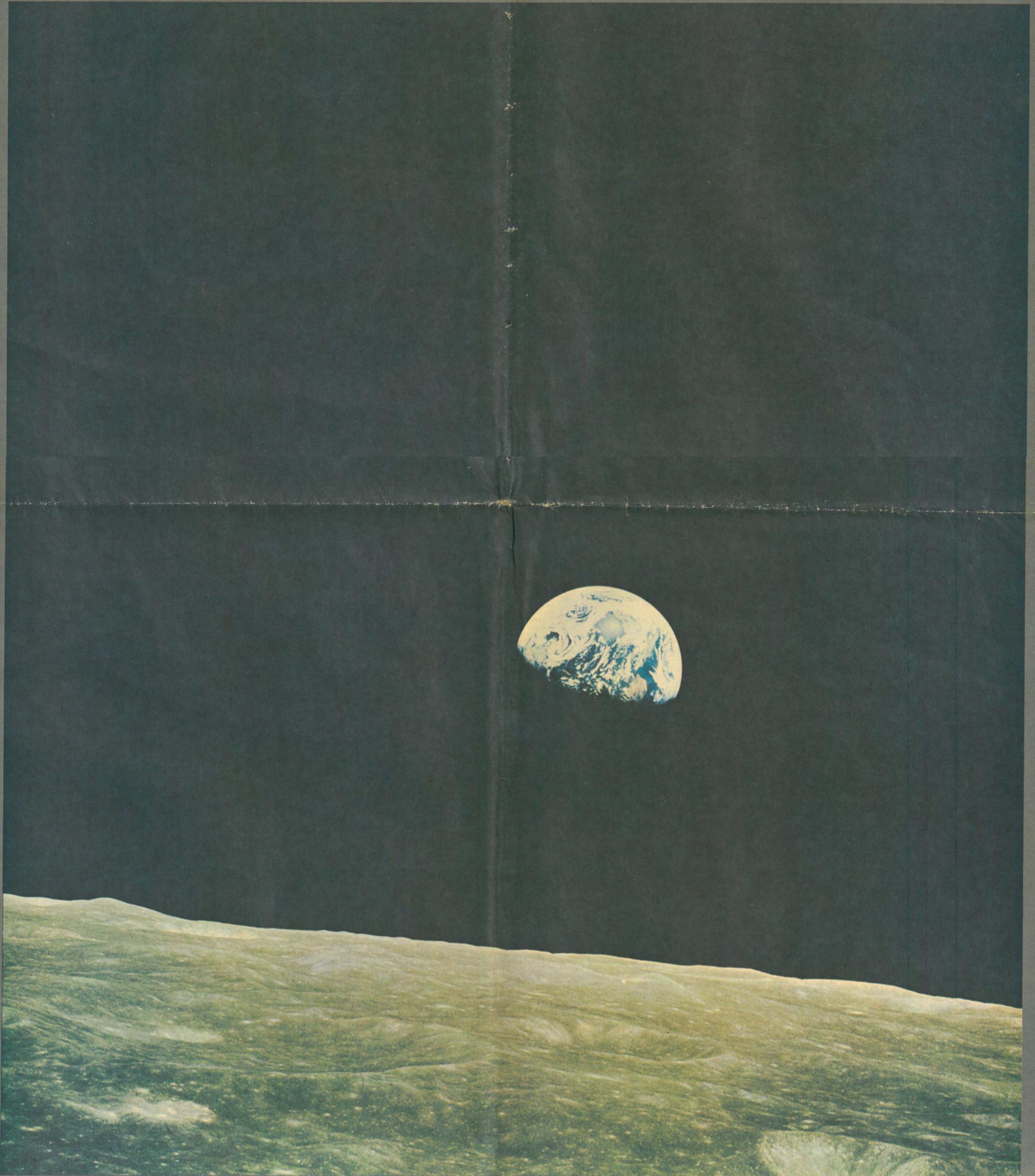


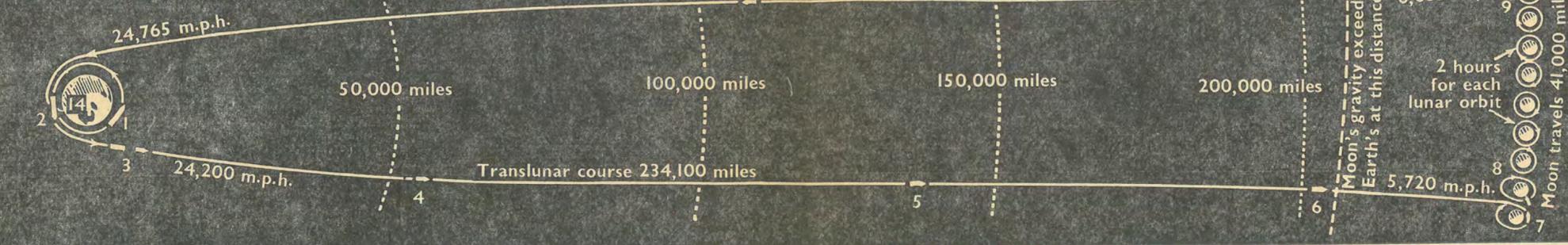
## The colour of space

Earth photographed by man from over the moon. "Then felt I like some watcher of the skies when a new planet swims into his ken . . ."



