned to sleep after the moon walk and then make their preparations for the lift-off for the return to a rendezvous with Colonel Collins in the command ship.

Apollo 11's journey into history began last Wednesday from launching pad 39-A at Cape Kennedy, Fla. After an almost flawless three-day flight, the joined command ship and lunar module swept into an orbit of the moon yesterday afternoon.

The three men were awake for their big day at 7 A.M. when their spacecraft emerged from behind the moon on its 10th revolution, moving from east to west across the face of the moon along its equator.

Their orbit was 73.6 miles by 64 miles in altitude, their speed 3,660 miles an hour. At that altitude and speed, it took about two hours to complete a full orbit of the moon.

The sun was rising over their landing site on the Sea of Tranquility.

"We can pick out almost all of the features we've identified previously," Mr. Armstrong reported.

After breakfast, on their 11th revolution, Colonel Aldrin and then Mr. Armstrong, both dressed in their white pressurized suits, crawled through the connecting tunnel into the lunar module.

They turned on the electrical power, checked all the switch settings on the cockpit panel and checked communications with the command ship and the ground controllers. Everything was "nominal," as the spacemen say.

LM Ready for Descent

The lunar module was ready. Its four legs with yard-wide footpads were extended so that the height of the 16½-ton vehicle now measured 22 feet and 11 inches and its width 31 feet.

Mr. Armstrong stood at the left side of the cockpit, and Colonel Aldrin at the right. Both were loosely restrained by harnesses. They had closed the hatch to the connecting tunnel.

The walls of their craft were finely milled aluminum foil. If anything happened so that it could not return to the command ship, the lunar module would be too delicate to withstand a plunge through earth's atmosphere, even if it had the rocket power.

Nearly three-fourths of the vehicle's weight was in propellants for the descent and ascent rockets—Aerozine 50 and nitrogen oxide, which substituted for the oxygen, making combustion possible.

It was an ungainly craft that creaked and groaned in flight. But years of development and testing had determined that it was the lightest and most practical way to get two men to the moon's surface.

Before Apollo 11 disappeared behind the moon near the end of its 12th orbit, mission control gave the astronauts their "go" for undocking—the separation of Eagle from Columbia.

Colonel Collins had already released 12 of the latches holding the two ships together at the connecting tunnel. He did this when he closed the hatch at the command ship's nose. While behind the moon, he was to flip a switch on the control panel to release the three remaining latches by a spring action.

At 1:50 P.M., when communications signals were reacquired, Mission Control asked: "How does it look?"

"Eagle has wings," Mr. Armstrong replied.

The two ships were then only a few feet apart. But at 2:12 P.M., Colonel Collins fired the command ship's maneuvering rockets to move about two miles away and in a slightly different orbit from the lunar module.

"It looks like you've got a fine-looking flying machine there, Eagle, despite the fact you're upside down," Colonel Collins commented, watching the spidery lunar module receding in the distance.

"Somebody's upside down," Mr. Armstrong replied.

What is "up" and what is "down" is never quite clear in the absence of landmarks and the sensation of gravity's pull.

As Mr. Armstrong and Colonel Aldrin rode the lunar module back around to the moon's far side, the rocket engine in the vehicle's lower stage was pointed toward the line of flight. The two pilots were leaning toward the cockpit controls, riding backwards and facing downward.

"Everything is 'go'," they were assured by Mission Control.

Their on-board guidance and navigation computer was instructed to trigger a 29.8-second firing of the descent rocket, the 9,870-pound-thrust throttable engine that would slow down the lunar module and send it toward the moon on a long, curving trajectory.

The firing was set to take place at 3:08 P.M., when the craft would be behind the moon and once again out of touch with the ground.

Suspense built up in the control room here. Flight controllers stood silently at their consoles. Among those waiting for word of the rocket firing were Dr. Thomas O. Paine, the space agency's administrator, most of the Apollo project officials and several astronauts.

At 3:46 P.M., contact was established with the command ship.

Colonel Collins reported, "Listen, baby, things are going just swimmingly, just beautiful."

There was still no word from the lunar module for two minutes. Then came a weak signal, some static and whistling, and finally the calm voice of Mr. Armstrong.

"The burn was on time," the Apollo 11 commander declared.

When he read out data on the beginning of the descent, Mission Control concluded that it "look great." The lunar module had already descended from an altitude of 65.5 miles to 21 miles and was coasting steadily downward.

Eugene F. Kranz, the flight director, turned to his associates and said, "We're off to a good start. Play it cool."

Colonel Aldrin reported some oscillations in the vehicle's antenna, but nothing serious. Several times the astronauts were told to turn the vehicle slightly to move the antenna into a better position for communications over the 230,000 miles.

"You're 'go' for PDI," radioed Mission Control, referring to the powered descent initiation—the beginning of the nearly 13-minute final blast of the rocket to the soft touchdown.

When the two men reached an altitude of 50,000 feet, which was approximately the lowest point reached by Apollo 10 in May, green lights on the computer display keyboard in the cockpit blinked the number 99.

This signaled Mr. Armstrong that he had five seconds to decide whether to go ahead for the landing or continue on its orbital path back to the command ship. He pressed the "proceed" button.

The throttleable engine built up thrust gradually, firing continuously as the lunar module descended along the steadily steepening trajectory to the landing site about 250 miles away.

"Looking good," Mission Control radioed the men.

Four minutes after the firing the lunar module was down to 40,000 feet. After five and a half minutes, it was 33,500 feet. At six minutes, 27,000 feet.

"Better than the simulator," said Colonel Aldrin, referring to their practice landings at the spacecraft center.

Seven minutes after the firing, the men were 21,000 feet above the surface and still moving forward toward the landing site. The guidance computer was driving the rocket engine.

The lunar module was slowing down. At an altitude of about 7,200 feet, with the landing site still about five miles ahead, the computer commanded control jets to fire and tilt the bug-shaped craft almost upright so that its triangular windows pointed forward.

Mr. Armstrong and Colonel Aldrin then got their first close-up view of the plain they were aiming for. It was then about three and a half minutes to touchdown.

The brownish-gray panorama rushed below them—the myriad craters, hills and ridges, deep cracks and ancient rubble on the moon, which Dr. Robert Jastrow, the space agency scientist, called the "Rosetta Stone of life."

"You're 'go' for landing," Mission Control informed the two men.

The Eagle closed in, dropping about 20 feet a second, until it was hovering almost directly over the landing area at an altitude of 500 feet.

Its floor was littered with boulders.

It was when the craft reached an altitude of 300 feet that Mr. Armstrong took over semimanual control for the rest of the way. The computer continued to have control of the rocket firing, but the astronaut could adjust the craft's hovering position.

He was expected to take over such control anyway, but the sight of a crater looming ahead at the touchdown point made it imperative.

As Mr. Armstrong said later, "The auto-targeting was taking us right into a football field-sized crater, with a large number of big boulders and rocks."

For about 90 seconds, he peered through the window in search of a clear touchdown point. Using the lever at his right hand, he tilted the vehicle forward to redirect the firing of the maneuvering jets and thus shift its hovering position.

Finally, Mr. Armstrong found the spot he liked, and the blue light on the cockpit flashed to indicate that five-foot-long probes, like curb feelers, on three of the four legs had touched the surface.

"Contact light," Mr. Armstrong radioed.

He pressed a button marked "Stop" and reported, "okay, engine stop."

There were a few more cryptic messages of functions performed.

Then Maj. Charles M. Duke, the capsule communicator in the control room, radioed to the two astronauts:

"We copy you down, Eagle."

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

"Roger, Tranquility," Major Duke replied. "We copy you on the ground. You got a bunch of guys about to turn blue. We are breathing again. Thanks a lot."

Colonel Aldrin assured Mission Control it was a "very smooth touchdown."

The Eagle came to rest at an angle of only about four and a half degrees. The angle could have been more than 30 degrees without threatening to tip the vehicle over.

The landing site, about 120 miles southwest of the crater Maskelyne, is on the right side of the moon as seen from earth. The position: Lat. 0.799 degrees N., Long. 23.46 degrees E.

Although Mr. Armstrong is known as a man of few words, his heartbeats told of his excitement upon leading man's first landing on the moon.

At the time of the descent rocket ignition, his heartbeat rate registered 110 a minute—77 is normal for him—and it shot up to 156 at touchdown.

At the time of the landing, Colonel Collins was riding the command ship Columbia about 65 miles overhead.

Mission control informed the colonel, "Eagle is at Tranquility."

"Yea, I heard the whole thing," Colonel Collins, the man who went so far but not all the way, replied. "Fantastic."

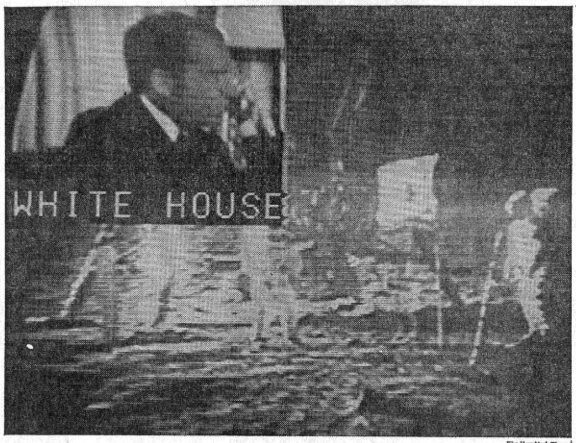
When the Apollo astronauts landed on the Sea of Tranquility, the temperature at their touchdown site was about zero degrees Fahrenheit in the sunlight, even colder in the shade.

During a lunar night, which lasts 14 earth days, temperatures plunge as low as 280 degrees below zero. Unlike earth, the moon, having no atmosphere to act as a blanket, is unable to retain any of the day's warmth during the night.

During the equally long lunar day, temperatures rise as high as 280 degrees. By the time of Eagle's departure from the moon, with the sun higher in the sky, the temperatures there will have risen to about 90 degrees.

This particular landing site was one of five selected by Apollo project officials after analysis of pictures returned by the five Lunar Orbiter unmanned spacecraft.

All five sites are situated across the lunar equator on the side of the moon always facing earth. Being on the equator reduces the maneuvering for the astronauts to get there. Being on the near side of the moon, of course, makes it possible to communicate with the explorers.



The New York Times

CONGRATULATIONS: President Nixon talking with Neil A. Armstrong and Colonel Edwin E. Aldrin Jr. on the moon

Nixon Makes 'Most Historic Telephone Call Ever'

By WALTER RUGABER
Special to The New York Times

WASHINGTON, July 20—President Nixon told the Apollo 11 astronauts tonight that their arrival on the moon would inspire man to work harder for a solution of the troubles on his own planet.

He spoke to the moon explorers during a two-minute radio hookup that he said "certainly has to be the most historic telephone call ever made."

"Because of what you have done," he said, "the heavens have become part of man's world. And as you talk to us from the Sea of Tranquility, it inspires us to redouble our efforts to bring peace and tranquillity to earth.

"For one priceless moment in the whole history of man, all the people of this earth are one—one in their pride in what you have done and one in our prayers that you will return safely to earth."

Mr. Nixon spoke to the two astronau[ts]—Neil A. Armstrong, a civilian, and Col. Edwin E. Aldrin Jr. of the Air Force—after he followed their landing and first steps on the lunar surface on television.

The conversation was televised from both ends. The President spoke from his oval office in the West Wing of the White House, and the spacemen stood in front of a small camera planted on the moon.

The voice signal went from the White House switchboard to the Goddard Space Flight Center in Maryland, over a radio link to the Space Center in Houston and through the Goldstone antenna in California.

"For every American this has to be the proudest day of our lives," the President said. "And for people all over the world I'm sure they, too, join with Americans in recognizing what an immense feat this is."

Mr. Armstrong, commander of the Apollo mission, thanked the President and said it was "a great honor and privilege for us to be here representing not only the United States but men of peace of all nations."

The President signed off by saying that he—and "all of us"—would look f[or]ward t[o] seeing the astronauts on the Hornet. Mr. Nixon w[il]l greet the three men on that aircraft carrier after their splashdown.

Like hundreds of millions of others around the world, the President spent much of the afternoon "glued to his TV set." He returned to the West Wing just before 8 P.M.

Col. Frank Borman, the astronaut, joined Mr. Nixon in the small den just off the oval office and explained the preparations for the first step on the moon. When Mr. Armstrong made it, Colonel Borman quoted the President as saying:

"It's an unbelievable thing. It's fantastic . . . isn't that wonderful?"

Mr. Nixon told Colonel Borman the moon landing had "a significance beyond the scientific value."

A special panel is working on American space goals beyond the moon. Their recommendations are due by Sept. 1 and Donald L. Ziegler, the White House press secretary, said that the President would decide on new objectives after receiving them.

TRANSCRIPT OF TALK

PRESIDENT NIXON: Hello, Neil and Buzz. I'm talking to you by telephone from the O[v]a[l] Ro[o]m at the White H[ouse] [an]d this certainly has to [b]e th[e] most historic telephone call ever made.

I just can't tell you how proud we all are of what you've done. For every American this has to be the proudest day of our lives. And for people all over the world I am sure they, too, join with Americans in recognizing what an immense feat this is.

Because of what you have done, the heavens have become a part of man's world. And as you talk to us from the Sea of Tranquility, it inspires us to redouble our efforts to bring peace and tranquility to earth.

For one priceless moment in the whole history of man all the people on this earth are truly one—one in their pride in what you have done and one in our prayers that you will return safely to earth.

ARMSTRONG: Thank you, Mr. President. It's a great honor and privilege for us to be here representing not only the United States but men of peace of all nations, men with interest and a curiosity and men with a vision for the future.

It's an honor for us to be able to participate here today.

NIXON: Thank you very much, and I look forward—all of us look forward—to seeing you on the Hornet on Thursday.

ARMSTRONG: Thank you. I look forward to that very much, sir.

Two Men Quickly Adjust To Conditions on Moon

By HAROLD M. SCHMECK Jr.
Special to The New York Times

HOUSTON, Monday, July 21—Two American astronauts proved last night that man can see, walk and work on the surface of the moon.

Moving very cautiously at first, they soon found they could walk across the lunar surface easily in bounding, almost floating steps.

They seemed to have a little difficulty in adjusting their vision to the deep shadows of the airless moon, but their depth perception appeared not to suffer at all, nor did their appreciation of the scene.

"Magnificent desolation," was the phrase Col. Edwin E. Aldrin Jr. used to describe the view when he joined Neil A. Armstrong on the lunar surface.

Shortly after he emerged, slowly and with great caution, from the lunar module, Mr. Armstrong said that he was having no difficulty in moving around and that it seemed perhaps easier than the simulations in which he had trained on earth.

Soon after that he was bounding across the surface in easy kangaroo hops. His heavy spacesuit and life-support pack, that weigh 183 pounds on earth, impeded his movements very little.

"You do have to be rather careful to keep track of where your center of mass is," Mr. Armstrong said after loping across the surface for several yards.

He and Colonel Aldrin picked up samples, set out an American flag and scientific instruments all with evident ease.

Although their steps made no sounds at all on the airless surface of the moon, their running conversation with each other and with the earth more than 200,000 miles away seemed to keep them from feeling isolation.

They spoke of light and dark grays as the principal, but not the only, colors. They said they found a purple rock.

The television pictures showed deep black shadows and glaring sunlight.

Because there is no air at all on the moon there is nothing to soften the light or to diminish the sun's fierce light and ultraviolet radiation.

Mr. Armstrong said he had some trouble adjusting his vision to the deep shadow when he walked to the dark side of the lunar module.

The surface temperature was estimated at 40 to 50 degrees Fahrenheit when the astronauts first stepped outside. In the shadows it was 150 degrees below zero.

Even though the astronauts are protected by their water-cooled spacesuits they said they could feel a difference when they went from shadow to sunlight or the reverse.

At lunar midday, long after the astronauts have left the moon, the temperature in sunlight will go as high as 243 degrees above zero. In the depths of the lunar night the surface temperature sinks to about 279 degrees below zero.

The scene the astronauts showed when they moved their television camera toward the horizon was just what had been expected — an almost flat crater-pocked, undulating surface. No lunar mountain or ridges could be seen in the pictures.

The American flag, held outspread by a wire supporting its top, hung completely motionless in the harsh sunlight.

Moving easily through their brightly lit and unearthly surroundings, the first two men to make their footprints on the moon acted as though they were comfortable and very much at home.

Lunar Tests May Give Answers to Old Riddles

By WALTER SULLIVAN
Special to The New York Times

HOUSTON, Monday, July 21—After centuries of speculation as to the nature of earth's silvery satellite, men dug into the moon's surface last night, collecting specimens that should help answer a wide range of long-standing riddles.

Moving with almost gay agility, the astronauts carried a miniature seismic station to what was hopefully a safe distance and implanted it to transmit data on moonquakes after their departure.

They also set up a reflector to bounce laser beams back to earth. By means of this device, physicists hope to resolve a debate concerning the constancy of gravity. One theory says it is slowly weakening.

Almost immediately after he descended to the surface of the moon, Neil A. Armstrong set up a banner of aluminum foil facing the sun. The purpose was to capture the nuclei of atoms blowing out from the sun in the so-called solar wind The foil is to be analyzed by a Swiss laboratory, looking in particular for nuclei of the "noble gases" such as neon, argon and krypton.

Firmness a Surprise

Perhaps the greatest surprise was the hardness of the lunar surface. It was covered with a very fine powder, but the four foot pads of the lunar module, or LM, penetrated only a few inches.

The surface powder was dark and almost carbon-like in appearance. The rocks were coated with it, making them slippery in the deep vacuum that exits on the lunar surface.

This made it more difficult to pick them up with the special tongs provided for the pur pose. Millions of watchers on earth were able to witness this first celestial geoogic prospecting. The long-handled tools—tongs and scoop—could clearly be seen as Lieut. Col. Edwin E. Aldrin Jr. made his selections.

Some of the rocks were described as vesicular, that is, full of small cavities. This is characteristic of certain forms of lava, but does not definitely establish the rock as a lava fragment.

Another rock was said to resemble biotite, a dark green or black form of mica that is characteristic of continental rocks on earth. Its presence on the moon could indicate that the history of the moon had features in cmmon with that of the earth. However, definite identification, as the astronauts pointed out, must await their return.

The samples were placed in two airtight boxes to be hauled aboard for transport home. They will be isolated from exposure to oxygen in the spacecraft or air on arrival on earth.

One of the last acts of the Apollo team was to drive coring tubes into the lunar surface, to capture material deep enough to be free of any exposure to exhaust gases from the rocket that lowered the LM to the surface. These core samples should also show any subtle layering of material near the surface.

Colonel Aldrin pointed out to the onlookers how hard he had to work to drive the tube into the resistant surface.

Although the discovery that they were coming down in the middle of a boulder-filled moon crater may have given the two Apollo astronauts a few anxious moments yesterday, it will likely prove to result in scientific boons.

They managed to delay touchdown until they had skimmed across the crater, large as a football field, and beyond its rim, but they came down in an area that was strewn with boulders of many sizes and varieties.

Some were presumably blown out of the lunar depths when the crater was formed probably by the explosive impact of a large meteorite. These boulders represent rock buried perhaps 100 feet or more below the surface—far beyond the reach of the two men's sampling tools.

Other rocks probably were thrown from over the horizon by more massive impact and thus are specimens from other regions of the moon. Since the moon has virtually no air and its gravity is only one-sixth as strong as earth's gravity, explosive impacts sometimes blow debris halfway around the moon.

The laser experiments are of major scientific interest because they could solve a number of puzzles. The reflectors should make it possible to detect variations in earth-moon distances as small as six inches. This, in turn, could provide the most sensitive tests to date of Einstein's general theory of relativity.

That theory concerns the behavior of gravity. It accounts for a slight departure of the orbit of the planet Mercury from the timetable predicted by the classical gravity laws of Sir Isaac Newton. However, another relativity theory has been devised by Drs. Robert H. Dicke and Carl H. Brans.

Continental Changes

That theory, too, accounts for the behavior of the Mercury orbit. It also predicts that, as the universe expands, gravity weakens and the moon therefore moves farther from the earth at about one inch a year.

The top priority assigned to the astronauts was the collection of moon samples. After years of inconclusive debate about the origin of the moon, it has become apparent that only with a representative collection of lunar rocks and soil samples can the correct answer be determined.

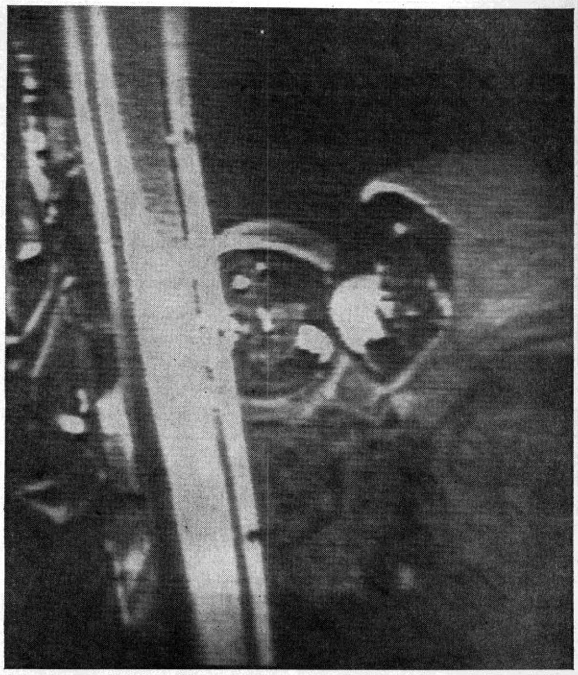
If the moon was torn from the earth, that should be evident in the composition of its rocks. If it is, in effect, a giant meteorite it should contain such formations as the chondrules (tiny, rounded inclusions that often look like rice grains scattered through the rocks).

Chondrules are not found in any rocks native to the earth.

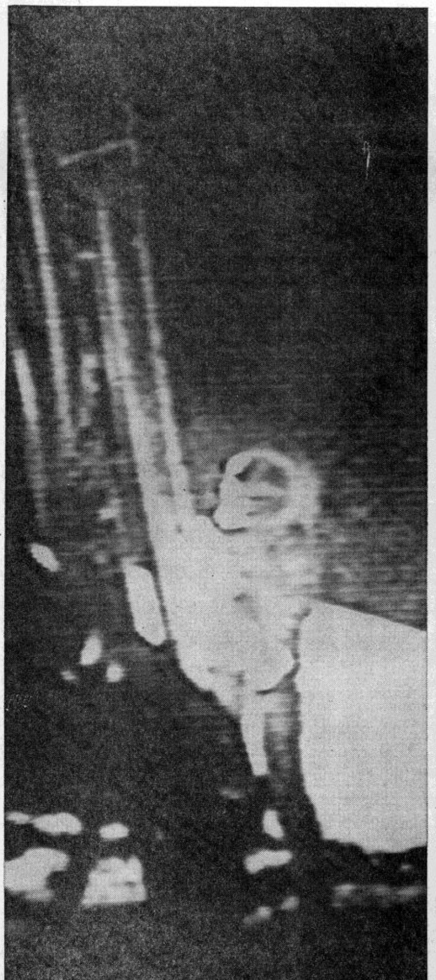
If the moon was once molten inside, allowing the iron and other heavy materials to sink to its core, as occurred on earth, the lighter material would have risen to the surface, like scum, to form lighter rocks, like those on our continent. This will be evident if any granites are found.

Television Camera Records the Activities of Astronauts on the Landing Area

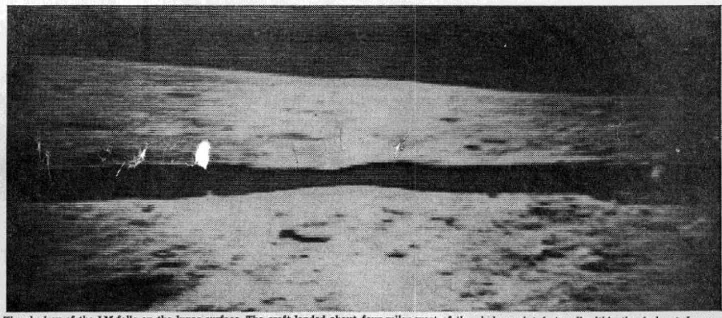
Man's first step on the moon: Neil A. Armstrong's foot silhouetted against moon surface as he descends ladder.



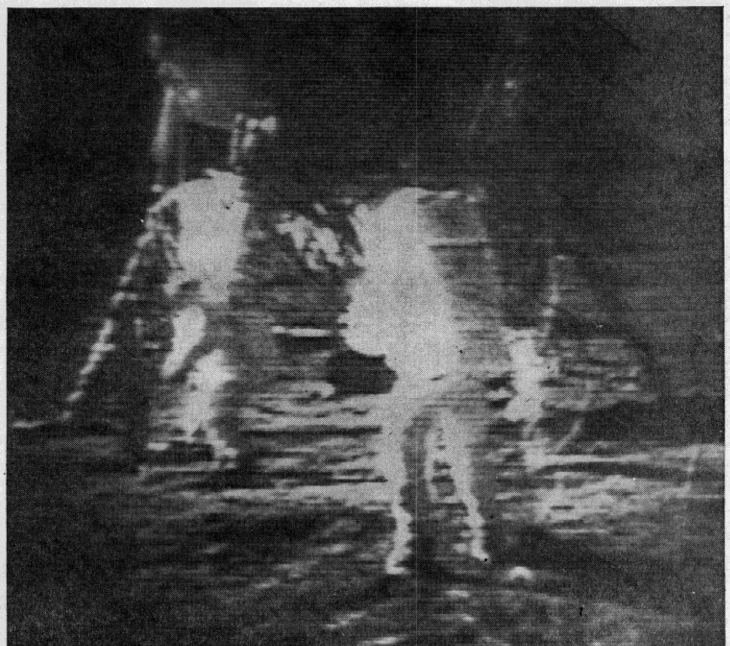
Mr. Armstrong and Col. Edwin E. Aldrin Jr. read words on a plaque affixed to craft. Plaque marks the lunar landing.



Colonel Aldrin descending. He set foot on the moon 20 minutes after his fellow astronaut.



The shadow of the LM falls on the lunar surface. The craft landed about four miles west of the aiming point, but well within the designated area.



Mr. Armstrong, at right, rejoins Colonel Aldrin after placing TV camera on a tripod. Colonel Aldrin can be seen setting up the "solar-wind" detector.

From the Lunar Surface, a Message to Mission Control: 'The Eagle Has Landed'

Continued From Page 1, Col. 2

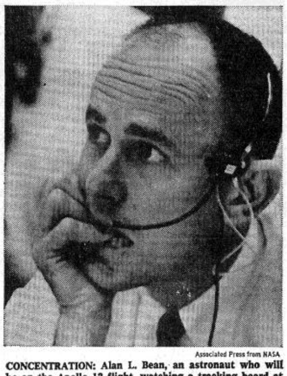
TRANQUILITY BASE: Roger. Stay for T2. We thank you.
HOUSTON: Roger, sir.
APOLLO CONTROL: That's stay for another two minutes plus. The next stay-no stay will be for one revolution.
TRANQUILITY BASE: Houston, that may have seemed like a very long final phase but the auto targeting was taking us right into a football field-sized crater with a large number of big boulders and rocks for about one or two crater diameters around it. And it required us to fly manually over the rock field to find a reasonably good area.
HOUSTON: Roger. We copy. It was beautiful from here, Tranquility. Over.
TRANQUILITY BASE: We'll get to the details of what's around here but it looks like a collection of just about every variety of shape, angularity, granularity, about every variety of rock you could find. The colors vary pretty much depending on how you are looking relative to the zero phase length. There doesn't appear to be too much of a general color at all. However, it looks as though some of the rocks and boulders, of which there are quite a few in the near area—it looks as though they're going to have some interesting colors to them. Over.
HOUSTON: Roger. Copy. Sounds good to us, Tranquility. We'll let you press on through the simulated countdown and we'll talk to you later. Over.
TRANQUILITY BASE: Okay, this one-sixth G is just like an airplane.
HOUSTON: Roger, Tranquility. Be advised there are lots of smiling faces in this room and all over the world. Over.
TRANQUILITY BASE: There are two of them up here.
HOUSTON: Roger. It was a beautiful job, you guys.
COLUMBIA: And don't forget one in the command module.
TRANQUILITY BASE: Roger.

Remark by Collins

APOLLO CONTROL: That last remark from Mike Collins at an altitude of 60 miles. The comments on the landing, on the manual take-over came from Neil Armstrong. Buzz Aldrin followed that with a description of the lunar surface and the rocks and boulders that they are able to see out the window of the LM.
COLUMBIA: Thanks for putting me on relay, Houston. I was missing all the action.
HOUSTON: Roger. We'll enable relay.
COLUMBIA (4:30 P.M.): I just got it, I think.
HOUSTON: Roger, Columbia. This is Houston. Say something; they ought to be able to hear you. Over.
COLUMBIA: Roger. Tranquility Base. It sure sounded great from up here. You guys did a fantastic job.
TRANQUILITY BASE: Thank you. Just keep that orbiting base ready for us up there, now.
COLUMBIA: Will do.
APOLLO CONTROL: That request from Neil Armstrong.
APOLLO CONTROL: We've just gotten a report from the telcom here in mission control that LM systems look good after that landing. We're about 26 minutes now from loss of signal from the command module.
HOUSTON: Tranquility Base, Houston. All your consumables are solid. You're looking good in every respect. We copy the DPS venting. Everything is copacetic. Over.
TRANQUILITY BASE: Thank you, Houston. Houston, the guys that bet that we wouldn't be able to tell precisely where we are are the winners today. We were a little busy worrying about program alarms and things like that in the part of the descent where we would normally be picking out our landing spot; and aside from a good look at several of the craters we came over in the final descent, I haven't been able to pick out the things on the horizon as a reference as yet.
HOUSTON: Rog, Tranquility. No sweat. We'll figure out—we'll figure it out. Over.
TRANQUILITY BASE: You might be interested to know that I don't think we noticed any difficulty at all in adapting to one-sixth G. It seems immediately natural to live in this environment.
HOUSTON: Roger, Tranquility. We copy. Over.
APOLLO CONTROL: Neil Armstrong reporting there is no difficulty adapting to the one-sixth gravity of the moon.
TRANQUILITY BASE: [Unintelligible] . . . window, with relatively level plain cratered with fairly a large number of craters of the 5- to 50-foot variety. And some ridges, small, 20 to 30 feet high, I would guess. And literally thousands of little one- and two-foot craters around the area. We see some angular blocks out several hundred feet in front of us that are probably two feet in size and have angular edges. There is a hill in view just about on the ground track ahead of us. Difficult to estimate, but might be a half a mile or a mile.
HOUSTON: Roger, Tranquility. We copy. Over.
COLUMBIA: Sounds like it looks a lot better than it did yesterday. At that very low sun angle, it looked rough as a cob then.
TRANQUILITY BASE: It really was rough, Mike, over the targeted landing area. It was extremely rough, cratered and large numbers of rocks that were probably some many larger than 5 or 10 feet in size.
COLUMBIA: When in doubt, land long.
TRANQUILITY BASE: Well, we did.

Question on Landing

COLUMBIA: Do you have any idea whether they landed left or right of center line—just a little bit long. Is that all we know?
HOUSTON: Apparently that's about all we can tell. Over.
COLUMBIA: Okay, thank you.
TRANQUILITY BASE: Okay. I'd say the color of the local surface is very comparable to that we observed from orbit at this sun angle—about 10 degrees sun angle or that nature. It's pretty much without color. It's gray and it's very white as you look into the zero phase line. And it's considerably darker gray, more like an ashen gray, as you look out 90 degrees to the sun. Some of the surface rocks in close here that have been fractured or disturbed by the rocket engine plume are coated with this light gray on the outside. But where they've been broken, they display a dark, very dark, gray interior and it looks like it could be country basalt.
HOUSTON: Tranquility, Houston. Please vent fuel and ox again. Over. It's building back up.
TRANQUILITY BASE: Okay, ox going now.
HOUSTON: Tranquility, Houston. You can open both fuel and ox vent now. Over.
TRANQUILITY BASE: Houston, Tranquility. Standing by for go AGS to the line and lunar line. Over.
HOUSTON: Stand by.
HOUSTON: Tranquility, Houston. You're go for the AGS the line and the lunar line. Over.
TRANQUILITY BASE: Roger.
HOUSTON: Tranquility, Houston. Please vent the fuel. It's increasing rapidly. Over.
TRANQUILITY BASE: We show 30 psi in the fuel and 30 on the oxydizer.
HOUSTON: Roger, we're reading somewhat different than that. Stand by.
TRANQUILITY BASE: The fuel temperature is reading 64 in the descent two and the oxydizer off scale low. Descent one is showing 61 in the fuel and 65 in the oxydizer.
HOUSTON: Roger, stand by.
HOUSTON: Tranquility, Houston. Please take the fuel vent switch and hold it open. Over.
TRANQUILITY BASE: Okay. We're holding it open, indicating about 24 psi on board.
HOUSTON: Roger.
TRANQUILITY BASE: Now indicating 20 psi in fuel.
HOUSTON: Roger.
TRANQUILITY BASE: And 22 in the ox.
HOUSTON: Roger.
TRANQUILITY BASE: Now indicating 15 psi in both tanks.
HOUSTON: Roger.
HOUSTON: Tranquility, Houston. If you haven't



Associated Press from NASA

CONCENTRATION: Alan L. Bean, an astronaut who will be on the Apollo 12 flight, watching a tracking board at the Manned Space Center record the lunar module landing.

done so, you can release the fuel vent switch. Over.
TRANQUILITY BASE: Roger.
HOUSTON: Tranquility, Houston. We have indication that we've frozen up the descent fuel helium heat exchanger and with some fuel trapped in the line between air and the valves and the pressure we're looking at is increasing there. Over.
TRANQUILITY BASE. Roger. Understand.
HOUSTON: Tranquility Base, Houston. If you have not done so, please close both fuel and ox vents now.
TRANQUILITY BASE: They're closed.
HOUSTON: Thank you, sir.
TRANQUILITY BASE: From the surface we could not see any stars out the window, but on my overhead patch I'm looking at the earth. It's big and bright, beautiful. Buzz is going to give a try at seeing some stars through the optics.
HOUSTON: Roger, Tranquility. We understand must be a beautiful sight. Over.
APOLLO CONTROL: We would like to point out that the fuel pressure problem that has been called to the attention of the crew is in the descent system. It is apparently downstream of the tanks where a small amount of fluid has been trapped in a line and we don't expect it to cause any problem. The line should be able to take far more pressure than the fluid would exert. In the event that there was an overpressurization, we would expect that the line would spring a small leak, the pressure would drop rapidly. Again I would point out that we do not see this as a significant problem.

'Going Over the Hill'

HOUSTON: Columbia, Houston. Two minutes to LOS [loss of signal]. You're looking great. Going over the hill. Over.
COLUMBIA: Okay. Thank you. Glad to hear it's looking good. Do you have a suggested attitude for me? This one here seems all right.
HOUSTON: Stand by.
COLUMBIA: Let me know when it's lunch time, will ya?
HOUSTON: Say again?
HOUSTON: Columbia, Houston. You got a [illegible] attitude right there.
APOLLO CONTROL: This is Apollo Control. We've had loss of signal now from the command module. Of course, we'll maintain constant communication with the lunar module on the lunar surface. We have some heart rates for Neil Armstrong during that powered descent to lunar surface. At the time the burn was initiated, Armstrong's heart rate was 110. At touchdown on the lunar surface, he had a heart rate of 156 beats per minute, and the flight surgeon reports that his heart rate is now in the 90's. We do not have biomedical data on Buzz Aldrin.
APOLLO CONTROL (5:04 P.M.): We have an update on that touchdown time on the lunar surface. This still is not the final official time, which we'll get from readout of data. But the refined time is 102 hours, 45 minutes, 40 seconds, which would have been 12 minutes, 36 seconds after initiating the powered descent. That was 102 hours, 45 minutes, 40 seconds for touchdown and a total time of powered descent 12 minutes, 36 seconds. And we would expect those numbers to change perhaps a little bit when we get final data readout.
HOUSTON: Tranquility Base, Houston. If you want me to, I can give you a hack on the mission time every 30 minutes. Over.
HOUSTON: Tranquility, Houston. I'm counting down to T3 time. If you'd like to give me a hack, we can set up an event timer. Over.
TRANQUILITY BASE: Okay. How about counting up.
HOUSTON: Roger, you want it counting up? Stand by.
HOUSTON: Tranquility, Houston. On my mark 6230. Mark 6230 from pass TDI.
TRANQUILITY BASE: What we're looking for, Charlie, is time counting up to T2 that will be equal to 60 minutes or T3 equal to 60 minutes—T3.
HOUSTON: Roger. We'll have it for you.
HOUSTON: Tranquility Base, Houston. Reset the event timer to 0 and on my mark at 103 3941. Will give you a hack and it will be in one hour. Over.
TRANQUILITY BASE: Roger.
HOUSTON: And we got about almost 3 minutes to go, Neil. Over.
TRANQUILITY BASE: Okay.
HOUSTON: Tranquility Base, stand by on the event timer.
HOUSTON: Tranquility Base, on my mark start your event timer, 5, 4, 3, 2, 1, Mark.
TRANQUILITY BASE: Roger. We got it. Thank you.
HOUSTON: Rog, Neil.

Statement by Paine

APOLLO CONTROL (5:17 P.M.): There will be a brief statement from Dr. Thomas Paine, NASA administrator, in the Building 1 auditorium at 4:30 [Houston time]. We also have updated information on the landing point. It appears that the spacecraft Eagle touched down at .799 degrees north or just about on the lunar equator and 23.46 degrees east longitude, which would have put it about four miles from the targeted landing point downrange. We're now 54 minutes—or rather 27 minutes from reacquisition of the command module and of course we're in constant contact with the lunar module on the surface.
At this point all LM systems continue to look very good.
APOLLO CONTROL (5:29 P.M.): We will be taking the release line down briefly for a statement from Dr. Thomas Paine, NASA administrator. We will be recording any further conversations with the spacecraft and will play those back following the statement.
APOLLO CONTROL (5:42 P.M.): We understand there's been a brief delay in the statement from NASA administrator Thomas Paine. We will catch up with the tape-recorded conversation that we've had with Eagle on the lunar surface at this time.
TRANQUILITY BASE: Down 86 plus 0538 plus all zeros and the last one was 0012 and what's the sign of that, please?
HOUSTON: Tranquility, Houston. The delta VY is minus all zeros. The delta VZ is plus 0012. Over.
TRANQUILITY BASE: Roger plus 0012.
HOUSTON: Good readback.
TRANQUILITY BASE: Houston, Tranquility Base. The diskeys yours and up data link to data.
HOUSTON: Roger, thank you, Tranquility. Hello, Tranquility Base, Houston. On my mark it will be 37 minutes to T3. Over.
TRANQUILITY BASE: Okay.
HOUSTON: Stand by. Mark 37 minutes till T3.
TRANQUILITY BASE. Okay. Thank you.
HOUSTON: Tranquility, this is Houston. It's your computer. We've got the load in. You can start your P57.
TRANQUILITY BASE: Roger, thank you. Houston, Tranquility Base. Did somebody down there have a mike buskeyed. Over.
HOUSTON: Stand by, we'll check.
TRANQUILITY BASE: Houston, Tranquility Base. Does somebody down there have a life button keyed? Over.
HOUSTON: Stand by. We'll check. Tranquility, Houston. Do you still hear it now? Over.
TRANQUILITY BASE: No, I still hear it. Sounds like somebody is banging some chairs around in the back room.
HOUSTON: Roger, that's a VOGA you hear for the CSM to keep the noise down on the loop. Maybe we got a missed relay or something. Stand by.
APOLLO CONTROL: Ladies and gentlemen, I'd like to at this time introduce the administrator of the National Aeronautics and Space Administration, Dr. Thomas O. Paine. I have a short statement then we'll be glad to accept questions. Dr. Paine.

Report to the President

DR. PAINE: Immediately after the lunar touchdown I called the White House from Mission Control and gave the following report to the President:
Mr. President, it is my honor on behalf of the entire NASA team to report to you that the Eagle has landed on the Sea of Tranquility and our astronauts are safe and looking forward to starting the exploration of the moon. We then discussed the gripping excitement and wonder that has been present in the White House and in Mission Control during the final minutes of this historic touchdown. I emphasized to the President the fact that we still had many difficult steps ahead of us in the Apollo 11 mission, but that at the same time a giant step had been made with our successful landing.
President Nixon asked me to convey to all of the NASA team and its associated industrial and university associates his personal congratulations on the success of the initial lunar landing and gave us his good wishes for the continuing success of this mission.
APOLLO CONTROL (6:01 P.M.): During the news conference with the NASA Administrator, Dr. Thomas Paine, we had conversation with both Eagle and Columbia and we'll play that tape for you now:
HOUSTON: Tranquility Base, on my mark 25 minutes until T3. Stand by. Mark 25 minutes until T3.
TRANQUILITY BASE: Roger. Thank you, Charlie.
COLUMBIA: Houston, how do you read me?
HOUSTON: Columbia, we read you about 3 by. You might be advised we have an update for you on the P22 for the LM. We estimate he landed about four miles downrange. Your T1 times are updated and the T2 if you are ready to copy it. Over.
HOUSTON: Hello, Tranquility Base. We copy the now 93. You can torque him. Over.
COLUMBIA: Is that four miles?
HOUSTON: Stand by, we'll have a map location.
TRANQUILITY BASE: Houston, do you have an updated LM wait for us? Over.
HOUSTON: Affirmative. Stand by on the data.
HOUSTON: LM weight 10,906.
HOUSTON: Columbia with a latitude and longitude over 2 update for LM position. Over.
COLUMBIA: Go ahead.
HOUSTON: Roger, Columbia. It's plus .799 for the lat plus 11.730 for the longitude over 2 over.
COLUMBIA: Thank you.
HOUSTON: Hello Tranquility Base. You are stay for T3. We have some surface block data if you're ready to copy. Over.
TRANQUILITY BASE: Roger. Understand we're stay for T3. Stand by. Okay, Houston, go ahead with your block data.
HOUSTON: Roger. Hello Columbia, Houston. Columbia we don't want you to transmit, Mike. We just want you in that position in case you want to talk to Tranquility.
HOUSTON: Tranquility, Houston, say again. Over.
TRANQUILITY BASE: Roger. I have a fairly good-sized difference between battery volts on five and six. Six is reading 33.5 and five is reading 36.5. Is that what you expect? Over.
HOUSTON: Tranquility. They are both coming up in voltage. No problem. We're still go. Over.

Praise Is Returned

HOUSTON: Hello Tranquility Base, Houston. You can start your power down now. Over.
TRANQUILITY BASE: Roger.
HOUSTON: Tranquility Base, the white team is going off now and the maroon team take over. We appreciate the great show; it was a beautiful job, you guys.
TRANQUILITY BASE: Roger. Couldn't ask for better treatment from all the way back there.
TRANQUILITY BASE: Houston, our recommendation at this point is planning an EVA [Extra Vehicular Activity] with your concurrence starting at about 8 o'clock this evening, Houston time. That is about three hours from now.
HOUSTON: Stand by.
TRANQUILITY BASE: We will give you some time to think about that.
HOUSTON: Tranquility Base, Houston. We thought about it. We will support it. We'll go at that time.
TRANQUILITY BASE: Roger.
HOUSTON: You guys are getting prime time on TV there.
TRANQUILITY BASE: I hope that little TV set works. We'll see.

Highlights of Apollo Plan

Following are highlights of the remainder of the Apollo 11 flight plan. The timetable is subject to change at any time during the mission. Times are Eastern daylight.

TODAY

1:55 P.M.—The lunar module's ascent engine fires, lifting module's ascent stage off the moon and leaving the descent stage on the lunar surface.
5:32 P.M.—Lunar module and command ship dock. Neil A. Armstrong and Col. Edwin E. Aldrin Jr. crawl through tunnel to rejoin Lieut. Col. Michael Collins.
9:25 P.M.—The lunar module is jettisoned.

TOMORROW

12:57 A.M.—While behind the moon, the astronauts fire Apollo's main engine, boosting the craft out of lunar orbit and putting it on course back to earth.
3:57 P.M.—Midcourse correction.
9:02 P.M.—Live television show from space.

WEDNESDAY, JULY 23

7:02 P.M.—Final television show.
8:37 P.M.—Midcourse correction, if necessary.

THURSDAY, JULY 24

12:22 P.M.—Command module and service module separate in preparation for return to earth.
12:37 P.M.—Command module re-enters earth's atmosphere.
12:51 P.M.—Craft splashes down in the Pacific Ocean about 1,200 miles southwest of Hawaii.

HOUSTON: Roger. Was your 8 o'clock Houston time in reference to opening the hatch or starting the prep for EVA at that time. Over.
TRANQUILITY BASE: At the hatch, it will be.
HOUSTON: That's what we thought. Thank you, much.
TRANQUILITY BASE (6:02 P.M.): It might be a little later than that. But—in other words, start the prep in about an hour or so.

HOUSTON: Tranquility Base, Houston. That's fine. We're ready to support you any time, Neil. Over.
TRANQUILITY BASE: Right.
HOUSTON: Right. Columbia, we see the noun 49. Stand by.
HOUSTON: Columbia, Houston. We got the data. We'd like a verb 34. Over.
COLUMBIA: Roger, Stand-by one, Charlie, for . . .
HOUSTON: Roger, Columbia. How did Tranquility look down there to you? Over.
COLUMBIA (6:03 P.M.): Well the area looked smooth. But I was unable to see him. I just picked out a distinguishable crater nearby and marked on it.
HOUSTON: Roger.
COLUMBIA: Looks like a nice area, though.
HOUSTON: Hello Columbia, Houston. I understand you could not see Tranquility. What were you marking on? Over.
COLUMBIA: Houston, Columbia. I say again. I could not see him. Auto optics pointed at a spot very close to the coordinates which you gave me. So I picked out a tiny crater in that area and marked on it so that I'll be able to have repeatable data. But I was unable to see him.
HOUSTON: Roger. Copy.
APOLLO CONTROL: You heard that last exchange and there is a very strong indication we might have an early EVA, with the hatch open perhaps at 8 o'clock, Houston time. One other item of significance: The pressure rise in descent propellant line downstage of the tanks has relieved. All aspects of the mission looking very good at this time.
HOUSTON (6:05 P.M.): Hello Tranquility Base, Houston. On our dips venting and that fuel problem, our heat exchangers, it's cleared up. It appears that the ice has melted and we're in good shape now. Out.
APOLLO CONTROL (6:31 P.M.): We expect Capsule Communicator Owen Garrett to pass along data to spacecraft Columbia momentarily. We are standing by for that. Meanwhile I think we should discuss a little further the projected EVA. Our current plan is to have crew members aboard the Eagle eat and relax for a little while prior to starting EVA prep. We won't know with certainty or have a reasonable time base until about an hour before the scheduled event. Right now it looks like it could occur at 8 o'clock, Houston time. We have conversation going now with the spacecraft and we'll pick that up.
Following is replay of tape of astronaut conversations recorded during the news briefing and press conference.
APOLLO CONTROL: At 105 hours, 30 minutes now into the mission Apollo 11. The spacecraft Columbia now out of range with Mission Control Center Houston, passing over the far side of the moon. As it passed out of sight we read an apolune of 63 nautical miles, a perilune of 56 nautical miles, a velocity of 5,367 feet per second. We've had conversation both with Tranquility Base and Columbia during this span of time. Also, as will come up in the course of that conversation, Lunar Module pilot Buzz Aldrin delivers a message to people everywhere listening. We'll play those tapes for you now.

'They'll Need Some Lunch'

HOUSTON: Columbia, we will have a stat vector update for you a little later. We're not prepared with it right now. And on another subject. From Tranquility Base they are prepared to begin the EVA early. They expect to begin depress operations in about three hours.
COLUMBIA: I guess they'll need some lunch before they go.
HOUSTON: We'd like your PRD readouts when possible and we've checked over your EM data and it's all okay.
COLUMBIA: Columbia's on the high-gain.
HOUSTON: Roger, Columbia. You're sounding much better now. Request accept and will uplink another stat vector. Over.
COLUMBIA: Roger. Accept.
HOUSTON: Suggest you put bat A on your bat relay buss. Over.
HOUSTON: Columbia, we're through with your computer. You can go to block.
COLUMBIA: Roger. Block.
HOUSTON: Tranquility Base. Over.
TRANQUILITY BASE: Go ahead, Houston.
HOUSTON: We've reviewed the checklist. About the only change in order to advance EVA that we've found is that you'll want to delay your hydroxide change and go after the EVA rather than before. Over.
TRANQUILITY BASE: Roger. We'd just as soon make the change and jettison the old one. Over.
HOUSTON: We would like to delay that LIOH change until after the EVA. There is a possibility you could jettison the canister when you jettison your pliss. Over.
TRANQUILITY BASE: All right. We'll plan it that way.
HOUSTON: Roger, Tranquility.
HOUSTON: Columbia. Over.
COLUMBIA: This is Columbia.
HOUSTON: We show your evap out temperature running low. Request you go to manual temperature control and bring it up. You can check the procedures in ECS Manual 17. Over.
COLUMBIA: Roger.
TRANQUILITY BASE: This is the LM pilot. I'd like to take this opportunity to ask every person listening in, whoever, wherever they may be, to pause for a moment and contemplate the events of the past few hours and to give thanks in his or her own way. Over.
HOUSTON: Roger, Tranquility Base.
APOLLO CONTROL (7:15 P.M.): You heard that statement in our taped transmission from lunar module pilot Buzz Aldrin. Our projected time for Extra Vehicular Activity at this point is still very preliminary. I repeat, it could come as soon as 8 P.M., Houston time. We won't know for sure about the time with reasonable certainty until about an hour before the event. Meanwhile, we'll soon be progressing toward man's first step on the lunar surface. We have an interesting phenomena here in the Mission Control Center, Houston, something that we've never seen before. Our visual of the lunar module—our visual display now standing still, our velocity digitals for our Tranquility Base now reading zero. Reverting, if we could, to the terminology of an earlier form of transportation—the railroad—what we're witnessing now is man's very first trip into space with a station-stop along the route.
HOUSTON: Tranquility Base, Houston. We'd like some estimate of how far along you are with your eating and when you may be ready to start your EVA prep.
TRANQUILITY BASE: I think that we'll be ready to start EVA prep in about a half hour or so.
TRANQUILITY BASE: We are beginning our EVA prep.
HOUSTON: Tranquility Base, this is Houston. Roger copy your beginning EVA prep. Break. Break. Columbia. Columbia. This is Houston, reading you loud and clear. Over.
COLUMBIA: You're loud and clear. The waste water dump is down to 10 per cent. I have a question on the B 22. Do you want me to do another B 22, or was all that information just for my own use in tracking the LM for photographic purposes?
HOUSTON: Columbia, this is Houston. We request that you perform another B 22. We'd like you to let the auto optics take care of the tracking and devote your energies to trying to pick out the LM on the lunar surface. If you can find the LM, of course, we're looking for marks on it. Tracking of geographical features doesn't do us at all that much good. Over.
COLUMBIA: Okay.
COLUMBIA (7:45 P.M.): Okay, I'll do it. And on the ECS system the—whatever the problem was seems to have gone away without any changing of J52 sensors, or anything like that. My evaporator outlet temp is up about 50 now and it's quite comfortable in the cockpit. So we'll talk more about that one later.
HOUSTON: Roger, Columbia. Did you shift into manual control, or did the problem resolve itself under auto control? Over.
COLUMBIA: The problem went away under auto.

Continued on Page 5

After Years of Anticipation, an Astronaut Tells About His Walk on the Moon

Continued From Page 4

HOUSTON: Roger. It's the best type. Out.

COLUMBIA: I did cycle out of auto into manual back into auto.

HOUSTON (7:55 P.M.): Tranquility Base. Tranquility Base. This is Houston. Over.

TRANQUILITY BASE: Go ahead, Houston.

HOUSTON: Tranquility, this is Houston. We need a second set of PRD ratings so that we may establish a rate. Over.

COLUMBIA (8:09 P.M.): Houston, Columbia. I'm coming up from . . . Do you have any topographical cues that might help me out here. I'm tracking between two craters. One of them is . . . that would be long at 11 o'clock. The other would be short and behind him at 5 o'clock. These are great big old craters, depressions.

HOUSTON: Columbia, this is Houston. The best we can do on topo features is to advise you to look to the west of the irregularly shaped crater and then work on down to the southwest of it. Over.

HOUSTON: Columbia, Houston. Another possibility is the southern rim of the southern of the two old-looking craters. Over.

COLUMBIA: Houston, Columbia. I kept my eyes glued to the . . . that time, hoping I'd get a flash of vector light off the LM but I was unable see in my scan areas that you suggested.

HOUSTON: Roger. On that southern of the old craters there is a small bright crater on the southern rim. One plot would put him slightly to the west of that small bright crater about 500 to 1,000 feet. Do you see anything down there? Over.

COLUMBIA: It's gone past now, Bruce. But I scanned that area that you're talking about very closely and, no, I did not see anything.

HOUSTON: Roger. Out.

HOUSTON: Columbia, this is Houston. Over.

COLUMBIA: Here I am.

HOUSTON: Columbia, this is Houston. On your LAM 2 map, we'd like to confirm the topographical area in which you were looking on this last period of sightings. As we understand you, you were looking in the vicinity of Papa 7 to November 8. Is that correct?

COLUMBIA: Stand by.

HOUSTON: Roger.

HOUSTON (8:17 P.M.): Columbia, go ahead.

COLUMBIA: One of the craters I was talking about is located exactly at 56.7.

HOUSTON: Roger, we found that one.

COLUMBIA: The other one's located at 7.2 two-thirds of the way from . . .

HOUSTON: Roger, we believe you were looking a little too far to the west and south.

COLUMBIA: Roger, I was looking where . . . was tracking on the average and I understand it should have been more to the north and more to the west; actually, a tiny bit outside the circle.

HOUSTON: More to the north and a little more to the east. The feature that I was describing to you, the small bright crater on the rim of the large fairly old crater, would be about Mike .8 and 8.2.

HOUSTON: Tranquility Base, this is Houston. Can you give us some idea where you are in the surface checklist at the present time.

TRANQUILITY BASE: They were at the top of page 27.

COLUMBIA: Roger. Finally got you back on. I've been unsuccessfully trying to get you on the high gain and I've got command to reset the process. How do you read me now?

HOUSTON: Roger. I hear you loud with back-ground noise.

COLUMBIA: Omni Delta and you were cut out and I never got your coordinance or estimated LM position.

HOUSTON: Estimated LM position is latitude plus .799, longitude over 2 plus 11.730.

COLUMBIA: What I'm interested is in direct coordinance on that map reading.

COLUMBIA: Could you enable the S-band relay at least one way from Eagle to Columbia, so I can hear what's going on?

HOUSTON: Roger. There's not much going on at the present time, Columbia. I'll see what I can do about the relay. . . .

HOUSTON: Columbia, this is Houston. Are you aware that Eagle plans the EVA about four hours early?

COLUMBIA: Affirmative. I haven't had any word from those guys and I thought I'd be hearing them through your S-band relay.

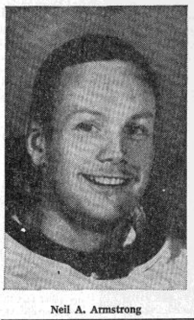
APOLLO CONTROL (8:48 P.M.): We'll still have acquisition of Columbia for another eight minutes. All systems in Eagle still looking good. Cabin pressure 4.86 pounds, showing a temperature of 63 degrees in the Eagle's cabin.

COLUMBIA: During the next pass I'd appreciate the S-band relay mode.

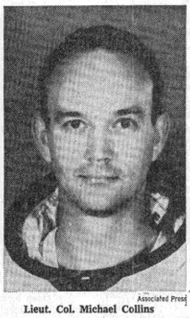
HOUSTON: We're working on that. There haven't been any transmissions from Tranquility Base since we last talked to you.

APOLLO CONTROL: We've had loss of signal on Columbia. The clock here at Control Center counting down to depressurization time on Eagle shows we're 36 minutes, 39 seconds away from that event. We believe the crew is pretty well on the time line in the EVA preparation.

APOLLO CONTROL (9:36 P.M.): This latest report


Neil A. Armstrong


Col. Edwin E. Aldrin Jr.


Lieut. Col. Michael Collins

Associated Press

the crew is—they're getting the electrical checkout—indicates they are about 40 minutes behind the time line. We will acquire Columbia in six minutes.

TRANQUILITY BASE: How do you read now?

HOUSTON: Okay. I think that's going to better.

HOUSTON: We have acquisition of Columbia.

HOUSTON: Roger, Columbia. Reading you loud and clear on the high gain. We have enabled the one-way Nixon relay that you requested. The crew of Tranquility Base is currently donning PLSSes [portable life support systems]. Com checks out.

COLUMBIA: Sounds okay.

TRANQUILITY BASE (9:45 P.M.): Houston, Tranquility. You'll find that the area around the ladder is in a complete dark shadow, so we're going to have some problem with TV. But I'm sure you'll see the—you'll get a picture from the lighted horizon.

HOUSTON: Neil, Neil, this is Houston. I can hear you trying to transmit. However, your transmission is beaking up.

TRANQUILITY BASE: Neil's got his antenna up now. Let's see if he comes through any better now.

TRANQUILITY BASE. Okay, Houston, this is Neil. How do you read?

HOUSTON: Neil, this is Houston, reading you beautifully.

TRANQUILITY BASE: My antenna's scratching the roof. Do we have a go for cabin depress?

COLUMBIA: They hear everything but that.

TRANQUILITY BASE: Houston, this is Tranquility. We're standing by for go for cabin depress.

HOUSTON: You are go for cabin depressurization. Go for cabin depressurization.

COLUMBIA (10 P.M.): I don't know if you guys can read me on VHF, but you sure sound good down there.

TRANQUILITY BASE: Okay, the vent window is clear. I remove lever from the engine cover.

HOUSTON: Buzz, you're coming through loud and clear, and Mike passes on the word that he's receiving you and following your progress with interest.

TRANQUILITY BASE: Lock system, decks, exit check, blue locks are checked, lock locks, red locks, perch locks, and on this side the perch locks and lock locks—both sides, body locks, and the calm.

HOUSTON (10:17 P.M.): Columbia, this is Houston. Do you read?

COLUMBIA: Read you loud and clear.

HOUSTON: Were you successful in spotting the LM on that pass?

COLUMBIA: Negative. I checked both locations and it's no dice.

APOLLO CONTROL (10:25 P.M.): In the control center a clock has been set up to record the operating time on Neil Armstrong's total life support system. EVA will be counted from that time.

TRANQUILITY BASE: Cabin repress closed. Now comes the gymnastics. Air pressure going toward zero. Standby LM suit circuit 36 to 43. That's verified. FIT GA pressure about 4.5, 4.75 and coming down. We'll open the hatch when we get to zero. Do you want to bring down one of your visors now or leave them up? We can put them down if we need them. We have visor down.

APOLLO CONTROL (10:33 P.M.): Coming up on five minutes of operation of Neil Amstrong's portable life support system now.

HOUSTON (10:37): Neil, this is Houston, what's your status on hatch opening?

TRANQUILITY BASE: Everything is go here. We're just waiting for the cabin pressure to bleed to a low enough pressure to open the hatch. It's about .1 on our gauge now. (Aldrin) I'd hate to tug on that thing. Alternative would be to open that one too.

HOUSTON: We're seeing a relatively static pressure on your cabin. Do you think you can open the hatch at this pressure?

TRANQUILITY BASE: We're going to try it. The hatch is coming open. (Aldrin): Hold it from going closed and I'll get the valve turner. I'd better get up first.

ALDRIN: Your window cleared yet?

ARMSTRONG: It was, yeah.

ALDRIN: Mine hasn't cleared yet.

(Following Is Conversation Between Armstrong and Aldrin): Okay. Bical pump secondary circuit breaker open. Back to lean—this way. Radar circuit breakers open. Well, I'm looking head-on at it. I'll get it. Okay. My antenna's out. Right. Okay, now we're ready to hook up the LEC. Okay. Now we need to hook this. Your visor. Yep. Your back is up against the perch. Now you're clear. Over toward me. Straight down, to your left a little bit. Plenty of room. You're lined up nicely.

Toward me a little bit. Down. Okay. Now you're clear. You're catching the first hinge. The what hinge? All right, move. Roll to the left. Okay now you're clear. You're lined up on the platform. Put your left foot to the right a little bit. Okay that's good. More left. Good.

'I'm on the Porch'

ARMSTRONG: Okay, Houston, I'm on the porch.

HOUSTON: Roger, Neil.

HOUSTON: Columbia, Columbia. This is Houston. One minute, 30 seconds LOS, all systems go. Over.

ALDRIN: Halt where you are a minute, Neil.

ARMSTRONG AND ALDRIN: Okay. Everything's nice and straight in here. Okay, can you pull the door open a little more? Right.

HOUSTON: We're getting a picture on the TV.

ALDRIN: You've got a good picture, huh?

HOUSTON: There's a great deal of contrast in it and currently it's upside down on monitor. But we can make out a fair amount of detail.

ARMSTRONG: Okay, will you verify the position, the opening I ought to have on the camera.

HOUSTON: The what? We can see you coming down the ladder now.

ARMSTRONG: Okay. I just checked getting back up to that first step. It didn't collapse too far. But it's adequate to get back up. It's a pretty good little jump.

ARMSTRONG: I'm at the foot of the ladder. The LM foot beds are only depressed in the surface about one or two inches, although the surface appears to be very, very fine-grained as you get close to it. It's almost like a powder. It's very fine. I'm going to step off the LM now.

That's one small step for man, one giant leap for mankind.

The surface is fine and powdery. I can pick it up loosely with my toe. It does adhere in fine layers like powdered charcoal to the sole and the sides of my boots. I only go in a small fraction of an inch, maybe an eighth of an inch but I can see the footprints of my boots and the treads in the fine sandy particles.

There seems to be no difficulty in moving around this and we suspect that it's even perhaps easier than the simulations of 1/6 G that we performed in various simulations on the ground. Actually no trouble to walk around.

No Crater from Descent

The descent engine did not leave a crater of any size. It has about one foot clearance on the ground. We're essentially on a very level place here. I can see some evidence of rays emananting from the descent engine, but a very insignificant amount.

Okay, Buzz, are we ready to bring down the camera?

ALDRIN: I'm all ready. I think it's squared away and in good shape. But you'll have to pay out all the LEC. Looks like it's coming out nice and evenly.

It's quite dark here in the shadow and a little hard for me to see if I have good footing. I'll work my way over into the sunlight here without looking directly into the sun.

ARMSTRONG: Looking up at the LM, I'm standing directly in the shadow now looking up at . . . in the windows and I can see everything quite clearly. The light is sufficiently bright backlighted into the front of the LM that everything is clearly visible.

I'll step out and take some of my first pictures here.

ALDRIN: Are you going to get the contingency sample? Okay. That's good.

ARMSTRONG: The contingency sample is down and it's up. Like it's a little difficult to dig through the crust. It's very interesting. It's a very soft surface but here and there where I plug with the contingency sample collector I run into very hard surface but it appears to be very cohesive material of the same sort. I'll try to get a rock in here.

HOUSTON: Oh, that looks beautiful from here, Neil.

ARMSTRONG: It has a stark beauty all its own. It's like much of the high desert of the United States. It's different but it's very pretty out here. Be advised that a lot of the rock samples out here, the hard rock samples have what appears to be vesicles in the surface.

ARMSTRONG: This has been about six or eight inches into the surface. It's easy to push on it. I'm sure I could push it in farther but it's hard for me to bend down farther than that.

ALDRIN: Ready for me to come out?

ARMSTRONG: Yeah. Just stand by a second, I'll move this over the handrail.

ALDRIN: Okay?

ARMSTRONG: All right, that's got it. Are you ready?

ALDRIN: All set.

ARMSTRONG: Okay. You saw what difficulties I was having. I'll try to watch your PLSS from underneath here. The toes are about to come over the sill. Now drop your PLSS down. There you go, you're clear. And laterally you're good. About an inch clearance on top of your PLSS. You need a little bit of arching of the back to come down.

ALDRIN: How far are my feet from the . . .

ARMSTRONG: You're right at the edge of the porch.

ALDRIN: Small little foot movement. Porch. Arching of the back . . . without any trouble at all.

ALDRIN: Now I want to back up and partially close the hatch—making sure not to lock it on my way out.

ARMSTRONG: Good thought.

ALDRIN: That's our home for the next couple of hours; we want to take care of it. I'm on the top step. It's a very simple matter tohop down from one step to the next.

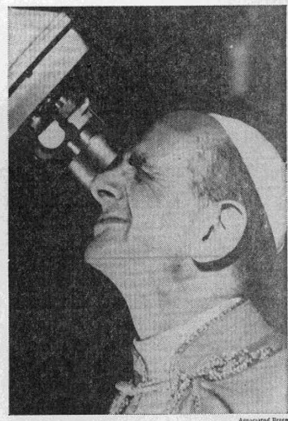
ARMSTRONG: Yes, I found that to be very comfortable, and walking is also very comfortable, Houston. You've got three more steps and then a long one.

ALDRIN: I'm going to leave that one foot up there and both hands down to about the fourth rung up.

ARMSTRONG: A little more. About another inch, there you got it. That's a good step.

ALDRIN: About a three footer. Beautiful view.

ARMSTRONG: Ain't that somethin'?



Associated Press

VIEWS LANDING ZONE: Pope Paul VI using a telescope to examine the area where the Apollo lunar module touched down. The Pope, at his summer residence at Castel Gandolfo, Italy, watched the landing on television.

A Fete in Central Park Celebrates the Landing

By McCANDLISH PHILLIPS

At dusk last night a few hundred moon-bedazzled citizens gathered in Central Park on the planet earth to celebrate man's first footsteps on another sphere.

A heavy downpour that began at 7:30 P.M. and lasted more than an hour nearly turned the moon watch into a washout. The police were ready to handle a crowd of tens of thousands.

There are no rules on how to celebrate an occasion of this kind, but the city had decided to provide a way for the people "to share the moment together" in the Sheep Meadow. The event was a cross between a carnival and a vigil.

By the time the television pictures from the moon were flashed onto three large screens grouped near the center of the meadow—one screen each for the National Broadcasting Company, the Columbia Broadcasting System and the American Broadcasting Company — the crowd had swelled to over 5,000 and the meadow had become a marsh.

Earlier in the day, in churches over the nation, prayers were said for the safety of the Apollo 11 astronauts. Everywhere, in baseball parks, in homes, on beaches, in bars, the moon landing impinged on other pursuits.

At the Yankee stadium, where the Washington Senators played the New York Yankees, the landing of the Eagle was flashed on the scoreboard with the words: "They're on the moon."

The game was halted for a moment of silent prayer and the singing of "America the Beautiful."

In the Nashville criminal court, Judge Allen R. Cornelius ordered a color TV set brought into the courtroom so a murder jury of 10 men and two women could watch the moon landing.

In a little luncheonette off Times Square a man spoke of the celebrations that would occur after the feat, and another man said, "Why not? It only happens once every several thousand years, doesn't it?"

No one knew how many Americans held their breath at once as the lunar module settled gently to the moon's surface without hint of mishap.

At Sing Sing Prison in Ossining, N.Y., there was disappointment when the warden ruled that inmates could watch television only during the normal viewing hours, which excluded most of the moon events. An exception was made for the one man on Death Row. He was allowed to watch as long as he liked.

At the Cathedral Church of St. John the Divine, Amsterdam Avenue at 110th Street, the Intercessions at the 4 P.M. Evensong were dedicated to the Apollo flight and to the astronauts.

In Spark's Pub, on Second Avenue near 79th Street, Larry Klau, a 27-year-old stockbroker from Brooklyn, and his date, Carol Kramer, a 22-year-old waitress from Manhattan, gazed raptly at the television screen as Mr. Armstrong planted his first shoeprint in moondust.

"This is our first date and I told her she'll never forget it," Mr. Klau said.

The Radio City Music Hall switched briefly from showing the film "True Grit' to congratulations for the astronauts.

A great gasp of appreciation rose from the crowd at the Time-Life Exhibition Center, Avenue of the Americas at 50th Street, when Mr. Armstrong did his kangaroo hop across the rumpled surface of the moon.

In Central Park, the sky was as bleak as the face of the moon in the early evening and the ground was soft and damp from afternoon showers, and those who came early sat mostly on outcroppings of rock that were hard but dry.

When the rain suddenly descended, spectators streamed across the broad field and into the 140-foot-long tent pitched at the west side of the meadow opposite West 66th Street, but about 125 people stood fast in front of the television screens through 68 minutes of heavy rain.

Hippies careened wildly across the meadow in what some took to be a rain dance, and Vice President Agnew's face on one big screen changed from shades of pink to red to pale green.

Young people did some jeering while simulated moon landing pictures appeared on television, but when the image of the American on the moon showed on the screens a great cheer rose from the crowd, which had grown to 8,000 people.

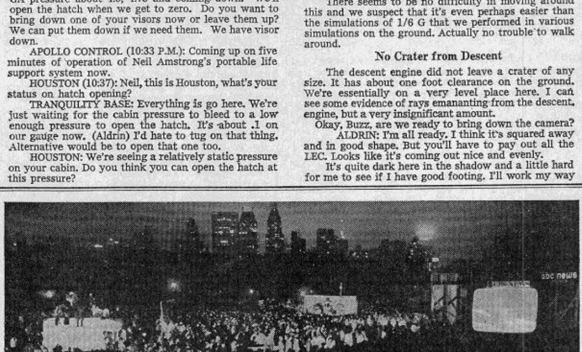
In commemoration of an earlier attempt to rise into space, a balloon with a man in the basket under it went up to treetop level in an enclosure in the meadow, while men held it fast by ropes.

It was a modest ascent, for at 6:50 P. M., Mrs. Doris Freedman, Director of the Department of Cultural Affairs, which staged the big show, had received a telegram from the Federal Aviation Administration permitting the balloon to go up to 150 feet.

"Anything that goes up in the air within a 5-mile radius of a major airport has to have F.A.A clearance," Mrs. Freedman explained.

Mayor Lindsay stepped out on the stage of a big Showmobile van parked near the tent and said, "This is an extraordinary evening for all New Yorkers."

