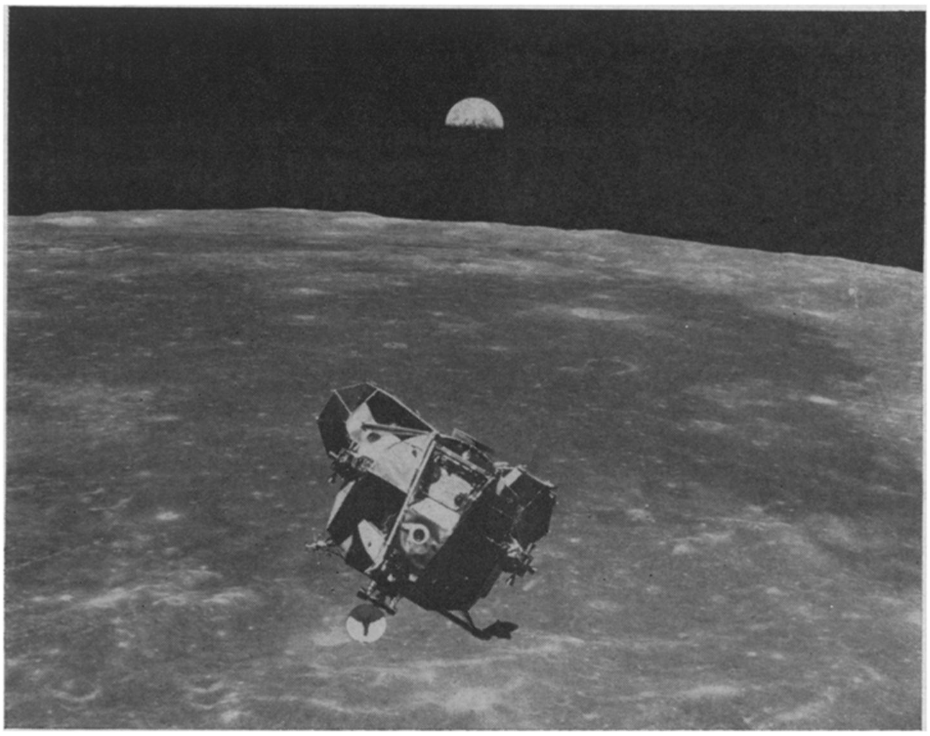
Science gets a chance

Ground-weary scientist-astronauts may find help in Apollo 12's accuracy



Photos: NASA

Mighty goofs from tiny errors, as the Apollo 11 LM approached the moon.

by Jonathan Eberhart

The Apollo 11 lunar landing was both triumphant and tricky. Astronauts Neil Armstrong and Buzz Aldrin reached the moon's surface in perfect shape, but only after a close enough call to give flight controllers on the ground a case of nerves.

The result was a not-unmixed blessing. It augured well for the future of manned space flight, but made the future even bleaker for the National Aeronautics and Space Administration's already dissatisfied ranks of scientist-astronauts, unless next month's Apollo 12 can save the day.

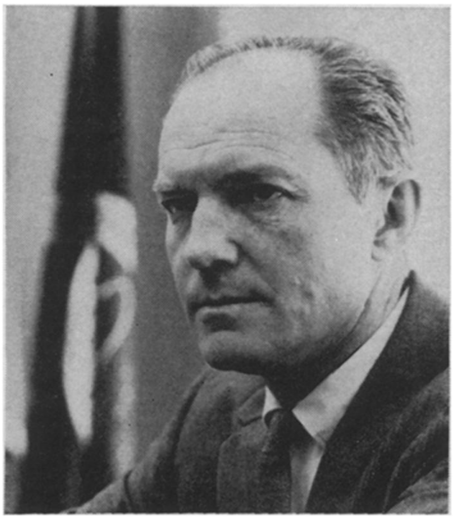
The accumulated tracking and guidance errors that put the Apollo 11 lunar module almost four miles west and a mile south of its intended landing point would have landed it in a dangerous, boulder-strewn crater, had not Commander Armstrong taken over manual control. The extra maneuvering cost all but 40 seconds of fuel in the craft's descent engine tanks.

As a consequence of what could have been a major problem, NASA officials became leery of entrusting flights to pilots less experienced than Armstrong and Aldrin. This appears fairly effectively to leave out the scientist-astronauts, most of whom have learned to fly aircraft only since joining the program at most four years ago. Unless the landings can be made more routinely safe, the moon assignments are likely to keep going to the career test pilots and military fliers comprising the rest of the corps.

