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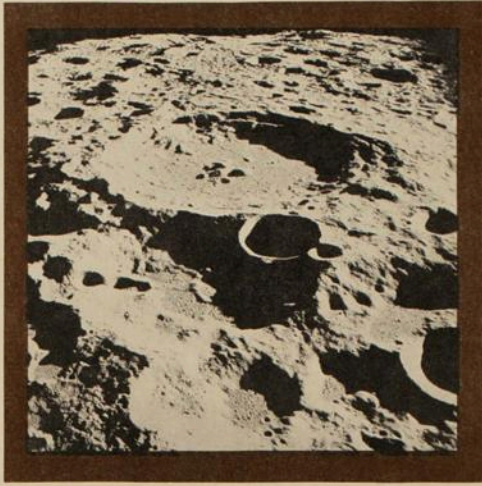
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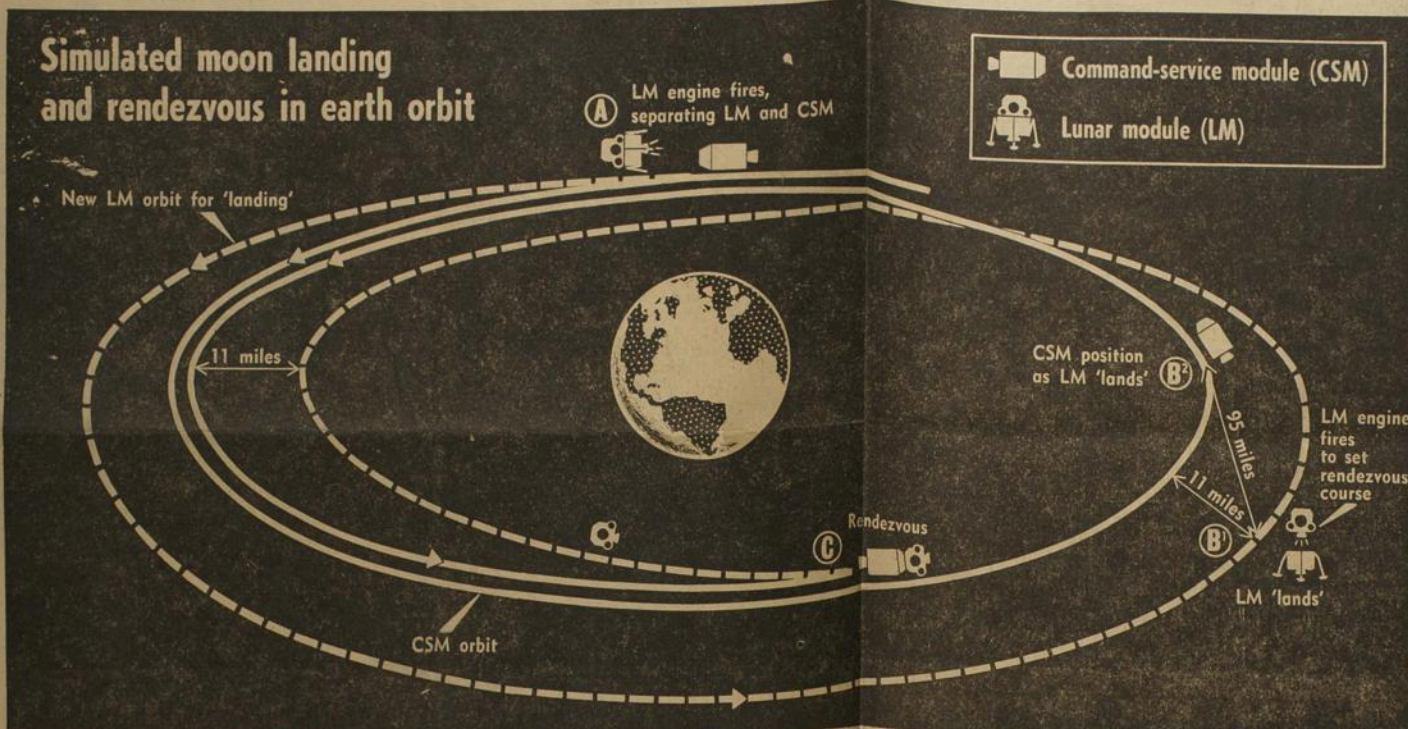
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The Hunt Institute for Botanical Documentation, a research division of Carnegie Mellon University, specializes in the history of botany and all aspects of plant science and serves the international scientific community through research and documentation. To this end, the Institute acquires and maintains authoritative collections of books, plant images, manuscripts, portraits and data files, and provides publications and other modes of information service. The Institute meets the reference needs of botanists, biologists, historians, conservationists, librarians, bibliographers and the public at large, especially those concerned with any aspect of the North American flora.

Hunt Institute was dedicated in 1961 as the Rachel McMasters Miller Hunt Botanical Library, an international center for bibliographical research and service in the interests of botany and horticulture, as well as a center for the study of all aspects of the history of the plant sciences. By 1971 the Library's activities had so diversified that the name was changed to Hunt Institute for Botanical Documentation. Growth in collections and research projects led to the establishment of four programmatic departments: Archives, Art, Bibliography and the Library.



# Apollo 11 Lunar Science Conference Proceedings



Command-service module (CSM)  
Lunar module (LM)

At A, the LM, with two astronauts aboard, starts on its path toward a simulated moon landing at B1. By the time it has reached this point, its slightly higher orbit has slowed it so that it is 95 miles away from the CSM mother ship (B2), piloted by the third astronaut. At B1 the LM jettisons its descent stage (as it would on the moon), and its ascent engine fires it on a course that will permit it to overtake, rendezvous (C), and dock with the CSM. If for any reason the LM cannot make the rendezvous maneuver, the CSM can be slowed to let the LM overtake it. (Drawing is not to scale and does not show various orbital adjustments by the LM. Actual "landing" and rendezvous exercise will take about 5½ hours and almost 4 orbits to complete.)

