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VOLUME XXIV

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Apollo 8 report

No. 2/1969

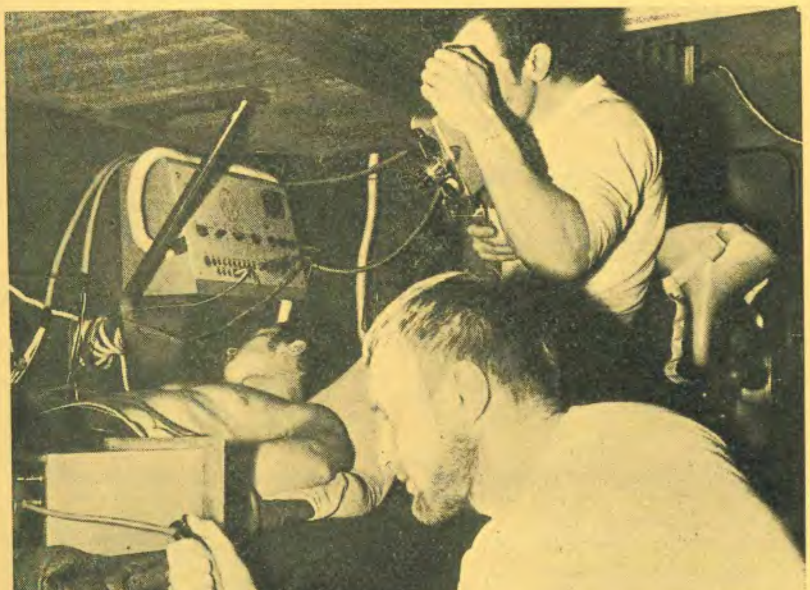
The Soyuz 4 and 5 Docking Mission

While the whole world was talking about the US astronauts' mission to make 10 orbits round the moon (see page 187 of ths issue), the Soviets were preparing for a no less notable undertaking. The *Soyuz 4* spacecraft was launched from Baikonur at 07:30 GMT on January 14, 1969, and, as is usual, there was no reference at that time to the purpose of the mission. The spacecraft circled the earth at a height of 107.5-140 miles, in an orbit inclined at 51.7° to the equator, with an orbit time of 88.25 minutes. Radio transmissions were made on the 20.8 MHz frequency.

The *Soyuz* astronauts before their mission (from left to right): Y. Khrunov; A. Yeliseyev; V. Shatalov; B. Volynov.

Observers soon conjectured that *Soyuz 4*'s occupant, Vladimir Shatalov, would undertake rendezvous manœuvres similar to those carried out by Georgi Beregovoy during his *Soyuz 3* mission in October 1968 and that a target satellite would be put into orbit. This actually happened with the launching of another satellite at 07 : 14 GMT on January 15, one day after the *Soyuz 4* launch. On board this space vehicle, *Soyuz 5*, were three astronauts : Boris Volynov, Commander of the satellite ; Alexei Yeliseyev, an engineer ; Yevgeny Khrunov, a research engineer. In contrast to previous practice, the Soviet television carried pictures of the launch only ninety minutes after lift-off. *Soyuz 5* orbited the earth once every 88.7 minutes, at a height of 124-143 miles, with an inclination of 51.7° to the equator, and was in radio communication with *Soyuz 4*. *Soyuz 5* was the first Soviet spaceship to carry more than a one-man crew since the mission of *Voskod 2* (Beliayev and Leonov) in March 1965.

As part of its space programme, and of special significance for the operation of large space stations, the Soviet Union is studying the problem of the support of human life in prolonged orbital conditions. Three men spent a whole year, from November 5, 1967, to November 5, 1968, in a ground-based " spacecraft "; they were: G. A. Manovtsev, a doctor, and leader of the group; A. N. Bozhko, a biologist; and B. N. Ulybyshev, a technician. Only a telephone linked them to the outside world. Their " space vehicle " contained the most modern life-support and control systems. The " astronauts " lived on a diet of preserves, green food grown under ultra-violet light and regenerated waste products. The photograph left shows A. Bozhko collecting produce from the " spaceship's greenhouse ", and below the " astronauts " are seen taking a medical observation (measurement of blood pressure). According to *Tass*, the three men felt quite well after their year's confinement. Naturally, they were not weightless in their " spaceship " and were not subjected to any harmful radiation.



According to *Tass*, Shatalov had meanwhile been making meteorological, geological and geographic observations as well as testing the manual control system of his spaceship. During the fifth orbit, Shatalov changed *Soyuz 4*'s orbit using the main propulsion motor. The new parameters were : perigee 128.5 miles ; apogee 147.2 miles ; orbit time 88.75 minutes.

The two space vehicles initially orbited the earth at a relatively short distance from one another, all systems were functioning normally and the condition of the four astronauts could not have been better. At 14 :30 GMT on January 15, *Soyuz 4* and *Soyuz 5* had made 21 and 5 orbits of the earth respectively. The astronauts undertook a number of experiments, observed the earth and stars and studied the passage of radio waves through the ionosphere. *Soyouz 5* then effected a small change in its orbit and afterwards circled the earth at a height of 131-157.2 miles every 88.92 minutes.

A direct television transmission from *Soyuz 5* made it possible to see some details of the spacecraft's construction (see also diagram on page 185 of this issue). Basically, it comprised three main sections : at the rear, the systems module with the 40 ft span solar cell panels, the propulsion system and other equipment ; the hemispherical centre-section, comprising the control module, with the astronauts' seats, guidance and navigation equipment, a heat shield, landing parachutes and the re-entry retro-rockets ; the 10 ft diameter spherical forward part, the service module, was connected to the control module by an air-lock and it was in this module that the astronauts carried out their scientific and technical experiments, as well as sleeping and eating. The docking system was mounted on the nose of this forward component.

The orbit of *Soyuz 4* was changed yet again early on the morning of January 16 to the following parameters : perigee 125 miles ; apogee 157.2 miles ; orbit time 88.85 minutes. The two satellites then carried out the docking manœuvre, with *Soyuz 4* beginning the " active " approach to the other space vehicle at 05 : 37 GMT under automatic control. When the two satellites were separated by a distance of only about 300 ft, Vladimir Shatalov took over manual control of *Soyuz 4* until the docking was successfully completed at 08 : 20 GMT. Following this, Yevgeny Khrunov and Alexei Yeliseyev donned space suits and went through the hatch of the orbital compartment of *Soyuz 5* into space. They spent an hour in space carrying out experiments and observations before entering the *Soyuz 4* satellite. The two satellites separated from each other 4 hours and 35 minutes after the docking manœuvre. The original docking, the astronauts' sortie into space, and the separation were all shown on Soviet television.