The rain had held off through the moon coverage on television, but it came again just as Mr. Lindsay finished and he jumped off the stage as several thousand people left the park, having seen what men had never seen, except in dreams, before.



The New York Times (by Donal F. Holway)

CENTRAL PARK SHEEP MEADOW: Spectators watching the landing of the astronauts on three giant television screens

Apollo Doctors Pleased At Astronauts' Reactions

By RICHARD D. LYONS

Special to The New York Times

HOUSTON, July 20—Within seconds of the lunar landing today the physical condition of Neil A. Armstrong and Col. Edwin E. Aldrin Jr. told the world that man could indeed live on an extraterrestial body.

Their breath came short and their pulses raced, but they were within those limits that had been predicted and considered safe. The astronauts quickly found that the lunar heat could be withstood and that they were not disoriented by the moon's abnormal gravity.

Although they were fatigued by more than four days of space flight and 30 excruciating minutes of anxiety during the touchdown, the astronauts — both nearing 40 years of age—withstood the most demanding physical challenge of their lives.

"They're in excellent physiological condition," Apollo program doctors said three hours after the touchdown.

The fears of aerospace surgeons that men might not be able to tolerate the totally different conditions of the moon had been dispelled.

"We have entered a new era," Dr. Thomas O. Paine, the space agency's administrator, said later. "Mankind is going to establish abodes beyond the earth."

Shortly after touchdown, the steady stream of chatter from the astronauts indicated to the Mission Control Center here that the men were standing up well to the physical ordeal of landing despite having been weightless for more than 100 hours.

"I don't think we noticed any difficulty at all adapting to one-sixth G," Mr. Armstrong radioed in a somewhat surprised voice from Tranquility Base to the Manned Spacecraft Center here.

At Mission Control, Dr. Charles A. Berry, the astronauts' chief flight surgeon, nodded agreement as he anxiously monitored the 10 oscilloscopes and dials that told him that a quarter of a million miles away the two most important patients of his career were all right.

Dr. Berry was even happier when he heard Colonel Aldrin say:

"One-sixth G is just like an airplane." The term "one-sixth G" refers to the fact that the moon has only that fraction of the earth's gravity, or G.

Flight surgeons have been particularly concerned about the effect of lunar gravity because it could be simulated on earth for only five seconds at a time — in airplanes — which was almost useless for drawing serious conclusions about its effect.

After reading the scopes and dials on the console before him after touchdown, Dr. Berry signaled Maj. Charles M. Duke Jr., the capsule communicator, who then relayed to the lunar party the medical opinion, that "Everything is copacetic."

Assessing these matters received the highest priority on the check-list of things to do before permission was granted allowing them to walk on the moon.

Reactions to Man's Landing on the Moon Show Broad Variations in Opinions

United Press International

Charles Lindbergh

I feel the development of space should continue. It is of tremendous importance. Undoubtedly things will evolve from it what we don't now foresee, as has always been the case with exploration in the past.

There is, though, a question of how rapidly this should go forward in relation to costs. But I cannot comment on that without making a far more detailed study than I have.

Along with this development of space, which is really a flowering of civilization toward the stars, you might say, we must protect the surface of the earth. That's even more important. Our environment on the surface is where man lives.

If we do that, I think there's almost no limit to the development of space that can be carried on—provided, of course, we protect our human roots in the surface of the earth. We cannot cut off those roots. If we do, none of the flowering, none of the developments we carry on, are going to be of importance.

I think this can be done. I feel sure it can be done; but it must be done in a balanced way.

Of course, you've got the extremists, some of whom say, leave space alone now, you've been to the moon, that's enough. Others say, we've spent much too much already on space. Maybe so.

I think there ought to be a balance there. And with that balance, I think everything will progress in a better way.

Pablo Picasso

It means nothing to me. I have no opinion about it, and I don't care.

Jean Monnet

French Economist

I am for it. It makes me grow beyond myself. It breaks down the last basic frontier.

Conflicts between men are almost always a matter of frontiers. The astronauts now have destroyed what looked like an unsurmountable frontier. They have shown us that we cannot any longer think in limited terms. There are no limitations left. We can think in terms of the universe now.

Lee A. DuBridge

Science Adviser to the President

The first attempt to land human beings on the surface of the moon is surely one of the great events in all of human history. It was a remarkably short time ago that the idea of having men travel in space seemed fantastic. In these last few years it has become a reality, and we can expect with confidence that human beings will set foot on the moon. That this is an enormous technological achievement is obvious. It goes without saying that it comes only as a result of many years of work by literally hundreds of thousands of scientists, engineers, skilled workers, administrators and managers.

But it is more than a technological achievement. Men will bring back from the moon information that will settle forever some of the speculation about the nature of the moon's surface. Even beyond that, as President Nixon has said, this represents a new venture of the human spirit and this kind of human achievement will lift the minds and hearts of men all over the world. It renews one's confidence in man's ability to reach out and do things which once seemed impossible. It restores our confidence that men will achieve other seemingly impossible things in the years to come.

Dalai Lama

The moon, which is a favorite of the poets and portrayed by the Buddhists as representing the esthetic qualities of peace, serenity and beauty, is now being conquered by man's ever expanding knowledge of science and technology. What was a mere conceptional imagination is today a concrete reality.

The American landing on the moon symbolizes the very acme of scientific achievement. It is indeed a phenomenal feat of far-reaching consequences for the world of science. We Buddhists have always held that firm conviction that there exists life and civilization on other planets in the many systems of the universe, and some of them are so highly developed that they are superior to our own. The perfection of scientific knowledge has enabled man to launch unmanned space-ships toward other planets.

A beginning has been made in space travel. We can now visualize earth people journeying to far-away planets, and opening up communications and relation with beings out in space. Man's limited knowledge will acquire a new dimension of infinite scope, development and dynamism. In this, the high degree of civilization developed in other planetary bodies will be of colossal help.

According to our ancient Buddhist texts, a thousand million solar systems make up a galaxy. . . . A thousand million of such galaxies form a supergalaxy. . . . A thousand million supergalaxies is collectively known as supergalaxy Number One. Again, a thousand million supergalaxy Number Ones form a Supergalaxy Number Two. A thousand million supergalaxy Number Twos make up a supergalaxy Number Three, and of these, it is stated in the texts that there are a countless number in the universe.

The moon landing will, no doubt, be an epoch-making event—a phenomena of awe, unrestrained excitement and sensation. But, the most wondrous event would be if man could relinquish all the stains and defilements of the untamed mind and progress toward achieving the real mental peace and satisfaction when he reaches the moon.

Rod McKuen

Poet and Composer

United Press International

The ocean's arms are wide enough to take in many lovers, that should be a lesson to us all. For if we turn our backs on things as yet untried within our own small realm of reference, we're guilty of a sin against ourselves: An unwillingness to experiment.

Man was made to try. Afterward he's free to keep or throw away what pleasures or what promise that he's found. What knowledge gained or stumbled on can be discarded or retained.

The voyager is always man, his vessel nothing less than all the world.

On yesterdays we started out to walk the ocean floor, today our own men stepped out on the moon. Some of us like our farms so much, we wouldn't go to town. That's as it should be, I suppose. Magazines and television bring the moon into our homes, a shuttered window leaves it out if that's our wish. To some, however, magazines are not enough and we are lucky that those kinds of men abound.

Personally, I greet our lunar landing with pride. After all, my brothers are involved. But there is more than a little envy because I didn't take the first walk myself.

If we can reach other worlds so easily, we might soon come to understand our own. Knowing how to fly beyond the boundaries of our earth hopefully will show us how to soar beyond our simple selves. That may not come with Apollo 12 or 15 or 54, but as we widen our worlds, I feel we cannot help but come upon new ways of narrowing the boundaries that keep us from understanding the people down the block.

It is important that as a country we keep on probing, prowling and prospecting. God and a natural nosiness has granted us enough brave men to act out all our fantasies. One day when all the myths have fallen, the poetry of living will begin.

To salute the astronauts is not enough. We must love them for their daring, their willingness to learn and the lessons that they pass back home to us. We are willing voyeurs on a hot night in July, praying, waiting, knowing that beyond the moon lies August.

Eric Hoffer

Longshoreman and Philosopher

I have always played with the fancy that some contagion from outer space had been the seed of man. Our passionate preoccupation with the sky, the stars, and a God somewhere in outer space is a homing impulse. We are drawn back to where we came from.

No observations and no data, however reliable, can be a substitute for the actual stepping of man on the moon. No one can doubt for a moment that landing on the moon is the first step, the beginning of an era of exploration which will surpass anything done and seen by man on this planet. We shall stifle our spirit and demean our energies if we divert resources from this magnificent exploration to any other pursuit, however necessary and desirable.

The necessary has never been man's top priority. The passionate pursuit of the nonessential and the extravagant is one of the chief traits of human uniqueness. Unlike other forms of life, man's greatest exertions are made in the pursuit not of necessities but of superfluities. Man is the only creature that strives to surpass himself, and yearns for the impossible.

It is an aspect of Lyndon Johnson's uniqueness that great as was his concern for the poor, and engrossed in efforts to better their lot, he was yet captured by the grandeur of a lunar landing, and did all in his power to help it come true.

It also seems to me providential that at a time when, in everyday life, Americans are showing unprecedented timidity in the face of abuse and provocations, we shall see displayed before our eyes unmatched examples of bravery and resourcefulness.

For the astronauts are our flesh and bone, nearer to common people than to the self-appointed élitists who make shrill noises on campuses, and in the literary-intellectual cliques of Manhattan and San Francisco.

Finally, if exploration of outer space becomes, as it should, a cooperative effort of nations and races it can bring nearer the realization of the ideal of common fellowship and general peace.

Charles Evers

Mayor of Fayette, Miss.

The eyes of most men are looking up at the moon today. I am looking at the earth our astronauts have left behind, the earth we all pray they will return to safely.

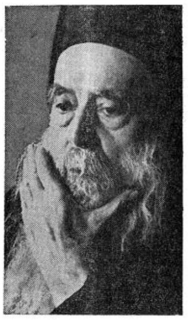
As a daring adventure, this exploration of the moon compares with the voyage of Columbus in 1492. There are a lot of similarities. Like our astronauts, Columbus left behind a world crowded with people who didn't have enough to eat, people who had no decent clothes to put on their backs, people who had no doctor to look after them when they were sick, people who had to live in a house with holes in the roof and rats under the floor, people who had no place to send their children to get a good education. And Columbus probably left behind a lot of people arguing that the whole trip was a mistake.

But there were some things about Columbus's voyage different from this moon shot. The political leaders who sent Columbus toward a new world made no claim to be concerned about the agony of poverty and deprivation. It didn't cost Queen Isabella billions of dollars to send her explorers. She didn't have to take food out of any child's mouth in order to put Columbus on thos leaky old boats.

The New York Times

The billions of dollars being spent on this moon exploration program means that it will be even longer before America begins to keep her promises to the poor.

America needs to look at the earth, not at space. Before one more dollar is spent on outer space, we must make sure that not one child here on earth goes to a dinner table with no food on it.



Patriarch Athenagoras

Leader of Greek Orthodox Church

The journey of man from the earth to the moon gives to history of mankind a new dimension, a cosmic dimension.

With man's landing on the moon an altogether new era of history is opening, or rather a new kind, the history of the universe, a history of the whole of creation. Therefore it is not a question of an important historical event in the value of evolution in the earthly conception and perspective of history, it is a question of the moving of history to positions and perspectives of such results, which cannot, at this moment be foreseen, results on the subsequent chronicle of the earth as well as the history of other worlds, which only now is beginning for man on this earth.

Philosophically the first reaction that comes with the presence of man on the moon is that man is organically tied not only with one planet but with the whole universe.

Now that man has achieved a cosmic biome we do not know which cosmotheories nor biotheories, to which new ideas, new penetrations and a new scale of values, unimagined at present, this new biome will lead man. The very fact that man is freed from his geocentricism and has become an interplanetary traveler is a great revolution in the world of ideas.

The landing of man on the moon especially opens a new epoch to theology and impels us to a new penetration into theology of the whole creation.

This marvelous enterprise of man as a start of his communication with other regions of the universe means at the same time the beginning of a new epoch in the fields of culture and science and in general in the articulation of the life of tomorrow of the human race on this planet.

Perhaps we are on the eve of the vision of a new wisdom, of a new understanding, of the revelation of God to his creations.

Henry Ford

Only a few generations ago, most men lived and died within a few hundred miles of their birthplace. Now our horizons are virtually limitless. If man can walk on the moon, he can look to the planets and beyond the solar system as Columbus must have looked across a forbidding ocean.

Conquering space can have even a deeper meaning for mankind. To be able to overcome gravity, survive weightlessness and subsist on an earth satellite in the absence of atmosphere should tell us that our problems here on earth are far from insuperable. If we show the same determination and willingness to commit our resources, we can master the problems of our cities just as we have mastered the challenge of space.

My personal admiration and congratulations go to everyone who helped the Mercury and Apollo programs. Our astronauts have earned a place with the great explorers and adventurers of all time.

Paul Goodman

Poet and Novelist

From the first Sputnik, I have been enchanted by this adventure of Man. I have written poems and stories about it. The beautiful equations of Galileo, Kepler, and Newton—and naturally one thinks also of Columbus and Magellan. How collective our enterprises have become! What complex and precise machinery and thousands of staff! I have been enormously impressed by the exquisite accuracy and carefulness of the American operations, of which we have news. It is remarkable, though sad, that there was one accident. I have wished, however, that we had chosen our astronauts more various in background, personality, race, and sex, as the Russians seem to have found possible.

It's good to "waste" money on such a moral and esthetic venture. These are our cathedrals. I don't think it is fair to say they are our circuses, for that is not the tone. We ought to see to it that people live well, but a part of living well is blowing money on big excitement, curiosity, entertainment, conversation. And the space budget never came to even one per cent of the G.N.P. Would that we did as well with the rest!

But I'd be prouder and happier if the trip to the moon had been international, with crews and honors shared. An international effort, without secrets, would have been more in the tradition of Western science, and it is logical to assume that it would be cheaper.

Vladimir Nabokov

Poet and Novelist

Treading the soil of the moon, palpating its pebbles, tasting the panic and splendor of the event, feeling in the pit of one's stomach the separation from terra . . . these form the most romantic sensation an explorer has ever known . . . . this is the only thing I can say about the matter . . . . The utilitarian results do not interest me.

Glenn Seaborg

Chairman, Atomic Energy Commission

Even as a scientist who has spent a good deal of his life involved in large-scale technological projects, I find the moon landing an amazing scientific and engineering feat. It personally reinforces my feeling about the great power and potential of science and technology and my belief that through cooperation and concerted efforts man is capable of solving almost any problem, of meeting almost any challenge. I hope the moon landing will have such an uplifting effect on people all over the world and help unite us toward meeting some of our goals here on earth.

Jacques Lipchitz

Sculptor

For me, of course, it is not only an American achievement but a human achievement. Extraordinary. It's something spiritual.

I'm an optimist. I think that humanity will be different after this. I'm happy to live in these times and to witness them. For me it is like humanity stepping out of the womb of nature.

In our art, especially the cubists, we have been announcing this time when men will mature and start a new life. For me it is only beginning.

For me it is something overwhelming. I'm tempted to accord to this event tremendous results. I can't foresee what kind of results, but it will be a kind of mutation of humanity.

Arthur Koestler

Novelist and Journalist

Coincident with cosmic euphoria, the world is in the grip of a cosmic anxiety. Both derive from the same source: the awareness of unprecedented power operating in an unprecedented spiritual vacuum. Prometheus is reaching out for the stars with an empty grin on his face.

Yes: 'Highest Priority . . .'

R. Buckminster Fuller

Architect and Inventor

I do not see the moon landing as an exciting event because I am romantic. I just cannot conceive it as a sideshow. The landing on the moon is in the dead-center of evolutionary events.

Humanity is about to learn that a lunatic (touched by the moon) is not a crazy man but one so sane, well-informed, well-coordinated, self-disciplined, cooperative and fearless as to be the first earthian human to have been ferried to a physical landing upon the moon, and thereafter to have been returned safely to reboard his mother space vehicle earth.

Up to the time I was born, average man in his whole lifetime moved to-and-fro about the surface of earth for an average of 30,000 miles. Historically, average man has seen only about one-millionth of the surface of his spherical planet earth. The year I was born the automobiles were born. When I was 9 the first airplane was flown. Both modes of travel have multiplied so fast that at 73 years of age I have now covered three and a half million miles around the earth's surface—one of 10 million human beings who have traveled such a distance. Yet, in the short span of eight years the American astronauts have traveled in earth- and moon-orbiting terms a total of 30 million miles.

Some of our politicians and many tax-abhoring citizens say: Never mind that space stuff—let's get down to earth. Let's take care of housing the Chinese! And we reply: Where and what is down to earth? Where is that non-

Art Shay

space of infinitely extensible and only one- and two-dimensional horizontality wherein their out-of-this-world, squarely-reflexing brains percolate—in a specialization-exonerated, socio-economic realm of utter irresponsibility for anything but this year's exclusively ego-centered profits? In which direction of universe is down located?

Not only must we put our space programs on highest priority of attention and world-around-resource investment, but all humanity must enter into a new re-educational system geared to develop our awareness that we indeed are in space.

No: 'A Symbolic Act of War . . .'

Lewis Mumford

Historian and Urbanologist

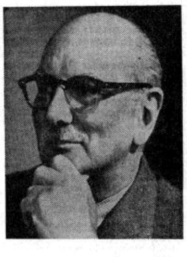
The most conspicuous scientific and technical achievements of our age — nuclear bombs, rockets, computers — are all direct products of war, and are still being promoted, under the guise of "Research and Development" for military and political ends that would shrivel under rational examination and candid moral appraisal. The moon-landing program is no exception: it is a symbolic act of war, and the slogan the astronauts will carry, proclaiming that it is for the benefit of mankind, is on the same level as the Air Force's monstrous hypocrisy—"Our Profession is Peace."

The program to land men on the moon serves more than one purpose. From a military standpoint, it was deliberately planned as a means of swiftly perfecting the equipment for total extermination—the strategic goal toward which our entire megatechnic power system, in the lethal grip of the "myth of the machine" is now pointed. The secondary purpose of space exploration, which commends it to our affluent society, is to support on a more exorbitant scale than ever the military-industrial-scientific establishment and maintain the current rates of industrial expansion and financial inflation.

In order to achieve both military power and economic 'prosperity' and support the power élite and their factotums in the style to which they are accustomed, every other human enterprise must either be trimmed to meet their needs or abandoned. It is no accident that the climactic moon landing coincides with cutbacks in education, the bankruptcy of hospital services, the closing of libraries and museums, and the mounting defilement of the urban and natural environment, to say nothing of many other evidences of gross social failure and human deterioration.

In order to make this misappropriation of public funds and human energies acceptable, the Space Agency has turned the moon landing program into a national sporting event whose excitement is augmented by the fact that, as in speed racing, it provides a morbid thrill in the ever-present possibility of a spectacularly violent death. To further mask the real nature of this enterprise, the promoters of space exploration have made the credulous and the scientifically uninformed believe that a better future may await mankind on the sterile moon, or on an even more life-hostile Mars—as if such a change of scene would bring our sick rulers and their still acquiescent victims back to health.

The old name for such regressive escapist fantasies was lunacy, and that epithet is still accurate as both a topographical and a psychiatric description. If the military space strategists do not terminate their own activities by turning the whole planet into a crematorium, they will soon transform it into a collective lunatic asylum, in which the patients, the attendants, the physicians, and the Board of Guardians (read Pentagon and Kremlin) will suffer the same hallucinations and be under the same



escapist compulsions. They have already demonstrated their inability to perceive, still less to cope with, the earthy human realities that urgently demand attention.

If a successful moon landing leads to a further expansion of space exploration, with a further drain on more important human enterprises and a further neglect of the conditions essential for human survival and development, we may look forward to a corresponding increase in social demoralization and psychological regression. Only a return to full waking consciousness, with an overwhelming transfer of interest from our dehumanized technology to the human person, will suffice to bring our moonstruck nation back to earth. Meanwhile, thanks to the very triumphs of technology, the human race hovers on the edge of catastrophe.

Some Would Forge Ahead in Space, Others Would Turn to Earth's Affairs

The New York Times

Rene Dubos

Microbiologist

There are men in the Apollo capsules, but what they do has all been simulated and is controlled at every step by an incredibly efficient technology — the dreaded portent of what could happen to our lives and our thoughts in the world to come.

In any case, the exploration of the moon comes too late. We already know most of what Apollo 11 can teach us about it. Subconsciously, we may even resent the scientific confirmation that our past imaginings were childish dreams. For thousands of years we have encouraged science fiction writers to entertain us with tales of various creatures supposed to live on the moon and on the stars. If nothing worthwhile can live on the moon we shall feel even more lonely in lifeless space; we also have to give up the hope of starting a new life there.

And yet! I believe that mankind will eventually benefit from the trip to the moon. Not because this adventure will yield new technologies or natural resources. But because the Apollo program has demonstrated once more that the human spirit derives boundless power from a poetical faith in what it can do. Since we learned so rapidly how to integrate the skills of scores of thousands of minds in the closely-knit space endeavor, we should be able to develop programs for the management of the ecological systems of the earth.

Most important, perhaps, is the hope that the moon explorers will bring us a message that will inspire a new religion. We have already heard this message from the crews of Apollos 8 and 10 when they reported that our Earth looks like an oasis in the emptiness of space. Our earth is so beautiful in comparison with the drabness of the moon that we can better understand now the admonition in Genesis "to dress it and to tend it."

I hope that the exploration of the moon will help us to develop a theology of the earth.

George Wald

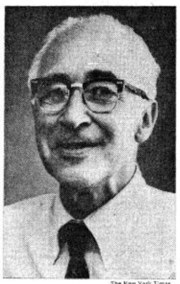
Harvard Biologist

This landing on the moon is the first step in man's occupation of the solar system. The solar system is our corner of space, our home in the universe. We are not likely ever to pass beyond it.

Within the solar system, almost surely ours is the only life. None of the other planets offers a hospitable environment. One could at best pay any of them a short visit, under duress, carrying along the environment we need. Man comes to those other planets as persona non grata. He can explore, but cannot in any real sense colonize.

Perhaps even on short visits we can find something we want. From samples of other planets we may learn more of what they and we are, and how we came about, though probably not much more. Perhaps some valuable materials may prove accessible there than here though that is exceedingly unlikely.

It is extremely unlikely that men will ever move beyond the solar system. The nearest star that may possess a planet capable of supporting life seems to be epsilon-Eridani, and that is about 10.8 light years away. Even traveling at the speed of light—and it is hard to do that without *being* light—that would be a long journey, and might then prove fruitless.



The New York Times

So let us be glad to explore this corner of space, the solar system, the more to feel at home in it; the more to realize that our home in space is the earth; and the more to treat it as our home, rather than a fief to exploit and consume.

Isaac Stern

Violinist

The first step has been taken in the quest to bring music to the moon. Some of us foresaw this some years ago with the launching of Mariner 1. It immediately became a controversial subject. I recall watching the Mariner shot on television while practicing Beethoven with Alexander Zakin, my pianist. As the rocket went up and up so did our fantasy.

"There it goes, Shura," I said. "Soon we will reach the moon, cities will be built with concert halls and people who will want music. How about it?"

"That's just fine," Zakin replied, "you go ahead and play. But please get yourself a local pianist."

Eugene Ionesco

Playwright

It's an extraordinary event of incalculable importance. The sign that it's so important is that most people aren't interested in it. They go on discussing riots and strikes and sentimental affairs.

The perspectives opened up are enormous, and the absence of interest shows an astonishing lack of goodwill. I have the impression that writers and intellectuals—men of the left—are turning their backs to the event.

Several years ago, when Sputnik was sent up, it was hailed as a victory of socialism. Now that America has been victorious in her struggle with space, it's a victory of man, not of socialism, but even this is not acknowledged.

Conquering space opens new and vast horizons. On earth the horizons are too small, and we find ourselves concerned with small events, with false charity. All this will pass.

To conquer space, to know the universe which was a wall for us, gives us vast perspectives. We are breaking down the wall of our smallness. We are demystifying the moon, and now anything is possible.

Who knows what will follow? When Columbus discovered America did anyone know what it would mean? When France sold Canada it was described as getting rid of a couple of snow-covered slopes. Important events always occur where one doesn't look for them.

I won't go to the moon, since I'm too frightened. Those who have gone there are heroes. It is much more heroic to go there than to go out on strike, or to write a play.

We have had such enormous profit from the exploration of space. We know how the earth is—we have seen it from space. We know it as the most beautiful of stars. And we have pronounced the name of God in space.

Ella Winter

Author

If it is true that what the astronauts bring back from the moon increases our knowledge of geology, I think the mission is very important. It is also important because it is a great display of courage, of daring.

If what they collect does nothing to contribute something to help solve the problems on earth—to increase productivity so that more people can live better—then it is a waste of money.

At all events the undertaking itself is so exciting, so imaginative and encouraging that man is capable of such incredible adventure. It is exciting to the human spirit.

That man can achieve this means we could do almost anything on earth if we'd only do it.

Saul Alinsky

Social Activist

It represents a major opportunity for the Administration to go to the moon. I think the President ought to be among those going. It would be great history.

Judging from the present record of the Administration, I don't know if it would make any difference if he goes to the moon or stays in Washington. If he goes it might be a great service to the American people.

It will be a giant step forward in man's search to understand the world about him. That world becomes the planets rather than just the suburbs and the city around him.

I wish to Christ they'd take the South Vietnamese Government and stick them in the capsule. Send them to the moon one way. That's the only way to get rid of them since they won't take dough and go to Switzerland. We'll have to fight a war of independence to free ourselves from the Vietnamese.

As far as statements on the historical significance, it is so obviously epoch-making that the answers are all cliches. The answers sound as stupid as the questions.

If you could have the Administration go—the President would never ask anyone to do anything he wouldn't do himself—and the South Vietnamese, then you could tie space and peace together.

Reinhold Niebuhr

Protestant Theologian

With all Americans I have a proper pride in the technical achievement of our first moon landing. It was a triumph of technology, teamwork and discipline.

Many speak of a "breakthrough" but one asks, breakthrough in what? The landing on the moon has been compared with the discovery of the new continent of America.

But the moon is dead and barren of all natural and human life; and America was rich in all physical and historic possibilities.

But the chief reason for assessing the significance of the moon landing negatively, even while the paens of triumph are sung, is that this tremendous technical achievement represents a defective sense of human values, and of a sense of priorities of our technical culture.

The same technology that gave us this triumph has created many of our problems.

Our population at the beginning of the century was only 20 per cent urbanized; and now 80 per cent lives in large cities. We have woefully neglected these urban centers. They are stinking with air and water pollution. Their inner cities are decaying.

They are filled with Negro minorities, increasingly resentful, even in violent resentment, because they have been deficient in technical training and therefore subject to a much higher level of unemploymet than the national average.

The rich nation which can afford the technical "breakthrough" cannot offer the impoverished cities tax help to feed the hungry or educate the uneducated.

We are betraying our moral weakness in our very triumphs in technology and economics.

Walter Burghardt

Jesuit Theologian

As a theologian, my attitude is best characterized as anticipation, for two reasons. First, there was a time when the theologian, queried about a planet like Mars, was inclined to fit it into preconceived categories. Either there is life on Mars or there is not.

If there is life, either there is human life, either the human beings there were affected by the sin of Adam, or they were not. If they were affected by the sin of Adam, either they were redeemed by Christ or they were not. And so on and so forth.

Today's theologian is more cautious and paradoxically more adventurous. He is remarkably open to what other disciplines present as part of the data on which he operates. As for the moon, therefore, his position is one of waiting.

Will moon science tell us something about life — how it began, what it is, whether moon life differs from the life we know? What does it mean for something or someone to "be?"

Then we can begin to put this new knowledge in the context of what we already know — about man, about his universe, about his God.

Anticipation, secondly, because it is part of man's task, his God-given destiny, to master the universe, to uncover its secrets, to make the universe serve man, make him more human, bring him closer to his fellow man and to God. The conquest of the moon gives some promise for all this.

As a human being who happens to be a theologian, my attitude is ambivalent. I am excited by man's thrust into space, the first human footstep on the moon, the limitless possibilities this opens up for science and knowledge and tomorrow's living.

But I am concerned about our priorities.

The gut question is, what do we — Government and people with power and people with money — what do we consider important? Are things more important than people?

I simply do not believe that a program comparable to the moon landing cannot be projected around poverty, the war, crime, and so on. So, when the first man walks on the moon, my joy will be tempered by sadness. For I shall be thinking of men who still walk this earth.

Arthur Miller

Playwright

There are two schools of thought about the moon landing. One heralds it as the start of a new Age of Discovery like the period that began in 1492. The other regards it as a distraction from social problems. Few, though, feel anything but pride in the men who step over the astral frontier; even the crab-bers are secretly envious of them.

I think it's a great thing for all of us. After the moon we undoubtedly will put men on other planets further and further away from Earth. The climax, which I doubt anyone alive will witness, will come when a scientific expedition finally lands on 125th Street or the North Side of Waterbury, Connecticut.

Stars like 125th Street, the Waterbury North Side, Watts, Newark and Chicago, are much closer to Earth than the Moon and consequently influence our lives here to a far more profound degree. Day and night they move in their timeless orbits, silent and obscure to Earthmen, excepting when occasionally parts of their surfaces explode, for reasons few of us care to examine, but the astral debris of these explosions has from time to time fallen into our streets and caused local fires and traffic dislocations.

Congress will undoubtedly be wary, as it has been in the past, about spending money on such expeditions, but the economic loss due to these explosions, which some theoreticians say will become more and more frequent, should justify appropriations to find out if there is anything Earthmen can do about them.

David Riesman

Sociologist and Educator

The possibility of nuclear destruction has made a greater difference in my life than space exploration is likely to make; I have been concerned with nuclear disarmament since Hiroshima. And when I think about the moon landing in international terms, I see it in one aspect as a moral equivalent for war (in William James's sense), a bit like the olympics but less benign than the nonchauvinistic spirit of the International Geophysical Year.

And I ask myself which country needs such a triumph most: is it the British, who feel that they have become post-industrial too soon; the Russians, who still feel defensive and inferior; or is it perhaps those Americans who seem to have moved in one jump from extravagant complacency to utter despair about our difficulties at home and abroad?

In world terms, the United States perhaps needs the triumph least of all. From the point of view of other countries we already have too much power: perhaps we need some humility. I think we Americans tend to crow and to brag rather less than we once did, but what remains is unpleasant; possibly, a triumph in space may make us more willing to pursue disarmament seriously with the Soviet Union and a political settlement in Vietnam. (The Schadenfreude that might turn up at home and abroad in the event of a tragedy is an understandable but hardly attractive human trait.)

Contrary to many critics of the space program, I have not been convinced we would spend more money to combat poverty, pollution, inner-city problems, if we did not spend on space. We would probably not spend more on AID, the Peace Corps, and other relatively non-invidious overseas programs. Perhaps this may change as our élite culture moves increasingly away from an interest in science and technology—a move not yet much reflected in our popular culture. Yet this élite denigration of science and technology (stronger here than in most industrial countries except for Great Britain) obscures the intellectual excitement and emotional transcendence that science and technology may both provide.

Jesse Jackson

Leader of Operation Breadbasket

It seems to me that only with mixed feelings and considerable misgivings can the person of moral concern contemplate America's moon shot and man's first extraplanetary steps. On the one hand, I stand in awe, amazed at this most dazzling of feats, one which bespeaks man's capacity to hurl himself hundreds of thousands of miles against the heavens and yet land feet first. On the other hand, a sense of irony grips me to the depths of my being when I view the moon feat as over against the mountainous problems which yet loom and which seemingly have rendered man and particularly American man, impotent and whimpering.

How can this nation swell and stagger with technological pride when it has a spiritual will so crippled, when it is so weak, so wicked, so blinded and misdirected in its priorities? While we can send men to the moon or deadly missiles to Moscow or toward Mao, we can't get foodstuffs across town to starving folks in the teeming Ghettos. While our astrophysicists can figure out the formulas that make the amazing trajectories and landings possible, we can't seem to get nutritionists and physicians to the shanties and shacks of Appalachia.

Yes, the nation yet inches along in dealing with the plagues of hunger, poverty, disease, racism and war. The United States of America staggers and lurches, a drunken giant sometimes up, most times down, in dealing with the diseases of our time, both physical and sociological.

The New York Times

Even as astronauts stride forth in the heady atmosphere of the moon, blindfolded America moves toward the whirlwind of another long, fiery summer and on to more campus rebellions and bloodletting come September. Thus, I bid us temper our shouts of exultation as man breaks the fetters of gravity while being unable to forge the links of brotherhood.

Pablo Casals

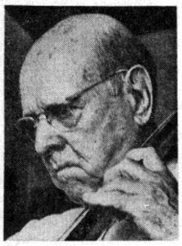
Cellist and Conductor

The moon landing was necessary. Many feel that it was not very practical when measured in terms of the billions of dollars spent on the project and when we look for immediate benefits to mankind.

This might be true when we think what could have been done with this money to alleviate hunger and disease and to disseminate better education.

But scientifically, Apollo 11 demonstrates the wonderful achievements of man's genius — how his inventiveness can sweep across any physical boundary.

And in science you can never say "halt"—you must continue to discover.



June Meyer Jordan

Teacher, Author, Poet

Nowadays the heroes go out looking for the cradle in the cold. They explore a cemetery for beginnings. And irony can kill. The children panic at the research in the glowing graveyard. (What about humanity in heat; the arms that kept the sleep alive?)

That moon, the moon, is the silver myth of a golden America. Money is the sun that makes us shine. Look for the life that reflects more than a conscience losing human value. (Can anybody sell this idea?) Look for the life, the godly gossip soon enough disclosing laughter and the belly of real joy.

Real seems to be the problem: How to push explosions into love, into soil that will not sully and destroy: love yielding only to more of the same. Or how to budget hunger into the column of rumor and mistake. Well, it is here. The possibility is here. Not there. Next to me. And I am next to you.

I wait to celebrate a discovery program that will develop that alarming, maybe wonderful, fact. It means that we are very near, you know, unknown, and dollar bills don't help. Not even twenty-four billion, for example.

So the President declares a holiday. The country glorifies its landing outside the whole scene, outside the extraordinary, common kiss among peoples. Nobody boggles at the mystery we, man and woman, used to offer the world.

How about a holy day, instead, a day when we concentrate on the chill and sweat worshipping of humankind, in mercy fathom? I mean, brothers and sisters, have you ever heard of children —bankrupt, screaming—on the moon?

Robert Jay Lifton

Psychiatrist

It must be said that not everything about the moon landing is, or will necessarily be, salutary to man on earth. What is troubling to me about the event is its painful reminder of our terrible gap between technology and imagination. The moon landing epitomizes the more general awe and helplessness we feel before our own tools and techniques.

Moon flights are just one form of technological transcendence; artificial hearts and the freezing of bodies are another; hydrogen bombs still another. Each of these derives from the over-all technological revolution which dominates contemporary history. And one of the terrible paradoxes with which we live is that the excitement of the scientific frontier has been as available to hydrogen bomb creators (as Edward Teller has made clear) as to space scientists or heart surgeons.

Yet, even as a worried and angry chronicler of the impact of the most malignant side of our technology, I must confess to sharing some of the general sense of celebration concerning the moon landing. For this is surely technology in the service of adventure — and it took no more than a glance at the ecstatic eyes of my 8-year-old son, focused upon the televised blast-off, to remind me that space technology is capable of restimulating the imagination in ways that are powerful if not yet wholly clear.

Jim Aiello

A 12-year-old Michigan boy

I like rockets of all kinds. They're pretty interesting. I'd like to be an astronaut. It sounds like a pretty good job to me. Good pay and you find something new every time you go up.

I read in books that ever since early man they've wondered what the moon was made out of and why it's up there. Now we're going to find out why. It's just like Columbus—finding a new world. People landing on the moon are just like another Columbus.

After moon shots are made safer, they will start developing things on the moon. They will find a suitable spot for little huts to be put up and little laboratories on the lunar surface. They could send up another shot with materials on board to make space stations. You could have one space station on the moon and another orbiting the lunar surface.

I think they'll first explore the rest of the moon but the huts they have will have to be specially insulated or something.

The moon is a stepping stone to the planets. With the population explosion, more people are being born every day than are dying. If they find like they could live on another planet they'd try it out first and then use it to find a home for people. They can't live on somebody's front lawn.

They have to be pretty brave and tough to go up there and look around.

Gerald Neuman

National Merit Scholarship Winner

I have always felt that man's thirst for knowledge is his way of transcending his physical life span. To have the ability to learn but not the courage is bestial.

So I consider this achievement vastly enobling. Peace can only be accomplished on earth through space. To realize that we are small, that the differences between us are petty and that we can only survive this indifferent universe through cooperation, must bring us closer together.

I am especially touched by the tribute to Yuri Gagarin and the other lost astronauts who believed that physical safety and comfort were less important needs than the fight to learn.

Personally, I am affected by the romance of the accomplishment. Many people have no use for poetry and consider the space program wasteful. But I see a confirmation of faith in the future, of long-range goals and beauty that excite me incredibly.

I am humble to realize that this week in the life of those men may be forever of infinitely greater importance than my entire lifetime.

And yet, it reminds me that I too am capable of greatness. The over-all impression is one of grandeur and I think I can begin to hear the music of the spheres.

Kenneth B. Clark

Psychologist

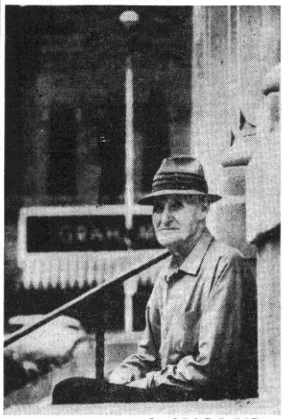
The great wall of China was built at the cost of countless thousands of human lives. The pyramids of ancient Egypt, symbols of indominatible humanity, emerged out of the ruthless exploitation of Egyptian slaves. The beauty of the Taj Mahal blossomed from a surrounding dung heap of human squalor. The great monuments to man's preoccupation with God, the medieval cathedrals throughout Europe, were erected while peasants were compelled to live with filth, disease, and ignorance.

In this regard, the contemporary triumphs of man's mind—his ability to translate his dreams of grandeur into awesome accomplishments—are not to be equated with progress, as defined in terms of man's primary concern with the welfare of the masses of fellow human beings.

In the quest for the evidence of the glory of God and the substance and meaning of life for an elite few—with which the masses may vicariously identify if they choose—the masses remain expendable.

But our triumph on the moon need not be an occasion for despair. This latest conquest may be an omen that we are on the threshold of returning to the unfinished business on earth—that the power of human intelligence which was mobilized to accomplish this feat can also be mobilized to address itself to the ultimate acts of human compassion.

Some Random Events in the Nation on the Weekend It Put 2 Men on the Moon



George Cecilia for The New York Times

A retired farmer sitting on the steps of the courthouse in Winterset, Iowa. A clipping pasted to a window of a nearby building proclaims that "Communism is Jewish."

The New York Times (by Michael Evans)

On a day when many Americans may have felt that God was indeed on their side, a bulletin board outside a Greenwich Village church called for prayers for the astronauts.

Charles O'Rear for The New York Times

Mark Gregg, 18, from Birmingham, Mich., sitting by a fountain on the U.C.L.A. campus. Like many other restless Americans, he plans to spend summer "bumming around."

By J. ANTHONY LUKAS

While two Americans spent yesterday on the moon, Eldridge Cleaver spent the day in Algiers denouncing the moon shot; Hubert Humphrey was on a bear hunt in Russia; The Mets were in Montreal splitting a double-header with the Expos; Jeffrey Ward, 14, of Cleveland, "Mr. Teenager 1969," was in Saigon to "assess" the war as a guest of the South Vietnamese government; David Robb of Missoula, Montana, was in Stockholm, Sweden, after defecting from the United States Army; Randy Geise of Keyport, Wash., was sailing a bathtub 36 miles into Vancouver Harbor, B. C., in the Great Canadian Bathtub Race; the West Virginia University Percussion Ensemble was beating triangles and woodblocks in Quito, Ecuador; the Henry Fords were cruising the Aegean Sea; some 500,000 other tourists were vacationing abroad and about 202,877,000 Americans were doing pretty much what they do on any summer Sunday.

Millions shared vicariously in the historic moon voyage through television, radio and newspaper.

Yet, the moon shot itself had piqued many Americans' curiosity about their own land. While two of their countrymen reached a goal men have only dreamed of, many were asking whatever happened to the American Dream; others were convinced the dream had arrived. And as the astronauts scooped up specimens that would help scientists determine what the moon is made of, Americans were asking what we as a people are made of.

Understandably, the headlines on front pages across the country this morning all dealt with the country's achievement in space. But buried deep on inside pages were some small items that may give clues to the mystery of America.

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SAN FRANCISCO, July 20—Mr. and Mrs. Adrian Ramazzotti celebrated their golden wedding anniversary today. Sixty members of the family honored the couple at a surprise dinner. Mr. Ramazzotti is a plumbing contractor.

Many Americans tend to live for their families. One of the great tribal rites of middle class America is now the weekend visit to camp.

Melvin Goldberg and his wife, Myra, forsook their spacious wood-and-fieldstone home in Scarsdale early Saturday morning to travel to Raquette Lake upstate where their 11-year-old son, Craig, and 8-year-old daughter, Jan, have spent the summer sequestered in the cool woods and waters of the Adirondacks.

An Exchange of Postcards

Last week, before they left on their trip, Mrs. Goldberg lunched at the redwood-porticoed Brae Burn Country Club where she and the other women spent most of the time exchanging postcards from their children at camp. Mrs. Goldberg was particularly proud of a card from Jan, who had just recovered from chicken pox:

"Today was brother and sister lunch. Could you please send me some shoe polish? I got out of the infirmary on Saturday. Men took our pictchures. I am having a lot of fun."

Mrs. Goldberg laughed delightedly:

"She's never in her life polished her shoes at home."

So intense are Americans' identification with their children that when one fails to live up to expectations it can be a devastating shock. When word of David Robb's defection to Sweden reached his home in Montana yesterday, his father refused to comment. But his second wife said: "He feels shocked, heartbroken, lost, helpless."

At an orange-roofed Howard Johnson's on Massachusetts Route 128, six miles from Weston, there were dozens of families traveling together—parents and children all squeezed into one big vinyl booth. One mother from Florida fed her child with the same spoon she used herself—the two alternating spoonfuls of crinkled coffee ice cream. ("People from down South order coffee ice cream because I guess they can't get it down there," explained Mae Kavigian, a veteran waitress.)

•

BELLE TERRE, L. I., July 20—William Heinbockel, a member of the village Board of Trustees, called today for a Suffolk County open housing law to replace a village ordinance repealed last week. Belle Terre was the first town on Long Island Sound to adopt such an ordinance, but it was removed after only five weeks on the books. The village of 350 people has only one Negro family.

In French, Belle Terre means beautiful earth. But for many of this country's 22,742,000 Negroes, America is still not so beautiful. Many of them do not share much pride in the country's technological achievements.

In Franks, one of Harlem's better restaurants, a headwaiter offered Saturday night to lead a couple to a table near the bar "so you can watch the moon shot on TV."

"Moonshot," the girl said, "I can do without that." Instead, the couple sat at a table in the corner, talking about some friends they had just visited on 123rd street:

"They always seem to be waiting for somebody to come along and lead them. Waiting for Godot. Waiting for Lefty, for somebody else. But somehow they survive, don't they? That's the name of the game for black people—survival."

A few blocks away, Mrs. Gladys Lockhart somehow survives with her nine children in a cramped five-room apartment. One room is strewn with rubble as the result of a recent fire. There are only four beds and some of the children have to sleep on the floor.

In James, Miss., Mae Alice Goodman; her common-law husband, Willie Evans, and their three children live in a three-room "shotgun house"—called that because the rooms are stacked end to end so a man could fire a shotgun through the front door and out the back door without hitting a wall.

Willie works on a white man's plantation. His take-home pay last week was $23, after money to pay his current bills was deducted by his employer. "The bossman, he just takes out and pays it hisself," Mae Goodman explains.

But not all Negroes live like the Goodmans and the Lockharts. Yesterday morning in Harlem there were middle-class Negroes—the men in well-cut black suits, the women in bright print dresses—flocking into towering churches like the Abyssinian Baptist Church as well as the store-front variety.

Even relatively well-off Negroes frequently feel their hold on prosperity is precarious. At New York's Kennedy Airport yesterday, a black man in a wrinkled, unkempt coat told his neat but shabbily dressed wife as they walked toward their San Francisco flight:

"Baby, just take it easy. You act like this plane was going to slip out of your fingers like a piece of paper. We paid for our tickets and now we have just as much right to get on as anyone."

There are Americans who resent the Negroes' progress. At their weekly poker game in a Detroit suburb, Bill Ross, a Detroit grocer; Harry, a school principal; Joe, an electrician; Stan, a clothing salesman; and Tony, a scrap dealer, started talking about a proposal to integrate the predominantly Negro Detroit schools with the white suburban system.

"I'm against it," Joe said. "I went to school with spooks who had bugs in their hair and I don't want my kids going to school with them."

The others disagreed. "You can call a guy a son of a bitch but don't call him a black son of a bitch," Mike said as he drew three cards. "Then you're hitting a man's race and that's wrong."

There are many other Americans who believe people should be treated equally irrespective of race. At Kennedy Airport on Saturday, Mike Bruno, an Italian-American taxi driver, decided to drive a young Dominican girl who spoke no English and had no money to her friends on 139th Street. He found the girl, with long hair and a red dress, standing forlornly outside the Pan American terminal. "I feel sorry for the kid," he explained.

Not all American prejudice is directed against the dark-skinned, though. In Winterset, Iowa, several clippings were pasted to the fly-specked window of an old office building just across from the limestone courthouse. One noted that John Wayne (born John Morrison) had been born there. Another proclaimed "Communism is Jewish" over a caricature of the three wise men.

•

SPRINGFIELD, Ill., July 20—The Rev. Charles Koen, leader of a group of ministers from Cairo, Ill., announced today that he and his colleagues would sit in in the Governor's office this week in an effort to obtain jobs and equal opportunities for Cairo Negroes.

There are many Americans who feel strongly about the injustices in this country and are prepared to do something about it. And despite growing reaction to protesters in many places across the country, their right to protest is still protected by the law.

In San Antonio, Tex., yesterday, Lieut. Gov. Ben Barnes told an American Legion meeting "We are not a sick country but a country bursting with vitality and initiative. We are dissatisfied people—yet this is our strength. Self-satisfied people do not have the will or the character to solve their problems. Americans do."

There are those who feel strongly the lack of sufficient dissent—or at least support for the dissenters. Father Bailey, a Roman Catholic priest in Rehobeth Beach, Del., said yesterday. "The primary community problems here, because of our large group of older people, is their total lack of sympathy for the young. Among the older people, there is an undeclared state of war against young people."

But many older people are trying to bring up their own children in a tradition of American dissent they respect.

In Washington, one family pulled up at the base of the Lincoln Memorial. The father, holding a young son by each hand, started climbing up the stairs. "Why did Mom stay in the car?" one boy asked. "She was too hot and tired and anyway she says she's seen it all before." Then standing before the statue the father explained: "He was the President back in the days when the whole country was falling apart."

•

NEW ORLEANS, July 20—Miss Ella Allen, 40, strolled last night to the Jackson Avenue ferry landing and jumped into the Mississippi. As she went under she yelled "Dear Lord, here I come!" After two patrolmen plunged in and rescued her, Miss Allen said she had been baptizing herself. But she was placed under arrest for disturbing the peace by attempting suicide.

America, which was first settled by religious innovators, is still seeking new forms of religious expression. In Phoenix, Ariz., the Rev. John Sharpe left yesterday to take up a new parish in Kansas City armed with a novel, "Psychedelic Vestment." The children of his former church presented him with the robe, which has "Joy" embroidered on the front and "Come Alive" on the back. Father Sharpe, who said he regards his job in the crime-ridden Kansas City parish as "cranking in the kids," believes the new vestment will help.

In Haight-Ashbury, San Francisco's hippie district, a woman with a baby carriage passed out pamphlets headed "Bobbed Hair and Dresses: An Appeal to My Christian Sisters." Into the hands of young passersby, most of whom (male and female) had streaming hair, she pressed her missives adorned with Biblical quotations like "To man, long hair is a shame; it is effeminate, unmanly. To woman, it is a glory."

But most American religion—particularly on a Sunday morning—is more conventional. In Winterset, the Rev. Edward Zeiser read of the miracle of the loaves and fishes to 85 parishioners gathered in St. Paul's Lutheran Church, a tiny, arched building. But in his sermon he focused on the astronauts ("Through these three men in orbit today, Jesus is announcing that something of tremendous value is about to be offered—the Kingdom of Heaven.").

But for many Americans the church is more a social than a religious institution. At Kennedy Airport Saturday, Mr. and Mrs. Stephen Chernock of Dothan, Ala., were on their way to Europe. They move frequently, and Mr. Chernock remarked:

"That's one of the reasons we always go to church. It's the best way to meet new people."

•

ZEPHYRHILLS, Fla., July 20—Lloyd W. Moore, a 70-year-old retired machine shop operator, returned home today after riding a motorcycle 2,000 miles to Searcy, Ark., and back to visit his daughter. "I love to feel the wind in my face," explained Mr. Moore, who made the round trip in 10 days.

A lot of Americans seem to like that wind. About 20 per cent of them change their residence every year. Even the others manage to keep on the move. On an average July day motorists use 250,000,000 gallons of gasoline, and get 30,000 flat tires.

In fact, many Americans have long since traveled the distance to the moon — 238,857 miles. One airline has a club of passengers who have flown a million miles, but it refuses to disclose the number of members ("Each one likes to think he's unique," an executive explains). Even a businessman who lives in Stamford, Conn., and commutes to Manhattan five days a week travels the distance to the moon in just over 13 years.

The poor travel least. Mae Goodman has been out of Mississippi only twice in her life—both times to visit a brother in Chicago (where the Mississippi Delta has already exported many of its poorest citizens). But even some of the poor have seen much of America. Mrs. Lockhart, who hasn't been out of Harlem much since her husband died six years ago, traveled with him to 38 states when he was a deep-sea diver during the war.

And almost anywhere in America one meets somebody from the other edge of the land. In Las Vegas's Tropicana Hotel Saturday night, a man with bushy grey sideburns, a brown chalk-striped coat and an orange and pink tie chanted "numbers, numbers" in a distinct New York accent as he rolled the dice — and lost.

The same day, Mark Gregg, an 18-year-old from Birmingham, Mich., was sprawled on the rim of a fountain at the University of California at Los Angeles, but this spring he was tear-gassed at Berkeley and he plans to spend the summer "bumming around."

And Peter Boehmer, ex-lumberman, ex-Korean war officer, ex-staff worker for the pacifist Fellowship of Reconciliation, has now fled all the way to Monhegan Island, a tiny isle of jagged cliffs and pine forests 12 miles off the coast of Maine. (To some extent, Monhegan Islanders must be considered refugees from the rest of America. "I'm just fed up with the noise and confusion in the city," said one elderly woman on the island yesterday. "I can't stand night life.")

•

BALTIMORE, July 20—Valerie Kay, arrested last week for indecent exposure, was stripping at the Circus Bar here tonight billed as "Miss Moon Girl of '69." Picked up by the police while sunbathing in her backyard, Miss Kay was released Thursday with "probation before verdict." The bar now advertises her as "the girl whose bustle-baring bikini landed her in the clink for showing too much of you know what."

Settled by Puritans, America is fast losing its innocence in the space age. Baltimore's clubs may be the raunchiest, but the casinos of Las Vegas are certainly the most opulent. At the Tropicana, the showgirls in feathered headdresses and dripping sequins manage to look overdressed with practically nothing on.

Many of the customers wear more, but seem to be enjoying it less. A girl in a black knit jump suit with the loosest of loose knits feeds quarters into a slot machine with a bored daze on her face, but still manages to draw every ogle in the room.

On a sunny summer Sunday, Americans also cover 340 square miles of their own flesh with suntan lotions, according to one lotion manufacturer. Yesterday it was raining at most East Coast resorts, but there was plenty of lotion being applied throughout the West and South.

The resorts are getting livelier all the time too. Even a staid vacation spot like Rehobeth Beach, Del., which draws most of its summer clientele from Washington, is developing a downright frolicsome air. Mrs. Ward Tanzer, the wife of a former Central Intelligence Agency official who now lives there year round, calls many of the summer visitors "three-B people — beach, bridge and booze."

But the beachers have had to brave a special peril this summer—a slimy, rust-colored jelly fish called cyanea capillata—and so boozing is up.

At the Red Run Golf Club in Royal Oak, Mich., a Detroit suburb, there was some pretty heavy drinking both in the red carpeted men's bar on the first floor, and in the pastel women's bar upstairs. At the downstairs bar, two judges, a salesman and an architect trudged off the 18th green and settled down around the two-inch thick oak table, ordering a quick round.

"As the judge says, let the perjury begin," said James Livington, the architect, calling for the foursome's scores at the last green (they were 8, 9, 10 and 5).

The Topic Is Poverty

At the women's bar upstairs, the drink flowed just as briskly. But instead of swapping golf scores and business deals, the women were talking about poverty.

"I give my maid clothes and stuff like that," one said. "It's pathetic; those children don't have enough clothes to go to school. They're human beings and I don't go for that — them having to live that way."

•

TUCSON, Ariz., July 20—The director of the National Welfare Rights Organization announced he would arrive here tomorrow to investigate cuts in state welfare payments. The director, Hubert James of Washington, said he had received reports that welfare payments were being reduced from 10 to 90 per cent of their former levels for 19,000 of Arizona's 31,000 recipients.

A significant minority of Americans still live in poverty. The latest statistics (1967) show 26,146,000, or 13 per cent of the population then, over the borderline of poverty set by the United States Department of Labor, a figure that ranges from $1,000 to $7,900 a year in income, depending on family size. Of the 26 million, about two-thirds are white and one-third are black.

Black poverty is often the most abject. Mae Goodman's home in Mississippi is a grim place for anyone to live. There used to be wallpaper in the front room, but Miss Goodman tore it off because she found roaches living beneath it and feared they would crawl over her 4-month-old baby, Rochandra.

Rochanda has open sores all over her face, which began with a mosquito bite that became infected. There are screens on the doors and windows, but the screen is filled with gaping holes and the flies pass through without obstruction.

Food Is Scarce

There is little money for food. Deidra, Miss Goodman's 2-year-old daughter, strolled onto the porch yesterday sucking on the baby's bottle. Her mother scolded her. "I've been trying to get her off the bottle," she explained. "Milk's too high." Miss Goodman herself had had only a cup of coffee for breakfast and some white beans and bread for lunch.

But even in the Delta, outright poverty is no longer as easy to find as it once was. Half of the roadside shanties that once housed Negro sharecroppers are empty, their former occupants moved North. The abandoned shacks are a standing reproach to the past and an enterprising civic leader has suggested the state pay a bounty for burning them.

Mrs. Lockhart's family in Harlem is a typical welfare case. To feed, clothe and educate herself and her 12 children, she gets $282 a month from welfare, $60 a month from Social Security and $90 a month from her husband's veterans' pension.

But she says that she spends everything she has and that it still is inadequate. Her chief goal is to find a new home. "I've applied to the New York City Housing Authority and they say they don't have any place big enough for my family." The present apartment has holes in the ceiling through which water pours every time it rains. The family pushes the water down the stairs with brooms.

Joe Clark for The New York Times

While a girl sunbathed on the pool diving board at the Red Run Golf Club in Royal Oak, Mich., suburban housewives talked about poverty in the club's women's bar.

•

ATLANTA, July 20—Eighty-year-old Estelle Hale of Statham, a cripple, has won $28,600 in the Atlanta Braves' "Home Run for the Money" contest. She won when Tony Gonzalez hit a grand slam in a 6-3 victory Friday night over the San Diego Padres. Mrs. Hale will use the money to build a greenhouse. "Ive talked about it for years," she said. "Now I've finally got the money Oh, I'm high as the sky. When you've been down all your life and then you're suddenly rich, its really something!"

America is still a country where an old woman or a young man can hit it rich quick. The rags-to-riches scenario may not be as valid today as it was in the 19th century when the country was less structured and institutionalized. But energy—or luck—still has its rewards.

Take the lobstermen who live year round on Monhegan Island, who go out in the small boats before the first light of dawn, set and check their traps all day long and return exhausted for dinner. The life is hard and the men's weathered faces show it. But Monhegan lobsters are favorites in restaurants on the mainland. Caught in deep, cold waters, they have the hard shell that guarantees sweet meat and thus a good price. A lobsterman who works hard can take in $12,000 to $25,000 a year.

Bill Ross of Detroit works hard too—60 to 70 hours seven days a week every week at the corner grocery store he took over from his mother. Like every other Sunday, he was up at 8:30 A.M. yesterday and was in the store by 9:45, assisted by his 13-year-old daughter Barbara.

But Bill does not resent it. The business brings in $10,000 to $13,000 a year. He and his wife, Tillie, have saved and invested in the stock market (two of the 26.4-million Americans who own stock)—and multiplied their savings into $50,000.

In Winterset, even the caretaker at the local cemetary is a member of the Lakeview Country Club (annual dues: $65).

Even in the Mississippi Delta there is far more chance to move up than one might think from a casual glance. At one farm, children were playing half-naked in the dirt yard. A crooked outhouse tilted behind the unpainted shack. But when the farmer came out to talk he said he owned 40 acres of the richest land in the Delta, held a good-paying job with the United States Corps of Engineers and had put 3 of his 11 children through college.

•

MADISONVILLE, Tex., July 20—Three Madison County men were charged today with conspiracy to kill Sheriff Ed Fannin. One is W. R. ("Bill") Owens, who was an unsuccessful candidate against the sheriff in 1968. He has been buying newspaper ads critical of Mr. Fannin.

Even America's lawmen seem to have a lawless streak these days. In Honolulu, Mayor Frank Fasi ordered the public prosecutor last week to arrest some 200 persons—most of them police officers—after a wild steak and beer party they held at picturesque Hanauma Bay Beach Park. The Honolulu Star-Bulletin, in a lead editorial, called the party—in which several coeds participated —"the worst police scandal since the vice investigations just after World War II."

The worst violence is in the cities—and the best place to sense it is the emergency room of any big city hospital. The clean, bright, plastic-coated ward of New York's Bellevue Hospital was a battle station Saturday night. A policeman came in pushing a handcuffed prisoner with blood caked on his forehead and a wild look in his eyes. Waiting to be treated, the prisoner explained he had been in the grocery store where he is a clerk when a man he knew to be a shoplifter began looking through the ice cream freezer.

"I pushed him out the door. But he came back, took a bottle of Schweppes Tonic Water and hit me over the head. I hit him back and somebody called the cops. Even they had to hit him. You know, when they searched him he didn't have a penny. What was he doing in the store then? I ask you that."

Crime In Iowa

In the small towns, the crimes are usually less spectacular, less violent. Larry Hooker, Winterset's owlish police chief, said his average weekly arrest register listed a few cases of breaking and entering and some wild driving charges. Recently he has had a new worry. "Some fellows have been in here trying to cut the marijuana that grows on the edge of the fields. But our kids don't smoke pot. Our worst narcotics problem is the oddballs who pass through and try to buy up all the cough syrup."

Out in the heartland, probably the worst violence occurs on the roads. On an average July Sunday, the National Safety Council says, there are more than 200 people killed on the nation's highways. After a particularly bad series of accidents in Montana this summer, Highway Patrol Captain John Heath said: "A draft-age person is safer in Vietnam than he is on Montana highways."

But Vietnam is undoubtedly taking its psychological toll on Americans. Outside Dallas early Saturday morning, a deputy sheriff awakened a young Vietnam veteran as he slumped asleep over his wheel on a deserted road. The veteran jerked upright and slugged the law officer. The boy's relatives say he often awakes swinging these days, apparently a reflex action from sleeping under combat conditions.

•

GILMANTON IRON WORKS, N. H., July 20—Several thousand persons attended an auction yesterday for the benefit of the Rev. and Mrs. Sherman Stevens, who lost 4 of their 13 children when their home burned down last month. More than $5,000 was raised through the sale of furniture, antiques, calves and puppies donated by the townspeople. The town's fire department barbecued 1,000 chickens donated by a farmer.

Despite all the strains and tensions of twentieth century life, Americans can still show great community spirit and downright concern for each other—particularly in a crisis. This has always been a philanthropic country; in 1966 Americans gave $13.6-billion to charity, according to the American Association of Fund-Raising Counsel, Inc.

And there are the little kindnesses that mean more than money. In the Bellevue Emergency Ward Saturday night, Ruby Sterhnback, the nurse in charge, went up to a dazed Puerto Rican boy lying on a bench. "How are you feeling, honey?" she asked. He shook his head and went back to sleep. Nurse Stehnback went on to another patient asking "And how are you, dear?"

In Philadelphia, 2,000 people from neighboring Delaware arrived to shower gifts on an injured baseball player reared in their state. Pitcher Chris Short of the Phillies, who has been out of action nearly all season, received a new car, a color television set, a watch and other gifts from a contingent led by Gov. Russell W. Peterson of Delaware.

In Haight-Ashbury—a community often associated with violence and freakouts—a 22-year-old hippie was selling The Berkeley Barb on the street. Asked how he would use the 7-cent profit he made on each paper, he said:

"We buy food. And we feed anybody who shows up for dinner. There are lots of people round here who need a little food. It's something you can do to help out."

But down the coast in Los Angeles, pretty, pug-nosed Janice Warner doesn't think there is much she can do. Sitting in the bright sunshine outside the U.C.L.A. library, she speaks contemptuously of the "nice, middle class, suburban, plastic" people. "I'm just down on everything," she says. "Even protest seems futile. All you can do is enjoy life."

On the day two Americans landed on the moon, Janice Warner thinks "there are no goals you can attain."

But obviously most Americans disagreed with her. In Albuquerque, N. M., yesterday hundreds of volunteers aiding in an "action program" to clean up the city's neighborhoods got their final instructions from their chairman, G. P. Reyes. "We've just got to have everything spick and span," he said. "In case those moon walkers photograph us on their way back."

This article is based on information gathered by 16 New York Times reporters — Earl Caldwell, John H. Fenton, Jerry M. Flint, Lacey Fosburgh, Ben A. Franklin, Peter Grose, Gladwin Hill, Thomas A. Johnson, John Kifner, Seth S. King, Michael Knight, Roy Reed, Robert Reinhold, Anthony Ripley, Steven V. Roberts and Murray Schumach — and by nearly 50 New York Times contributors in all parts of the nation.

32 MOONS REVOLVE IN SOLAR SYSTEM

6 Planets Have Satellites—10 Moonlets Circle Earth

Special to The New York Times

HOUSTON, Monday, July 21—The moon the astronauts landed on yesterday is only one of at least 32 in the solar system, which may contain contain many others, including 10 moonlets circling the earth.

Mars, Jupiter, Neptune, Saturn and Uranus also have moons, with such exotic names as Io, Ganymede, Triton, Nereid, Phobos, Deinos, Callisto, Miranda, Oberon, Umbrel, Iapetus, Rhea, Dione, Tethys and Mimas.

Mars and Neptune have two moons each, while Uranus has five, Jupiter an even dozen and Saturn 10, the tenth being discovered only last year.

The earth's moon, 2,160 miles in diameter, is only the fourth largest of all the moons, the biggest being Ganymede, a Jovian satellite having a diameter of 3,120 miles. The smallest moon observed to date is Deimos, a Martian satellite with a diameter of five miles.

In a remarkable concidence, Jonathan Swift wrote in "Gulliver's Travels," 150 years before they were discovered, that Mars had two satellities.

The four largest of the Jovian moons, about the size of the moonless planet Mercury, were observed by Galileo soon after the invention of the telescope in 1610. All four are large enough and close enough to cast shadows across the face of Jupiter.

Titan, the largest satellite of Saturn, is believed to be the only moon with an atmosphere, perhaps of methane. The satellite of Neptune named Triton, which may be a huge ball of ice, is believed to be on a collision course with its planet, but it is not expected to hit for another 10 million years or so.

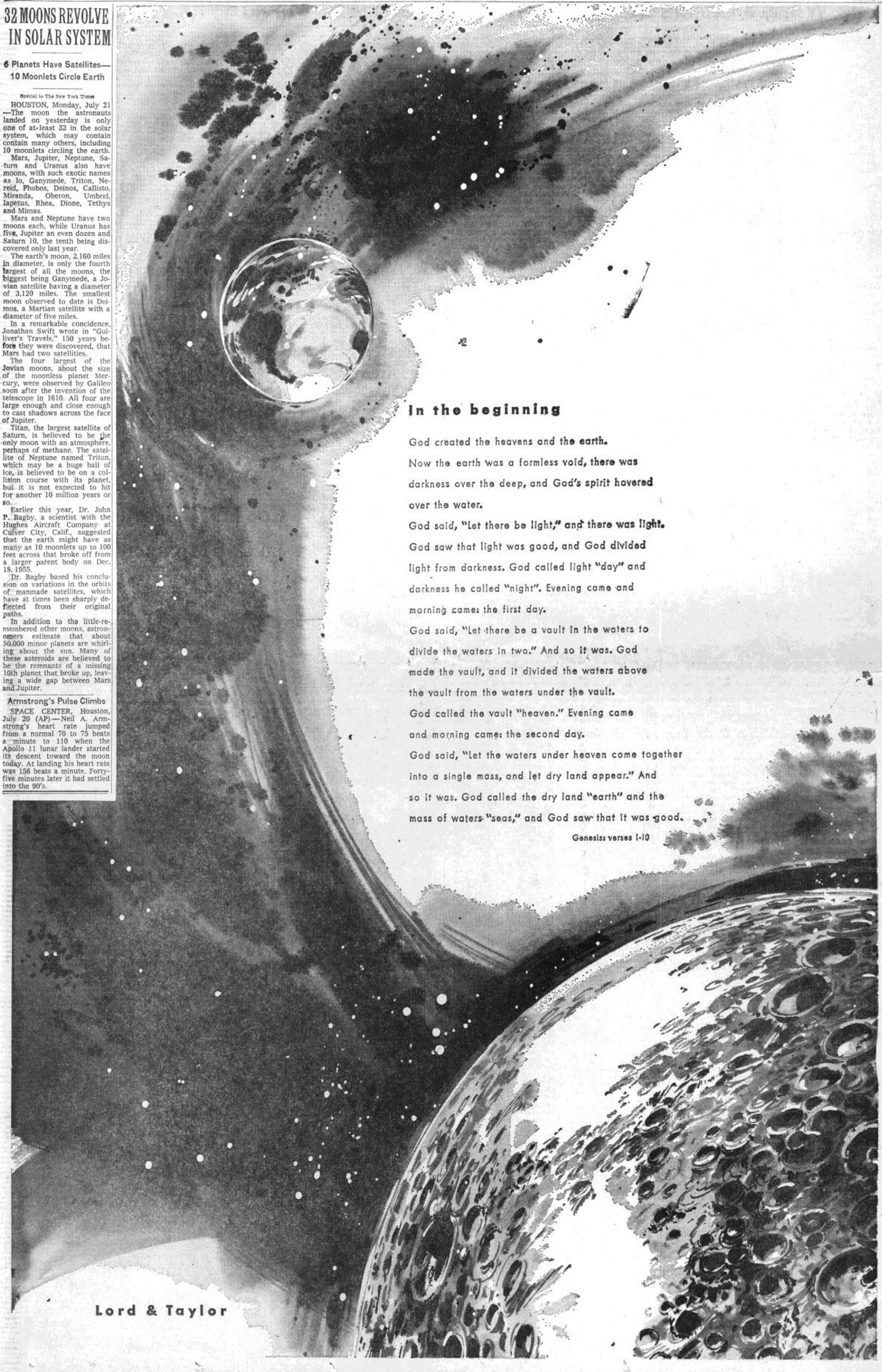
Earlier this year, Dr. John P. Bagby, a scientist with the Hughes Aircraft Company at Culver City, Calif., suggested that the earth might have as many as 10 moonlets up to 100 feet across that broke off from a larger parent body on Dec. 18, 1955.

Dr. Bagby based his conclusion on variations in the orbits of manmade satellites, which have at times been sharply deflected from their original paths.

In addition to the little-remembered other moons, astronomers estimate that about 50,000 minor planets are whirling about the sun. Many of these asteroids are believed to be the remnants of a missing 10th planet that broke up, leaving a wide gap between Mars and Jupiter.

Armstrong's Pulse Climbs

SPACE CENTER, Houston, July 20 (AP)—Neil A. Armstrong's heart rate jumped from a normal 70 to 75 beats a minute to 110 when the Apollo 11 lunar lander started its descent toward the moon today. At landing his heart rate was 156 beats a minute. Forty-five minutes later it had settled into the 90's.



The World's Cheers for American Technology Are Mixed With Pleas for Peace

By WILLIAM E. FARRELL

The landing of two astronauts on the moon and the subsequent walk on the lunar surface were greeted around the world with cheers for American technology, calls for an end to conflict among nations and sighs of relief that the adventure had proceeded without mishap.

From Rio to Nairobi, words of congratulations were spoken for the astronauts who ushered in a new era.

Prime Minister Wilson, speaking on television less than an hour after Eagle touched down on the Sea of Tranquility, expressed Britain's "deep wish for a safe return at the end of what has been a most historic achievement in the history of man."

A rapt throng in London's Trafalgar Square faced an enormous television screen as the lunar countdown neared its completion. When the touchdown was announced, many faces smiled in relief and applause rippled through the crowd.

"Thank God they're made it," a woman cried out.

At the Jodrell Bank Observatory, where British astronomers have been tracking the Apollo 11 mission, Sir Bernard Lovell, the director, said that the success of the mission "opens the most enormous opportunities for future exploration of the universe." Sir Bernard said that he wished "to convey our heartfelt congratulations to the Americans on this demonstration of their tremendous superiority."

Reaction in Paris

A burst of applause and exclamations of "formidable" from several thousand normally blasé Parisians gathered at the Science Museum greeted the news of the space feat.