"I do think," says Apollo mission director Chester M. Lee, "that until we have more experience and know more about the descent profile, a professional pilot is essential."

The space agency's nervousness, however, is not confined to the pilot's job. The next three Apollo crews have all been chosen, the latter two since the moon landing, and none of them, nor their backup crews, includes a single scientist-astronaut.

"Selections beyond Apollo 14 have not been made," says Brig. Gen. Samuel C. Phillips, who was Apollo Program director through the landing and has since returned to the Air Force. "Factors to be considered in such selections would depend in large part on what is learned in the next two flights about the difficulties and skills required to accomplish the lunar landings and to operate on the surface of the moon."



Phillips: Watch the next two flights.

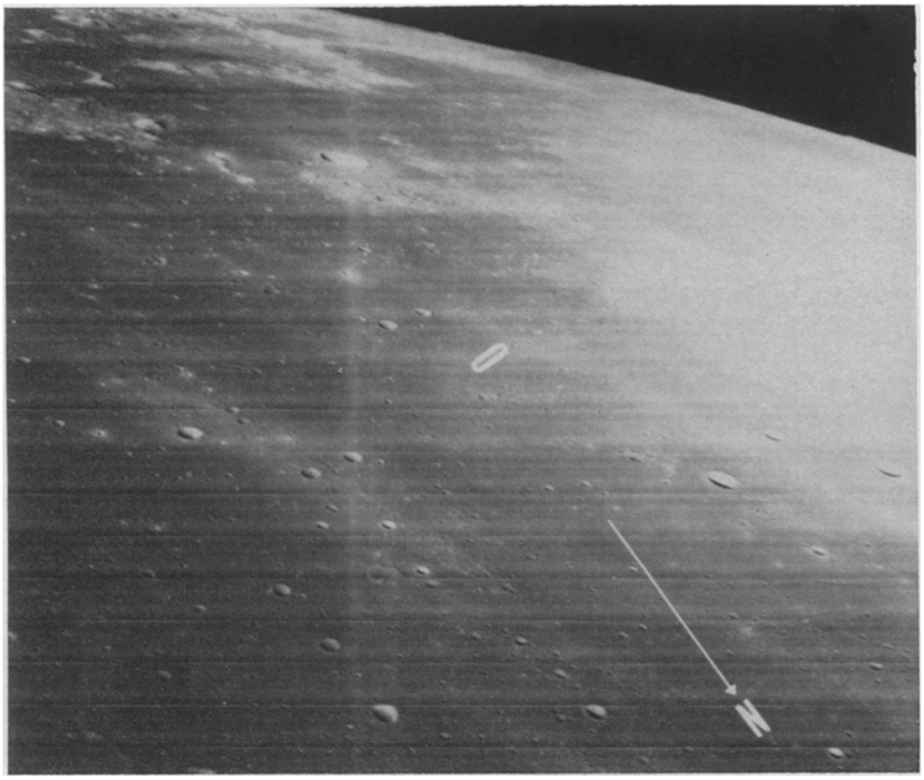
The scientist-astronauts rather heatedly disagree that there is not already a role for them on the moon.

"All of us could do the job of co-pilot, certainly," says Dr. F. Curtis Michel, a physicist who finally quit the astronaut corps in frustration over the diminishing chances of a lunar assignment, "and without extraordinary training could learn to be pilots."

Apollo pilot training requires a mission assignment, he points out somewhat ruefully. However, he says, even the pessimism caused by the difficult Apollo 11 landing should not mean that the co-pilot's job cannot go to one of the scientist-astronauts. "They all," says Dr. Michel, "would be trainable as adequate to the mission."

And it is generally conceded that a scientist should be aboard to take advantage of some of the rougher—but scientifically more interesting—sites tentatively planned for later Apollo flights (SN: 8/2, p. 92). But the Apollo 11 experience has even led space officials to reconsider those plans, with an eye to swapping the science offered by those sites for smoother landings and greater assurance of safety. If more conservative sites are chosen—such decisions should start to emerge after Apollo 12—the need for getting the most out of them scientifically will become particularly important, and could suffer if scientist-astronauts such as geologist Jack Schmitt don't get to visit them.