# JOURNEY OF APOLLO 8

590,000 miles in 147 hours shown at true Earth-Moon scale



1. Dec. 21—1.51 p.m. B.S.T.: Saturn 5 lift-off from Cape Kennedy into earth orbit. 2. 4.41 p.m.: Saturn's third stage fires Apollo on translunar course. 3. 5.12 p.m.: Third stage separates and goes into orbit around sun. 4. Dec. 22—00.51 a.m.: First mid-course correction by service propulsion system (SPS) engine. 5. 9.01 p.m.: First TV broadcast. 6. Dec. 23—8.58 p.m.: Second TV broadcast. 7. Dec. 24—10.59 a.m.: SPS engine sends Apollo into lunar orbit. 8. 1.29 p.m.: TV broadcast from lunar orbit. 9. Dec. 25—03.31 a.m.: TV broadcast from lunar orbit. 10. 7.10 a.m.: SPS engine sends Apollo on return journey to earth. 11. 9.51 p.m.: Only mid-course correction on return trip. 12. 10.15 p.m.: Fifth TV broadcast. 13. Dec. 26—9.51 p.m.: Final TV broadcast. 14. Dec. 27—4.51 p.m., Splashdown.

## How they went to look at the far side of the moon

They came back. The men who went on history's most hazardous journey, some half a million miles through space to look at the far side of the moon, dropped safely back into the Pacific on December 27.

They had seen what man had never seen before. They left the pull of the earth and soared out into the universe in their tiny, cramped craft. They circled the moon 10 times and turned for home.

Roaring down through the atmosphere at nearly 25,000 m.p.h., their capsule streaming a fiery white tail 100 miles long, they returned from man's first great journey into space to their "good earth". They smiled, posed for photographs, and thanked the thousands of people who made his possible.

They knew the risks: there was one-in-four chance of failure, and a one-in-10 chance of death, according to some experts before the flight of Apollo 8. But, on November 12, Dr. Thomas Paine, acting director of the National Aeronautics and Space Administration (Nasa), announced the "Christmas round-the-moon" trip.

The astronauts, Colonel Frank Borman, Captain James Lovell, and Major William Anders, were eager to proceed, Nasa said. Our engineers unanimously commend the mission, and, without being over confident, we believe that we understand the hazards involved and are now ready to take this next step forward in the nation's space programme.

The hazards were great. No man had ever left the earth's gravitational field before. A rocket failure as the craft entered lunar orbit could cause a crash on the moon's surface. A failure coming out of orbit could mean perpetual circling of the moon. On reaching the earth's atmosphere, Apollo 8 had to come in through a seven-mile-wide "window". Otherwise it would overshoot the earth or burn up.

All the hazards were overcome, and the flight was as copybook as any previous American effort. It was, Dr. Paine said afterwards, "something for all mankind. Man has started his drive out into the universe".

The drive had started 147 hours before the splashdown on Pad 39 at Cape Kennedy. At 7.51 a.m. Eastern Standard Time—1.51 p.m. in Britain—the 363ft. high Saturn 5 rocket belched vivid flame on the launching pad as the five engines produced a combined thrust of 7,500,000lb. Six-tenths of a second behind schedule, the 2,750-ton vehicle began lifting off smoothly to push Apollo 8 on its way.

The three men, strapped in the 12ft. command module on top of the rocket, reported a smooth lift off. Picking up speed as it turned slightly to the south-east the rocket soared out over the Atlantic, leaving a 500ft. long tail of fire.

Ground control told the crew: "You're looking good." At an altitude of 100 miles, having dropped the first and second stages, the rocket turned into its temporary 113 to 118-mile orbit around the earth.

Two hours and 39 minutes into the launch, Houston gave the order: "You are to go for T.L.I.—Translunar Injection. Over the Pacific the third stage burned for five-and-a-half minutes to raise the speed from 17,500 m.p.h. to 24,200 m.p.h. and swing the spaceship out towards the moon. The third stage was jettisoned, and the Apollo mission was heading "right down the centre-line" on its Christmas journey.

Looking through Apollo's window, Colonel Borman reported: "I can see at the same time Florida, Africa, Gibraltar, Cuba, Central America all the way down to Argentina and Chile." From farther out than man had ever gone, he said the earth looked simply like a disc—the round window I'm looking through seems bigger than the earth.

Five hours and 19 minutes out, and 19,000 miles from home, Apollo began to slow down as the earth's gradually weakening pull held the spaceship back. Twenty-eight hours out, Colonel Borman told mission control that he had been suffering from diarrhoea, vomiting chills and a fever, and Major Anders was "not at his best".

There were fears that the astronauts might have Asian flu, then sweeping America. But they took Lomolol to cure diarrhoea, and Marezine an anti-seasickness pill,

and recovered quickly from what doctors decided had been "24-hour flu, or gastroenteritis".

When they made the first of six television broadcasts, from 138,000 miles out, Colonel Borman said they all felt fine. British viewers watched as he described the bright blob of the earth as "beautiful, beautiful," with a predominantly blue background and a cover of white clouds. Difficulties with the telephoto lens meant that they were unable to show the best pictures.

Instead they turned the cameras inside. Captain Lovell grinned towards the camera and wished his mother a happy birthday, but there was none of the clowning that had been a feature of earlier American space broadcasts.

By the next broadcast, on December 23, the lens was working again, and viewers saw better pictures, the first detailed shots taken by man from deep space. As they gazed at it Captain Lovell reflected: "What I keep wondering is, if I am some lonely traveller from another planet, what I would think about the earth at this altitude, whether I think it would be inhabited or not."

All the men were in good condition, sleeping between 10 and 15 hours in rotation and eating most of their food. Apollo was nose down towards the moon and entering its gravitational pull more than 200,000 miles from earth.

As they approached the moon the most important decision of the whole mission had to be reached; whether to allow Apollo to whip once round and boomerang straight back to earth, or to attempt L.O.I. (Lunar Orbit Insertion) by firing the engines. When the ground staff were satisfied, the duty communicator at Houston told Colonel Borman simply: "This is Houston at 68.04 (68 hours and four minutes into launch). You are going for L.O.I."

Equally tersely, Colonel Borman acknowledged: "O.K. Apollo 8 is go." Houston added encouragingly: "You are riding the best bird we can find." As they prepared for the delicate manoeuvre, Colonel Borman noted: "As a matter of interest, we have yet to see the moon." The target was dimly illuminated and with the windows clouding over it felt like being in a submarine, he said.