"Splendid—they've done it," said Premier Eisaku Sato of Japan. "I never thought such an event would take place in my lifetime," he told newsmen. "Didn't you feel the same way?"

In Tokyo's mammoth Shinjuku Station, where every weekend young people have gathered to sing antiwar songs and sell radical literature, a youth with tousled hair said: "I'm glad they made it."

"Fighting in Vietnam is one thing," the young radical added. "Going to the moon is another. I'm against the Vietnam war, against American bases in Okinawa and Japan, against the whole political and social establishment here. But when I think of narrow Japan, and those men out there touching down on the moon, I wish I were with them."

Pope Paul VI followed the lunar landing in the Vatican Observatory near his summer home in Castel Gandolfo, Italy. In an emotional statement the Pope said: "Honor, greetings and blessing to you, conquerors of the moon, pale lamp of our nights and our dreams. Bring to her, with your living presence, the voice of the spirit, a hymn to God, our creator and our father."

Alluding to wars and famine, the Pope said he prayed that the day's "sublime victory" would also produce "true progress toward the temporal and moral good of humanity."

One bitter response to the pleas of world leaders that the moon landing mark the beginning of an era of earthly amity came from a Jordanian in Amman who said: "The moon is our enemy. Its light exposes our movements when we raid the Israelis. If those two Americans would paint it black we would be very grateful to your country, for a change."

Premier Golda Meir of Israel said the moon voyage was the "culmination of a long tradition of learning and inquiry into the impossible."

Mrs. Meir urged that those responsible for the mission "find a way to bring about peace on this earth with the same zeal demonstrated on the Apollo 11 flight. May all of us benefit from the great future ahead of us."

At jet-set parties in Paris, around tribal fires of southern Zambia, in the courtyards of Buddhist temples in Bangkok, on street corners in Colombo, Ceylon, and in snug Dublin pubs millions huddled close to TV sets or radios as the Apollo voyage was described in dozens of languages.

For days, newspapers, radio and television stations throughout the world have featured the historic space journey, often giving little attention to domestic issues. It seemed as if there was no part of earth unaware that two men had set foot where no man had ever been before.

Silence in China

The China mainland appeared to be the exception. While the moon shot was big news in Hong Kong, it was ignored on the other side of the barbed-wire fence that separates the British Crown Colony from the Communist nation. News of the event may have traveled by word of mouth to a few areas, such as the southern province of Kwangtung, where there is some contact with travelers.

While yesterday's feat was being heralded in banner headlines in dozens of countries, it was played down by the Soviet Union. Reports of the touchdown were buried in Soviet television and radio newscasts. But individual Russians appeared to be less taciturn.

"It's a great event, I congratulate you," a woman said in a telephone call to the Moscow bureau of United Press International.

In Madrid, an excited Spanish newsman speaking from Mission Control Center in Houston, reminded his listeners that the New World was discovered by Columbus, whom Spain claims as her son, and that the descendants of that voyage had now conquered the moon.

In many foreign countries citizens were given half or full holidays today.

President Chung Hee Park of South Korea issued a statement terming the landing "the historical moment at which the dream of man for half a million years came to realization."

In Prague, the streets were deserted last night as Czechoslovaks crowded before TV sets in beer gardens and hotel lobbies.

"It's a historic day—just like the discovery of America," said Helmut Ruckriegal, a Foreign Ministry official in Bonn.

"A great triumph over Communism," exclaimed Jurgen Mohr, a young lawyer from West Berlin. He watched the developments on television in the communal apartment he shares with several male and female friends.

In Lisbon, writers and artists threw moon parties while hundreds of Portuguese silently watched television at the national lottery office.

In Rio de Janeiro, special United States space centers equipped with TV sets were the only places where Brazilians without sets could watch the landing.

"It's great to be alive on this day — hats off to America," said Prime Minister Forbes Burnham of Guyana, where almost the entire nation of 700,000 seemed to be following the moon adventure.

In Greece, a new hymn commemorating man's landing on the moon was sung at all major Greek Orthodox churches for the first time yesterday. The hymn, composed by Bishop Dionyssios of Kozane, asks God to protect man from "arrogance and haughtiness" as "we enlarge the divine realms."

The Irish Interest

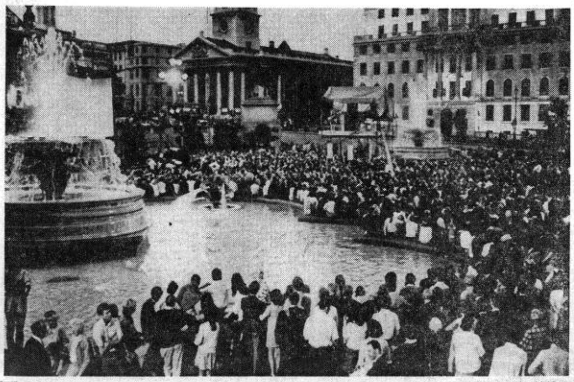
In Ireland, the astronaut who evoked the greatest interest was Lieut. Col. Michael Collins, who bears the same name as General Michael Collins, one of the leaders of the Irish fight for independence. Also, two of Mrs. Collins's uncles, Patrick and John Finnegan of County Mayo, took part in a big family gathering last night that watched the landing.

In Zambia, President Kenneth D. Kaunda, returning to the capital city of Lusaka from a rural election tour, listened to the astronauts' progress on a small transistor radio he carries with him when major news events are happening.

In rural parts of the country, tribesmen who received some of the 50,000-transistor radios issued by the government as education aids listened to descriptions of the landing and moonwalk.

In South America the progress of Apollo 11 was followed mainly on radio. "Human beings have now gone to the moon," a Chilean metal worker said. "It's wonderful, although it was inevitable. The United States and Russia can do anything they want because they have the money. Poor people like us can't and that's the way the world will always be. But good luck to them."

In Cairo, interest in the landing was keen but it faced strong competition in the disappointment over Thor Heyerdahl's abandonment of his papyrus vessel, Ra, and his attempt to prove that Egyptians could have discovered American thousands of years ago.



Associated Press

TRAFALGAR SQUARE IN LONDON: Crowd turns momentarily toward the television camera in the booth at the right while the giant screen in the fountain at left transmits the simulated descent of the lunar module to the moon.

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Col. Edwin E. Aldrin, Jr.
Lt. Col. Michael Collins

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PRAYERS OFFERED AT WHITE HOUSE

300 Leaders at Service—Borman Reads Genesis

By NAN ROBERTSON
Special to The New York Times

WASHINGTON, July 20—President Nixon, his family and more than 300 leaders of the American Government and the diplomatic corps began this epochal day with prayers for three men the whole world was watching.

They gathered in the East Room of the White House while Col. Frank Borman of the Air Force read the opening words of Genesis, as he and two comrades did while orbiting the moon last Christmas Eve.

They were the first men ever to circumnavigate that body.

Quoting the first 10 verses of Genesis, Colonel Borman began: "In the beginning God created the heaven and the earth. And the earth was without form, and void, and darkness was upon the face of the deep."

Paul S. Smith, the teacher that Mr. Nixon said had "most inspired me" and a "birthright Quaker" who now is president of Whittier College in California, gave the short sermon.

"My own faith in mankind is renewed this morning in the knowledge that countless millions of all nations are praying today, not so much that one brave astronaut may set foot upon the moon, but that three brave astronauts may put their feet again upon the earth," Dr. Smith said.

Senator Mark O. Hatfield of Oregon, a devout Baptist, delivered one of the prayers today. The other was given by John H. Buchanan Jr. of Alabama, an ordained Baptist minister.

Navy Hymn Sung

Those at the prayer service sang the first and fourth stanzas of the Navy hymn. The last was particularly appropriate to the day. It begins:

Lord, guard and guide the men who fly
Through the great spaces in the sky

It ends with these words:

O hear us when we lift our prayer
For those in peril in the air.

Five hours later, Neil A. Armstrong and Col. Edwin E. Aldrin Jr. landed on the moon, while Lieut. Col. Michael Collins orbited overhead.

President Nixon disclosed just after the service that he had asked Colonel Borman if he thought the Apollo 11 flight was going well.

"It's like talking to Columbus after he'd been to the new world and asking him whether he thinks Magellan is going to make it," Mr. Nixon said.

The President then paused and said: "I'm not sure whether Magellan came after Columbus."

Colonel Borman assured him he had, going around the world in 1526.

The Magellan voyage, first circumnavigation of the earth, took place between 1519 and 1522. Magellan was killed in the Philippines in 1521; only one of his ships made it back to Spain.

Mr. Nixon said he did "not know much about the technical" aspects of the Apollo 11 flight, but that he was reassured "if Borman says it's okay."

This was the 10th religious service in the White House since Mr. Nixon entered it as President. It was also the largest, with 346 persons attending. All the Cabinet was there except John A. Volpe, Secretary of Transportation, and Commerce.

A big Congressional contingent was on hand, including most of the leaders in both parties and many members of the Space and Foreign Affairs committees in the Senate and House.

Mrs. Nixon, David Eisenhower and his wife, Julie, and Tricia Nixon took part in the service. Later today, they were joined by Mrs. Dwight D. Eisenhower, wife of the late President, who motored down from the farm in Gettysburg.

In his invocation, Senator Hatfield prayed for the safe return of the three astronauts and for the thousands of their support personnel who "literally are their brothers' keeper."

"Excite our imagination to transfer this genius of cooperation and spirit of teamwork to our many other needs lest our success on the moon mock our failures on the earth," the Senator said. "Even as our astronauts go to the moon in the name of peace our world aches from the pain of wars."

Mr. Hatfield, a Republican, has long been a leading critic of the war in Vietnam.

The President opened the service with the comment that this was "A historic day . . . the day when man will first set foot on the moon."

Today, there were five reception lines after the service instead of the usual one. The President and Mrs. Nixon, Dr. Smith and his wife and Chief Justice and Mrs. Warren E. Burger shook hands and chatted with guests filing through the State Dining Room.

Homes of the Apollo Astronauts Echo to Whoops of Happiness

HOUSTON, July 20 (AP)—Whoops and shouts of happiness rocked the homes of the Apollo 11 astronauts today as Neil Armstrong and Col. Edwin E. Aldrin Jr. landed on the moon.

"Good, good, good," shouted Mrs. Armstrong as she leaped from a bed covered with maps and charts on which she had followed the final minutes of descent.

"I just can't believe it," said Mrs. Aldrin, hugging her father, Michael Archer, Ho-Ho-Kus, N.J.

"I thought it was fantastically marvelous," said Mrs. Michael Collins, wife of the Apollo 11 crewman who is in the command capsule.

All three wives have already made plans for a pre-splashdown celebration Tuesday night at a party planned by Lieut. Col. William A. Anders, who is an astronaut.

Colonel Anders was with Mrs. Armstrong during the moon descent, pointing out on the charts and maps the locations named by Mr. Armstrong and Colonel Aldrin on the way down. The Mission Control monitor relaying all communications from the spacecraft was on one side of the bed and a color television set on the other.

Others in the room were Mr. Armstrong's son, Eric; the astronaut's younger brother, Dean, and his wife, and Mrs. James A. Lovell, wife of another astronaut, Capt. James A. Lovell Jr. of the Navy.

All jumped to their feet and cheered the touchdown.

In the Aldrin home, Russell Schweickart, another astronaut, kept Mrs. Aldrin advised of the lunar lander's descent. She sat on a sectional sofa, alternately looking at a chart, listening to the Mission Control "squawk box," and watching TV. During the final few feet of descent, Mrs. Aldrin rose to her feet and shouted "touchdown" when she heard the landing report.

"There were whoops and hollars from everyone," said an official family spokesman. "I got so excited I forgot to note who they were, but there was a lot of noise.

"When it quieted down, someone said: 'Resume Breathing.' And I don't even know who said that."

In the Armstrong home when the cheering subsided, Mrs. Armstrong, who very seldom smokes, lighted a cigarette and stretched out in relaxation.

Throughout History, Restless Men Have Always Been Lured by the Unknown

By ISRAEL SHENKER

The biped who walks like a god and acts like a man now stands triumphant on the moon, looking back toward a planet that was once home enough for his pleasures and his grief.

Restless, unsated by the unending trials of his brief evolutionary hour, man has now moved from earth to heaven to write destiny in bolder script.

There were no natives to fear the strange invader, no satraps to proclaim his coming, nothing but stillness and grandeur and perhaps the uncomfortable feeling that Little Brother on earth was watching.

Giving body to his infinite longings, man has moved in every direction for discovery, pleasure, and escape—on whatever pretext and often on none. As the new lunar age opened, the latest heroes of the celestial hop, skip, and jump had finally conquered a first foothold in space.

The astronauts who went to the surface of the moon are members of a breed that sets impossible goals and (with a little bit of luck) stays alive.

The Urge to Locomotion

In nursery rhymes and folklore, in mythology and literature, and in the hardest way of all — history—man has not only moved mountains but moved round them, penetrating inner and outer space, this world, heaven and hell.

The urge to locomotion is deeply inscribed in man's psyche, perhaps even more deeply than the sweet delight of resting in one place.

Orpheus, the mythical musician, was perhaps the most luckless and certainly the most limbless tripper of all the ages. On the death of his wife, Eurydice, he followed her into the underworld. The Queen of Hades let them rise again, but when Orpheus disobeyed instructions not to look back at his wife she was taken from him again.

Sorrowing Orpheus then rebuffed a band of amorous ladies, so they tore him to pieces limb by limb and threw his head into the Hebrus, whence it floated to Lesbos.

Jason Brought the Fleece

Not every classic trip was that tragic. Jason and the Argonauts brought back the Golden Fleece from their meanderings, and it was the peregrinations of Demeter, goddess of grain, that kept the world fertile (when she stopped looking for her abducted daughter, the earth went sterile).

Getting about, even gadding about, is the stuff of which adventure is made. Alice went down a rabbit hole and through a looking glass. The wanderings of Aeneas, the Trojan hero, gave Virgil epic material for the Aeneid. Astride a winged horse named Pegasus, Bellerophon slew a monster and battled the fiery Amazons.

Daedalus took flight with wax wings, which he had made for himself and his son, Icarus. When Icarus flew too close to the sun, his wings melted and he fell to the sea and drowned. Daedalus flew on and on, eventually reaching Italy.

Bettman Archive

Seeking a western route to Indies, Christopher Columbus reached a new world in 1492. Seeking Japan, he found Cuba.

Many of the greatest voyages of discovery date back tens of thousands of years, before there was paper or a written language to permit recording. Right through the Middle Ages and into the Renaissance the terrors of the unknown clutched at the entrails of the hardiest explorer. To the north lay frozen, fog-bound mystery; to the south was the torrid zone that no man could survive; east and west were uncharted areas of darkness. Sea monsters churned the depths and hostile gods roiled the air.

Notable in the hazy procession of adventurers sailing westward to tempt fate was Erik the Red, a Norwegian whose temper was evidently as fiery as his hair. As punishment for killing a man he was sent into exile (like his father before him). Sailing from Iceland he discovered Greenland, giving his discovery that name so that it might attract settlers.

The greatest traveler of the Middle Ages may have been Marco Polo, a Venetian who went to fabled Cathay and entered the service of Kublai Khan. He kept meticulous journals that were long believed nothing more than a collection of fabrications. But Christopher Columbus had a copy and was influenced by the Venetian's writings. When Columbus set sail across the Atlantic he sought the Cathay Marco Polo had described.

Columbus is almost certainly the most celebrated among the great travelers. By various accounts he was Italian, Spanish, Jewish, of high, medium, or low station. He kept two sets of books (one to encourage his men, one to tell himself the truth), an accounting practice not unknown in the Mediterranean area in more recent times.

Westward he sailed from Spain on Aug. 3, 1492, hoping to reach the Indies, in the east, by sailing west. With desperate cajolery and high-minded determination he dampened threats of mutiny, and his expedition sighted land—San Salvador in the West Indies—on Oct. 12.

He then set off to find Japan, discovered Cuba instead. His expedition found not old gold, but new Indians smoking cigars. Columbus concluded finally that it was not Japan, that it was China.

Columbus was to report back to his Spanish royal patrons:

"The people all go naked, men and women, as their mothers bore them, although some women cover a single place with the leaf of a plant or with a net of cotton that they make for the purpose. They have no iron or steel or weapons, nor are they fitted to use them, not because they are not well-built men and of handsome stature, but because they are very marvelously timorous . . . they are so guileless and so generous with all they possess that no one would believe it who has not seen it."

He sailed on three more voyages of discovery, and always had to make do with second-best America, instead of the supreme prizes—the Indies and Cathay.

It was Vasco da Gama who reached India, sailing from Lisbon round the Cape of Good Hope. He, too, had to master deathly obstacles to win out: Moors (he tortured them with boiling oil), an erring pilot (he had the fellow flogged for mistaking islands for mainland), would-be assassins, and a shortage of Indian buyers for his wares.

Pope Divides the World

In 1493 Pope Alexander VI split the world into a Spanish hemisphere in the west and Portuguese lands in the east, and a Portuguese noble named Ferdinand Magellan offered his services to Spain to clear up the boundaries, and to prove that the spice-rich Moluccas were within the Spanish zone. Magellan hoped to find a strait at the southern end of South America, which was held to extend indefinitely southward, reaching perhaps even to the pole and then on to Africa.

Five ships under Magellan set off from Seville on Aug. 10, 1519. The expedition sailed across the Atlantic, then south till it found a passage that Magellan named the Patagonian Strait and that now is named after him. Because of the fires burning to the south, the land there was called Tierra del Fuego. It took Magellan and his men five and half weeks to sail the 300 miles through the strait.

Three ships (one had deserted and another had been wrecked) headed out across the Pacific. Magellan discovered the Philippines and died there in a battle with the islanders. One vessel, the Vittoria, made it back to Spain, completing the first circumnavigation of the globe. Only 35 of the 280 men who had set out with Magellan returned.

Antonio Pigafetta, an Italian who accompanied Magellan, left an account of the expedition:

"On Wednesday, the twenty-eighth of November, we left the strait and entered the ocean to which we afterward gave the denomination of Pacific, and in which we sailed the space of three months and twenty days, without tasting any fresh provisions. The biscuit we were eating no longer deserved the name of bread; it was nothing but dust, and worms had consumed the substance, and what is more, it smelled intolerably, being impregnated with the urine of mice. The water we were obliged to drink was equally putrid and offensive.

"We were even so far reduced, that we might not die of hunger, to eat pieces of the leather with which the mainyard was covered to prevent it from wearing the rope. These pieces of leather, constantly exposed to the water, sun, and wind, were so hard that they required being soaked four of five days in the sea in order to render them supple; after this we broiled them to eat. Frequently indeed, were were obliged to subsist on sawdust, and even mice, a food so disgusting, were sought after with such avidity that they sold for half a ducat apiece.

"Nor was this all. Our greatest misfortune was being attacked by a malady [scurvy] in which the gums swelled so as to hide the teeth, as well in the upper as the lower jaw, whence those affected were thus incapable of chewing their food."

Three Voyages by Cook

Capt. James Cook, on three voyages of discovery during 11 years, did more to fill the gaps of geography than any other man of his time, 250 years after Magellan. His first voyage (1768-1771) went round Cape Horn and on to Tahiti. He discovered New Zealand, found Australia, and meticulously reported his wonder at the tatoos of natives and the configurations of animals, such as the kangaroo ("Excepting the head and ears, which were something like a hare's, it bears no sort of resemblance to any European animal I ever saw. . . . We din'd of the animal & thought it excellent').

On his second voyage (1772-1775) Cook probed the Antarctic and sighted penguins but no people; he then went on to explore Easter Island, and the New Hebrides (people but no penguins). The third and final voyage was back to Tahiti, then Hawaii, north to Alaska, and finally back to Hawaii where he was killed by islanders who cut him to bits. He was buried at sea.

Robert E. Peary prepared for man's first trip to the North Pole by studying the methods and materials of the Eskimos. He learned to use the winter months, live in snow houses instead of tents, employ dogs to pull his sledges, and wear clothes of skins cut according to Eskimo style. His principal food was pemmican, a preparation based on lean, dried meat, that was introduced by Indians of the American Middle West.

The expedition to the Pole sailed from New York in July, 1908. Included in the final assault parties were Peary, an American Negro (named Matthew A. Henson), four Eskimos (Egingwah, Seegloo, Ootah and Ooqueah), five sledges, and 40 dogs. Beginning 133 nautical miles from the Pole, Peary planned five marches of at least 25 miles each.

"Underlying all these calculations," he reported, "was the ever-present knowledge that a 24-hours' gale would open leads of water that might be impassable, and that all these plans would be negatived."

"This was the time for which I had reserved all my energies," he recalled, "the time for which I had worked for 22 years, for which I had lived the simple life and trained myself as for a race. In spite of my years (53), I felt fit for the demands of the coming days and was eager."

Peary's account of his march to the pole is one of the sagas of hardy perseverance in the face of dread.

"Often a man has the choice between the possibility of drowning by going on or starving to death by standing still, and challenges fate with the briefer and less painful chance. . . . That night I put all the poorest dogs in one team and began to eliminate and feed them to the others, as it became necessary."

With the goal in sight, "I was too weary to take the last few steps," he wrote. "The accumulated weariness of all those days and nights of forced marches and insufficient sleep, constant peril and anxiety, seemed to roll across me all at once."

But on April 6, 1909, Peary hoisted the American flag and, honoring tradition, took possession of "the entire region, and adjacent, for and in the name of the President of the United States of America."

Shackleton at the Pole

Peary left the South Pole to others, carefully noting that the project was much less hazardous: the South Pole was on a plateau two miles high, the North Pole in a sea two miles deep; to reach the North Pole, he had to sledge during the coldest part of the year, for the great hazard was open water. At the South Pole, the ice was firm and one could walk in the warmest part of the year. One could leave supply caches in the Antarctic and find them again, but in the Arctic the risk was that the ice would move and take supplies with it, unless a polar bear had dislodged them earlier.

It would have been hard to persuade Ernest H. Shackleton of the ease of Antarctic exploration. In his journal, Shackleton reported a withering series of trials:

"Again all day in our bags, suffering considerably physically from cold hands and feet, and from hunger, but more mentally, for we cannot get on south, and we simply lie here shivering. Every now and then one of our party's feet go, and the unfortunate beggar has to take his leg out of the sleeping bag and have his frozen foot nursed into life again by placing it inside the shirt against the skin of his almost equally unfortunate neighbor."

The explorer who made it first (Dec. 14, 1911) to the South Pole was Roald Amundsen, and he called the land, "King Haakon VII Plateau."

Richard E. Byrd went flying from one extreme to the other. In a Fokker trimotor piloted by Floyd Bennett, he was the first to fly over the North Pole. In another trimotor, with a crew of three, the adventurous naval officer made the first flight over the South Pole in 1929. Congress saluted his mastery of skies north and south by making him a rear admiral, retired. President Coolidge had already awarded him the Congressional Medal of Honor for his earlier flight.

The admiral was just getting warmed up. He led three more Antarctic expeditions, and the name Byrd became virtually synonymous with the deepest south of all — and the greatest trials of survival.

By and large this was the end of the era of discovery on earth. But it was not the end of adventure. There remained endless vistas tempting the visionary and the brave.

Lanky, taciturn Charles A. Lindbergh was the first to fly solo across the Atlantic, in 1927. He took off from Roosevelt Field, N. Y., in his single-engined plane, The Spirit of St. Louis, navigated through storms and darkness, and after 33½ hours and about 3,600 miles landed at Le Bourget Field, outside Paris. A tumultuous reception swept him off his feet and into history.

The first seacraft to reach the North Pole was the Nautilus, a nuclear submarine of the United States Navy. She began her trip at Pearl Harbor, went north to the Bering Strait, on to Point Barrow, Alaska, and then down below the Arctic ice. On Aug. 3, 1958, the Nautilus glided submerged across the North Pole, its 116 men the largest group ever assembled at the pole.

From the pole the submarine continued her trip right across the top of the world and down the other side surfacing at the edge of the ice pack, northeast of Greenland. In four days the ship had covered 1,830 miles below the surface.

Five years earlier, on May 29, 1953, two men had reached the highest peak of man's earthly ambitions. In a combined assault, Edmund Hillary, a New Zeland beekeeper, and Tenzing Norkay, a Sherpa guide, with the support of an expedition led by Col. John Hunt of Britain, scaled Mount Everest, 29,028 feet high, impregnable through all the centuries.

It was a Russian — Yuri Alekseyvich Gagarin, son of a collective farm carpenter—who made the first manned space flight, on April 12, 1961. In the spaceship "Vostok," Major Gagarin orbited the earth in 1 hour 48 minutes, flying at a maximum speed of 18,000 miles per hour. He was awarded the Order of Lenin, made a Hero of the Soviet Union, and hailed as the Columbus of space. He died in an airplane crash last year.

Other Kinds of Voyages

Many trying voyages, unhappily for those along the way, have been military: Alexander conquered the entire world as it was known in his day; Hannibal transported elephants across the Alps; Genghis Khan and his fierce Mongol tribesmen subjugated vast territories from China to the edge of Europe; Tamerlane (1336-1405) built pyramids of human skulls and spread carnage and terror across the breadth of Central Asia.

Traders and missionaries have been less ferocious but no less dogged. Franciscans had trekked all the way from Rome to China 200 years before Columbus set sail. Greek, Phoenician, Chinese, Buddhist, Moslem, Christian —wherever they went they took new goods and arts and creeds, prospering against all hazards, from banditry to unfair competition.

New Dimension Added to History by Moon Landing

By JAMES RESTON

"And I saw a new heaven and a new earth, for the first heaven and the first earth were passed away."—I Revelations xxi.

The great achievement of the men on the moon is not only that they made history, but that they expanded man's vision of what history might be. One moon-landing doesn't make a new heaven and a new earth, but it has dramatized the possibilities of doing so.

The leaders of men have in recent years been in a state of profound depression over their inability to make more progress with the social, economic and political problems of the world. Even in the United States, which has gloried in its capacity to do the impossible, men had begun to doubt their capacity to control events.

What the moon landing has done is to revive hope, but the old heaven and the old earth have not passed away. The stubborn facts of the human family remain the same. The population of the world increased by 400,000,000 in the decade of the sixties. It will grow, on the best estimates available, by about 500,000,000, outside of China, in the seventies.

According to the United Nations more than half of the people now living on earth are malnourished and therefore vulnerable to disease; 500,000,000 actually live in a state of constant hunger, and 3,000,000 actually die of starvation every year.

Population Soars Daily

Meanwhile, the population of the earth increases by 200,000 every day, mainly in the underdeveloped countries, where 40 per cent or more of the people are 15 years of age and under.

Three wars were being fought on earth when the three astronauts landed on the moon—in Vietnam, the Middle East and Nigeria. Rebellion and insurrection were common elsewhere. China, Germany, Vietnam and Korea were divided between hostile political factions, and there were boundary disputes between the Soviet Union and China, East and West Germany, Italy and Austria, Israel and the Arab States, India and Pakistan, India and China, Thailand and Malaysia, Thailand and Cambodia, Cambodia and South Vietnam, and Mexico and Guatemala.

Of these danger spots, perhaps the most ominous is the conflict between the two Communist giants, the Soviet Union and China. Though the Middle East could get out of control, it was clearly in the interest of the United States and the Soviet Union to prevent it from doing so. The Sino-Soviet dispute, however, is deep and bitter and could develop into a major conflict in which nuclear weapons would be used and threaten through atomic fallout, the existence of human life far beyond the area of the fighting.

The nations of the earth were spending over $180-billion a year on military arms, a 50 per cent increase since 1962, and an arms race of apocalyptic proportions was in progress between the United States and the Soviet Union, each of which had enough atomic weapons to threaten the very existence of human life.

A very large proportion of the human race was thus confronted by the intolerable paradox of great deprivation in the midst of plenty, existing between the two abysses of imposed political order in the totalitarian states and chaotic disorder in many of the 56 new countries that have come into existence since 1950.

Clash of Rich and Poor

It would perhaps not be too much to say that at this time there was a kind of class war developing in the world between the rich and poor within many countries and also between the very rich industrial nations of the Northern climes and the very poor agricultural countries of the Southern climes.

In the week of the moon flight, U Thant, the Secretary General of the United Nations, issued a report, which was scarcely noticed in the excitement.

"I continue to be struck," he said, "by the magnitude of the stake and the relatively limited sacrifice, in financial terms, which would be needed to improve [the life] of the developing countries; only a slight reduction in expenditures on armaments would suffice to make available the external resources required for solving at least some of the gravest economic and social problems of today's world.

"On one or two occasions in the past, I have referred to the danger of the rich countries sinking into a kind of prosperous provincialism. But another danger should not be overlooked, that of sinking into a morass of poverty and despair. . ."

Nevertheless, by the end of the sixties, which were supposed to be "the development decade" among the nations of the world, the large, rich nations were actually contributing a smaller proportion of their annual wealth to help the poor nations than they were at the beginning of the sixties. And as the seventies approached, there was increasing evidence of racial tension in the world and a kind of rising revolt among the educated young against the values of their elders.

Even in the relations between Moscow and Washington, there were some signs of progress. The Brezhnev regime has become increasingly repressive at home in the last year or so, and frightened of the rise of freedom in the Communist states of Eastern Europe, but it is preoccupied with the Chinese problem and therefore does not want too much trouble in the West.

Accordingly, it is at least willing to talk about bringing the arms race under control and working to avoid the spread of nuclear weapons. Moscow is still the arsenal of Communism and continues to arm the Arab states, but all indications are that it will cooperate with the United States at least to the extent of avoiding direct military involvement with the United States in the Arab-Israeli conflict.

The trend in Vietnam was clearly toward peace at the end of July. The United States had started withdrawing its troops from the battlefield, and while this policy of detachment promised to be long and painful for the American people, the outlook was for winding up a war that has divided the United States and limited its capacity to deal with its internal problems and help the underdeveloped countries.

Everywhere in the United States there was fierce debate and analysis of the nation's policies and priorities. Within the churches, the universities and the Government itself, old assumptions were being challenged and there was widespread anxiety that this was going to lead to division, disruption and maybe even to a separation of the races into two hostile camps.

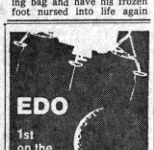
With the end of the Vietnam War, however, the chances for an easing of the tensions seemed fairly good. Between revolution and resignation, the trend of the moderate and rising middle class was toward reconstruction and peace. In fact the major tendencies of policy within most of the advanced countries of the West were away from great adventures abroad and toward concentration on social and economic policies at home.

The moon landing undoubtedly dramatized the rapidity of change in the world and may therefore encourage new approaches, new attitudes and new policies toward contemporary problems. In a way, this great achievement focused the mind of the entire race on a single event and said to the world what Mr. Lincoln said to the American people in 1862:

"As our case is new, we must think anew and act anew. We must disenthrall ourselves, and then we shall save our country."

HUNTING WORLD

OUR LITTLE ELEPHANT HAD BET HIS SOUL THAT HIS FAVORITE THREE WOULD REACH THEIR GOAL



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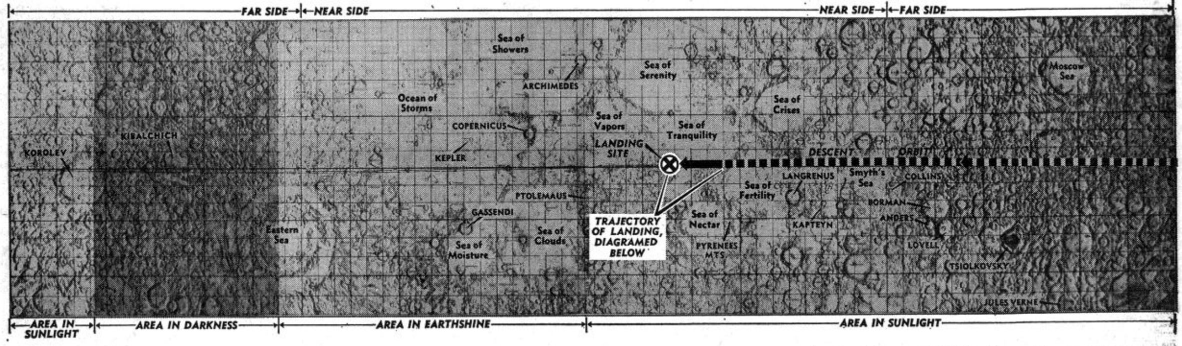
We've already given our best in the way of systems and components. Our Arrowhead Division designed and built the fuel and liquid oxygen lines used for the Apollo spacecraft engines in both the first stage and the lunar module.

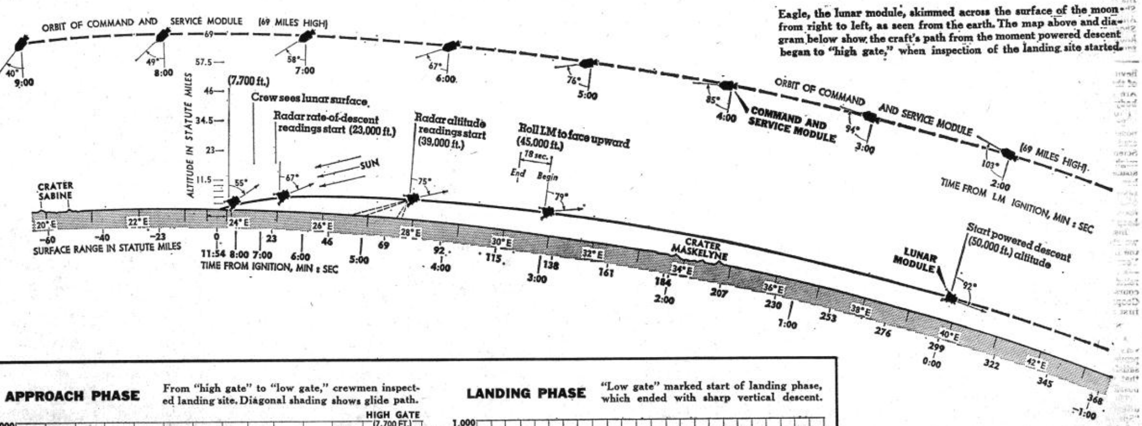
Now we'd like to give our best in the way of wishes for a safe and successful return. When man first landed on the moon, we were as proud as any group of people can be. Not just because of our contribution . . . but because of our American heritage.

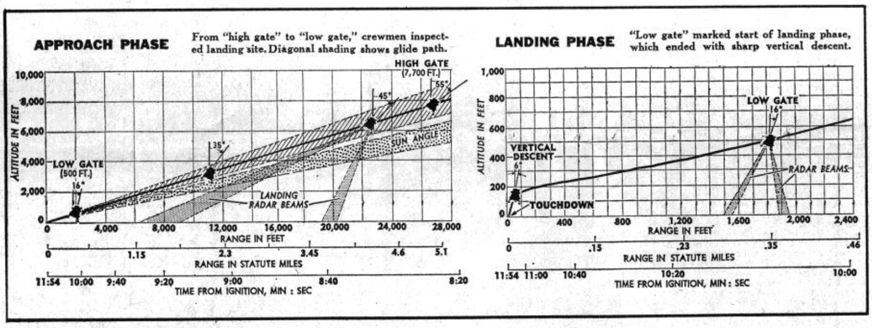
FEDERAL-MOGUL

How 'Eagle' Touched Down: A Step-by-Step Account of the Last 50,000 Feet



Eagle, the lunar module, skimmed across the surface of the moon from right to left, as seen from the earth. The map above and diagram below show the craft's path from the moment powered descent began to "high gate," when inspection of the landing site started.

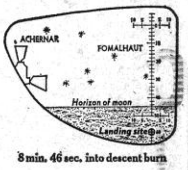




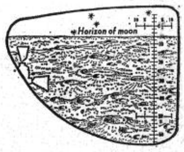
VIEW FROM THE LM

In final descent, astronaut Armstrong saw these views out his window at key intervals. The objects at left of the window are nozzles of landing craft's maneuvering jets.

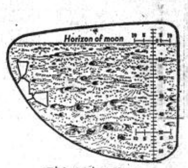
7 min. 46 sec. into descent burn



8 min. 46 sec. into descent burn



11 min. 6 sec. into descent burn.



End of descent burn

Shortly Before Landing, Armstrong Took Over From Computer

By RICHARD WITKIN

Eagle started its final descent to the lunar soil from an altitude of 50,000 feet—about as high as military jets routinely fly above the earth.

It started with a gentle, one-tenth-power burst of fire from the lunar module's descent rocket, and then a build-up to the engine's full 9,850 pounds of thrust.

Eagle was flying tail—or rocket nozzle—first. So the ignition had the effect of slowing the craft, causing it to "fall" out of lunar orbit and slant down toward its target site in the Sea of Tranquility.

The time of ignition, called "powered descent initiation," was 4:05 P.M. Eastern daylight time. The site was not quite 300 miles away.

For several minutes before ignition, Neil E. Armstrong, the Apollo 11 commander, and Col. Edwin E. Aldrin Jr. had gone through elaborate steps to prepare for the fateful engine firing.

Using a keyboard of 19 square black keys, they had punched up "Program 63" in their computer. They had double-checked figures on a flashing display abovie it. They had flipped switches and turned knobs. And they had pushed the keyboard button marked "PRO" for "proceed."

Engine Fired by Computer

It was the computer, actually, that fired the engine. In fact, the computer, following further instructions inserted through the keyboard, was to do all the throttling and all the squirting of the small attitude-control rockets until Mr. Armstrong manually took over the flying, near the rugged lunar surface.

Eagle was moving tail first. So the two astronauts "standing" before their instrument panels and individual triangular windows were moving feet first when the final descent began.

"Standing" is inexact, since they were still weightless, without a meaningful "up" or "down." They had to be held in place by harnesses, shoe grippers and whatever support they might occasionally add by grabbing handholds.

There was an important reason why the engine firing was at only one-tenth power for the first 26 seconds. This was to give the gimbal that provided basic steering (like a hand balancing a broomstick) enough time to feel out the precise center of gravity of the craft above it. That would insure that the thrust was directed in precisely the desired direction.

The same engine, with an initial 10 per cent burn, had been used half way around on the other, the dark, side of the moon to bring the lunar module initially out of its 69-mile-high circular orbit, down to the 50,000-foot low point. Now it had re-started to bring Eagle down the last 50,000 feet to the ground.

In the early moments of the final descent, the windows were turned downward so the astronauts could compare what was passing below with what their maps and other data had led them to expect. Pilots generally like to have the ground in view as long as possible.

Craft Rolled Over

On the Eagle's descent, it was not possible for long. As the craft descended to the 43,300-foot level, the computer rolled it over like a hot dog on a griddle, leaving the astronauts looking upward at the stars.

This was necessary so that the four beams of the landing radar could start pointing toward the lunar ground below. One was to tell the astronauts their altitude: the other three were to calculate their rate of descent.

Actually, by design, the initial rollover was only 174 degrees instead of the full 180, giving the radar beams a better "look angle" at that stage.

By the time the capsule was down to 39,500 feet the crew was supposed to be getting accurate altitude data. Communications were somewhat garbled during the descent, and the two astronauts were not very talkative. But all indications were that the altitude data arrived close to schedule. The rate of descent data was to come later.

'Go' to Continue

Just a few moments earlier one of the few space-to-ground exchanges had taken place that momentarily raised doubts whether everything was operating well enough to go through with the lunar landing.

"My position checks down range seem to be a little off," was the message from the landing module.

Maj. Charles M. Duke Jr., the astronaut serving as "cap comm" (capsule communicator at the Houston control center) acknowledged. A moment later he added: "I think it's going to stop. You're 'go' at four minutes. You are 'go' to continue powered descent."

And stop it did. "Four minutes" meant time elapsed of a total of about 12 minutes it would take from start-up of descent engine to touchdown. The landing site was about 95 miles away.

Then came an important decision point—comparable to the decision to fire up at 50,000 feet and fall out of lunar orbit.

The new decision point was five minutes into the engine burn at about 36,000 feet. This was the last point from which it would have been possible to climb back to a rendezvous with the mother ship—the command module still circling in a 69-mile-high orbit—by using the descent engine alone.

Below this point it would have been necessary to use up the descent fuel, then drop off the lower, or descent, stage of the two-stage vehicle, and use the ascent stage to make it back to a rendezvous.

No Problems

That would have meant throwing away the lower stage "consumables"—oxygen, reaction jet fuel, batteries and the like. These items might have been necessary if things were not shipshape aboard the command module.

But there were no problems, and the decision point slid by without comment.

By now the computer was beginning to put the two-man craft through a gradual "pitch up" maneuver. This was so the astronauts would eventually be able to see the terrain where so many unknown perils lay in wait for them.

The astronauts had been flying feet forward, heads up. So the "pitch up" was programed to pivot them upward, around their heels. They were about one-third of the way to the vertical by the time the capsule was down to 27,000 feet.

Things now began to happen at a busier pace. At 24,639 feet the computer was programed to cut back from full throttle to something under 60 per cent. This is technically known as "throttle recovery."

"Throttle down better than the simulator," the crew radioed to Houston control.

At 23,200 feet, the radar beams calculating the craft's rate of descent were supposed to start giving the crew solid readings. Evidently they did. By now the craft had pitched up two-thirds of the way to the vertical.

The Braking Phase

Failure of the radar to produce dependable-looking readings by 13,000 feet would have meant "aborting" the flight.

The entire powered descent to this point was part of what was known as the braking phase. Its main aim was to kill off the bulk of the module's speed around the moon. It was aimed at a point in space about 7,700 feet above the moon's surface and about five miles from touchdown. This point was known as "high gate."

At about 18,000 feet altitude, seven minutes after the descent began from 50,000 feet, the pitch-up had gone far enough for the moon's horizon to creep into the bottom of the window. But the landing site was still below eye level.

Finally, somewhere around "high gate," the site moved up into view. The craft's speed over the ground had by now been slowed from the 3,818 miles an hour at which it had started the final descent to about 370. But it was descending vertically at a rapid rate of about 90 miles an hour.

At the 7,700-foot altitude of "high gate," the so-called approach phase began, with a new target at "low gate," down at 500 feet.

With the landing site now in view, a prime aim of the two astronauts was to gauge whether the actual touchdown point looked suitable — looked free enough of craters or rocks — for the landing just ahead.

Pinpointing Lines

The astronauts could pinpoint the site by reference to graduated vertical and horizontal lines on their windows. Called the "landing point designator," it resembled the device used on fighter planes for aiming guns.

If the actual ground looked too forbidding, as it eventually did look to Mr. Armstrong, he could instruct the computer to shift the descent path to another location. He could do this simply by flicking a switch on his attitude controller.

The big fear had always been that, in landing, one or more of the craft's four foot pads might strike a sizeable boulder or sink into an unseen crater. In either case, this could either topple the craft on its side or tip it so precipitously that the ascent engine would not be able today to rocket it off the moon into a safe orbit.

Just before "low gate" came another major decision point. A check had to be made that the landing craft had at least six hours of "consumables" aboard—that leaks of oxygen or fuel had not developed and depleted these supplies. No problem.

"Low gate" was just three miles short of the originally intended landing site. It was the start of the so-called landing phase.

The plan at that point had been for Mr. Armstrong, commander of Apollo 11, to shift from fully-automatic flight to semiautomatic. In other words, he would stop relying completely on the computer to translate programed instructions into movements of the main throttle and into squirts through the attitude-control rockets.

In the semiautomatic mode, he could change the rate of descent by increments of just one foot a second by clicking a control at his left hand up and down. But this was not good enough for Mr. Armstrong, as the crew radioed shortly after the historic touchdown on the moon.

"Houston," came the message, "that may have seemed like a very long final phase. But the auto-targeting was taking us right into a football-field-sized crater with a large number of big boulders and rocks for about one or two crater diameters around it. And it required us to fly manually over the rock field to find a reasonably good area."

Goes to Manual Control

He punched a program into the computer that gave him full manual control. He did it so he could stretch out the landing, feel his way forward over the hostile lunar surface to find a smooth patch.

To listeners on earth, these final maneuvers appeared interminable. To fliers, they were a clue that this experienced test pilot might not have found everything to his liking at the targeted landing site.

"Down two and a half," came the radio report, probably from Colonel Aldrin. "Forward, forward 40 feet. Down two and a half. Picking up some dust. Thirty feet. Two and a half down. Shadow. Four forward, four forward, drifting to the right a little."

The fuel in the descent engine was now running low. This was not necessarily dangerous. But it did raise the threat that a suitable spot would not be found in time and that the crew, using mainly the ascent engine, would have no rocket back to orbit without reaching the goal that had been so close.

A moment later, from Eagle, came the welcome words: "Contact light." That meant a blue light in the cockpit had flashed on, indicating one of the five-foot-long probes extending beneath three of the four pads had touched the ground.

Almost immediately, Eagle settled onto solid soil, and the crew radioed that the engine had been cut.

Shackleton Is Ambivalent As Beliefs Are Fulfilled

By LORD SHACKLETON

I belong to a small and at one time very select band of people who have actually been to the moon. I first went to the moon with H. G. Wells—I didn't really count Jules Verne—and later with greatly improved space travel techniques journeyed with Arthur C. Clarke and other science fiction writers, and in a more allegorical way with Ray Bradbury.

For that once small, select band of believers the actual arrival of man on the moon has seemed such a near certainty for so many years that we read of it with mixed feelings.

Has the magic of being a prophet amongst the unbelieving gone now that the rest of the world knows the truth? Are our egos offended? Nobody will care when we say, "I told you so."

Lord Shackleton is Lord Privy Seal in the British Cabinet and the Labor party leader in the House of Lords. His father, the late Sir Ernest Shackleton was the famous Antarctic explorer. Lord Shackleton himself is a well-known explorer and mountaineer.

Back in the 1950's I proposed to a rather high-powered mixed Parliamentary-Scientific Committee that we might have a symposium on space research. I still remember the somewhat embarrassed silence and the advice of one of my Lancashire colleagues that "we ought to keep feet on ground."

Instead, I suggested that we should have a session on the International Geophysical Year that was then planned—a proposal received with relief! Yet it was in the course of the International Geophysical Year that the first satellites went up.

'Space Travel Is Bunk'

A mere month before, a very distinguished scientist proved conclusively to his satisfaction, but not to mine, that space travel was an impossibility.

The then Astronomer Royal uttered the famous words, "Space Travel Is Bunk."

Leaving these vague egotisms, there remains the inevitable satisfaction that one's romantic beliefs are fulfilled. Equally, the argument remains as to whether the enormous cost is justified.

If the choice were mine, I would choose to spend the money in other directions, yet it is not as simple as that. Scientific advance cannot be as neatly planned to conform with entirely rational criteria. Nor is the human spirit capable of being so confined.

The basic motivation, of course, is the competition between the United States and Russia. I would rather that competition, despite the military undertones, be in peace than in war.

Antarctic Treaty Hailed

Every sort of argument, military and economic, has been used for and against this adventure. Many of them were spurious, but I am certain that for America's own self-esteem she was bound to enter the competition. Still, I hope that the spirit contained in the simple notice that "we come for all mankind" proves to be the end result. I believe that it will.

There are analogies already in existence that can guide us. The Antarctic treaty in which many nations cooperate and which has frozen the sovereignty issue has insured that the Antarctic is the one part of the world to which the Cold War has never come. Scientists of all nations cooperate freely and even more strikingly, openly. The model is there.

The implications politically, therefore, are profound. I remember jocularly many years ago refusing to join the World Government Movement on the ground that I didn't wish to be associated with a purely earth bloc, but the fact remains that venture into space should be a unifying rather than a separating influence.

The year in which war left the earth and landed on the moon inevitably is the beginning of a new age. Horizons are bound to grow wider. The planets will follow in due course.

Within our present scientific knowledge, bound by the limitations of the speed of light, it seems impossible for man ever to leave the universe and go to other star systems and explore the Galaxy, but who will say what the story will be in another hundred, another thousand, another million years.

Mystical Thrill

This does not mean that we should turn our backs on the desperate needs of humanity on earth. Outer space must not drain resources from our own biosphere and from other sciences.

But the wider perspective given by the journey to the moon should encourage us to think more rationally and with more determination to achieve solutions; scientific horizons on earth should not be shortened.

As with the pure pursuit of scientific knowledge no one can foretell what new knowledge and understanding may come. For the landing on the moon is only a beginning.

What then of the motives of the men who make these journeys? What is the lure? Man has always accepted challenges at the very margin of his capacity, sometimes beyond. He did so for various reasons.

Wider Perspective

Early explorers from Pytheas onward went in pursuit of knowledge, trade or wealth. In the last century and the early part of this century some of the great explorers were in pursuit of national glory.

My father, when he sought to reach the South Pole, wished to carry the Union Jack into the heart of the great Antarctic continent and to lay his achievements at my mother's feet.

In my generation before the war, when debunking had become fashionable, we at the Oxford University Exploration Club used to boggle at the word "explorer" and excused ourselves by saying we were just trying to cure our inferiority complexes.

Equally, we insisted in a purist way that an expedition must justify itself in the quality of its scientific work, while privately we knew we explored for all sorts of personal reasons best summed up perhaps under the title "adventure."

When at the age of 21 I stood, as I believed, the first man on the highest mountain in Sarawak, Borneo, or we sledged across pack ice and up on the ice caps of Ellesmere Island, northwest of Greenland where no man had been, there was an astonishing feeling, a mystical thrill, only to be found in moments of religious ecstasy or great love.

This feeling will surely be present in the minds even of those highly trained, technological travelers who have now stepped on to land outside the earth.

What then is my own reaction? Certainly not surprise, but the wonder remains. Pride? The American people have every right to feel proud and should. The quality of imagination is shown again to be a decisive element in human life. Now we look to the stars.

Gilloon

COMMENTS ON LANDING: Lord Shackleton, the Lord Privy Seal of Britain.

Technology a Spur to Changes in Religion

By EDWARD B. FISKE

The flight of Apollo 11 takes place at a time of widespread theological and ecclesiastical turmoil, and will probably have the effect of further intensifying this unrest in the religious world.

The moon shot can be expected, for instance, to accelerate the trend already under way among theologians toward increased respect for man's capabilities in relation to God.

It could also contribute to the undermining of traditional authority and increase the receptivity of the man in the pew to doctrinal change.

In a series of conversations, Protestant, Roman Catholic and Jewish thinkers agreed that the moon landing would have none of the shattering effects of Darwin's theory of evolution or Copernicus's discovery that the earth is not the center of the universe.

For one thing, the mainstream of modern religious thought has long since made its peace with the scientific method. Only extreme fundamentalists in the various faiths still see a conflict between religious teachings and the discoveries of science.

For another, religious thinkers, like everyone else, have been expecting man to reach the moon for some time. "As they say in the stock market, such an achievement has already been discounted," said Rabbi Eugene Borowitz, a theologian at the Hebrew Union College, a Reform seminary.

Nevertheless, while theologians no longer debate the three-story universe or the literal truth of Genesis, they are intensely interested in the pace of technological change and man's increasing ability to solve virtually any problem to which he assigns sufficient priority.

The most obvious effect of this has been a higher respect for man among Christian theologians.

In the past, theology has placed considerable emphasis on man's sin and helplessness. While some preachers, such as Billy Graham, the evangelist, continue to emphasis these themes, most theologians have begun to emphasize man's strength, creativity and capacity to shape the world in which God placed him.

For members of local congregations this shift has been reflected in such trends as the decline of the sacrament of penance in Catholic churches and the development of folk masses and other liturgical forms that emphasize joy and celebration of creation.

For theologians the shift has meant emphasis on a God who is involved in the quest for justice in the world rather than a Barthian "wholly other" who is distant and aloof. It has produced speculation about how man can act as a "co-creator" with God in the continuing evolution of the world.

'The Idea of Creativity'

"Without sacrificing the notions of reason and freedom, Western theology needs to develop far more explicitly the idea of creativity as a distinguishing characteristic of human existence," said Harvey Cox, a professor at the Harvard Divinity School. "This means that man does not live in a world which is already finished but in an open universe in which he has the privilege and responsibility of continuing the process of creation. In fact, the refusal to continue might very well be considered the major form of sin in the contemporary world."

Another obvious theological issue raised by the technology of which Apollo 11 is a product is the nature of man's freedom.

Theology has always seen man as torn between obedience to God and sin, but now the dimensions of both have been expanded. Obedience to God can extend to dramatic conquest of the world in accord with the command of Genesis 1 to gain dominion over creation, but the possibilities for sin now also include the destruction of this same creation.

"It is impossible for man to ignore the radical nature of his freedom," said Leslie Dewart, a lay Catholic theologian at St. Michael's College of the University of Toronto. "If man spreads himself beyond the earth, he must face the grave question of what kind of a universe he is going to create."

Related to this new-style freedom is the fact that in exercising it man increasingly confronts not so much the universe as himself. As he becomes a "co-creator" with God, he also takes on the heretofore divine characteristic of omniscience.

"There are no virgin environments anymore," said Michael Novak, a lay Catholic philosopher. "Everywhere you go you find man's own efforts at transformation. In the past almost any technical advance was of humanistic value to man. But the growth of science and technology have brought us to the point where every choice of goals is a moral choice. If we put resources here, we neglect this and that. Everywhere you go in science, you don't find the world so much as the questions man addresses to the world."

Most theologians interviewed agreed that technological development would bring about significant changes in the religious life of ordinary churchgoers.

Laymen, for instance, will have to become accustomed to rapid changes in church teaching. "If in a decade you can go from having no space program to putting a man on the moon," said Dr. Dewart, "then you can expect equally rapid changes in theology."

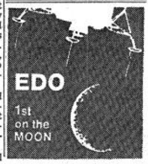
An important consequence of this, he predicted, will be an end to the generally accepted notion that religion is at least one field that deals with permanent and eternal verities.

"Theology will have to get accustomed to an environment in which there is no certitude and no perennial religious truth," he said.

Another source of anxiety to many religious persons will undoubtedly be changes in the source of religious authority.

While religion has traditionally looked to the past for authoritative teachings and the justification of ecclesiastical authority, technology is producing a society in which, according to Roger Shinn of Union Theological Seminary, "one tends to put confidence in the future rather than in the past."

Dr. Cox said that this could be easily accepted by Christianity because the early Christians were "basically future-oriented people in the midst of a civilization which was by and large oriented toward the past."



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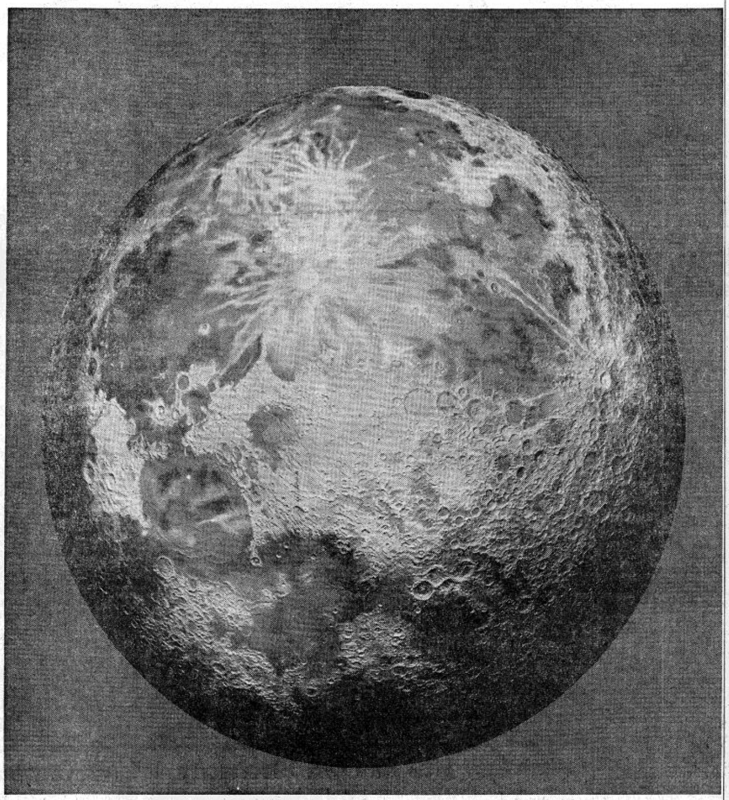

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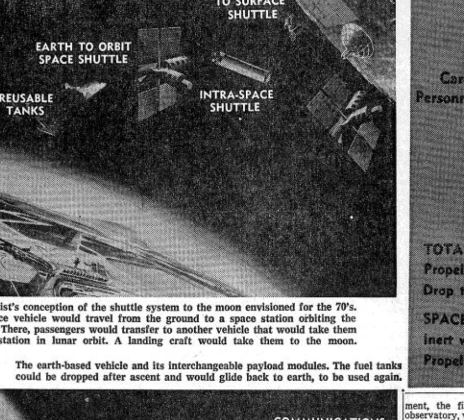
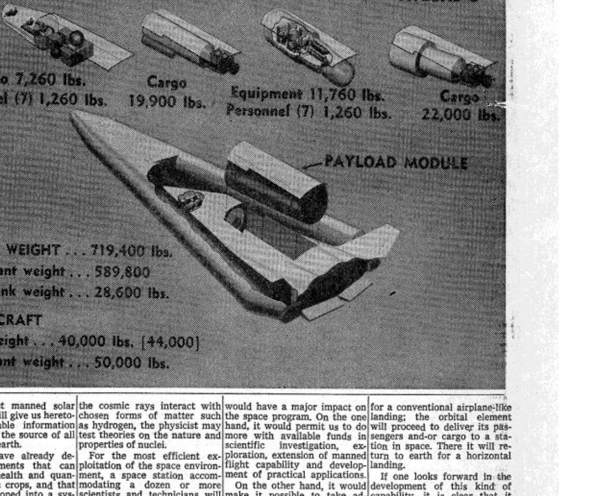
In the Next Decade: A Lunar Base, Space Laboratories and a Shuttle Service



An artist's conception of the shuttle system to the moon envisioned for the 70's. A space vehicle would travel from the ground to a space station orbiting the earth. There, passengers would transfer to another vehicle that would take them to a station in lunar orbit. A landing craft would take them to the moon.



The earth-based vehicle and its interchangeable payload modules. The fuel tanks could be dropped after ascent and would glide back to earth, to be used again.

An earth-orbiting complex. Six-man Apollo spacecrafts could dock against main station.

By GEORGE E. MUELLER

This day man's oldest dream is made a reality—this day the ancient bonds tying him to the earth have been broken. Apollo has given us a new freedom. With the achievement of the first manned landing on the surface of the moon, we have accomplished the most momentous feat in the long history of man.

The triumph of Apollo is nevertheless only a beginning—it has given us the confidence to dream those impossible dreams and the knowledge required to make those dreams a reality.

No event in the world's history has so sharply focused the attention of people everywhere. For men of all nations, and of all stations, Apollo is a portent of progress, a benign symbol of their ability and of their civilization.

But Apollo is more than a portent—it has already contributed greatly to the advancement of knowledge and the utilization of technological innovation, which are the keys to better living for all people everywhere on this earth. In addition, the pursuit of excellence that characterizes space activity, has directly advanced all of those nations that have entered this arena.

Dr. Mueller is Associate Administrator of the National Aeronautics and Space Administration.

A Factor in Politics

It is clear that leadership in science and technology is a dominant factor in the economic and political competition among the industrial nations. It is also clear that only continuing growth in national productivity can produce the wealth that is necessary to provide the rising standard of living that more and more people are coming to expect.

The stimulus of the space program has already produced more new knowledge and more innovations in all aspects of our lives than any previous endeavor, even including a major war.

The basic idea of the space helmet has been used in the design of a hood worn by patients in a children's clinic so that their consumption of oxygen can be measured while they perform exercises.

A filtered air system that eliminates virtually all dust and airborne bacteria within minutes from the operating room and other medical environments has been developed.

The National Aeronautics and Space Administration program for assembly of spacecraft in a dust-free environment provided the scientific basis for these surgical and medical applications.

Plastic-Metallic Spray

A plastic-metallic spray for attaching heart electrodes to test pilots is being used experimentally in equipment with which electrocardiograms of ambulance patients can be flashed ahead by radio to a hospital receiving room.

A sensor designed to count meteorite hits on a spacecraft is the basis of an instrument that, by measuring muscle tremors, may help doctors in early detection of certain neurological ailments, including Parkinson's disease.

An instrument designed to measure air pressure on small flight models in wind-tunnel tests has been adapted to measure blood pressure. The sensor is so small it can be inserted through a hypodermic needle and pass along an artery into the heart.

There are many examples of the use of space technology in industry and other nonmedical fields.

A 24-ounce, battery-operated television camera no bigger than a king-size pack of cigarettes, which photographs the separation of Saturn 5 rocket stages in flight, is on sale in a commercial version for monitoring industrial processes.

New Lubricant Developed

Bearings now being marketed are coated with a ceramic-bonded dry lubricant developed for use at high temperatures in a vacuum where other lubricants evaporate.

Research in developing models to display spacecraft trajectories has resulted in the marketing of a new education device that enables a student to determine quickly the relative positions of the planets on any day in this century.

And yet the most important product, the one that will have the most enduring effect, is, I believe, the permeation of society by that psychology which accepts and, indeed, expects the use of new technology. Over half a million people have been trained in new ways of doing things, and their influence will continue through the coming years.

Scientific parochialism has been broken down before such challenges as the requirement to keep a man in comfort on the lunar surface—where there is no atmosphere, and where the temperature varies between 260 degrees and minus 330 degrees Fahrenheit.

Engineers worked with medical doctors, chemists and metallurgists with biologists—all these and others learned to work together to prepare the environmental control system that Buckminister Fuller has called "man's first scientific home."

We have learned much and we have built well, and we are now prepared to meet the next challenge—to utilize this new territory, this "other world," the moon. Nine more Apollo-Saturn mooncraft are being readied to continue the exploration of this fascinating new land.

Our lunar exploration program has planned landings at 10 sites, four of which lie essentially in the zones of the initial Apollo lunar landing candidate sites. The first landing was in an eastern mare region and the second will be in another mare of different characteristics in the western region.

The third flight will be directed to a highland, flat region characterized by the Fra Mauro formation. The fourth landing will be the first attempt to land in the cratered highlands near the Crater Censorius.

The fifth landing mission is planned for the Littrow area, which is characterized by dark volcanic material.

The next visit will be on the rim of the Crater Tycho, the site of the Surveyor 7 landing, where we will use the rocks thrown out by the impact to learn about the composition of the first few hundred feet of the lunar crust.

This will be followed by a landing mission in the Marius Hills area with its many volcanic domes.

Site at Schroter's Valley

The eighth landing is planned for Schroter's Valley, with the purpose of looking for and examining possible transient events and to learn more about the red flares that have been seen in the area.

Hyginus Rills will be the site of the ninth landing mission where we will be looking for volcanic craters in the Linear Rille to determine whether or not its origin is volcanic.

The last landing will be inside the Crater Copernicus, where rocks taken from the central uplift will give us our first material from thousands of feet below the surface, thrown up by the explosive force that formed the crater.

Over $3-billion has been invested in facilities that are now being used to produce additional vehicles for continuing space activity. Although the Apollo work force has been reduced to about half of its peak number, much of the expert team is still in place.

And these are, indeed, fortuitous conditions, for we could hardly expect to ignore the 14.6 million square mile lunar surface—less than three days travel time from our shores.

We already know that the moon, which is likely to have been formed of the same materials and at the same time, is a vastly different body from the earth. Our studies and the information returned by unmanned probes have stimulated many interesting theories about its characteristics. We will want to verify these theories.

It has been surprising that as we have learned more about the moon, we have found it is a much more dynamic planet than any one thought four or five years ago. For example, many geophysicists now believe that there were at one time oceans on the moon. And from our orbital pictures, we have seen evidence of what might have been the flow of rivers on the moon.

Wherever there are oceans and the atmosphere that has to accompany them, there may have been the kind of conditions that led to life on this planet.

More than that, if there were once large quantities of water on the moon, then there still should be major deposits of this, the most important natural resource required to establish self-sustaining systems on the moon.

The combination of a nuclear power plant located so as to use its waste heat to melt the permafrost and its electrical out-put to separate the melted ice into hydrogen and oxygen and to drive the nitrogen out of the basic rock will, in a few months of operation, provide the atmosphere we need for men to live on the moon and the propellants they need to travel over the surface.

Understanding the Earth

The addition of suitable housing would provide a base from which to explore, and perhaps eventually to exploit, the rich natural resources I believe the moon will have.

Of course, before we can consider these possibilities we must carry out the preliminary exploration required before a decision as to whether there are sufficient potential rewards to justify the establishment of a lunar base, whether nationally or internationally supported.

One may not overlook the advantages of being able to invite our international colleagues to join us in this new territory to which we have opened the door—an invitation only feasible with a lunar base.

We will also want to investigate the possibility of similarly using the moon as a convenient island base near our earth from which to explore more distant parts of our solar system.

Finally, by investigating the characteristics of the moon we have the opportunity to gain new understanding of the origin of the solar system and perhaps to gain clues to the origin of life. In the judgment of the scientific community, the moon ranks next to Mars as an objective for exploration.

And it has the advantage of nearness now; it is within the capability of the present Apollo-Saturn 5 transportation system. Scientific attention to the moon will produce very substantial additions to our understanding of the earth and the solar system, during the next few years.

I fully expect that on the moon we will find both material resources and information that will be of sufficient importance for us to want to continue our activity there.

Our space program has opened a new world on the moon, but on the way to the moon we have discovered another new environment that holds rich promise—the area beyond the earth's atmosphere, the weightless vacuum of near-earth space.

In order to exploit this area for specific earth-benefits, it is the opinion of our scientific advisers as well as ourselves that the establishment of a large and flexible space station is the most practical approach.

Flexibility would be achieved by building the station on a modular basis, each module supporting some specific function of the space station.

Given such a laboratory beyond the earth's atmosphere, studies that have direct application to the needs of man on earth could be conducted over long periods. An early experiment, the first manned solar observatory, will give us heretofore unattainable information about the sun, the source of all energy on the earth.

Scientists have already designed experiments that can measure the health and quantity of specific crops, and that could be developed into a system for seasonally measuring the viable rice, wheat, and corn crops of the world.

Especially important will be the development, testing and establishment of operating techniques for telescopes, multi-spectral cameras, infra-red radiometers, radar, lasers, spectrometers and other instruments that will give new information to trained astronauts in earth orbit in atmospheric and earth science problems.

Examples of such special observations are studies of atmospheric circulation, heat balance, air pollution, and meteorologic and oceanographic dynamics.

These observations will permit man to discover, by seeing and carrying out sophisticated measurements upon these phenomena, information not available from the preprogramed observations of automated instruments.

I would expect that these manned observations will provide the analysis and direction that will permit a total earth sensing program, both automated and manned, to take advantage of the unexpected knowledge and insights that will result in rapid and effective use of the earth-sensing information.

Effects of Zero Gravity

We expect that manned space laboratories in earth orbit will be the natural means of studying the effects of the space environment on man, animals and plants. While the initial emphasis must be to qualify man himself for space flight, studies on the effects of zero gravity, lack of diurnal cycles and radiation effects are certain to lead to useful increased knowledge of living systems on earth.

A manned space station will afford, for the first time, the possibility of carrying out studies on man in a reasonable volume, with good medical facilities, for long duration and with many crewmen.

The availability of astronauts to conduct tests and observations on plants and animals *in situ*, to use microscopes, and to return specimens to earth, will make enormous progress possible in this field.

In another module of a manned space station, we expect eventually to see a high energy cosmic ray and high energy physics laboratory. Studying the cosmic rays for their own properties will tell us about the nature and origin of the universe, observations that cannot be carried out on earth or even in balloons.

Letting the rare but extremely high energy particles from the cosmic rays interact with chosen forms of matter such as hydrogen, the physicist may test theories on the nature and properties of nuclei.

For the most efficient exploitation of the space environment, a space station accommodating a dozen or more scientists and technicians will be required. The station will be designed for a minimum of ten years of operational life, its cost being amortized by extended use.

Since the station will be a modular installation, modules can be changed, thereby preventing obsolescence and providing research flexibility. Three kinds of modules—for utility, living and experiments—will form the basic station.

To these can be added whatever facilities are appropriate at later dates. The installation of such a platform in earth orbit will give us a research, development and operations facility for accomplishing the increasingly important space goals we envisage. I believe that such a space station system could and should be in being by the mid-1970's.

The viability and success of long duration space station flight programs are critically dependent on the availability of a cost-effective and versatile round-trip transportation system.

Our studies have shown that a low cost reusable shuttle system will provide the most economical means of space station support. So we plan that the development of a space shuttle should be implemented in parallel with the space station.

Logistics systems for personnel rotation, expendables resupply, and experiments and experiment module delivery represent a major share of the cost of a manned earth orbiting space station flight program.

Planning studies underscore the importance of and the need for this more operationally effective and cost - effective manned round-trip earth orbital transportation system, a space shuttle.

In my judgment, the future of all space exploration is clearly dependent on the degree to which costs can be reduced. In recent years, substantial progress has been achieved in engine technology, in lifting bodies, and in system design.

This advance has created an opportunity to develop those reusable space vehicles that will have the most significant effect upon our future in space.

Unlike any other form of transportation, our space vehicles are discarded after a single flight. Obviously, no regular transport system could long withstand such costs.

Through reusability, however, we can expect to establish a reasonably economical transport system for all space activity within the next five or six years.

Resulting cost reduction would have a major impact on the space program. On the one hand, it would permit us to do more with available funds in scientific investigation, exploration, extension of manned flight capability and development of practical applications.

On the other hand, it would make it possible to take advantage of the presence of man in space to supervise, check out, and maintain experimental equipment and unmanned satellites.

If the transportation costs can be reduced substantially, man's use will increase and eventually it will be less expensive to use man than to design machines to partially replace him.

New space transportation concepts based on available and newly emerging technology, with emphasis on operational simplicity, can result in cost reductions exceeding a factor of 10 by the middle 1970s.

With the maturing of operational experience later in the decade, much greater cost reductions can be expected to occur, as they did when jet aircraft were introduced into commercial aviation.

I believe that progress in our engines, particularly, but also progress in our understanding of heat protection and structural design, have grown to a point in the last five or six years to where we can now design a vehicle that is capable of taking off from the ground, going into orbit, off-loading either its fuel tanks or its first stage, rendezvousing with other spacecraft in orbit, and then returning, landing horizontally at an airport and being refueled and reloaded, and then taking off and repeating the mission.