For the scientists, modifications to



Hitting the oval is not enough: Apollo 12 is bound for its central pinpoint.

be introduced in the Apollo 12 mission could brighten the picture. Scheduled for launch Nov. 14 to a western site in the Ocean of Storms, about 80 miles southeast of the two-mile-high walls of Lansberg crater and within walking distance of Surveyor 3, Apollo 12 will see the introduction of a host of techniques designed to ensure safer, more accurate landings.

If they work, the confirmed ability to land in the area of a football field instead of a small town could increase flexibility in both sites and crews.

Some of the techniques are small ones, such as the elimination of all waste dumping from the spacecraft in lunar orbit, but as many trouble spots are being covered as is possible. Even the relatively tiny thrust—as little as 0.1-foot-per-second—produced by letting body wastes overboard through a vent is enough, when compounded over two or three trips around the moon, to produce a sizable error by the time the LM reaches the ground.

Apollo 12 will also limit the number of tests of the landing module's ability to translate—move through space without changing its orientation—following separation from the command module. No matter how precisely the astronauts use the vehicle's control rockets to move it in a given direction and back again, the net effect is likely to be a tiny added velocity in an unplanned direction, which again can add up to a big landing error.

The act of separation can itself also be a source of considerable downrange error, since the maneuver is usually performed by using the rockets of the two spacecraft to pull them apart along their axis of travel. Since this is, in effect, the path of least resistance, it does not take much of a nudge to get the vehicles moving at other than their intended speeds, relative either to each other, or to the landing site.

The attempted remedy on Apollo 12 will be to reorient the two spacecraft, while still coupled, so that they are on a line pointing straight up from the moon, perpendicular to the direction of travel. This should minimize the effects of the separation maneuver.

In addition, Commander Charles Conrad may also let the LM stay briefly in the soft-docked position, with the coupling latches open but the docking probe still in place, to let any residual motions caused by the undocking die out.

One important aid to accuracy, says Owen Maynard, chief of the Apollo systems engineering division at the Manned Spacecraft Center in Houston, is to give the manned space flight tracking network on earth as much time as possible to follow the LM as it crosses the visible face of the moon. To do this, Apollo 12 will undock one orbit earlier than did Apollo 11, thereby giving the tracking stations a full extra pass to compute the LM's precise path. The LM guidance computer will then get its final report from earth on

. . . Apollo science

the LM's position just before the spacecraft begins its final powered descent to the surface, instead of two orbits early, as on Apollo 11. Armstrong and Aldrin had to start their downward trip knowing that their computer's information was outdated by two orbits full of accumulated errors; Conrad and Alan Bean will be almost up to the minute.

This idea is so logical that it might have been tried on the earlier mission, except that, says Maynard, the LM is a busy place once it's on its own, and the object of the first landing was just to get down safely, not to risk extra work in the cockpit to achieve pinpoint accuracy. Also, Apollo 11's site was on the eastern face of the moon, which, because of the spacecraft's east-to-west passage, would have given the crew only 16 minutes in radio view of the earth to accept the new data before having to begin the final descent, even if the last-minute update had been used. Apollo 12, aimed at a western site, will have twice that.

The Apollo 12 LM will probably, in addition, use its main engine less for braking between about 7,000- and 500-foot altitudes, in order to leave more fuel for final maneuvering. As a result, it will be moving 22 feet per second faster by the 500-foot mark, which means it will get there eight or nine seconds sooner—time that would have been useful for various cockpit tasks. But NASA planners feel that the trade-off will be worthwhile.

Finally, the LM computer will be told to aim short and to the right of the landing site, so that the site will be in perfect view from the commander's window for the final, manual maneuvers. Apollo 11, for simplicity, was targeted right to the spot—which, begging the question, it missed.

Still more is in store for Apollo 13 next March. On that mission, the command module, instead of releasing the LM almost 70 miles above the moon as on Apollo 11 and 12, will spend the better part of a day in an orbit that reaches down to only 50,000 feet, finally releasing the LM at the low point. This will both save LM fuel and improve precision by giving more tracking time.

Though Apollo officials may remain unable to take full advantage of a given mission's scientific findings for planning until two missions later (SN: 9/20, p. 235), they are hopeful that the kinds of minor flight modifications made on Apollo 12 and 13 will increase their crew selection flexibility beyond Apollo 14.

To some extent, Apollo's scientific payoffs depend on it. □