Picking up speed as it came to the leading edge of the moon, Apollo stayed in radio contact until it disappeared round the edge. Behind the moon it would be out of radio contact, unseen and unheard, and beyond any earth help.

As the tense moment of the black-out approached, Major Anders told Houston: "Thanks a lot troops. We'll see you on the other side." There were some 36 minutes to wait, and officials at Houston admitted that there was a great deal of anxiety as scientists and technicians watched their blank screens.

It all depended on the 20,500lb. thrust rocket, the Service Propulsion System (S.P.S.), of the spacecraft, little bigger than a jet aircraft engine. Too short a firing on the dark side of the moon could send Apollo crashing down.

Colonel Borman pressed a button marked Proceed on his flight computer, which took over and fired the engine for just over four minutes. Apollo's speed was slowed from 5,700 m.p.h. to 3,600 m.p.h., calculated to make it a manned satellite of earth's natural satellite.

It was 11.26 a.m. when Houston picked up the spacecraft again. The words that everyone had been waiting for came jubilantly from an official at Houston: "We've got it. We've got it. Apollo 8 is in lunar orbit. There is a cheer in this room."

Captain Lovell said from Apollo 8: "Good to hear your voice."

In orbit, the astronauts reeled off a string of figures and data on the spaceship's performance and technical condition. They were in an elliptical orbit of 70 miles by 194 miles, almost exactly as planned. From nearly a quarter of a million miles away Captain Lovell then gave the first close-up description of the moon's surface. "The moon", he said, "is essentially grey. No colour. Looks like plaster of Paris... The Sea of Fertility doesn't stand out as well here as it does back on earth."

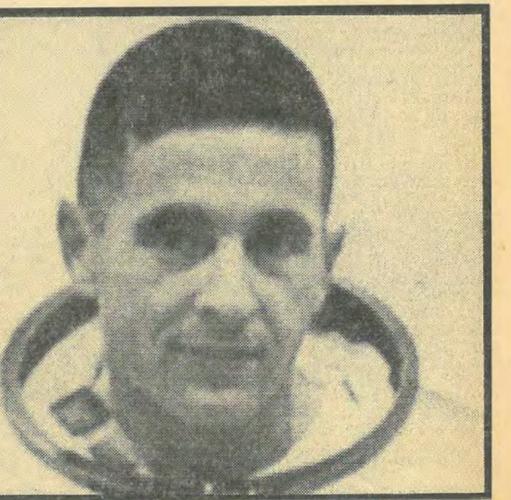
"The craters are all rounded off... some of the round ones look as if they've been hit by meteorites or projectiles of some sort..."



Colonel Frank Borman



Captain James Lovell



Lieutenant-Colonel William Anders

A banner proclaiming "Welcome Home Buck Rogers, Flash Gordon and Captain Kirk" greeted the three Apollo astronauts when they arrived back at Houston after their flight.

Yet the men who have travelled farther and faster than any others are a far cry from such American comic strip heroes. The stringent physical, mental and technical qualifications demanded of space explorers seems to have submerged most of the incidental attitudes and mannerisms that project individual personalities.

Instead, it has produced an elite of rather formal, highly stable, remarkably modest, yet seemingly stereotyped figures.

Their modesty was explained by Colonel Frank Borman after the wonders of the Apollo flight when he said: "This is not a Charles Lindbergh type of thing. He did everything. He practically built his own plane and flew it too. But there are so many involved in what we do."

For all that, the space pilots remain an elite, sharing an acutely tenacious dedication, and an aggressive, competitive spirit.

Colonel Borman, Apollo 8's commander, is aged 40, with blue eyes and crew-cut blond hair.

Invariably described as calm and precise, he is also highly ambitious. He was selected as an astronaut in 1962 and, in the face of fierce competition, leap-frogged several others to command the 14-day Gemini 7 flight in 1965. On this flight he clocked up a number of "firsts", including the longest manned space flight (330 hours 35 minutes) and the first rendezvous of two manned spacecraft when Gemini 7 was joined in orbit by Gemini 6.

Afterwards, he was promoted a full colonel at the early age of 37.

Colonel Borman was eighth out of a class of 670 cadets when he graduated from the West Point Military Academy in 1950 with a Bachelor of Science degree. He was assigned to various fighter squadrons in the United States and the Philippines before returning to West Point in 1957 as an instructor in thermo-dynamics and fluid mechanics. While there he obtained a master's degree in aeronautical engineering from the Californian Institute of Technology.

Deeply religious, Colonel Borman is a lay reader in the Episcopal Church and describes the activities of the church and his two teenage sons' school as "the ferries to the mainland of the community" from the isolated world of the astronaut fraternity.

The attitude of the astronauts to the risks they take is hard to fathom, but Colonel Borman has described the dangers as being similar to those faced by fighter pilots in Vietnam. With some fatalism he has said: "When we do lose our first crew in space, I hope our people will be mature enough to accept it."

Naval Captain James Lovell is also aged 40, blue

eyed and blond haired. Apollo 8's navigator, he was the tallest (5ft. 11in.), heaviest (12st. 2lb.) and most extrovert member of the crew.

Like Colonel Borman, he developed his passion for flying and space flight as a schoolboy. While at high school, he built and launched model rockets. When he was a midshipman at the Naval Academy he wrote a thesis on rocketry and obtained a Bachelor of Science degree.

Captain Lovell has spent longer in space than anyone else—a total of more than 23 days. He accompanied command pilot Borman on the Gemini 7 mission, and returned to orbit 11 months later in Gemini 12.

The major accomplishments of this four-day, 59-revolution flight included a rendezvous with the previously launched Agena rocket, and the first pictures taken from space of an eclipse of the sun.