Shuttle Within a Decade

Great savings would also ensue if we were able to carry out an economical shuttle system between low-earth orbit and high-earth orbit or between low-earth orbit and lunar orbit. Here I believe that we will use nuclear rocket engines to build a second shuttle system, if you will, between the earth and the moon and, eventually, the planets. I foresee that taking place by the end of the 1970s.

Within the next decade I would believe, since it is possible and desirable, that a low-cost, completely reusable multi-shuttle transportation system will be in operation between the planets earth and moon. Such a system will deliver people and materials for hundreds of dollars per pound or less, a thousand times less than the costs today.

The system I envision, which will be technologically feasible well within that time period, will consist of three vehicles.

First, the earth to low-earth orbital shuttle, which we can begin to build today. This machine will take off vertically on rocket power; its tanks will peel off and return to earth for a conventional airplane-like landing; the orbital element will proceed to deliver its passengers and-or cargo to a station in space. There it will return to earth for a horizontal landing.

If one looks forward in the development of this kind of capability, it is clear that it is possible for these vehicles to take off from any of a number of locations, and essentially to land at those same or other locations.

In effect, almost any air field that we now have could be modified to provide for the necessary launching and landing facilities for vehicles of this sort.

In the long term, one would anticipate that these vehicles could take off from almost any airport. It will be a very versatile space transportation system. It has the potential of a point-to-point transportation system.

It should take no more than a second generation of the space shuttle to bring any point on earth to within an hour's travel of any other point on earth.

The second vehicle, an orbital shuttle, will be docked with the space station. When it has received its cargo it will proceed to a lunar orbiting station, deliver and pick up a payload, and return to its home port, the near-earth space station.

The third shuttle will transport cargo and passengers between the lunar orbit station and the lunar surface.

I believe that we will find enough exciting new things on and about the moon that we will want a continuing program of lunar exploration in the coming 1970's.

By the end of this decade the moon could be, and I believe will be, regularly visited, using the tri-shuttle transportation system I have described.

Similarly I believe we will want an aggressive program of space activities in the regions of space near the earth to take advantage of the weightless environment to produce new materials, to carry out observations of the earth and the stars, and even to use this strange new environment as our newest tourist attraction.

Thus we will use two major new developments in the realm of manned space flight that are within our grasp today, a long-duration manned space station and reusable transportation between the earth and space, within space itself, and out to the moon.

These capabilities provide the principal basis for fulfillment of our goals in the space sciences and our goals for eventual manned planetary exploration.

The ancient promise of Apollo moves nearer to fulfillment as we approach the day when knowledge and its application will have dispelled forever hunger, ignorance, disease, and, perhaps, even war. That is the promise of space.

Lunar Suit Has Its Own Electricity, Water, Oxygen, Fan, Refrigerator, Etc.

Special to The New York Times

HOUSTON, July 20 — The proper costume for a stroll on the moon weighs more than the man who wears it and is almost as self-sufficient as a space ship.

This lunar spacesuit is much more than a garment because it must carry its own atmosphere and offer protection against total vacuum, extremes of temperature and the risk of puncture by a hurtling micrometeroid.

Yet it must be flexible enough so that the wearer can walk, climb, dig and set out instruments on the lunar surface. Its flexibility is just great enough to meet that need. An astronaut in the lunar suit can only reach an inch or so above his head and only as far down as his knees.

He couldn't stoop over to tie a shoelace—even if he had shoelaces. Probably he couldn't get up unaided if he fell down.

Each moon explorer's suit weighs, altogether, 185 pounds—earth weight. The astronauts, Neil A. Armstrong and Col. Edwin E. Aldin Jr., weighed about 165 pounds each when they left home. On the moon, everything weighs one-sixth of what it would on earth.

The materials of the spacesuit and its life-support package include plastics, synthetic fibers, artificial rubber and several metals, including silver and gold.

Has Own Electricity

The moon-walk costume carries its own supply of electricity, water and oxygen. It has a fan, a refrigeration element and a sophisticated two-way radio. Even when the astronaut is not talking this keeps up a steady chatter of automatic signals to the lunar module and thence to earth.

For the guidance of mission controllers in Houston, it sends nine different kinds of information: battery current and voltage, oxygen supply pressure, suit pressure, four other readings of the temperature and pressure in the life support system and the astronaut's electrocardiogram, which shows the natural electrical activity of his heart.

The items were chosen to allow the mission controllers to maintain their own independent check on the moon explorers' safety and level of exertion. Much of the latter can be inferred from heart action and oxygen consumption.

The spacesuit and its portable life support system were developed separately by different companies.

The life support system, made by the Hamilton Standard Division of United Aircraft Corporation, Windsor Locks, Conn., is worn as a back pack. It contributes about 120 pounds to the total suit weight.

The pack's upper section, containing the radio antenna and an emergency oxygen supply, is detachable. It gives an extra 30 minutes' oxygen supply to augment the main system's capacity of roughly four hours without recharging.

Another separate unit, worn on the chest, carries the radio controls and instrument displays showing the astronaut his oxygen pressure and other critical readings.

In the main pack assembly a little more than a pound of oxygen is stored in a tank at a pressure of 1,000 pounds for each square inch.

Norman L. Bailis, an engineer at Hamilton Standard, said that this was enough to allow the astronaut to generate 4,000 B.T.U.'s (British thermal units) of energy. This is enough for about four hours, more or less, depending on how much energy a moon explorer expends.

The electrical power to keep the whole complex life support system functioning is produced by an array of silver zinc batteries in a container about half the size of a loaf of bread.

Many Layers in Suit

The astronaut's air is kept clean and scrubbed of its carbon dioxide by a canister of lithium hydroxide and activated charcoal.

The suit's cooling unit, a device without moving parts, cools by the sublimation of a thin layer of ice in a honeycomb chamber through which the suit's oxygen and water pass continually.

Sublimation is the process by which a solid changes to vapor without passing through a liquid phase.

The spacesuit itself, developed by I.L.C. Industries, Inc., of Dover, Del., is made up of many layers. Each has its own vital functions.

The lunar explorer's equivalent of underwear is a nylon covering with a network of thin vinyl plastic tubes. Water circulates through the tubes to keep the astronaut cool. He can vary the rate of flow to suit his comfort.

A Pressure Garment

Over the water-cooled garment is the extravehicular suit. First comes a multilayer pressure garment to give the astronaut his own atmosphere in the airless void of the moon.

Over that is an outer suit the National Aeronautics and Space Administration calls an "intergrated thermal micrometeoroid garment."

It combines the basic functions of the thermos bottle and a suit of armor. It must protect against fire, abrasion, temperature extremes, the impact of space dust and particles that might be hurtling to the moon at 64,000 miles an hour and infrared and ultraviolet rays.

It is a laminated covering of Teflon, fiberglass Beta cloth, metal coated Mylar film, Dacron, nylon and several other synthetic coatings. Knees, elbows and shoulder areas have an extra layer of Chronel-R, a woven metal fabric used because it can take a lot of abrasion without damage.

Over his head the astronaut wears a clear plastic pressure helmet and an extra-vehicular covering consisting of another clear plastic shell and two adjustable visors.

One visor is for protection against micrometeoroids; the other, gold plated, is to reflect some of the dangerously intense ultraviolet radiation in the moon's glaring sunlight.

The tough metal fabric used for portions of the suit was also used for the upper covering of the disposable lunar boots.

Maps of Moon Evolved Over 3 Centuries

Galileo Discovered Surface's Features With Telescope

By EUGENE M. SHOEMAKER

Scientific exploration of the moon began in 1610, when Galileo Galilei first aimed a small telescope at the moon. He discovered broad plains, high mountains, and enormous craters on the lunar surface.

During the next two centuries these features were plotted on maps and charts and given names by a succession of astronomers. Galileo called the plains *maria* because he thought they were seas, and he called the mountain areas *terrae*, the Latin word for "lands."

In 1648, the Jesuit astronomer Hevelius gave fanciful names to the different maria—*Mare Tranquillitatis* or Sea of Tranquility and *Mare Serenitatis*, Sea of Serenity—names that are still in use today.

This process of mapping and naming culminated in the nineteenth century in the comprehensive maps of Mädler and Beer and of J. F. J. Schmidt; these maps showed nearly all the features that can be seen through a small telescope.

Dr. Shoemaker is head of the geology department at the California Institute of Technology and is actively associated with the Branch of Astrogeology of the United States Geological Survey at Flagstaff, Ariz.

Toward the close of the nineteenth century a new era in lunar exploration was ushered in by the development of photography and by the construction of large telescopes.

Shape of Moon Measured

Photographs taken with a 36-inch refracting telescope at Lick Observatory in California were used to measure the precise shape of the moon.

Later the 100-inch reflecting telescope at Mount Wilson in California was used to take some remarkable photographs in the years between 1919 and 1923. Craters as small as one-half mile in diameter were recorded on the Mount Wilson pictures.

Some of these photographs remained the best scientific record of the lunar surface until 1964, when close-up television pictures taken by Ranger 7 showed craters as small as three feet across.

During the first half of the twentieth century, many telescopic studies were made of the physical properties of the lunar surface.

The moon was discovered to be shrouded in a porous layer of relatively fine particles, which impart peculiar optical and thermal properties to the lunar surface.

The fine particles effectively insulate the lunar interior from the heat of the sun and the cold of deep space.

In addition, the moon was found to be essentially devoid of an atmosphere. This means that no water can be present on the lunar surface and that the moon is not a likely abode of life.

At the lunar equator the temperatures range from about minus 300 degrees Fahrenheit during the lunar night to about plus 250 degrees Fahrenheit at lunar noon.

Direct physical exploration of the moon began in 1959 with the flight of the Soviet spacecraft Lunar 2. Luna 2 carried a magnetometer to the moon and showed that the moon, unlike the earth, has almost no magnetic field.

Later in 1959, the Soviets obtained the first pictures of part of the back side of the moon with Luna 3. They found that much of the back side consists of mountainous *terrae*.

The next step in direct exploration came with the successful flights of the American spacecraft, Rangers 7, 8 and 9.

Ranger 7 took close-up television pictures of *Mare Tranquillitatis*, near the spot where Neil Armstrong and Edwin Aldrin landed the Apollo 11.

The Ranger television pictures showed that the moon is pock-marked with a myriad of tiny craters. Most of these small craters are almost certainly produced by the bombardment of the moon by meteorites.

In 1966, the Soviet Union beat the United States in the race to land the first unmanned spacecraft on the moon. They won with Luna 9, a capsule that took pictures from a height of two feet above the lunar surface.

For the first time, the Luna 9 pictures revealed the particles that make up the lunar shroud. Although most of the particles are of microscopic size, some were found to be several inches across.

Shroud of Particles

The Luna 9 pictures showed that the lunar surface is complex and that there will be important scientific observations to be made by the astronauts.

The United States retaliated in the scientific competition with five successful landings of the Surveyor spacecraft and five successful Lunar Orbiters.

From the Surveyors we learned that the lunar shroud of fine particles is typically about 10 feet thick. It is strong enough to support the landing of an Apollo spacecraft as well as astronauts walking on the surface.

We also learned that the particles on the lunar surface have the same composition as the most common types of volcanic rock on earth and that the lunar *maria* are probably great lava plains.

With the Lunar Orbiters, the United States mapped in detail the planned landing site for the astronauts and completed the mapping of the back side of the moon.

Lunar Orbiter 4 also provided nearly complete high resolution picture coverage of the front side of the moon. These pictures revealed features that have provoked sharp scientific controversy.

Sinuous trenches on the lunar surface, some of them hundreds of miles long, are thought by some scientists to be channels carved by ancient streams. Others believe these trenches are lava drainage channels.

Careful analysis of the orbits of the Lunar Orbiters showed that the gravity field of the moon is unexpectedly rough.

The rough gravity field makes pinpoint landing of the Apollo spacecraft more difficult than anticipated, but it also provides clues to the structure and strength of the moon.

Each of the lunar *maria* is underlain by a mass of rock that has been deposited as an excess load on the lunar surface. Apparently this load is made up of a pile of lava flows extruded from the deep interior of the moon. It is supported by a strong, rigid lunar crust.

The most crucial scientific objective for the Apollo 11 astronauts will be to collect samples from the lunar surface and return with them to earth.

From these samples it will be possible to determine the detailed composition and age of lavas on *Mare Tranquillitatis* and the state and history of the interior of the moon, from whence the lavas came.

The astronauts will also set up a seismometer on the lunar surface to listen for moonquakes and probe the moon's inside.

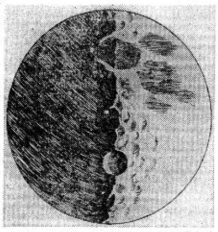
The information from returned lunar samples and from the lunar seismometer will form the basis for a great advance in the scientific understanding of the moon.

By itself, however, this information will not tell us what we really want to know. Where did the moon come from? How is it related to the earth? How was the earth formed, and when, and how did life originate on earth?

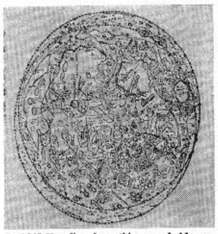
These questions can only be answered by an intensive program of scientific exploration of the moon, the earth, and the other terrestrial planets, Mars, Venus and Mercury.

The first manned landing on the moon is only a first step. It is the scientific beginning — not the end.

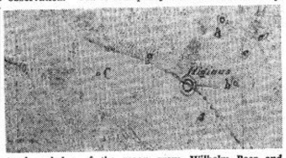
Today Armstrong and Aldrin stand at the threshold of one of the great quests for knowledge in the record of mankind. Shall we pursue this quest or stand pat and complacent on our laurels? That is the question that faces the people of the United States at this moment in history.



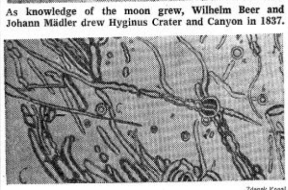
An illustration by Galileo Galilei published in 1610. His are the first drawings of the moon made from telescopic observation.



In 1648 Hevelius drew this remarkably accurate lunar map. He named the maria—Sea of Tranquility and the Sea of Serenity.



As knowledge of the moon grew, Wilhelm Beer and Johann Mädler drew Hyginus Crater and Canyon in 1837.



Zdenek Kopal

In 1878 Julius Schmidt, director of Athens Observatory, made this drawing of the same area near Sea of Vapors.

United Press International

Finally, man himself photographed the area. This picture was made from Apollo 10 last May, from about 69 miles.

MOON WIDE OPEN TO HUMAN STRIFE

Rivalry Expected to Develop Despite Space Treaty

By MAX FRANKEL

Special to The New York Times

WASHINGTON, July 20 — There was, alas, no flag of earth to be planted on the moon today. By necessity, as well as by the demand of Congress, the astronauts unfurled an American standard, which was all right for the moment of national pride but irrelevant to the new era of interplanetary relations.

Once again, science has outrun the diplomats. The engineers have outpaced the lawyers. The moon will be no more exempt from mundane strife than the New World has been these last 500 years. The rivalries of nations will spill into the ocean of space just as surely as they spilled into the Atlantic in Columbus's wake.

Some of the problems of spatial diplomacy have at least been anticipated.

A part of humanity, excluding the people of mainland China and several other millions, have already agreed in solemn treaty that outer space, including the moon and other celestial bodies, shall be free for exploration and use by all "in accordance with international [sic?] law" and "not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means."

That flag, in other words, means little more than that kilroy was there.

The treaty also pledges most earth governments not to place nuclear weapons in orbit around the earth and it stipulates that the moon and other celestial bodies shall be spared all military installations, maneuvers, fortifications and weapons.

It takes no lunar legal training to perceive that even those who would obey such treaties remain free to orbit what they wish around the moon and to conduct what maneuvers and construct what fortifications they choose anywhere between here and the moon. They are liable, under the outer space treaty, for damage to another state that has signed the treaty by their space objects, but the effort to define that liability has already given the United Nations a lease on life into the next century.

Space, in other words, offers ample room for human mischief. Two thousand pieces of space junk have already plummeted back from orbit since the launching of Sputnik I in 1957. At least an equal amount of debris is still spinning toward a fall.

After that will come only stellar legal and diplomatic problems.

If an American crop surveillance team in space or on the moon should suddenly detect impending famine in Communist China, will Washington be obligated to tell Peking?

Will the celestial Broadcasting System bouncing programs off the moon be free to teach Brazilians birth control?

And what will be the rights of the man on the moon if he discovers oil on a Nebraska farm? Did he have any right to go lunar prospecting in the first place?

The moon may be deemed to belong to no man, but not a few American corporations are ready to exploit the ideal lunar location for profit-making enterprises that gather and relay information useful to fishermen, ocean shippers, mineral prospectors and air traffic controllers.

By the time the first space generation gets itself bogged down in consideration of these difficulties, wonderfully vast new problems are sure to develop from man's modest first journey to the moon.

The diplomats have thus far thought of the moon as a harmless wasteland that can be domesticated as easily as Antarctica has been, but that is a rash assumption. Colonists from earth are bound to settle on the moon before they settle in Antarctica and they may gain control there of a strategic way station to the planets and the stars. At the least, they will be running some hotels there, but they may be tempted to open a toll station as well, much like that on the famous rock on the old Rhine.

Not even better space treaties would solve the international difficulties that will flow from the moon landing. Moscow and Washington may shoot this or that nation's instruments or citizens into space, but they will remain the preeminent moon powers and space voyageurs in the foreseeable future. How will mankind really share in the benefits and what troubles will it inherit from the disparities between those who can and cannot reach the moon?

Conquest of the moon will lead to new forms and powers of communication, to new experiments with the control of climate and new techniques of warfare and espionage. If the earthlings did not trust each other to sit together in the moonship, will they ever work together on the moon?

If there were an earth flag flying on the moon today, the men up there would obviously be tempted to label it the banner of a race of lunatics.

Johnson Says Feat Shows 'We Can Do Anything'

To former President Lyndon B. Johnson, the successful landing on the moon means that America "can do anything that needs to be done" in other areas, such as health and welfare.

"What we must have in this country is the determination to do it, and that's what we had in space," Mr. Johnson said in an interview with Walter Cronkite of the Columbia Broadcasting System.

The interview, the first of a series that Mr. Johnson has contracted to grant the network, was filmed at the LBJ Ranch July 5 for broadcast during the landing on the moon.

It was devoted entirely to the space program and the role played in it by Mr. Johnson.

"I've ridden on every mission," the former President said of the space flights—one of many comments in the interview that reflected his great enthusiasm for the program.

He also disclosed that he and Ho Chi Minh, the President of North Vietnam, had exchanged letters about the space program, and Mr. Johnson recalled urging President Kennedy not to appoint a military man as head of the space agency.

President Kennedy had been considering General James M. Gavin to be the administrator of the National Aeronautics and Space Administration, Mr. Johnson said.

"And I said, 'Mr. President, I think that's the worst thing we could do for the program, would be put a man with stars on his shoulder and a general's uniform in charge, because it would frighten other nations and be a great disservice to our program.'"

Mr. Johnson's letter from Ho Chi Minh was received in May. Just before leaving the White House last January, he explained, he wrote to 186 leaders of foreign Governments, sending each a picture of the earth taken during the Apollo 8 flight.

The letter, Mr. Johnson said, was "thanking me for sending him this picture, and expressing his appreciation for this act."

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APOLLO 11— MAN ON THE MOON

Last Night "Eagle" as the Astronauts call their landing craft, landed on the moon. You will have shared a great moment in history. Now you can have something to remember it by. This August, the Post Office will issue what will be the most unusual stamp ever issued in the U.S.A. The master die to produce the stamps is with our men on the moon this night. It will be used to produce this very special stamp after decontamination. The stamp marks the first man on the moon and for such a stamp and such an event, a very special envelope was created.

Embossed and engraved in red, white and blue on fine paper, the envelope depicts the American Eagle, much like the one used on the shoulder patch of the Astronauts, descending to the Lunar surface with the American Flag. Stamp collector or not, this is one of those mementos of a time, a place and achievement that none of us is sure to forget.

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Luna 15 Orbit Dips to 10 Miles From Moon

By BERNARD GWERTZMAN

Special to The New York Times

MOSCOW, July 20 — The Soviet Union announced tonight that the orbit of its unmanned spacecraft Luna 15 had again been altered, bringing it to within 10 miles of the moon's surface.

Tass, the Soviet press agency, made the disclosure only minutes before the Apollo 11 moon module detached from its mother ship on its historic attempt to land men on the moon and return them to earth.

The new elliptical orbit of Luna 15 created tension among observers here, who wondered if the latest correction was a prelude to an attempted lunar landing by the Russians, perhaps even in the same vicinity where the Americans were due to land.

Soviet officials have given assurances to the Americans that Luna 15 would not interfere with the Apollo mission. But the new orbit led to renewed speculation that the Russians might try to land the Luna craft and return it to earth with moon rock in an effort to demonstrate that unmanned craft were the equal of manned ships, if not more valuable.

As usual, Tass gave no information on the goal of Luna 15. It said only "the automatic station Luna 15 continues scientific exploration in the near-moon outer space."

Tass said that the latest maneuver took place at 5:16 P.M. Moscow time today (10:16 A.M. Eastern daylight time).

Luna 15 was launched last Sunday and went into moon orbit on Thursday. Last night Tass announced that its orbit had been altered to between 136 miles at the maximum and 59 miles at the minimum from the surface of the moon.

Today's correction brought the craft into an orbit of 68.3 miles maximum and 9.94 miles minimum.

The orbit's inclination to the plane of the lunar equator was given as 127 degrees, a slight change from yesterday's 126.

In its new orbit, Luna 15 was circling the moon every hour and 54 minutes, Tass said. The previous orbit took 2 hours 3½ minutes.

"According to the data of the telemetric information, the systems and scientific equipment on board the station are functioning normally," Tass said.

When Luna 15 was first launched, Tass said that its mission was to conduct research in the moon and near-moon space, leaving open the possibility of a moon landing.

Many observers here believed that it would continue the research started by previous unmanned craft in the Luna series that orbited the moon but did not return to earth.

But Communist sources have insisted for months that the Soviet Union was plannning to land an unmanned craft on the moon and then return it to earth.

So far Soviet media have given minimum attention to Luna 15, and most Russians are much more aware of the Apollo 11 mission.

Moscow radio has moved short news items on the progress of the Apollo mission. Russians wanting a full account of the flight have to have good short-wave sets and a knowledge of a foreign language. Russian-language broadcasts from the Voice of America and the British Broadcasting Corporation were heavily jammed as usual.

The landing of the Apollo moon module was not reported here immediately, but later Moscow radio announced it briefly.

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Ad Astra

In the long evolution of the human race up from the primeval ooze, no more significant step has ever been taken than yesterday's when man the worldling truly became but "little lower than the angels" and first set foot upon another planet. For thousands and thousands of years—all through the brief span of recorded history and through the dim ages of the darkening past—that puny creature endowed with the most powerful of all weapons, the human brain, has raised his eyes, his arms, his aspirations—first to the hills and the mountain tops, then to the skies and the stars.

And now he has attained the unattainable; he has lifted himself from this little speck of matter to walk the surface and probe the depths of another world. True, it is an even tinier world than the one we know, presumably a lifeless world, a forbidding world—but another world.

This is the year, this the month, the week, the day when, so far as we can know, for the first time in all the eons of existence of this universe of ours, a sentient being has transported himself from his earthly habitat to a different sphere floating in the endless sea of space. The men that landed yesterday on the moon represented not any group or creed or nationality; they represented all humanity and they carried with them a little bit of all the hopes and struggles of mankind to attain the heights throughout the ages.

Yesterday, July 20, 1969, will be marked forever as the day man transcended the bonds of his nature and his environment, and the human race entered a new era leading to realms beyond comprehension and even beyond imagination. Man has realized the unrealizable because he dared to conceive the inconceivable; now one can believe that the limitations to the accomplishments of man are set only by the limitations of the human spirit.

And therein lies the irony inherent in this most extraordinary expression of man's prowess. As man gains another world—with the prospect of adding another and still another, literally ad infinitum—he stands in imminent danger of losing his own. Transfixed by the glowing vision of the stars, he too easily turns from his ugly failures on this earth. He cannot afford to do so, least of all at this moment of his triumph in the skies. The godlike quality of his better nature must not blind him to the dismal realities of life today, marked as they are by vicious struggles of men and nations for power and control over each other, as they have been from the beginning of time.

For all his resplendent glory as he steps forth on another planet, man is still a pathetic creature, able to master outer space and yet unable to control his inner self; able to conquer new worlds yet unable to live in peace on this one; able to create miracles of science and yet unable properly to house and clothe and feed all his fellow men; able eventually to colonize an alien and hostile environment and yet increasingly unable to come to terms with the nurturing environment that is his home.

The great question for the decades to come is not how or why or when man will continue his excursions under the arch of heaven, as he certainly will; but whether the magnificent accomplishment celebrated throughout the world today will at last inspire him to achieve the age-old goals of which he is capable and for whose realization he has yearned so long: life in harmony with nature, peace with his fellow man and a just society on this no longer lonely planet earth.

Tranquility Base

Eagle landed safely yesterday afternoon and Tranquility Base was born. The hundreds of millions here on earth who followed those triumphant but anxious last minutes before touchdown knew they were witnessing the greatest achievement of human technology in history. Then a few hours later came the equally historic first walk on the moon, followed all over the world through the magic of television realizing its highest potentialities in the cause of science. Within minutes, centuries of speculation about the nature of the lunar surface and about the ability of man to function on the moon were ended, replaced by verified facts reported from the scene by the first two men on the moon. These fantastic and immortal accomplishments made July 20, 1969 more than comparable to the day in 1609 when Galileo first turned his telescope on the moon and discovered it was a world like earth with its own valleys and mountains. But the drama of yesterday's unprecedented manned landing on the moon will stand unchallenged until some future descendant of Eagle brings the first astronauts down gently to the surface of Mars.

There is so much glory to be shared that all who had a part in the great enterprise of Armstrong, Aldrin and Collins can have their fill. John F. Kennedy made the fateful decision to go to the moon eight years ago. Lyndon B. Johnson worked effectively before and during his Presidency for this project. James Webb created and directed the vast NASA organization responsible for this feat during the most important years of its work until almost the culmination. Thousands of scientists and engineers made contributions; the great rocket pioneer Wernher von Braun and the originator of the lunar rendezvous technique, John C. Houbolt, stand out among them. Many great industrial organizations contributed, too, notably North American Rockwell, Grumman and Boeing. Nor should one forget the indispensable contribution of the Soviet rivals, particularly Nikita S. Khrushchev and the late Yuri Gagarin, who supplied so much of the stimulus that challenged the United States to this height of achievement. And all the astronauts who have flown in space rank high on the honor roll of those who brought man to the surface of the moon.

* * *

Science, of course, will be the immediate great gainer from this triumph of human reason. It looks to the moon, above all, for new light on the mysteries of creation both of the material universe and of life itself. The origin of the moon is the first question toward whose answer the findings at Tranquility Base will provide indispensable new data. Was this new world men have finally reached once part of this planet, torn away by vast tidal forces? Or is it an interloper from distant space captured by accident as it wandered through infinity? Or, as many suspect, is it a smaller twin brother of this globe, condensed from the same vast aggregation of gases that gave birth to earth itself? Soon the answers may be known.

It would be staggering indeed if any native life were found on the moon, or even if fossil remains of past living organisms turned up. Most scientific opinion discounts these possibilities, but they cannot be entirely ruled out. Yet even if the moon proves devoid of organic life, a whole new era is opened for biology by the prospect of studying the adaptation of organisms evolved here on earth to the reduced gravity and other very different conditions of the new lunar habitat.

The study of the moon itself will occupy diverse branches of science for decades and centuries ahead. But even while that important work progresses, other scientists will be using the lunar surface as a platform for studying the universe beyond the tiny two-body system that men have populated. Optical and radio telescopes on the moon will uncover new secrets of this amazingly complicated universe and pose new riddles akin to those raised by the recent discoveries of quasars and pulsars. And the moon will also serve as a launching pad for even more daring flights to further objectives beyond that which Apollo 11 has reached.

But all these glittering prospects lie in the tomorrows ahead. For the moment, there can only be enormous satisfaction at the immense leap forward all mankind has made.

New Priorities

The monumental achievement of man's landing on the moon poses for the United States a profound question—whether to follow up at once the lunar triumph or to pause in the conquest of space for a comparable crash program to treat our domestic ills.

It is by now almost a platitude to contrast the fantastic efficiency of the Apollo program with the ineffectual approaches the country has made to the poverty and malnutrition of its least fortunate citizens, to the alarming decay of its cities, to the sad decline of its public services, and to the pollution of its air and water. Many of the world's leaders have made the point, none more bitingly perhaps than Arnold J. Toynbee: "If we're clever enough to reach the moon, don't we feel rather foolish in our mismanagement of human affairs?"

We have sympathized with that point of view and in some degree we still do. But it is no longer the pertinent question. Now that men have reached the moon, it will be cogently argued that the sacrifices and courage already invested will be wasted unless they are allowed to exploit the epochal breakthrough, to explore the lunar world, unlock its history, and study its possibilities, including the search for subsurface water that would make possible its permanent settlement by human communities.

* * *

For this purpose the cost need not be a barrier to those social advances that need so desperately to be made. The civilian space program has cost the country more than three billion dollars a year since President Kennedy eight years ago fixed the goal of putting a man on the moon by the end of this decade; and the nine Apollo missions remaining in the planned series would cost approximately an additional $350 million each.

These sizable outlays are not to be belittled, but they should be viewed in perspective. If annual expenditures on the program are continued at the present rate, they will represent about one-half of what the country spends each year on liquor. On the other hand, the cost of modestly rehabilitating America's cities is reliably estimated at some $55 billion, or roughly twice the investment spent and projected for the entire Apollo series. It is not the moon program alone, in short, that has prevented the nation from doing what it should to improve the quality of life, and that program should not be allowed to explain or excuse the failure.

* * *

When Vice President Agnew talks seriously of putting a man on Mars by the end of the century, however, it is time to take renewed thought of the nation's priorities. For a program leading to a manned journey to Mars would be of a staggeringly different financial dimension from that required to explore the moon. This country could undertake such a project by itself only at the cost of grossly neglecting its pressing social needs.

After yesterday's dramatic event few will be rash enough to discount the possibility of an eventual landing on that planet, but if the objective is to be pursued at all in the foreseeable future, it should be pursued only in conjunction with other world powers—preferably with all of them under the auspices of the United Nations. Not only would costs for any one nation then become endurable, but the goal itself would be a spur to that unity here on earth which is the best of all justifications for man's exploration of the universe.

Capitalist Moon or Socialist Moon?

By HARRY SCHWARTZ

Long ago the question was asked how a future titan of private enterprise — a Henry Ford or John D. Rockefeller of space — might organize and finance the first manned trip to the moon.

An American science fiction writer posed and fictionally solved the problem in an ingenious and unjustly forgotten short story. The author had his entrepreneur-hero raise the needed money by selling advance monopoly concessions on the moon to the earth's great corporations, each paying handsomely for the exclusive right to mine minerals, run radio stations, or operate manufacturing enterprises on or under the lunar surface.

Matters have not turned out that way. The race to the moon has been a competition between governments, each financing the huge costs from the public treasury. The three Apollo astronauts are all government employes, and Neil Armstrong —the first man ever to walk on the moon—belongs to the civil service. James Webb and Thomas Paine, the two chiefs of NASA this past decade, are both energetic people, but they are successful bureaucrats, not entrepreneurs in the grand Ford-Rockefeller tradition.

Realization of these facts should dispose of any notion that the race to the moon was in any sense a test between two ideologically based economic systems. The stereotype has been that this was a competition between American capitalism and Soviet socialism. But the triumphant United States moon program was as socialistic in its central direction and financing as its rival Soviet effort. The huge private corporations that built the Apollo hardware made immense contributions, of course, but only as servants of the state that paid the bills. And Luna 15 is an effective reminder that Soviet enterprises too can build space hardware.

What Lunar Administration?

This ironic history is relevant because it helps focus attention on a question immediately raised by the historic first manned landing on the moon. Is it to be a socialist moon or a capitalist moon?

It can be taken for granted that tomorrow's lunar world will have mines, factories, hotels, newspapers, radio and television stations, and probably even professional sports teams like the Mets and the Jets. Are they to be run by private businesses as the science fiction writer mentioned above assumed, or will they simply be bureaucratic subsections of some huge over-all MAA (Moon Administrative Authority), or whatever it may be called.

Are those lunar hotels to be Hilton swank or Intourist spartan? Should securities analysts be gearing up to study the prospects of companies named Lunar Industries Inc. or Moon Minerals Exploration Ltd.?

One difficulty in answering these questions is that nobody owns the moon. The Apollo 11 astronauts won't have to pay anyone for the lunar rocks they intend to pick up and bring to earth. Nor is there any landlord to whom they will have to pay rent for the territory that they land on and explore.

Until very recently such questions of property rights on the moon seemed as unimportant as the possibility of men landing there seemed fantastic. Now the landing is a reality, and problems that yesterday only science fiction writers worried about are today on the agenda of world politics and economies.

The Space Treaty adopted and ratified by most nations a few years ago—including the U. S. and the U. S. S. R.—declares that "the exploration and use of outer space, including the Moon . . . shall be carried out for the benefit and in the interests of all countries." But these and other vague provisions give little guidance for solving the practical problems ahead, especially in the present concrete situation where only two nations have the capability to send men and equipment to the moon.

One possible outcome is the transfer of the ideological rivalry to the second inhabited world. American lunar mines, factories, hotels and the like might be run by private firms, while their Soviet analogues might simply be branches of the corresponding Moscow ministries. The wastes and dangers in this "solution" are plain.

For U.N. Ownership

A much more sensible way out—but one that may be hard to achieve because it was not decided before men reached the moon—is for the nations of the world to agree that the United Nations is the owner of the moon.

Then the U.N. could assign different sectors of the future lunar economy on the basis of competitive bids offered by rival private companies and government agencies in all countries. The income thus received could be used to help the poverty-stricken nations of the world, regardless of political or economic systems. That solution would make the moon an instrument for unifying mankind, not continuing or widening today's dangerous fissures.

HARRY SCHWARTZ is a member of the editorial board of The Times.

Letters to the Editor of The Times

Draft as Servitude

To the Editor:

Your July 11 editorial "A Moral Obligation" which chides the Congress for not holding hearings on President Nixon's draft reform proposals in my view misses the vital point. There is no moral obligation to implement either Nixon's proposals or the other so-called draft reforms which were urged in the last Congress by Senator Kennedy and other Senators, on which hearings were held but did not result in any legislation.

These reforms, merely altering the method of selecting draftees, do not go to the heart of the issue which is that the draft itself for this war is the inequity, the injustice, the immorality. What difference does it make whether our young men are selected by lot or any other way to become cannon fodder in a war which many consider totally unjustified and immoral?

What this means is that they are compelled in violation of their consciences to kill people against whom they feel no grievance, perhaps get killed or maimed in the process, with the alternative, if they refuse, of imprisonment for five years at hard labor with probable ruin of their future careers in civilian life.

This is an infamous dilemma, and no American citizen—indeed no member of a society that calls itself free—should be subjected to it. But so far as the executive and legislative branches of our Federal Government are concerned, neither has had the vision or understanding to face this issue. Neither (with the exception of Justice William Douglas) has the Supreme Court, which has repeatedly refused to overrule the draft convictions.

It is difficult for a layman—and for this layman—to understand why the 13th Amendment of the Constitution which the Warren Court has done so much to interpret and implement is not applicable to the draft.

The draft is involuntary servitude and it is a betrayal of our finest traditions and of everything America should stand for. The moral obligation on the Congress should be not to reform its procedure but to abolish it for the rest of this war, particularly as we continue to exact the wanton sacrifice of our young men in a war that we can't win, shouldn't want to win, and which President Nixon has declared we have no purpose to win militarily.

No wonder there is unrest, bitterness and rebelliousness among our young people.

Why should we keep on sending our boys to die or be crippled in vain?

ERNEST GRUENING
Former United States Senator
Washington, July 11, 1969

Taxes on Oil Industry

To the Editor:

Your July 3 editorial comments on the petroleum industry's tax burden "No Surrender on Tax Reform" showed strong symptoms of tunnel vision.

The editorial confined itself to Federal taxation. However, the petroleum industry, like everybody else, pays taxes at three levels of government—Federal, state, and local.

Though its Federal tax bill is somewhat below average, it pays substantially higher state and local taxes than other businesses. This is largely due to heavy state and local taxes on oil and gas production that nonextractive industries do not have to pay.

Comparative studies have shown that the petroleum industry's Federal, state and local tax bill on its earnings, operations and properties runs consistently higher than the corresponding burden of other business corporations.

With oil company earnings on invested capital averaging consistently somewhat below the profit rate for all manufacturing industries, a reduction in percentage depletion would lead either to a falling off in the search for new reserves or higher price realizations on petroleum products. Either way, the consumer would be the one to suffer.

STEPHEN P. POTTER
New York, July 10, 1969

The writer is director of the American Petroleum Institute's Committee on Public Affairs.

'Qualified' Workers

To the Editor:

It was reported in The Times of July 14 that the State Department of Civil Service has "remove[d] vocabulary and reading comprehension from the subject matter in examinations for beginning office workers" and that "the entrance examination for stenographers and typists has been revised through elimination of the vocabulary test."

The purpose of these measures, according to Governor Rockefeller, is to "assist qualified minority group members to enter state service." This strikes me as an odd way to recruit "qualified" office workers. Or are reading, writing and other basic skills henceforth to be regarded as a rather quaint (and, of course, "irrelevant") white middle-class hangup?

J. HERMANN
New York, July 16, 1969

Right to Jerusalem

To the Editor:

It would be interesting and important to know whether Harry G. Dorman Jr., in his July 15 letter, speaks officially for the National Council of Churches in the U.S.A. He recalls that churchmen have made "very clear . . . that any expansion by force of arms cannot be condoned, and second, that Israel's unilateral annexation of the Jordanian portions of Jerusalem cannot be approved."

If this implies that the National Council or the World Council of Churches did approve Jordan's unilateral annexation of portions of Jerusalem, when and by what authority did this occur? If it implies that the American churchmen condoned Jordan's expansion by force of arms, by what moral or theological principle was this justified?

The moral basis of Israel's actions in Jerusalem is crystal clear. The city—not "portions" of it, but the entire, strategically indivisible city—was Jewish by a two-to-one preponderance of population at the time of its enforced partition, and has had a Jewish majority for about a century. Not its unification, as Mr. Dorman pretends, but its division "completely discounts the rights and desires of the people of the city."

Mr. Dorman's plea on behalf of the "people of the city" is based on the unspoken assumption that, in Jerusalem at least, Jews have no rights and are not entitled to any consideration of their desires, and thus may be completely discounted in any weighing of popular opinion there. He apparently does not consider it "cultural imperialism," let alone an expression of theological odium, if the traces of Jewish attachment to the center of their universe are deliberately obliterated.

The Romans attempted to keep Jews out by sowing the land with salt, the Christian Crusaders by bloodshed, the Moslems by burying Jewish shrines in dung. Only when the Jews plan to restore space and beauty to the holy places does the Christian conscience of the American churchman rebel.

This is the kind of reaction which has shocked many Jews since the Six Day War. If it is not official, nor characteristic, it would be essential for any restoration of an ecumenical spirit that it be repudiated or corrected by an official, representative voice.

BENJAMIN HALPERN
Prof. of Near Eastern Studies
Brandeis University
Waltham, Mass., July 15, 1969

Future of Classics

To the Editor:

The trend to replace the study of Latin and Greek with the classics in translation as reported in your July 14 news article ("Classicists Seek Place in Present") should be interpreted within the broader context of the decline of language study in general. The paperback explosion has exposed countless students and their teachers to works which they could never have read in the original. With so many excellent translations available, the student naturally asks why he should learn Greek to read "The Iliad" or Russian to read "The Brothers Karamozov."

The utilitarian nature of American education makes such naive questioning inevitable. But there is another question, more ominous and perplexing, which English professors and deans are beginning to ask: With the availability of so many works in paperback plus "advanced" methods of teaching English in the elementary and high schools (films, recordings and, above all, no grammar), how is it that college freshmen have become so illiterate that even the best universities have despaired of teaching composition and have shunted the students off into World Lit as a sort of oubliette?

Latin, the *bête noire* which incompetent teachers and overzealous administrators have pacified into inactivity, was one of the few ways by which a student could learn English grammar, particularly if his English teacher was inadequate. With the decline of Latin and the banishment of the traditional methods of teaching English (teachers have been fired for showing fifth-graders how to diagram sentences), we are faced with the most articulate, sophisticated and illiterate generation of students in our history.

Classics in translation will thrive, except that many students will have as much difficulty reading the translations as they would the original texts. But we need not worry, since the techniques of Latin instruction will have to continue. In fifty years coll[illegible] freshmen will be parsing [illegible]mlet" in much the same [illegible] [illegible]e parsed Cicero's "First Catilinarian."

BERNARD F. DICK
Assoc. Prof. of Classics
Iona College
New Rochelle, N. Y.,
July 14, 1969

Student Loans

To the Editor:

I am not in favor of student protest, but I feel that when an injustice such as increasing the interest rate from 3 per cent to 7 per cent on student loans can go through unannounced and without a voice of any kind from the youth it affects, some voice must be heard.

This increase more than doubles the previous rate and hits directly middle-class students who require this money to further their education. Students will have to repay these loans, taken out in their name. Then why are they not voicing their opinions on this injustice?

HERMINA LINDAUER
Roosevelt, L. I., July 16, 1969

Ban on Smoking Ads

To the Editor:

Broadcasters, under extreme pressure, have "volunteered" to phase out cigarette commercials. In effect they are asking Congress to allow them to continue killing for another four years, if they promise to stop by 1973.

Every day some 4,000 youngsters—over one million each year—take up smoking largely as a result of the climate created by cigarette commercials.

Reliable estimates are that over 300,000 people die each year from smoking, that many more millions suffer increased disease and disability, and that the costs to the American people of the deaths, disabilities, and damages caused by smoking are over $10 billion a year. Cigarettes each year take more lives than the war in Vietnam, automobile accidents, crimes of violence, and deaths caused by drugs.

Even before the "deal" was offered, the House of Representatives voted overwhelmingly to do nothing about cigarette ads for six years. It is to be hoped that those who do not like the "deal" will let their two Senators know.

JOHN F. BANZHAF 3d
Washington, July 11, 1969

EMILY IN WINTER: AMHERST

Born in December, from the start
You knew a sunstruck winter of the heart.

Gales now blow clouds of snow-dust ghosts, that bloom
With rainbows round your black-railed room.

I come once more with flowers and alone
To speak with you behind your stone.

You who can move upon the crusted whitenesses
And leave no track, I press

My handprint on the snow, and feel the heat
Above the buried breastbone where your heart once beat.

JAMES KIRKUP

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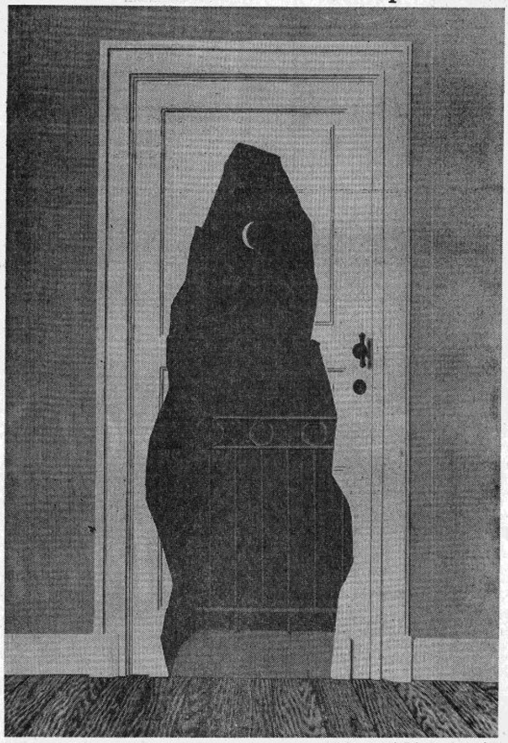
Some Reflections on Man and the Moon at Their First Closeup Encounter

TO THE MOON, 1969

YOU are not looked for through the smog, you turn blindly
Behind that half palpable poison—you who no longer
Own a dark side, yet whose radiance falters, as if it were
fading.
Now you have been reached, you are altered
beyond belief—
As a stranger spoken to, remaining remote, changes from being
a stranger.
Astronomers know you a governor of tides, women as the mistress
Of menstrual rhythms, poets have called you Hecate, Astarte,
Artemis—huntress whose arrows
Fuse into a melt of moonlight as they pour
upon earth, upon water.
We all know you a danger
to the thief in the garden, the pilot
In the enemy plane, to lovers embraced in your promise
of a shining security. Are you a monster?
A noble being? Or simply a planet that men have, almost casually,
cheapened?
The heavens do not answer.
Once, it was said, the cry: "Pan is dead! Great Pan is dead!"
shivered, howled, through the forests: the gentle
Christ had killed him.
There is no lament for you—who are silent
as the dead always are.
You have left the mythologies, the old ones, our own.
But, for a few, what has happened is the death of a divine
Person, is a betrayal, is a piece of
The cruelty that the Universe feeds,
while displaying its glories.

BABETTE DEUTSCH



"L'Acte de Foie," by René Magritte

IMAGINATION is your true Apollo.
In our translunar skulls the moon's small beer.
Fact's crippled fancy. Acts are slow to follow
Words (small cheese, I meant—small green cheese).
We're
Too long beyond the moon. The moon's too near.

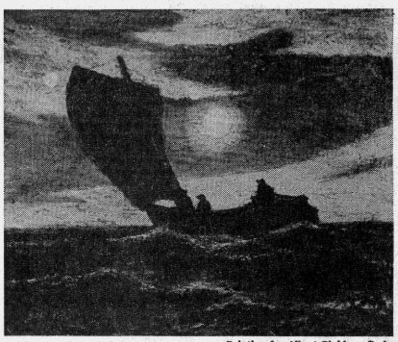
Bored with the merely possible, SF
Spends trillions on each fresh galactic race
Yet shells out not one cent to make us deaf
To the shrill signals from the silver face,
Attuning us to tunes from deeper space.

Still, it was all romance, drawn up from wells;
Or myth—an uncertain lantern in the air,
Or Prester John's balloon, the Christian hell's
Chill annexe, or the huntress in her chair.
Now Armstrong (Neil) and Aldrin (Ed) are there,

And Collins with his clucking mothercraft.
Old Glory on the desecrated crust
Is all th' old glory that, alas, is left.
So glory in, in your progressive lust,
These heroes who sift silver for its dust.

Where the black gods deliciously prevail,
You find cool tribes. Our hot entropic plan
Submits to seeing human order fail,
Erects inhuman order where it can,
And smiles and sighs at lunonautic man.

ANTHONY BURGESS



Painting by Albert Pinkham Ryder

a luna kanulɒ

ANDREI VOZNESENSKY

"'a luna kanula,' means in Russian 'the moon has disappeared,' that after the astronauts have touched down upon the moon, it is gone as a sentimental myth, as a symbol of unreality, as a subject for poetry.

"'a luna kanula' reads both ways, making it possible for the reader to follow, to travel letter by letter all the way to the moon and back. For the man on the moon, the earth becomes the moon, and it is for this reason that the last 'a' in 'kanula' is printed backwards.

"Transplanetary flights connect the earth and the moon like links in a chain."

Thus did Andrei Voznesensky explain his palindrome to Bernard Gwertzman, Moscow bureau chief of The New York Times. The one-line poem is displayed here in a space-flight arc and in lower-case letters, as prescribed by Mr. Voznesensky.

For two years the noted Soviet poet has been experimenting with "visual poetry," in which the form is part of the message. His latest poem was written in Latin letters for English-speaking audiences. In the Cyrillic alphabet, it would read as follows:

а луна канулв

Why on Earth Are We There? Because It's Impossible

By RUSSELL BAKER

So there he is at last. Man on the moon. The poor magnificent bungler!

He can't even get to the office without undergoing the agonies of the damned, but give him a little metal, a few chemicals, some wire and twenty or thirty billion dollars and, vroom!, there he is, up on a rock a quarter of a million miles up in the sky.

Ask him, "Man, why are you up there on that rock?" And the best reply he can give you is a tired old wisecrack. "Because it's here." He doesn't even know what makes him tick.

What he is doing up there is indulging his obsession with the impossible. The impossible infuriates and tantalizes him. Show him an impossible job and he will reduce it to a possibility so trite that eventually it bores him.

Because it was impossible to make the night blaze with light, he did it. It was impossible to put the world in a box in the living room, so he did it. Because it was impossible to fly, he flew. Impossible to bring the sun's power to earth? Of course. So he released nuclear energy.

The impossible he does with dispatch, but do not bore him with requests to try the possible. He believes with Browning that a man's reach should exceed his grasp, and he is very good at reaching. What he is capable of grasping, however, he has little stomach for.

Like Ahab on the doomed Pequod, he would rather die attempting to assert his mastery of fate than cope with the workaday excitement of doing the possible.

This is why the triumph of man on the moon is diluted with so many banal ironies. How ingenious, we may rightly marvel, that man was able to provide himself on this adventure with a pure atmosphere to breathe on that airless rock.

How ironic that while he was contriving to breathe pure air on the moon, he was at the same time poisoning the sweet air of the home rock with the byproduct garbages created by old impossibilities overcome.

•

It is entirely, dully, boringly possibly, of course, to preserve the air of the home rock, which is why man has so little appetite for doing it right now. Later, when he is told authoritatively, with the proper Doomsday voice, that it is impossible to salvage enough air here to keep him alive, his blood will stir and he will start trying.

The same principle applies to the other possibilities he declines to pursue because they are "too expensive," or "too complex," or because somebody—industry, labor, kids, parents, teachers, blacks, cops, the establishment, the Russians, etc.—"wouldn't stand for it."

The public school system, for example, was allowed to decay for years when it was possible to do something about it and will probably rot a few more before it is pronounced "impossible" and man's juices begin to flow at the challenge.

When the juices do begin to flow, man is a formidable fellow indeed. Cranking up for one of his impossible feats like going to the moon, he immediately creates for himself the kind of environment necessary for him to perform at his peak. This of course is the same kind of environment he could easily live in at home if doing the possible were not such a bore.

The space vessel must take air. Shall it be the kind of air he breathes in his cities? Good God, No! Get us some air that's fit to breathe.

How about some water from one of the great American rivers or lakes? Insanity! Men's lives will be at stake.

Shall we cut corners on rocket development in order to hold down costs, as we do with programs for mass transportation and city maintenance? Congress, President and public wouldn't dream of it. The lives of three men would lie on their consciences. Let the billions be poured.

No one would dream of asking three men to stake their lives on a program financed as parsimoniously as the programs affecting the lives of the multitudinous poor and city dwellers.

No one would dream of manning the rocket with the product of the typical ghetto school, or of fitting it with equipment of the shoddiness that goes into millions of cars and home appliances.

Doing the impossible, man contemptuously abandons the standards of the shabby everyday world he inhabits, a world made shabby by his blundering refusal to tackle the possible.

And now he is up there and marvels at himself. They said it couldn't be done. so he did it. And if somebody points out something else that can't be done, he'll show them by doing that too.

•

It is hard not to like him up there. Moby Dick got away from Ahab, but now man is having another last word by bringing back the big one.

("Look what I got in there." "Hey, isn't that—?" "That's right, Jack, that's the old June-croon-moon itself. Bigger than the white whale and twice as dead.")

What courage! What ingenuity! What excellence! What a shame that he will now come back to the mother rock and continue to shirk its possibilities.

And why did he do it? Because it was there? Not really. He did it because it is intolerable to him to know that there is any place in the universe where man can not leave his tracks and boast to an astounded posterity that "Kilroy was here."

MOON SONG, WOMAN SONG

I AM alive at night.
I am dead in the morning,
an old vessel who used up her oil,
bleak and pale boned.
No miracle. No dazzle.
I'm out of repair
but you are tall in your battle dress
and I must arrange for your journey.
I was always a virgin,
old and pitted.
Before the world was, I was.

I have been oranging and fat,
carrot colored, gaped at,
allowing my cracked o's to drop on the sea
near Venice and Mombasa.
Over Maine I have rested.
I have fallen like a jet into the Pacific.
I have committed perjury over Japan.
I have dangled my pendulum,
my fat bag, my gold, gold.
blinkedly light
over you all.

So if you must inquire, do so.
After all I am not artificial.
I looked long upon you,
love-bellied and empty,
flipping my endless display
for you, you my cold, cold
coverall man.

You need only request
and I will grant it.
It is virtually guaranteed
that you will walk into me like a barracks.
So come cruising, come cruising,
you of the blast off,
you of the bastion,
you of the scheme.
I will shut my fat eye down,
headquarters of an area,
house of a dream.

ANNE SEXTON

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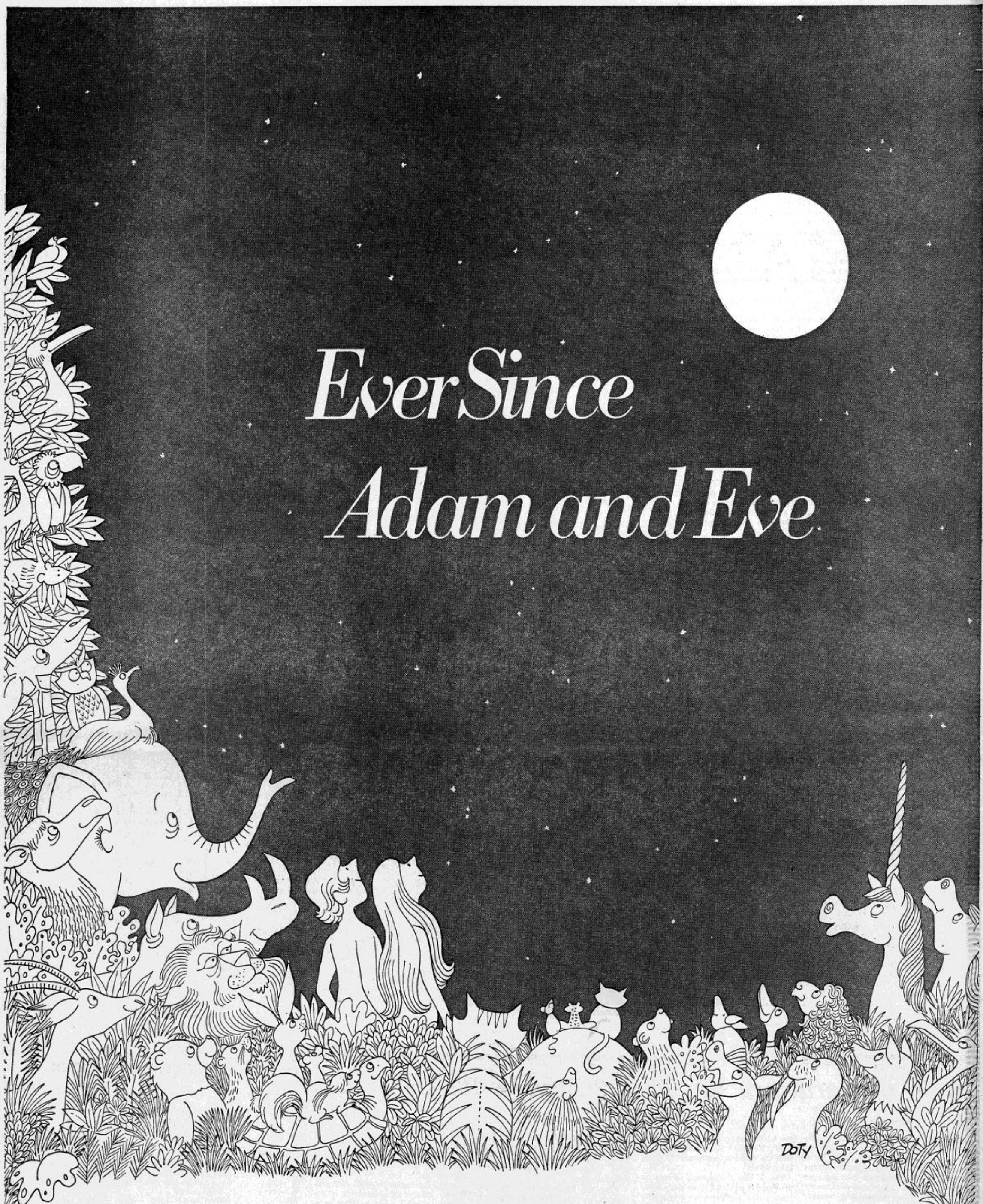


Said Adam to Eve,
"I believe I perceive
the face of a man on the moon."

Said Eve, "We could fly
to the guy and say hi!
if you'd just invent the balloon."

Today goes to show
how a notion can grow
when two people gaze at the moon:

We broke Newton's law
and the world saw with awe
the face of our man on the moon.

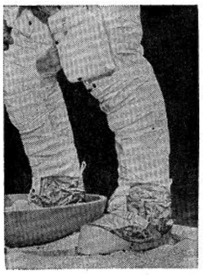
GIMBELS

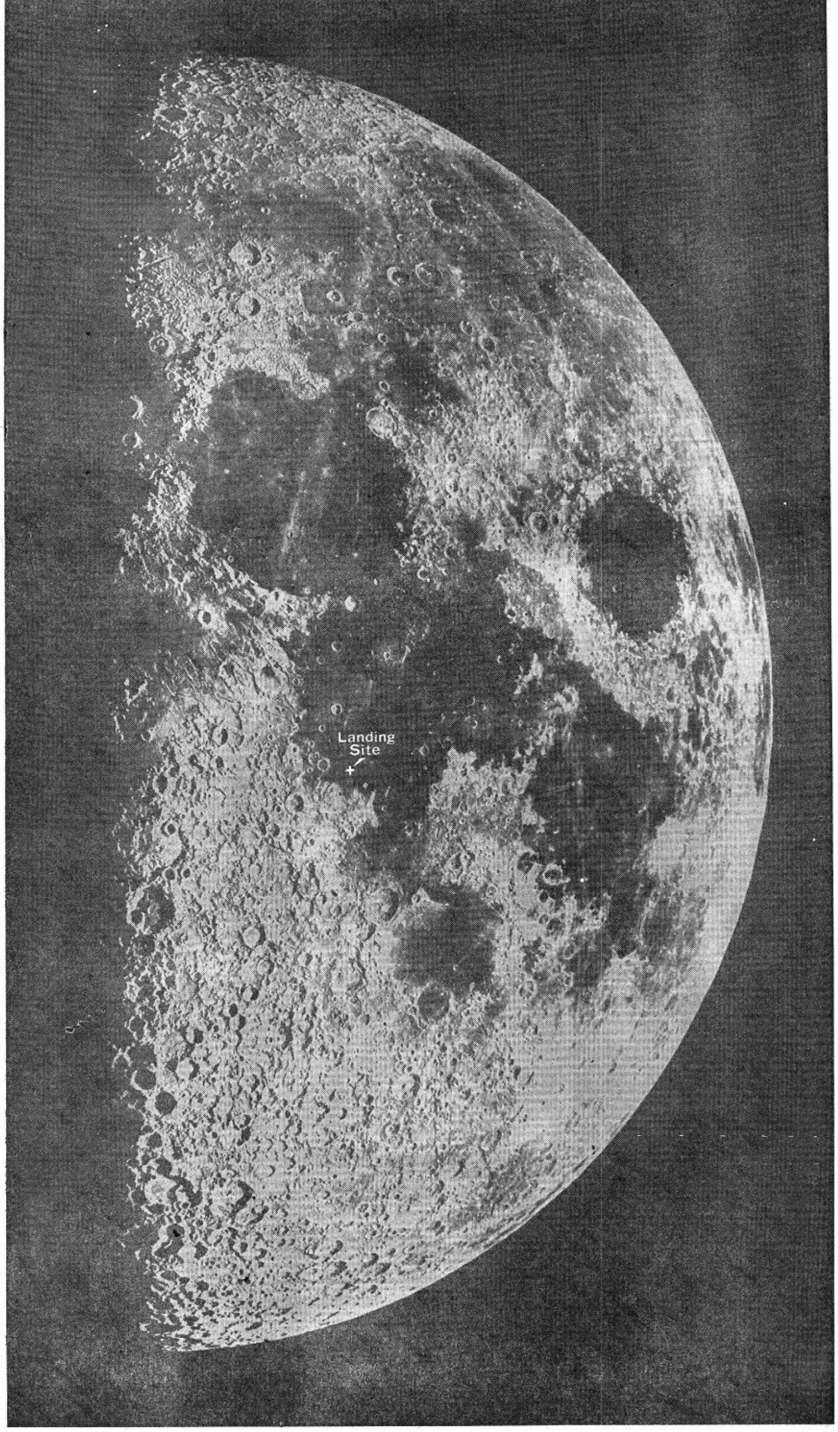
The New York Times

SPECIAL SUPPLEMENT / THURSDAY, JULY 17, 1969

APOLLO 11

MAN AND THE MOON





THREE men, two of them military and one a civilian and all honed by the sum of mankind's technical knowledge, are traveling today through the blackness of space to the moon, a quarter of a million miles away.

Once they get there, the duty of one will be to stay aloft in the circling mother ship, Columbia, and the duty of the two others will be to descend in a fragile space ferry called Eagle and climb down its ladder to the moon's silent surface.

If they succeed, their footprints on the lunar soil will be man's first on another celestial body. If they fail, others almost surely will try again simply because it seems possible. Throughout history man has always attempted to achieve and extend the possible.

"Are you fearful?" someone asked the astronauts. The answer, given by one for all three, was that fear was not unknown to them, but that everything conceivable had been done to erase the causes of fear—the unexpected, the inability to cope—and that, therefore, there was no fear of setting forth.

To achieve such serenity had taken not only the astronauts' own strength of spirit, but the accumulated knowledge of science, the accumulated skills of technology, the accumulated work of many explorers of the mind and the universe. The adventure is individual, yet for man collective.

Even if the mission is entirely successful, it will raise more questions than it will answer immediately.

What does a landing on the moon mean for man on earth? Will it be a major turning point in the development of his creativity and evolution or simply the extension of his destructiveness deeper into the solar system? Will it be recorded as the beginning of a great new era or only as an expensive diversion from earthly reality?

It may be decades, perhaps centuries, before the full answers will be known. But uncertain as are the consequences of the voyage of Apollo 11, there is knowledge and insight to be gained from an examination of how man reached this point.

This special supplement deals with some of the processes—of science, of engineering, of politics, of industry—that led to this moment in history and with what may follow. Besides members of The New York Times staff, the contributors include other writers, scientists, technologists, officials and former officials, among them some of the men most directly responsible for bringing about this great adventure.

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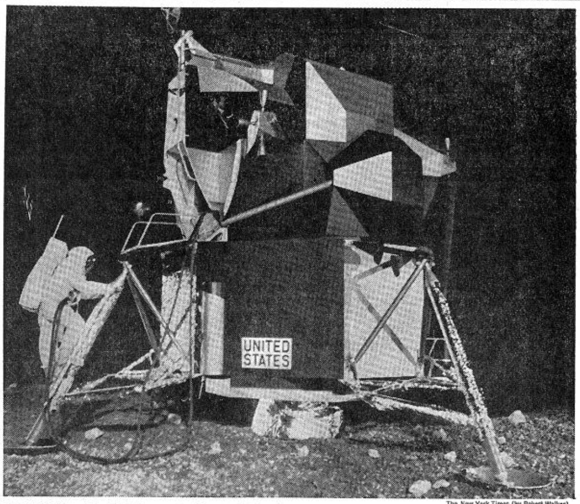

The New York Times (by Robert Walker)

The LM during a simulated descent. It will not look like this when it lands on the moon: layers of aluminized insulation sheet will completely shroud the craft's exterior. Some of the foil can be seen covering the legs and the engine nozzle.

An Ungainly Craft Called 'Eagle'

By RICHARD WITKIN

"EAGLE," the insect-like lunar module in which the first men are to ride down to the moon, is a rare species of flying machine different from anything man has ever flown before. The lunar module, or LM for short, is the first manned vehicle to perform exclusively in the airless regions of space.

Most of the nicknames that the LM has borne suggest nothing of the vehicle's imposing two-story height and fail to account for what seem to be not-very-neat "Christmas wrappings" hanging soft and crinkled on much of its surface.

"The layman won't get an esthetic response," Stephen G. Tsontakis, a top-level engineer at the Grumman Aerospace Corporation, says in a typical assessment. "It's an ugly beast, by lay standards. Only an engineer, most likely, would appreciate the texture and sophisticated design."

From Kitty Hawk on, airplanes have had wings to support them in the atmosphere. The faster they flew, the more they emphasized conventionally esthetic streamlined shapes to cope with airflow.

Even early space vehicles had to hew to clean lines to accomplish re-entry into the atmosphere. So does the cone-shaped command module that will bring the Apollo 11 crew home.

But the LM needs no streamlining, except for the brief ascent through the atmosphere. It gets around that requirement by crouching, legs tucked close, inside a disposable shroud below the command and service modules.

So its designers, freed from airflow problems, could mount antennas at jutting angles no plane designer would dream of. Insulation and micro-meteorite shielding could be fastened outside the basic structure where, if there were airflow, it would be shredded.

The entire LM structure is wrapped in a featherweight "blanket" of insulation—at least 25 layers of wrinkled aluminized sheets considerably thinner than the average kitchen Saran wrap. On half the total surface, there is a thicker firm top sheet. But on the other half, even the outmost layer is a wrinkled flimsy sheet, generally colored yellow, gold or silver.

•

These soft areas are probably the oddest-appearing features of the LM. The wrapping looks like something that was put on at a factory and should be removed before launching. But it stays on all the way to the moon.

The varied thicknesses of insulation keep the LM's critical elements at tolerable temperatures despite extremes of heat and cold. The sun heats exposed surfaces up to 250 degrees Fahrenheit, and attitude-control rockets on the sides of the LM subject some areas to temperatures as high as 2,300 degrees. Surfaces in the sun's shadow can get as low as minus 320 degrees.

"The LM is really like a space-borne Thermos bottle," suggests Grumman's Moe Tawil. "The insulation is so efficient it lets out less heat than the heat from a 100-watt light bulb." Mr. Tawil was assistant manager of LM thermodynamics until promoted to work on thermal problems for a proposed space station.

By contrast with the LM exterior, the cockpit is not much of a departure from familiar shapes and gadgets. It might almost be an airplane cockpit, except for the lack of seats and the inclusion of devices (hand hold, harnesses, foot grippers) to help the astronauts contend with weightlessness.

Once the two crewmen enter the LM, there is need for active cooling, in addition to the passive external insulation, to keep the right heat balance in the cabin and the crew's space suits. The crewmen produce heat with their own exertions. More heat is generated by powering up electronic gear.

An important change made between Apollo 10 and 11 was the addition of about 30 pounds of insulation. The original plan had been for the crew to shut off the descent engine when one of the three landing probes, extending five feet below three of the landing pads, touched the moon and turned on a blue cockpit light.

But Neil A. Armstrong, the Apollo 11 commander, decided some time ago that he would keep the engine idling at about one-tenth its power until the LM had settled on its pads and he was sure last-second maneuvers were not needed. That meant lots more engine heat bounced back from the lunar surface onto pads and struts, and other nearby surfaces. So insulation was added in these areas.

The probe intended for the fourth (front) landing pad has been removed for fear that, after it had been bent back in landing, it might rip an astronaut's pressured space suit as he descended the ladder. Puncturing a suit would be fatal.

Weight has been the biggest worry for the LM developers, the usual story in the aerospace field. There was a maximum that the Saturn 5 could hurl into lunar orbit. The spacecraft modules had to add up to no more than that, or the mission was "no go."

It became clear, early in the game, that a good deal of weight could be saved in fuel needed for launching from lunar surface back to lunar orbit. It could be done by leaving on the moon as much of the LM and associated equipment as possible.

That meant designing a two-stage LM. The bottom or landing stage, with the descent engine, would be left behind. It would also serve as launching pad for the ascent stage and its cabin.

Still, when the initial two-stage designs were analyzed, the weights were far too high. Quickly discarded were stools for the pilots. It was decided the astronauts could stand, with the aid of harnesses. Out with the stools went two thick windows at seat level.

The weight-cutting program was seriously retarded by the on-the-pad command-module fire of January, 1967, in which three astronauts died. Rigorous new standards for fireproofing cockpit equipment added 500 pounds to the LM weight.

"Before the fire," the spokesman recalls, "we were spending about $10,000 to lop off each pound. After the fire, we were willing to spend up to $50,000 a pound."

The LM's weight on Apollo 11 at take-off was expected to be 33,205 pounds, according to calculations about a week ago. Weight for the ascent stage, not counting crew or fuel, was put at 4,804 pounds.

The LM has had what most observers consider an expectable run of other difficulties.

In trying to save weight through the use of tinier electronic parts on the rendezvous radar, engineers ran into electrical interference problems. The temporary delay (solved with special shielding) led to scratching the LM from last December's Apollo 8 flight.

There has been a running problem with "stress corrosion"—a phenomenon wherein bolted metal parts lose strength if not perfectly seated against one another. Several parts suspected of having been affected were changed a week ago.

It is hoped that all critical problems have cropped up in tests or early flights, and have been corrected. If so, the LM named "Eagle" should be touching down safely on the moon three days from now.

IN THIS SECTION

DESCENT TO THE MOON

50,000 Feet to Touchdown

By HENRY S. F. COOPER Jr.

ONE of the paradoxes of the space age is that the greatest modern hero is not an astronaut but Charles A. Lindbergh, who only flew across the Atlantic Ocean. The reason may be that Lindbergh flew his craft alone, whereas the astronauts, even when they are on the backside of the moon and out of touch with the earth, are still able to fly by a computer programed ahead of time. It is hard to make heroes of men who really needn't be aboard their craft to make it fly.

This image may change when Neil A. Armstrong and Col. Edwin E. Aldrin Jr. set their lunar module onto the moon Sunday, for landing the LM ("Lem," it is usually called) on the moon has less in common with automated rocketry than it has with the early days of aviation, when pilots often landed in rocky places using little more than the seat of their pants. The LM is as ungainly a crate as any old biplane, and like one it is held together partly by glue; its outer aluminum sheathing is flimsier than any canvas. It can bang and rattle as badly as an old Sopwith Camel. Indeed, the lunar landing may have more in common with the events at Kitty Hawk than Cape Kennedy, for this will be only the third time that men have flown in the LM and the first time the LM will have landed anywhere.