While *Soyuz 4*, containing Shatalov, Khrunov and Yeliseyev, returned to earth, landing at 06 : 53 GMT on January 17 at a site about 25 miles from Karaganda in Kazakhstan, *Soyuz 5* continued to orbit the earth crewed only by Volynov. During *Soyuz 5*'s 36th orbit, Volynov made a further change in the parameters and he finally initiated re-entry after 50 orbits. This spacecraft landed about 125 miles southwest of Kustanai in Kazakhstan at 08 : 00 GMT on January 19. The landing site was about 375 miles northwest of the Baikonur space centre, from which both satellites were launched. From the launch of *Soyuz 4* to the landing of *Soyuz 5*, the whole mission had lasted 96 hours 30 minutes. Both space véhicles were landed in the same way : the spherical forward section and systems module were both jettisoned and in the final stages of the re-entry manœuvre retro-rockets were fired to permit a landing by parachute.

Although the Americans had already carried out a docking manœuvre in space in March 1966, using *Gemini 8* and an *Agena*, the Soviets carried out the first docking of two manned space ships with *Soyuz 4* and *Soyuz 5*. The necessary techniques had been tested during the missions of *Cosmos 186* and *188* in October 1967 and *Cosmos 212* and *213* during April of last year. It is perhaps too much to talk in terms of a space station after the link-up of two manned space vehicles for a few hours, but this mission could pave the way to the construction of a real space station in the not too distant future. Such space stations in earth orbit, with crews being periodically relieved, would not only be important from technical and scientific standpoints but also, despite assertions to the contrary, would have a tremendous military significance.

The United States Air Force is also aware of this fact and its Manned Orbiting Laboratory (MOL) programme involves the launching of a manned research satellite into earth orbit with crews being changed, after a maximum of 30 days in space, by means of a *Gemini* space vehicle. The successful *Soyuz 4/5* mission shows that the Soviets have been able to gain a definite lead over the Americans in the execution of this type of mission.

Soyuz Spacecraft and Launch Vehicles

The Soviet Union has released pictures of the *Soyuz-3* manned spacecraft and its launch vehicle. The pictures were released with a much shorter delay after the launching than was the case with the *Vostok* launchings, the Soviet Union's first manned spacecraft. The first *Soyuz* launching, *Soyuz-1*, took place in April, 1967. The mission which lasted about 25 hours ended tragically when the spacecraft crashed on landing, killing the pilot Col. Vladimir Komarov. The *Soyuz-3* pictures, a few of which are shown here, are not of a very high quality and as is usual, the Soviets have not released any details of dimensions, weights or engine thrust for either the spacecraft or the launch vehicle. It is known that the *Soyuz* spacecraft is designed to form part of a much larger space station and that a *Soyuz* could stay in orbit for a period of up to 30 days with a single pilot, or for 10 days with a three man crew. On extended missions, power is provided from solar cells. An interval of eighteen months elapsed before the next manned *Soyuz* launching. The spacecraft *Soyuz-3*, piloted by Col. Georgi Beregovoi carried out a rendezvous manoeuvre with the unmanned *Soyuz-2* launched a short while before. *Soyuz-4*, which was launched on January 14, 1969 and *Soyuz 5*, launched on January 15, carried out a successful docking manoeuvre. A separate report on the *Soyuz 4* and *5* space flights appears in this issue. ++

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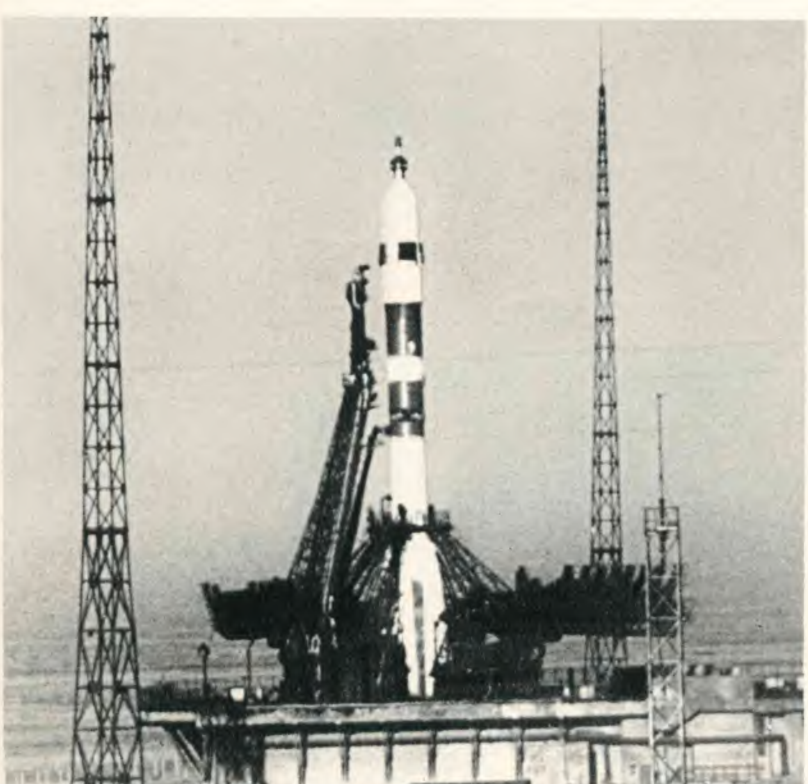

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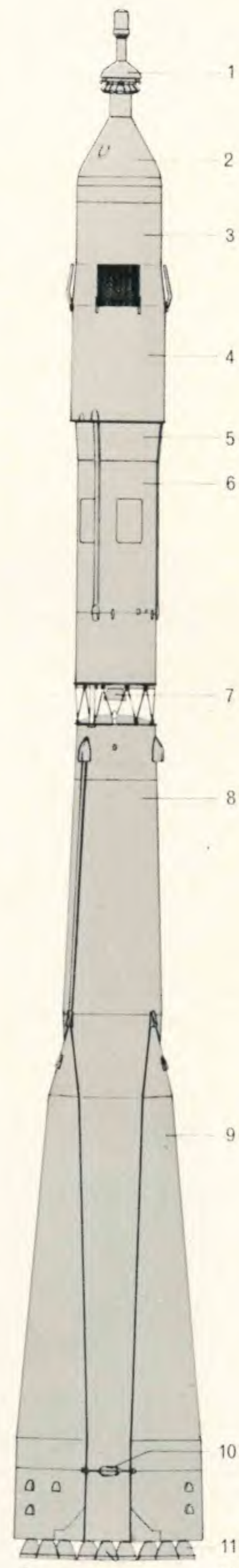

