The Utility of a Small Pressurized Rover with Suit Ports for Lunar Exploration: A Geologist's Perspective

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Rover trade study: As summarized recently [1], mission simulations at Black Point Lava Flow (Arizona) that included realistic extravehicular activity (EVA) tasking, accurate traverse timelines, and an in-loop science CAPCOM (or SciCOM) showed that a small pressurized rover (SPR) was a better mobility asset than an unpressurized rover (UPR). Traverses within the SPR were easier on crew than spending an entire day in a spacesuit, enhancing crew productivity at each station. The SPR, named Lunar Electric Rover (LER), and sometimes called the Space Exploration Vehicle (SEV), could also provide shelter during a suit malfunction, radiation event, or medical emergency that might occur on the Moon [2].

Intravehicular activity (IVA) capabilities: From within the vehicle, crew could describe and photo-document distant features during drives between stations, as well as in the near-field, directly in front of the LER, providing an ability to begin EVA planning on approach to each outcrop prior to egress. The vehicle can rotate 360º without any lateral movement, providing views in all directions. It has high-visibility windows, a ForeCam, AftCam, port and starboard cameras, docking cameras, and a GigaPan camera.

EVA capabilities: To reduce timeline, mass, and volumetric overhead, rapid egress and ingress were envisioned, replacing an airlock with lower cabin pressure than on the International Space Station and suit ports on the aft cabin wall [2]. When needed for closer inspection and sample collecting, crew could egress in about 10 minutes through suit ports. Crew use SuitCams for additional photo-documentation, transmit mobile observations verbally, and collect surface materials. Typical simulations involved 3 to 4 EVA stations/day and 2 to 3 hr/day of boots on the ground. This allowed crew to explore a far larger territory, with more complex geological and in situ resource utilization (ISRU) features, than would a single, longer-duration EVA at one location, while also minimizing crew time in a spacesuit. Additionally, the vehicle could be driven with crew locked into the suit ports. This approach could involve a driver in the cockpit with a suited crewmember in a suit port, or the vehicle could be driven from the aft deck with both crewmembers in their suit ports. This approach was used when distances between stops were short enough that vehicle ingress and egress were less efficient than remaining in the suits and driving.

Utility of suit ports: The advantages of suit ports were clearly demonstrated in those field-based trade studies. To illustrate those advantages further, consider the consequences of a SPR without suit ports at the Apollo 17 landing site. At that site, the crew's second EVA was an approximately 18 km loop conducted in a UPR, called the Lunar Roving Vehicle (LRV), in 7 hr 36 min 56 s. The traverse was composed of 5 formal stations, plus 8 additional LRV stations where crew made brief scientific stops. In a scenario involving a SPR without suit ports, crew would go EVA through an airlock and probably be limited to a single EVA per day. In that case, crew could drive the SPR ~9 km from the landing site to station 2, go EVA, and complete station 2 tasks. However, to conduct station 3 tasks, the crew would then need to walk ~3 km to station 3, while ground control in Houston tele-robotically drives the LER to station 3. A walk of ~3 km is possible, as that is what the Apollo 14 crew did before LRVs were deployed, but it is a lengthy and potentially grueling EVA. Assuming crew completes station 3 tasks, they would likely need to re-enter the SPR, ending the day's EVA, and return to the landing site. They would not be able to walk the additional distances to stations 4 and 5 (the latter being about 6 km from station 3). Thus, crew in an SPR without suit ports would require two days to accomplish the same tasks Apollo 17 crew completed in a single day. If a future crew is involved in long duration traverses on the lunar surface, the deployment of a vehicle with suit ports would probably be a better solution.

References: [1] Kring D. A. (2017) European Lunar Symposium. [2] Abercromby A. F. J. et al. (2012) *NASA/TP-2012-217360*, 144p.