Captain Lovell quickly emerged as the crew's humorist, informing the world from the moon's orbit that there was indeed a Santa Claus, and bringing a touch of romance to the journey by selecting a mountain in the moon's Sea of Tranquility which he named after his wife, Marilyn.

On earth, apart from the time he devotes to his wife and four children, Captain Lovell has a passion for physical fitness. Golf, swimming, handball and tennis are his hobbies, and in June, 1967, he was selected as special consultant to the President's Council on Physical Fitness.

Air Force Lieutenant-Colonel William Anders is 35, blue eyed with brown hair.

"For the past four years", he said shortly before the Apollo 8 flight, "any time I've looked at the moon I've thought about what it would be like to be flying around it and landing on it."

The Apollo 8 flight was Lieutenant-Colonel Anders' first journey into space, although almost certainly not his last. He may very well be the first man to land on the moon. Since joining the space team in 1963 he has specialized in work on the development of the moon landing vehicle.

A Roman Catholic, and married, with five children, Lieutenant-Colonel Anders obtained a Bachelor of Science degree at the United States Naval Academy before switching to the Air Force. He took a Master of Science degree in nuclear engineering at the Air Force Institute of Technology in Ohio.

In addition to being an expert on space radiation, Lieutenant-Colonel Anders is an expert on the highways around the Houston Space Centre. Concerned by the poor condition of the streets when he moved to the area, he complained to the local authorities and was appointed a street commissioner. As a result he spent much of his spare time investigating potholes and compiling detailed reports on them for the local council—a similar, if somewhat more mundane, task to that which he may find himself doing on the lunar surface later this year.

[Although the moon is essentially grey, Nasa's photographs show a green shading of the surface. This is probably the effect of a change in the colour response of the film, which did not record the exact value of white or sandy-grey, an official said. Some optical shift may also have been caused by the inter-reaction of cabin window glass with the camera lens.]

Of the back of the moon, Captain Lovell reported that it "looks like a sand pile my kids have been playing in for a long time. It's all beat up, no definition, just a lot of bumps and holes."

As the craft neared the end of its third circuit, Colonel Borman broadcast a prayer dedicated to St. Christopher's Episcopal Church near the Houston centre "as well as to people everywhere". It was a prayer for "The Coming of the Day of Universal Peace".

While the world was preparing to celebrate Christmas the crew were occupied in taking photographs, conducting navigation exercises, and carrying out routine chores about the spacecraft.

Major Anders, particularly, was kept on the hop taking photographs. "He is moving from one couch to another, using several kinds of camera, changing lenses, and he is as busy as one man—one astronaut—could be", a space official said.

Suddenly Colonel Borman told Houston: "We're scrubbing everything. I'll stay up and keep the spacecraft vertical but I want Jim and Bill to get some rest. We're getting too tired." Captain

Lovell's snoring, Houston said, could be heard on earth.

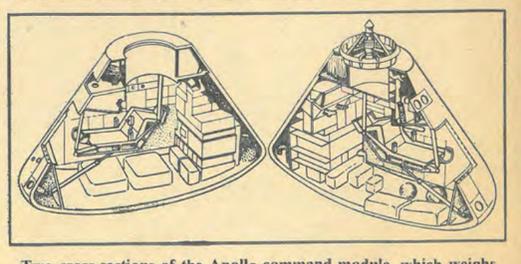
But they were fit enough to make a second lunar television broadcast on Christmas Eve, during the ninth orbit. The 4½lb. camera proved an invaluable aid to identification for Houston, and demonstrated that the first explorers of the moon will find plenty of landmarks when they arrive.

Only a few months ago, one astronaut had suggested leaving the camera out to make room for an extra set of underwear. It had always been a controversial item; Apollo 7's Commander, Walter Schirra, always said he did not like the idea of flight controllers looking over his shoulder. Although he took a camera, he refused to go on television the first scheduled time, saying that he had a bad cold and the crew were too busy and hungry.

The Apollo 8 crew seemed relaxed and happy with their television. Colonel Borman reported on the second Christmas Eve show that his impression of the moon was "a vast, forbidding type of expanse of nothing... not a very exciting place to live or work."

Captain Lovell called the moon "awe-inspiring". "It makes you realize just what you have back there on earth. The earth from here is a grand oasis in the big vastness of space."

As the camera panned over the harsh and empty scene on the dead satellite below, Major Anders's voice was heard. "We are now approaching the lunar sunrise and for all the people back on earth the crew of Apollo 8 have a message that we would like to send to you."



Two cross-sections of the Apollo command module, which weighs about five-and-a-half tons and is 12ft. high by 13ft. across. It is pressurized, so the crew did not need to wear their suits in flight. To make detail clearer, the drawings omit the centre seat.

and coffee after making their fifth television broadcast. During the show Major Anders demonstrated how astronauts eat, with a package of chicken and gravy and a drink of orange juice.

Reportedly "extremely tired", the crew caught up on their sleep and took a day off. With only the re-entry and landing—"a piece of cake"—to face, they relaxed more. Major Anders, at 35 the youngest man on board, was reminded by Houston to hang up his stocking before he went to sleep. "It's beside my teddy bear", he answered.

Colonel Borman was told of the comments of the Flat Earth Society of London. "There were only a few Scrooges that pooh-poohed the Christmas voyage", said Houston. "The most notable was Samuel Shenton of London's Flat Earth Society; he said the public was being bally-hoed, taken for a ride. How does that grab you, Frank?"

Colonel Borman replied: "It doesn't look flat from here, but I don't know—maybe something is wrong with our vision."

During the final television broadcast on Boxing Day Colonel Borman said the astronauts felt something like the travellers of old after a very long voyage away from home. "Now we are heading back we feel proud of our flight—but we're glad to be heading back for home."

They ended: "We will see you back on the good earth very soon."

During the last few hours before re-entry the crew stowed away all loose gear. They came dead straight for the seven-mile-wide 38-mile-deep "window", pulled in ever faster by the earth's gravity until they reached 24,765 m.p.h.—faster than any spacecraft has ever travelled on re-entry.