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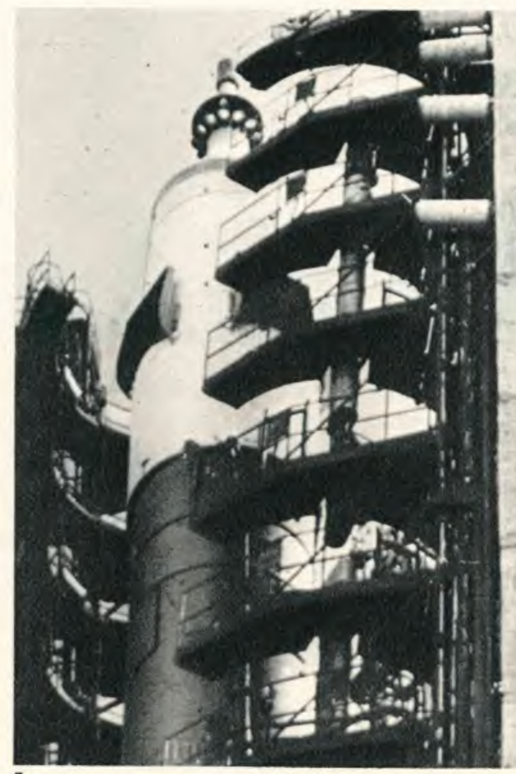

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Fig. 1: The *Soyuz* spacecraft and its launch vehicle were moved to the launching pad by means of a rail vehicle.—*2.* on the launching pad shortly before launch. The spacecraft and launch vehicle are still connected to ground facilities by umbilical cables.—*3.* the spacecraft's nose. Probably this shows the jettisonable rescue module.—*4.* sketch of spacecraft and launch vehicle. The numbers indicate 1 – rescue module; 2 – spacecaft living and working module; 3 – control module; 4 – instrument and equipment module; 5 – propulsion units (two); 6 – launch vehicle third stage; 7 – third stage engines; 8 – second stage; 9 – first stage (four groups with same type of construction as *Vostok* (first stage); 10 – first stage clamp; 11 – first stage engines; 12 – second stage engines.—*5.* Assembly tower with working platforms on the launching pad.

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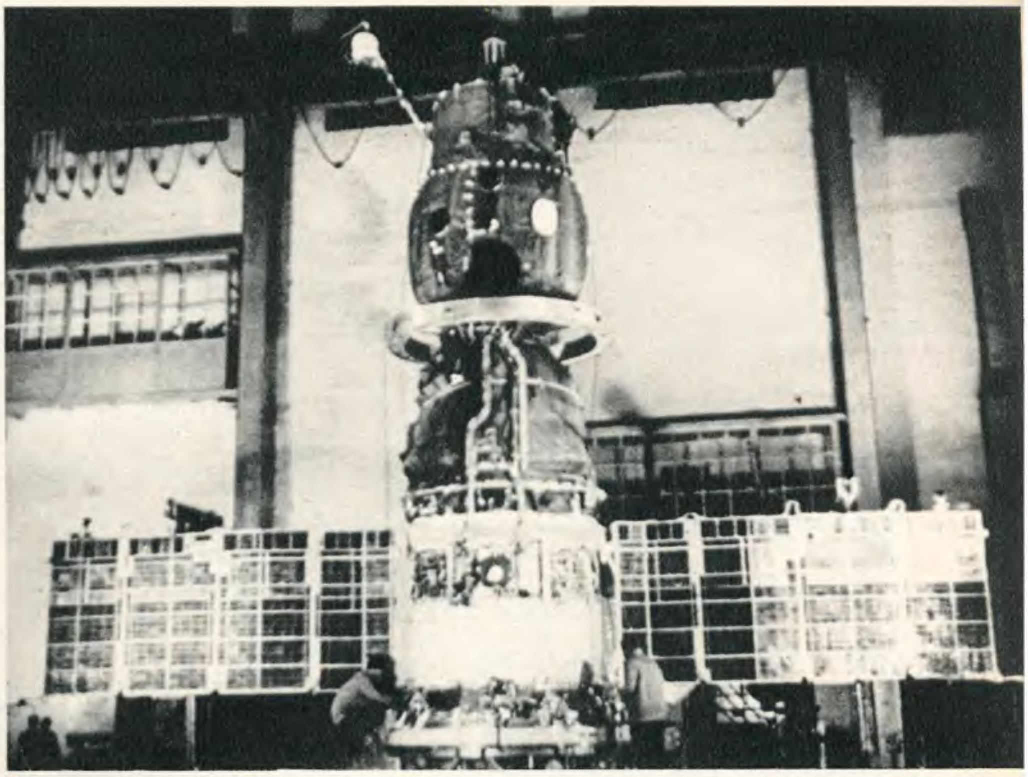

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Fig. 6: Shortly after launch of the *Soyuz*. As with the *Vostok* launch, first and second stage engines are fired at the same time. — 7. Assembly of the spacecraft. The spherical living and control modules can be seen. The solar cell panels are unfolded. — 8. Astronaut Georgi T. Beregovoi in the spacecraft's roomy rest area. During his mission, he did, of course, wear a special suit.