# Around the world for 9.3 days

A major task of the Apollo 9 flight set for next Friday will be to test the craft that will land men on the moon. To do this, two astronauts will simulate a moon landing in earth orbit aboard the lunar module, while a third stays with the mother ship. Here is a profile of how the 4.2-million-mile flight is expected to go.

By Neal Stanford  
Staff correspondent of The Christian Science Monitor

**Cape Kennedy, Fla.**  
**THE 10-DAY TRIP COMING UP FOR** astronauts James A. McDivitt, David R. Scott, and Russell L. Schweickart should cover 4,200,000 miles before splashdown. The Apollo 9 astronauts expect to complete 90 percent of the flight's work schedule in the first five days. In that period they will have accomplished the major task of their mission: to man-rate the lunar module (LM) that will ferry two astronauts between a moon-orbiting Apollo mother ship and the lunar surface. The decision to test the LM in the relative safety of earth orbit means that the moon-landing craft will have to be tested with no moon available. A simulated landing will have to do. This isn't ideal, but it does permit testing out all the subsystems of both spacecraft, their ability to fly together, to fly separately, rendezvous, and dock. It is all that NASA officials feel wisdom and caution permit for the first manned flight-testing of the LM. Here in abbreviated form is the "Triptik" for the Apollo 9 flight, prepared not by the American Automobile Association but by the National Aeronautics and Space Administration. NASA's "Triptik" comes in several volumes, which the three astronauts have been studying for years. Since the Saturn-Apollo is expected to blast off from Cape Kennedy as close to 11 a.m. Feb. 28 as possible, the flight days in this summary run from 11 a.m. to 11 a.m., e.s.t.

**First day:**  
Launch from Complex 39 will place the Saturn 5's third-stage S-4B in a 103-nautical-mile circular earth orbit, with the Apollo command-service module and lunar modules attached. Then the first big maneuver begins. The four-panel aluminum shroud which protected the LM during launch is blown off, revealing the angular lunar craft. The command-service module, or CSM, pulls away from the S-4B and its attached LM, turns around and then docks with the LM. Immediately the CSM and docked LM pull away from the S-4B, which has now finished its job. With a couple of burns the S-4B flies off into space for permanent orbit around the sun. The purpose of these burns is to demonstrate the restart ability of the S-4B. In a moon landing flight it will have to restart and send the joined CSM and LM on the way to the moon. This first day ends with the service-module engine doing a short firing to check it out and raise the orbit to 131 by 113 miles.

**Second day:**  
This day will not be as busy as the first. It includes three different burns of the service-module engine, to test it out. The crew will also be shaping the orbit to what gives the best lighting and ground tracking for the coming rendezvous maneuver. They will be evaluating the whole Apollo spacecraft

During this day, as on the first day, the Apollo and LM will be joined, or docked, flying together. There will, of course, be time out for meals, for sleeping, and house-keeping as on every day.

**Third day:**  
This is IVA day (for intervehicular activity). LM pilot Schweickart and flight commander McDivitt will open up the three-foot docking tunnel between the Apollo spacecraft and the LM, transfer to the LM, turn on its subsystems, and check them out preparing to fly the LM separated from the CSM. Also on this day they will fly the joined spacecraft, burning the descent propulsion engine of the LM. This is to demonstrate one of the rescue modes available in the event the astronauts have difficulty with the service-module engine when they arrive at the moon. If, having achieved lunar orbit, they decide the SM engine may not restart to kick them out of orbit back toward Earth, they can use the LM's descent engine for that purpose. Obviously on an actual lunar flight this would abort any moon landing. It also would only be possible before an LM descent to the lunar surface. For, once on the moon, the descent stage, with its engine, is abandoned, and the ascent stage brings the two astronauts back to the orbiting mother ship. The smaller ascent-stage engine lacks sufficient thrust to return the Apollo spacecraft to Earth.

**Fourth day:**  
This day and the fifth day are the highlights of the flight. On the fourth day LM pilot Schweickart will spend 11 hours in an EVA (extravehicular activity) operation, getting ready for a walk in space, taking it, then returning inside the LM. First, he and astronaut McDivitt again will transfer to the LM through the tunnel. Astronaut Schweickart will spend some two hours just suiting up, and later unsuiting, for his space walk. Of the 11 hours, he will spend only 2 hours, 10 minutes outside the LM. He will back out of the LM hatch and step out on the "front porch" of the LM. From here a ladder goes down one of the LM's four spider legs. But Astronaut Schweickart will go in the other direction, crawling up the LM to the docked command module,

using hand rails all the time. Reaching the hatch of the CM, he will step inside, standing on one of the couches. CM pilot Scott will hold his legs so he won't float back out the hatch. During this EVA operation, both spacecraft will be depressurized, with hatches open and all astronauts suited up in their pressure garments. After a 15-minute rest—movement in space is very tiring as was demonstrated in Gemini flights—Astronaut Schweickart will step out of the CM, climb back to the LM, reenter, and close the hatch. On the way back he will pick up five thermal samples that were put on the spacecraft before the flight. These are designed to show the effect of space environment on various types of material. The EVA operation is to prove that astronauts could make a EVA transfer from the LM to the Apollo spacecraft if, for instance, the LM couldn't make it all the way back to the mother ship or if, when the LM reached the mother ship, the astronauts found return via the tunnel impossible.