Too steep an entry would burn up the capsule, too shallow would make it bounce off helplessly into space again, with the crew dying slowly of oxygen starvation.

It came in perfectly, "like a real fireball", the crew said. Minutes before they hit the upper levels of the atmosphere 80 miles above China, they fired the small rockets to separate their cone-shaped command capsule from the service rocket aft, and turned to come in backwards.

On board the Yorktown the three smiled and waved to acknowledge the cheers of hundreds of sailors. "We're very happy to be here with you", Colonel Borman told them.

There was a telephoned message from President Johnson. "You have made us feel kin to those Europeans five centuries ago who first heard news of the New World. You've seen what man has never seen before."

Medical examinations and preliminary debriefings followed. All three spent the rest of the day on board the Yorktown, and next day flew to Hawaii and on to Houston for a brief reunion with their families.

Meanwhile Major Anders was promoted to Lieutenant-Colonel by the President.

Then the men who had seen the far side of the moon went off for a week's secluded, concentrated debriefing with space officials.

# Aiming for the planets no longer just a dream

With the landing on the moon a matter of months away, the question of what lies beyond Apollo has been given extensive analysis by the National Aeronautics and Space Administration.

Scientists at Nasa see several long flights around the sun, and to Mars and Venus as the next big challenge.

But first there are the samples of lunar rock and soil to be gathered and brought back to earth. Before this can be achieved, the Lunar Excursion Module has to be tested.

Once on the moon, the astronauts will scoop up about 100lb. of soil and rocks. There are on earth more than 100 scientists waiting to give this material the most detailed analysis. The examination of the mineral specimens from the moon will give the space agency an opportunity of extending its work to further international collaboration. Fostering cooperation between the world's scientists is one of the declared aims of Nasa's charter.

Apart from bringing its precious cargo back to earth, the craft that lands men on the moon will take equipment to be left behind as a robot laboratory. A seismic station will continuously monitor for moon quakes, a reflector will allow scientists on earth to bounce laser beams to the moon and back, and a barrier of aluminium foil will be erected to interrupt the solar wind—the stream of gases that come from the sun.

The success of Apollo makes it no longer an idle dream that man might aim for the planets, first with unmanned craft to pave the way for more ambitious flights. Relatively modest vehicles, in terms of the scientific equipment on board, have already begun to provide tentative reconnaissance data from Mars and Venus.

But apart from finding out the physical details of the planets, in the same way as landing sites have been explored on the moon by robot laboratories, ways have to be found to sustain interplanetary travellers with power and food.

Journeys to the planets will take months and even years if the dream of a round trip to take in, say, Jupiter and Saturn is realized. At great distances from the sun the solar energy available to recharge photoelectric cells diminishes. Radio communication also be-

comes difficult over such vast tracts of space.

The cost of sending a vehicle carrying scientific instruments to make a soft landing on a distant planet is similar to that already borne for many projects. Sending a man on such an exploration could involve expenditure that would make the cost of the Apollo venture shrink by comparison.

Against this background, it is reasonable to expect a change in Nasa's approach to space research over the next few years. It seems certain to start moving on ventures that have been kept on the shelf and which together will cost less than Apollo.

An analysis of Nasa's budget request for 1970 reveals an interest in developing earth applications. These will be in fields such as weather forecasting, communications, and exploring the earth for mineral resources. Development of an orbiting space station from which up to 12 scientists may work in space is another change in emphasis.

Physicists and astronomers who have been more than dubious about the scientific value of landing a man on the moon can see the value of making repeated experiments in laboratories free from interference of the earth's atmosphere.

The attitude of the new Administration to Nasa's proposals is still unknown. The recently appointed science adviser to Mr. Nixon, Dr. Lee DuBridge, retiring president of the California Institute of Technology, has not been an overwhelming supporter of the effort to put a man on the moon. And he comes from a centre that has an unparalleled reputation in high quality research embracing all the natural sciences.

One important aspect of the recommendations for future work is an extension of the Nerva programme—the project for perfecting a nuclear engine to drive large spaceships. Nuclear power may be the answer to difficulties of designing motors that can last for a journey of years.

The biggest slice of the budget requested for advanced research has been allocated to aeronautics. This is a return to the space agency's original charter which stated that the first A in the aerospace organization stood for aeronautics.

Substantial research in the aero-

nautics field has already been funded through Nasa. Such work ranges from research into quieter jet engines and automatic all-weather landing equipment, to looking for ways of dispersing fog.

What happens next depends largely on the ability of the scientists to convince the administrators of the worthiness of certain ideas.

One of the key sources of scientific inspiration is Nasa's special group in the Office of Advanced Research and Technology. Their slogan is that man should be given the freedom of choice to go wherever he wishes in space or in the atmosphere.