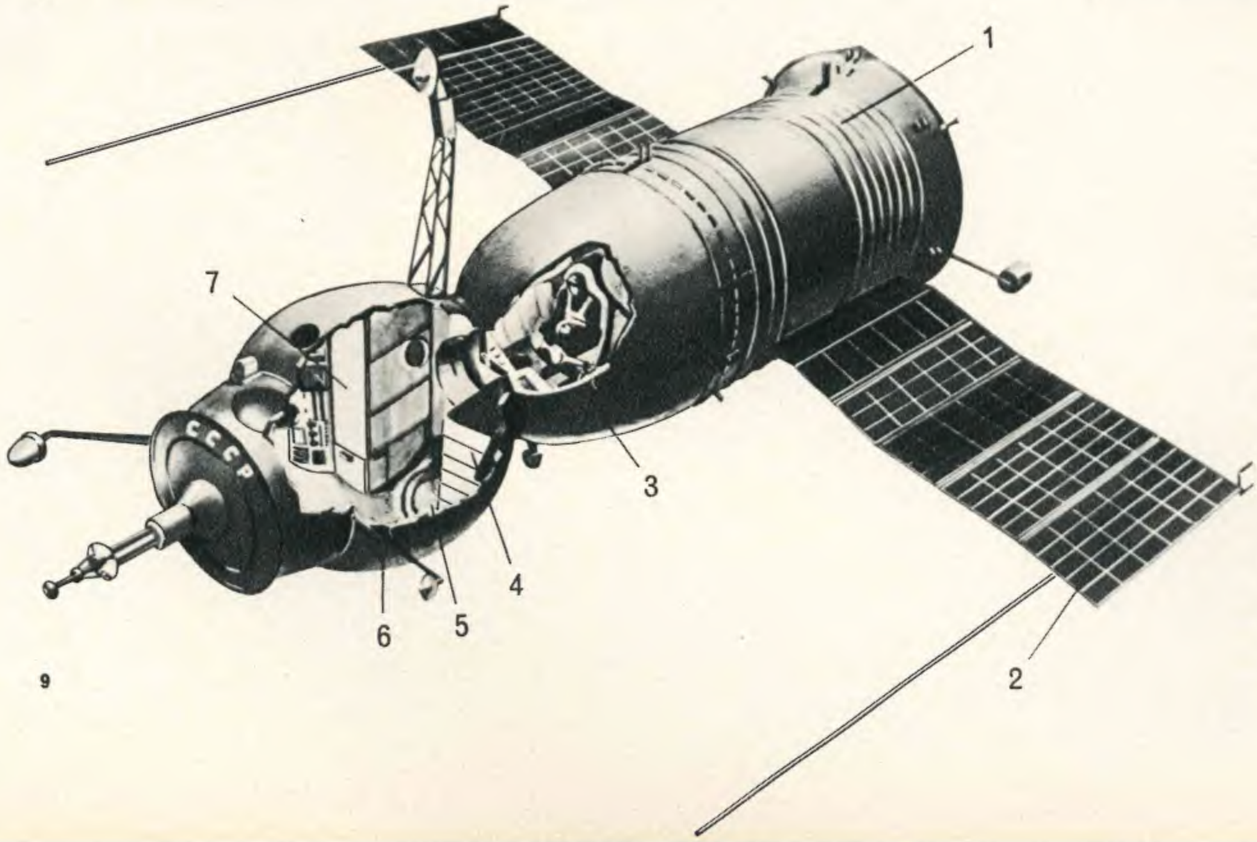

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Fig.9: Cutaway view of *Soyuz* spacecraft. The numbers indicate 1 – systems module with control systems, instruments, two large engines (one as reserve) for large orbital corrections and small propulsion units for steering manœuvres. The systems module is jettisoned before re-entry into the earth's atmosphere; 2 – folding wing-like panels carrying the solar cells; 3 – command module with couches for one to three astronauts, control elements, control levers, navigational systems, etc, as well as two windows, heat shield, parachutes and a set of braking rockets which are fired when the spacecraft is within four feet (120 cm) of the ground; 4 – astronaut's rest area (see also picture 8); 5 – entrance; 6 – service module fitted with four portholes and equipment for conducting scientific experiments. The astronauts eat, sleep and exercice in this area. Before re-entry the service module is jettisoned in the same way as the systems module. Service and systems modules together have 318 cu ft (9 cu m) of space, which is some 50 per cent more than that of the American *Apollo* spacecraft. The *Soyuz* is also fitted with four television cameras, two mounted internally and two externally.

Apollo 8 Astronauts report on their flight around the moon

Interavia has already given a short report in No. 1/1969 of the *Apollo 8* mission to the moon, with Frank Borman, James A. Lovell and William A. Anders as crew. In this issue the *Apollo 8* astronauts themselves describe their mission. The following statements (given here in a shortened version) were made by the astronauts at a Houston press conference on January 9. Since the *Saturn/Apollo* programme was fully described in issues 10 and 12/1966, it would be superfluous to cover it once more.

*

Frank Borman: We thought that it would be most appropriate if we first described our flight, each of us covering selective portions and then answered your questions. I will first discuss the launch, Jim Lovell will tell you about navigating to and from the moon and Bill Anders will tell you what he saw on the moon.

The launch with a *Saturn 5* is an incomparable experience. As far as we astronauts were concerned, it was very similar to the *Gemini* launch, with the exception that as we cleared the tower, the noise within the spacecraft became so loud that effective inter-crew communication for all practical purposes was lost. The acceleration increased rapidly and the first stage separation seemed to me to be more abrupt than with the *Titan* first stage. Apart from a slight oscillation about 30 seconds before second stage burnout there were no problems. Jim could plot the trajectory in real time and assured me continually that we were exactly on course. Injection into parking orbit took place with nearly perfect precision.

On separation of the third stage, the thrust was considerably greater than we had been led to expect. We turned around and simulated a rendezvous manoeuvre in order to convince ourselves that it could be easily done. Then we thrust away from the third stage, but unfortunately it was more friendly than we had anticipated and it needed some time and another manoeuvre before we were on our way.

James A. Lovell: After I finally figured out that I was really on the way to the moon, I decided to do some navigation. Whilst Frank and Bill stayed in their seats, I had already unstrapped during the parking orbit, in order to check the functioning of the optical equipment and align the inertial platform. This was of course very important before we committed ourselves to the translunar voyage. In the *Gemini* vehicle I found the navigation easier because the ground tracks you quite closely. But when we go to the moon, we have to be pretty careful of two things: one is that we don't want to run into the moon, and two, we want to come back at a particular angle to re-enter. And of course if we lose communications, our on-board navigation is prime. My particular job was to check the onboard navigation.