**Fifth day:**  
This is rendezvous day, the crux of the whole flight. On a real moon flight the LM must be able to leave the Apollo command ship, fire its descent engine for the trip to the moon's surface 60 miles below, fire its ascent engine to rejoin the command module, rendezvous with it, dock with it, and transfer the two-man LM crew back to the Apollo spacecraft via either IVA or EVA. Rendezvous has to work if there is to be a successful moon landing and return. In the Apollo 9 rendezvous operation, Astronaut Scott will pull his CSM a mile or two away from the LM. During this gradual separation he will "eyeball" the LM to be sure that the landing legs have unfolded

and locked properly and that everything is "go."

If all is well, the LM astronauts, after a check of their systems, fire the descent-stage engine to put the LM in an orbit a little higher than that of the CSM and therefore slightly behind it. When the two craft are about 25 miles apart the astronauts again check systems. If things are not "go" at this point for the full rendezvous maneuver, a third burn can lower the LM's orbit, enabling it to catch up with the CSM. But if all is "go," the LM descent-stage engine fires again to raise the LM's orbit still farther, till the two craft are about 95 miles apart. At this point, the LM has "landed" on the moon. While the actual lunar surface would be only 60 miles below the LM when it separated from the mother ship, the LM's actual descent path out of orbit would be a 95-mile curve, not straight down. Hence, the Apollo 9 test. After Astronauts McDivitt and Schweickart "land," they jettison the descent stage, fire the ascent engine, and start on a curved 95-mile trajectory relative to the orbiting CSM. A docking then occurs and Astronauts Schweickart and McDivitt climb back through the tunnel to the command module. On an actual moon flight, the ascent stage would then be jettisoned and left in lunar orbit, while the service-module engine fired the CSM out of orbit back toward earth.

**Sixth through 10th day:**  
After jettisoning the LM's ascent stage, Apollo 9's crew will spend the last four days of the mission flying the Apollo spacecraft. They will do additional burns of the service-module engine, rest a lot after the two strenuous days of testing the LM, and engage in

a number of star-sighting and navigational exercises.

They will also test a new four-camera combination, each lens with a different filter. Pictures from these cameras—synchronized for simultaneous exposure and attached to a common mount—will, it is hoped, detect crop characteristics on earth and locate drought areas. Splashdown and recovery in the Atlantic are scheduled for Sunday, March 9.

What about the next Apollo flight—No. 10? If Apollo 9 shows up bugs in the LM or in rendezvous and docking procedures, Apollo 10 will have to be an earth-orbital repeat. That could be as early as late April. If, on the other hand, Apollo 9 is a success and the LM is man-rated, NASA has two choices:

- It can send Apollo 10 into lunar orbit, practice with the LM there, but only let it down 25 to 50 miles toward the moon, instead of the full 60 miles to touchdown.
- Or, it can give the crew the "go" and do the actual landing on that flight.

At present NASA's schedule doesn't call for a moon landing until Apollo 11—some time in late summer or early fall. Dr. George H. Hage, Apollo program deputy director, is playing it safe.

"Many of us in the program feel it is prudent at this time to conduct two manned flights with a lunar module before we attempt a landing. That is the way our program is now laid out. But I can't completely rule out the possibility, after we assess the results of A-9. We might modify plans for Apollo 10 to be more ambitious—or even less ambitious." Apollo 9 will decide which.

Last of three articles.

## How to enjoy 'village Asia'

# 300 miles of beaches on Malaya's East Coast

By Nancy L. Snider

Written for *The Christian Science Monitor*  
Beaches and batiks—make highlights on a visit to the East Coast of the Malayan Peninsula.

The travel-weary tourist in tropical Southeast Asia will delight in the beauty and practicality of both these attractions.

Most countries in this part of the world have long coastlines. But the beaches are often not easily accessible, or sometimes subject to tides which turn them into mudflats for 12 hours each day.

Jet-hopping travelers who tire of the bazaars, temples, and colorful traffic that produce "instant Asia" in such cities as Hong Kong, Bangkok, and Singapore, now have the opportunity to enjoy "village Asia" along Malaya's East Coast. And if one desires, the trip includes a daily swim at unspoiled white-sand beaches fringed with jungle palms.

There are about 300 miles of such beaches, and a well-paved highway now runs up the coast from the Republic of Singapore all the way to the Thai border.

Since about 80 percent of the Malayan peninsula is covered with dense jungle growth, much of the area through which the road passes is still in a rugged primitive state.

What about batik? This hand-blocked Indonesian-Malaysian cotton fabric is prized by the ladies for its intricate colors and designs, as well as for its wearability in the humid tropics. Many of the batik craftsmen live and work in the coastal area of north-eastern Malaya.

With the assistance of the Malaysian Government rural development agency, MARA,

their livelihood is rapidly being changed from a small cottage industry into a thriving commercial tourist and export business.

To drive the East Coast road from Singapore to the Thai border and back, travelers should allot at least 10 days' to two weeks' time. In Singapore there are two well-known American rent-a-car agencies.

Self-drive rates compare favorably with those charged in the United States. Both air-conditioned and chauffeur-driven cars are also available at premium rates. Gas in Malaysia is about twice as expensive as in the United States.

For this reason visitors will probably find it preferable to hire a small European or Japanese car. These get about 40 miles to the gallon, thus reducing the price of gas to a cost only slightly more than the cost in the United States.

Such cars are also more comfortable to drive on narrow Asian roads than larger and more luxurious American models. A valid international driving license is easily obtained upon presentation of a United States license.

