

PREPARING FOR LUNAR SURFACE SCIENCE OPERATIONS. David A. Kring^{1,2}, ¹Center for Lunar Science and Exploration, Lunar and Planetary Institute, Universities Space Research Association, 3600 Bay Area Blvd., Houston TX 77058 (kring@lpi.usra.edu), ²NASA Solar System Exploration Research Virtual Institute.

Introduction: On March 26, 2019, at a meeting of the National Space Council, the Vice President defined a five-year horizon for the implementation of Space Policy Directive-1, which is to land astronauts on the lunar surface. NASA Administrator Bridenstine further articulated the task before us: land on the Moon's South Pole by 2024. That prompts three questions: (1) What needs to be done to meet the mission objective? (2) What is the schedule of tasks needed to meet the mission objective? (3) Who has the required expertise? We need a plan and it needs to be implemented immediately. That is certainly true with regard to lunar surface science operations. Recall, Armstrong and Aldrin and the science staff supporting them had 5 years 4 months to develop surface science plans before the first Apollo landing; and Cernan and Schmitt and the science staff supporting them had more than 8 years to develop surface science plans for the final Apollo landing. To meet a 5 year time-scale for a lunar South Pole landing requires immediate attention. Here I outline several elements required for lunar surface science operations.

Evaluate the landing site: Evaluate the scientific and exploration potential of the landing site using existing data and fill in or mitigate missing data to reduce mission risk while enhancing mission productivity.

Integrate program elements: Develop notional extravehicular activities (EVAs), integrate with hardware systems, iterate with engineering teams and flight operations personnel, and modify as needed, echoing the work we did with 3- to 28-day mission simulations between 2008 and 2012. Routine communication between all teams involved in a lunar surface mission needs to be established early.

Train crew for surface ops: Expand our work with astronauts during their basic geologic training and in 3- to 28-day mission simulations. It is important to recall the experience of Apollo astronauts who found field training and traverse exercises to be the most important component of their EVA preparation. Charlie Duke said "The geology field trips were outstanding. The monthly trips we did from the time we started on the crew were just right." John Young added that a field exercise "helps you get a team work pattern and I think that's real important. You are not very effective unless you're working as a team up there. Otherwise you're just going to be spinning your wheels on the Moon and that's not where they want you to spin them."

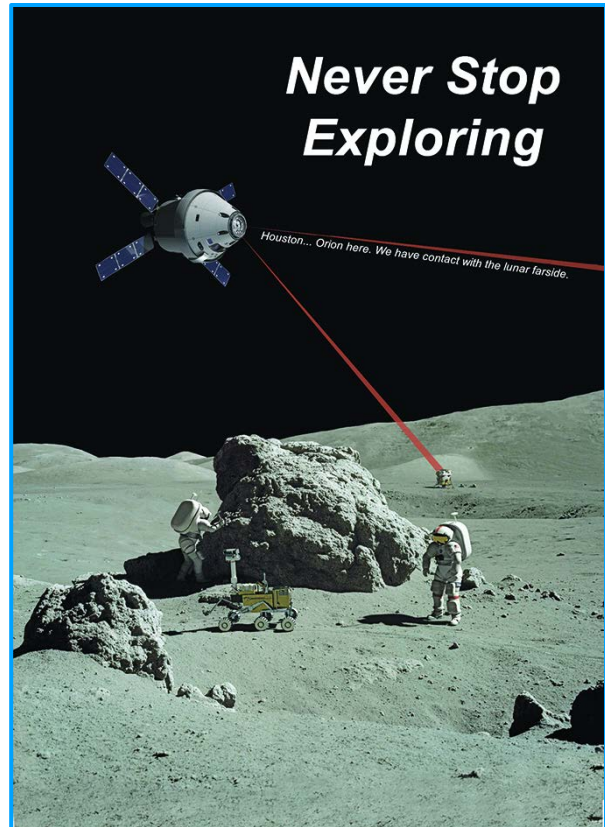


Figure 1. Crew on lunar surface with Orion overhead. Art by Daniel D. Durda for CLSE.

Train scientists for mission operations: In a series of mission simulations between 2008 and 2012, we established protocols for an integrated mission control center with a science team and traditional flight operations personnel working side-by-side. In those simulations, when crew went EVA, the Flight Director turned operations over to a SciLead who managed a science team sitting at their own consoles. Scientists who will support lunar surface EVAs need to be trained in mission operation procedures that involve crew.

Conduct mission simulations: All personnel who will be involved with an actual lunar flight need to participate in mission simulations. The simulations will uncover unanticipated challenges, produce a well-working team, and give that team the resiliency needed to successfully resolve unexpected conditions that may arise during a lunar surface mission.

That is a lot of work to do in 5 years; we need to begin immediately.