

Four Out of Six Apollos

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Apollo 15 Lunar Module Falcon at the Hadley-Apennine landing site. Hadley Delta in the background rises approximately 4,000 meters (about 13,124 feet) above the plain. The base of the mountain is approximately 5 kilometers (about 3 statute miles) away.

(PhysOrg.com) -- Their names are now part of exploration history - Sea of Tranquility, Ocean of Storms, Frau Mauro, Hadley Rille, Descartes and Taurus-Littrow. They are the sites on the lunar surface visited by America's Apollo astronauts. Six unique locations. each with its own unique set of challenges to those who wanted to explore its secrets.

"To paraphrase an old bromide, those who forget the past are doomed to land like it," said Chiold Epp of NASA's Johnson Space Center in Houston. "Having looked at the Apollo landings I have come to two conclusions. One - those crews did a great job. Two - data from several of the landings support the idea that we must give future moon landers more information to increase the probability of mission success."

To prepare for their missions, Apollo crews were heavily trained to recognize specific large-scale lunar surface features at or near the designated landing site. These features would help the astronauts find their way to a safe area as close to the planned landing site as possible. But sometimes lighting conditions would conspire with local topography to deceive even the most highly-trained eye.

With two minutes left on the descent of the lunar module Falcon, Apollo 15 mission commander David Scott looked out his window and could not find the sequence of four craters as a visual guide to his planned landing spot northwest of the fourth and final crater, Index. Said Scott during a 1971 Technical Debrief: "When we pitched over, I couldn't convince myself that I saw Index Crater anywhere."

On the very first Apollo landing, the surface features were prominently displayed, just not the right kind in the right place. At 1,500 feet above the Sea of Tranquility Neil Armstrong saw the kind of surface features an Apollo commander does not want to find in his landing zone. Said Armstrong during a 1969 Technical Debrief: "...we were landing just short of a large rocky crater surrounded with a large boulder field with very large rocks covering a high percentage of the surface."

The closer each moon crew came to the lunar surface, the more detail they could make out. The hills, valleys and boulders of the local terrain came into view and the craters became more defined. But the astronauts did not have time to appreciate their surroundings. Their fuel supply was limited and getting to the surface under rocket power was mandatory to mission success.

As each of the six crews entered the final minute of their ride to the surface, the hills, valleys, boulders and craters that had just moments ago been there for the viewing had all but disappeared.

Observed Armstrong during the Technical Debrief: "...at something less than 100 feet; we were beginning to get a transparent sheet of moving dust that obscured visibility a bit. As we got lower, the visibility continued to decrease."

Dust problems were not exclusive to the Apollo 11 landing site. All of the moon landing crews encountered some form of vision-obscuring dust. On Apollo 12, Pete Conrad encountered so much dust that his final descent to the surface was done in the blind. Said Conrad in a 1969 Technical Debrief: "The dust went as far as I could see in any direction and completely obliterated craters and anything else... I couldn't tell what was underneath me. I knew I was in a generally good area and I was just going to have to bite the bullet and land, because I couldn't tell whether there was a crater down there or not."

With limited piloting time available and restricted visibility below, the Apollo crews skillfully put their lunar modules down on the ground. But each of the six crews knew that getting to the lunar surface was not the endgame. Staying on the lunar surface long enough to walk around and complete the mission's scientific goals was what they came for. For an Apollo mission's success, attitude was important.

"In one respect an Apollo lunar module is like a pinball machine - it doesn't like to tilt," said Epp. "If a lunar module came to rest at an angle beyond 12 degrees tilt the astronauts might not be able to launch themselves off the surface. So if a crew landed on a hill or with a footpad or two on a large rock or in a crater, that could make for a bad day."

Apollo 15's lunar module Falcon came to rest with its rear footpad on the rim of a 20-foot-wide crater. This caused one of the lunar module's footpads to be off the surface entirely and placed the spacecraft at an 11-degree tilt. Stated Scott in the mission's debrief - "...at the altitudes

looking down as we approached the landing, it was very difficult to pick out depressions... as far as the shallow depressions there and the one in which the rear footpad finally rested, I couldn't see that they were really there. It looked like a relatively smooth surface."

Although Apollo 16 lunar module's landing tilt was only 2.5 degrees, if it had come down less than 100 feet in any direction from that point would have placed them on a slope of between 6 and 10-degrees. Apollo 16 commander John Young commented in the mission's Technical Debrief: "I couldn't judge slope out the window worth a hoot, and that's the truth. Even down low. The ground looks flat, but I'm sure it would look flat if it had been a 6 - 8-degree slope too. I don't see any way around that."

Young made his statement soon after he returned from the moon in 1972. The boulders, craters, crevices and dusty slopes of the Descartes Highlands were fresh on his mind. Tomorrow's moon crews will certainly encounter the same challenges. But thanks to a new NASA program that remembers the lessons of Young and the other intrepid men of Apollo, these future lunar explorers may very well have a way to "see any way around that." With NASA's Autonomous Landing and Hazard Avoidance Technology (ALHAT), they could be seeing their lunar landing sites in a whole new light.

Provided by NASA

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