Hotel and eating accommodations along this route are limited, and vary greatly from town to town. It is wise for the tourist to obtain a list of rest houses and hotels in Malaysia before setting out from Singapore.

These lists may be obtained from the Singapore Automobile Association, or from the Malaysian Government Tourist Office in Kuala Lumpur (by mail). Rest houses were established during the period of British rule in Malaysia. They provide reasonably clean, moderate, Western-style accom-

modations in towns which had no such facilities.

Although some of these towns now have hotels as well, in others the rest houses still provide the best lodging available. Their quality ranges from very good to very poor. In towns such as Kuantan, Kuala Trengganu, and Kota Bahru, there are fairly good hotels which tourists may prefer to rest houses.

Both rest houses and hotels along the East Coast are extremely cheap by American standards. A night's lodging in the beautiful new rest house on the beach near Kuantan costs about \$5 for a double room. An air-conditioned double room with bath in a newly opened hotel in Kuala Trengganu costs only \$4.

Travelers will probably want to check the accommodations list with a tourist agent in Singapore to get some idea of the quality and caliber of the various hotels listed before starting out on their trip.

Highlights of the trip, going north from Singapore, may include a visit to the modern chrome and Danish-teak-furnished palace of the Sultan of Pahang in the old capital city of Pekan.

More adventurous travelers may also wish to plan a boat trip up the Pahang River to the inland Lake Chini, rumored to have its own Loch Ness monster. On the shores of this lake one can visit the homes of Malayan orang asli (aborigines) who number some 50,000 of Malaysia's total population of about 8 million.

On the coast just north of the Pahang River is the town of Kuantan. This is a bus-

tyling place located at the junction of the East Coast highway and the road leading west to Kuala Lumpur, Malaysia's capital.

Kuantan is noted for beautiful Chempedak Beach three miles north of the town. Visitors may stay at the new rest house already mentioned, or at a reasonably good hotel, both of which are located within walking distance of the beach.

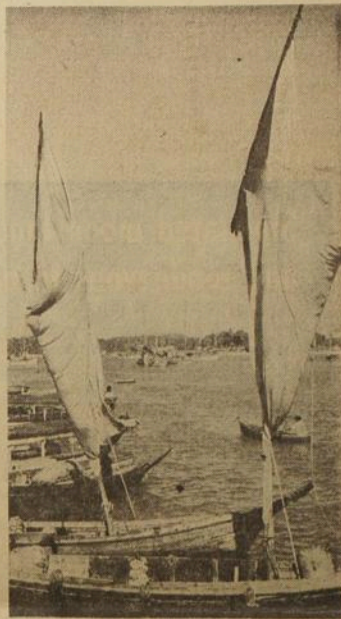
Three-fourths of the way up the coast toward Thailand, is the lovely Malaysian fishing town of Kuala Trengganu. A visit to the MARA government-run shopping center in Kuala Trengganu is a must. A great variety of local items, including Kelantan silver jewelry and batak clothes and yard goods, may be purchased there.

Batek is still a real bargain at about \$2 per yard. Both traditional designs and more contemporary ones suited to Western tastes are available. The attendants will gladly give visitors directions on how to find some of the many small batak factories nearby.

Watching the difficult hand stamping and dyeing process involved in making batak brings renewed appreciation for the type of craftsmanship that is fast disappearing in our age of mass production techniques.

Driving north for another hundred miles brings the traveler to Kota Bahru, only a few miles from the Thai border. This city is the center of the silver industry of the State of Kelantan. One can watch the silver being pounded and shaped into beautiful designs at various factory shops.

Kota Bahru marks the turnaround point on a trip up the coast. Rather than return



Sails are 'trade mark'

The distinctive canvases, or sheets, hung up by Malaysian fishermen, are displayed on these fishing boats in Kuala Trengganu in the northeast section of Malaya on the Trengganu River.

to Singapore over the same route, however, tourists may wish to drive southwest from Kota Bahru to Kuala Krai where they may transfer themselves and their automobile to the Malaysian National Railroad.

## Michigan museum to mark 40th year

Special to *The Christian Science Monitor*  
Dearborn, Mich.

On Oct. 21, one of America's oldest folk museums celebrates its 40th year. It was on this date four decades ago that the Henry Ford Museum and Greenfield Village here officially opened.

Actually, the nucleus of the museum began many years before, when Henry Ford started collecting all sorts of Americana connected with the development of the nation. Ultimately, he had to find a setting for the things he had collected and the Ford Museum and Greenfield Village was the result.

A 260-acre site was laid

out, of which a major portion was Greenfield Village. Here were placed original homes and shops of many notable and less-noted Americans which had been transplanted here from their original locations.

Thomas Edison's laboratory, where he invented the electric lamp, was moved lock, stock and barrel from Menlo Park, N.J., to Dearborn. It was here on Oct. 21, 1929, that the 50th anniversary of the invention of the lamp was celebrated in a re-creation of the event with Mr. Edison, Mr. Ford, President Hoover, Harvey Firestone, and many other notables present.

The Wright Cycle Shop,

where Wilbur and Orville built the components for their first frail aircraft that flew at Kitty Hawk, N.C., was moved from Dayton, Ohio. It was rebuilt, along with the Wright homestead, under the personal supervision of Orville Wright.

The Webster House, where Noah Webster worked on his dictionary; Ann Arbor House, where Robert Frost, American poet, lived while at the University of Michigan; Logan County Courthouse, where Abraham Lincoln once practiced law and which houses the chair in which he was assassinated, are there.

Other buildings are

located here because they are significant of a period of American life or marked a milestone in technological development. There is a windmill from Cape Cod, for example, a covered bridge from Pennsylvania, and a farmhouse from New Hampshire.