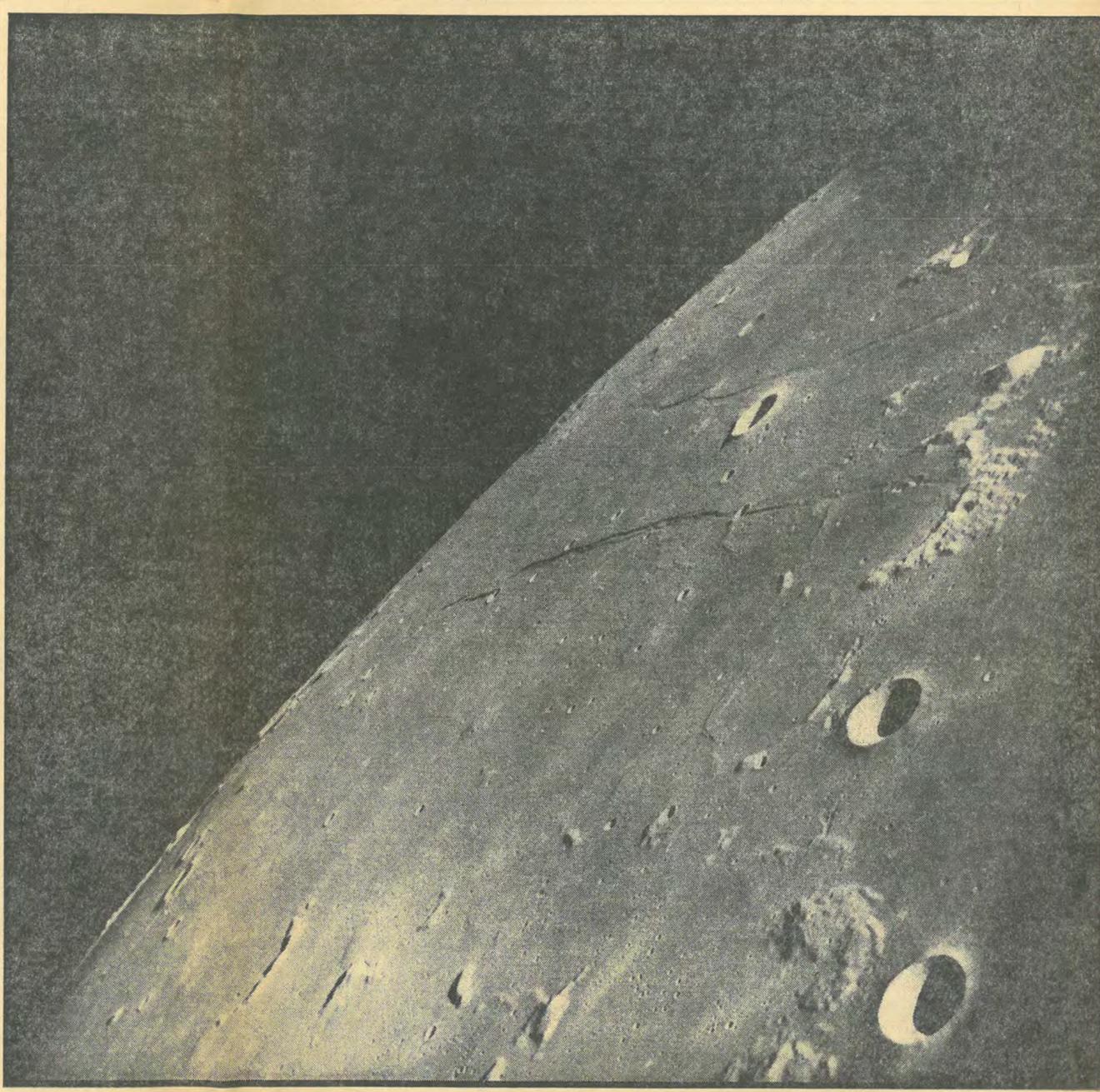
Before an astronaut is finally asked to step out on to the lunar surface, scientists need to be satisfied about the reliability of the Lunar Excursion Module, the craft that will ferry two men down to the moon's surface from a capsule parked above them.

Though this spider-like contraption remains untested so far, some information has been gained about its likely behaviour 250,000 miles away from earth. Worried about the possibility of the motors of the L.E.M. throwing up dust and obscuring the astronauts' windows, scientists made tests with a Surveyor spacecraft. Ground control started the engines of the unmanned vehicle after it had landed to see if a dust shower obscured the television equipment: it did not.

Of course, there is still a chance that the Russians may try for a consolation prize. There are still six months or so to go before the Americans attempt a moon landing. A Soviet astronaut could be the first man to step on to the barren lunar soil.

Hints have been dropped by the reticent Russians that the Zond craft that circled the moon three months ago could have carried a man. On present evidence it seems unlikely that these craft are big enough to carry the same number of men and equipment as the Apollo.

The biggest known Soviet rocket, Proton, is considerably smaller than Dr. von Braun's mighty Saturn, which has been through months of tests. Nevertheless, the Russians have in the past shown a facility for making a series of launches close to one another. So it would be foolish to rule out an intensive campaign in the coming months.



A view across the Mare Tranquillitatis from above its eastern shore. The sea is traversed by two rilles, which here are shallow valleys with level floors, about a tenth as deep as they are wide. Between the two rilles lies the crater Cauchy, roughly 10 miles across. From the crater in the foreground to Cauchy is about 100 miles.

## From Sputnik to Apollo

It was seven years ago that President Kennedy set the United States the target of landing a man on the moon by 1970.

From that moment the struggle for supremacy between Russia and America included the space race. Although both countries have gone out of their way to deny that they are racing for the moon, the fact remains that an expenditure approaching £8,000 million to do just that carries with it no small incentive to be first.

Only in the past few days has the American Government approved expenditure for the 1970 financial year. Expenditure was a meagre \$330m. in 1959. Last year it was 15 times as much.

As is shown by the accompanying table of the highlights of man's cautious steps into space, an almost casual beginning in 1957

soon turned into major endeavours by the two teams. Sputnik I was almost derided by the Eisenhower Administration in 1957.

But soon the two parties were seen to be involved in a race to which the rest of the world was a bystander. Early shots at the moon with scientific instruments by both sides missed. The Russians tried to get a glimpse of deep space with a shot at Venus.

Then as a rehearsal for the great drama which was to come, Yuri Gagarin assured his place in the history books with his first and single orbit of the earth. Within four months, a Soviet colleague had repeated the venture by flying round the earth 17 times.

To the Americans this was more than a scientific achievement. It was an indication of Soviet rocket

might and all that that entailed. Back at the launching pad, the first reply to Colonel Gagarin's flight was a suborbital journey by Commander Shepard, one month after the Russian's journey.