◄

Two of the close-up photographs of the moon brought back by the *Apollo 8* astronauts. The upper picture shows the far side of the moon at approximately 160 degrees west longitude and looking south. It covers an area from a large crater (whose southern rim lies at latitude 10 degrees south) and extends to the horizon 275 miles away —The lower picture was taken with a telephoto lens looking south at the Godenius crater. An unusual feature is the prominent rille crossing the crater rim. The crater is approximately 40 miles in diameter, and is situated at latitude 10 degrees south, longitude 45 degrees east. The three smaller craters close together are Magelhaens, Magelhaens A and Colombo A.

We made two heading corrections. The first was with the service module engine, and we did that particularly so that we knew that we would have a good engine when we arrived at the moon. Our second manoeuvre was to get our closest approach to the moon at about 60 nautical miles. I might add that the third stage put us on such a precise trajectory that we actually had to burn out of it a little bit so that we could use the service module engine.

William A. Anders: I should say that my main job on the flight was to keep the spacecraft systems running, and to be prepared to take care of any possible malfunction that might arise. But my job was pretty easy. The contractors and subcontractors have done a wonderful job in building the vehicle. The Cape had done an excellent job of checking it out. When we got into lunar orbit, I become one of the photographers. First of all we photographed the earth. We could see Florida, the Grand Banks of the Bahamas, Cuba and a large weather cell. Later we could see the back side of the moon. It's very heavily cratered. We referred to the ground as sand—dirty beach sand—dark grey. Very little colour, if any at all, maybe just a faint whiff of brown. The Langrenus crater has the characteristic centre peak of a large impact crater. We could see the slumping of the sides that occurs with age after the impact. As you know, there has always been the controversy among those who studied the moon as to the nature of the holes—whether they are volcanic in origin or meteoric impact. Certainly there are both.

Lovell: Now, on the back side of the moon—we had photography taken from *Orbiter*—but we were not too sure of the co-ordinate system. The people felt that the actual locating of the craters could be as much as 10 degrees or 160 miles off. And one of the jobs of navigation was to determine just what the co-ordinate system was, just where the craters were located in relation to one another.

Anders: We also took photographs of the large crater named by the Russians as Tsiolkovsky. They were taken at a relatively high sun angle which brings out colour contrast quite well, but does obscure topographical detail. Slides taken almost at the sub-polar point—that

Even on a mission as important as this, things do not always proceed absolutely seriously. Here, Frank Borman, commander of the spacecraft receives a Christmas stocking from ground personnel, prior to the *Apollo 8* mission. Other members of the crew were James A. Lovell, pilot of the command module, and William A. Anders, pilot of the lunar module, which was not taken along on this mission. Before the 147 hour mission, Lovell had already logged 425 hours 10 minutes in space in *Gemini 7* and *Gemini 12* and Borman had logged 330 hours 35 minutes in *Gemini 7*. This was the first mission for Anders.

point where it's high noon on the moon and looking straight down you get the very dramatic difference in albedo that occurs with the very bright, new impact craters.

Lovell: One of our main objectives in the flight was to observe one of our landing sites. It's a landing site on the eastern side of the moon as we see it from earth. It's called East 2. And our job was to look at the landing site to see whether the sun angles were correct, as had been predicted for observing, for proper landing. Our landing site is near the area of the crater Maskelyne. I'm happy to announce that from

In the Cape Kennedy Launch Control Centre, numerous engineers monitor pre-launch checks of the *Saturn 5* launch rocket and the *Apollo 8* spacecraft. The countdown did not encounter any important interruptions and the launch took place on December 21, 1968, only a few seconds after the previously announced time. This was the third launch of a *Saturn 5*, but the first carrying a manned spacecraft. The overall length of the launch vehicle, with the *Apollo* spacecraft and launch escape system, was 363 ft and weight at ignition was 6,218,558 lb. The first stage, S-1C, was constructed by the Marshall Space Flight Center and Boeing; the second stage, S-2, was constructed by North American Rockwell and the third stage, S-4B, by McDonnell Douglas. The engines for all stages were produced by Rocketdyne.

our visual observation of this particular site, it appears that from the first initial point right on through to our landing site area the lighting conditions are sufficient and adequate for a lunar landing.

Borman: I would like to take this opportunity here to describe the re-entry. It was the most unrealistic event of the entire flight for me. The whole spacecraft was bathed in a light that made you feel you were inside a neon tube. Now, you should remember that the entry was made in complete darkness, and all the chutes were put out in darkness and we were really not sure when we were going to hit the water. But once we got the main chutes out, we all sort of relaxed and felt, well, this is the end of a long, hard trip, and it's going to be great, because the *Apollo 7* crew had mentioned how soft they entered the water. And just about the time we were congratulating ourselves, we hit the water with a tremendous impact. I got doused with water that was forcing its way in through some vent tubes. And I looked around to see why we were sinking, and by the time I got back to release the parachutes, we were in nose down position. So we ended up upside-down in the Pacific, but we uprighted ourselves in about four and a half minutes.

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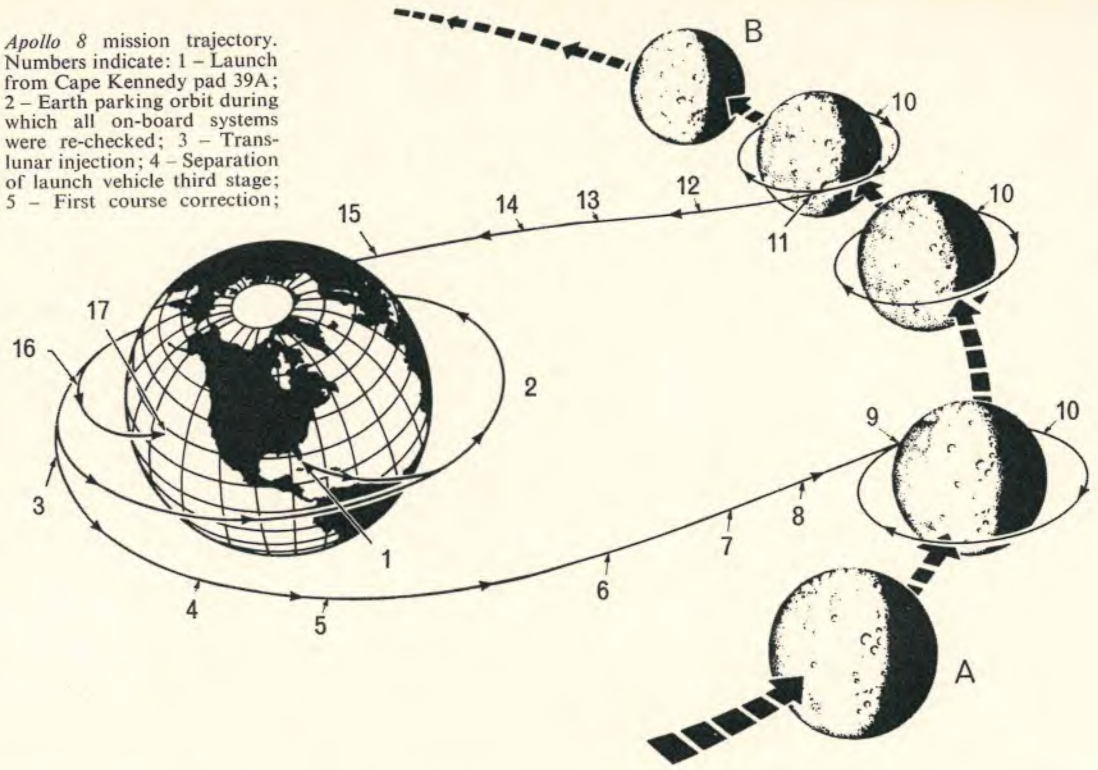