Around the "Village Green" are the Martha-Mary Chapel, Clinton Inn, a 100-year-old hostelry, and the town hall. On the outskirts of the village are a sawmill, a cider mill, a sugar mill, a grist mill, and many workshops and factories showing how our ancestors produced the necessities of life in previous periods.

## Quick comparison of Caribbean isles

Written for *The Christian Science Monitor*

For a choice of Caribbean islands, here is a list of destinations and their special attractions. They are classified according to popularity, based on the number of visitors.

**Puerto Rico**  
Spanish atmosphere, luxury beach-front hotels, super clubs with big-time entertainment. Excellent sports, fishing, golf, horseback riding. Many colorful festivals throughout the year.

**U.S. Virgin Islands**  
The islands feature \$200 duty-free shopping as against \$100 maximum elsewhere in the Caribbean. St. Thomas is lively with big shopping center at Charlotte Amalie, night clubs, many hotels. St. Croix is more pastoral but with good selection of hotels and a fine 18-hole golf course. St. John, with Virgin Islands National Park, is unspoiled. All offer excellent beaches, water sports, big game fishing.

**Jamaica**  
Excellent hotels and beach resorts on north coast at Montego Bay and Ochos Rios. Fine hotels at Kingston. Authentic native art and atmosphere. Scenic mountains.

*Travel*

Chief Officer Lindstad suggests:

## "Cruise to a month of Mediterranean Spring...Norwegian Style"



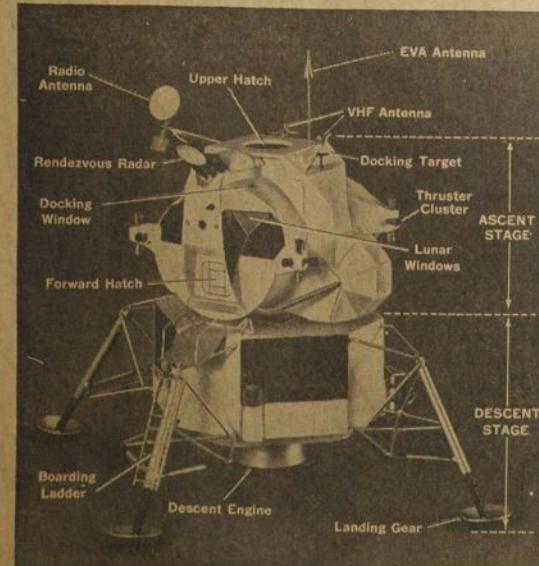
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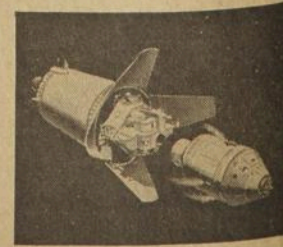
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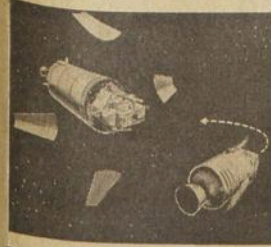
# Apollo 9 and Crew, Recovered From Colds, Lift Off Today to Test Lunar Craft



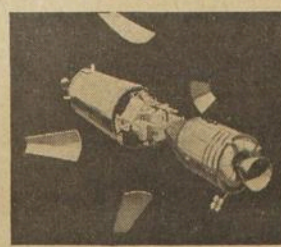
This is the Spider, to be flown and tested on the Apollo 9 mission. Twenty-three feet high, 31 feet wide, the two-section lunar module will one day ferry men between the moon and an orbiting spaceship.



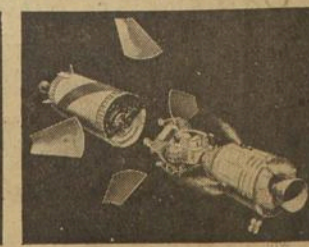
FIRST DAY: As the 10-day flight begins, Apollo pulls away. Spider is still fixed to the third rocket stage.



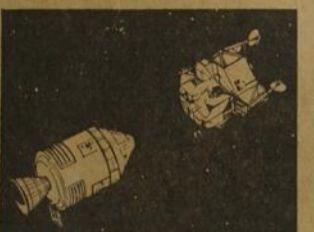
SECOND DAY: Command ship and Spider execute various maneuvers to test their somewhat flexible linkage. Three engine burns are scheduled.



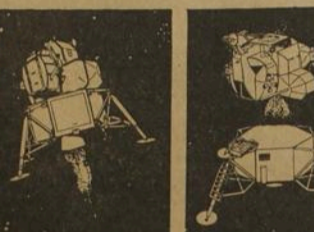
THIRD DAY: Col. James A. McDivitt and Russell L. Schweickart go through tunnel from command ship to check out Spider. They do a live TV broadcast.



FOURTH DAY: Astronaut Schweickart walks in space for more than two hours while Colonel McDivitt stays inside Spider. Plan calls for second live TV broadcast.



FIFTH DAY: Command ship and Spider undock, drawing apart to begin maneuvers that are crucial to land on moon.



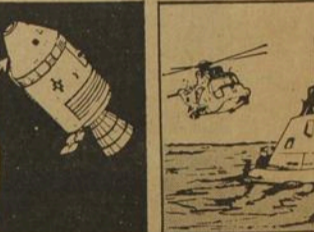
SIXTH TO NINTH DAYS: One of the highlights of this relatively jettisoned. It stays in space. Leisurely period is earth mapping.



TENTH DAY: The command ship re-enters earth's atmosphere, splashing down in the Atlantic near Bermuda.