Mr. Cooper is on the editorial staff of the New Yorker magazine.

The two astronauts could, of course, land the LM automatically simply by doing nothing once they have punched the keyboard buttons that instruct the craft's computer to carry out Program 63, thereby starting the landing sequence. But most of the people who know Mr. Armstrong and Colonel Aldrin are certain that they will want to take over from the computer just before the final approach starts and bring the LM in themselves. Even so, most of the trip down from the command module, orbiting about 69 miles above the moon, will be flown automatically or semi-automatically.

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The astronauts will start down exactly as Apollo 10 did, but when they reach an altitude of 50,000 feet, approximately the lowest point reached by Apollo 10, the Apollo 11 astronauts will blast their rocket, aimed ahead of them, to slow themselves down. During the next 12 minutes, the rocket will be blasting continuously as the LM falls along a steadily steepening trajectory to the landing site 250 miles away, near the southwestern shore of the Sea of Tranquillity.

At an altitude of about 7,000 feet, when the landing is just three minutes and 22 seconds away according to the flight plan, they will have a good view of the site. The astronauts will scrutinize it carefully to see whether it is as flat and smooth as the Apollo 10 crew said it was; if it isn't, they will pick a better spot in the vicinity, get a fix on it through a gauge imprinted on the left-hand window, and quickly punch the information into the computer.

The exact moment when Mr. Armstrong takes control of the craft is up to him, though it will probably be during the last couple of minutes, when the LM, at about 500 feet, will be descending vertically at about 13 feet a second and moving horizontally across the moon at a little under 60 miles an hour—a speed more appropriate to a Curtiss Jenny than to a spacecraft. To take control, Mr. Armstrong—who, as commander, will be standing on the left—will have to flick a switch transferring the throttle from automatic to manual operation.

From this point on, he will have to keep his hands near two levers: One, on the right, which looks like the handle of a sword, controls the craft's attitude or the way it is facing; and the other, on the left, which looks like a sports car's gear shift, controls all movement of the craft—up and down, back and forth, and side to side. It is the throttle for the main rocket, the only one in existence whose thrust is adjustable, like a jet engine's, over such a wide range.

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Out of his small, three-cornered window, Mr. Armstrong will see a triangular patch of brownish gray moon that looks like a mud flat extending emptily to the horizon which, at 500 feet, will be approximately 12 miles away. One of his first jobs may be to stop the LM's horizontal movement, which he can do by pulling back on the right-hand lever so that the LM's attitude changes, the craft pitching slightly backward so that the rocket's jet aims ahead. He will know when the LM is stationary horizontally (it is still moving vertically down) by looking at a gauge resembling a small television screen set into the dashboard in front of him at eye level. On it there are two lines, and when they intersect at the center of the screen they show that the horizontal movement is zero.

The cockpit of the LM is battleship gray and softly lit like a jet airliner's. The astronauts are surrounded by enough knobs and levers to make Ralph Nader wince. (They should be well protected inside their spacesuits, which are 28 layers thick. The suits are not inflated during the descent as it would make handling the spacecraft difficult, but the astronauts will be wearing their helmets, and if the pressurized cabin should spring a leak, they may find themselves blowing up, automatically, like balloons.)

In spite of the bewildering array of dials and switches, the only ones Mr. Armstrong will need for the manual landing are not more numerous than those in a small airplane, and most of these will be centered at eye-level on the dashboard in front of him. (Colonel Aldrin, standing on Mr. Armstrong's right, will have a duplicate set.) Perhaps the most important is one the astronauts call the eightball, a free-floating globe set into the dashboard that acts like a carpenter's level. If Mr. Armstrong finds the eightball askew, and the LM tilted, he can push the lever in his right hand until the small jets spotted around the outside of the craft have pushed the LM upright.

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The ride down should be as smooth as an elevator's, though it may be a little disconcerting, like the descent in one of the outdoor elevators in the Eiffel Tower. Astronauts, however, are not supposed to get vertigo. During the final vertical descent, the craft, riding down on its rocket, is supposed to slow from 13 feet a second to three feet a second, though to Colonel Aldrin, who will have done the navigating, and who will now have more time than Mr. Armstrong to look out the window, the rate of descent may seem greater than it is. Already the Hypatia Rille and the Moltke Crater, two landmarks to the south that he will have used to locate the landing site, will have disappeared. Because the moon is smaller than the earth, objects will vanish faster over the horizon, giving the illusion of a rapid fall; and the horizon itself will be constricting alarmingly around the LM, as though the moon were in a hurry to swallow it up.

A thin gauge to the right of the eightball will tell the correct rate of descent, as determined by radar, and if it is a little faster than it should be, Mr. Armstrong can flick a little toggle switch by his left hand and it will increase or decrease the rate of descent in increments of one foot a second. He will also have an eye on the fuel gauge, about eight inches above the eightball, which flashes in electronic digits the percentage of fuel remaining in the tanks. As the rocket burns fuel voraciously, the thrust must constantly be adjusted to compensate for the loss of weight, a delicate balance that he can keep track of by looking at another meter, just right of the vertical descent gauge.

The windows of the LM are canted inward so that Mr. Armstrong and Colonel Aldrin will have a better view of the surface when they come to pick the precise spot for the landing. As they will be coming down in the early morning, the sun will be low in the sky, throwing the flat ground into as much contrast as possible. The myriads of small craters, just a few feet in diameter, will be filled almost to their brims with inky blackness—just their western rims will be touched with sunlight—and the medium-sized stones will be casting lengthy shadows. Mr. Armstrong can cut the vertical motion of the craft to zero and dart from one hopeful spot to another; he will probably try to keep moving across the surface to avoid the cloud of dust the rocket will kick up. As the LM flits about, he will try to keep from looking into the sun, which can be blinding, and before he settles down onto the ground he will try to shift the LM's attitude so the sun is to the side. He won't have much time to look around as the LM's fuel supply, kept to a minimum to make the craft light, has about 60 seconds left.

If he cranes his neck, Mr. Armstrong will be able to make out the LM's forward footpad as it touches the ground, but since the rocket may be kicking up a terrific cloud of dust, even though he may try to land with some forward motion to leave it behind, he may nevertheless see nothing but the inside of a dark gray duststorm. In the moon's low gravity, the dust cloud would take some time to settle. Consequently, a blue light just above the eightball will flash on when the LM is about five feet from the ground—the length of the three landing probes that hang down like feelers from three of the LM's four feet.

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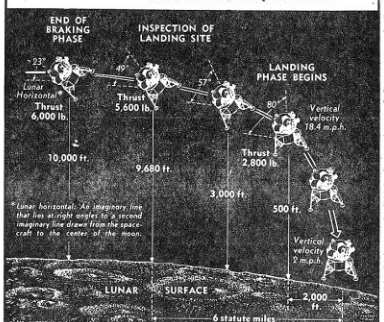
Mr. Armstrong may turn off the rocket as soon as he sees the blue light and drop the remaining five feet, or he may prefer to settle all the way onto the moon before he shuts off the engine, which he will do by pushing with his left hand a black-and-white button surrounded by a yellow cross hatching and labeled, simply, STOP. The sooner he snuffs out the rocket the better, for the blast may weaken the ground under the LM, possibly digging a crater that could be six feet in diameter. A serious tilt could endanger the LM's take-off later.

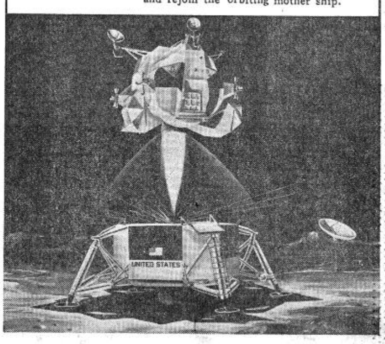
The astronauts will land with their knees slightly flexed in case there is a jolt (though it it estimated to be less than the equivalent of a three-foot jump on earth) and if they need to they can grab onto some white bars set into the dashboard in front of them. As the LM's footpads settle onto the moon, the three landing probes will snap off. The feet should sink into the ground as far as they would on a wet sandy beach. The LM's legs telescope down (they are stuffed with a sort of honeycomb material that compresses to absorb shock), so the touchdown couldbe imperceptible.

Not unnaturally, the astronauts' first task will be to rehearse the procedures for taking off again.

LANDING: In last phases of the descent from 50,000 feet, "Eagle" is to assume a vertical position, gradually. It lands after crew inspects surface.



TAKEOFF: After crew explores surface, ascent stage of lunar module is to blast off and rejoin the orbiting mother ship.



THE CREW

What Kind of Men Are They?

By WILLIAM K. STEVENS

NEIL ARMSTRONG walked into the room, a conservative plaid sports jacket draping his small-boned 5-foot-11-inch frame, his blond hair parted on the left and slicked down like a Sunday schoolboy's. He was about to talk with a stranger, and his odd sort of lopsided grin suggested he was trying hard to meet the stranger halfway.

That does not appear to come easily to the commander of America's first lunar landing mission, the man chosen to set first foot on the moon. He is surrounded by protective walls of shyness and modesty. There is an almost palpable air of reserve about him. During a chat in Houston—his part in a round-robin of conversations with the men of Apollo 11—Mr. Armstrong comported himself formally, weighing his words carefully, often pausing inordinately long before delivering a sparse answer to a question.

On the basis of such an encounter, you would never know that he was a champion chug-a-lugger of beer in the night spots around Edwards Air Force Base on the Mojave Desert of California, where he once flew the X-15 to the fringes of space and earned a reputation as one of the world's best test pilots; or that he is a shrewd player of the stock market; or that among close friends, he is one of the most cherished of companions; or that he has lived for one thing—flying—ever since he was a precocious, introverted little boy who often would rather stretch out with a book on the living room floor than play with other children.

Lieut. Col. Michael Collins, pilot of the Apollo 11 command ship, was as open and breezy in the interview as Mr. Armstrong was reserved. He is slightly, almost delicately built, with merry brown eyes and dark brown hair that is receding gradually toward the crown. He was in shirtsleeves, with a pencil behind his ear, and he sat down, threw his leg over a chair and talked animatedly. "Stay casual" has always been his unspoken motto.

This manner seems to mask much, too. Hidden is the fact that Mike Collins's existence was drifting and unfocused until late in life, leading some of his colleagues to expect that he would never do anything special. But lurking beneath the casual exterior all along were a hard competitiveness and determination. These qualities, which make him the untouchable handball champion among astronauts, also made him an astronaut in the first place, once a late-blooming excitement about space flight gave his life an organizing focus.

Col. Edwin E. (Buzz) Aldrin Jr., who is to join Mr. Armstrong on the moon's surface, gives an immediate impression of suave urbanity. His disappearing blond hair, once thick and curly, is closely cropped, accentuating his protruding ears. But the graying sideburns he sometimes wears counter the stereotyped image of The Astronaut. During the conversation in Houston he wore a stylish, subdued aqua suit with a crisp handkerchief in the pocket, flashed two rings on the right hand and one on the left, crossed one knee over the other, and sat toying with a pipe as he talked.

Behind this urbane demeanor is an intelligence that very nearly enables him, some of his colleagues say, to compute orbital maneuvers in his head. The suave manner covers a fierce ambition and an enthusiasm so intense that Colonel Aldrin has been known at times to irritate associates and friends with his assertiveness and compulsion to talk business. And the stylish clothes hide a well conditioned body whose individual muscles are under disciplined control, an asset that has made Colonel Aldrin probably the most accomplished of the six Americans to "walk" in space.

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ASTRONAUTS Armstrong, Aldrin and Collins, who set out yesterday to accomplish the first manned landing on another celestial body, are among the supertechnicians of their day. They are not scientists seeking fundamental truth — although astronauts on future flights will be — but supremely self-confident pilots, who like action; and highly disciplined engineers whose natural habitat is the sometimes bewildering technology of the electronic age.

From one point of view, they are the most flexible and versatile components in what is perhaps the most complex technological system ever devised. But they are also in many ways ordinary men, who, despite an extraordinary psychological stability, display very human foibles of personality.

All three astronauts were born in 1930 as the nation skidded toward the bottom of the Great Depression—Colonel Aldrin on Jan. 20, Mr. Armstrong on Aug. 5, and Colonel Collins on Oct. 31. But all three were sheltered from the ravages of that depression. None has ever come close to privation.

All three are expressions of the dominant values of the broad American middle class, but each represents a different current in that mainstream of society.

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IN the late eighteen-sixties, families of stolid German farmers and merchants fleeing the draft under Bismarck's blood-and-iron foreign policy emigrated to northwestern Ohio, and in succeeding years mixed their blood with that of the descendants of Revolutionary War veterans who settled the country in the eighteen-twenties, when the Shawnee Indians were still vigorous. This produced a culture whose dominant verities still include hard work, honesty, church on Sunday and the Republican party.

Neil Alden Armstrong was born of that heritage, and into that culture, in the living room of his grandparents' farm house six miles southwest of Wapakoneta (population about 7,000), a place whose open manners, broad, tree-lined streets, and abundance of old-fashioned, two-story clapboard houses make it almost a model of small-town mid-America.

Neil was the first of three children of Stephen Armstrong, a sometimes bluff but usually gentle and smiling state employe who spent Neil's formative years as an auditor of county records around the state, a job in which he once helped to send some cheating Cleveland officials to prison; and Viola Engel Armstrong, a slim, gracious woman who has always been drawn to music and books, and whose attitudes influenced her son.

"My parents are characteristic of the area where I grew up," the astronaut said in Houston. "At the risk of being wrong, it was my observation that the people of that community felt it was important to do a useful job and do it well."

Young Neil began working part-time at age 7, cutting grass in a cemetery in Upper Sandusky, Ohio, for 10 cents an hour and progressing as a teen-ager to stock boy in a Wapakoneta drug store. This kind of thing was simply expected in Wapak, as the local residents call the town.

"I told all my children I hoped they would pick out something worthwhile, that would do some good for other people, to set their goals high, do the best they could, and they'd have a happy life," says Neil's mother.

Because of the elder Armstrong's roving job, the family moved from one northern Ohio town to another six times during Neil's first six years. But the essential quality of family life remained constant. Mrs. Armstrong put her finger on one of its essential ingredients: "I was an only child, and I was so thrilled at having the children that I thought I would never be as near to heaven. Just being around them was enough for me." Young Neil flourished in an atmosphere of such attention and care.

The hours Mrs. Armstrong spent leafing through magazines with her son, reading books to him, and constantly talking with him produced a very bright little boy who talked early, read 90 books during the first grade and skipped the second grade because he could read on a fifth-grade level. Later, at Wapakoneta's Blume High School, he flourished in science and mathematics, studying calculus outside of school and teaching science and math courses temporarily during the illness of Grover Crites, the teacher who encouraged and guided him in his advanced studies.

Always small, younger than most of those in his classes and looking even younger, Neil developed into a shy, unassertive, not particularly athletic boy. His younger brother, Dean, recalls that although Neil moved in a small circle of close friends who went to the normal teen-age parties of the day, he seldom had dates in high school; that he went away to Purdue University in Indiana at age 17 an immature, withdrawn youth, and that he grew into a man and developed an underlying self-confidence only when he left Purdue after two years to become a Navy combat pilot.

Neil, at age 20 the youngest man in his squadron, flew 78 combat missions off the carrier Essex during the Korean war. Kenneth Danneberg of Englewood, Colo., a squadron-mate of Neil's aboard the Essex, recalls that on one mission much of the wing of Mr. Armstrong's jet was clipped off by a cable strung by the Communists across the North Korean valley made famous in James Michener's "The Bridges at Toko-Ri." Neil won the respect and admiration of the older pilots by nursing the plane back over friendly territory, then bailing out safely.

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Neil's obsession with flight began on a casual family excursion to the Cleveland municipal airport when he was two years old. Four years later, a frightened, white-faced Stephen Armstrong took a delighted six-year-old Neil for his first plane ride in a Ford Tri-Motor. A year later the boy built his first 10-cent model plane, the first of hundreds of models to grace, and sometimes clutter, his bedroom over the next several years. He worked as a teen-age greasemonkey at Wapakoneta's small airport; he paid $9 an hour for flying lessons, and won his pilot's license before he was licensed to drive a car. He built a wind tunnel in the basement of the Armstrongs' tree-shaded two-story white clapboard house. He collected vintage issues of the magazine "Air Trails," and was as upset about their loss as about anything else when, years later after he became an astronaut, his house burned down in Houston.

"With Neil," says Paul Haney, the former Voice of Apollo, "flying comes on like a religion. When he talks about the Wright brothers his voice is almost hushed. He took along a part of the Wright flyer on his Gemini mission, like it was a piece of the True Cross."

Aside from aeronautics, the young Neil filled his time with Boy Scout activities, reading, playing baritone horn in the school band and for a jazz combo he organized, learning the piano, and making his first forays into space science. Several such forays were made in the backyard observatory of Jacob Zint, Wapakoneta's amateur astronomer.

With his telescope, Mr. Zint could bring the moon within 1,000 miles. "Most of the kids would look for two or three minutes and that would be enough," Mr. Zint recalls. "But Neil would look and look and look."

For all of his shyness and apparent immaturity, the teen-age Neil went about his activities with an inner drive and quiet decisiveness that impressed his friends and earned him this descriptive line in the Blume High yearbook: He thinks, he acts, 'tis done."

A bigger, stronger, more experienced, but still reserved and youthful-looking Neil Armstrong returned to college after Navy service, then left Purdue in 1955 with an aeronautical engineering degree and joined the National Aeronautics and Space Administration (then the National Advisory Committee on Aeronautics). His father says he had declined to remain a Navy flier partly because of the semi-compulsory wining-and-dining required to get ahead in the naval officer corps.

The already-skillful aviator spent the next seven years at Edwards Air Force Base, becoming one of the most accomplished test pilots in the world. Characteristically, perhaps, he and his wife, Janet, chose not to live in the nearby town of Lancaster, Calif., where most of the test pilots lived, but to acquire and restore a former forest ranger's cabin in the isolated foothills of the San Gabriel mountains. Those years were marred by the death of one of the Armstrongs' three children, Karen, of a brain tumor.

If anyone was a natural to become an astronaut, Neil Armstrong was it. He was assigned as a pilot on the now-defunct Dyna-Soar project, in which he was to have flown a craft that was to have been part spacecraft and part airplane. Apparently anticipating the end of Dyna-Soar, which finally came in 1963, he applied for the astronaut corps. In 1962 he became the first civilian to be admitted to the corps.

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EDWIN EUGENE ALDRIN Jr. was born of mixed Swedish, Dutch, Scottish and English ancestry in the affluent New York City suburb of Montclair, N. J. He lived in that serene enclave for the first 17 years of his life, a relatively sheltered youth in a relatively sophisticated environment.

He grew up as the highly prized only son of a very proud man in a household dominated by six women.

Col. Edwin Eugene Aldrin Sr., United States Army, retired, now a 73-year-old resident of Brielle, N. J., has himself accomplished much in aviation, and has brushed the fringes of fame. He learned physics at Clark University under Dr. Robert Goddard, the father of modern American rocketry; he taught himself to fly airplanes; he served at intervals as military aide to Gen. Billy Mitchell, whom young Buzz Aldrin met as a boy of five; he started what is now the Air Force Institute of Technology at Dayton, Ohio, and he set a cross-country flying record of 15 hours and 45 minutes in 1929, the year before his son was born.

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Colonel Aldrin's work kept him away from home a lot. For two years, when Buzz was a budding adolescent, he was gone altogether, having returned to active duty in World War II. Edwin Jr. was surrounded most of the time by women. There were two older sisters, who let him get away with nothing. There was his mother, who was at once affectionate (the Aldrins, mother and children, always kissed good-by), letting her children always know where she was so they would feel secure, and insistent that her children do their best. There was his grandmother, whose last name, coincidentally, was Moon. And there was a woman Negro cook and a Negro nursemaid.

Mrs. Fay Potter of Cincinnati, Ohio, 20 months older than the astronaut and the younger of his two sisters, is responsible for her brother's nickname. As an infant she could not pronounce "brother." "Buzzer," as it came out, stuck, and was shortened to "Buzz" when the boy was about 10.

Mrs. Potter remembers Buzz as "a typical rascal boy, a pest." She describes him as "forever moving, the kind of kid that would drive a mother crazy, I would think."

"He was very active, but easy to manage," recalls Mrs. Alice Howard of Montclair, who was Buzz's nursemaid for most of his first nine years of life. Despite the boy's easy manageability, she said, he had a tendency suddenly to run off, disappear and cause great anxiety. And he would not take naps, but, in Mrs. Howard's words, "would get out of bed and sneak down the stairs, and I'd have to push him back up time and again."

Buzz Aldrin was athletic from the start. As a young boy he set up hurdles in the back yard of the three-story, seven-bedroom home next to a park at 25 Princeton Place in Montclair. He walked on stilts, set up a chinning bar and did calisthenics. Today, Mrs. Potter says, he does "the most fantastic exercises" on the beach. When the popular Royal Canadian Air Force exercise book was published, an adult Buzz Aldrin turned to the last page, reserved for champion athletes, and zipped through the whole series.

The boy had his share of traumas. There was the time he came home and found that the adult white mice he kept had eaten their young, and burst into tears; and the time a big wave knocked him down on the beach, causing him to fear water for a long time afterward. But mostly he was a happy, healthy, blond boy who was able and willing to respond to his mother's expectations.

"Mother was very demanding of excellence, in a nice way," Mrs. Potter says. "She provoked us to do our best, but she never attacked our self-respect. She never hurt me, that I recall."

When Buzz was pushed ahead into first grade a year early because he was bored with the second year of kindergarten, then required in Montclair, he "strained every nerve to prove he could make good," recalls Miss Rita Hogan of Montclair, now a retired teacher, who inherited Buzz in the second grade. "In school," said Miss Hogan, "he was all business."

The astronaut himself believes the seven summers he spent at a boys' camp in Maine had much to do with shaping his personality. "It was the competition, the athletics, being with people," he said. "Schooling didn't really provide that." The camp "turned him into a real boy-kid," Mrs. Potter says.

In fact, the camp turned him into such a "boy-kid" that as high school approached, Buzz's passion for sports sent his grades into a downward spiral. They rebounded permanently to A's and B's after his parents convinced him his college prospects would be bleak if he did not get back on the track. He ultimately graduated in the upper tenth of his class.

The Buzz Aldrin of high school days took a full part in the social activities of the time, but there was much about him that was unusual. These aspects are recalled by his former football coach, his former mathematics teacher, and a former classmate.

The coach, Clarence Anderson, once asked the 140-pound Buzz to switch from halfback to fill the vacant center spot on what turned out to be a state championship team. "He accepted it as a matter of fact, like 'I'm a team man and here we go,'" Mr. Anderson says. "He was clean, crisp and quick, and he never made a bad pass from center. He had backbone, heart and guts."

Allen Dumont of Montclair, Buzz's former classmate, who now hunts executive talent for a major management consulting agency, recalls: "He was the most physically and mentally disciplined guy I've known, then and now. He spent his time on serious things. There was not much clowning around."

And William Filas, the math teacher at Montclair High, recalls: "He seemed to enjoy success where you can see success, as in solving math problems. There was no attempt to outshine other students on a commonplace problem, but when it came to deep analysis and thought, he had this drive to excel. He was a natural in mathematics, and he gave the appearance of being absolutely sure of himself at all times."

These qualities enabled him to graduate third in the class of 1951 at the United States Military Academy. Having grown up in an aviation household and gone to West Point at a time when the Air Force was viewed as the coming service, Buzz decided to become a pilot.

Eventually he wound up flying an F-

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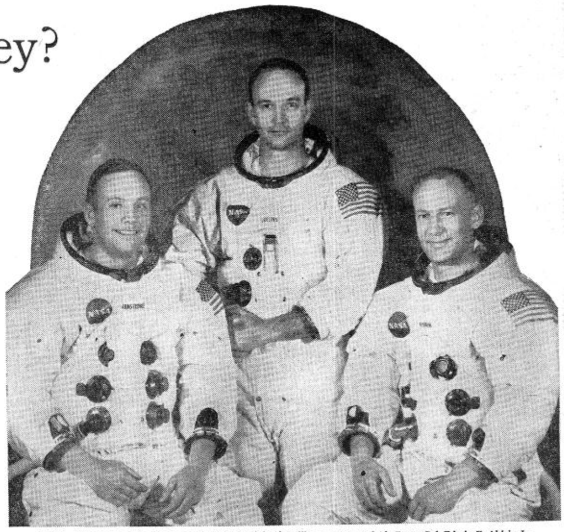

Neil A. Armstrong, left, Air Force Lieut. Col. Michael Collins, center, and Air Force Col. Edwin E. Aldrin Jr.

A 16-year-old Armstrong (kneeling second from the right) joined flyers at airport in Wapakoneta, Ohio. He won his pilot's license before driver's license.

Collins, at the age of 6, with his dog "Punch" on the porch of home on Governor's Island in New York Harbor. The Collins family traveled a great deal.

Aldrin, about 13. He was a versatile football player on high school team.

THE DECISION

Space and Power Politics

By JOHN M. LOGSDON

NOW it is time to take longer strides—time for a great new American enterprise. I believe we should go to the moon."

On May 25, 1961, in these words, President John F. Kennedy asked the Congress and the nation to accept a commitment to send Americans to the moon "before this decade is out."

This request was a manifestation of his decision to use space achievement as an instrument of national strategy, a means of advancing American purposes in the world. This essay reconstructs the process by which this decision was made.

Although Mr. Kennedy's lunar landing decision was primarily political, it rested on a relatively firm scientific and technological foundation. By 1961, Americans had been thinking for some time and in some detail about how to go to the moon.

During the late 1950's, in the process of attempting to justify a military space program, the Air Force and the Army studied problems associated with manned flight to the moon. One Air Force plan in 1958 called for a high-priority effort to land a man on the moon before the end of 1965.

Mr. Logsdon is an assistant professor of politics at Catholic University in Washington. His book-length study, "'We Should Go to the Moon:' Space Policy and National Decision-Making," is being published by the M. I. T. Press, Cambridge, Mass.

Until 1959, Dr. Wernher von Braun and his team of German rocket engineers worked under Army direction. At the Army Ballistic Missile Agency at Huntsville, Ala., they prepared elaborate plans for manned space flight. Dr. Von Braun was a consistent advocate of a program to land men on the moon as soon as possible.

One proposal prepared in 1959 by the Huntsville team called for an initial landing in April, 1965, followed by establishing a 12-man lunar base in November, 1966.

The National Aeronautics and Space Administration was established in 1958. A first order of business for the new space agency was getting America's first manned space flight program, Project Mercury, under way.

Then, during 1959, space agency planners considered what manned program should follow Mercury. They had two broad alternatives: a program aimed at developing an orbital space station and one aimed at developing the capability for flights to the moon.

Basing their decision solely on scientific and technological criteria, the planners decided, almost two years before Mr. Kennedy approved their choice, that the better second-generation manned flight program was that intended to send men to the moon.

While Dwight D. Eisenhower was President, he never approved any plans advanced for a manned expedition to the moon or for the intermediate steps leading to that goal. President Eisenhower consistently followed a policy of calm conservatism with regard to space. He did not believe that the political and psychological impacts of space achievements were important factors in international politics, and he refused to allocate resources to any program justified primarily in such terms.

President Eisenhower's scientific and economic advisers supported his attempt to limit the funds spent on space spectaculars, preferring to concentrate American efforts on unmanned scientific, commercial, and military space projects.

When, in 1960, the space agency asked White House approval for Project Apollo (then aimed at a circumlunar flight by 1969), Mr. Eisenhower asked his President's Scientific Advisory Committee to study the proposal. The committee report reached the President in December. It concluded that "man-in-space cannot be justified on purely scientific grounds" and that a space program targeted on a 1975 lunar landing goal would cost between $34-billion and $46-billion.

Mr. Eisenhower, upset by these cost estimates and unconvinced of the scientific justification for the proposal, refused to approve NASA's plans for Project Apollo.

He announced in his final budget message that "further tests and experimentation will be necessary to establish if there are any valid scientific reasons for extending manned flight beyond the Mercury program."

When John Kennedy became President in January, 1961, the future of the nation's space program was uncertain. Project Mercury was undergoing severe difficulties; the success of the project in launching an American into space was not yet assured. The space agency had no manned flight program to follow Mercury. The Air Force had stepped up its campaign to gain control of a greater share of the manned space program. The continued existence of NASA as an agency with expensive operational programs was in some doubt.

The new Administration did little at first to resolve these uncertainties. Mr. Kennedy had stressed the "space gap" as well as the "missile gap" in his election campaign. His Vice President, Lyndon B. Johnson, was known as a vigorous supporter of a large civilian space program.

After the election, Mr. Kennedy had assigned Mr. Johnson special responsibility for the space program. The man selected to head NASA, James E. Webb, had a reputation for strong leadership. From these indications, it seemed that Mr. Kennedy would pursue a more aggressive space policy than had Mr. Eisenhower.

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There were contrary indications, however. A task force commissioned by the President-elect to recommend a new space policy was sharply critical of NASA's manned flight programs.

The scientist heading this task force, Jerome B. Wiesner, became Mr. Kennedy's science adviser. Exaggerated emphasis on manned flight, the task force suggested, was distorting the over-all balance of the space program and taking support away from more instrinsically worthwhile unmanned activities. The task force recommended that Mr. Kennedy not endorse Project Mercury and take the blame for its possible failures. A panel of the President's Scientific Advisory Committee was formed to review Project Mercury, with the possibility that the project might be canceled rather than risk the death or injury of an astronaut.

For the first two months of his Administration, Mr. Kennedy did not actively involve himself in space policy. At the end of March, Mr. Kennedy, though deep in deliberations over whether to intervene with American troops in Laos, was forced to turn his attention to the space program.

The space agency refused to accept a Bureau of the Budget decision not to approve a large addition to the NASA budget, an addition that implied the approval of Project Apollo, and requested a meeting with the President.

On March 22, the President met with NASA officials to hear their arguments for immediate approval of Apollo (by now aimed at circumlunar flight by 1967, and a lunar landing in 1969 or 1970). Mr. Kennedy deferred decision at this time, indicating that he would not decide on the future of NASA's manned programs until later in the year, after several Project Mercury flights.

Events in April convinced Mr. Kennedy of the need to compete with the Soviet Union in space on an urgent basis. On April 12, the Soviet astronaut, Yuri A. Gagarin, became the first man in space. World reaction to the Soviet achievement was almost unanimous praise and admiration. The Soviet Union was quick to capitalize on the propaganda significance of the flight, declaring that it demonstrated the superiority of the Communist system.

The American reaction to the Gagarin flight was disappointment and chagrin. For many, the flight came as almost as much of a shock as the Sputnik I flight of 1957. Many in Congress demanded an immediate response.

Mr. Kennedy told an April 12 news conference that "no one is more tired than I am" of the United States being second in space. On April 14, Mr. Kennedy called a meeting to discuss the options for an American effort to compete with the Soviet Union in space. At the end of the meeting, Mr. Kennedy said that there was "nothing more important" than winning the space race.

During the following week, Mr. Kennedy talked to hundreds of people about the appropriate United States response to the Soviet space achievement and about the proper direction and pace of the United States space program. By April 20, the President had become convinced, according to Dr. Wiesner, "that space was the symbol of the twentieth century."

On that day, the President asked the Vice President to conduct a study aimed at answering these questions:

"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?"

At the same time, the United States became involved in the Bay of Pigs operation. Dr. Wiesner recalls that the Bay of Pigs put Mr. Kennedy "in a mood to run harder than he might have." Ted Sorensen suggests that the United States loss of prestige in Cuba coupled with Soviet prestige gains following the Gagarin flight "pointed up the fact that prestige was a real, and not simply a public relations, factor in world affairs."

During the two weeks following April 20, Vice President Johnson conducted the study of the space program Mr. Kennedy had requested. On April 22, NASA told Mr. Johnson that "there is a chance for the United States to be the first to land a man on the moon and return him to earth if a determined national effort is made."

The space agency suggested 1967 as a possible target date for the earliest attempt at such a feat. On April 24, Mr. Johnson heard representatives of the military services and Dr. Von Braun discuss their views on the space program.

Sitting with Mr. Johnson at this meeting were three close friends: George Brown, of the Houston construction company of Brown & Root; Frank Stanton, president of the Columbia Broadcasting System and Donald Cook, of the American Electric Power Corporation.

Air Force Gen. Bernard Schriever told the group that a manned lunar landing program should be adopted because "it would put a focus on our space program." Dr. Von Braun said that the United States had "an excellent chance of beating the Soviets to the first landing of a crew on the moon," probably by 1967 or 1968.

On May 3, Mr. Johnson met with the chairman of the Senate space committee, Senator Robert S. Kerr, and its ranking Republican, Senator Styles Bridges. Space agency officials briefed the Senators on possible means of accelerating the space program. NASA had not yet specified what degree and direction of acceleration it favored; by the end of the meeting Mr. Johnson was demanding that NASA come forth with specific proposals.

On Thursday, May 4, Mr. Johnson learned that he would be leaving the following week on an inspection tour of Southeast Asia. He asked NASA and Department of Defense officials to meet over the weekend to prepare detailed recommendations for submission to the President.

On the next day, Alan B. Shepard was successfully launched on a 15-minute suborbital flight, becoming the first American in space. A mood of national euphoria following the flight removed whatever political obstacles might have remained to a dramatic acceleration of the American space effort.

On Saturday, space and defense officials met at the Pentagon. They agreed that the nation should undertake space programs for prestige, as well as for other reasons. They also agreed that the first program with a large prestige payoff in which the United States had a chance to be first was the lunar landing project.

If the United States decided to undertake such a project, they thought that it should be publicized in some dramatic fashion, such as setting a lunar landing as a national goal.

In picking the lunar landing as the central feature of an accelerated space program, the Pentagon group had no firm intelligence estimates on whether the Soviet Union was already embarked on a similar undertaking.

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The group formulated a program calling for across-the-board United States pre-eminence in space. Not only would the United States undertake to beat the Soviet Union to the moon, but other space programs in which the United States could excel would also be accelerated.

These recommendations were incorporated in a memorandum signed by Dr. Webb and Secretary of Defense Robert S. McNamara. The memo was delivered to the Vice President on May 8; Mr. Johnson added his approval to the recommendations and forwarded the memorandum to the President on the same day. On May 10, Mr. Kennedy ratified the recommendations, without change.

One remaining area of controversy was the schedule that Mr. Kennedy should announce for the lunar landing. Budget plans were based on a 1967 target date, and the first draft of Mr. Kennedy's speech announcing the decision mentioned that year as a goal.

The space agency, realizing the difficulty of meeting distant target dates, suggested that the President should set the date for the landing as within the decade, and the White House accepted the suggestion.

On May 25, Mr. Kennedy announced his decision. In the following months, Congress approved the acceleration of the space program, almost without dissent.

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The lunar-landing decision was the product of a long and complex process, one typical of the way in which major national decisions are reached. As in all such decisions in the pluralistic American political system, a wide variety of interests were served by the decision to go to the moon.

For those who had always favored a large-scale space program, the lunar-landing project provided a focus around which that program could grow. For those planning future space flights, the moon was the logical first step in man's exploration of his universe.

For the American nation, stung by continued Soviet space firsts and insecure in its position as the leading world power, the lunar-landing decision was a congenial means of restoring national pride and of once again demonstrating the superiority of the American way of life.

All of these views converged on the White House. John Kennedy, at first uncertain but finally convinced that the United States should accept the Soviet challenge and seek to be first in space, calculated the costs, weighed the need, and finally decided that "we should go to the moon."

The New York Times

President Kennedy presenting plan for moon landing to a joint session of Congress on May 25, 1961. Behind him are Vice President Johnson and Sam Rayburn, Speaker of the House. The note at right was sent by the President to Mr. Johnson month before Mr. Kennedy made commitment.

C
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File White House

April 20, 1961

MEMORANDUM FOR THE VICE PRESIDENT

In accordance with our conversation I would like for you as Chairman of the Space Council to be in charge of making an overall survey of where we stand in space.

1. 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?

2. How much additional would it cost?

3. Are we working 24 hours a day on existing programs. If not, why not? If not, will you make recommendations to me as to how work can be speeded up.

4. In building large boosters should we put out emphasis on nuclear, chemical or liquid fuel, or a combination of these three?

5. Are we making maximum effort? Are we achieving necessary results?

I have asked Jim Webb, Dr. Wiesner, Secretary McNamara and other responsible officials to cooperate with you fully. I would appreciate a report on this at the earliest possible moment.

/s/ John F. Kennedy

Kennedy Listened, Raised Questions, Deliberated, Then Acted

By THEODORE C. SORENSEN

THE decision to go to the moon was not made by the Cabinet, the National Security Council or even the National Space Council. Nor was it made merely to compete in the Cold War or to recoup lost prestige. It was made after intensive study and for a variety of complex reasons by one man, John F. Kennedy, 35th President of the United States.

As was true of most of President Kennedy's decisions, there was no one day when the final choice was made.

Mr. Sorensen was Special Counsel to President Kennedy. He is now a partner in the law firm, Paul, Weiss, Goldberg, Rifkind, Wharton & Garrison.

Months, indeed years, of discussion and deliberation were reflected in his conclusion. Expert analyses and wise counsel were sought from many. A tentative premise grew into a firm conclusion only after it had been carefully studied, the costs calculated, the responsibilities allocated and the Congress consulted and convinced.

If there was one day that was more crucial than all the others, it may well have been April 14, 1961. Two days before, the Soviet Union had awed the world by becoming the first nation to place a man in orbit.

The wondrous round-the-world flight of Yuri Gagarin dramatized as nothing else could the Soviet Union's superiority in rocket thrust and manned space exploration.

Mr. Kennedy had wired congratulations to Mr. Khrushchev on April 12 and accelerated his own thinking on the subject. On Friday morning, April 14, he asked me to conduct a brief review of America's options in the space race and report to him that evening just prior to his discussing the subject with a Time magazine correspondent.

Joined by Budget Director David Bell, I called to my office White House Science Adviser Jerome Wiesner and Deputy Space Administrator Hugh Dryden, the two foremost experts in Government on this nation's prospects in space and with somewhat differing points of view.

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After several hours of probing and prodding, we briefed the President on our tentative conclusions: If the United States, in order to demonstrate convincingly to all the world the leadership and superiority of our science and strength, felt compelled to compete with the Soviet Union in dramatic manned space achievements, the latter's early lead in big-booster development made it unlikely that this country, no matter how much we accelerated our effort, could score a "first" in reaching any of the intermediate rungs on the ladder of manned space exploration — astronaut orbits lasting several days, then two and three men in an orbiting spacecraft, then possibly a space laboratory, perhaps a fixed space waystation, and eventually circumnavigation of the moon without landing.

If the Soviets still disdained to cooperate with our comparatively infant effort, we in all likelihood would lag behind on all of those steps, which nevertheless had to be taken. We had little or no chance to be "first" until the most dramatic step of all was to be taken: landing space explorers on the moon and safely returning them to earth.

A highly concentrated effort might—and it was no more than a "might"—enable this nation to achieve that powerful victory for peace, if we started pointing in that direction immediately.

The President listened, questioned, deliberated. A dozen more immediate crises were on his mind, ranging from the Congo to Laos to the Bay of Pigs. The conservative mood of the Congress was not receptive to controversial new spending programs.

A race in which one's competitor advanced in secret, virtually uninhibited by the limitations necessarily imposed by a constitutional democracy, was not a welcome undertaking.

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He would not make a final commitment to us or the Time correspondent that evening. But it was clear to me from his questions and reactions that in his heart a decision was taking shape: If the Soviets still refused to join in a cooperative space effort, thereby assuring all the world that neither superpower would seek to dominate this new ocean through national, military or other hostile means, the United States would focus its space effort on being first to the moon.

Six weeks later he stood before the Congress announcing his decision. The preceding 42 days of intensive study, led by Vice President Johnson as chairman of the Space Council and conducted principally by Secretary of Defense McNamara and James E. Webb, head of the space agency, had produced documented answers to the President's questions on cost, manpower, alternatives and administrative responsibility.

Nevertheless, he sensed as he spoke an air of skepticism in the House chamber. For the first and only time in his four addresses to the Congress, he temporarily set his text aside and launched into an urgent if somewhat uneven effort to make certain all present understood the magnitude of this task.

A few weeks earlier the first launching of an American astronaut into space had won acclaim for the program on Capitol Hill. But "unless we are prepared to do the work and bear the burdens to make it successful," President Kennedy pleaded, an undertaking of this size and risk should not be started.

Congress overwhelmingly voted to "set sail on this new sea," as JFK described it. Like many of his decisions, his determination to land a man on the moon and return him safely to earth would show its most striking results long after he was dead; and its origin was credited by him to many of his advisers as well as his predecessor.

But is many ways the decision was uniquely his own.

The level of support provided to the space program under the Eisenhower Administration would not have achieved a lunar landing until a decade after the Russians, if then.

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The lag in this nation's space effort had been criticized in his campaign for the Presidency as symbolic of the sluggishness and complacency that had gripped a country he wanted to get "moving again."

A nation on whom world leadership had devolved at least in part because of its productive wealth and inventive genius could not afford to mount only a second-rate, second-best effort in this new age. The idea of going to the moon was consistent with his sense of national history and his sense of human adventure.

Frequently he expressed the hope that the United States and the Soviet Union could cooperate closely in this effort to save the waste and duplication inherent in a "race." But he understood Moscow's unwillingness to talk seriously about cooperation until Washington had some serious bargaining power or potential contribution in this area.

President Kennedy's 1961 decision was not an open-ended, unconditional commitment, however. He sought persistently if not always successfully to cut the fat and the frills out of the burgeoning space program. He wanted all possible safeguards of astronauts' lives, even if they delayed the moon project.

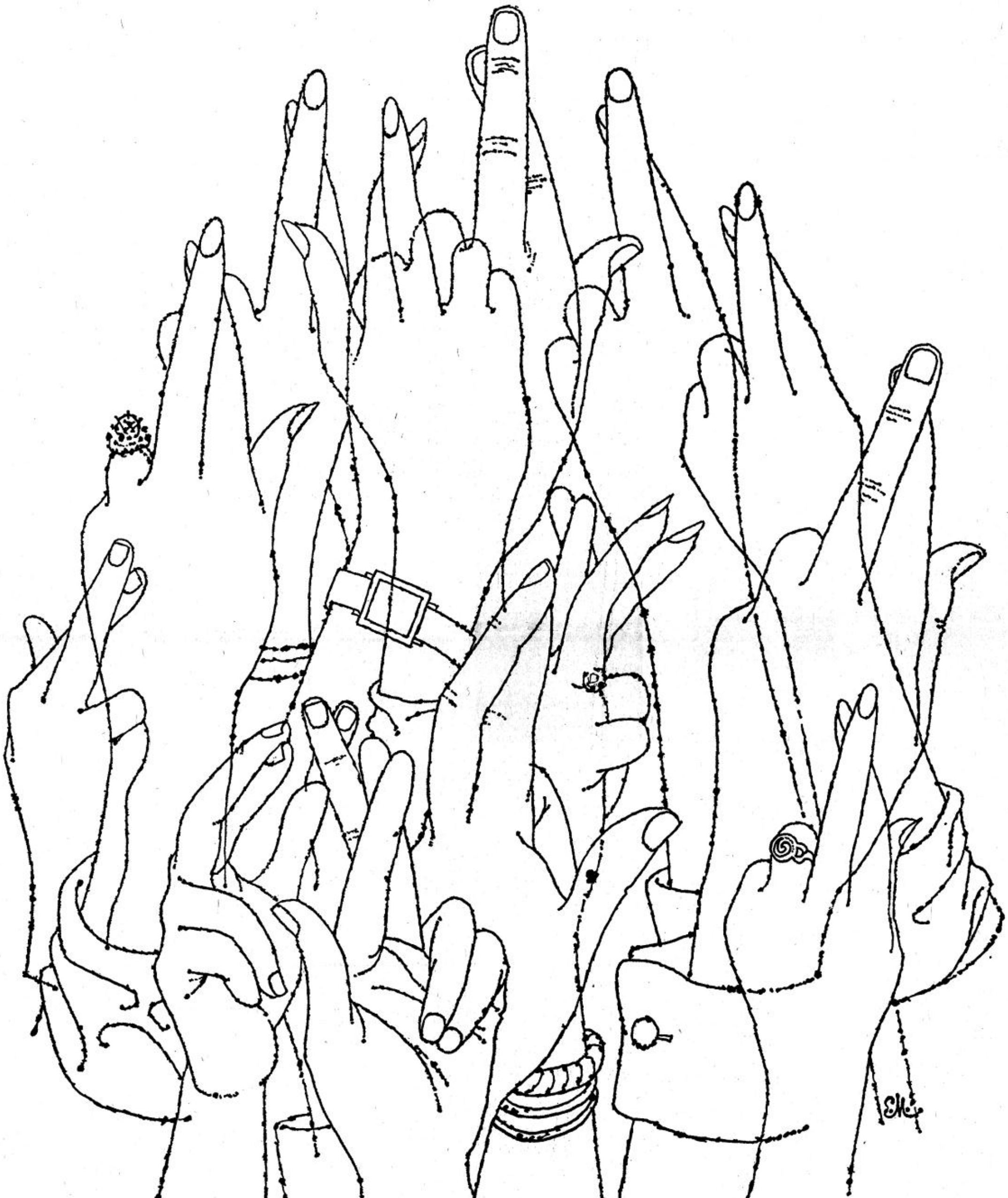
He was unwilling to see this program absorb a disproportionate share of our scientific and engineering talent and effort.

Above all, even then — before the nation had fully recognized the extent to which our cities and schools and promise of equal opportunity had deteriorated, before the massive escalation in Vietnam had distorted the Federal budget—even then he regarded his programs for education, conservation, health and full employment to be more important than the space race.

He would be proud today that the United States had become, as he hoped, "the world's leading spacefaring nation"; but he would not be satisfied with the Congress's voting NASA more funds than the agency wanted while cutting back on schools and libraries.

He wanted to win the space race; but no competition was more important to him than "the race between education and chaos."

The hopes and dreams and good wishes of everyone on earth ride with you



The whole world is watching and waiting as Apollo 11 carries you to your great adventure. Good journey, happy landing, and triumphant splashdown to Neil A. Armstrong, Col. Edwin E. Aldrin Jr. and Lt. Col. Michael Collins.

Macy*s

THE APOLLO PROGRAM

$24-Billion for Big Push to the Moon

By JOHN NOBLE WILFORD

THE Space Age was in its fourth year when the long countdown for the voyage to the moon began in the spring of 1961.

President Kennedy's decision that year to put a man on the lunar surface by the end of the nineteen-sixties set in motion the greatest mobilization of men and resources ever undertaken for a peaceful project of science and exploration.

This vast, diffuse and far-flung effort was to be directed and welded into a smoothly functioning enterprise by the fledgling National Aeronautics and Space Administration, which, like President Kennedy's decision, was born of reaction to a Soviet triumph in space.

In October, 1957, the Soviet Union had sent into orbit the first artificial earth satellite, Sputnik 1, shocking an American public that had grown used to the idea that technological superiority rested with the United States and touching off a somewhat panicky effort to catch up to the Russians.

In that climate, Lyndon B. Johnson, then the Democratic leader of the Senate, spearheaded a drive in the Congress that culminated within 10 months of Sputnik 1's launching in the creation of NASA—a powerful new civilian agency to oversee America's venture into space—out of the old National Advisory Committee for Aeronautics.

Once President Kennedy's decision was made it fell to James E. Webb, a former director of the Bureau of the Budget and NASA's administrator from 1961 until last October, to persuade Congress to finance the flight to the moon.

The effort was to cost $24-billion, not including $392-million for Project Mercury and $1.3-billion for Project Gemini, the precursors of Project Apollo, the moon venture itself.

Mr. Webb succeeded. The space agency's annual budget grew from $966.7-million in fiscal year 1961 to $5.25-billion in fiscal year 1966, the peak year of the development effort for Apollo.

The momentum of the lunar landing project was to spark a rich variety of unmanned space activities as well—nearly $10-billion worth in a 10-year period. Only 21 of more than 250 major rocket launchings carried out by NASA have involved astronauts. The unmanned launchings, about three-quarters of which succeeded, have carried weather or communications satellites or scientific experiments, or have borne robot craft to probe the moon and planets.

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As Project Apollo began to gain momentum under NASA's direction, abandoned war factories sprang to life as rocket assembly plants. A Massachusetts hosiery mill was turned into a laboratory for guidance instruments. Piney Woods in Mississippi were cleared for rocket test firings. A desolate stretch of sand in Florida was transformed into a billion-dollar moonport. A network of tracking stations was strung around the world on ships and islands at remote sites in Africa and Australia. A pasture outside Houston was bulldozed for the flight control center, a complex of training simulators and test chambers, electronic computers and control consoles.

The NASA investments had an invigorating effect on Southern localities that became home to various aspects of Project Apollo. Activity at the Cape Canaveral and Kennedy Space Center launching pads caused the population of Florida's Brevard County, historically a sultry agricultural area, to soar from 24,000 to 224,000 between 1950 and 1965. The manned space program accounted for the last five years of that growth.

Huntsville, Ala., once a declining textile town, became the home of the Marshall Space Flight Center, which developed the rockets for Project Apollo. Its population grew by 90 per cent between 1960 and 1965, its employment by 95 per cent.

Houston, which became the home of the Manned Spacecraft Center, felt less impact than the other areas because the Texas petrochemical industry had already introduced a boom. (Conversely, Houston stands to suffer least from the budget cutbacks the space program is now facing.)

Building the rockets and spacecraft for the moon voyage required the concerted efforts of thousands of industrial contractors, scores of university laboratories and hundreds of thousands of people. They were drawn from disparate backgrounds.

There was the "Langley crowd," engineers who had learned their trade at Langley, Va., in the old national advisory committee. Under Dr. Robert R. Gilruth, these men took leading parts in designing the vehicles, plotting the mission and training the astronauts.

There were "the Germans," the most prized booty of World War II. They were the men who, under Dr. Wernher von Braun, developed the first workable ballistics rocket, Hitler's V-2 at Peenemünde on the Baltic Sea. After Germany's defeat, the United States Army brought Dr. Von Braun and 118 aides, their rocket blueprints and some captured V-2's to this country. From this talent and experience came the design for the moon rocket, the Saturn 5.

There were also the bright and eager engineers at the Jet Propulsion Laboratory in Pasadena, Calif. Directed by Dr. William H. Pickering, they developed many of the guidance and communications techniques required for traveling moon distances.

In addition, all three unmanned scouting probes to the moon — the Rangers, Surveyors and Lunar Orbiters — were controlled from JP. They returned the pictures and data reassuring the men of Apollo that the moon, though barren, harbored no insurmountable hazards to a manned landing.

And finally there were the men to fly in this strange new realm. The three Apollo 11 crewmen—Neil A. Armstrong a civilian; and Col. Edwin E. Aldrin Jr. and Lieut. Col. Michael Collins of the Air Force—were chosen from a corps of 50 active astronauts, many of whom had gone before them in pathfinding flights to prove the spaceworthiness of the machines and to scout their landing site on the moon.

These were ordinary men with families and dogs, dreams and disappointments. They were extraordinary men who had guided jet aircraft through combat, risked their lives in experimental planes, hardened their bodies, and filled their minds with a knowledge of the sophisticated instruments that would get them to their destination. And they were men with a high sense of adventure. As Frank Borman, the Apollo 8 commander, said on his return from the first flight around the moon: "Exploration is the essence of the human spirit."

But the biggest number of people were those who worked for the aerospace companies that had won contracts from NASA to build the Apollo "hardware."

The North American Rockwell Corporation built the Apollo spacecraft, the second stage of the three-stage Saturn 5 and the engines for all three stages. The Grumman Aircraft Engineering Corporation built the lunar module, the craft in which the men will actually land on the moon. And the Boeing Company, the McDonnell Douglas Corporation and the International Business Machines Corporation produced the other main components of the Saturn 5 rocket.

Apollo 11 is not, therefore, a lonely journey by romantics in search of an unknown shore. It was carefully conceived and elaborately planned. Nevertheless, there have been accidents.

The three astronauts who were to make the first test flight of the Apollo command ship died in the flames that broke out in their cockpit on Jan. 27, 1967. It happened suddenly and where an accident was least expected — on the launching pad at Cape Kennedy, during an unfueled countdown rehearsal.

The deaths of the three men — Virgil I. Grissom, Edward H. White and Roger B. Chaffee — plunged the Apollo program and NASA into their gloomiest period, a time of self-doubt and near-paralysis. Investigators uncovered "many deficiencies in design and engineering, manufacture and quality control" in the project.

As engineers began picking up the pieces, rebuilding the spacecraft and subjecting it to more rigorous tests, a growing number of Americans questioned the value of the project. They began to look upon Apollo as a magnificent irrelevance.

Apollo's critics usually raised these basic objections:

¶It cost too much. This became an issue debated in many an American home as taxes rose, as the war in Vietnam imposed new strains on the Federal budget and as the nation's long-neglected social ills became more evident.

¶The money and talent could be more usefully directed to down-to-earth problems. Riots on the campuses and in the city slums, lingering poverty amid plenty and rising crime left people disturbed by different things toward the end of the decade than they were when the Apollo decision was reached.

¶It was a "childish stunt" to make a race out of going to the moon and insist on such an artificial deadline as the end of the decade. The moon, they pointed out, had been there a long time and showed no signs of disappearing any time soon.

To those who argued that man should first set his own earthly house in order before going to the moon, Dr. Margaret Mead, the anthropologist, replied that they were "shrinking from the future." She declared: "A society that no longer moves forward does not merely stagnate, it begins to die."

Some scientists, while sharing the enthusiasm for moon exploration, felt that it was being gone about in the wrong way. They argued that it would have been cheaper and less risky to send unmanned vehicles to gather the rocks and to probe the lunar surface.

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John H. Glenn, the first American to orbit earth, gave the following defense of man's usefulness on a moon flight: "Instruments that we design can only measure what we know is there. Man has the unique ability of course, to perceive and relate to unknowns, and to make judgments on these things as to how he can use them or of what value they are."

Opposition from the scientific community had largely died down by the time the voyage began. Geologists and physicists, chemists and biologists are eager to learn of the moon's secrets. They want to know what the moon is made of and how it came to be, whether it ever had any form of life or has any now.

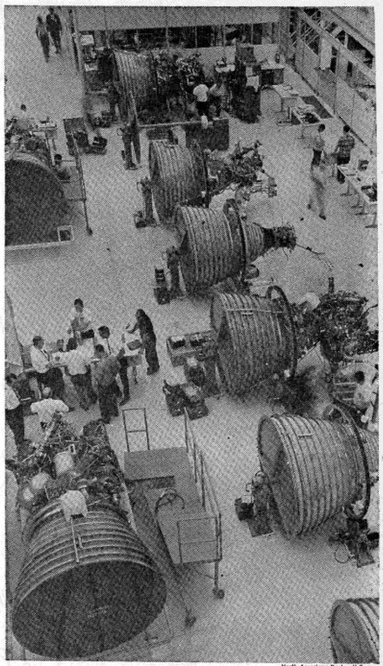
They also want to know from the moon some of the secrets of the earth. For preserved on the surface of the airless moon, whose very changelessness makes it a museum-piece of what worlds may have been like billions of years ago, may be clues to the formation of the earth and the other planets orbiting the sun.

Whatever its impact on man, earth and science, the voyage of Apollo 11 marks a bold new extension of man's dominion over his environment. As Mr. Webb, the former NASA administrator, said: "We are not limited to the water anymore. We are not limited to the air. We are not limited by the gravity of the earth. We can overcome those limitations and move out any place we really want to go."

There are already plans for nine more landings on the moon by men. There are plans for launching in the mid-1970's a large earth-orbiting space station, a place where men can study the earth's weather and resources from a new perspective.

Nor is it unreasonable to think of men walking on Mars before the century is out, of close-up inspections of a comet or of unmanned grand tours of Jupiter, Saturn, Uranus and Neptune.

"While the moon has been the focus of our efforts," Dr. Thomas O. Paine, the present NASA administrator, said recently, "the true goal is far more than being first to land men on the moon, as though it were a celestial Mount Everest to be climbed. The real goal is to develop and demonstrate the capability for interplanetary travel."



North American Rockwell Corp.

Rocket engines being constructed. Thousands of people have been involved in the manufacture of the "hardware" needed to send the astronauts to the moon.

Six Leaders Of Program

Thomas O. Paine
Administrator of NASA

James E. Webb
Former NASA Administrator

Sam C. Phillips
Apollo Program Director

Robert R. Gilruth
Director, Houston Center

Kurt H. Debus
Director, Kennedy Center

Wernher von Braun
Director, Huntsville Center

Experts Were Stunned by Scope of Mission

By ROBERT R. GILRUTH

WHEN I heard President Kennedy announce that American spacemen would land on the moon, I could hardly believe my ears. I was literally aghast at the size of the project.

At that time, there were no studies in depth on how the landing could be done, but we did have ideas on how to fly around the moon and back. It was a tremendous act of faith by the President.

I listened to the President's speech with James E. Webb, Administrator of the National Aeronautics and Space Administration, and a planeload of scientists and engineers. We were flying to Tulsa in a space agency plane. I already held the heavy responsibility for Project Mercury, the nation's first man-in-space program.

Dr. Gilruth is Director of NASA's Manned Spacecraft Center in Houston.

More than anyone else on that airplane, I realized how much work was required before an American, or any other spacemen, could set foot on the moon's hostile surface.

America had, at that time, only 15 minutes of space flight experience. Capt. Alan B. Shepard's flight in a Mercury capsule 20 days earlier had been our first. He had flown to a height of over 100 miles on a suborbital trajectory.

It was May, 1961, and all our efforts were being spent in getting ready to orbit an American astronaut. When I had taken on Project Mercury a few years earlier, I wasn't sure I wanted to stay in the space program after Mercury. I had then, and still do have, an ambition to sail around the world with my wife in a boat of our own design.

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But the challenge of Apollo was too great. I was soon spending all possible time in scheming ways to go to the moon and land there. The boat would have to come later.

In November, 1961, we were assigned the job of developing the moon spacecraft, and I became head of a new NASA center for that purpose, to be located in Houston. Our next few years in Houston were to be spent in a group of rented buildings while the center was under construction.

We still faced major operations in Project Mercury, though we had taken a big step that summer in an unmanned flight that proved the ability of the heat shield to protect astronauts returning from the moon.

While studies on Apollo were moving along, we had ahead of us the toughest kind of conceptual and opening work on the lunar project.

Many of the key ideas for going to the moon evolved in this period of stress, turmoil and major flight activity. However, even before the President's announcement, we had been working on guidelines for lunar flight.

This was done in a series of bull sessions on how we would design a space ship for just circling the moon. We got together evenings, weekends, and whenever we could to discuss such questions as crew size and other fundamental factors.

We determined that we would need three men on the moon trip to do all the work required, though some felt three was the wrong number psychologically, perhaps because of the saying: "Two's company, three's a crowd."

We established a need for normal atmosphere in the cabin, so the crew could take off their space suits during the journey, a 14-day maximum duration, on-board navigation and controlled re-entry. These original "guidelines" were then presented to all NASA centers and to industry. They have not required any change to this day.

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The basic design of the moon ship was really done in two phases: the command and service modules came first; the lunar lander was added later. We were extremely fortunate that the design that evolved had such intrinsic merit. This was not just good luck.

We had designed our space ship to have the command module on top so the astronauts could escape, if necessary, by means of the escape tower.

The service module was underneath it, with its big rocket for space propulsion.

The bottom element was a module to which the crew could transfer for earth orbital experiments. When the full landing mission came along, we were able to substitute the lunar lander for this module.

The shape of the command module was really Max Faget's idea. Remember, now, that back in 1961, re-entry was a tentative and mysterious business. The highly secret flight of Yuri Gagarin marked the only time man had returned from orbit.

The speed coming home from the moon was over 40 per cent greater than orbital speed, and the heating would be expected to increase by 100 per cent. Dr. Al Egger and Harvey Allen of NASA's Ames laboratory in California were warning us about an additional heating factor from shock wave radiation.

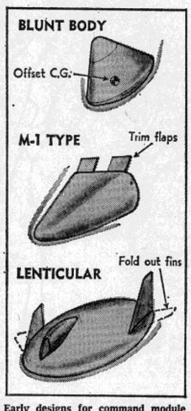
Our studies, however, showed that the shape could be blunt and that the afterbody should be more highly tapered than the Mercury capsule because we would have to use a lifting re-entry, allowing the atmosphere to slow the craft relatively gradually, and because we needed to keep the spacecraft walls from being overheated by the airflow.

Max also determined the original internal arrangement of the capsule, working closely with Caldwell Johnson, a creative young engineer who can also draw like an artist.

All along, I had been greatly concerned about the effects of solar radiation on the astronauts. I remember Dr. Van Allen, whose name has been given to the Van Allen belt, saying it would take very heavy lead shielding to stop the radiation on a trip to the moon.

However, George Low, who is now Apollo director at the Houston center, convinced me that shielding of the normal cabin walls, together with the low probability of high solar activity, would alleviate this hazard.

He has been right, and the radiation experienced by the astronauts on the moon flights has been of no medical significance.



Early designs for command module included types that could be guided back to earth by means of flaps or fins. Model finally chosen was conical, with an offset center of gravity.

Navigation in space might have been a problem had not Stark Draper and his group at the Massachusetts Institute of Technology tackled the job. The system they designed has proved amazingly accurate.

The pieces were now beginning to fit together. But there were still two major areas to be settled. These were the launching vehicle design and the method to be used for landing on the moon.

The rocket plan really came first. By this time, the large Nova rocket for direct ascent to the moon had lost many of its early backers. Dr. Wernher Von Braun and the Huntsville team were beginning to zero in on a so-called C-5 rocket.

This rocket used five of the huge F-1 engines in the first stage and a new hydrogen-oxygen engine in the upper stages. It could send more than 90,000 pounds on course to the moon.

I strongly supported the C-5 (later called the Saturn 5) for two major reasons: first, because it was a logical technical design; and second, because I knew that one Saturn 5 would put us on the moon if I could only get lunar rendezvous approved. This was to be quite a problem, however.

Brainerd Holmes, whom Mr. Webb had selected as head of the Apollo program in Washington, strongly favored a scheme called earth orbit rendezvous. This would use multiple launchings of Saturn 5 rockets—joining them in orbit and pumping fuel from one to refill the other; then realigning and lighting off that rocket to go on to the moon. The Huntsville group, quite naturally, favored this method also.

From the earliest time, I supported lunar orbit rendezvous. In this mode, the lander goes down from lunar orbit and later returns to rendezvous with the mother ship.

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Lunar orbit rendezvous was proposed by John Houbolt, who was chairman of a group that studied the plan at the Langley Research Center. Early one Sunday morning in June, 1961, Charley Donlan and I went over to Langley and listened to a briefing by Dr. Houbolt and Clint Brown.

When I heard of this plan, I was convinced for the first time that we could really land on the moon. It required less weight injected toward the moon but, even more important in my view, it allowed the separation of functions of landing from those of the command and service modules.

I believe the credit for selling the lunar orbit mode must be given to the Houston people. Their studies converted first the key Huntsville officials and, finally, Brainerd Holmes. Joe Shea, Mr. Holmes's assistant, carried the decision to the higher echelons of the Government.

Mr. Webb now had a master plan to go ahead with. It consisted of a giant three-stage launching rocket; a command module with three astronauts on board; service module to carry the propulsion engine, attitude control jets and fuel cells for power; and a two-man module designed specifically for the lunar landing. In its simplest terms, this was the technical plan for Apollo; and it was to need no change as it went forward in development.

The NASA System: A Meshing of Many Parts, People and Ideas

Leaders Find Simple Way Is Best

By SAM C. PHILLIPS

THE water that suddenly filled my eyes must have been tears, by technical definition. In earlier years, I might have been tempted to attribute it to the plaster dust that filled the air as it was shaken from the ceiling of the launch control center by the roar of Apollo 4 rising majestically at the Kennedy Space Center at precisely 7 A.M. on Nov. 9, 1967.

Apollo 4, the first flight of the mighty Saturn 5, was under way. The Apollo spacecraft it carried aloft was destined to re-enter the earth's atmosphere eight hours 37 minutes later at a speed of 24,165 miles an hour to prove that its heat shield could withstand the heat and stresses to which it would be subjected when returning from the moon.

No flight crew was aboard. Since the purpose of this mission was to prove the flight-worthiness of the new Saturn 5 and the spacecraft's heat shield, some elaborate electro-mechanical equipment had been developed so that functions the flight crew would normally perform could be done automatically or commanded from the ground. This equipment, installed on a large pallet carried in lieu of crew couches, actually made the flight more difficult than a manned flight.

Lieutenant General Phillips is the Apollo Program Director.

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So much more equipment had to work properly, and we did not have the advantage of a flight crew to select alternate modes or take manual control in case of malfunctions.

Unmanned flights to prove the flight-worthiness of manned space vehicles were a necessary step in Project Apollo, just as they were in the Mercury and Gemini programs. However, I believe unmanned flights will be unnecessary in future manned space vehicles if proper steps are taken in development and tests on the ground.

Some of our people feel we achieved that position by the time of the Apollo 4 flight. One of the Apollo astronauts remarked that he would have had full confidence in the equipment were he aboard the vehicle, which was then climbing steadily toward its parking orbit 100 nautical miles above the earth.

Apollo 4, a perfect flight, was the first after the tragic spacecraft fire that took the lives of three of my friends on Jan. 27, 1967. My emotions were, I am sure, typical of those experienced by most of the Apollo team who had given so much of themselves in working toward the national goal set by the President in May, 1961: a manned lunar landing in this decade.

Those of us who believe, as I do, that the strength of our nation depends heavily on meeting that goal do not take lightly the responsibility that has been entrusted to us: responsibility for the lives of men, for progress in hundreds of disciplines, for prudent use of money and other resources, and wise use of time. Emotional reactions to major steps forward, and to disaster or setbacks, are inescapable.

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How is the Apollo program managed? How have we managed to build the tremendously complex array of new equipment to standards of safety and reliability unparalleled in history? How have we developed the operational procedures and flight plans? And how have we trained men so that they can operate in the hostile environment of space?

If I appear to oversimplify or belabor the obvious, my long experience in large programs convinces me it is necessary to do both. Indeed, managements often fail because they allow an organization to find complex answers by haphazard approaches rather than to seek simple solutions along well defined paths.

The Apollo management process is to integrate hundreds of thousands of people at, literally, thousands of institutions into an organized relationship with one another, and to provide them with the means to insure progress at a planned rate and cost to attain the specific objective.

For the Apollo program is far too big to be carried out by any one organization. We have instead divided it into many tasks, distributed among many organizations, and developed common standards and procedures. We have found it necessary to use 35 major contractors, more than 4,000 lesser prime and sub-contractors, and a large number of Government, scientific, and academic organizations. Some 300,000 people were involved at the peak.

Our general approach has been to contract with industry to develop and produce the equipment we need. We have retained in NASA the functions of program management, over-all systems engineering, some of the testing and quality and reliability assurance activities, and all flight operations. We have found it necessary to use contractors at various times for tasks we would have preferred to do in-house.

These so-called support contractors are very useful in areas where it is necessary to bolster our in-house capabilities or where we do not consider it wise to build up within NASA.

Technical know-how is essential. As obvious as this seems, I have seen programs flounder because the right technical know-how was not brought to bear in timely fashion. I suspect that this principle applies more widely than just to space programs.

The foundation of the Apollo program is what I call systems engineering. Our systems engineers are the people who identify the way in which hardware, software, facilities, people and procedures will be put together. These are also the people who define the technical requirements of the pieces that constitute the system.

In the early period of Apollo, the trade-offs among several possible ways of accomplishing the lunar landing were studied to select the best approach. The decision to use lunar orbit rendezvous was the result of such a study.

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Once the approach had been decided upon, detailed performance and design requirements had to be generated. These prescribe features that must be designed into equipment so that it will be reliable, so that it can be inspected to assure quality, so that it will be safe, so that it can be tested and maintained.

Spare parts must be planned for in the beginning, and the logistics of moving enormous pieces of hardware from one location to another must be considered.

As the hardware progresses through design, manufacture, testing and preparation for flight, a series of design reviews, acceptance reviews, certification reviews, and flight-readiness reviews is conducted. Required changes or unanswered questions become the subject of action items that are assigned to individuals for resolution on strict schedules.

These reviews become the meeting place of all the management, technical, and operational disciplines in the program. Their purpose is to approve the design in the early stages and the hardware in the later stages—or to find deficiencies and insure that they are fixed. These reviews involve excruciating attention to detail to insure that weaknesses are discovered and corrected.

An example may help to illustrate the flexibility and quick reaction capability so essential to progress. A little over a year ago, Apollo 6, the second unmanned flight of the Saturn 5, experienced an unacceptable longitudinal oscillation during the first stage boost.

This oscillation, commonly referred to as the "Pogo" effect, involves a complicated coupling between the vehicle structure and propulsion systems. The phenomenon is analogous to the annoying feedback squeal encountered when the microphone and loud speaker of a public address system are coupled.

In the case of Saturn 5, the coupling subjects the spacecraft to excessive up and down oscillating forces.

We immediately established a task force under direction of the Marshall Space Flight Center. We called together experts from several NASA centers, and from our contractors. An astronaut, Bill Duke, was assigned full time to the working group, as was my deputy director, George Hage. Before we solved that problem, we had about 700 professionals involved, including consultants from companies that had run into this problem on other vehicles.

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The task force succeeded in solving the problem in time to support the Apollo 8 flight last December.

Development is an iterative process, and changes are inevitable. We control all changes in specifications, drawings and hardware through configuration control boards at my level, at my project managers' level at NASA centers, and at the contractors' level. Changes are bumped higher and higher as their safety, cost or impact on schedules becomes greater.

Program planning, closely allied with the systems engineering process, adds the critical dimensions of time and resources to program definition. This definition—or plan—is the program's cornerstone. It becomes the baseline against which management can judge progress and take action.

In my opinion, one of the great benefits of such plans derives from the exercise of preparing them. The coordination and approval process forces definition of what is to be done and who will be responsible.