Apollo 8 mission trajectory. Numbers indicate: 1 – Launch from Cape Kennedy pad 39A; 2 – Earth parking orbit during which all on-board systems were re-checked; 3 – Trans-lunar injection; 4 – Separation of launch vehicle third stage; 5 – First course correction; 6 – Non-powered coasting towards moon; 7 – Entry of moon's gravitational field; 8 – Second course correction; 9 – Commencement of lunar orbit; 10 – Lunar orbit, firstly elliptical, later circular; 11 – Transearth injection; 12 – Further course correction; 13 – Entry of earth's gravitational field; 14 – Coasting towards earth; 15 – Separation of service module; 16 – Re-entry of atmosphere; 17 – Landing in the Pacific Ocean near aircraft carrier *Yorktown* and recovery of crew and spacecraft; A – Position of moon at time of launch; B – Position of moon at time of landing.

This view taken by the *Apollo 8* astronauts shows nearly the entire Western Hemisphere of the Earth from the mouth of the St. Lawrence river to Tierra del Fuego. Whilst (on the original picture) Central America is clearly outlined, nearly all of South America, except for the peaks of the Andes mountains, is covered by clouds. The west African coast can be seen along the shadow line at the right.

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This artist's impression shows the *Apollo 8* in lunar orbit. In the cutaway section of the command module, one of the astronauts can be seen observing the lunar surface. The astronauts took many photographs and films, having at their disposal two 70 mm Hasselblad still cameras with two 80 mm lenses and a 250 mm telephoto lens, and also a 16 mm Maurer ciné camera with 5, 18, 75 and 200 mm lenses, as well as black and white and colour films of various sensitivities for interior and exterior photography.

Question: Was this a difficult flight psychologically?

Borman: Not for me it wasn't. Psychologically it was a far easier flight than *Gemini 7*. You adopt a philosophical approach after you burn trans-lunar injection, and I wasn't really concerned about anything. When you are in earth orbit you are always aware that if something happens you have to react immediately. Once you burn your trans-lunar injection, you really are not concerned with reacting swiftly because it is going to take you two or three days to get home anyway.

Question: You mentioned the new impact craters. How new are these impacts? Since the last *Lunar Orbiter* for instance?

Anders: I think we are talking about new geologically, if I may use that expression.

Lovell: We don't know. A couple of hundred thousand years perhaps.

Question: Are these craters that have not been identified previously in pictures?

Anders: The *Lunar Orbiter* did an excellent job of mapping the moon on the near side. But, because of its highly elliptical orbit, on the back side it was roughly 1,100 miles away and it only got rather distant views.

Question: How tough is the lunar landing going to be in terms of lighting, based on the experience that you have had. Were the lighting angle and the sun angle worse or better than you thought?

Borman: We, of course, looked at lighting simulations here on earth. I think the lighting is much more amenable to landing the LM *(Lunar Module)* than we had expected.

Anders: I think we have all seen, in the *Orbiter* pictures, that you do get this washout of detail in topography at the zero phase sun angle—that is, looking at the point where your head shadow would be. But I think that the human eye has a much greater dynamic range, a much greater ability to look into these bright areas and at the same time see in the shadows, so that I think the lighting situation will be much better.

Question: From what you saw of the moon, have you picked out one or two places you would most like to land and visit?

Lovell: On the near side we had a crescent moon. We were only seeing a portion of that side that is familiar to us. Certainly the landing site which has been selected—that was in sunlight—was, in my way of thinking, an excellent place to go.