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## MANNED MOONSHIP WILL ORBIT EARTH

10-Day Flight Set at 11 A.M.—2 Men to Fly in Vehicle Unable to Return to Earth

Continued From Page 1, Col. 4 that all major components for a lunar landing mission—the Saturn 5, the command ship and the lunar module—are flown together. Cost of the mission is estimated at \$340-million.

It will be the first manned space flight of the lunar craft. The squat, spindly-legged craft was designed to ferry future astronauts to the moon's surface and back to the waiting command ship in lunar orbit.

The command ship was tested by the Apollo 7 astronauts last October and by the Apollo 8 astronauts in their flight around the moon last December.

Series of Maneuvers On Apollo 9, the astronauts plan a series of risky maneuvers and Apollo officials had a cautious outlook on the chances of a completely successful flight.

"This is an extremely complex mission, probably one of the most complex we've ever flown," Christopher C. Kraft, director of flight operations, said.

"It would probably not surprise any of us if we did not come out with 100 per cent success, but we have every confidence we have an opportunity to do that."

The Saturn 5's task will be to boost the Apollo command ship and the lunar module into an 119-mile-high orbit. The Saturn's full stage will still be attached to its payload. Nearly three hours later, the astronauts plan to separate the command ship, turn it around and hook up nose to nose with the lunar module.

Third Stage Will Separate. The third stage rocket will then be separated and its engine fired twice on command from the ground to send it off into a wide orbit of the sun.

The Apollo 9 flight plan then includes a two-hour space "walk" between the linked lunar module and command ship by Mr. Schweickart on the fourth day and rendezvous exercises in which the manned lunar module on the fifth day must hunt and find the command ship, as in a return maneuver from the moon.

Two television transmissions to earth are planned. One is scheduled Wednesday and another during Mr. Schweickart's "walk" on Thursday.

When Colonel McDivitt and Mr. Schweickart crawl into the lunar module and cast off Friday from the command ship, piloted by Colonel Scott, it will mark the first time men have been in orbit in a vehicle incapable of getting them back to earth.

The lunar module, designed only for operations on and around the airless moon, lacks any shielding against the tremendous heat generated when a spacecraft plunges through earth's atmosphere.

At one point, the two men in the lunar module should be more than 100 miles away from the command ship. If the lunar module is crippled, however, it

## Timetable of Major Events in Apollo's 10-Day Flight

Following are highlights in the flight plan of the Apollo 9 spacecraft, scheduled to be launched today at Cape Kennedy. The plan is subject to change at any time, depending on how the flight progresses. Times are Eastern Standard.

- TODAY**
- 11 A.M.—Saturn 5 blasts Apollo command ship and unmanned moon landing craft, or lunar module, into 119-mile-high orbit.
  - 1:43 P.M.—Command module and lunar module separate. Command module turns around to face lunar module, which is still attached to inactive third stage of Saturn 5.
  - 1:53 P.M.—Command ship and lunar module dock.
  - 3:08 P.M.—The two modules separate from third stage of Saturn 5 rocket.
  - 5:02 P.M.—Astronauts fire their command ship's main engine for first time, raising their own orbit to an altitude ranging from 130 to 147 miles.
  - 5:07 P.M.—Third stage engines re-ignite. Stage goes into solar orbit four minutes later.
- TOMORROW**
- 9:12 A.M.—Main command ship engine fires a second time, raising high point of orbit to 221 miles.
  - 12:19 P.M.—Third firing of main engine raises peak of orbit to 310 miles.
  - 3:28 P.M.—Fourth firing of main Apollo engine results in orbit of 312 to 132 miles. This firing and the three before it are designed to test the performance of the command ship with lunar module attached.
- WEDNESDAY, MARCH 5**
- 5:10 A.M.—Russell L. Schweickart, lunar module pilot, crawls through tunnel in command module's nose to enter moon lander in space for first time, followed at 6:08 by Col. James A. McDivitt of the Air Force, spacecraft commander.
  - 9:27 A.M.—Space television show inside lunar landing craft, scheduled to last seven minutes.
  - 12:42 P.M.—Still inside lunar module, Colonel McDivitt fires module's descent engine. This tests engine's ability to propel both moon lander and command ship, and ability of crew to control its thrust manually.
  - 1:15 P.M.—Colonel McDivitt re-enters command ship, followed at 2:12 P.M. by Mr. Schweickart.
  - 5:26 P.M.—Fifth firing of command ship's main engine circularizes orbit at 153 miles.
- THURSDAY, MARCH 6**
- 10:08 A.M.—Mr. Schweickart and Colonel McDivitt re-enter lunar module.
  - 12:10 P.M.—Mr. Schweickart climbs out hatch of moon landing craft, starting space walk to command ship hatch and back.
  - 2 P.M.—Standing outside moon lander, Mr. Schweickart