The basic requisites for a successful organization are two: clear assignment of responsibility, and accountability for results at all levels.

In Apollo we have settled on an organization with relatively small program offices in Washington and at the three centers.

The program managers at each center report to their respective center directors, but are under me for program direction. There is continuous and free communication between the functional elements of their offices and mine.

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Our communication channels are designed to provide timely information at various levels for keeping track of progress, identifying problems and action required and gauging the effectiveness of decisions.

I conduct a monthly review in the Apollo program office of the various aspects of the program. The Manned Space Flight Management Council, consisting of Dr. George E. Mueller, associate administrator for manned space flight, and the directors of the three centers, meets monthly and spends at least one day reviewing all manned programs.

At the top of the review cycle, I personally report once a month to Dr. Thomas O. Paine, NASA administrator, and his staff.

There has been an evolution, particularly rapid in the last two years, in the reporting of program status. As Apollo has moved into the flight phase, significant problems had to be identified more rapidly, since they affected day-to-day plans.

My view of them is greatly enhanced by the "breakfast club," 30-minute meetings conducted each morning by my staff. Mission status and all constraining problems are reviewed on the basis of up-to-date information gained by telephone, travel and personal contact.

The ability to react to problems and opportunities, and to focus the judgment of key people quickly on critical situations, was perhaps best demonstrated in the decision to undertake the first flight around the moon with Apollo 8 last December.

By mid-August, it had become apparent that the lunar module would not be ready for the first manned test planned for December.

Yet we were confident we would be able to launch a good first manned flight of the Saturn 5 by then, and hopeful that the command and service modules would have proved themselves in the Apollo 7 flight scheduled for October.

Was there anything we could do to keep the program moving, rather than wait until February or March to fly the complete moon craft, including lunar module, with men aboard?

George Low, brilliant Apollo spacecraft program manager in Houston, came up with a startling idea: Why not, instead of waiting to man-test the combined spacecraft in earth orbit, first fly around the moon in December with the hardware at hand?

The rewards would be earlier experience in lunar navigation and long distance communication, and added experience with most equipment.

In a flurry of flying visits among our centers, weekend meetings in Washington and trans-Atlantic calls to officials then in Europe, the go-ahead was given to start detailed planning.

By November, with the results of Apollo 7's success written into the record, the decision was made to go for the moon in December.

I am convinced that the results of that historic Apollo 8 flight significantly advanced the chances of success by Apollo 11 this summer.

The New York Times (by William E. Sauro)

John C. Houbolt, who proposed that lander descend from a mother ship orbiting the moon as alternative to direct flight or earth rendezvous

How Concept of Lunar Rendezvous Unfolded

By JOHN C. HOUBOLT

THE idea of using a small lunar landing craft in conjunction with a lunar orbit rendezvous germinated in late 1960 and early 1961. The concept came from a basic notion that appealed to me greatly:

When you approach the moon in the main space craft or "basic living room," why take the whole living room down to the lunar surface with you?

Why not leave it in orbit and descend to the lunar surface in a small landing craft, then come back and rejoin the main living quarters by means of a rendezvous operation?

Surely, it seemed, the amount of energy or fuel required to do the job this way would be considerably less than that required to take the whole living room down.

Dr. Houbolt, senior vice president of the Aeronautical Research Association of Princeton, N. J., developed the concept of lunar orbit rendezvous.

If this was the case, then the over-all vehicle that left the earth could be smaller, which in turn meant that a smaller launching vehicle could be used.

In effect, the use of a small lunar landing craft (the LM) and a lunar orbit rendezvous (known as LOR) appeared to offer a chain reaction simplification of all project elements: development, testing, manufacturing, erection, countdown, flight operations. The mission could also be accomplished in a shorter time and with much less expense.

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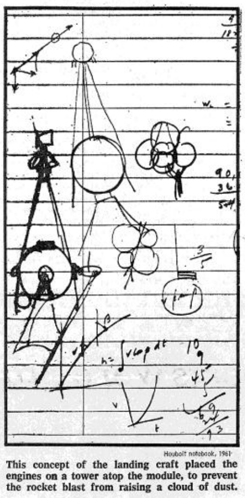
To bolster these intuitions, I roughed out a few design numbers. In confirmation of my feeling and to my delight, I found that the use of LM and LOR would allow a landing mission to be done with an initial weight on earth from one-quarter to one-half the weight that would be required to do the job by a direct flight.

It was at this point that I had the thought: "This is fantastic. If there is one idea we must push, it is this one." I vowed to dedicate myself to the task.

But no one was interested. Almost everyone connected with manned space flight projects was thinking only in terms of the "brute force," or direct way, of going to the moon. Later, after much committee study, the alternative of using earth orbit rendezvous (or EOR) was introduced for consideration. The idea was to place several payloads in earth orbit, then assemble them and finish the mission as in the direct scheme.



Houbolt notebook, 1961

This concept of the landing craft placed the engines on a tower atop the module, to prevent the rocket blast from raising a cloud of dust.

I presented the LOR idea many times, to various individuals and committees. The reaction to the idea of having astronauts perform a rendezvous maneuver 240,000 miles from the earth was generally negative. In some cases direct hostility was evoked; in others the individuals thought we had "gone off the deep end."

In 1958, the Langley Research Center set up a committee to examine the problems involved in establishing and operating a space station. Several groups were set up within this committee to consider the various technical aspects, one of them being rendezvous—obviously a key operation in any space station project. Because of my known interest in rendezvous, I was asked to head this group. One idea we proposed was to perform the missions with very small one-man landers, and perhaps use only two rather than three men in the over-all crew.

The idea was predicated on the thought that, since an astronaut was going to be out in space in his spacesuit alone for two to four hours anyway, why not send him down to the moon in just his space-suit in a very elementary type of lander, quite similar to the little craft used in the Dick Tracy comic strip?

To a limited extent, we could convey our ideas as they were generated, for it was possible to make presentations before other groups and committees in NASA.

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After one particularly discouraging session, it was suggested that if I felt so strongly, I should write a minority report. At this point, I told my colleagues: "Look, if we are to get anywhere at all we ought to document all our findings on LOR and work it up in the form of a proposal and an evaluation with regard to other schemes."

We worked furiously. In short order we had a nice two-volume report. Because we included scheduling, funding and development programs, the report could not be published for external use, but internally it was to become a "best seller." The more than 100 copies that were printed were soon gobbled up within various space agency groups.

In due course, after studying the plan intensively, all the main groups that would be involved in any final decision swung over to the plan. Suddenly, it seemed, after two years or more of indifference, there was practically complete agreement throughout the space agency on LOR.

In July, 1962, the decision to use the LOR technique was officially adopted. Even after that, some influential holdouts continued to argue against the scheme.

But NASA officialdom held firm, and by September contracts had been awarded for the odd-looking vehicle, an elaboration of our plusher concepts, that will soon ferry two astronauts from lunar orbit onto the moon.

Full Buildup Took Only 18 Months

By D. BRAINERD HOLMES

IN August of 1961 I found myself in Washington with an illustrious title, an organization of somewhat conflicting interests, and the challenge of establishing a program to send a man to the moon and bring him safely home. It was a formidable assignment.

Jim Webb, the administrator of the National Aeronautics and Space Administration, had asked for my services, presumably because I had had experience in organizing the multi-million dollar ballistic missile early warning system.

My job was Director of Manned Space Flight. I found NASA to be an organization of immense capability and technological depth but one in which much had to be done to mold it into a hard-hitting, cohesive team able to undertake the staggering task set for us by President Kennedy.

Project Mercury was already in existence and formed the base upon which we would build for Project Apollo. The lunar mission would require the vast expansion of Mercury and the addition of new facilities.

Mr. Holmes, formerly the director of manned spaceflight at NASA, is now executive vice president of the Raytheon Corporation.

Houston was designated as the location for NASA's Manned Spacecraft Center, where the lunar vehicle for future manned flights would be designed and perfected, and where our astronauts would be trained.

The tremendous problems of design involved in propulsion, structure, guidance, control and reliability made it essential that NASA's Marshall Space Flight Center, at Huntsville, Ala., under the direction of Dr. Wernher von Braun, be made a fundamental part of the team.

Cape Kennedy (then called Cape Canaveral) underwent enormous change and a new NASA center was constructed there for launching operations.

Houston, Huntsville and the Cape, then, evolved as the major centers in a network of operations that would make going to the moon a reality.

Past experience indicated that a strong Program Office was required to provide focus and direction, and, in the end, to make the crucial decisions necessary for the success of the mission.

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Further, the typical program organization would require some special tailoring to assure that the management strengths of the centers were brought to bear with maximum effectiveness.

My first move in Washington, therefore, was to establish my organization as a Program Office, committed to getting things done rather than a Headquarters Office, aware of things that ought to be done. With the help of Robert Seamans of NASA, we found capable and experienced men to lead the program management of each of the major elements of Apollo.

Our next job, one requiring thousands of hours of preparation, was the testimony before Congress to obtain the funds to pay for the Apollo mission. It was heartening that we came away from Washington with a commitment that the multi-billion-dollar program would be financed.

At the same time, our systems engineering people were busy with a basic question: How would we get to the moon? By direct ascent from earth or by rendezvous in earth orbit or moon orbit? It produced intense controversy, but we finally chose lunar orbit rendezvous.

A number of contracts were set in motion. Final decisions on the sites of engines and designs of stagings were made. The maximum effort was under way.

Getting such a large and complex program in motion is extremely difficult. Start slowly. Think. Plan. But then come on like gangbusters!

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With all these activities started, we conceived of the Gemini program as a transition between Mercury and Apollo. Gemini, another series of earth orbits but for longer periods of time, would supply new data on unknown factors that worried us, such factors as the effect of weightlessness over prolonged periods and the possible effect of radiation densities in space.

As it developed, Gemini turned into an eminently successful program in its own right, and put to rest a lot of false fears about space flight.

I suppose I would be guilty of a gross oversimplification if I were to say, "And there we had it." So many arduous hours lay ahead before we could actually be ready for the lunar assault.

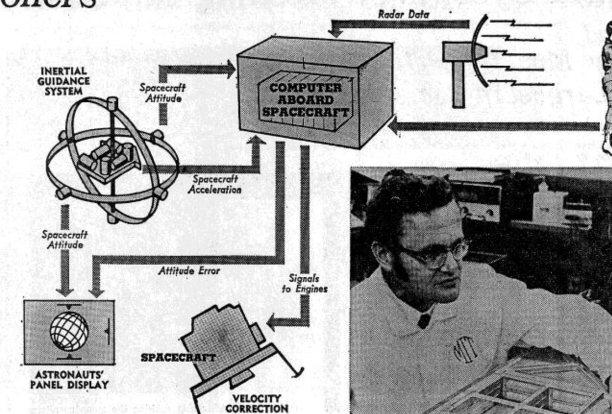
And yet the formal mobilization for Apollo had been accomplished in about a year and a half from the time of President Kennedy's commitment.

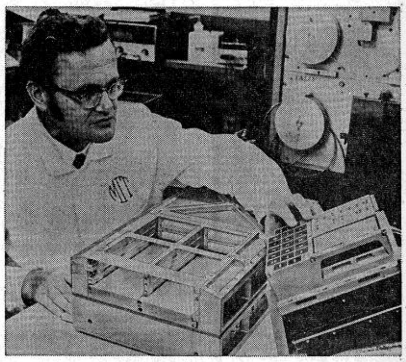
More important, the total effort had started to move as a body and with direction. It was as though one had pushed a static glacier into motion and its momentum was growing with each passing day.

Perhaps when we hear the tired old cliché that America is getting soft, we should remember such endeavors as these, and know that when given a challenge Americans today can be as hard, as aggressive and as brave as the men who founded this land.

Computers and Controllers

By CHRISTOPHER C. KRAFT Jr.





Eldon C. Hall of the Massachusetts Institute of Technology (right) displays computer used aboard spacecraft, one of hundreds vital to the Apollo program. As shown in diagram above, it receives navigation data from radar, astronauts' optical sightings, and the inertial guidance system, a combination of gyroscopes and accelerometers that determines spacecraft's motion relative to a fixed point in space. Acting on the basis of this information, computer guides craft and displays data for crew.

IF I had to single out the piece of equipment that, more than any other, has allowed us to go from earth-orbit Mercury flights to Apollo lunar trips in just over seven years, it would be the high-speed computer.

On Apollo, we have begun to use computers, literally, by the hundreds.

They are used, first of all, to check out the space vehicle before launching. And then they help to carry out the launching itself.

During flight, miniaturized computers jammed with more data than the full-sized on-the-ground computers that handled entire Mercury flights perform incredibly complex jobs. They keep track of speed and position; calculate needed changes in flight path; watch for malfunctions, and display data on "cockpit" panels.

Mr. Kraft is the director of flight operations at NASA's Manned Spacecraft Center in Houston.

But it is in the operation of the worldwide network supporting each Apollo flight that the full scope of what the computer contributes to a lunar voyage can best be appreciated.

The network consists of 17 ground stations, four instrumented ships and half a dozen or more instrumented planes. The role of the network is to keep the flight-control center at Houston in almost instantaneous contact with the spacecraft with just a few exceptions. These come during the brief periods that the spacecraft is between network stations on initial earth orbits, and for about 45 minutes of each lunar orbit, when the crew modules are behind the moon.

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Even for sophisticated engineers, it is hard to comprehend fully what a fantastic advance this Apollo network represents.

In the Mercury program, we had relatively simple needs. Our chief concern right after launching was to determine whether the spacecraft had been rocketed into a satisfactory earth orbit and, if not, what actions we should take to accomplish a safe recovery. Once the capsule was in a proper orbit, the only maneuver that could change the flight path was the retro-fire that would slow the vehicle to bring it out of orbit and down to a safe landing.

The problems of assessing whether the initial orbit was satisfactory, and of assuring safe recovery, seemed monumental. But comparing them with the problems involved in carrying out the many combinations of maneuvers required on a lunar mission is like comparing simple addition to the most complex mathematical equation.

The communications that initially tied together the worldwide Mercury network consisted mainly of messages sent over low-speed teletype equipment. But that would not permit any direct voice contact between the flight controller at what was then called Cape Canaveral and the orbiting astronaut, except when the Mercury passed within range of Canaveral. So it was necessary that highly trained individuals take up residence at the Mercury stations around the world to serve as flight controllers. By means of meters and charts of data telemetered down from the spacecraft these individuals monitored the performance of spacecraft and astronaut, and relayed information via teletype back to Canaveral.

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Very early in the Mercury series we realized that the 15 minutes it took to absorb teletype data from distant stations was too long and that it was vital to have voice communications. We set to work to connect the stations and the Canaveral center by high-frequency radio. This type of gear was not very reliable. But HF radio sufficed to provide the necessary control of the Mercury vehicle, with its limited capabilities.

The Mercury's successor, the two-man Gemini, was designed to do a lot more maneuvering. It could change orbit and carry out rendezvous and docking with unmanned Agenas. It was vital therefore that the ground-control center have much more immediate and more reliable data. This meant connecting stations of the worldwide network, first by cable and then by communications satellite.

Finally, in designing the system that would support Apollo missions, it was obvious that the quality of the world network would have to be advanced far beyond even Gemini's capabilities. That meant using not only high-capacity comsats but also the high-capacity computers needed to process the vast amounts of data that had to be sent. Once such equipment was in operation, it was no longer necessary to dispatch ground controllers to each station.

The progress made since early Mercury days is staggering. For instance, during the seven minutes a Mercury was in range of the station at Carnarvon, Australia, we were able to teletype to Cape Canaveral data summarizing 30 to 40 on-board functions. These might include heart beat and respiration of the astronaut, cabin temperature, oxygen supply, etc.

Today, we can get almost instantaneous data at our Houston control center on as many as 500 gauges, dials or meters. The aero-medical doctor on duty can study the electrocardiogram from each of the three Apollo astronauts as though they were patients in his office. The doctor can speak directly to the astronauts.

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The computer used on the ground in the initial control center for Mercury was an adaptation of a computer originally designed with no thought of space flight. It had been designed essentially for scientific projects. It had a storage capacity of 32,000 words, 4,000 fewer than are compressed into each of the miniaturized computers aboard the Apollo modules.

The primary on-the-ground computer used on an Apollo flight has a capacity—an incredible contrast—of 5.5 million words. To the layman, this comparison may seem like a numbers game, and have little impact. But he would understand how phenomenal the advance was if he considered the thousands of man-hours needed to fit together complex equations and endless instructions into a workable set of computer programs for a lunar mission.

A Government-industry team has been working on these programs since 1962. There were times when the task appeared beyond our capability. But the challenge of the Presidential appeal to put an American team on the moon in this decade proved sufficient inspiration so that the programing was finally accomplished. It is my opinion that the progress made by the nation in computer technology—spurred primarily, I think, by the space program—is worth a large portion of the dollar outlay for the program. The progress has given us a wealth of knowledge that can be applied to almost every engineering, scientific and industrial endeavor on which we embark.

Though more complex missions have required these great strides in computers, the basic techniques of flight control have remained fundamentally the same from the beginning of our program. Our philosophy requires that we be prepared to handle any emergency. In our mission planning, we go through a painfully thorough process of figuring out the possible contingencies. We call this the "what if" game. And we play it for each different phase of a particular mission.

The mission plan begins with spelling out a basic flight-test objective and working out flight trajectories to carry out the objective. The men in flight operations then analyze each facet of the plan. Of course, it would be impossible to analyze in detail every possible situation. What we do, therefore, is consider the probabilities for particular contingencies, and we plan in greatest detail to handle those emergencies that seem to have the greatest chance of occurring.

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The solutions worked out are documented. They are then distributed to the numerous groups who have the most intimate knowledge of the hardware and flight operations for final analysis.

This process culminates in a final trajectory plan and a set of mission rules—a thick volume of "rules of the game" that will govern what we do in particular situations.

For instance, in the final descent of the lunar module to a moon landing, we are critically dependent on a radar system that will determine the precise altitude over the lunar terrain. Normally, the LM must be turned so that the radar is pointing downward by about the time the vehicle has descended to 30,000 feet. It is hoped the radar will promptly start providing accurate altitude readings. However, there is some leeway in the rules. These allow a descent to as low as 13,000 feet without what is called "radar lock"—in other words, hard evidence that the radar is working perfectly. If it is not, the mission rules say the mission must be "aborted." The LM must break off the descent and return to the mother ship.

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During the last decade, we have greatly increased our proficiency in contingency studies. But because of the infinite number of possible flight paths, the difficulty of working out mission plans has increased by what engineers call "several orders of magnitude." In layman's language, that means it has increased by a factor of hundreds or perhaps thousands.

The approach to developing our lunar-landing capability has not differed widely from the approach used in testing high-speed airplanes. That is, we have attempted to reach our ultimate goal through a step-by-step sequence of missions designed to explore the problems of the various phases of the total lunar mission. Each flight builds on the knowledge gained from the previous one.

The lunar landing will be a tremendous accomplishment but it is a step we can now approach with a high degree of confidence. The amount of effort required to achieve this goal is hard to imagine, even by those most directly involved. However, the one ingredient that has made it possible, and can be understood, is the sustained motivation of the Apollo team. Probably the most rewarding experience of my entire 10 years on the manned space flight program has been the privilege to be part of this group.

In Developing Space Hardware, Human Judgment Still Counts Most

By GEORGE M. LOW

GUMDROP and Spider, Charlie Brown and Snoopy, Columbia and Eagle—these are the names given to two of the most complex pieces of machinery yet devised by man, the Apollo command and service module and the lunar module.

Seventeen tons of aluminum, steel, titanium, copper and synthetic materials. Thirty-three tons of propellants. Nearly four million parts, 230,000 feet of wire, more than 100,000 drawings, 26 major subsystems, 678 switches, 410 circuit breakers, all fashioned into two flying machines that must function with precision and perfection to perform their assigned tasks: To bring three Americans to the vicinity of the moon, take two of them to a landing on the lunar surface, and bring them back safely to earth.

Mr. Low is manager of the Apollo spacecraft program at NASA's Manned Spacefraft Center in Houston.

Each of the two spacecraft is designed to perform a specific function. The command module, part of the CSM, (command and service modules) must bring the crew back to earth. It is designed to withstand the fiery heat of re-entry. Thus it is compact, with no protrusions, and is covered with an ablative material, a plastic that chars and vaporizes under the heat generated as the spacecraft slams back into the atmosphere at 24,000 miles an hour. Col. Frank Borman, Capt. James A. Lovell Jr. and Maj. William A. Anders said they felt as if they were inside a fluorescent light bulb, so bright was the re-entry fire that engulfed them during the Apollo 8 mission in December.

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The service module, the sister component of the CSM, carries along the stores needed for an 8- to 11-day journey through space: oxygen, power-generation equipment, water that is a by-product of power generation. The service module also has the large engine needed to place the spacecraft into orbit around the moon, and to eject from lunar orbit upon completion of that part of the flight.

The LM looks very much like the spider — a gargantuan, other-worldly spider—that the crew of Apollo 9 named its LM for. Since it does not return to earth, and need not fly through the atmosphere, the LM is a rather funny looking flying machine. But it is designed to do its part of the mission: descend from lunar orbit to the surface of the moon; operate on the moon for more than 21 hours during the Apollo 11 mission (longer on later ones); climb back into lunar orbit, and rendezvous with the circling command and service modules. The LM has paper-thin walls (so thin, in fact, that when we recently tried to repair a small hole in the Apollo 11 ship, we punched through two more small holes before we were done), and is crammed with electronic gear, navigation aids, propellant tanks and engines.

Within each spacecraft are subsystems to provide comfortable living conditions for the crew, to help them navigate through space, to allow them to communicate with the ground and among themselves, and to propel their craft along the precise trajectories needed to perform the mission. The environmental control systems provide oxygen, remove carbon dioxide and moisture, and heat or cool the craft as required under a great variety of thermal conditions.

The many radios have allowed us to talk with the crewmen while they were orbiting the moon as clearly as if they were in Houston. They have sent back thousands of pieces of information about the well-being of the spacecraft systems (and the crew), and have even provided color television of the lunar surface. (Who will ever forget the Stafford-Young-Cernan telecasts describing the moon—telecasts that helped win Emmy awards for the crews of the first four Apollo flights.

United Press International

Lieut. Col. Virgil I. Grissom, Lieut. Col. Edward H. White 2d, and Lieut. Comdr. Roger B. Chaffee, killed on Jan. 27, 1967, during a test of the Apollo 1 craft.

Perhaps the most complicated equipment on board is the guidance and control system on each spacecraft. Each system consists of a miniature computer with an incredible amount of data in its memory, and an array of gyroscopes and accelerometers, called the inertial measurement unit. Together, they can calculate precisely where the spacecraft is between the earth and the moon. But these devices don't work automatically. They also need a navigator to give them instructions, to take sextant sightings and to direct their over-all operation. On Apollo 10, this equipment made it possible to fly nearly a quarter-million miles through space, make only one tiny midcourse correction and land within television range of the recovery ship, within 35 seconds of the time calculated many months before the flight.

But the guidance equipment alone only tells us where the spacecraft is and how to correct its course. It provides the brains while the propulsion system provides the brawn. There are 50 engines on the Apollo spacecraft, many more than on the Saturn that propelled it toward the moon. They include small ones, on each of the modules, to orient the craft at any desired altitude, and big ones to make the larger midcourse corrections, to get the craft in and out of lunar orbit, to descend to the moon's surface, and to ascend back into lunar orbit. Three of the engines use solid propellants and are used to get away from the launch vehicle, should an emergency arise. The 47 others use hypergolics, propellants that ignite spontaneously when the fuel and oxidizer come in contact with each other.

Manned spaceflight is unforgiving. We once made a serious mistake, a mistake of not maintaining absolute control over all flammable materials, and in the Apollo fire of January, 1967, it took the lives of three of the finest men I have known: Gus Grissom, Ed White, and Roger Chaffee. Since then, we have made every conceivable effort to avoid similar mistakes in the future. We have re-examined every drawing, every circuit, and every component of the Apollo spacecraft. We have made thousands of changes in design, in manufacturing techniques, and in tests.

We have, for example, developed a brand new coating — fireproof and waterproof — to wrap around silicone rubber insulation. And we have added extra switches to some systems to prevent a single-point failure from prematurely actuating a critical device. We have literally rebuilt each Apollo craft, starting with Apollo 7, the first of this series to fly men into space.

We now have behind us four of the most successful flights in the short history of manned flight: Apollo 7—an 11-day flight in earth orbit in October, 1968, that wrung out the command and service modules; Apollo 8—man's first venture in December to orbit around the moon; Apollo 9—when the lunar module joined the stable of qualified manned spacecraft in March; and Apollo 10—a dress rehearsal in April of the lunar landing during which our astronauts descended to within 9.4 miles of the moon's surface. Each flight was flawless; all spacecraft performed with near-perfection.

I have often been asked: "How is this possible? How can you make four million parts work so well together for so many days, with such precision and without serious failures?" There is no simple answer to these questions. Flight safety and reliability stem from many factors: good design, excellent quality in manufacturing, a thorough test program and, above all, firm control over each and every change.

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The basic Apollo design principle relies heavily on simplicity and redundancy. Engines use hypergolic, self-igniting propellants and, therefore, need no sparkplugs and ignition systems. Engine thrust chambers and nozzles are made out of ablative material that chars and vaporizes like the command module's re-entry heat shield, thereby avoiding the need for complex engine cooling systems. Engine valves are duplicated, so that if one fails, the other will still allow the engine to run. Three independent fuel cells generate electric power, with one cell alone sufficient to return safely from the moon. Two wires run from point A to point B, along different paths, with only one required to do the job. I could go on and on, but I think I have made the point: Build things simply, and then build two of them so that, if one fails, the crew can still return to earth. A fuel cell did fail on Apollo 10 while in lunar orbit, but this in no way detracted from the complete success of the flight.

Quality in manufacturing is a must. The technicians at North American Rockwell Corporation of Downey, Calif., and at Grumman Aircraft Engineering Corporation of Bethpage, L. I., where our spacecraft are built, take a great deal of pride in their work and would do anything for the men who fly their machines. More than once while I was on the floor in one of the assembly plants, a technician stopped me and said, in effect: "Please don't make any more changes to my ship. I'd hate to have somebody else come in and spoil my work."

But design and manufacturing alone aren't enough. The proof comes in a well-conceived test program. Here we take each component, each part and each subsystem and subject it to every possible environment that it might encounter in flight: heat and cold, vibration, noise and shock, vacuum and pressure. Then we take complete spacecraft and put them through their paces: drops from airplanes to test the parachutes; drops on land and water to test the impact resistance; other drop tests to simulate the lunar landing at one-sixth the force of earth gravity; manned tests in giant altitude chambers; vibration tests, engine tests and many more.

Often the results of these tests are unexpected. For example, just two weeks before Apollo 10, we dropped a complete lunar module in a simulated lunar landing; then we performed all of the functions that LM would have to perform on the moon after landing. This included severing the ascent stage from the descent stage, pressurizing the propellant tanks, and firing the engine. In this test, a valve used to pressurize the propellant tanks sprang a leak. Even though the valve had been successfully tested hundreds of times in the past, there was only one thing to do: fix the identical valve on the Apollo 10 LM. In a period of three or four days, we had identified a new type of failure, developed a way to fix it, tested the repair job and installed it in an almost inaccessible area on Apollo 10. The flight was able to go on time, and the valve did not leak.

Design, manufacturing, testing are three of the elements of manned spaceflight development. But there is a fourth element, the most important element: the people who apply their best judgment, and who make the decisions in each of these areas.

On the Apollo spacecraft, for the last two years, every significant decision, large or small, has been made by my configuration control board. The board members, by and large, are manned-spaceflight veterans: Chris Kraft, our director of flight operations; Max Faget, our chief engineer; Deke Slayton, director of flight crew operations; Chuck Berry, the medical director; Tony Calio, representing manned-space science; Rip Bolender, responsible for LM: Ken Kleinknecht, in charge of the CSM: Scott Simpkinson, for flight safety; George Abbey, our secretary; and Dale Myers and Joe Gavin, representing North American and Grumman.

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We sit together once each week, for as many hours as required (usually at least six) and review every problem and every proposed change to our hardware. Once each month, we have an all-day session at Grumman and another at North American. We realize that no change is insignificant, that a change that may, in a subsystem engineer's mind, appear to be an improvement might well degrade the over-all reliability. We know, from long experience, that attention to every detail, no matter how small, is mandatory.

Attention to detail. And a knowledge that there is risk in manned flight, just as in any other pioneering venture. These principles and this knowledge have guided every judgment, every decision that has made the Apollo command and service modules and the lunar module the machines they are today. In doing all this, there has been but one motive for all of us, those of us on the board and the thousands of men and women building the Apollo spacecraft: To provide the best equipment possible for the men who have already flown, for Neil A. Armstrong, Lieut. Col. Michael Collins and Col. Edwin E. Aldrin Jr., as well as for all others who will follow them to the moon.

The Saturn 5: 'Monstrous Machine' Makes Moon Trip Possible

Rocket Is the Most Powerful and the Largest in Use

By WILLIAM A. MRAZEK

THE Saturn 5 is the largest and most powerful rocket in use in all the world, and the problems and the drama associated with its development were equally huge.

Many of us at the Marshall Space Flight Center in Huntsville, Ala., have more than three decades of experience in rocketry. But when we completed the first drawings of the proposed three-stage Saturn 5 launching vehicle and took an over-all look at them, we couldn't believe that this monstrous machine would ever lift itself off the pad.

This nation's first satellite, Explorer 1, had weighed a mere 30 pounds. This new super-rocket was intended to orbit the weight of more than 9,000 Explorer 1's in a single launching.

The problems connected with the size of the vehicle were secondary only to money in the Saturn project. The Saturn 5, with its Apollo spacecraft payload, towers 363 feet high on the launching pad. Its first stage measures 138 feet long and 33 feet in diameter.

New manufacturing buildings had to be constructed, new machine tools designed, special transportation vehicles invented, extra-wide roads constructed, and power lines moved as the stage took shape.

Dr. Mrazek is the assistant director for program management at NASA's George C. Marshall Space Flight Center at Huntsville, Ala.

A massive concrete and steel test stand had to be built at the Marshall center for static firing the first stage, and special barges were constructed to take stages down the Tennessee, Ohio, and Mississippi rivers to the launching pads in Florida.

A mothballed Army facility in New Orleans, the chief feature of which was a single manufacturing building that covered 42 acres, became the Michoud Assembly Facility for Saturn stages. And 40 miles away giant earth-moving equipment cleared scrub pine trees and dug canals for the Mississippi Test Facility.

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Behemoth stands were built here for firing all engines of the Saturn 5's first stages, which were to be assembled at Michoud and its second stages, which were to be built on the West Coast and shipped by ocean-going vessels through the Panama Canal because they were too big to be transported by railway or highway.

And at the Kennedy Space Center mammoth launching facilities sprang up among the palmetto swamps and isolated orange groves. Here the three stages of the Saturn 5 would be stacked atop one another and crowned with the spacecraft in a Vehicle Assembly Building standing 525 feet tall and larger altogether than the Pentagon and Chicago's Merchandise Mart combined.

The Saturn 5 did not emerge from the drawing boards full-blown as a totally new creation. It is the beneficiary of tremendous advances in rocket technology made in preceding programs.

A proposal for clustering several engines and tanks for greatly increased rocket thrust was submitted to Washington by the rocket team at Huntsville in 1957. Sputniks 1 and 2 stirred the project into life.

Extremely large launching vehicles had not been considered necessary for national defense purposes, because at that time the advanced nuclear weapons of the United States used smaller ballistic missile payloads than those of the Russians. But space exploration demanded larger rockets, especially for manned space flight.

The money problem was acute at the birth of the Saturn project. The Advanced Research Projects Agency of the Department of Defense approached us on Aug. 15, 1958, with a meager money bag but a tall order: Go ahead with your proposal, we were told, to demonstrate a clustered propulsion system to provide more thrust, using existing rocket engines. There was urgency in the request.

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This was considered the quickest way to respond to the clear Soviet advantage in payload lifting capability.

With the limited funds initially provided, it was obvious that only by severe scrounging and improvisation, based on long experience, could we possibly fulfill our promise.

We spent some of the money recalling discarded rocket engines from laboratories and displays for re-use. Then we scavenged through our warehouses for surplus and discarded components, pipelines, valves, and so forth.

By making bare necessity a virtue, we designed the Saturn 1's first stage, with its well-known corrugated or pipe organ appearance.

Few people may now remember the Army's Jupiter missiles, which stood guard on the Mediterranean shores during the Cuban crisis, and the Redstone missiles in the hands of NATO troops in Europe.

Both systems were retired, but they lived on in the containers of the Saturn 1-B's first stage. The 108-inch diameter Jupiter body formed the core of this stage. Around it there was a cluster of 70-inch diameter Redstone containers, alternately filled with liquid oxygen and kerosene. And eight Jupiter-type engines were grouped beneath the tanks to provide the then unprecedented thrust of 1.5 million pounds.

This jerry-built rig worked. Clamped to the side of a modified Jupiter concrete test stand, it gushed flame, smoke, and thunder from all eight engines for the first time on April 29, 1960. The concept proved, we then set about making it fly.

Since the Saturn project was begun purely as a research and development effort, there was no assigned mission and there were no plans for upper stages. Our cost-consciousness caused us to recognize the value of re-using such an expensive piece of equipment, rather than discarding it in the ocean after depletion of its fuel and separation from the second stage. So we drew up plans for parachute recovery of this rather large first stage. All these diverse requirements kept the design engineers on their toes.

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The first Saturn 1 was launched from Florida's east coast on Oct. 27, 1961. This was the first of 10 straight successful firings that completed the Saturn 1 research and development program, each one spectacular evidence of the skill of engineers and managers in problem-solving since inception of the project.

When President Kennedy called for a trip to the moon in this decade on May 25, 1961, however, it was an entirely new ball game. This goal really put the Saturn project in the major leagues, and money was no longer a major problem.

The lunar orbital rendezvous method of going to the moon called for a spacecraft of 85,000 pounds, according to first estimates. Working from the payload backward, we came up with a three-stage liquid-fueled vehicle, the first stage of which would generate an incredible 7.5 million pounds of thrust.

To achieve this power five F-1 engines, each one providing as much thrust as all eight engines in the first stage of the Saturn 1, would be harnessed together.

The first few years of Project Apollo were filled with organizational and contracting operations on the same immense scale as the Saturn 5 itself, as NASA and its contractors staffed themselves with the skilled scientists, engineers and technicians who would create the moon rocket. Soon there were 125,000 people in the Saturn program, most of them in private industry throughout the country.

While feasibility and planning studies were under way, the payload capability of the proposed rocket was extremely elastic. In-depth studies of the lunar journey showed a demand for higher performance in the spacecraft, and its weight grew correspondingly, like creeping inflation.

Faced with these new requirements, our design engineers stayed on their drawing boards night and day, and the lifting capability of the Saturn 5 slid upward from 90,000 to 92,000, to 98,000, to 100,000, and ultimately to 102,000 pounds for a lunar trajectory.

All sorts of tricky problems appeared as development actually got under way, for we were pushing against the limits of technology.

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Materials gave us numerous headaches. While a Saturn 5 contains everything from gold to plastics, the most common metals are aluminum, carbon steel, stainless steel, and titanium, with aluminum alloys predominating.

Because of their chemical compatibility with propellants, weldability, corrosion resistance, and low temperature behavior, aluminum alloys provide the lightest structures for self-supporting launching vehicles.

Structural stresses during manufacture and transport of the enormous Saturn stages later caused tiny hairline cracks in critical areas. Welds that appeared all right after extensive X-ray tests and dye testing later blew apart under pressure testing. After one serious explosion of a stage on a test stand we found that a welder had inadvertently used the wrong type of rods for the material in the stage. There are literally miles of welds in each Saturn 5 launching vehicle.

Handling of large quantities of liquid hydrogen, cooled to 423 degrees below zero Fahrenheit, during extensive ground tests and in flight called for new types of insulation and special fueling techniques.

All the problems I have mentioned, and numerous others, were solved through the ingenuity and tenacity of those in the Saturn 5 program.

The next decade should see a great deal of progress toward a more economical, reusable space transportation system and the establishment of a large manned space station for long duration operations in earth orbit.

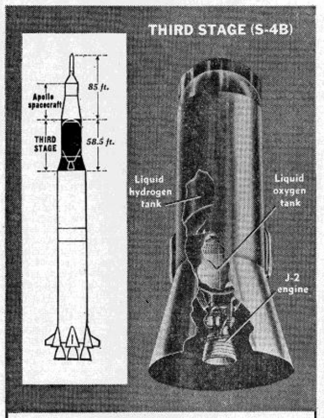
A low-cost transportation system is the key to the efficient operation of such a space station. At the same time, plans must be made for a transportation system that will take man to the planets.

Whether the time is near for these discoveries, or still in the distant future, plans must be made for departing from the earth-lunar region for direct observation of the nearest planets.

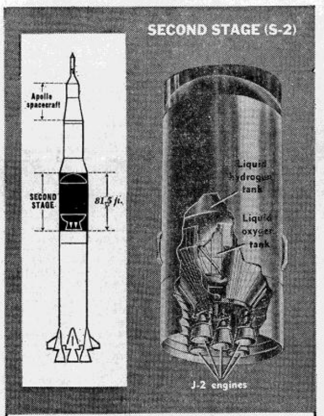
The potential and the promise of space exploration have never been brighter. We must continue to sow the seeds if we are to reap the rewards.

The Apollo Booster

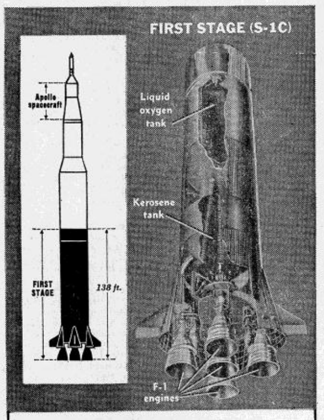
America's moon rocket consists of three stages, which ignite successively to boost the Apollo spacecraft into earth orbit. After the third stage fires, it shuts down. But later it is re-fired to push the spacecraft out of earth orbit and put it on course to the moon. Rocket and craft stand 363 feet tall.



CONTRACTOR: McDonnell Douglas Astronautics Co.
ENGINE.......... J-2 (one)
PROPELLANT..... Liquid hydrogen, liquid oxygen
THRUST......... 200,000 pounds (in vacuum)



CONTRACTOR: North American Rockwell Corp.
ENGINES......... J-2 (five)
PROPELLANT..... Liquid hydrogen, liquid oxygen
THRUST......... 1 million pounds (in vacuum)



CONTRACTOR: The Boeing Co.
ENGINES......... F-1 (five)
PROPELLANT..... Kerosene, liquid oxygen
THRUST......... 7.61 million pounds (sea level)

At the Pad, Each Launching Is a 5-Month Marathon

By ROCCO A. PETRONE

THE liftoff of an Apollo space vehicle with three men aboard is an awesome "moment of truth," but it is also just the top of an engineering iceberg as far as the launch team is concerned.

The launch team has actually been working on Apollo 11 hardware since it began arriving here by sea and air more than five months ago. For much of that time the team worked on Apollos 9 and 10 besides.

But in one sense Apollo 11 really began for us at the Kennedy Space Center in 1961, when we started to think seriously about checking out and launching a rocket larger than the Statue of Liberty.

Last May 20, while the Apollo 10 spacecraft was on its final approach to lunar orbit a quarter of a million miles away, I watched the Apollo 11 space vehicle move on its launcher from the checkout building to the launching pad two and a half miles away, and I could not help reflecting on these last eight years.

Here was more than 18 million pounds moving out of "dry dock" like a new ocean liner, but the trip was more or less taken for granted. After all, we'd rolled out a Saturn 5 eight times before. Eight years ago, however, the concept of moving this tremendous weight — and some $340-million worth of space vehicle — down a crawlerway as wide as the New Jersey Turnpike seemed a staggering task.

Mr. Petrone is the director of launch operations at the Kennedy Space Center at Cape Kennedy, Fla.

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It is our job, at the end of the Apollo pipeline, to catch all the problems before committing to flight. That's what the intense five months of assembly and checkout here are all about. The philosophy has been to check and double check through testing to make sure everything is right.

There have been three Apollo/Saturn 5 manned launchings in the program leading up to Apollo 11 — and each has occurred on the assigned day on the assigned second.

The more you know, the more you wonder how such space vehicles ever get off the ground. The closer you are to the space program, the more aware you are of its complexity.

The prime answer for our success thus far has been the people — the caliber and dedication of the people involved.

Shortly before liftoff, more than six million pounds of highly complex machinery stands poised on the launching pad. No matter how much automation is introduced, however, it still takes men to launch it.

The launch team's job is to receive the components of the rocket and spacecraft, check them out individually to make sure they work, and then mate them together to create a single entity called the space vehicle. Interestingly enough, none of these components or stages has ever met the others until it winds up at the Kennedy Space Center.

The rocket stages go into the massive Vehicle Assembly Building. The mobile launching pad is moved in by the transporter and the stages begin to meet each other for the first time during the stacking operation. The concept is to first make sure that the individual stage is flight-ready and then that it plays together with the other stages and the intricate ground support system.

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Five miles away in another facility the command ship that houses the astronauts and its propulsion module are placed in a bell-shaped vacuum chamber. The two stages of the lunar module are carefully eased into a second chamber.

Enough air can be pumped out of the chambers to simulate conditions at altitudes above 200,000 feet. This is a key test for the spacecraft since it is about as close as we get to the vacuum of outer space while on the ground.

The astronauts come aboard in their space suits and fly an abbreviated mission at the chamber's altitude limit. The nine-hour test exposes the crew and their spacecraft to realistic space conditions. We want to make sure particularly that such systems as breathing oxygen, cooling and other controls for the spacecraft cabin environment will work up there as well as down here.

Both the prime and back-up crews spend about nine hours at altitude in the command module. Similar runs are later conducted with the pilots aboard the lunar module in the adjacent chamber. The complete performance is controlled by spacecraft specialists in firing rooms nearby.

Before the spacecraft are removed from the chambers, the lunar module is physically docked with the command module. The next time this maneuver occurs will be about three hours after liftoff as the two spacecraft are on their escape from the earth on the way to the moon.

Once these major milestones are accomplished, the complete spacecraft assembly is ready to meet the now mated rocket stages that will later carry it through the earth's gravity barrier. The lunar module is tucked into a protective adapter, the command and service modules are placed on top; the unit is moved five miles to the Vehicle Assembly Building and lifted some 320 feet until it rests atop the Saturn 5.

The space vehicle now is born. The spacecraft can "talk" to the stages below and the rocket can also communicate electrically with the top.

Before leaving the building, the Apollo 11 space vehicle electrically "flew" a complete mission profile in an over-all test designated the "Plugs In." The test is so named because the ground connections remain intact. During this test just about every moving part that must function in flight — every valve, switch and sensor — is activated to assure that it operates the way it is designed to and on the proper time line. Now we have the space vehicle properly integrated with its mobile launcher, ground support equipment and the electronic controls in the firing room.

Next comes the rollout. On Apollo 11 we broke away from the building at 12:30 P.M. on May 20 and were locked on the pad by 7 P.M. The next major milestone in the preparation for launching is the Flight Readiness Test. Once again the complete vehicle is counted down and the command module is flown through its paces on a mission run to the moon and back, including the earth re-entry and landing sequence.

The Countdown Demonstration Test is the last major hurdle to be covered before we are ready to commit to the final count. The test is a "dress rehearsal" of the complete countdown. It includes the loading of the liquid oxygen and liquid hydogen aboard the vehicle stages and ends at T minus 8.9 seconds, the time for ignition on launching day.

We try to hit the exact time we will be aiming for that day.

Once this portion of the test is completed, the oxygen and hydrogen propellants are drained from the launching vehicle tanks and the final four hours of the count are repeated.

As launch director, my green light is the countdown test. Only when it is satisfactorily completed do I know we have accomplished all our checkout procedures and that I am ready to give a "go" to start the 93-hour countdown that leads to the launching.

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Ninety-five per cent of our work on an Apollo launching has been completed at this point. Only the top of the engineering iceberg remains.

We attempt to spread the count over five days, introducing some built-in holds at key points to permit time to solve problems as they inevitably occur, and to prevent launch crew fatigue.

The magic moment — and perhaps most critical moment — begins shortly after T minus 9 hours, when we start the final propellant loading. The kerosene fuel is already sitting in the first-stage tank and various propellants are aboard the spacecraft modules.

Now the task is to load more than 4.4 million pounds of liquid oxygen and hydrogen into the tanks of the three stages. These so-called cryogenic propellants are exacting to work with, simply because you need a temperature of 295 degrees below zero to maintain oxygen in a liquid state and minus 423 degrees to do the same to hydrogen.

Automation plays a big role in the propellant loading, which operates at rates from 1,000 to 10,000 gallons per minute. Despite the high fill rate, the over-all task still takes about four and a half hours.

The closest anyone is to the launching pad during this operation is three and a half miles back in the firing room, where a team of propulsion specialists monitors the status of the oxygen and hydrogen as it flows into their stage. The computer gives them inputs, but some are watching a closed-circuit television system that has zoomed in on certain flanges and connectors. They are watching for possible leaks or anything that might be suspect.

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The propellant loading is the major highlight on launching morning, until we are ready to accept the crew.

As the big green clock in front of us continues to click off the seconds, the countdown procedures establish the readiness of the spacecraft, launching vehicle, and the associated ground support equipment vital to a successful launching.

At three minutes, seven seconds the automatic sequencer comes in — and if all goes well, the count is automatic from there on down, being run by the master computer.

Over those last several minutes, however, most of the people in the firing room are reading their "red lines" — the acceptable high or low points for various pressures, temperatures and other parameters within the vehicle. Any "out of tolerance" will result in a human call for a hold.

Despite these marvelous computer techniques, the three men on top are riding on the capability of the 500 men in the firing rooms. They are a group of very dedicated people who know their jobs and know how to react.

Their operation has to be a combination of the discipline and proficiency of a professional football team and a military unit in action.

This is how the "moment of truth" is reached after five months.

Imaginary Trips Chart a Path to Moon

By JOHN P. MAYER

THE official mission requirements for Apollo 11 arrived on my desk bearing the somewhat undramatic title: "Mission Requirement, SA-506/CSM - 107/LM-5 G-type Mission, Lunar Landing." The basic aim was stated in one sentence:

"The following single primary mission objective is assigned to this mission: Perform manned lunar landing and return."

But the section on constraints was much longer. In effect, it specified a number of conditions:

Mr. Mayer is chief of the Mission Planning and Analysis Division at NASA's Manned Spacecraft Center in Houston.

Launch in daylight; land on the moon at sunrise; land on earth in daylight; don't get the spacecraft too hot or too cold; don't lose communication and tracking with the earth; don't stay in the radiation belts too long; don't burn the engines too long—or too short; don't use too much propellant, oxygen, electrical power; miss the moon by 69 miles; land within three miles of the lunar target; let the crew get enough sleep; be sure the crew can see to land on the lunar surface; don't let the guidance system lose inertial reference; etc., etc., etc.

For just as spacecraft hardware must be designed, so must the course to the moon. The trajectory to be flown must be designed around the capabilities of the launching vehicle, the spacecraft and ground hardware, and the operational constraints planned on the use of these systems.

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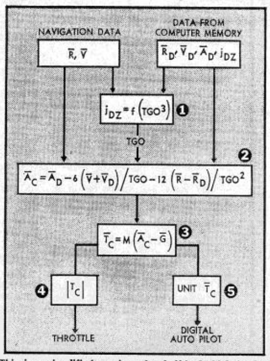
What is meant by trajectory design? It is easy to understand hardware design, where a piece of equipment that you can see and touch is built to perform certain mechanical or electrical functions. Software design (i.e., trajectory, flight path), on the other hand, is not so tangible and is more difficult to comprehend, for the end result of software design is the actual course or flight path to the moon and back.

The beginnings of software design are in the theories of astrodynamics that have been developed from those of Galileo, Kepler and Newton into the theories of today. Theoretical equations that model the environment (sun, earth, moon, atmosphere) and the various systems (propulsion, guidance, navigation) are then used to plan the path to the moon.

All of these equations are then written in a form that can be accepted by a computer. In this form the series of equations that result in the trajectory to the moon are called computer programs. These programs then are inserted into the memory of the on-board and ground computer systems. In the case of the computers aboard the spacecraft, they are actually wired into the permanent memory. In the ground computers they are simply typed in on a keyboard. These programs are then used to plan and fly the mission within the many operational spacecraft and ground system constraints.



This is a simplified version of a half-inch-thick book of logic symbols fed into the lunar craft's computer to govern the moon landing. Equation 1 determines the time to go until descent engine cutoff; 2 determines the acceleration needed; 3 calculates the engine thrust required. The output at 4, when converted to electrical signals, controls engine thrust by adjusting the throttle. Output at 5 is programmed into digital autopilot, which controls direction of thrust.

The list of constraints seems endless, and often is contradictory. For example, the space craft attitude best for communications may not be best for avoiding solar temperature problems or maintaining the inertial guidance system's stable platform in proper position. Similarly, during lunar descent, the astronauts want to see the lunar surface, and the landing radar of the lunar module must be operating; however, at the beginning of descent the landing radar points in the opposite direction from that in which the crew can see. Therefore, some of the constraints must be relaxed.

The guidance system is required to place the spacecraft in a 69-mile circular orbit above the moon after a trip of 245,000 miles, to land within three miles of a target point on the lunar surface, to launch from the moon and rendezvous with the command module, to return to earth, piercing an entry corridor 30 miles wide, and to land within five miles of the recovery ship in the Pacific Ocean.

Consider a basketball as the moon. Then 69 miles from the moon is about one-quarter inch above the surface of the basketball. The spacecraft arrives at this altitude after a trip of 245,000 miles from the earth. This is equivalent to a baseball pitcher's throwing a ball within one-fifth of an inch of the middle of the strike zone.

Hitting the earth entry corridor is equivalent to the pitcher's throwing the ball to within 7/100ths of an inch of the batter. If you now consider the earth to be the size of a basketball, this entry corridor is only 6/100ths of an inch wide.

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The Apollo guidance and navigation system combines the best characteristics of the navigation systems on board the spacecraft and the ground tracking and computing systems. The spacecraft system controls all powered maneuvers and, if necessary, can do navigation and targeting normally done by the ground. The computers of the Mission Control Center use the data of the ground-tracking system to determine the actual path of the spacecraft in flight. It provides targets for the on-board guidance that will keep the spacecraft on its course, or, if necessary, return the spacecraft to its course.

Combining the ground and spacecraft systems improved the over-all accuracy. For example, the spacecraft system measures the angle between a star and the earth. But the earth's atmosphere causes the horizon of the earth to be less distinct than that of the moon. This means that different astronauts may choose different positions for the earth's horizon, especially close to the earth. Therefore, to determine the exact position, the ground system calibrates the horizon chosen when the crew is on the way to the moon.

The spacecraft system must also cope with the inability of the crew to see stars in daylight. Before the Apollo missions, the crews found that they could not see many stars on the daylight side of an earth orbit. Since lunar trajectories are in sunlight most of the time to and from the moon, the ability to see stars for navigation was questioned.

It was felt that, once away from the earth's atmosphere, space would have the appearance of complete blackness and thousands of stars would easily be visible, even close to the sun. Apollo 8 and Apollo 10 showed, however, that the crew could not easily see stars except when they were facing directly away from the sun, probably because of light reflecting from the spacecraft. Fortunately, with the sextant, they found that stars can be seen to within 10 degrees of the sun. Therefore, for lunar missions, the stars that are selected must be visible through the sextant.

The ground navigation system has different problems. A low thrust is produced when the spacecraft vents excess water. It was calculated that a continual force as low as 3/100ths of a pound could make the spacecraft crash into the moon. So procedures had to be developed to prevent continuous venting, and dumping of excess water had to be planned so that it could be considered in the ground navigation system. During Apollo 8 and Apollo 10, water dumping was easily seen in ground displays from the tracking stations. Ground tracking is so sensitive that rotation of the spacecraft antenna at about one revolution per hour could easily be seen in the ground tracking displays.

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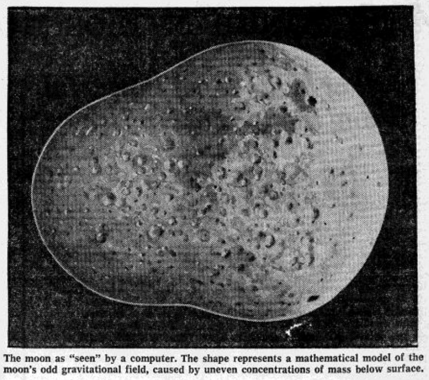
Inexact knowledge of the physical characteristics of the moon caused the greatest problem for both the ground and spacecraft systems. In the Lunar Orbiter program, it was found that when the spacecraft was nearest the moon there was a considerable difference between the observed and expected orbits. Because of this difference, a Lunar Orbiter spacecraft was placed in an orbit similar to the orbits to be used in Apollo. Perturbations were then found over the entire orbit.

Large local concentrations of mass (mascons) were also found on the Lunar Orbiter flights. At first we felt that these mass concentrations were the major contributors to our inability to accurately predict a lunar orbit. Now, however, we have determined that our prediction is poor mainly because we lack an adequate model of the physical characteristics of the moon for our computers. The physical characteristics of the earth were adequately determined by the early Vanguard satellites. Whereas the earth is somewhat pear-shaped, the moon is even more so.



The moon as "seen" by a computer. The shape represents a mathematical model of the moon's odd gravitational field, caused by uneven concentrations of mass below surface.

Errors in the model of the physical characteristics of the moon cause the most errors in navigation in the guidance systems during the lunar module descent to the moon and, later, during the rendezvous between the lunar module and the command module in lunar orbit.

We are solving these problems in two ways: first, an improved model of the lunar characteristics was incorporated in the ground and on-board computers; second, empirical corrections were made in the computers of the Mission Control Center using the knowledge of the moon acquired during the Apollo 8 and 10 missions.

In space flight, we are always weight-conscious. It is extremely expensive to send a pound of useless weight to the moon. Therefore, all equipment on the spacecraft must serve a purpose, and the consumables (propellants, oxygen, battery capability) must be carefully calculated. For example, about 95 per cent of the propellant in the lunar module is used to land and take off from the moon. Suppose a man was planning an automobile trip through a desolate desert where there are no gasoline stations. If he had to plan his trip as carefully as space flights are planned, he would have only one gallon of gasoline left when he arrived at his destination.

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To determine that we have enough propellant to fly the mission but are not carrying excess weight, we have developed mathematical models of the sun-earth-moon environment and all the spacecraft systems. Using these models, we fly hundreds of imaginary missions to the moon and back to determine the propellant necessary and the landing accuracies obtained.

The computer programs used to fly these imaginary missions are called Monte Carlo programs. They contain thousands of possible Apollo 11 missions, from the worst possible missions to the best possible missions. The computer program then picks several hundred of these missions at random and in this way the probability of the actual mission's success can be determined.

All these problems must be solved and a nominal course to the moon (the one flown if everything works perfectly) must be found. But more time-consuming than finding the nominal course is an effort we hope will never be used. This effort is planning for contingencies that could occur during the flight.

Each minute of the flight we are ready to protect the crew in case of a system malfunction or a human error. For example, if the engines cut off early during the lunar orbit insertion burn, the resulting orbit might send the spacecraft crashing into the moon or sailing off into an orbit around the sun never to return. Techniques were developed to return the spacecraft safely to earth in such cases. Descent to the lunar surface has been carefully analyzed since it has not been attempted before. If a contingency occurs during descent, we must be able to get the lunar module back into lunar orbit and to complete rendezvous with the command module.

The enormous time and careful analysis spent developing alternate techniques mean that recovery is certain from an extremely high percentage of possible failures.

After the preflight planning is completed, the logic and mathematics for landing Apollo 11 on the moon are incorporated into the on-board and ground computers. All the years of experience in designing missions can then be called from the computers within seconds to land the Apollo 11 crew safely on the moon and return it to earth. Frank Borman has stated that not only are the three astronauts going to the moon but also the hundreds of persons who supported the program before and during the mission. The people who have plotted the path to the moon for the last several years feel a sense of personal responsibility for the safety of the Apollo astronauts. Ours is not a job—it is part of the greatest adventure of all time.

Space Adds New Factor to 'Delicate Power Equation'

By ROBERT C. SEAMANS Jr.

MAN'S ability to plan his future is one of his most striking characteristics and yet, historically, we plan mostly in reaction to unplanned events. If our lot is to react to what is often an uncontrollably changing environment, we must equip ourselves as well as possible for the task. The wider the range of actions that are available to meet the challenges of our surroundings, the better assurance that goals may be reached.

Dr. Seamans, formerly the deputy administrator of NASA, is now the Secretary of the Air Force.

The oft-discussed population explosion was not planned, but it is a major factor in the overburdening of our environment. We must preserve ecological relationships where irreparable damage seems imminent, and change them where necessary to produce more food, more water and more room. Similarly, there was no plan for the evolution of a bipolar world with two superpowers championing hostile ideologies. But we must have effective plans for dealing with this situation, attempting to avoid a devastating war and to preserve our national heritage.

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All plans, however, must be based on knowledge, and the first decade in space has been primarily devoted to this basic requirement. Advances in spacecraft and booster technology, information on the characteristics of the space environment, the effects of space flight on man, the analysis of possible returns from satellites and probes into our solar system—all of these have been necessary first steps in a new venture.

It is essential to man's well-being to replace the assurance of ignorance with the less comfortable uncertainties that go with knowledge. In space, our investment to that end has been considerable. Since 1955 we have spent some $50-billion on space activities, but I feel certain that the knowledge we are acquiring about our largest spacecraft, the earth with its three billion people hurtling through space, is well worth the investment.

We are not yet able to control our environment to any appreciable degree, although we have made some progress with weather predictions dependent on satellite observations. Better forecasting has reduced injuries, fatalities and property damage, but we are still vulnerable to the damaging effects of drought and storms.

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We have made considerable progress in particular fields, compact and efficient power supplies, for example. In the mapping of water resources, such as lakes and snow cover, satellite photographs greatly aid hydrologists. The seasonal and yearly variations in snow cover on mountain ranges help in establishing trends and predicting water supplies. Crop inspection using color photography could, on a regional or even continent-wide basis, aid in early detection and treatment of diseases or nutriment deficiencies. Biological experiments may hold the key to vastly increased production of food and its storage for future needs.

But even if the food and energy requirements of man are not aided directly by space activities, these activities have contributed a number of by-products that are useful in solving our environmental problems. Efficiency in extracting the greatest return from available resources is increasingly dependent on the ability to manage large organizations and to handle masses of data.

One of the direct pay-offs of our space efforts has been the development and extensive use of computers to store and manage information. The designing, building, testing and use of space equipment is extremely complex. All activity has to culminate at one point, at one time, in a prescribed manner—the launch and subsequent operation of a space vehicle.

The Apollo Applications Program will use the established capabilities and resources of the Apollo lunar flights. In the applications phase, a relatively uncomplicated space station will be established using an empty propellant tank as the laboratory for experiment. Attempts will be made to determine among other things, the effects of long-duration space flight, space station potentials, the best and most efficient relationships between manned and unmanned operations. One particular experiment will involve a telescope in space to study solar flares. These eruptions on the surface of the sun, extending tens of thousands of miles in space and lasting days and weeks, may hold the key to an understanding of the forces and elements that control or affect our solar system.

The Intelsat 3 satellites can handle 1,200 two-way communications at one time.

Progress toward the solution of social and economic problems would not mean much if the security of our nation were not maintained.

There is the possibility that, with a preponderant and unmatched capability, an antagonist could define his interests to suit himself, and have no effective opposition. If, in the future, space should hold the potential for this kind of capability, we must not allow our nation to be placed in so impotent a position. Peace, in this era of nuclear weapons, is a function of our ability to deter an aggressor. Space adds a new element to the delicate power equation of the 20th century.

The danger to man in using space for weapons of mass destruction has been recognized by the major powers of the world. In a treaty on the uses of outer space that went into effect in October, 1967, the United States and the Soviet Union, among others, have agreed that they will not place in orbit around the earth any objects carrying nuclear weapons, or any other weapons of mass destruction, nor install such weapons on celestial bodies or station them in outer space.

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The unsettling characteristic of weapons in orbit is that if an attack were launched, there would be little warning. Some of the retaliatory weapons that deter an aggressor from launching an attack would be vulnerable and the world power balance could shift, perhaps becoming unstable.

Space systems can also provide insurance against orbiting weapons. The ability to monitor space objects in earth orbit, be they manned capsules, bombs or debris, greatly diminishes the chances of surprise. For a number of years the United States has been able to do this. Our defense systems can detect new objects in space, track them and compute their orbits. We also have the capability to intercept and destroy hostile satellites within certain ranges.

There are other ways that space can be used to make nuclear war even more unlikely. Of all the systems being investigated, probably the one most important for our continuing ability to deter a nuclear war is a satellite early warning system. With the ability to detect missiles launched from land or sea, and to relay the information to our armed forces, this system will do a great deal to preclude the possibility of surprise attack. This will further deter a potential aggressor, and help to preserve peace.

Other defense-sponsored systems have been developed during the first decade of attempts to learn about this new environment. In communications, the Department of Defense system started as a research and development program, but was so successful that it was declared operational in July, 1967. Using 25 solar-powered satellites and a worldwide network of ground terminals, uninterrupted contact can be maintained between the national authorities and our forces stationed overseas.

For example, in the recent past, breaks have occurred in submarine cables in the Pacific and Far East, resulting in interruption of cable traffic for some 19 days in each instance. During those periods, the satellite system handled high priority voice and teletype traffic in support of our forces in Vietnam. One important service provided by the system has been the rapid transmission of photographs from South Vietnam to the United States.

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A satellite navigation system is available to military and civilian ships, while satellite geodetic surveys benefit the cartographer and navigator, civilian or military. The navigation system was initially operational in 1965. Shore stations, reading radio signals from the satellites, compute and predict the position of a satellite at particular times in respect to the earth's surface. This information is then stored in the satelllite memory circuits and rebroadcast to shipboard computers. These, in turn, can determine the position of the vessel with an accuracy of about one-tenth of a nautical mile.

In the second decade of space explorations, now beginning, we will continue to improve our space capabilities. We will continue to deploy systems that will economically enhance surface military facilities, or add a new and needed dimension. We are being extremely careful that there is as complete an interchange between our military and civilian space activities as is possible, and that this extensive cooperation precludes any wasteful duplication of effort.

In communication, the next generation of satellites for contact between fixed terminals will be ready for use in 1971. This sytem will use larger relay stations, but in smaller numbers, than the present 25-satellite arrangement. These new, more efficient and reliable satellites will be able to adjust their position on command and remain over a predetermined point on the ground in a synchronous orbit.

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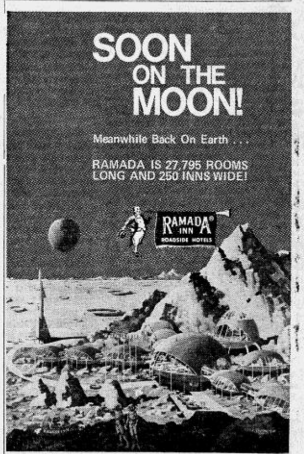
An experimental tactical communication satellite, already in orbit, will be able to handle conference-type calls from mobile ground stations on land, at sea, and in the air. Whether such a system will be adopted for regular use depends on how effective it proves in comparison with present communications links.

Space—like the land, the seas, or the air—is another environment that is now available for our use. Like those other environments, it can be used for man's benefit if we choose to do so. There is great promise that much can be done to ameliorate our problems on earth by applying our new-found skills in space. The field has been prepared and the seed sown. For those who cultivate with care, the ultimate harvest may be rich beyond our still earth-bound imaginations.

But the technology of this century not only has given us ready access to the regions beyond the earth's atmosphere, it has also created weapons of awesome destructive power. Space can be used to endanger peace or it can be used to make war more unlikely. Our programs are designed for the latter goal. To ignore the military potential of space could well promote the former.



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Astronauts Training At the Ph. D. Level

By WARREN J. NORTH

THE first six Apollo missions are being flown by 18 astronauts who have the following composite background profile:

Age: 38 years. Education: Five years of college. Aircraft flight experience: 4,300 hours. Space flight experience: 70 hours.

When one considers this crew background and the complexity of the Apollo mission, it is clear that the training program should be similar in some respects to graduate studies in several disciplines at once.

The flight crew must assimilate knowledge of space flight trajectories, lunar geology and many spacecraft and launching vehicle systems' operational details.

Then, working with the design, procedures, flight planning, and simulation personnel, they must learn to fly not only the planned mission but also the planned or alternate missions under an almost infinite number of abnormal conditions.

Mr. North is chief of the Flight Crew Support Division at NASA's Manned Spacecraft Center at Houston.

The Apollo training program is based on extrapolations from Mercury and Gemini training experience. Simulation hours can be used to compare the relative operational complexity of Mercury Gemini, and Apollo.

Considering only the time spent in spacecraft simulators, which represents approximately 20 per cent of the training activity, the average totals are: Mercury, 50 hours; Gemini, 195 hours, and Apollo 380 hours.

From a training standpoint, the most significant difference between Apollo and Gemini and Mercury is in the area of guidance and navigation. Learning the capability and gaining proficiency in the operation of the spacecraft guidance and navigation systems absorbs approximately 40 per cent of the training hours.

The flight crew must use on-board sextants and telescopes to align the spacecraft navigation systems with the stars, landmarks or the horizon. They must also insure that the navigation systems of their two modules are tracking each other.

For each mission phase, such as launching, mid-course navigation, lunar descent, lunar ascent, rendezvous, and earth re-entry, there is a corresponding computer program that must be activated by the crew.

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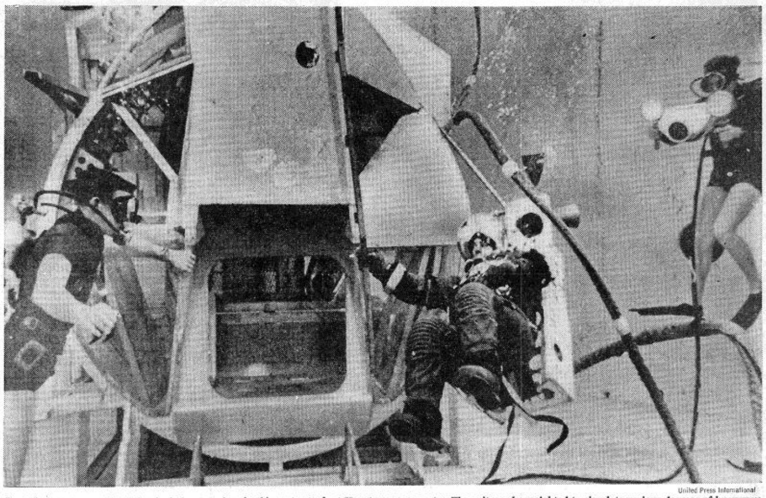
Within each individual program there are many routines and options that may be selected. The crew entry into the spacecraft computers, one in the command module and two in the lunar module, is through computer keyboards that are about half the size of a typewriter keyboard.

The characteristics of the control system can also be selected through this keyboard. For each vehicle configuration and weight change there is an optimum control sensitivity that must be selected.

To accomplish the full mission, 10,500 individual computer key strokes are required to change the computer programs and perform maneuvers.

The optimum integration of this guidance and navigation activity into the normal and emergency operation of the other spacecraft systems has been an iterative process in which experience gained during simulations and previous flights is fed back to improve the procedures and arrive at the best concept for subsequent flights.

Crew procedures also involve the handling of 445 items of stowed equipment ranging from 20 pounds of procedures checklists to an emergency life raft. Special mockups are provided for crew walkthroughs of these procedures, the most critical being those used during preparation for lunar EVA (extra-vehicular activity) and tunnel transfer between spacecraft.



United Press International

Part of the astronauts' training includes exercises in this water tank at Houston space center. The suit can be weighted to simulate various degrees of buoyancy.

The pilot can control in a normal or emergency mode each of the 87 rocket propulsion engines in the launching vehicle/spacecraft combination. These solid or liquid propellant engines begin with the 1.5 million-pound thrust engines of the Saturn first stage and terminate 360 feet above with the small solid-propellant pitch-control motor in the launching escape system. Pilot control can involve the capability to ignite, throttle, cut off and maneuver the engines.

Mission flexibility and crew safety are enhanced by providing the crew with several alternate methods of operating these engines.

Manual backup control of the launching vehicle's attitude begins at the separation of the first stage. At this point the vehicle weighs approximately 1.4 million pounds. The smallest vehicle that is pilot-controlled is the LM ascent stage, which weighs approximately 5,000 pounds after lunar ascent.

Consequently, the crew must train to control vehicles that, as a result of the sequential separation of stages, change in weight by a factor of 280. In contrast, aircraft pilots fly vehicles in which weight changes only by a factor of 2.

To provide training for control of the various configurations, 11 simulators are used. Five have motions similar to those of the spacecraft in flight.

The most unusual simulator is the lunar landing training vehicle. It has the same pilot handling characteristics as the lunar module, but uses a turbojet to offset five-sixths of the vehicle's weight and thus approximate the one-sixth gravity of the lunar surface.

It has been difficult or effectively impossible to provide a realistic landing simulator without going to a free-flight device. The landing trainer has the additional constraint of simulating, in the earth's atmosphere, accurate motions in the one-sixth gravity and wind-free lunar environment.

Pilots who have flown this vehicle are impressed by the high pitch and roll attitudes required to start and stop horizontal motions in a simulated one-sixth gravity environment.

Although the lunar surface operation will in some ways be similar to previous Gemini EVA activity, the different aspects include the visual washout effect when looking down the sun's rays, thermal and visual contrast between solar and shadow areas, and one-sixth gravity.

Several techniques or facilities are used to provide this training. Initially, the crew trains in shirtsleeves with training mockups. Pressurized suits are then used with the training mockups. The one-sixth gravity training is accomplished in three facilities: the KC-135 airplane, the Water Immersion Facility, and the overhead supported Partial Simulator.

One of the initial concerns regarding lunar operations was walking stability. Training simulations to date have shown that such concern was probably unfounded. Any tendency to fall as a result of leaning can easily be countered because it appears relatively easy to react to any falling motions that develop slowly in a one-sixth gravity environment.