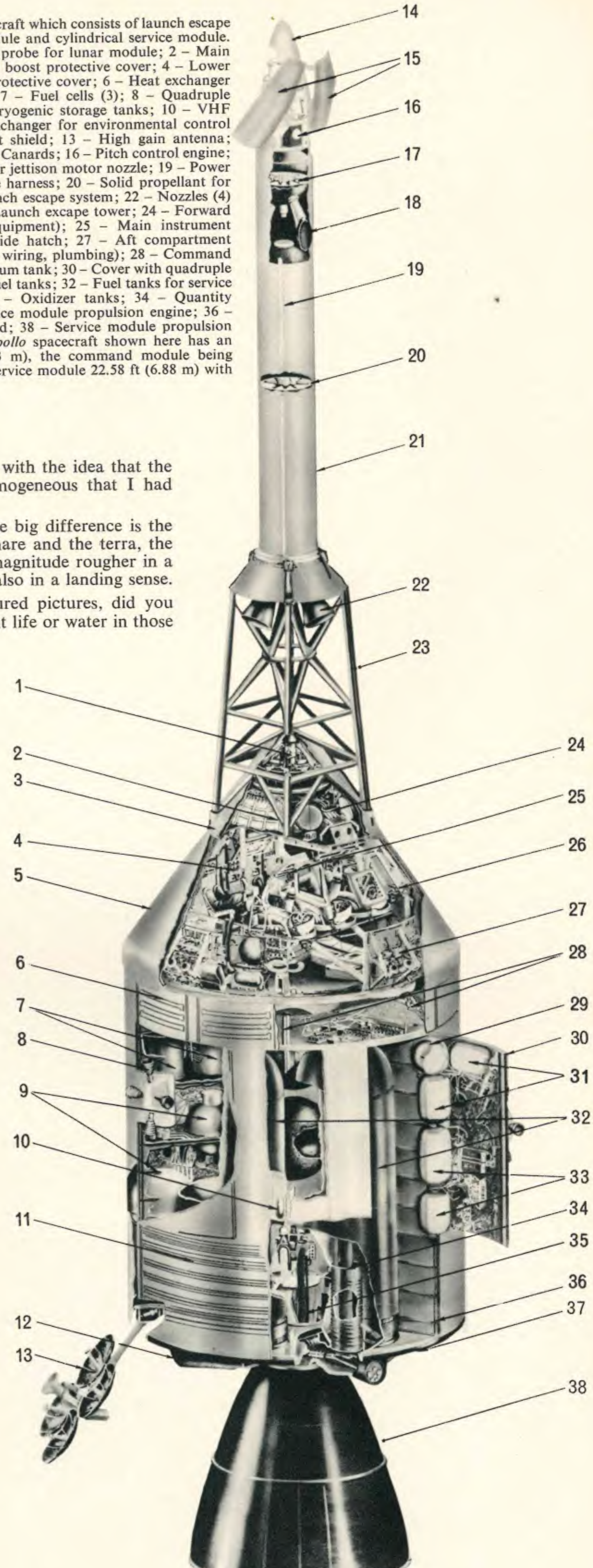
The *Apollo* spacecraft and the lunar module has a guidance and navigation system produced by the General Motor AC Electronics Division. The picture shows an AC technician carrying out systems tests. The main contractors for the spacecraft and the lunar module are North American Rockwell and Grumman respectively, although nearly all large firms in the American aerospace industry have participated in the *Apollo* programme.

Construction of the *Apollo* spacecraft which consists of launch escape system, spherical command module and cylindrical service module. Numbers indicate: 1 – Docking probe for lunar module; 2 – Main parachute (1 of 3); 3 – Forward boost protective cover; 4 – Lower equipment bay; 5 – Aft boost protective cover; 6 – Heat exchanger for on-board electrical system; 7 – Fuel cells (3); 8 – Quadruple reaction control engines; 9 – Cryogenic storage tanks; 10 – VHF Antenna (1 of 2); 11 – Heat exchanger for environmental control system; 12 – Aft bulkhead heat shield; 13 – High gain antenna; 14 – Nose cone and Q-ball; 15 – Canards; 16 – Pitch control engine; 17 – Solid propellant; 18 – Tower jettison motor nozzle; 19 – Power system and instrumentation wire harness; 20 – Solid propellant for launch escape system; 21 – Launch escape system; 22 – Nozzles (4) for launch escape engine; 23 – Launch excape tower; 24 – Forward compartment (earth landing equipment); 25 – Main instrument console; 26 – Quick opening side hatch; 27 – Aft compartment (tanks, reaction control engines, wiring, plumbing); 28 – Command module support beams; 29 – Helium tank; 30 – Cover with quadruple reaction control engines; 31 – Fuel tanks; 32 – Fuel tanks for service module propulsion system; 33 – Oxidizer tanks; 34 – Quantity measurement system; 35 – Service module propulsion engine; 36 – Radial beam; 37 – Aft bulkhead; 38 – Service module propulsion engine nozzle. The complete *Apollo* spacecraft shown here has an overall length of 63.33 ft (19.3 m), the command module being 10.58 ft (3.23 m) long and the service module 22.58 ft (6.88 m) with a diameter of 12.83 ft (3.91 m).

Borman: I came away with the idea that the moon may be more homogeneous that I had realised.

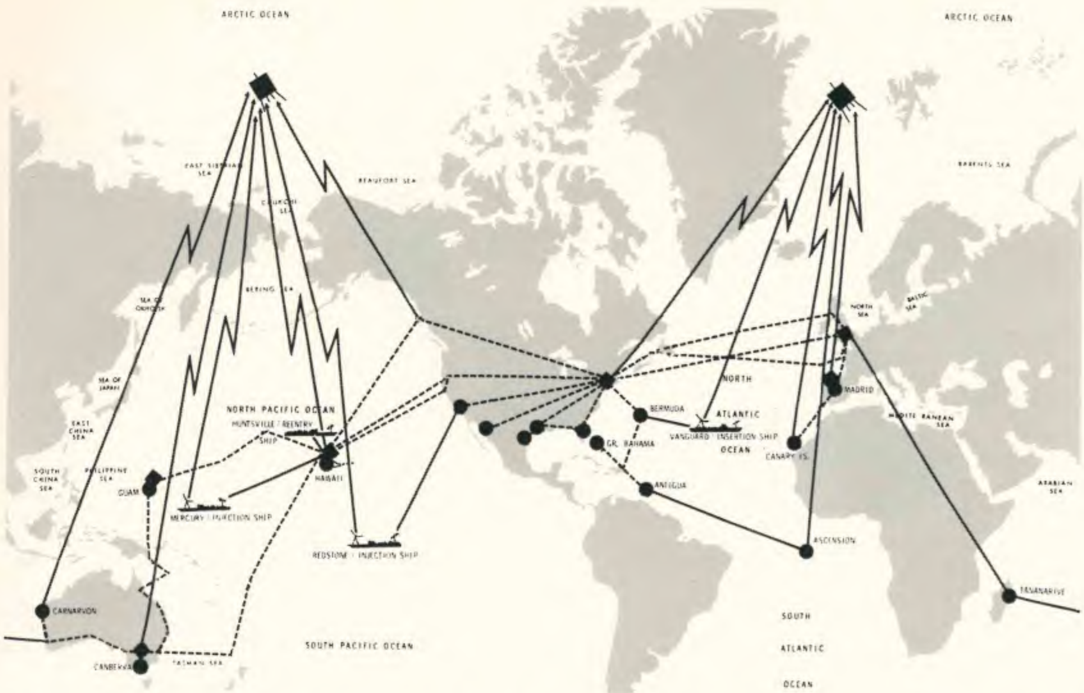
Anders: I think the one big difference is the difference between the mare and the terra, the terra being an order of magnitude rougher in a topographical sense and also in a landing sense.

Question: In the coloured pictures, did you see any indication of plant life or water in those dark areas?