In 1962 Lieutenant-Colonel John Glenn helped restore the balance with a three-orbit trip in his Mercury capsule. The Russians replied with a master-stroke, surely worthy of the French, when Valentina Tereshkova captured the Miss Universe title as the world's first woman in space, with a journey of 48 orbits.

In 1964 the Russians sent three men into orbit in Voskhod I. This was the year that the Americans made big strides in the development of scientific and technology applications machines.

Ranger 7 took close-up photographs of the lunar surface. The Nimbus family of weather satellites began to give meteorologists unprecedented pictures of cloud systems in the upper atmosphere. In spite of the dearth of manned flights by the Americans, these were crucial days. Men like the German-born Werner von Braun were already poring over the drawing boards in the search for powerful machines that would later take man deep into space.

It was at this time that ideas were thrashed out about the best method of accomplishing such a feat. Should a platform be built in space close to the earth first and used as a launching pad? Or should the journey be made in one operation?

The Americans chose to take the direct route, hence the development of von Braun's giant Saturn. Alexei Lenov became the man to make the spectacular walk in space in March, 1965. Edward White followed him in June. A year later a manned Gemini craft docked with a spent Agena rocket case. The Russians put Luna 9 down for a soft landing on the moon, to be followed by television transmissions from the American Surveyor.

Then disaster struck. The first serious setback came two years ago this month with the death of three astronauts during ground tests of the Apollo capsule.

Once again the spectre of Russian supremacy in space research haunted the Americans. Indeed, the pattern of space exploration might well have changed had not the Russians suffered a comparable tragedy with the death of Vladimir Komarov a few weeks later.

The successful Apollo 8 flight must have come as something of a disappointment to the Soviet scientists and technicians, particularly as they have scored so many firsts in space. The launching of Sputnik I in 1957 not only caught the western world by surprise, there were observers who were unprepared to accept it as anything more than an impressive stunt.

## Colour pictures may solve some riddles

By Nature-Times News Service.

The series of colour photographs snapped by Colonel Borman, Captain Lovell and Lieutenant-Colonel Anders will be a proud addition to the record albums of the National Aeronautics and Space Administration, even though these are already bulging with the black and white photographs from unmanned moonshots. But whether the new pictures will tell scientists anything about the moon that they did not know before is open to doubt.

Photographic expeditions to the moon, initiated by the Russians in the late 1950s, have posed almost as many questions as they

have answered, but it may be that the new series of colour photographs will solve some of the riddles.

What scientists will look for in the new pictures are clues as to how the moon came by its pock-marked surface. No single geological process seems to account for all the features of the moon's craters which earthbound telescopes and space probes have revealed. It is the relative importance of the various possible mechanisms that astronomers would like to determine.

The moon's surface is indented not only with craters but with curious furrows known as rilles. Some of the straighter rilles are

almost certainly cracks in the moon's surface, but others seem too crooked for this explanation to hold. One view, much in dispute, is that the crooked furrows are dried up river beds representing the fossil remains of water that may once have been on the moon.

Some astronomers have gone even further and suggested that the moon still holds water, not on its surface but trapped in the interior. The possibility that reservoirs of water exist on the moon will be of crucial importance as manned occupation becomes a reality.

In spite of crude chemical tests carried out by the American Surveyor craft soft-landed on the sur-

face, little is known of the moon's composition. Several interpretations can be drawn from the chemical data, and the colour pictures may help to decide between them. But final answers may well have to wait until astronauts landed on the moon can describe the landscape at first hand, and collect interesting looking fragments of rock for study.

There are two reasons why colour may not help astronomers in their task. First, the lunar landscape is shrouded by a sprinkling of cosmic dust swept up from the solar system. Much of the dust is made up of meteoroids, tiny grains of material that burn up in the earth's atmosphere as shooting stars. Because the moon has no atmosphere, the dust falls on to the surface undamaged.

Second, centuries of exposure to sunlight, unfiltered by an atmosphere, has probably bleached the colour contrast out of the moon's landscape, leaving the monochromatic surface that the three astronauts described last week.

Absence of contrast had already been inferred from the television pictures radioed back from the Surveyor craft. By orders telemetered from earth, different colour filters were inserted in front of the lens of the black and white television camera, allowing scientists to reconstruct the colours of the original scene. Good colour photographs of the moon are

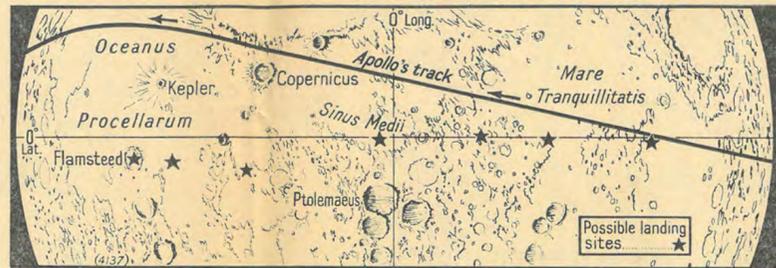
notoriously difficult to obtain with earthbound telescopes.

Highlands and maria are the two main types of landscape on the moon. The maria, extensive dark plains once thought to be seas, are probably vast basins of solidified volcanic lava. The lunar crust in its original state, unaffected by floods of lava, is visible in what are called the highlands. Some areas—blanketed by debris thrown out of the larger craters—cannot be fitted into either of the categories.

The craters that cover the moon's surface were probably caused by bombardment meteorites. There are more craters in the highlands than in the maria, presumably because the highlands are older. Unlike the few meteor craters known on the earth, many lunar craters have more or less flat floors. This is probably because flooding by volcanic lava has filled in the deep pits that the meteorites must have excavated.

The type of crater left by a meteorite probably depends on the temperature of the moon at the time when the meteorite fell. Extensive lava flows into the bottom of the crater are more likely to have occurred at earlier periods of geological time when the moon was hotter than it now seems to be. There are some craters, however, that look as if they were formed entirely by volcanic action. © Nature-Times News Service, 1969.