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The crew have learned through practice that initiation and stopping walking motion will have to be accomplished by leaning excessively, much the same as is required when maneuvering the landing trainer.

Training in a lunar vacuum and thermal environment is accomplished in the large vacuum chamber at the Manned Spacecraft Center in Houston. Here the crew uses the actual flight suits and environmental support back packs to provide breathing oxygen and cooling.

The objective of the mission simulation program is to provide a series of rehearsals that will encompass all normal and emergency situations that might be encountered during the flight. There is an attempt to simulate everything that the crew can see, feel and hear. Consequently, much actual equipment is used.

Approximately one-half of the effort and cost of a mission simulator is involved in providing realistic visual scenes out the spacecraft windows and in the navigation sextant and telescopes. Speakers and other acoustic devices provide actual recordings or simulations of rocket, aero-dynamic, and pyrotechnic noise.

Because the simulator must appear and perform identical to the spacecraft, all changes to the spacecraft and the mission profile must be incorporated in the simulator with sufficient time for training.

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The conversion of the command module simulator from the Apollo 7 single-vehicle mission to the Apollo 9 Saturn 5-launching rendezvous-and-docking configuration required 27,000 man-hours of engineering.

For the last three years updating and maintaining simulator operation has required a three-shift effort, seven days a week.

Although most of the simulations are autonomous, the most complex and significant operations occur when the simulated flights of the command module and the lunar module are conducted simultaneously.

During the later phases of training, the Houston Control Center is brought in and becomes an important part of the simulations. At that time, 12 high-speed digital computers are involved, seven in the Houston or Cape Kennedy crew simulator complex and five in the control center.

This 12-computer operation has been compared with such complexes as SAGE, the air-defense system, and the huge airline ticketing program.

The space agency's requirements for high speed data transfer of vehicle dynamics, systems performance, and velocity and position data have been shown to far exceed the other programs in over-all complexity.

The Crew of Apollo 11: What Kind of Men Are They?

Continued From Page 31

86 Sabrejet in the Korean War, in which he shot down two MIG-15's.

Jack Waite, an official of the North American Rockwell Corporation in Houston, who has known Colonel Aldrin for years, summed up the Aldrin of the Air Force this way: "Gung ho, eager, always trying to get the most out of the plane, always trying to get the highest gunnery score."

Buzz Aldrin won a doctor of science degree in astronautics at the Massachusetts Institute of Technology in 1963, and soon thereafter, as an expert in orbital rendezvous, was assigned as an Air Force representative at the Manned Spacecraft Center. It was only a short step to astronaut status in 1964.

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MICHAEL COLLINS was born in a plush apartment house off the sculpture-studded Borghese Gardens in Rome, one of Europe's most beautiful parks, of an ancestry extending back to County Cork, Ireland, on his father's side and into pre-Revolutionary America on his mother's.

The youthful Michael was as insouciant as Buzz Aldrin was intense and disciplined, and as drifting and undirected as Neil Armstrong was single-minded.

Such a personality might at first glance seem unlikely, in that few people have ever come from so military a background. Mike Collins happens to be the son of an Army general (the late James L. Collins, who was military attaché in Rome when Michael was born), the nephew of another (J. Lawton Collins, a former Army Chief of Staff) and the brother of yet another (James L. Collins Jr., presently commander of 5th Corps artillery in Darmstadt, Germany).

But the Collins household was lively, cultivated, free of military stiffness. Michael's father was a short, athletic man who spoke his mind when he felt like it, played polo, was able to do handstands at age 65, and was Gen. John J. Pershing's aide in the Philippines, in the Mexican campaign against Pancho Villa, with the American Expeditionary Force during World War I, and at the Coronation of King George VI. From his father Michael got the athletic bent that made him a quick, aggressive captain of the wrestling team at St. Albans School for Boys in Washington.

Collins, a schoolboy in Washington

From his mother, a slight, soft-spoken woman who now lives in Washington, he got an affinity for books and music. "Mother studied a lot," says one of Michael's two sisters, Mrs. H. C. Weart of Merritt Island, Fla., near Cape Kennedy. "She learned to speak Italian in Rome, and she saw that we spoke the languages, too. She used to take us to museums and churches and places like that."

By the time Michael entered St. Albans School at age 12, he had lived in Rome, in Oklahoma, on Governor's Island in New York Harbor, just outside Baltimore on Chesapeake Bay, in Texas and in Puerto Rico. In San Juan, where his father was commander of the Army's Puerto Rico Department, the family lived in a great, sprawling, sixteenth century mansion called Casa Blanca, and Michael attended a private school.

"I think a life like that is good for a kid," Colonel Collins says of the constant moving about. "You learn some things twice in school, and others not at all, and you have to leave a lot of friends. But on the other hand, it's a damned interesting life for a kid. On balance I think it's an advantage."

The family's gypsy life caused it to grow closer in support of each other, Mrs. Weart believes. Her mother adds: "We did a great many things together. We were quite a close family, we really were, and I thoroughly enjoyed my children."

Because he was by far the youngest of the family — his brother, for example, is 13 years older — young Michael was its pet. He was also subject to a subtle, love-laced discipline, which, in the astronaut's words, caused him to "go to great lengths to avoid doing anything to displease my parents. To gain their approval was important to me."

But the parents were not pushers, as is evidenced by Mrs. Collins's attitude toward the children's careers: "We just told them they were to do what they wanted. Neither one of us thought we should live our children's lives."

In such an atmosphere, young Mike did what was expected of him, did not attract particular attention from those looking for achievement, and enjoyed the swimming, fishing and playing that make up a normal boy's life.

Carrying his low-voltage demeanor to St. Albans, a fashionable preparatory school in leafy, secluded surroundings next to the Washington National Cathedral, Mike Collins quickly became one of the most popular boys there, one of the least dedicated, and one of the most mischievous.

"I've got to say I just didn't like school," he explains now. "I think St. Albans let me in sort of to be nice."

Boarding students at St. Albans live an almost Spartan existence in small cubicles that resemble monks' cells. But within this atmosphere, Mike Collins was known among the masters as a perpetrator of mischief. To this day, they say, they are unable to pinpoint exactly what he did, but they were always sure he was in on much of what went on behind the scenes. "He had an immobile face," says Ferdinand Ruge, one of the masters. "You always wondered what he was concocting."

Mike served as a prefect — one of the top student leaders — during his senior year, and the St. Albans yearbook for 1948 noted that he was one of the four most popular boys in the school. It noted also that a little knowledge might have seeped into him "despite the lures of Morpheus [the Greek god of sleep]." His sleepiness may have been the result of having to get up to be a Cathedral altar boy at the 6:30 A.M. service.

Armstrong in his high school yearbook

His grades at St. Albans were not spectacular, although he made the equivalent of B-pluses in mathematics, his best subject. John Davis, now assistant headmaster and a former teacher of Mike's, noted "an intellectual precision" and "a desire to see the limits of a problem and then go to the heart of it."

Michael Collins graduated from West Point in 1952 with a less than brilliant academic record. The yearbook noted that his battle cry was "stay casual" and that "he took the cash and let the credit go and seldom heeded the distant rumble." Freely translated, that means "live today and don't worry about tomorrow."

What led Mike Collins into the Air Force is not exactly clear. But once in, the astronaut says, he was interested in flying the newest kinds of planes. So he became a test pilot. "To avoid being static, that's why you do something like that," he explained.

"Even after he came here [to Edwards Air Force Base] to test pilot school, I thought he was just going to be another guy who was going to drift through life," says Bill Dana, a NASA test pilot who knew young Collins well at West Point and was his roommate in flight training. "I think the space briefings here really turned him on, and he bloomed."

Once his ambition was fired, Mike Collins applied his underlying intelligence and determination.

"And voilà, here I am," he says. "I don't know where I go from here."

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THE astronautical accomplishments of the Apollo 11 crewmen speak for themselves. The Gemini 8 flight of Neil Armstrong in March, 1966, was testimony to the dangers of space-faring. Maneuvering thrusters ran wild, causing the spacecraft to tumble out of control, and Mr. Armstrong's superb piloting skill helped save the lives of himself and his crewmate, David Scott. Four months later, Mike Collins in Gemini 10 walked twice in space and took part in a rendezvous with two separate space vehicles. In November of the same year, on Gemini 12, Buzz Aldrin established a five-and-one-half-hour record for time spent walking in space.

On the job, according to those who have worked most closely with the crewmen during their training for the moon landing, Neil Armstrong displays pride in his skill at the manual art of flying, in his ability as a man to master the machine. Buzz Aldrin, they say, is more of a computer man who takes pleasure in making the machine work for him. Mike Collins is said to be fascinated by the wide variety of tasks required of the command module pilot, who must run an entire spaceship by himself. It is a fortunate balance.

All three are said to be basically quiet and relaxed, not officious or overbearing, although Colonel Aldrin is more apt to tell people what he thinks and is more stubborn in his convictions. His constant display of knowledge, his unending stream of suggestions for better ways to do things let him in for much good-natured ribbing — as in his nickname, "Dr. Rendezvous."

Mike Collins is described as being "very understanding, perhaps too understanding"; a nice fellow who doesn't want to make people feel bad. Neil Armstrong is said to be almost infinitely patient. No one can recall ever seeing him lose his poise.

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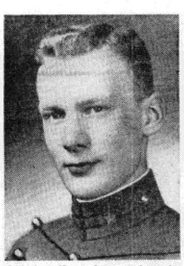
OFF the job, the men who are flying to the moon are what one associate called "home and hearth" men. In training at Cape Kennedy, they do not carouse as some astronauts have been known to do, although an associate of Colonel Aldrin's says he has occasionally been seen after midnight in Cocoa Beach cocktail lounges. In their comfortable suburbs near the Manned Spacecraft Center outside Houston, the Apollo 11 crewmen are basically home-bodies.

Neil Armstrong likes to listen to a wide variety of music, enjoys fishing and sailplaning, and seeks utter privacy with his wife and two sons. Unlike his crewmates, he has an unlisted telephone number. He and Janet attend parties, where Neil often stands bashfully back and declines to mix at first, but then invariably warms up slowly and becomes the last to leave. He smokes cigars, but rarely. He drinks, but is never visibly affected. He keeps his own counsel so effectively that even his parents do not know what his philosophical and religious beliefs are.



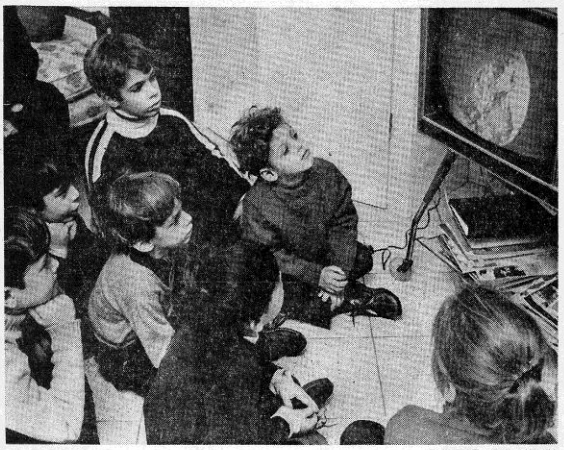
Aldrin in uniform of West Point cadet

Buzz Aldrin, according to his sister, Mrs. Potter, is so thoroughly wrapped up in his work that he sometimes finds it difficult to give full attention — psychologically — to family matters. He and his wife, Joan, are said to attend parties rather more frequently than the other Apollo 11 astronauts. On some such occasions, according to Jack Waite, when Colonel Aldrin really relaxes, "he has some drinks and it oils his mouth real good." Mostly, he talks business. Colonel Aldrin is a Boy Scout merit badge counselor and an elder and trustee of the Webster, Tex., Presbyterian Church. His hobbies are running, scuba diving and high-bar exercises.

Mike Collins is perhaps the most stay-at-home of the three. He is said to be quick to admire people, impossible to dislike, so considerate that he will not say anything unpleasant to anyone. He drinks martinis, sometimes several of them, but with no apparent ill effects. He has a passion for fishing and for books, and although he gains much pleasure from tending roses, he declines to fertilize his lawn so that he will not have to cut it. Sometimes he can be seen hopping around trying to catch the family's white rabbit as it munches clover. He and his wife, Pat, and their three children form what a neighbor says is "a very close family circle."

There are indications that the men of Apollo 11 are beginning to be concerned about the consequences of the fame that surely awaits them if they carry out the moon landing and return to earth. Mrs. Potter says her brother, Colonel Aldrin, is starting to worry about loss of privacy and freedom. Colonel Collins's mother says her son is slightly irritated that because of him, his family should be subjected to public scrutiny and prying. "He doesn't think an old lady like me should have to put up with that," said the 73-year-old Mrs. Collins.

The astronauts' concern about such things is one of the latest facts of existence for all three, and one thing is certain: If they succeed in the epic mission on which they are embarked today, all that is in their personal past will be merely prologue, and life for them — and perhaps the world — will never be the same again.



The New York Times (by Meyer Liebowitz)

Youngsters—some of whom were not even born when the first American astronaut was launched into space—see the face of the earth as telecast from a manned spacecraft. But the awe and wonder of it all are sometimes missing.

Some Fear Change, Others Ignore It

By SANDRA BLAKESLEE

THIS week millions of Americans will sit emotionally tethered to their television sets, as though there were a Superbowl of the moon, waiting for two astronauts to touch down on the lunar surface.

Like people watching a championship football game, few of the spectators are likely to be unmoved by the achievement as it occurs.

But what about the rest of the time? How do Americans feel about the space program in general, especially during the "off-season" months when men are not producing live drama in orbit?

An inspection of the polls indicates that since the early sixties the nation has been pretty evenly divided on the notion of getting to the moon. At one time 38 per cent are for it, 39 per cent are opposed and 23 per cent could not care less; at another, 51 per cent want to go, 45 per cent don't and 4 per cent are ambivalent.

Like stock market gyrations, the popularity of the space effort is largely dependent on successes and failures. What the polls do not show, however, is the complex nature of the attitudes they reflect. On a scale of emotions, if one existed, these attitudes would probably run from apathy to zealousness, with a large area of confusion in between.

For example, Dr. Percy G. Harris, a 41-year-old physician from Cedar Rapids, Iowa, said recently: "Do you ever run across people who don't have opinions about things? I'm confused about the space program. I'm happy when we meet with success but I keep wondering if we should be doing all this when we have so many problems."

Dr. Harris seems to be echoing the sentiments of many Americans. Few people, for or against, get as exercised over the space program as they do over the Vietnam war, racial integration or sex education.

What, then, is the source of these lukewarm attitudes to the space program and what makes people say they are in favor of, or opposed to, going to the moon?

One decisive factor seems to be age.

A child who is eight years old today was born the year Alan B. Shepard was launched into space. The books the youngster has read, the television shows he has watched, the vernacular of his generation, all have been conditioned by the space age. Many such children, in fact, have grown up playing with Billy Blastoff, an aerodynamic toy, instead of teddy bears.

As the father (age 40) of one space age child (age 8) put it recently: "It is in my son's curious and uncluttered mind a simple fact: Man will explore the stars. The notion that we should not do so has never occurred to him. Men have been in orbit since he was a baby."

The father, Nelson Wood of Scarsdale, N. Y., added with an air of incredulity: "When I was his age, all we had was Buck Rogers and Captain Midnight and science consisted of nature walks."

To many of the older generation Buck Rogers was real enough in their imaginations, but it remained science fiction. But today, what was once science fiction is turning dizzily into scientific fact and for some, it is hard to keep pace.

Thus, some adults, while verbally uncertain of their feelings toward moon exploration are emotionally opposed if not outright afraid of it.

Some psychiatrists, in fact, have called this phenomenon "future shock." Instead of marching into the future in clear, demonstrable steps, many people feel catapulted into an alien age that they do not understand.

The younger generation, on the other hand, seems unperturbed by it all, a state that some observers have called a new "generation threshold." This simply means that when one is born into an age, one is likely to accept its achievements without much fanfare.

A child in 1920, for example, accepted the arrival of the automobile with savoir faire. Grandpa goggled at the new sedans, but then he in turn had amazed his parents by his calm attitude toward the telephone.

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Apart from being born before or after sputnik, however, there are a tangle of other factors—education, sex, income, geography, politics—that help to determine how a man feels about the moon landing, or about anything else for that matter.

For many Americans, the space program should have a lower priority. Mrs. Muriel B. Knight, a manpower training specialist in Boston's poverty program, is one of them. "I think it's a waste of money," she said recently. "After we get up there, then what—when people are still starving on earth?"

She is looking to the earth rather than to the stars, and it is just that viewpoint—or Weltanschauung, rather, for it is an over-all personal and philosophical view of the world—that seems most often to separate one person from another in his attitude toward the space age.

For some, man should restrict his endeavors to the earth; for others, his destiny is defined by the stars.

TV Has Involved and Educated Millions in Mysteries of Space

By JACK GOULD

TELEVISION has among other things sent man into a history-making kind of intellectual orbit; whether rich or poor, educated or deprived, so long as he has access to a television set he can see at first hand the wonders of science and technology exemplified in the planned landing of Apollo 11 on the moon.

In the annals of space technology, the medium of TV stands as an audio-visual aid whose full dimensions might conceivably not be totally appreciated for another generation.

In the absorbing simplicity of pictures readily grasped by young and old alike the viewer is obtaining an introduction to the intricacies of science that would take weeks, months or years to extract from textbooks.

Thanks to the powers of the home screen, the precision, imagination and toil of scientific development are simplified so the layman can enjoy a feeling of intimate familiarity with details that otherwise might easily put him off in dismay.

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One of the byproducts of the TV coverage of space exploration, intuitively sensed but often taken as a matter of course, is a further acceleration of the nation's educational process beyond the wildest dreams of even a decade ago.

The power of television to personalize human daring and evoke awe over technological advance first arose in the 15-minute suborbital flight of Alan B. Shepard Jr. on May 5, 1961.

There was a nationwide hush as the rocket vehicle was ignited and the Mercury craft made a graceful arc out over the sea.

What was not discerned by the viewer at home, but surely was felt, was the omnipresent possibility of disaster.

If only because of the novelty of the first such flight by an American, the layman's introduction to televised space feats remains fixed in the memory.

Not the least significant aspect of the program of the National Aeronautics and Space Administration was the agency's willingness to allow the presence of live TV cameras as contrasted with the edited and brief TV reports supplied by Moscow on the achievements of its cosmonauts.

As the United States program progressed steadily through the Mercury, Gemini and Apollo chapters, there was no gainsaying its impact on the youth of the country.

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The classics of "Treasure Island" and "Robin Hood" may have their enduring niche as accounts of derring-do, but for many a child the opportunity to take part vicariously in circling the earth and to see color pictures from far out in space opened a new era in adventure.

In recent years, with the introduction of communications satellites, the American space program has been an international as well as a national occasion on the picture tube.

Different time zones notwithstanding, untold millions in Europe, Asia and South America have witnessed the take-offs and splashdowns of the astronauts.

The role of television in welding together humans of many lands and many tongues is an integral byproduct of science's advance.

From Houston, Tex., there have been periodic reports of differences among astronauts over the advisability of carrying live TV facilities on spacecraft.

One theory was that playing around with video gadgetry was an intrusion on a serious undertaking.

A contrary argument was that TV might generate enthusiasm for larger Congressional appropriations for NASA's future.

In viewing terms, however, the presence of TV cameras made it possible for the world to see what astronauts, both American and Russian, have had such difficulty in reducing to words.

The Apollo 10 pictures in color of the earth said more about the vastness of the universe and the transitory existence of mankind than all the sermons of clergymen or the musings of philosophers.

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The sight of continents and seas in their minute dimensions was a self-told story.

For the Apollo 11 flight, no rational statisticians will even attempt to estimate how many millions will be watching, if all goes well, as Neil A. Armstrong sets foot on the moon. And it doesn't really matter.

The high point will be the individual's own realization that through television he was there in heart, tension and excitement at the historic moment.

The summer of 1969 will establish a new maxim: Adventure isn't just for adventurers, it's for everybody.

moon gems (TEKTITES)

What is a tektite?

• tek-tite (tek' tite), [Gr.; melted], molten droplets of the moon's crust hurled into space by the impact of a meteor on the moon.

Are they available?

• a quantity of authentic tektites ¼" to 1" in size is available for immediate delivery. Supplier has sold these tektites to NASA and various museums. Purchase orders and bills are available for inspection.

• responsible inquiries on your letterhead will receive immediate attention. Write Z 7660 Times.

ATTITUDES

A Critic's Views of Apollo

By RALPH E. LAPP

A NUMBER of American scientists have been very eager for men to land on the moon, but not entirely for the most obvious reason. They have been eager for the National Aeronautics and Space Administration to wind up its manned space spectaculars and get on with the job of promoting space science.

The United States has had a score of space flights with a total of 4,514 man-hours of experience away from earth. This effort, culminating with Apollo 11, will have cost about $25-billion. Yet manned space flights have given scientists very little valuable information about space. Man, himself, has been the main experiment. And man is the principal reason why Project Apollo has cost so much money.

Dr. Lapp, author of "Man in Space" and "The Weapons Culture," is a long-time critic of manned space flight.

On the other hand, unmanned space vehicles have hit paydirt in space. They have given scientists new data about the radiation environment of the earth and disclosed valuable knowledge about the sun and the planets. It's no wonder, then, that some scientists long for Apollo astronauts to complete their mission to the moon so that some sense of priorities can be assigned to scientific research.

But just as scientists were hoping for relief they found themselves in new difficulties. On one hand, they have found Federal funds for the support of research hard to come by and, on the other, they have found NASA preparing to parlay Apollo 11 into a prolonged extravaganza. The space agency has plans to follow up the initial lunar landing by shooting off nine more moon missions.

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I suggest that when Apollo 11 returns to earth, it will be time for cerebration as well as celebration. We should all rejoice that man has conquered his ancient enemy—gravity — and has thus shrugged off his earth-bonds. But we should also think carefully before we decide to explore every nook and cranny of the far-off moon.

First, let's be realistic about the cost of these lunar missions. The space agency has put out a mission cost figure of $350-million for Apollo 10. The agency uses a unit price of $41-million for the lunar module and $42-million for the command module. In point of fact, contract costs to date for these two modules amount to $6-billion; if figured on the basis of 10 missions, the cost would thus be $600-million for each complete lunar vehicle. If you include $800-million for each Saturn 5 launching vehicle and $100-million for operations, the cost for each lunar mission is $1.5-billion. That is on the basis of 10 missions.

Next, let us ask what men will do on the moon. Space enthusiasts wax romantic over the glories of lunar exploration, but they sound pretty hollow-headed when it comes to explaining the earthly value of these exploits. Analysis of the first rock samples brought back to earth will probably tell scientists much about the moon's origin. The second and third bags of rocks will be of diminishing value, especially if you allow some down-to-earth scientists to tell you what they could do with similar sums of money if spent here.

To get down to earth — the United States Government spends about $40-million a year for mineral resource development in the Bureau of Mines and about $95-million for the United States Geological Survey. What's on the lunar surface so tempting that we should make repeated landings there? No one with any knowledge of rocket transportation costs thinks that minerals can be imported from the moon — not even gold. To mine and ship gold from the moon, assuming it's to be found there, would cost a thousand times its earth-value.

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What we are after on the moon — after the primary goal of prestige is attained— is knowledge. That means that we have to shift from spectacle to science as a base of support for further trips to our nearest neighbor in space. But at this point, especially in view of our needs here on earth, we need to compare the benefits of research conducted in the laboratory with that accomplished in space. Further, we need to compare space benefits from unmanned vehicles with those from manned missions.

Because man is a very fragile thing to export from earth, he has to be gently boosted on his way and once in space his earth-habituation requires that he have a life-support system. All of this makes for a cumbersome space capsule. Weight for weight, manned space vehicles are about a hundred times more costly than instrumented missions.

Man's space costs are so exorbitant that they simply outrank any value he might have in space. One of the reasons given by the Air Force for the cancellation of its Manned Orbiting Laboratory was this :"It was determined that most essential DoD [Department of Defense] space missions could be accomplished with lower-cost, unmanned spacecraft."

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Practical benefits of space are largely restricted to near-earth orbits. An intensive study of the civilian applications of orbital space was conducted recently by a task force of the National Academy of Sciences. Manned space stations were considered too expensive to compare with instrumented satellites.

In its haste to land men on the moon, NASA is gambling that the two-man lunar module will bounce down softly on a flat spot, sustain no damage, and then take off to rejoin its parent module in a lunar orbit.

In this sequence of events, the space agency has planned for no back-up or rescue should there be a mishap. Indeed, such a rescue capability is two to three years away in NASA's planning. The agency could have provided a margin of safety by first landing an automated craft, like the Surveyors, to put down a TV camera to survey the site and a beacon to allow automatic homing of the manned spacecraft.

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Some NASA officials feel that the moon is merely a way station and that the United States should target Mars for a manned mission in the early nineteen-eighties. Such a program would push the annual NASA budget up past the $6-billion level, and it is probable that more than $100-billion would be required for the project.

There is very little sympathy in the Congress for such a Mars mission; most legislators are increasingly aware that we have enough problems to solve here on earth without going off to Mars.

President Nixon hasn't committed himself on the future of the United States space program. He has a task force studying the long-term goals for NASA; it is scheduled to report its findings in September. One hopes that the scientists participating in this study will be level-headed and not recommend the expenditure of fantastic sums purely to acquire scientific knowledge. The quest for more knowledge is a noble undertaking, but some cost reckoning should be made as to its earthly value. Furthermore, space research funds should be brought in line with the Federal Government's over-all support of research.

With the success of Apollo 11 the main reason for urgency in the space program will vanish. The space race with the Russians will have been won. It is utterly foolish to promote this competition in the future based on some invention of "who's winning." We should then settle down to a rational space effort keyed to basic values in science and to reaping the benefits of orbital applications.

I have a midsummer dream that President Nixon might travel to Houston to greet the quarantined Apollomen and to accept (through glass) the lunar samples. In my dream Mr. Nixon says: "The people of the world salute your heroism. In the name of all the people on this planet I accept these lunar specimens. I declare the senseless space race ended. And now, gentlemen, let us point our science and technology in the direction of man."

Successful landing, Apollo II

Our best wishes are traveling with you all the way

Stein & Blaine

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MARK BLACKTON
President

memo to a great-grandson

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By that time, going to the moon may be commonplace. But in 1969, as you can see from these pages, it was quite a thing. After all, it *was* the first time that man had ever set foot outside the earth.

We'll save the complete paper so that you can see the ads and have a good laugh at the fashions of the Sixties. Those were the days when men's and women's clothes were still differentiated and the abbreviated remains of women's skirts could still be seen.

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Headquarters for
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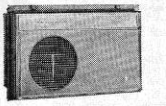

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THE SOVIET CHALLENGE

A New Marxist Frontier

By CHARLES S. SHELDON

ALTHOUGH details of Soviet grand strategy in space can only be surmised in the absence of budget data, organization charts, or even the names of space administrators, Russian leaders have talked for many years of their ultimate goal as the extension of Soviet society throughout the solar system by the application of advanced technology.

The Soviet equivalent of the National Aeronautics and Space Administration may

Dr. Sheldon is chief of the Science Policy Research Division, Legislative Reference Service, Library of Congress.

have been established as early as 1953, five years ahead of our organization. Performance to date suggests that goals without an exact timetable were probably projected then for 25 years. The Russians reaped the advantage of having selected their intercontinental ballistic missile as their standard space launching vehicle. This reliable workhorse with a first-stage thrust of 1.1 million pounds not only put up Sputnik 1 in 1957, but even now is used for the latest Soyuz manned craft of about 16,000 pounds' payload.

The Soviet planners started with a bare minimum of facilities for manufacturing, testing and launching. Early space events were many months apart, each calculated to make substantial steps forward and used as a political tool to impress the world. In the years that have followed, some of the apparent delays in the Soviet program have represented efforts to go back and fill in gaps, with a wider variety of launching vehicles, a more complete tracking network and better ground testing facilities.

At present, the Soviet Union has reached a level of investment in equipment, manpower and experience that roughly parallels the tremendous commitment of the United States to this new medium. Compared with the United States, the Soviet Union has not only launched a greater weight of payload to orbit but for the last three years has also been making a larger number of launchings. This is in contrast to earlier years, when the Russians were content to launch less frequent but larger payloads.

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The Soviet Union now operates three large space launching complexes, roughly corresponding to the three in the United States, at Cape Kennedy, Fla., Wallops Island, Va., and Vandenburg Air Force Base, Calif. The original and main base is the Baikonur Cosmodrome at Tyuratam in Kazakhstan. A smaller test site is at Kapustin Yar on the lower Volga River. The main military operational base is at Plesetsk, well north of Moscow.

The stable of Soviet launching vehicles has proliferated to meet the varied needs of its broadly based program, ranging from a vehicle derived from the Sandal medium-range ballistic missile, which can put about 500 pounds in orbit, to the Proton class, which can orbit about 50,000 pounds. Somewhere waiting to be unveiled may be the huge vehicle that NASA officials have predicted will be half-again the size of Saturn 5, America's chief launching rocket.

Lacking the overseas land-based tracking stations and communications links used by the United States, the Soviet Union has presumably concentrated its corresponding facilities across the wide expanse of its home territories. It also operates a sizable fleet of specially equipped ships. The impressive *Kosmonavt Vladimir Komarov*, with its huge antennas, shows up in the tropical waters of the Atlantic whenever major flight tests of man-related deep space vehicles are under way.

Like the development of a grandly orchestrated symphony, the Soviet space program has unfolded with added themes, has been embellished and has played reprises over the years since 1957. In a swift jump in complexity, the simple Sputnik 1 of 184 pounds was followed by the biological experiment with Laika, the dog in orbit. Sputnik 3 was a 2,926-pound comprehensive geophysical laboratory that returned data from orbit for two years.

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By 1959 the early Luna spacecraft sailed into orbit around the sun, struck the lunar surface carrying the Soviet coat-of-arms, and returned photos by radio of the far side of the moon. The following year came the first precursor flights of manned craft, one of which returned dogs to earth in a successful re-entry. Although it became known to the public only later, 1960 was also the year of first launchings toward the planets, when Mars probes failed to reach orbit.

These and indeed all the first 18 deep-space probes failed to return any planetary data. But they marked the seriousness of the Soviet effort to reach the planets with large and complex payloads on a scale more ambitious than our own to date. The last three Venera craft have been successful in probing the atmosphere of Venus. Apparently not even Venera 5 and 6, which arrived last May, succeeded in remaining intact and functioning all the way to the planet's surface because of high pressures.

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The April 12, 1961, flight of Maj. Yuri A. Gagarin around the earth in Vostok 1 produced some of the same universally electrifying effects as had the earlier Sputnik 1. In a progression over three years, the six Vostok flights built a commanding lead in Soviet manned flight experience, including up to five days of "stay time," near rendezvous, and the only flight by a woman, Lieut. Valentina V. Tereshkova, who gained more orbital experience than all the Mercury astronauts combined.

In 1964 and 1965, the two Voskhod manned craft seemed to indicate a continuation of Soviet leadership when one carried the first three-man crew into orbit and the other provided the first "space walk." Instead, the Russians elected to delay further manned flights while developing a more versatile craft, later unveiled in 1967 as Soyuz. The accidental crash during recovery in which a cosmonaut was killed had the same traumatic effects on the Soviet program and people as the Apollo fire three months earlier had had in the United States. The Russians fell back to a more cautious position of unmanned test flights. Only by 1969 did we see a full exercise of manned docking and crew transfer with Soyuz 4 and 5—in all likelihood what had been intended in April, 1967.

Russian space applications flights did not show up in their program until 1962, when they labeled most of these with the blanket name of Cosmos. It took on the average several years for these applications to reach routine and reliable status. Today the Russians operate a comprehensive television distribution system with Molniya 1 satellites, and a fairly sophisticated weather satellite system under the name Meteor. Still under the Cosmos label are military navigation satellites, described as a system but not identified by individual flight.

The largest single program element is the Cosmos series that is only indirectly acknowledged to be a military observation photographic or electronic ferret project. These satellites maintain an almost continuous watch from their low orbits on targets of Soviet interest, and are routinely recovered every eight days or so.

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The other principal military element in the Cosmos program has been the partly hidden fractional orbit bombardment satellite system (called FOBS). The 13 known orbital flights in this project have brought international concern even if not yet any technical violation of the treaty banning weapons of mass destruction from outer space.

The conjunction of Soviet manned flight with lunar exploration now can be traced. Luna payloads to return surface pictures and soil tests of the moon, and to measure the intricacies of lunar orbit, were clearly more concerned with operational data than science alone. Abortive attempts from 1963 on led finally to successes by 1966.

Meanwhile, a larger vehicle capable of supporting manned circumlunar flight, the Proton, appeared in 1965. After signs of technical troubles it finally was successful in the circumlunar flights of Zond 5 and 6, one recovered in the South Indian Ocean, the other using lifting body techniques to reach Soviet territory. Any haste to repeat such flights with men was probably reduced by remaining doubts on reliability and the impressive successes of Apollo 8 and 10.

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A Soviet lunar landing will require much more than a direct flight of a single Proton vehicle with the Zond variant of Soyuz as a payload. Either a large number of Proton-lifted payloads will have to be assembled in earth orbit—no mean feat—or the postulated very large vehicle will have to be used.

Depending on the operational mode and the efficiency of propulsion, either two such vehicles must meet in earth orbit for a further flight to the moon, or lunar orbit rendezvous in the Apollo manner may be used.

Lead times inherent in such major programs would suggest such a Soviet manned landing is still years away. However, Lieut. Alexei A. Leonov reportedly stated early last month that the Soviet manned landing would be accomplished in time to provide rock samples for the Osaka Expo 1970.

If so, the previous Soviet care and conservatism in all manned flights suggests that unmanned tests will appear very soon. An unmanned Luna 15 spacecraft is on a mission to the moon as this is written. It could represent either a continuation of earlier, modest flights, or could represent the first step toward automatic recovery on earth of sample lunar materials before men are committed to a similar mission within the year.

Sovfoto

Model of Sputnik, first artificial satellite, on display in Moscow. Its launching marked the start of the space race.

Sovfoto

Maj. Yuri A. Gagarin of the Soviet Union was the first man to orbit the earth. The flight took place eight years ago.

It All Started With Sputnik

By RICHARD D. LYONS

SHORTLY after the first Soviet satellite streaked into the heavens a dozen years ago, joyful crowds assembled in Red Square to hear Russian leaders boast of Communism's technical superiority and to buy Sputnik cigarettes and Cosmos perfume. The race to the moon had begun.

Western capitals were stunned by the news of the Sputnik launching from the steppes of Central Asia. Some European newspapers carried headlines saying: "America Beaten."

Parisian waiters smirked at the discomfort of American tourists when they were reminded of Russian space feats and some Englishmen, weary of American technical chauvinism, admitted that they were glad for once that "the Yanks aren't first in something."

Reaction in Washington ranged from attempts by the Republican "ins" to minimize the impact of Sputnik to ominous statements by the Democratic "outs" that the nation was facing "a Pearl Harbor in space" and must embark on a "do-or-die struggle" for the control of space.

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And all this storm was caused by a 184-pound metal ball called Sputnik.

It was launched on Oct. 4, 1957, and it circled the world every 96 minutes, doing nothing but radioing "beep beep" with its two small transmitters.

American anxieties intensified within the next few years as the Russians launched more Sputniks, sent a spacecraft into orbit around the sun, landed a rocket on the moon and placed a cosmonaut in orbit.

Meanwhile, the United States was trying to launch its first satellite. On Dec. 6, 1957, a Vanguard spacecraft traveled only two feet from its launching pad, then disappeared in a ball of flame.

The failure, only two months after the Russians' spectacular success, sent a wave of frustration and chagrin across the country, a feeling summed up by Dr. John P. Hagen, director of the Vanguard program, in one word: "Nuts."

In the view of Lyndon B. Johnson, then Democratic leader of the Senate, the Vanguard explosion was "one of the most humiliating failures in our history." Senator Richard B. Russell of Georgia called it "a grievous blow to our already waning world prestige."

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Altogether, the Vanguard affair was a major propaganda defeat for the United States, an American "flopnik," as it was called in the foreign press.

Perhaps the low point came when members of the Soviet delegation to the United Nations slyly asked their American friends if the United States would like to apply for aid under Russia's program of technical assistance to backward nations.

Public discomfort was not aided by disclosures before Congress that the United States could indeed have been first to put a satellite in orbit but that rivalries between the Army and the Navy as to which service would have the honor had stalled the first American liftoff.

Aside from the political oratory, many serious-minded Americans felt that somehow, someway, the system had gone wrong, and they started criticizing the American way of life in a surge of public recrimination.

"Everyone is blaming it on everyone else," said Dr. Lawrence A. Kimpton, chancellor of the University of Chicago. "Everyone is to blame except the guy who's talking. I'm fed up."

Much of the blame was to fall on the nation's educational system, from kindergartens to graduate schools. Critics felt that the system was too soft, that students were having it too easy and that college courses such as basket weaving and fly casting would not help in closing the "technology gap."

The charges were made at a time when the nation was investing $15-billion a year on education, about the amount Americans were spending annually on liquor and tobacco.

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Two months after Sputnik, the President's Committee on Scientists and Engineers warned that the Soviet Union would be superior in science in five or 10 years unless the United States broadened and strengthened its own efforts to improve the quantity and quality of technical talent.

The Presidential panel said that the United States' reaction to Soviet satellites and other scientific achievements should not be to focus on "purely military needs."

"Russian advances in other technological fields present an equally grave threat to the ultimate security and well-being of our people," it said. "This lies in the Soviet Union's well-directed and energetic program to achieve and assert scientific pre-eminence in order to gain economic, political and cultural supremacy in the world."

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The report went on to call for "marshalling our brainpower" to meet "the broader challenges of the scientific age."

David J. McDonald, head of the United Steelworkers of America, offered his own plan to meet the educational and technical challenge of Sputnik: "A $15-billion school building project with no frills, no fuss, no gyms, no stadiums and no football fields."

Suddenly statistics that for years had been either buried, overlooked or disregarded became front-page news. The Federal Office of Education, for example, said a shortage of 140,000 public school classrooms existed.

Other groups estimated that only 20 per cent of the country's brightest students were graduating from college and charged that tens of thousands of American school children were being taught by incompetent teachers.

A general awareness was developing that the American educational system was inadequate for the scientific and technical demands of the nation.

Some persons in Government believed that the firing of Sputnik heralded the outbreak of World War III, but that it was a different type of war, one that would be fought with technological brains and scientific feats, more than with guns and bombs.

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By 1958 there were indications that the vast legislative inertia was being overcome. Two important acts were passed by Congress: The first transferred the national space effort from the feuding military services to civilian control and set up the National Aeronautics and Space Administration to direct it. The second was the National Defense Education Act.

With the door now open, several new education measures emerged from Congress in the next five years, including programs that supplied money for teacher education, vocational training facilities, medical school construction and aid to grammar and high schools.

Academic entrepreneurs rushed in to meet the well-financed demand for better science education. Soon the New Math proliferated in the nation's classrooms. Millions of parents, who earlier had been racked with doubts about "why Johnny can't read," discovered that they could not understand, let alone do, Johnny's math homework.

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Another dramatic response to Sputnik was a vast increase in Government and private spending on science. Between 1955 and 1967 American expenditures on research and development nearly quadrupled to about $24-billion. The huge increases went not only into the space program, but also into medical research, the basic sciences and technology.

But the financial pendulum started to swing the other way as the war in Vietnam escalated and pressure mounted to solve the problems in the nation's cities. Federal spending for science leveled off and, viewed as a percentage of the gross national product, even declined.

Many of the long-dormant questions about the value of investing in space, or even of going into space at all, again began to be heard.

Yet men, regardless of their nationality, apparently have had to go to the moon just as they have had to cross the oceans and as they may eventually have to go on to the stars — because man is never satisfied until he finds out what is on the other side of the hill.

For Western Europe, It Is Joint Task

By HERMANN BONDI

WESTERN Europe's achievements in space are real, though puny beside those of the two great space powers.

Since the combined gross national product and the total population of non-Communist Europe are of the same order as those of either the United States or the Soviet Union, the small size of Western Europe's space effort clearly demonstrates that she does not attach as much

Dr. Bondi is director-general of the European Space Research Organization.

importance to space as the two superpowers do.

Indeed, while the annual budgets of the National Aeronautics and Space Administration during the nineteen sixties have generally reached about $20 a head of the population, in no West European country has the total exceeded $2 a head during the same period.

Nevertheless, Western Europe's efforts are significant, not only because of technical and scientific achievements but also because of the vitally important advances that are being made in that most difficult of all techniques — international collaboration in an industrially competitive field.

Western Europe's achievements in space can perhaps best be understood when divided into separate categories.

First, there are the purely national efforts. France has built and herself launched three small scientific satellites (each weighing less than 200 pounds) into low orbit, and another is scheduled for 1971 with an improved launcher. Her launching base in the Algerian Sahara was abandoned in 1965 and a new one is being established in French Guiana.

Britain is due to launch a small satellite, also less than 200 pounds, next year with her own launcher from a base at Woomera in Australia.

There are, second, the efforts involving one West European country and one of the great space powers in cooperation.

The United States, using Scout vehicles, has launched several small but sophisticated scientific satellites built by France, Britain and Italy. More launchings are planned soon for West Germany, France and Britain.

The Italians have themselves launched a small scientific satellite using the Scout vehicle from the equatorial platform they have established off the coast of Kenya.

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A large French scientific satellite was due to be launched by the Soviet Union, but the shot had to be canceled during the recent French economic crisis.

A major Italian experimental telecommunication satellite is now in the early stages of development for a launching by a United States Thor Delta rocket.

A third category is the narrow West European grouping. France and West Germany, for example, are jointly building, with some Belgian participation, a television relay satellite for launching in 1972 by the European Launcher Development Organization.

That organization, for a fourth category, represents a medium-sized grouping. Its member nations are West Germany, France, Belgium, the Netherlands, Italy, Britain and Australia.

The organization plans to build a launcher capable of putting a vehicle weighing about 1,800 pounds into low orbit (Europa I, completion of development due soon) or one weighing 400 pounds into a higher stationary orbit (Europa II).

Its base will be in French Guiana, and its budget is about $100-million a year.

Finally, there is the wide grouping — the European Space Research Organization. Its member nations are West Germany, Britain, France, Italy, Sweden, Belgium, the Netherlands, Switzerland, Denmark and Spain.

Its first three scientific satellites—small but sophisticated—were launched by the United States space agency in 1968.

More small satellites are due to be launched later this year and in 1971 and 1972, and its first major one (1,000 pounds) is planned for 1972. Several other major scientific projects are under consideration, including a television relay satellite. The organization's budget is just over $50-million a year.

It is clear from the dispersal of effort that there are doubts in the West European countries about how best to organize their space programs.

The heavy cost of keeping the technical "infrastructure" in being, the massive cost of major projects and the difficulty of assembling large teams of skilled men, all point toward a single international effort.

At the same time, there is the natural desire of individual governments to keep matters under their sovereign control, and the problems of international cooperation tend to make each government prefer a national effort or perhaps narrow groupings.

In space, as in many fields, the advantages of a broad base are increasing all the time. It is therefore a vital interest of all countries to master these problems of working together.

We have made much progress and, with the decision of the West European governments to join E.L.D.O. and E.S.R.O. into one organization, we can surely expect a growth of confidence.

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The small magnitude of the space effort should thus not be allowed to obscure its real achievements. Every one of Western Europe's satellites so far produced, nationally or internationally, has fulfilled its mission with complete success, technically and otherwise.

There has been real political success in the demonstration that multilateral efforts can be effective, although the industrial work must, for obvious reasons, be spread reasonably fairly among the member countries. International cooperation has thus been shown to be compatible with industrial efficiency and competitiveness.

With the laying of this groundwork for a common European space endeavor, we are looking forward to a bright future for Europe in space.

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ENGINES FOR SPACE

Pioneers of a New Age

By WERNHER VON BRAUN

APOLLO 11 will always be remembered as a magnificent achievement in the history of applied science and technology in the United States, and we Americans are justifiably proud of it. In reality, however, the team that brought Apollo 11 to fruition cuts across national boundaries. The mission itself had its beginnings not on July 16, 1969, but several centuries ago.

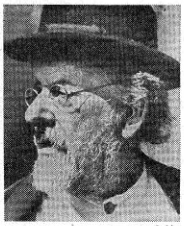
The sense of history involved in this realization of man's ancient dream of voyaging to the moon is easily overlooked, and we tend to consider this particular feat as a product of Twentieth Century science and technology. It is not overlooked, though, by men such as Col. Frank Borman, who is a pioneer himself in the centuries-long journey to the moon. In addressing the House of Representatives on Jan. 9, following his return from orbiting the moon, the Apollo 8 commander said:

"Yet when we say that this was an American achievement, we really have to go back to Newton and paraphrase him. . . . How can anyone think of Apollo 8 without thinking of Galileo or Copernicus or Kepler or Jules Verne or Oberth or Tsiolkovsky or Goddard or Kennedy or Grissom or White or Chaffee or Komarov? We truly stood on the shoulders of giants."

Apollo 11 also owes as much to men such as those named by Colonel Borman as it does to the hundreds of thousands of engineers, scientists and technicians who labored for a decade to make possible man's first landing on the moon. For men such as Tsiolkovsky, Goddard, and Oberth worked out the basic principles of astronautics, drawing in turn on the earlier, fundamental work of Newton and Kepler in the Seventeenth Century. Without the knowledge of *why* a rocket works, we could not hope to place an artificial satellite around the earth or to escape earth's gravity and land men on the moon.

We sometimes, too, underestimate the influence of the arts on the sciences (and vice versa), particularly in astronautics. It is interesting to note that the three modern pioneers in astronautics—Tsiolkovsky (1857-1935), Goddard (1882-1945) and Oberth (1894-—), all had something in common, in addition to their learning and passion for science. They had imaginations that were initially inspired by the fiction of Jules Verne, who made space travel sound exciting and—even more important—technically feasible to young boys with an aptitude for science. These two elements of his books were the spur needed to turn serious minds toward serious scientific problems in the latter years of the Nineteenth Century and the opening years of the Twentieth Century.

Dr. Von Braun is the director of NASA's George C. Marshall Space Flight Center at Huntsville, Ala.



Sovfoto

Konstantin E. Tsiolkovsky advocated the principle of rocket staging and was a pioneer in study of propellants.

How many people for how many years idly watched the sky rocket streaking into the air and thought nothing of it except to marvel at the colorful pyrotechnics? The prose magic of Verne was the probable catalyst that began the process of scientific inquiry within Tsiolkovsky's mind. In his later years he wrote:

"For a long time I thought of the rocket as everybody else did — just as a means of diversion and of petty everyday uses. I do not remember exactly what prompted me to make calculations of its motions. Probably the first seeds of the idea were sown by that great author of fantasy, Jules Verne —he guided my thought along certain channels, then came a desire, and after that, the work of the mind."

Nearly two centuries elapsed between Newton's formulation of the laws of motion and Tsiolkovsky's mathematical proof that the rocket was the only means by which man would some day place himself into space (a date which Tsiolkovsky predicted as 2017, an underestimation of 53 years). His mathematics revealed the principle of mass ratio. Basically, this told him that the size and weight of the rocket was ultimately limited. However, it suggested two alternatives to overcoming the problem. He could find the best combinations of propellants to increase the velocity of his exhaust gases or he could reduce the weight of the rocket and all its parts in order to carry more propellants.

These alternatives opened up new vistas for theoretical research to Tsiolkovsky: using various combinations of fuels and oxidizers to produce the greatest exhaust velocities. His calculations, done painstakingly by hand, led him to state that the best propellants for practical use were kerosene and liquid oxygen, or liquid oxygen and liquid hydrogen. He even pointed out that the ozone as an oxidizer would be better than liquid oxygen. In this suggestion, he is still ahead of contemporary propellant chemists.

Other studies led him to the principle of rocket staging to achieve the velocities required for escape from earth's gravity. He pointed out that the staging could be done in two ways: in series or in parallel. In other words, one rocket could be placed on top of another (as we do with Saturn 5) or several could be clustered into a bundle (as we do with the Titan 3C).

Tsiolkovsky's deep insight into the full scope of astronautics led him also to speculate on the life support system for the future astronaut. Indeed, he envisioned the spacecraft as "a metallic elongated chamber (the least resistant shape) supplied with light, oxygen, absorbers of carbon dioxide, miasmata, and other excretions . . ." While his studies in the biomedical field are not as extensive as his other contributions to astronautics, they do show that he had a total grasp of what is involved in manned spaceflight.

The implications of Tsiolkovsky's pioneering work are obvious today. It supplied us with the mathematical tools we need to design multistage space carrier vehicles such as Saturn 5. The studies in propellant chemistry and rocket propulsion gave us the starting point for the design of the F-1 and J-2 engines used by the Saturn 5. These engines are powered by liquid oxygen and kerosene and liquid oxygen and liquid hydrogen because Tsiolkovsky's findings over a half century ago are as valid today as they were then. Tsiolkovsky's theories have stood the tests of time and the empirical tests of our modern laboratories.

Contemporary rocketry and Apollo 11 also owe a debt to a native American pioneer in astronautics—Robert H. Goddard, the shy and brilliant professor of physics at Clark University in the early nineteen-hundreds at Worcester, Mass. Though some 25 years younger than Tsiolkovsky, Goddard was certainly his intellectual peer. Goddard was a theoretician, but he was also a builder. He was the perfect example of the practical New Englander who likes to prove things to himself. His work most relevant to today's problems began shortly after World War I, but his theoretical studies and experiments with gunpowder rockets antedate that conflict.

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Goddard's monograph, "A Method of Reaching Extreme Altitudes," published by the Smithsonian Institution in 1919, is a classic in the literature of astronautical science. It was a primer for the early research in rocketry in the United States and was well known in Europe. But Goddard was not content with mathematical models and theories. He designed and helped build his own flight hardware.

His contributions to the modern space booster are too numerous to recite. During the 42 years between 1914 and 1956, he received 214 patents in the field of rocketry alone. Many of these were for components that have become standard today. Goddard's greatest contribution was probably in the field of rocket engineering. He proved that liquid propellant rockets could be built and that they would perform as he and Tsiolkovsky before him had mathematically predicted they would. He launched the world's first one in 1926. He introduced, among other things, the gyroscope control, turbopump-fed liquid propellant engines, regeneratively cooled engines and the gimballed engine mounting. All these proved essential to the later rockets that boosted man into space, and without them the Saturn 5 would simply have not been possible. In summary, it can be said that Goddard did most of the basic research and development that made possible rockets such as the Saturn 5.

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Apollo 11 also owes a debt to the work of Hermann Oberth, the German pioneer in astronautics. He was a contemporary of Goddard, and in one of those twists of circumstance that one often finds in the history of science, Oberth spent many long hours performing intricate mathematical proofs of what had taken Tsiolkovsky and Goddard an equally long time. Tsiolkovsky was an obscure Russian school teacher working by himself in a small rural village. His work was published in Russian, and he had little contact with fellow scientists in his own country and practically none outside. Thus, Oberth was completely unaware of the Russian's work until his own was practically done. The same was true with Goddard, who worked in secrecy for the most part, publishing little except for his masterpiece, "A Method of Reaching Extreme Altitudes," a copy of which he sent to Oberth upon request.

Oberth was more like Tsiolkovsky than Goddard. He was a theoretician rather than a designer and builder. And like Tsiolkovsky his scope of interest in astronautics encompassed more than just the rocket. He was interested in the problems of man in space, because of his early training in medical school.

The influence of Oberth on modern astronautical engineering is probably more direct than that of Tsiolkovky, however, because of geographical and temporal factors. Oberth was working in Germany and publishing in German at a period when a group of young rocket enthusiasts were beginning to associate in the late 1920's and early 1930's. Oberth's work, including the layout of a two-stage, liquid propellant rocket using liquid oxygen and alcohol, was known to them and became the basis of the practical work that soon found the amateur spacemen building and firing liquid propellant rockets. From these groups came the cadre of engineers and scientists that were to build the first really large rockets such as the V-2 of World War II, which proved that the space booster was an engineering possibility.

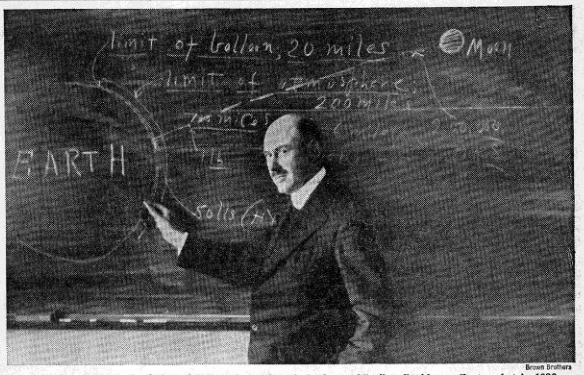
Lesser known but equally important early members of the Apollo 11 team include men such as Robert Esnault-Pelterie (1881-1957) of France. He was an adventuresome French aviation pioneer who had made flights in the Wright brothers' airplane, and he was the author of L'Astronautique (1930), one of the early and most comprehensive studies in astronautics.

Dr. Walter Hohmann (1880-1944), city engineer of Essen, made theoretical studies of the energy required for the optimum trajectories to the moon and planets. His work, of course, is indisputably present in the mission planning that preceded Apollo 11's lunar trip and landing.

Other names that can be added to the role include Eugen Saenger (1905-1964) of Germany; Helmut von Zborowski (1905- —) of Germany; Guido von Pirquet (1880-1966) of Austria; Johannes Winkler (1897-1947) of Germany; and Friedrich A. Tsander (1887-1933) of Russia. All of them made significant scientific or technical contributions to rocketry, which, in turn, made missions such as Apollo 11 possible.

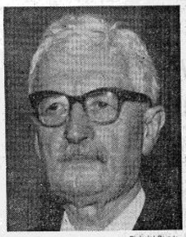
Today we see that manned exploration of space is a continuum. It began several centuries ago, and Apollo 11 is one of its more historic points. The essential timelessness of spaceflight was recognized well before our first satellites were even thought of by one of those giants upon whose shoulders men like Armstrong, Collins, and Aldrin stood. In 1932, Robert H. Goddard wrote:

"There can be no thought of finishing, for aiming at the stars, both literally and figuratively, is the work of generations, but no matter how much progress one makes there is always the thrill of just beginning."



Brown Brothers

Robert H. Goddard, the father of U.S. rocketry, launched the world's first liquid-propellant rocket in 1926

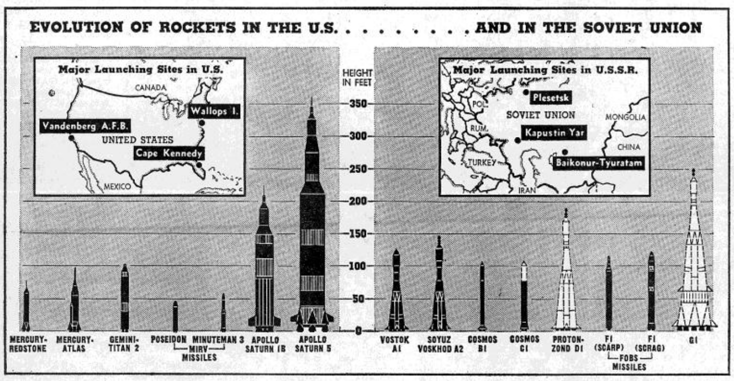


Pictorial Parade

Hermann Oberth, whose theories on rocketry influenced the work of German engineers before World War II.

Bettman Archive

Robert Esnault-Pelterie of France, who wrote one of the earliest and most comprehensive books on astronautics.



TRW

V-2 to Saturn 5

ON Oct. 3, 1942, a 46-foot-long missile, fueled by ethyl alcohol and liquid oxygen and designated A-4 by its developers, roared into the sky from Peenemünde on Germany's Baltic shore.

It was the masterpiece of the triumphant German rocket scientists who had put together in hardware the ideas of Oberth, their countryman, Goddard, the American, and Tsiolkovsky, the Russian. With its rise into the Baltic sky, the age of modern rocketry opened.

In the fall of 1944 this rocket took the place of what the Third Reich called Vengeance-Weapon One, the famous jet-propelled "buzz bomb" that had been raining death and destruction on London. The new weapon was renamed Vengeance-Weapon Two, or, more simply, V-2.

Although the V-2 appeared too late to influence the course of World War II, it was nonetheless the first ballistic missile, the ancestor of the missiles that today carry nuclear warheads. It was the progenitor of the boosters that blast men into space as well.

For some years after the United States and the Soviet Union appropriated the V-2 and its builders for their own rocket development programs, both nations concentrated on military missiles.

For example, the American Redstone, Atlas and Titan 2 were all designed expressly to carry atomic warheads, as were the Russian A-1 and A-2.

These five rockets were adapted as spacecraft boosters when the days of manned flight came along—the Redstone and Atlas for Project Mercury, the Titan 2 for Project Gemini, the A-1 for the Vostok series, the A-2 for the Voskhod and Soyuz vehicles.

Soon, though, both nations were turning out families of rockets for specialized purposes.

In Russia, the B-1 and C-1 boosters were developed for launching unmanned earth satellites of the Cosmos series. (In the large chart above, dotted lines indicate informed estimates as to rockets' shapes.)

The Proton, which appeared in 1965 and has already sent two Zond spacecraft around the moon, is thought to be capable of sending men around it too.

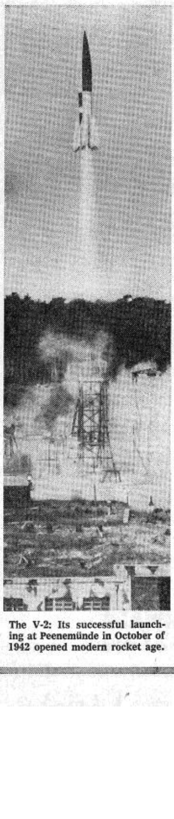
The G-1 is believed to be under development for future manned spaceflights, possibly to the moon.

Either the "Scarp" or "Scrag," both wholly military missiles, might be used for the Russians' fractional orbital bombardment system (FOBS), in which a nuclear warhead would be sent in either of two directions in a partial earth orbit (See diagram at right, above).

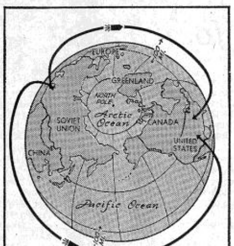
America's Poseidon and Minuteman 3 missiles, each of which can carry the multiple warheads of the Multiple Independently Targeted Re-entry Vehicle, or MIRV (diagram at right), represent the latest in specialized military rockets.

The Saturn family was created especially for Project Apollo.

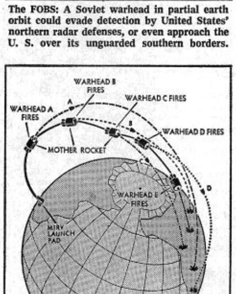
It was a Saturn 5, so far the biggest and most powerful of the V-2's descendants, that blasted the Apollo 11 astronauts yesterday toward a planned lunar landing.



The V-2: Its successful launching at Peenemünde in October of 1942 opened modern rocket age.



The FOBS: A Soviet warhead in partial earth orbit could evade detection by United States' northern radar defenses, or even approach the U. S. over its unguarded southern borders.



The New York Times July 17, 1969

The MIRV: Many nuclear warheads drop from a single mother rocket that can change course.

Spacecraft, Like Squid, Maneuver by 'Squirts'

By ISAAC ASIMOV

FOR thousands of years, man has envied the birds their independence of the ground, their ability to soar into the sky. Yet the bird's locomotion was essentially like ours—it was the result of a push against something else.

If we walk or run, our feet push against the ground. So do the legs of a running horse and the wheels of a moving locomotive or automobile. On the seas, the paddle or ship's propeller pushes against the water. And in the air, the wing of the bird, or the propeller of the airplane, pushes against the air.

Dr. Asimov is associate professor of biochemistry at the Boston University School of Medicine. He is the author of scores of books on science, the most recent being "Twentieth Century Discovery."

But the air is a thin layer of gas a few miles thick, clinging to the earth's surface. What if we want to travel beyond the air, where there is *nothing* to push against. Birds and airplanes would be as helpless in space as a fish.

Yet there is a way out, and millions of years ago the squid discovered it. When the squid wants to dart through the water, it squirts a jet of water out behind and that makes it move forward. It is, literally, jet-propelled.

So is the jet plane, of course. The jet plane sends a stream of heated gases backward, and the plane proper moves forward.

It may seem that the squid's jet pushes against water and that the jet plane's exhaust pushes against air, but that is not the essential part of the workings. The system of jet-in-one-direction-and-move-in-the-other would work in a vacuum, too.

We *know* it does because that's *how* space vehicles maneuver, but let's see *why* it does.

Imagine an object suspended in the vacuum of outer space. If there's nothing to move it, it must stay in the same place forever.

But suppose that an explosion inside the object sends part of it flying off in one direction. There is only one way to keep the *average* position of the object in place. The rest of the object must move in the opposite direction. As the two parts of the object continue to fly apart, the *average* position stays the same.

The faster one part is hurled in one direction, the faster the rest moves in the opposite direction. A jet plane burns fuel and sends the blazing hot exhaust gases through a narrow nozzle. Those gases must move at great velocities through the nozzle if they are to escape as quickly as they are formed; hence the plane builds up a very rapid speed, too—in the opposite direction.

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Could a jet plane zoom out of the atmosphere altogether in this way? Not quite. It carries fuel only, and picks up its oxygen from the surrounding air. As the air gets thinner with height, the fuel eventually stops burning and there is no exhaust. The jet plane can gain no more speed and, as it coasts, gravitational pull brings it down into the thicker air again.

If a vehicle carried not only fuel but also something to mix with it and make it burn (like liquid oxygen, for instance), then we would have a rocket. The rocket could keep its jet going even in outer space because it carried its own air, so to speak.

As long as the rocket jet was maintained, the vehicle would keep moving faster and faster. As soon as the jet ceased, the vehicle would coast and begin to respond to the earth's gravitational pull (since there would now be no jet effect to counter that pull.)

Like the jet plane, the rocket would proceed to drop downward and, eventually, fall to earth. It is possible, however, for a rocket vehicle to fall without ever hitting the ground, if it is pointed in the right direction and is moving quickly enough.

Suppose a rocket vehicle is a hundred miles up and is coasting parallel to the earth's surface. It is constantly falling, but the earth is round and the surface of the planet is constantly curving away from the vehicle. The falling vehicle and the curving surface can move "in step" so that although the vehicle is falling, falling, falling, it always remains a hundred miles above the curving, curving surface. The vehicle is "in orbit."

In order to be in orbit, the vehicle must travel at least five miles per second. Otherwise, it doesn't move far enough, while falling, to allow the ground to curve sufficiently, and it eventually strikes the ground.

What's more, the vehicle can only do this outside the atmosphere. Inside the atmosphere, a five-mile-per-second speed would burn it up because of friction with the air.

Suppose a vehicle in orbit turns on its engines and sents out a jet of exhaust. It speeds up. After the jet is shut off, the vehicle is coasting more rapidly than it had been before. It moves farther while it falls a given amount and therefore moves away from the earth's surface.

Now it is, in effect, climbing away from the earth, and the earth's gravitational pull gradually slows it. Eventually, it begins to fall back toward the earth, speeding up as it does so.

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If the vehicle continues to circle the earth without further use of its engine, it repeats its new orbit over and over, climbing up and away from the earth, then sinking toward it again. The orbit has become a flattened curve called an ellipse.

By using the rocket engine at the proper moment and for the proper length of time, a vehicle can be put into an ellipse about the earth that is as flat and as elongated as we wish. One side of the ellipse can stretch far out, as far as the moon, while the other side continues to hug the earth.

By choosing the right orbit (and allowing for the fact that the moon is itself moving and has a gravitational pull of its own), a vehicle can coast to the moon. If the orbit turns out to be not quite perfect, an additional touch of rocket-firing at the right time and for the right duration will make a mid-course adjustment that will alter the orbit and place the vehicle on target.

Actually, once it becomes possible to place a vehicle into orbit, it doesn't take much more power to reach the moon.

The strength of the earth's gravitational pull weakens as the distance from the earth increases. The greater the height a vehicle attains, the less power it takes to pull it higher still.

Suppose a vehicle is moving seven miles per second to begin with. The earth's gravitational pull will eventually slow it to 3.5 miles per second, but by that time the vehicle will have gained such a height that the earth's gravitational pull will have been cut to half its original force. Now the gravitational pull can only slow the vehicle's speed at half the original rate. It takes the vehicle as long to drop down to 1.75 miles per second as it had taken to drop down to 3.5 miles per second originally.

•

After every equal unit of time, the vehicle's speed is cut in half (1, $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$ and so on). Thus it is never cut entirely to zero. If the vehicle leaves with a speed to seven miles per second it need never return to earth. That speed is "escape velocity" from the earth's surface. This means that though five miles per second is required just to put a vehicle into orbit, something less than two additional miles per second is needed to carry it to the moon.

Of course, the vehicle is still in the sun's gravitational field. It will therefore continue in an orbit about the sun and become a man-made planet. As the vehicle and the earth move in their separate orbits about the sun, the two may someday pass close to each other, but they will be independent bodies when they do so, each going its own way.

The sun-circling vehicle might use its retrorockets. These send out a jet of exhaust ahead of the vehicle, giving it a push in the opposite direction (that is, backward.) Naturally, the vehicle slows down and begins to fall closer toward the sun. The orbit is a new ellipse with one end hugging the sun, and if it is correctly chosen, the vehicle will pass close to Venus.

Or else the vehicle may make use of its ordinary rear engines to increase its speed. It will then lift away from the sun and move into an elliptical orbit that will carry it farther from the sun than the earth's own orbit ever does. Along this new ellipse, the vehicle may pass close to Mars.

Suppose a vehicle in space manages to attain a speed of 26 miles per second. This is the escape velocity with respect to the sun (at least at earth's distance from the sun.) The vehicle can then move away from the sun at such a speed that the sun's gravitational field will weaken with distance too quickly to bring it back.

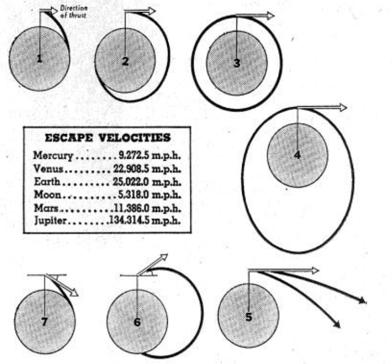
The vehicle can then move out of the solar system altogether and coast toward the stars.

There is only one catch. Even the nearest star is a hundred million times as far as the moon, and with a starting speed of 26 miles a second, it would take many thousand years to reach it even if that speed could be maintained.

Even if we took off with the speed of light—186,281 miles per second—it would take 4.3 years to reach the nearest star. And faster than the speed of light nothing can go.

So reaching the stars will prove a hard problem indeed. For a while, perhaps, we had better be satisfied with the moon.

FUNDAMENTALS OF SPACE TRAVEL



ESCAPE VELOCITIES

Mercury	9,272.5 m.p.h.
Venus	22,908.5 m.p.h.
Earth	25,022.0 m.p.h.
Moon	5,318.0 m.p.h.
Mars	11,386.0 m.p.h.
Jupiter	134,314.5 m.p.h.

Flying to the moon is largely the art of putting a spacecraft into earth orbit and then stretching that orbit until the craft reaches the moon. Achieving earth orbit is a matter of speed. If the spacecraft moves too slowly at what is called the orbital injection point, gravity pulls it back to earth after a more or less lengthy run (see 1 and 2 at left). If the craft's speed reaches about five miles a second, it will have enough outward momentum to exactly counterbalance earth's gravity and go into a circular orbit. (3). Extra thrust will put the craft into an elliptical orbit (4). If enough extra thrust is delivered, the high point of this orbit will reach far enough outward to take the spacecraft to the moon. If the craft goes more than about seven miles a second—that is, achieves escape velocity—it will pull free of earth's gravity altogether and, if guided correctly, head for another planet (5). (Table lists escape velocity for some bodies in the solar system). If thrust is not delivered at the proper angle (6 and 7), the craft will "intercept" the earth. The principle of the rocket, which delivers the thrust, is illustrated below. When fuel is ignited in a combustion chamber, it exerts equal pressure on all walls of the chamber. If an opening, or nozzle, is made at one side of the chamber, gas streams out at supersonic speed. At the same time, a reaction force is exerted on the side of the chamber opposite the nozzle. This reaction force thrusts against the chamber's inside forward wall, pushing the rocket forward.

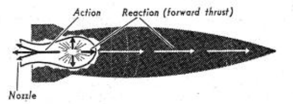


Diagram Above Adapted from the McGraw-Hill Encyclopedia of Space

A Correction

On Jan. 13, 1920, "Topics of The Times," an editorial-page feature of The New York Times, dismissed the notion that a rocket could function in a vacuum and commented on the ideas of Robert H. Goddard, the rocket pioneer, as follows:

"That Professor Goddard, with his 'chair' in Clark College and the countenancing of the Smithsonian Institution, does not know the relation of action to reaction, and of the need to have something better than a vacuum against which to react—to say that would be absurd. Of course he only seems to lack the knowledge ladled out daily in high schools."

Further investigation and experimentation have confirmed the findings of Isaac Newton in the 17th Century and it is now definitely established that a rocket can function in a vacuum as well as in an atmosphere. The Times regrets the error.

East and West Wooed Germans

IN the late spring and summer of 1945, as Germany lay sprawled in chaos, a splendid spoil of war—some 12,000 highly trained rocket scientists and engineers — was eyed jealously by both the American and Russian armies.

Both sides made some spectacular goofs in what was almost a stampede to lay claim to the experts and their wares.

The Americans failed to ransack some valuable installations, thus overlooking new rocket-building tools and plans for the experimental A-10 rocket that eventually sped the genesis of Sputnik. The Russians failed to find many scientists right under their noses in the Soviet zone.

Ultimately, under a rather informal maneuver called "Operation Paperclip" the Americans managed to bring 492 Germans and 644 of their dependents to the United States.

Among these were Dr. Wernher von Braun and 117 of his leading experts from the famous German rocket center at Peenemünde, a fishing village on the Baltic coast.