This television camera developed by Radio Corporation of America enabled live transmissions to be made from the spacecraft. The camera was fitted with a 160 degree wide-angle and a 9 degree telephoto lens. It is only 1/85 as large as those used in TV studios and has a weight of 4.5 lb.

When this television picture of William A. Anders was received, *Apollo 8* was 120,653 nautical miles from Earth. Six transmissions were made, two during the flight to the moon, two during the lunar orbit and two during the return flight. The signals were transmitted to the Goldstone, California and Madrid ground stations where they were converted to normal television frequencies and after release by the Houston control centre transmitted either directly, over relay stations, or over telecommunications satellites by numerous companies.



For communications, which were only interupted whilst *Apollo 8* was on the far side of the moon and on re-entering the earth's atmosphere, the National Aeronautics and Space Administration Communications Network (NASCOM) of ground stations, ships and communications satellites, shown on the map, was used. ● Ground stations; ✦Switching stations; — Radio links; ---- Landlines and underwater cables. With the aid of *Intelsat 2* satellites over the Atlantic and Pacific, as well as ATS-1 and ATS-2, NASA could maintain communications with the *Apollo* spacecraft. ATS-1 was the only satellite which could receive television transmissions of the recovery operation near the aircraft carrier "*Yorktown*". They were then retransmitted by the Brewster Flat, Washington ground station to *Intelsat 3F-2,* which also transmitted pictures from the moon via the stations of Etam, West Virginia and Raisting, West Germany to Puerto Rico and Europe.

Anders: Quite a number of our colour photographs do show what appear to be some greens and purples. Let me assure you that it was a black-and-white world, and no signs of grass or algae.

Question: A lot of us were worried about your indisposition during the early part of the flight. Can you tell us what it was like and how you coped with it medically?

Lovell: As I said in my little talk before, I was the first one out of my seat during the earth parking orbit, and I had quickly gone to work doing the various odds and ends of things that I had to do, and I was sort of the chief cook and bottle-washer, getting everything for everybody else, and I moved around quite rapidly. And I found out that's a mistake, because in moving around rapidly in zero g before you become used to it, it can be very similar to that queasy feeling you get if you are not used to being aboard ship—sea-sickness, to be exactly correct.

Borman: I had this initial indication, but it went away, and then, as I mentioned before, we had difficulties getting away from the S-4B. We stayed with it longer than we wanted to. So when I went into the sleep station for my sleep cycle, I was two hours behind. I took a sleeping pill. And when I woke up I felt terrible. I suffered as long as I could, and I finally vomited twice, and I immediately felt better. We're not certain whether it was the 24-hour virus or reaction to the sleeping pill, but by the time the people on the ground had prescribed something, I was all better and I didn't take any of the medication that was prescribed.

Question: Where there any unexpected developments in the area of space medicine as a result of your mission?

Borman: No. Jim and I can both testify that when we landed from this flight we were in far better shape than we were when we got out of *Gemini 7* after 14 days.

Question: Were there any significant changes brought about by radiation, a combination of radiation and weightlessness, or anything of that sort?

Anders: No, our radiation dose was barely measurable.

Question: At the Sea of Tranquility landing site were there any obstacles to landing?

Lovell: I looked for but did not find any boulders, and I was looking for boulders primarily to see if I could see something about the size of the *Lunar Module,* and to see if we could track the LM, which would be important in our guidance system when it comes back up to rendezvous. I feel that we can do this.

Question: Did you learn anything from this flight that will change things on future visits?

Borman: I don't believe we learned anything significant except that we performed the flight test. We flight-tested the ground system and the airborne system.

Lovell: One thing that we checked on the way home, which was very comforting to the crews, was our onboard capability of returning to earth, which is done via the optical computer system, which came out very close to what the ground predicted. The second thing, which had nothing to do with the hardware system, but which looked to us to be significant, is the fact that our sleep-rest cycles will probably have to be more like they were in the later *Gemini* flights, where all three of us are going to be bedded down for the translunar journey so that we have full capacity when we get to lunar orbit.

Question: Did you detect the presence or the influence of anything like mascons (mass concentrations)? If so, could you equate them with any visible topography on the moon?

Anders: Our ground tracking people, I understand, were able, by analysing our flight path, to detect slight anomalies in our trajectory in lunar orbit. Certainly we wouldn't have the physiological capability to check this on board.

Question: A good many thoughtful Americans are thrilled by this mission and fully appreciate the importance of exploration, but still harbour serious doubts about heavy funding for programmes like this when so many unfortunate situations remain on earth. Do you understand the point that they make? And what is your reply to them?

Borman: Well, I think we all understand it. There's no question in anyone's mind that we have many serious problems here on the earth and in this country. I'm not sure you will solve them all by neglecting the quest for knowledge that we are undertaking. And certainly within NASA—in my own station in NASA—I am not the one that makes the decisions as to how many funds or how much monies will be spent where.

I hope that the next Administration will carefully consider not only the technical and the scientific value of this programme, but also the value, the almost nebulous value, that it has to the spirit of this country.

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NASA has announced that the *Apollo 9* Spacecraft will be launched using a *Saturn 5* launch rocket on Februray 28, 1969. The crew will consist of James McDivitt, spacecraft commander, David Scott, Command Module pilot, and Russel Schweickart, Lunar Module pilot. The main purpose of the ten day mission in earth orbit is to evaluate LM systems performance as well as separation and rendezvous manoeuvres between the spacecraft and the LM. The first landing of American astronauts on the moon should take place with *Apollo 11* about the middle of this year.

With the extremely successful *Apollo 8* mission, the Americans are one step nearer the goal set by President Kennedy of a landing on the moon by 1970. This will, without doubt, soon be achieved, but the *Apollo/Saturn* programme will then be by no means completed. The equipment and techniques developed for this programme will serve as a basis for still greater undertakings. To these belong not only the exploration of interplanetary space, but also the construction of a space-station by using burned-out launching rocket stages, the spacecraft then operating a shuttle service between earth and the space station. ✦✦

Recovery of the *Apollo 8* Command Module on December 27, 1968 from the Pacific Ocean. The three balloons ensured that the Module floated the correct way up after splashdown. The ring was fitted by frogmen. A helicopter transported the three astronauts to the aircraft carrier *Yorktown;* later they were flown via Hawaii to Houston, where they reported on their mission.