- presents second and last TV show. It is to last 10 to 12 minutes.
  - 2:22 P.M.—Mr. Schweickart climbs back into lunar module, ending space walk.
  - 3:45 P.M.—Colonel McDivitt re-enters command ship, followed at 4:36 P.M. by Mr. Schweickart, for the night.
- FRIDAY, MARCH 7**
- 4:46 A.M.—Colonel McDivitt and Mr. Schweickart enter lunar module and prepare for rendezvous maneuvers.
  - 7:39 A.M.—Command ship and lunar module separate, pulling slightly apart after 25 minutes.
  - 8:50 A.M.—Colonel McDivitt fires moon lander's descent engine in first of three maneuvers that will place lunar module up to 105 miles behind the command ship, which carries Col. David R. Scott of the Air Force, command ship pilot.
  - 11:22 A.M.—Lunar module's descent stage is jettisoned.
  - 12:00 P.M.—Rocket engine of lunar module's ascent stage is fired to start Colonel McDivitt and Mr. Schweickart back toward command ship.
  - 1:35 P.M.—Ascent stage catches up with command ship, docking with it 35 minutes later.
  - 4:30 P.M.—Astronauts, now all back in command craft for rest of flight, jettison ascent stage. Half an hour later the ascent engine is fired by remote control, sending unmanned craft into orbit 4,795 miles high.
- SATURDAY, MARCH 8**
- 1:01 P.M.—Command ship's main engine fires to lower astronauts into orbit ranging between 109 and 155 miles high.
- SUNDAY, MARCH 9**
- 10 A.M.—Astronauts begin first of five landmark tracking assignments scheduled for this day.
- MONDAY, MARCH 10**
- 12:49 P.M.—Command ship's main engine fires to raise orbital high point to 242 miles, the final orbital adjustment before re-entry.
- TUESDAY, MARCH 11**
- 9:25 A.M.—Astronauts begin day of experimental infrared photography to study crop conditions and natural resources from space.
- WEDNESDAY, MARCH 12**
- 9:25 A.M.—Astronauts start second day of photography experiment.
- THURSDAY, MARCH 13**
- 9:12 A.M.—Command ship fires main engine for eighth and last time, slowing craft and sending it back toward earth.
  - 9:47 A.M.—Astronauts splash down in Atlantic Ocean, 250 miles east-southeast of Bermuda.

## 3 Spacecraft to Join in Mission

By RICHARD D. LYONS Special to The New York Times

HOUSTON, March 2—The products of hundreds of American factories, laboratories and think tanks will mesh 126 miles over Texas tomorrow when the three spacecraft designed to fly man to the moon and back are assembled in orbit for the first time.

Should the launching from Cape Kennedy of Apollo 9 occur as scheduled at 11 A.M., the three spacecraft built to carry, power and ferry astronauts to the moon's surface will be linked together at 2 P.M. They will then form a single, 45-ton unit containing four million parts.

The conical command module that will carry astronauts through the atmosphere into space and then return them to earth, already has flown almost perfectly on Apollo flights No. 7 and 8.

These also were the first manned proving flights for the cylindrical service module containing the engine and propellants that power the spacecraft to the moon and back.

Lunar Module in Space But tomorrow will mark the first time that the "space train" car—the lunar module—will operate in space under the command of astronauts.

The lunar module, the spidery-looking spacecraft that eventually will land astronauts on the moon, will be unzipped from its metal cocoon and docked with the command module shortly after the start of the 10-day Apollo 9 mission.

Apollo 9 is a test flight for the modules needed to get to the moon, but more important, it is the first mission of the lunar module with astronauts aboard.

Tomorrow's flight also has been categorized by officials of the National Aeronautics and Space Administration as the most complicated and hazardous mission to date.

Two manned spacecraft will

## Command, Service and Lunar Modules to Link in Orbit

fly in formation and maneuver in space at distances up to 100 miles and more.

Col. James A. McDivitt of the Air Force, the Apollo 9 commander, and Russell L. Schweickart, a civilian, will fly the lunar module for more than five hours on Friday, while Col. David R. Scott of the Air Force mans the command module.

Aside from blastoff and splashdown, this period will be the most hazardous in Apollo 9 since the lunar module is not designed to re-enter the earth's atmosphere. Should something go wrong and the two vehicles drift apart from each other, there would be no way for Colonel McDivitt and Mr. Schweickart to return to earth alive.

The lunar module, which has been under design and construction for six years at the Grumman Aircraft Engineering Corporation at Bethpage, L. I., is an intricate package of engines, propellant tanks, life support systems and instruments.

Two-thirds of the lunar module's 16 tons of weight is hydrazine fuel and nitrogen tetroxide oxidizer, which ignite on contact, giving the spacecraft the aura of a flying bomb.

The propellant powers 18 engines, 16 of which are relatively small ones of 100 pounds of thrust each that are used to control the attitude of the lunar module and to make minor adjustments in its flight path.

The largest engine—the descent engine having 10,000 pounds of thrust—is designed to lower the lunar module to the moon's surface and brake it, providing a gentle landing.

After lunar exploration, the two

astronauts will take off from the surface in the upper half of the 23-foot-high lunar module, which has its own engine.

This ascent engine, having 3,500 pounds of thrust, is designed to carry the astronauts up from the moon's surface to a rendezvous with the command and service module.

The command craft during the lunar landing will be orbiting the moon at an altitude of about 69 miles.

To Simulate Many Maneuvers. The Apollo 9 flight will simulate many of the maneuvers necessary to achieve the landing on the moon.

The ascent, descent and re-entration control engines all will be fired, and the two main sections of the lunar module will be separated, or "staged."

The life support systems that provide the two lunar module crewmen with oxygen and water also will be thoroughly checked. The main environmental control system aboard the lunar module provides oxygen to pressurize the cabin the space suits and for breathing.

A heat transport system keeps the cabin at a comfortable temperature, while off environmental controls vent late the cabin and provide water.

Aboard the lunar module is 80-pound portable life support system, which Mr. Schweickart will wear on his back during his two hours of extravehicular activity on Thursday, and smaller portable oxygen tanks for both himself and Colonel McDivitt.

A Complicated System The most complicated system aboard the lunar module is its guidance, navigation and control equipment. This combination of radars, computers, attitude sensors and instruments tells the astronauts where they are, and where they are going.

Should the astronauts need to return to the command module if something suddenly goes wrong, an abort guidance system is designed to hasten their flight to safety.