	AMERICA	RUSSIA
1957		Oct.: Sputnik I, first man-made satellite launched into orbit. Nov.: Sputnik II carried dog, Laika, into space.
1958	Jan.: Explorer I, America's first satellite, launched. Oct.: Pioneer I failed in orbit to crash-land on moon but flew record 70,600 miles from earth.	
1959		Jan.: Luna I, first Soviet attempt to explore moon, missed by 3,000 miles and went into orbit around the sun.
1961	May: Commander Shepard launched into sub-orbital flight.	Feb.: Venus I, first attempt to explore another planet. April: Vostok I took first spaceman Yuri Gagarin, into one orbit. Aug.: Major Titov made 17½ orbits.
1962	Feb.: Lieut.-Colonel John Glenn becomes first American astronaut, orbited three times.	June: First woman space traveller, Valentina Tereshkova, 48 orbits.
1963		June: First woman space traveller, Valentina Tereshkova, 48 orbits.
1964	July: Ranger 7 takes more than 4,000 close-up pictures of moon. Nov.: Mariner 4 launched, sends back pictures of Mars eight months later.	Oct.: Three men sent into orbit in Voskhod I.
1965	Mar.: Gus Grissom and John Young in two-man spaceship. Three orbits. June: Edward White walks in space. Dec.: Frank Borman and James Lovell orbit for 14 days in two-man Gemini 7, and also rendezvous with Gemini 6.	Mar.: Alexei Lenov, first man to walk in space.
1966	Mar.: Manned Gemini craft docks with unmanned Agena rocket. June: Surveyor I makes soft landing, sends back television pictures.	Jan.: Luna 9 makes first soft landing on the moon. Feb.: Two dogs make highest flight by living creatures.
1967	Jan.: Spacemen Grissom, Chaffee and White killed when fire breaks out in launch pad test.	April: Soyuz 1 crashed and Cosmonaut Vladimir Komarov killed. Oct.: Venus 4 makes first soft landing on Venus. Oct.: Two satellites in first unmanned space link-up.
1968	April: Apollo 6 launched, dress rehearsal to try out Saturn 5 rocket. Oct.: First manned splashdown in Apollo craft, 240 hours in space. Dec.: Apollo 8, manned flight round the moon.	April: Luna 14, first Soviet moon orbital flight—did not return. Sept.: Zond 5, first unmanned craft to go round the moon and back to splashdown. Nov.: Zond 6, similar trip but lands on earth, proves feasibility of safe re-entry.



During their 10 orbits the astronauts inspected sites for a possible lunar landing that had been selected by Nasa from photographs taken by the Lunar Orbiter reconnaissance craft. They particularly liked one site in the Mare Tranquillitatis, easily identified from above by two craters near by and a triangular mountain.

## Life on the moon? But of course . . .

When the first astronaut lands on the moon later this year there is a good chance he will find life there. This, at any rate, is the opinion of Wayne Hillard, a Tottenham space enthusiast. "Of course there is life on the moon—otherwise where do all the flying saucers come from?" Wayne said firmly. The fact that Wayne is aged seven and was putting his views on record only minutes after visiting the Unidentified Flying Objects stand at the Daily Mail New Year Show at Olympia no doubt explains this lone voice flying in the face of expert opinion.

Nevertheless, considering his years, Wayne is something of a connoisseur of space exploration. He can reel off the names of the world's first spacemen, the planets and a miscellany of astronomical data. A spot poll among youngsters at Olympia effectively disproves the theory that a diet of highly imaginative space fiction might have left the real-life adventure as something of an anticlimax. The Apollo

8 flight was followed on television as enthusiastically as the more sophisticated adventures of Joe 90 there. This, at any rate, is the opinion of Wayne Hillard, a Tottenham space enthusiast. "Of course there is life on the moon—otherwise where do all the flying saucers come from?" Wayne said firmly. The fact that Wayne is aged seven and was putting his views on record only minutes after visiting the Unidentified Flying Objects stand at the Daily Mail New Year Show at Olympia no doubt explains this lone voice flying in the face of expert opinion.

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really everyone should join up and do it together. It would be safer that way."

All the children knew that the first man in space was Yuri Gagarin, but were generally less sure of the other astronauts. The commander of Apollo 8, said one, was Colonel Martin Bormann. "The trouble is," said Sean Hilston, aged 11, of Marsham, near Abingdon, "they keep sending different spacemen, and you do not hear very much about them as people."

Robert Nightingale, aged eight, of Billericay, said: "I know the names of the Apollo crew, but just at the moment I have forgotten them. They are very brave and I am glad they went. Going to the moon is very important because when the men come back they will get lots of money and medals. I expect I will go one day but my friend won't because he wants to be an artist."

The giant Saturn 5 rocket, standing as high as the top of St. Paul's Cathedral dome, lifts off (below) from the launching pad at Cape Kennedy. Generating seven and a half million pounds of thrust, it propelled the Apollo 8 spacecraft 38 miles in two and a half minutes. Destination: the moon, visible on the right of the picture. Shortly after beginning the first of 10 lunar orbits, the astronauts look down at the crater Langrenus, 85 miles in diameter (top right). Its central peak and conspicuous terraces of the inner crater can be detected in this picture taken from 150 nautical miles above the moon. The small circular crater near by is Langrenus C. At about the same time, the astronauts look back at the blue earth. The photograph (second right) shows where they came from. Beneath the cloud is the American coastline; the Bahamas, Cuba, Hispaniola and Puerto Rico are strung out eastwards across the Caribbean. The six-ton Apollo 8 space capsule, its memorable journey over, floats serenely in the Pacific, where it came down within sight of the recovery ship at first light. After a brief helicopter ride, the astronauts (bottom picture) are on board U.S.S. Yorktown, where Colonel Frank Borman (centre) remarks "we're very happy to be here with you".