The Von Braun team opted for the West, feeling that they would get a better deal from the Americans. They were for the most part, observers have agreed, the brain trust behind all spectacular German rocket feats.

•

The Russians, on the other hand, took in about 2,000 German rocket men (reports of the total vary) plus 10,000 dependents. Most of these men had chosen to stay near Peenemünde, and their homes, in the Russian zone.

In October, 1946, however, the Russians rolled night trains into the area and transported them, by force and stealth, it is said, to the Soviet Union.

Most of those taken to Russia were the skilled artisans who knew how to build and assemble V-2 rockets. They were the production men.

Not too much is known about the German role in Soviet rocketry because the Germans themselves, who were repatriated to East and West Germany during the 1950's, were kept in small, isolated communities and were never permitted to visit Russian rocket facilities. Their brains were picked, in essence, and they were sent home.

The experts that went to America, however, were generally absorbed into the scientific and industrial complex. But the Von Braun group clung together.

"We had something no one else had," says Dr. William A. Mrazek, a key official under Dr. Von Braun at the Marshall Space Flight Center in Alabama. "Everyone fitted like a mosaic stone. If one dropped out, we felt it. Basically we're doing the same jobs today we did then."

Of the original Von Braun group, 54 are still at the Marshall center. One is with the Army rocket program, 30 are working for industry or other Government agencies, 15 have returned to Germany, 7 are retired and 11 are dead.

The group has reunions every five years. The next is slated for 1972. The oldest living is in his seventies.

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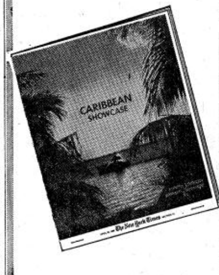

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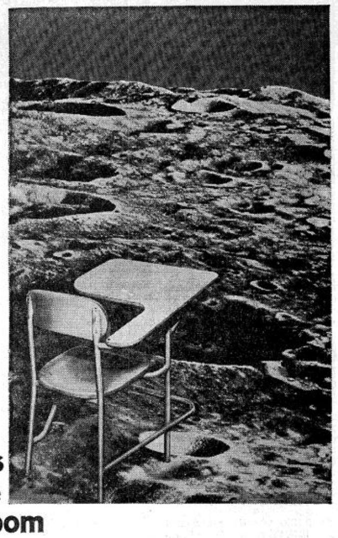

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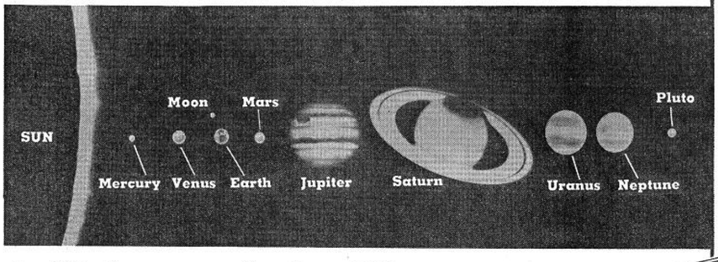
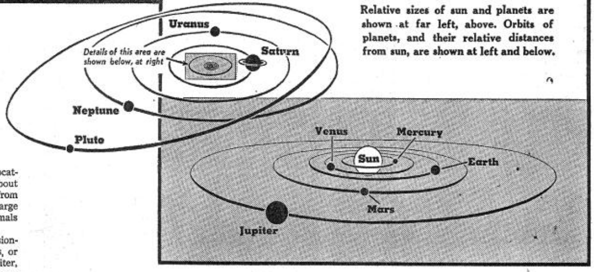


THE SOLAR SYSTEM

	Average distance from Sun (Millions of miles)	Diameter (Miles)	Length of day (In earth time)	Length of year (In earth time)	Number of moons
Sun		864,000			
Mercury	36.2	3,100	176 days	88 days	0
Venus	66.9	7,500	243 days	225 days	0
Earth	92.9	7,920	24 hours	365 days	1
Mars	141.2	4,150	24.6 hours	1.9 years	2
Jupiter	483.0	87,000	10 hours	12 years	12
Saturn	882.6	71,500	10 hours	29 years	9
Uranus	1,783.7	32,000	11 hours	84 years	5
Neptune	2,787.0	31,000	16 hours	165 years	2
Pluto	3,623.1	4,500	6 days, 9 hours	248 years	0

Approximate diameter of solar system (across Pluto's orbit): 7.3 billion miles



Relative sizes of sun and planets are shown at far left, above. Orbits of planets, and their relative distances from sun, are shown at left and below.

A Primer of the Heavens

By ROBERT JASTROW

THE earth is one of nine planets that are bound to the sun by the force of gravity. Together the sun and planets, their moons and a large number of lesser bodies, including asteroids and comets, form the solar system.

The four innermost planets — Mercury, Venus, Mars and the earth — are grouped together and referred to as the terrestrial planets because, different though they are in their surface conditions, all are similar to the earth in size and density. They are believed to be composed of the same mixture of rocky materials and iron and nickel that make up the bulk of our planet.

The moon, for which the Apollo 11 astronauts are now bound, is the earth's nearest neighbor in space. It may be included among the terrestrial planets, for it is also composed of rock and iron and is not very much different in size from the small planets, such as Mercury.

The moon is one-fourth the size of the earth, weighs one-eightieth as much and moves in a nearly circular orbit at a distance of about one-quarter of a million miles from us. It is one of 32 satellites that circle the nine planets of the solar system and is distinguished from its sister satellites only by the fact that it is relatively close in size to its parent planet.

Dr. Jastrow is the director of NASA's Institute for Space Studies, the New York City division of the Goddard Space Flight Center.

Essentially, the earth and the moon may be considered as a double planet rather than as a planet accompanied by a moon.

Lacking an atmosphere and oceans, the moon is a poor piece of real estate and a most unlikely abode for life. Yet the very features of the moon that make it undesirable for colonization also give it a unique scientific interest.

The moon has preserved the record of its past for an exceptionally long time. It may hold clues to the history of the solar system that are unavailable to us on our own planet, whose early history has been obliterated by the erosive action of winds and running water, and by the churning over of the surface in mountain-building activity.

Large areas of the moon may be as well preserved as if they had been in cold storage for billions of years.

The oldest rocks on the surface of the earth go back 3.5 billion years. But the age of our planet is 4.5 billion years. What happened during those first billion years of the earth's history? We would like very much to know, because it was during this critical period that life appeared on the earth, according to the fossil record.

What were the physical and chemical conditions under which life arose on the earth? What path did evolution follow from non-living chemicals to the first simple organisms? What is the probability that evolution will cross the threshold from non-life to life on other planets?

We can never know the answers to such questions from the study of the earth alone because the events to which they refer are a blank page in the history of our planet. But the antiquity of the moon's surface offers the hope that it may shed light on these basic questions relating to the origin and uniqueness of life on the earth.

The moon may be the Rosetta Stone of life.

•

ACCORDING to evidence uncovered in 1966, the universe began its existence some 10 billion years ago as a dense, hot globule of gas, expanding rapidly outward. At that time the universe contained nothing but hydrogen and helium. There were no stars and no planets.

When the universe was about 100 million years old, stars began to condense out of the primordial hydrogen and continued to condense as the universe aged. The sun arose in this way 4.5 billion years ago, when the universe was about 5 billion years old.

Many stars came into being before the sun was formed; many others formed after the sun appeared. This process continues and through telescopes we can now see stars forming out of compressed pockets of gas in outer space.

Planets appear to be formed as a natural accompaniment to the birth of stars. It is probable that many or most of the stars in the sky are circled by families of planets.

Our own solar system was born 4.5 billion years ago out of a parent cloud of hydrogen and helium mixed with small amounts of other substances. The dense, hot gas at the center of the cloud gave rise to the sun; the other regions of the cloud — cooler and less dense — gave birth to the planets.

The earth condensed in this way out of atoms of gas to form a compact ball of rock and iron 8,000 miles in diameter. Gradually, light rocks accumulated at the surface of the young planet and formed the continents. The areas between the continents were natural basins in which water, rising from the interior of the planet through volcanoes and fissures in the crust, collected to form the oceans.

Slowly the earth acquired its present appearance.

•

BEYOND the moon, the earth's next closest planetary neighbors are Venus, Mars and Mercury. Mercury is the closest planet of all to the sun. It is a small body, less than half the size of the earth. The rocky, barren surface of Mercury, alternately baked on the side facing the sun and frozen on the side facing away, is extremely inhospitable to life. The planet is difficult to reach by rocket from the earth because of its closeness to the sun, and it is unlikely that we will learn more about it than we know now for many years to come.

Moving outward from the sun beyond Mercury, we come to Venus.

Venus is the earth's sister planet, closely similar to the earth in size and weight, although somewhat closer to the sun than we are. The surface of Venus is completely covered by clouds, and conditions on the planet have always been an enigma, yet romantic hope has flourished that beneath these clouds lie teeming masses of flora and fauna.

But in 1956, radio astronomers obtained indications that these hopes were illusory. These indications were definitely confirmed by the Soviet and American spacecraft flights to Venus in 1967, which established that the temperature on the surface of Venus is a sizzling 800 degrees Fahrenheit, which is approximately the melting point of lead.

The temperature of Venus is raised to this high value by a heavy atmosphere of carbon dioxide, roughly 100 times as dense as the earth's atmosphere, which seals in the planet's surface heat. It is certain that no forms of life remotely resembling terrestrial organisms could survive at this temperature.

Beyond Venus lies the earth, and beyond the earth lies the planet Mars.

Mars has half the radius and one-tenth the mass of the earth. It is one and a half times farther from the sun than the earth, has a rather cold and dry climate, with only a trace of moisture, and a very thin atmosphere, about 100 times less dense than that of the earth.

It is possible for life to exist in this arid climate of Mars, although we would be very surprised to find intelligent life. However, there is a chance that substantial amounts of water covered the surface of Mars when it was a younger planet.

This year's Mariner flights to Mars, scheduled to arrive on July 31 and Aug. 6, carry high-resolution TV cameras that may reveal signs of the former presence of such bodies of waters. If water existed in abundance for as long as a billion years, relatively advanced forms of life might have developed on the planet. In that case, surprises are in store for us when we reach Mars with manned expeditions in the next two or three decades.

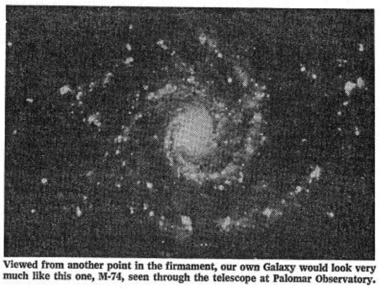
Beyond Mars there is a large gap in the distribution of the planets. We might expect to find a planetary body located outside the orbit of Mars, about three times the earth's distance from the sun; but instead we find only a large number of small bodies — planetesimals — circling in a ring.

These are called asteroids. Occasionally, collisions between these bodies, or perhaps the gravitational pull of Jupiter, the next planet past Mars, will pull one of them out of its orbit and into a collision course with the earth. It is believed that many, if not all, of the meteorites that hit the earth have this origin.

Five planets lie outside the orbits of the asteroids. Four of these — Jupiter, Saturn, Uranus and Neptune — have a completely different character from the earthlike planets. They are five to 10 times larger in diameter than the earth, and hundreds of times more massive. These four planets are known as the Giant Planets.

The Giant Planets are less dense than the earth and its neighbors because they are made up largely of the lightest elements, hydrogen and helium. These elements make up most of the matter in the universe; they also constitute most of the matter in the sun and in the Giant Planets, but for some reason, not clearly understood, they are not an abundant constituent of the earth and inner planets.

Jupiter is the largest of the Giant Planets and the most massive planet in the solar system. It is 11 times the size of the earth and 318 times as heavy. On a planet as large as Jupiter, the force of gravity is so great (six times the force of gravity on the earth) that most of the gases of the planet's original atmosphere will remain with it throughout its lifetime.



Viewed from another point in the firmament, our own Galaxy would look very much like this one, M-74, seen through the telescope at Palomar Observatory.

Not even the lightest gases, hydrogen and helium, can escape. For the same reason, the common gaseous compounds of hydrogen have also been retained. These compounds — ammonia, methane and water vapor — were present in abundance in the primitive atmosphere of the earth, and are believed to have played a critical role in the events that led to the development of life on our planet.

Their importance in evolution on the earth has ended, and they have long since escaped, but their continued presence on Jupiter leads us to wonder whether at least the initial steps along the path to life also occurred on that planet.

The ninth planet, Pluto, was found in 1930. It is the last planet to have been discovered in the solar system. At its furthest point, the orbit of Pluto is four billion miles from the sun. This distance from the sun is greater than that of any other planet. Because Pluto is so far away, we have been able to learn very little about it, except that it appears to be similar in size to the earth, and probably is composed of similar substances.

All the planets — even the heaviest, Jupiter — are dwarfed by the sun, whose mass is 700 times greater than the combined masses of the nine planets.

The diameter of the sun — one million miles — is one ten-thousandth of the diameter of the solar system. This is also approximately the ratio of the size of the nucleus at the center of the atom to the size of an entire atom. Like the atom, the solar system consists of a massive, central body — the sun — surrounded by small, light objects — the planets — that revolve about it at great distances.

•

BEYOND the solar system lies nothing but a tenuous distribution of hydrogen atoms, with a density of 10 atoms per cubic inch, until we reach the nearest neighbor. This is, according to information available at the present time, the star Alpha Centauri.

Alpha Centauri is 24 trillion miles from our solar system, slightly closer than the average distance between stars, which is 30 trillion miles. It is actually a triple star — a family of three stars formed simultaneously out of a single cloud of gas and dust. Ever since their birth, the three stars have circled one another under the attraction of gravity.

The largest of the three stars in Alpha Centauri resembles the sun in size, with a similar surface temperature and color. The other two are smaller, redder stars.

The middle-sized star of the triplet, somewhat smaller than the sun, and orange in color, circles around the largest star in a close waltz at a distance of 2 billion miles. One turn around takes 80 years for this pair. The third member is a very small, faint, red star, a tenth as massive as the sun, which circles the two "close" members of the triplet at a distance of a trillion miles, completing one turn in a million years.

The next nearest neighbor of the sun beyond Alpha Centauri is Barnard's Star, 30 trillion miles away. Barnard's Star is smaller than the sun, and a thousand times fainter. The temperature at the surface of Barnard's Star is 8,000 degrees Fahrenheit versus 11,000 degrees Fahrenheit at the surface of the sun, and its color is orange-red rather than yellow.

Barnard's Star, unlike Alpha Centauri, is a single star. However, it was discovered in 1965 that an object approximately the size of the planet Jupiter revolves in orbit around it. In 1968, a second Jupiter-sized planet was discovered orbiting Barnard's Star. Since Jupiter is one of nine planets in our solar system, it is possible that Barnard's Star, like the sun, also possesses a family of many planets, among which there may be one resembling the earth in size and distance from its star.

Thirty other stars exist within 50 trillion miles of the sun. Some are yellow stars, resembling the sun in size and temperature; a few are larger and brighter than the sun and blue-white in color; most are faint, reddish stars. Ten of the 30 are multiple stars — either doubles or triples. On the average, about half the stars in the universe are multiple.

The sun and its neighbors are only a few among 100 billion stars that are banded together by gravity in an enormous cluster called the Galaxy. Most if not all of the stars in the universe are held within such clusters. These other clusters are also called galaxies. Our own Galaxy, singled out because it contains the sun, is usually written with a capital "G."

The stars in the Galaxy revolve about its center as the planets revolve about the sun. The sun itself participates in this rotating motion, completing one circuit around the Galaxy in 200 million years.

When we look into the sky in the plane of the galactic disk, we see so many stars that they are not visible as separate points of light, but blend together into a luminous band stretching across the sky. This band is called the Milky Way.

The stars within the Galaxy are separated from one another by an average distance of 30 trillion miles. To avoid the frequent repetition of such awkwardly large numbers, astronomical distances are usually expressed in light year units, defined as the distance covered in one year by a ray of light traveling 186,000 miles per second. This distance turns out to be six trillion miles; hence, in these units, the distance from the sun to Alpha Centauri is 4.3 light years, the average distance between the stars in the Galaxy is five light years, and the diameter of the Galaxy is 100,000 light years.

An analogy may help to clarify the meaning of these astronomical distances. Suppose we start with the scale of distances within the solar system. Let us shrink the sun to the size of an orange; on that scale of sizes the earth is a grain of sand circling in orbit around the sun at a distance of 30 feet; Jupiter 11 times larger than the earth, is a cherry pit revolving at a distance of 200 feet or one city block; Saturn is another cherry pit two blocks from the sun; and Pluto, the outer-most planet, is still another sand grain at a distance of 10 city blocks from the sun.

On the same scale the average distance between the stars is 2,000 miles. The sun's nearest neighbor, Alpha Centauri, is 1,300 miles away.

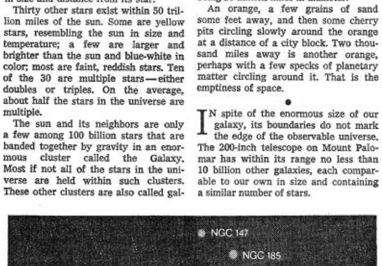
In the space between the sun and its neighbors there is nothing but a thin distribution of hydrogen atoms, forming a vacuum far better than any ever achieved on earth.

The Galaxy, on this scale, is a cluster of oranges separated by an average distance of 2,000 miles, the entire cluster being 20 million miles in diameter.

An orange, a few grains of sand some feet away, and then some cherry pits circling slowly around the orange at a distance of a city block. Two thousand miles away is another orange, perhaps with a few specks of planetary matter circling around it. That is the emptiness of space.

•

IN spite of the enormous size of our galaxy, its boundaries do not mark the edge of the observable universe. The 200-inch telescope on Mount Palomar has within its range no less than 10 billion other galaxies, each comparable to our own in size and containing a similar number of stars.



The nearest galaxy to ours is Andromeda. A light year is the distance covered in one year by a ray of light moving at a speed of 186,000 miles per second.

The average distance between these galaxies is one million light years. The extent of the visible universe, as it can be seen in the 200-inch telescope, is about 10 billion light years. Although the stars within any one galaxy are separated from one another by relatively great distances, they are, nonetheless, relatively close together in comparison to the still greater space that separates them from neighboring galaxies.

It is difficult to imagine the emptiness of intergalactic space. Once outside our Galaxy, we encounter a region empty of stars, dust and even empty of atoms except for one hydrogen atom per cubic yard.

No vacuum ever achieved on earth can match the vacuum of the space outside our Galaxy. But if we go far enough away from our Galaxy, we come to other galaxies, clusters of billions of stars held together, like ours, by the force of gravity. These galaxies are island universes — isolated clusters containing vast numbers of stars and planets — each separated from the others by the void of intergalactic space.

The closest galaxy to ours is the Andromeda Galaxy, which is 2 million light years from us. This galaxy happens to resemble our own closely in size and shape; it is a disk-shaped spiral of stars, gas and dust, containing approximately 100 billion stars in all, the entire collection of matter slowly spinning around a central axis like a gigantic pinwheel.

Andromeda is the only major galaxy visible to the naked eye, and is the most distant object that can be seen without the aid of a telescope. However, it is not conspicuous, despite the fact that its intrinsic brilliance is 100 billion times that of the sun. Because of its enormous distance, Andromeda is barely visible, under the best conditions, as a very faint patch of light.

But if it is photographed with even a modest-sized telescope, and the exposure lasts for 30 minutes to an hour, the faint patch is seen to have a structure that reminds one of our Milky Way Galaxy, with a brightly glowing center, a distinct impression of spiral arms, and dark lanes presumably formed by obscuring clouds of dust.

Approximately a dozen other galaxies, including the two dwarf galaxies known as the Magellanic Clouds, exist within three million light years of ours.

Enormous though a single galaxy is — with its sweep of 100,000 light years in diameter and its massive complement of 100 billion stars — it does not constitute the largest collection of matter known in the universe.

It has been discovered that galaxies themselves occur in clusters, held together, once again, by the force of gravitational attraction that each galaxy in the cluster exerts on the others. The number of galaxies in a cluster ranges from as few as three to as many as 10,000.

Some clusters contain as few as three or four galaxies; an example is the cluster of five galaxies known as Stephans Quintet, which is about 200 million light years from our Galaxy.

The Local Group, of which our Galaxy is a member, is another example of a modest-sized cluster. We know it to be a cluster because all its member galaxies move through space with a common speed — about 500 miles per second — relative to other galaxies in the neighborhood.

About 300 million light years from our Galaxy, in the constellation Hercules, is a giant group of galaxies, called the Hercules Cluster, that contains about 10,000 galaxies, each with 10 billion to 100 billion stars.

The Hercules Cluster and other large clusters of galaxies like it are the largest systems of matter known in the universe. We might expect to find clusters of clusters of galaxies, but no evidence of them has ever been uncovered.

Perhaps clusters of clusters will be discovered when astronomical observations are improved in accuracy. For the present, the reason for their absence is a mystery.

Knowledge Promises to Be Main Boon of Manned Lunar Landing

By WALTER SULLIVAN

ALTHOUGH Project Apollo was born as a by-product of the Cold War, posterity almost certainly will remember it, not as a race won, but as man's first personal encounter with another celestial body.

Why should we go to the moon? From the scientific standpoint there are a good many reasons.

The landings should vastly enrich our scientific knowledge. From the first moon samples we may be able to guess whether the moon is, in fact, a wayward planet that played a catastrophic role in the history of the earth.

We may find clues to the manner in which chemical evolution beyond the earth set the stage for life to appear on this world and countless others. We may learn whether the moon once had an atmosphere and, perhaps, true seas.

Very probably there are already lunar samples in our museums in the form of meteorites and, possibly, those glassy, streamlined fragments called tektites.

Some scientists believe the tektites and some meteorites that have fallen to earth were knocked off the moon, perhaps by explosive impacts. However, until the astronauts bring back their own samples, no one can say which of these objects, if any, came from the moon.

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As a result of Apollo 11 we should know whether or not the moon is "alive," with a hot, churning interior and current volcanic activity; or whether it is "dead" with no such activity, despite the fleeting daylight glows seen occasionally on its surface.

Few areas of scientific speculation have aroused such controversy as those relating to the moon: Is it hot or cold? Are the dark "seas" formed of lava or deep dust? Were the craters produced by impacting objects or internal eruption?

Did the moon condense from a ring of debris left around the earth after the earth itself was formed (the process postulated for the 31 other moons of the solar system)?

Was the moon torn from the young, fast-spinning earth? Or is the moon a former planet whose original (but unstable) orbit lay elsewhere in the solar system?

The moon has long perplexed scientists both because of its size—it is far larger, relative to its "parent" body (the earth) than any other moon of the solar system—and its density.

The average density of the moon is substantially less than that of the earth. This led Sir George Darwin to propose, late in the 19th century, that the moon was torn from the upper layers of the earth, whose density is less than the average density of the earth as a whole.

This theory is no longer popular, and some have proposed that the low density of the moon might mean that it contains large amounts of ice.

If the moon was never very hot inside, there would not have been the volcanic eruptions that belched forth great volumes of gas on earth, producing this planet's atmosphere and the water of its oceans.

Also, if the moon was never hot enough to become plastic, its heavier material would not have sunk to form an iron core, like that of the earth.

In 1955 a German scientist, Horst Gerstenkorn, proposed that the moon was once an independent planet whose elongated orbit brought it near enough to the earth for eventual capture by the earth's gravity.

In his theory, as later revised, the orbit of the moon, for a few hundred years, carried it to within 10,000 or 15,000 miles of the earth. This would have produced tides on earth four miles high and other catastrophic effects.

The earth's gravity, in turn, could have torn large hunks off the moon, some of which flew off into space, chasing the earth in its yearly journey around the sun. Others would have fallen back onto the moon after the latter moved out to a more distant orbit.

The impacts of these chunks would then account for many of the huge craters that pock the lunar surface. In reviewing this theory in the July 4 issue of the journal Science, two leading Swedish scientists note that a large portion of meteorites of certain types (octahedrites and hypersthene chondrites) that show signs of severe shock appear to be roughly the same age (700 million years).

Thus it is proposed that some 700 million years ago, shortly before the higher animals began to evolve from the primitive life of the sea, giant tides swept across the dry land.

The authors of the Science article—Dr. Hannes Alfvén, a visiting scientist at the San Diego campus of the University of California, and Dr. Gustaf Arrhenius, who is on the faculty at the nearby Scripps Institution of Oceanography—believe the first lunar samples may show whether or not the earth and moon did indeed have a cataclysmic encounter some 700 million years ago.

If they were within a few thousand miles of one another, tidal effects on the crusts of both bodies would have produced extensive heating.

Thus, if analysis of igneous (once molten) rocks from the moon shows that most were last melted some 700 million years ago, the hypothesis will be greatly strengthened.

If, on the other hand, many of the rocks prove to have gone some 4.5 billion years without having been melted, the idea will have to be dropped.

Age determinations of meteorites and the oldest earth rocks indicate that most, if not all, bodies of the solar system were formed about 4.6 billion years ago.

Because of the peculiar nature of the lunar environment, the Apollo 11 astronauts should be able, within the small patch of ground that they explore, to collect specimens (on the surface and below it with core samples) representing a great variety of lunar areas and formations. The reason is that the moon has no air and very weak gravity.

Hence, when an object hits the moon, exploding from the heat of its high-velocity impact, it not only gouges a large crater but sends debris flying in all directions.

The "rays" or bright streaks that radiate from some of the largest craters extend around a large part of the moon's circumference, showing the extent to which such debris is spread over the lunar surface.

While the astronauts are on the moon a sheet of aluminum foil will be mounted on the lunar surface to react to high velocity particles blowing out from the sun as the "solar wind."

The sheets will be folded and brought back in one of the two vacuum-sealed containers for study by a Swiss specialist.

A small instrument package will be set up with the chief aim of monitoring "moonquakes," to show whether the interior of the moon is hot and "alive."

Likewise a box of reflectors will be set up to reflect back to earth intense light beams aimed at the moon by laser. In this way it is hoped to record subtle changes in the earth-moon distance that should help resolve a dispute concerning the general theory of relativity and also determine whether or not the positions of the continents on earth are changing relative to one another, as many now believe.

The samples will not be exposed to the earth's atmosphere until they have been studied in vacuum chambers at the Lunar Receiving Laboratory at the Manned Spacecraft Center in Houston, Tex. Nor will they be released for study by other laboratories until extensive tests have convinced a team of specialists that the moon dust contains nothing harmful to life on earth.

Not only will the moon samples be kept in quarantine, but so will the astronauts and their spacecraft. Only for a few minutes after splashdown and before frogmen throw them special isolation garments through the open spacecraft hatch, will the astronauts breathe directly into the earth's atmosphere.

They will then don the garments, which include face masks, until they have entered a quarantine van on the aircraft carrier for transport back to the Lunar Receiving Laboratory in Texas.

A few scientists have objected to these measures as inadequate. Drs. Leroy Augenstein and Barnett Rosenberg of Michigan State University believe an earlier plan, which would have kept the astronauts in their spacecraft until hoisted aboard the aircraft carrier, would have been safer.

It would have made it possible to link the spacecraft to the quarantine van with a tunnel, preventing any exposure to the atmosphere.

Dr. Martin Alexander of Cornell University believes a far more extensive quarantine than the planned 21-day period would be advisable. He is fearful that lunar material, even if seemingly harmless to healthy astronauts or those plants and animals chosen for quarantine tests, might prove lethal to other organisms after the quarantine is lifted. This could endanger some vital part of the world's interdependent life cycles, he says.

It has long been contended by such figures as Dr. Joshua Lederberg, winner of the Nobel Prize in Medicine, that moon dust may help explain how the chemistry of life evolved on earth—and elsewhere.

Some meteorites (the carbonaceous chondrites) contain a hodgepodge of complex organic substances that some have proposed are relics of life somewhere beyond the earth.

The prevailing view, however, is that such precursors of life have been synthesized spontaneously by processes elsewhere in the solar system. Samples of moon dust may provide the answer.

Moon shots preliminary to Apollo 11, both manned and unmanned, have fueled the fires of controversy, rather than settled the scientific debates.

Close-up photographs obtained by five Orbiter spacecraft have revealed flow features resembling lava flows on earth as well as craters of small- or intermediate-size with seemingly volcanic appearance. This has encouraged those who believe the lunar seas are volcanic in origin.

The five Surveyor craft that landed intact on the moon found its surface carpeted with particles of dust and sand-like material—the seas to a depth of several yards, the highlands to depths ranging from inches to tens of yards.

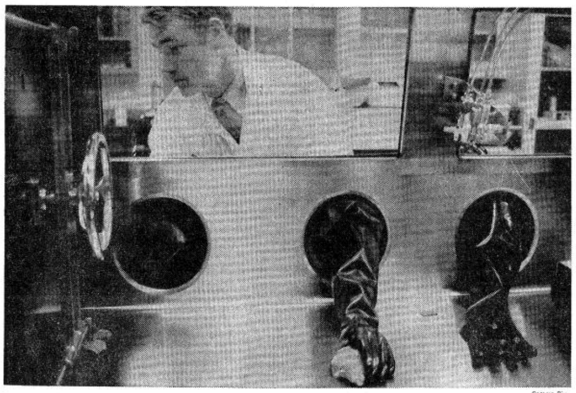
Radiation scanning indicated that the material carpeting the seas resembles basalt with a rather high iron content. Material at the one site scanned in the highlands appeared to be a low-iron basalt.

This was taken to show that there has been melting and the sorting out of light-weight and heavy materials at least near the surface of the moon. A review of the Surveyor results, published May 16 in Science by Dr. Leonard D. Jaffe, former Surveyor project scientist, said the moon's fine material "moves gradually downhill," which was good news to those who believe the seas were filled by such downhill transport.

The Orbiter photographs also showed that large numbers of "rilles"—snaking canyons—exist near the rims of circular seas on the moon. This has heartened those who believe ice exists beneath the surface whose melting could have generated ephemeral rivers.

An unexpected result of the Orbiter missions was the discovery that their flight was modified by chunks of heavy material beneath the large, circular seas. These "mascons" are obviously a by-product of the manner in which those seas were formed.

However, as with other lunar puzzles, there is no general agreement as to their meaning. Such agreement is unlikely until direct sampling and study of the moon has forced off the stage those theories that prove untenable.



Gamma-Pix

Lunar samples will be placed in a vacuum chamber at laboratory in Houston and quarantined up to 80 days for testing

Lunar Facts

Diameter: 2,160 miles (about ¼ that of earth).

Circumference: 6,790 miles (about ¼ that of earth).

Mass: 1/100th that of earth.

Weight: 81 billion billion tons.

Surface Gravity: 1/6th that of earth.

Magnetic Field Intensity: Less than 1/400th that of earth.

Density of Molecules in Atmosphere: Less than in most complete vacuum created on earth, but 500,000 times denser than in interstellar gas in the Milky Way.

Surface Temperature: 250 degrees (sun at zenith); minus 250 degrees (night).

Lunar Day and Night: 14 earth days each.

Average Distance From Earth: 238,857 miles.

Maximum Distance From Earth: 252,710 miles.

Minimum Distance From Earth: 221,643 miles.

Average Velocity in Orbit Around Earth: 2,287 miles per hour.

Period of Rotation About Earth: 27 days, 7 hours, 43 minutes.

What Has Space Taught Us So Far?

By HOMER E. NEWELL

THE Apollo astronauts heading for the moon and the many others supporting them on earth are drawing on the results and services of a wide variety of space activities besides those that are so visible on worldwide television.

Small scientific satellites and space probes circling the earth and the sun keep track of solar behavior and interplanetary conditions so that the mission directors may know about radiation hazards to the crew.

Weather satellites are used to monitor and predict weather conditions in both launching and recovery areas.

Dr. Newell is the associate administrator for space sciences and applications at NASA.

Communications satellites not only televise the mission to viewers all around the world, but also handle essential communications for mission operations.

Moreover, long before the first manned Apollo mission took off to circle the moon, last December, the unmanned Ranger and Lunar Orbiter spacecraft had photographed almost the entire lunar surface and given important information on the moon's field of gravity.

Surveyor spacecraft had landed at several spots, giving information on the moon's ability to sustain a landing through closeup photographs of the lunar terrain and surface material. Also with equipment operated from a quarter of a million miles away, Surveyor poked and prodded and dug and analyzed to measure the physical, magnetic and chemical properties of the lunar material.

All these data, important in the scientific study of our nearest neighbor in space, were put to use as fast as they were acquired. They were used in checking the Apollo design, in preparing maps of the lunar surface and selecting sites for manned landings, and in designing and planning the mission itself.

Hitherto NASA has launched 239 unmanned satellites and space probes. When the country was wrestling with the problems of creating a manned space flight capability these unmanned craft were acquiring exciting and important information about space and about our earth and its atmosphere.

Stemming from the sounding rocket work that began in the mid-1940's these unmanned spacecraft lie at the heart of our total national space capability. They permit man to extend his senses into unknown and hitherto inaccessible regions, and to blaze the trail for man himself into his new domain beyond the earth's atmosphere.

From sounding rockets and Explorer and Orbiting Observatory satellites we have learned a lot about the earth's upper atmosphere and ionosphere, and about how they vary with the sunspot cycle, becoming hotter and more intensely electrified at times of maximum sunspot activity.

One of the most exciting discoveries of space research has been the earth's magnetosphere, which occupies a huge cavity carved out of the solar wind by the earth's magnetic field.

The solar wind was also first observed by space-borne instruments. It consists of only a few particles per cubic centimeter, primarily electrons and hydrogen nuclei, with some helium nuclei, ejected into space by the sun.

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The wind sweeps by the earth at velocities of hundreds of kilometers per second. Being electrically charged, the solar wind particles are deflected by the earth's magnetic field, developing an immense shock wave that sweeps around the earth in much the same way that an aerodynamic shock wave accompanies a supersonic aircraft.

Within the magnetosphere itself are the trapped radiations that make up the Van Allen radiation belts, which were discovered by the first Explorer satellites.

It is now known that the magnetosphere is connected in various ways with the aurora, magnetic storms, magnetic fluctuations, disturbances in communications and even possibly with some weather anomalies.

Investigation of the magnetosphere is interwoven with studies of the earth's atmosphere, on the one hand, and of the interplanetary medium and solar activities on the other.

One of the most fascinating aspects of space research is our new ability not only to investigate the immediate space environment of the earth, but also to compare the results with similar investigations of the moon and other plantets.

Over the last decade, using Mariner space probes and ground-based studies, we have learned that Venus, which is almost a twin to the earth in size, has about a hundred times the amount of atmosphere that the earth does.

The Venus atmosphere consists mostly of carbon dioxide, with a little oxygen and water vapor. The surface temperature is about 800 degrees, well above the melting point of lead.

Venus, with a very slow rotation rate of 243 days around the sun in the opposite direction to that of the earth, has no appreciable magnetic field.

As a consequence Venus has no magnetosphere. The cavity created in the solar wind, being generated by the planet itself and its atmosphere, is therefore different in character from the earth's magnetosphere.

Thus sun-Venus relationships are decidedly different from sun-earth relationships, in which the magnetosphere plays a significant role.

Mars also has been observed by Mariner spacecraft. That planet, which is decidedly smaller than either the earth or Venus, also has no appreciable magnetic field, and hence no magnetosphere.

The Martian atmosphere is very thin, with a surface pressure about 1 per cent that of the earth's sea level atmosphere. Solar radiations create an ionosphere (region with charged particles that reflect or absorb radio waves) on Mars as they do on earth.

With no magnetosphere, and a very thin atmosphere, most of the effect of Mars on the solar wind is due to the planet body itself, although some effect comes from the thin atmosphere.

It is reasonable to suppose that the earth, Venus and Mars were all formed at about the same time. One may rightly wonder, then, why the three planets have such different atmospheres.

As one studies the problem, it begins to appear that planetary atmosphere might be quite fragile in the cosmic sense, and different influences may lead in the end to drastically different results.

It is certainly clear that life on earth has had a lot to do with the present state of our own atmosphere, which in turn has everything to do with maintaining life on earth.

If drastic changes can be brought about by relatively small influences, we most certainly want to pursue every avenue open to us to understand these matters, to avoid starting an irreversible chain of events leading to the destruction of life-supporting conditions on earth.

North America seen from a Nimbus weather satellite on an exceptionally clear day. Two photographs were transmitted to earth and then joined at center.

Experiments have shown that plants, insects and other biological material are importantly affected by conditions in space. Under weightlessness, radiation has markedly greater effects on some living matter than it does at the surface of the earth.

Further study will be needed to understand fully the meaning of these results. But most exciting of all is the approaching possibility of searching for life on other bodies of the solar system. Special preparations have been under way for many years to use equipment landed on Mars for this purpose.

We live beneath an atmosphere that blankets out most of the electromagnetic radiation that comes to us from the sun, stars and other galaxies. Instruments, including specially prepared telescopes, have been sent above the atmosphere first in sounding rockets and now in the Orbiting Astronomical Observatory, the most complex and intricate unmanned satellite yet launched to observe the universe in the hitherto hidden wave lengths.

Already the results are spectacular. The sounding rockets have disclosed X-ray sources over the sky which are yet to be explained.

The observatory measurements have shown some of the stars to be much brighter in the ultra-violet than had been supposed. One explanation of this may be that the universe is twice as large as it had been thought to be.

These unmanned space experiments give us an ever increasing knowledge of our space environment, a knowledge and understanding that we can put to use in numerous practical ways. What began as simple experimenting with earth photography, back in the 1940's, has now blossomed into operational meteorological satellites, which provide both daily pictures of the earth's cloud cover and infra-red observations. These data are used routinely in improving one-day to two-day weather forecasts.

Such weather pictures are provided for trans-Atlantic pilots. They have been used to save ships at sea by directing them out of the midst of storms into good weather conditions. They are used to help manage field operations in construction and agriculture. They have made possible more accurate hurricane and storm warnings.

It was recently shown that temperature profiles could be made of the earth atmosphere with satellite-borne instruments aboard the Nimbus 3, giving encouragement to those who foresee the day when a global meteorological satellite system will make long-range weather forecasting possible.

The Applications Technology Satellites in synchronous orbit have shown that it is possible to keep watch on the development of hurricanes, typhoons, thunderstorms, tornado weather, and the whole range of weather conditions.

The importance of this capability to improve weather forecasting is inestimable, but the ultimate value to agriculture, transportation, commerce, construction, and other fields has been put at billions of dollars annually.

Intelsat communications satellites in synchronous earth orbit now provide point-to-point communications services from continent to continent.

With observations made on a variety of the artificial satellites that have been put into orbit, scientists have been able to improve our knowledge of the earth's gravitational field by many orders of magnitude.

It has been possible to greatly improve the accuracy of positioning on the earth's surface, so that now the distance between continents is known to within approximately 25 meters.

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With photographs taken from space it is possible to see in a broad perspective that is not achievable from the ground or from aircraft, glaciers, snow fields, total watersheds, geological provinces, ocean situations, forests, agricultural activities; and even the growth and development of cities and their land use.

The long list of scientific and practical results from our nation's space program is impressive. These are all tangible returns in which we can take both satisfaction and pride. But in the long run they may well not be the most important result. When taken together the achievements of the unmanned and manned space efforts represent a clear capability to undertake and accomplish very complicated and challenging goals.

They give to the nation not only a feeling of self-respect, but also an awareness of what it can accomplish.

They constitute, therefore, a steady challenge to tackle and solve those vexing problems of the cities, our environment, food, and transportation, and others, that the nation, and indeed the world, face.

They constitute not only such a challege, but also a reassurance that such problems must and can be solved.

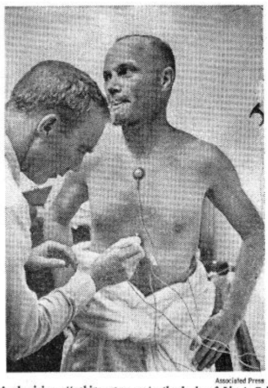
Man Proving to Be Adaptable Space Traveler

By CHARLES A. BERRY

AS we stand on the threshold of the first manned lunar landing, it is difficult to recreate the atmosphere of concern that existed a scant 10 years ago about man's ability to penetrate space even for a 15-minute flight. Members of the President's Scientific Advisory Committee seriously wondered whether man could survive a rocket launching and a brief flight above the earth's atmosphere and back.

I have always been an optimist in the field of aerospace medicine. I have been particularly optimistic about man's ability to adapt to new environments. And I am personally convinced, from physiological findings on astronauts exposed to space, that man makes a "downhill" or relatively effortless adaptation to this new environment.

Dr. Berry is director of medical research and operations at NASA's Manned Spacecraft Center, Houston.



Associated Press

A physician attaching sensors to the body of Lieut. Col. John H. Glenn Jr. to monitor the effects of space flight on the astronaut, the first American to orbit earth. Much has been learned since that mission, flown Feb. 20, 1962.

What makes this possible is the fact that weightlessness reduces the total demands on him. His heart need not pump as hard to circulate his blood. His reflexes are not called upon to help pump blood back to the heart against the force of gravity.

The trouble comes, of course, when he returns to the earth's gravity and, having adapted easily to space, must readapt, not so easily, to the environment he grew up in.

Historically, man has summoned the courage and drive to explore the unknown, whether he has had medical support or not. However, proper medical support can make such ventures more feasible, easier and safer.

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I feel that supporting man on his current assault on the lunar frontier has brought the practice of aerospace medicine to a new peak.

There are no textbooks for guidance. Human responses have been observed for the first time as Apollo missions moved toward the program's goal.

Our present medical confidence about a lunar landing was achieved by exposing astronauts to the space environment for as long as 14 days. This span—six days longer than is required for a lunar round-trip — was accomplished in the Gemini missions.

Our first experience in manned space flight, though, was on Project Mercury. Prior to the first flight, dire predictions had been made about the possible effects on almost every body system. Questions arose about man's ability, when weightless in space, to swallow, defecate, urinate and perform other functions.

We quickly learned with Mercury that man could survive the rigors of launching and re-entry, and function more than adequately.

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The first significant effect of weightlessness to be experienced was a deterioration in the condition of heart and blood vessels. The medical term is cardiovascular deconditioning. It showed up as a drop in blood pressure and an increase in heart rate when an astronaut got up on his feet after returning to the earth's one-G environment.

There was one occasion when the astronaut (Gordon Cooper) almost fainted shortly after emerging from his capsule on the aircraft carrier deck.

Warnings that body functions would deteriorate again were voiced as we approached the four, eight, and 14-day flights of Project Gemini. A number of competent people felt that, when flights were stretched to four days, the crew would lose consciousness during re-entry into the earth's atmosphere or on assuming upright positions following the landing.

I always thought that these predicted effects were "straw men." But proof was needed to build up our confidence.

One of my most valued treasures, hanging in my den at home, is a large photo of Jim McDivitt and Ed White on the carrier deck after their four-day mission. It is inscribed this way: "To Chuck Berry—the day the 'straw men' fell down"—Gemini IV—7 June '65."

The eight- and 14-day flights added to this confidence.

During the Gemini exposures to space, we did note moderate cardiovascular deconditioning. It was evident in increased heart rate and a drop in blood pressure when an astronaut was subjected to stress like that produced on a tilt table. We also noted moderate loss of exercise capacity, which we measured on a bicycle ergometer.

The readings returned to normal preflight levels within 50 hours after a flight as the astronaut's body readapted to one-G conditions. In addition, a loss of bone density was noted in the heel and hand, and there was a very minor loss of muscle nitrogen.

During these missions, the astronauts occasionally had difficulty sleeping. There were two big surprises. One was the moderate loss of red-blood-cell mass. The other was the high expenditure of energy during extra-vehicular activity.

We entered the Apollo program with this legacy from Gemini and a need to confirm or deny whether the data would be the same for astronauts launched in Apollo craft. Many of these phenomena could have an adverse effect on crewmen at the time they ventured out onto the lunar surface.

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However, I felt that the larger volume of the Apollo spacecraft, by permitting crewmen to exercise more and move about freely, would probably reduce the cardiovascular effects and the falloff in exercise capacity.

The four manned Apollo flights to date have produced more man-hours of exposure than all those logged in the Mercury and Gemini programs—2,514 vs. 1,993 hours—and much information of medical importance for the lunar landings has been gathered.

Apollo 7 gave us our first experience with in-flight illness. All three crewmen developed a common cold. This experience confirmed our expectation that sinus and post-nasal drainage would not normally occur in space because of the absence of gravity.

The prospect of having to care for an ill crew at lunar distances caused some revamping of the contents of the spacecraft medical kit. Additional decongestants were provided, and the amount of medication was increased to allow for treatment of three crewmen for a period of at least three days.

On Apollo 7, 8 and 9, illness was observed before, during and after the flights. Indeed, one of the more painful decisions I have had to make was delaying the Apollo 9 launching for a three-day period because all three crewmen had upper respiratory infections.

The length of missions is such that a crewman may develop an illness, during or after flight, to which he has been exposed in the immediate preflight period. For this reason, a preventive medicine program has been outlined requiring some control of crew exposure for a 21-day period before launching.

It is impossible to isolate a crew totally and have them ready to fly a mission. There are activities that require them to be in contact with other project personnel during the immediate pre-flight period. But controls have been instituted to reduce the number of persons to whom they are exposed, and to check the health of those persons.

These controls have been even more important on the lunar-landing mission because of the planned post-flight quarantine and the possibility of developing symptoms during this period.

Any illness the crew develops after leaving the lunar surface must, if this is humanly possible, be proved to have originated on earth rather than the moon. It will be a difficult task, medically, and could very well extend the period of quarantine.

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The Apollo 10 crew had no immediate preflight illness, though two crewmen did have an influenza strain, known as influenza B, shortly before the 21-day preflight control period. They had no illness during or immediately after the flight.

There appear to have been two main reasons why their health proved better than the health of earlier Apollo crews. They were launched at a time when viral disease was less prevalent than it often is (in the winter particularly). Their resistance was high because they were able to get adequate rest and relaxation during the immediate preflight period.

Motion sickness has been another area of concern. Before the first of our space flights, it was widely predicted that astronauts would experience vestibular, or inner-ear, difficulties that could lead to motion sickness.

And our concern grew after the Russian experience with Gherman Titov and some of the other cosmonauts. As matters turned out, we encountered no evidence of vestibular disturbances in our manned space flight programs until Apollo.

The problem turned up for the first time on Apollo 8 and continued on Apollo 9.

Five of the six crewmen on the two flights (all but Jim McDivitt) developed symptoms, apparently the result of head and body movements. The symptoms ranged from mild stomach queasiness to frank nausea and vomiting. Duration varied from two hours to five days. Illusions of tumbling were experienced by two astronauts.

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In all cases, the crewmen eventually adapted and the symptoms disappeared, allowing them to move freely both inside and outside the spacecraft.

Three body systems help us determine our position in space. Vision is the dominant one. Next, there are three semi-circular canals in each ear, which tell us of motion in any of the three planes. Finally, there is the otolith, an inner-ear organ that, by sensing the gravity pressure of tiny granules on hair cells, tells us what is up and what is down.

Another function of the otolith is to filter inputs from the semi-circular canals to the area of the nervous system that stimulates nausea.

Absence of motion sickness on Mercury and Gemini flights was due to two things: the astronauts' experience as test pilots made them less susceptible, and they were restrained on their capsule couches.

But in the Apollo capsule, there is a lot more room, and the astronauts can move about freely. This results in increased head and body movements and greater inputs to the nausea-producing areas—inputs that are not filtered because the otolith, being sensitive to gravity, is inactive in the weightless conditions of space.

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Experience in the Navy's slow-rotation room at Pensacola has shown it is possible to increase the rate of adaptation by doing a series of planned head movements. We gathered very limited data on effectiveness of such measures on an actual flight —Apollo 10—and are still evaluating the results.

This is a problem that still concerns us, one that may limit crew functioning unless medication is taken until they adapt.

Data on deterioration of heart and blood-vessel condition have been about the same on Apollo flights as on Gemini. This leads me to the conclusion that weightlessness is more a factor in producing this deconditioning than is confinement.

The red-blood-cell mass was studied on three Apollo flights. Contrary to the 20 per cent loss experienced on the eight- and 14-day Gemini flights, an insignificant loss was noted on the first two Apollo flights.

It is important to remember that, while Gemini craft had an atmosphere of 100 per cent oxygen at 5 psi (pounds per square inch), the Apollo craft have been launched with an atmosphere of 60 per cent oxygen and 40 per cent nitrogen. Replacement of leaked atmosphere never brought the cabins above 95 per cent oxygen.

On Apollo 9, however, the crew modules were decompressed to vacuums at the time of extra-vehicular activity and then recompressed with 100 per cent oxygen from the on-board supply.

Thus, the crew was exposed to 100 per cent oxygen at 5 psi for the last seven days of flight, and we again noticed a significant loss in red cell mass.

This leads to the conclusion that 100 per cent oxygen causes the red-cell-mass loss and that a very small amount of nitrogen affords protection against such loss.

The question then arises whether nitrogen is truly inert, physiologically, or whether it plays some active role. At any rate, we do not expect any loss in red cell mass before two Apollo 11 crewmen set foot on the moon. So we need not be concerned with any effect of such loss on their ability to do work on the lunar surface.

Since our experience with high loss of energy on excursions outside Gemini capsules, we have been worried about man's ability to operate efficiently on the moon. We must avoid producing heat loads exceeding the cooling capacity of the back pack and must make sure astronauts on the moon do not get overtired.

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Through preflight measurements on each Apollo 11 crewman, we can equate a given heart rate to metabolic output. We have good figures on the metabolic cost of each planned activity on the lunar surface.

Another problem that has concerned us has been that of work-rest cycles. It is hard to program flight activity so that sleep periods will coincide with those on earth, and the crewman's day-night cycle not be disturbed.

I am particularly concerned about the crew's getting adequate rest before stepping out on the moon. The excitement of the mission will obviously make it difficult to sleep in lunar orbit or shortly after the landing.

We have been testing various drugs to see how much help they may be in providing adequate rest. In the case of sleep-inducing drugs, we must check not only the astronauts sensitivity but also their ability to perform efficiently at specified intervals after awakening. This is vitally important to the safety of the mission.

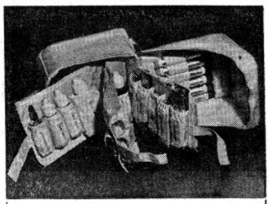
So - called "habitability" items necessary to sustain man in space or anywhere else seem to have been given least attention. They have occasionally caused crew dissatisfaction on Apollo flights. None of the problems has appeared likely, so far, to bar a successful lunar landing. But they are irritants, and significant improvements must be worked out for long-duration space flights.

•

Management systems for both liquid and solid wastes are of very questionable acceptability, from an esthetic point of view. They serve the purpose but are rather primitive. Questions concerning these human functions are the ones most frequently asked me by heads of state or people on the street.

The greatest problem with food in space comes from the necessity to package it for use in the weightless environment and the long time needed therefore to prepare it for eating. Our efforts have been directed at trying to provide more normal types of food.

The provision of safe drinking water has continued to be a rather difficult problem for us in the Apollo spacecraft. This is because of the cross connection between waste water and drinking water systems, required to allow transfer of drinking water to the water-boiler system in case that is necessary for increased cooling. To protect against migration of bacteria past cross-connection valves, it has been necessary to treat water bacteriologically in both the command and lunar modules. This has been effective so far. There has been no illness that could be attributed to the water supply, and we expect none.



Apollo 11
Medical Kit Contents

Injector-Pain, Demerol 100 mgs	3
Injector-Motion Sickness, Marezine 45 mgs	3
Capsule-Pain, Darvon Compound	18
Tablet-Stimulant, Dexedrine 5 mgs	12
Capsules-Motion Sickness, Scopolamine 0.3 Mg/5 mg Dexedrine	12
Tablet-Diarrhea, Lomotil 2.5 mgs with .025 Atropine	24
Tablet-Decongestant, Actifed	60
Tablet-Analgesic, Aspirin	72
Capsules-Antibiotic, Ampicillin 250 mgs	60
Capsules-Sleep, Seconal 100 mgs	21
Tablet-Defoaming, Mylicon 40 mgs	40
Liquid-Nasal Emollient, Ponaris	1
Spray-Nasal, Afrin	3
Ointment-Antibiotic, Neosporin	1
Cream-Skin, J&J First Aid Cream	1
Bandage Compress	2
Band Aids	12
Drops-Eye, Methylcellulose	2
Oral Thermometer	1
Cuffs Urine Device	6
pH Paper Roll	1
Sternal Electrode Harness	3
Auxiliary Electrode Harness	1
Electrode Paste	1

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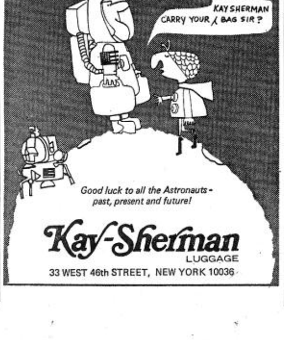

Good luck to all the Astronauts - past, present and future!

Kay-Sherman
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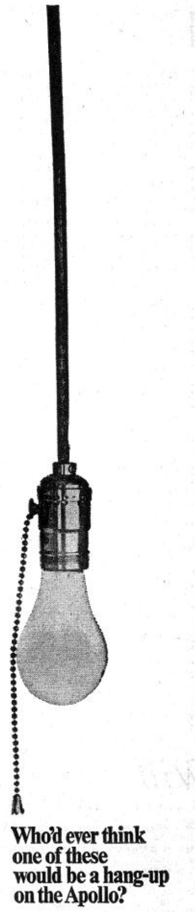

Who'd ever think one of these would be a hang-up on the Apollo?

Well, it was. The modern answer for lighting the astronauts' cabin should always have been fluorescents. But standard fluorescents use extra circuitry and generate noise that interferes with radios. So the early space capsules used bulky hot-to-the touch incandescents.

The answer to that problem was a DC fluorescent light bright enough even for the TV cameras, but cool to the touch. A lightweight light that can be dimmed to almost nothing. And that answer came from Microdot.

Microdot?

That's right. Not one of the giant light fixture manufacturers, but a highly flexible organization of unique problem solvers. In this instance, we borrowed an idea from one of our commercial designs: a low voltage DC fluorescent light for automobiles, trailers, boats, and airplanes. In many other cases, we've solved problems by adapting aerospace developments to commercial applications. We don't really care, so long as we solve the problem.

And the Apollo program is excellent testimony to that unique ability. The hookups for communications and biomedical readings on the astronauts' suits are made with our high density microminiature connectors. Other Microdot connectors do a job in the airborne computer, the main capsule, the Lunar Module, the inertial measurement navigating system, and the guidance system.

Does that make Microdot a space technology company? No more so than $40 million in automotive product sales last year made us an automotive firm. Because classifying us in either category would overlook a revolutionary new industrial material handling system and some exciting new developments in metallurgy.

So please don't fence us in. And don't just mutter the word "diversified" as a substitute for real understanding. Because a closer look will reveal a pattern, a definite plan, a strong management philosophy that have made us what we are today. And the fact that we've been growing at a yearly average of thirty percent over the last decade makes us worth a closer look. For our latest annual report and other illuminating information, write to the Corporate Communications Department, 1901 Avenue of the Stars, Los Angeles, California 90067.

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WHAT NEXT?

Head of NASA Has a New Vision of 1984

By THOMAS O. PAINE

WHILE Orwell's old foreboding of a static, monolithic society still haunts us, the lunar voyage of Apollo 11 could open for mankind a dramatic new vision for 1984.

Man can now navigate the new ocean of space; he may soon make his first landfall on the nearest of an infinity of new worlds. As in early America, human settlements

Dr. Paine, formerly head of the General Electric "think tank" called TEMPO, is the administrator of NASA.

on these new worlds in space can reopen the way to a pluralistic humanity.

Mankind can avoid the genetic and intellectual horror of Orwell's dead-end society. Man's destiny can now and forever remain diverse and open-ended.

But isn't the prospect of life on other worlds just science-fiction? No! Man will settle other worlds.

Although space-agency engineers haven't yet put their computers to work on the detailed designs and calculations, it appears likely that by 1984 a round-trip, economy-class rocket-plane flight to a comfortably appointed orbiting space station can be brought down to a cost of several thousand dollars.

•

Further, a deep-space nuclear rocket shuttle between the earth and lunar orbiting space stations promises to bring the eventual cost of earth-moon flights down to the $10,000 price range.

This goal offers formidable technical challenges to our engineers, but no greater than the challenges of the Saturn 5-Apollo system that they designed and built to carry the first men to the moon in the nineteen-sixties.

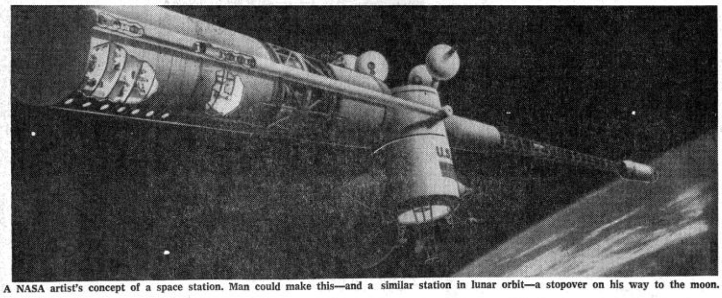
To attain this goal the safety, reliability, and cost standards of current jet aircraft will have to be achieved in spacecraft by 1984. But given adequate resources, NASA, teamed with American industry and universities, can do the job.

Granting practicality and economical travel costs, will men want to go to the moon? Yes! Exploration and scientific understanding are the primary motivations for the 10 currently scheduled Apollo moon flights.

The first 30 astronauts, and the young scientists who follow them, will unravel secrets of the origin and evolution of the solar system that led to the origin of life.

Useful lunar resources for future recovery and utilization will be sought: water, oxygen, contruction materials, nickel, iron, copper, uranium and other metals.

The year 1984 should see a permanent lunar orbiting space station passing over each point on the moon every 14 days, and the establishment of an initial lunar surface base.



A NASA artist's concept of a space station. Man could make this—and a similar station in lunar orbit—a stopover on his way to the moon.

Astronauts there will take advantage of the lack of an obscuring atmosphere and the moon's low gravity to study radio, optical, X-ray, and high-energy particle astronomy with a 240,000-mile base line back to terrestrial observatories.

Solar and nuclear power stations will provide and reprocess air, water, light, heat, and food, although the base will be far from self-sustaining, and the accommodations will be Spartan.

Much depends on the discovery of usable resources on the moon, which cannot yet be predicted with confidence. We will be prospecting an entire new world, however, equal in real estate area to the Western Hemisphere; it will be surprising if the required discoveries are not forthcoming.

Over the years, lunar surface bases will evolve into increasingly self-sustaining communities as modern technology powered by solar and nuclear energy finds ways to process lunar resources into the materials and structures required to build, support, and grow the small communities into domed cities.

Construction of large domes will be facilitated by the absence of external pressure and the moon's low gravity, in which structures weigh only one-sixth of their earthly weight.

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The moon is a fascinating new world on which to construct a new human society. People there have in effect six times their earthly strength, opening up entirely new kinds of activity (including winged athletes and dancers flying with their own muscle power).

The 14-day-long nights will reveal the heavens with a brilliance and clarity never known on earth, while our blue planet waxes and wanes overhead. The 14-day-long days will be characterized by cloudless landscapes of a stark and jagged beauty even beyond that of the American Southwest.

Although wresting a living from the moon will pose many new and difficult problems for lunar society, great new human energies will be released and a number of old earthly problems will be left happily behind.

Continuing fratricidal wars and the nuclear balance of terror will be a welcome quarter of a million miles distant together with germ warfare experiments, atmospheric pollution, insecticides, epidemics, urban slums, and other earthly ills.

As with the American experience of 1776, founding a new society in a demanding environment will sweep aside old world dogmas, prejudices, outworn traditions, and oppressive ideologies.

A modern frontier brotherhood will develop as the new society works together to tame its undeveloped planet for posterity. Advances in extraterrestrial societies will surely be reflected back on earth.

The true significance of Apollo 11 in the long sweep of history is thus likely to be its demonstration that man can open new worlds, where eventually exciting new extraterrestrial societies will be founded.

No longer must all of humanity's hopes and fears reside on our shrinking home planet earth. Future terrestrial and extraterrestrial societies will surely develop on diverging cultural trajectories.

By 1984, the first men will also have landed on Mars, opening another opportunity for mankind to evolve pluralistically.

Orwell's 1984 may still haunt us but continuing advances in space transportation offer man new alternatives for free societies comfortably situated with respect to each other.

In each and all of these there will be new opportunities for men to work together in peace and brotherhood to win bright new worlds for our descendants.

Thus the specter of a monolithic imperium over all mankind may well be receding by 1984, if America has the vision and determination now to press forward in Apollo 11's fiery wake.

Will Advent of Man Awaken a Sleeping Moon?

By ARTHUR C. CLARKE

FOR thousands of years the moon has signified many things to mankind; a goddess, a beacon in the night sky, a celestial body, an inspiration to lovers, a danger to beleaguered cities, a symbol of inaccessibility—and finally, a goal.

In only 10 years, this last image has become dominant, but the change has occurred with such explosive speed that most of the world has

Mr. Clarke is a scientist, technologist, modern-day prophet and a prolific writer on science and of science fiction. He is the author of many books and, with Stanley Kubrick, wrote the film "2001, A Space Odyssey."

not yet made the necessary emotional and mental adjustments. The stunning impact of the first close-up photographs still seems only yesterday; last Christmas, the crew of Apollo 8 swept over the far side of the moon and sent greetings back to earth, 240,000 miles distant. Now, even before the wonder of that event has abated, we are preparing to land.

There may be setbacks—perhaps even disasters—in the years ahead; it is unreasonable to suppose that the conquest of a new and strange environment will not demand its toll. But men have never hesitated to pay the price, in blood as well as treasure, of exploration and discovery. Nor will they hesitate now, as they stand, for the second time in a thousand years, on the frontiers of a new world.

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Like all human achievements, travel to the moon will pass through three phases: impossible, difficult, easy. The parallel with the development of commercial aviation will be close, though the time scale may be longer because the challenge is so much greater. But it is naive to imagine that lunar flight must always be an enormously expensive operation and that astronauts will always be highly trained pilots, scientists, or engineers.

If you run your car for a day, the engine does enough work to take you to the moon; the actual cost of the energy involved for the trip is only about $10. The fact that the present cost is millions of times greater is the measure of our present ignorance and the primitive state of space technology; the time will come, through the use of reusable boosters, orbital refueling, nuclear propulsion and other foreseeable developments, when the cost of a lunar journey may be comparable to that of round-the-world jet flight today.

It is obviously impossible, on the eve of the lunar landing, to predict in detail just what we shall do with an Africa-sized world, the resources of which are still almost entirely unknown. However, the moon provides such tremendous opportunities for so many types of research that every effort will be made to establish temporary bases there as soon as possible, analogous to those already set up in the Antarctic and those that may be established on the seabed.

Beyond the immediate deployment of small instrument packages that is planned on the Apollo missions, we may eventually expect physics laboratories and astronomical observatories. At first, they will be remote-controlled and visited from time to time by servicing crews; later, they will be permanently manned.

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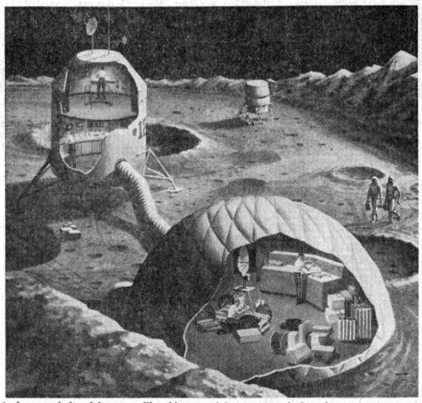
The moon might have been designed as the ideal site for an astronomical observatory. Its almost total absence of atmosphere means that seeing conditions are always perfect, not only in visible light, but also in the vitally important ultraviolet, X-ray and gamma-ray regions of the spectrum, which are totally blocked by the earth's atmosphere. The low gravity and absence of wind forces will also greatly simplify the design of large instruments; and the slow rotation means that objects can be kept under continuous observation for two weeks at a time.

These advantages, great though they may be for the optical astronomer, will be even more overwhelming for the radio observer, who can also find another bonus on the moon. At the center of the far side, he will be permanently shielded from all the electrical noise and interference of civilization by 2,000 miles of solid rock. A hundred years from now optical and radio astronomers will find it hard to believe that serious observing was ever possible on earth.

To the geologist, the moon represents a bonanza of more value than all the gold mines ever found. Until now, he has had a single example of a planet to study. How much would a biologist know of life, if he had been allowed to examine only one specimen of our planet's teeming flora and fauna?



A six-man shelter laboratory like this one might support missions for up to six months

The evolution and geological history of the moon may be wildly different from that of the earth; we are not even sure whether the two bodies were once combined or whether the moon had an independent origin and was later captured. One recent theory suggests that it is a residual 'drop,' a sort of umbilical fragment left over when the earth and Mars split asunder from an ancient protoplanet.

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Whatever the facts, we can be sure that the moon will provide many exciting and valuable surprises. Indeed, it has already done so. In the astronomy books of only a decade ago, it was described as a dead, unchanged world. Now we know that there is a good deal of activity there. Orbiter photographs have shown the tracks of rolling rocks, startlingly like footprints, down (and sometimes up) the lunar slopes. There is evidence of immense lava flows, and even what looks like dried-up river valleys. If this is the case, water may still be there, locked in permafrost a few meters underground, where the temperature is constant and far below the freezing point.

The discovery of easily available water or ice would be of the greatest importance to lunar explorers. Electrolyzed, it would provide both oxygen for breathing purposes and fuel for returning spacecraft. Obviously, this last development would not be possible until large-scale engineering operations could be carried out on the moon. This is not likely for some decades, but eventually it will completely transform the economics of space flight. For a remote comparison, imagine that today's trans-Atlantic aircraft had to carry the fuel they needed for the round trip. The cost of a ticket would be reduced by a factor of perhaps a hundred as soon as it became possible to refuel in Europe. So it will be with lunar operations.

After air and water, the third immediate necessity of life is food. Many plans have been drawn up for growing totally enclosed, or hydroponic, crops on the moon, using the materials that may be found there. This idea looks particularly promising, now that the Luna and Surveyor spacecraft, in close-up views of the lunar surface, have revealed that it is neither rock nor dust, but nice, crumbly dirt.

Some years ago I suggested that it might be possible to develop plants resembling earth's with tough, impermeable skins that could grow unprotected on the lunar surface and I am delighted to discover that the National Aeronautics and Space Administration now has a project investigating this idea. Perhaps a transparent plastic sheet may be necessary to minimize the escape of water vapor; but it is at least conceivable that we may start farming on the moon without having to build pressure domes and hermetically sealed greenhouses.

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The lunar vacuum, so valuable to the astronomers, may turn out to be a much exaggerated hazard to the explorers. The old myth that a man exposed to the vacuum of space will blow up like a deep-sea fish still dies hard; hopefully, the movie "2001: A Space Odyssey," may have spread the news that this is simply not true. Obviously, an unprotected man in space will die from lack of oxygen, but this takes an appreciable time. Animals have survived up to four minutes in a vacuum, and anything an animal can do, a trained and prepared man can do better. There will be many emergencies, in space and on the moon, where the 10 or 15 seconds of consciousness that a man can expect in vacuum will make the difference between life and death.

Whether the moon has any indigenous life of its own is a question that may be answered shortly. No one expects to find higher organisms, but microscopic forms of life are a remote possibility. Hence the elaborate precautions of the Lunar Receiving Laboratory, which is intended to establish a quarantine in both directions.

Even if the moon is sterile, it may be avid for life. Those terrestrial bacteria that have managed to thrive in boiling sulphur springs or at the bottom of oil wells should find the moon a delightfully benign environment, with consequences that may be annoying to future scientists.

It has been estimated that the combustion products and cabin leakage from only 20 landings of the Apollo type could double the mass of the very tenuous lunar atmosphere. When mining, food-production and similar activities begin, the rate of contamination will be much increased and though it may seem early to worry about lunar smog, it could be a matter of great concern to the physicists.

•

At the moment, the moon's surface provides a vacuum laboratory of unlimited extent. It would be the ideal place for many types of electronic and nuclear experiments. One can even imagine that the great particle accelerators of the future will be wrapped around the moon, so that the vacuum will be provided automatically, and there will be no need for today's elaborate enclosures and pumps.

This sort of experimenting, which may well revolutionize the many branches of physics concerned with vacuum phenomena, may be possible only in the early stages of lunar occupation. For sooner or later, as industry, commerce and tourism spread across the face of the moon, it will begin to acquire an atmosphere of its own.

And if it turns out, as some have suggested, that the expectation of life is considerably increased in low gravitational fields, there will be a move to give the entire moon a breathable atmosphere, probably by using biological systems to unlock the immense amounts of oxygen (probably about 50 per cent by weight) bound up in the crust. The astronomers and physicists will have to move elsewhere in search of ideal conditions, just as on the surface of this planet they have had to retreat from the lights of the cities.

And a century or so after that, as I gloomily predicted in "The Promise of Space," there will be committees of earnest citizens desperately trying to preserve the last vestiges of the lunar wilderness.

Beautiful.

Congratulations and best wishes for a safe and successful mission from everyone at Rosenthal.

(We have a re-entry of our own to look forward to—Studio Haus in New York will re-open soon at 584 Fifth Avenue. Beautiful.)

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THE LONGEST JOURNEY BEGINS WITH A SINGLE STEP

The step is, of course, the one that will be taken by astronaut Neil Armstrong when—early Monday morning—he becomes the first man to set foot on the moon.

In one sense, Armstrong's step will be the climax of an astounding procession of preliminary adventures in space. Yet the nearly incredible event we'll be watching Monday morning will be more of a beginning than an ending.

For who would now doubt that there are longer—much longer—journeys ahead? Or that one day this trip to the moon may take on the quaintness which now surrounds the Wright Brothers' 40-yard flight made less than 66 years ago?

And today the thrill of discovery is no longer the exclusive province of the explorer. Through television, and the far-flung operations of the networks' news divisions, millions upon millions of spectators will be experiencing the exultation of astronaut Armstrong's first step onto a never-never land. And all those other first-steps in the wondrous journeys that lie ahead.

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