Eight different radio systems also keep the astronauts in communication with the command module pilot and ground controllers. Their antennas, together with the radars and the craft's spindly legs, give the lunar module an insect-like appearance. This has led to its nickname of Bug or Spider.

The lunar module, which costs more than \$100-million, has been space-tested only once, on an unmanned flight 13 months ago. During that test, which was the Apollo 5 mission, the ascent and descent engines worked extremely well.

Tomorrow's flight is scheduled to be the first docking of two spacecraft, in which crewmen will go back and forth between the two vehicles through interlocking hatches.

During the flight, the vehicles will dock twice, aided by a docking shaft on the command module that fits into a hole on the lunar module. This so-called drogue and probe assembly holds the two spacecraft tightly together so the lunar module crew may crawl through a 16-inch tunnel connecting the two vehicles.

On Saturday, after many of the prime objectives of the mission have been accomplished, the lunar module will be jettisoned later to burn up as it enters the earth's atmosphere.

should be possible for Colonel Scott to steer the command ship to the rescue.

After the final rendezvous, the two astronauts are to crawl back through a connecting tunnel into the command ship. They are scheduled to return to earth in it on March 13, with a splashdown in the Atlantic Ocean southeast of Bermuda.

During the last five days in flight, the astronauts are not expected to be quite so busy. They will concentrate on practicing navigation and taking pictures of the earth.

Nothing in the mission plan is more important to future Apollo astronauts than the rendezvous and docking of the two ships.

If the lunar module performs without serious flaw, it should clear the way for the Apollo 10 astronauts to fly around the moon in May as a test of the landing craft in the lunar vicinity. No landing would be attempted on that flight.

Then Apollo 11 astronauts would follow, possibly in July, with the attempt to make the historic landing and fulfill the Apollo project's goal of putting men on the moon in this decade.

An unmanned lunar module was orbited in January, 1968, in the only previous test of the two-stage craft's rockets and guidance system.

The lower half of the vehicle houses a rocket for the descent to the moon, and the astronauts' cabin is in the upper section, which also contains the rocket for boosting men off the moon.

Both of these rockets, as well as the module's smaller maneuvering rockets, will be fired during the rendezvous maneuvers.

For most of the journey the astronauts will work, eat and sleep in their cone-shaped command ship, which is 12 feet long and 13-feet wide. It weighs 12,405 pounds.

Attached behind it is a 22-foot-long canister housing the spacecraft's electricity-generating units, oxygen supplies and the rocket used for major maneuvers, including the return to earth. This section is called the service module.

But most of the preflight concern centered not on the machines, but on the three astronauts. Last Wednesday all three developed sore throats and stuffed noses.

In space the astronauts cast the command module free and turn it around 180 degrees with their maneuvering thrusters so that its nose can be inserted into the third-stage booster rocket to pick up the Lunar Module. This is an extremely delicate operation, for it is important not to jostle the booster and its load of liquid hydrogen fuel.

This booster is designed to carry enough liquid hydrogen into earth orbit to inject the Apollo spacecraft on a lunar trajectory. How the booster's partial load of fuel would respond to jostling in the weightless environment of coasting space flight has been a cause of concern.

To reduce such jostling and achieve an air-tight lock between the Command Module and the Lunar Module, a special docking system has been devised. The attempt to join the two spacecraft in space will be the first such test of the system.

The docking apparatus consists of an extendable probe in the nose of the Command Module and a cone-shaped receptor on the Lunar Module to receive the probe, much as the

sides of a ferry slip guide the ferry to its mooring. At the apex of the cone there is a hole four inches wide—just large enough to receive the tip of the probe. As wide as the latter has penetrated the hole, three capture latches spring out to hold it firmly inside the hole.

The probe, powered by compressed nitrogen, then retracts from 34 inches in length to 24 inches as do the hinged supports surrounding it, like so many grasshopper legs. This draws the two spacecraft firmly together and 12 latches on the Command Module lock onto a circular flange on the Lunar Module.

Docking Completed This completes the docking. The docking probe can be removed from the Command Module nose, and its cone-shaped receptor, or "drogue," in the Lunar Module can also be removed and stowed, leaving an open tunnel linking the two spacecraft.

Later in the mission, before two of the astronauts cast loose in the Lunar Module to flight-test the craft, the docking gear must be replaced for the critical return of the Lunar Module from its solo excursion. It will be flown by Col. James A. McDivitt of the Air Force,

## Apollo 9 to Attempt Most Ambitious and Perilous Feats to Date

By WALTER SULLIVAN Special to The New York Times

CAPE KENNEDY, Fla., March 2—The three Apollo 9 astronauts to be launched into earth orbit tomorrow will undertake what are, by general consensus, the most ambitious and perhaps the most perilous operations yet attempted in space.

They will make the first attempt by men to fly a spacecraft—the lunar-landing module—that cannot return them to earth.

One of the astronauts will step into space for the first time with no connection to the life-support system on board the spacecraft. Instead he will carry a backpack that provides oxygen, purges his exhaled breath and keeps his body cool with a water-circulation system.

They will follow in their Apollo spacecraft. If the launching goes off on schedule at 11 A.M., this maneuver will occur shortly after 2 P.M.

The purpose is to position the Lunar Module, or LM (pronounced Lem) at the nose of the Command Module in which the three astronauts are riding. The Lunar Module rides into space tucked behind the Command and Service Module, at the top of the towering Saturn

rocket, and ahead of the third stage of the Saturn.

In space the astronauts cast the command module free and turn it around 180 degrees with their maneuvering thrusters so that its nose can be inserted into the third-stage booster rocket to pick up the Lunar Module. This is an extremely delicate operation, for it is important not to jostle the booster and its load of liquid hydrogen fuel.

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