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SINGLE-PERSON SPACECRAFT TRANSFORMS WEIGHTLESS OPERATIONS

Abstract

The Single-Person Spacecraft (SPS) will radically transform our perception of extravehicular activity (EVA). Gone are the bulky pressure suits, lengthy pre-breathing, airlock pump down, and the risk of getting the “Bends.” They are all replaced by a small, form-fitting, spacecraft that allows rapid access to space without an airlock. Hand-over-hand translation gives way to flying directly to the work site and the pressurized gloves are replaced with multi-tool, force multiplying manipulators. Shaped around the astronauts’ weightless neutral body posture, the SPS cockpit eliminates space suit trauma that has resulted in abrasions, contusions, delaminated fingernails, and shoulder surgeries. Improvements to pressurized space suits are at a point of diminishing returns. Like the steam engine to horses and printing press to scribes, the SPS offers a different solution. More than a replacement, it redefines the EVA architecture significantly reducing overall system mass, complexity, and cost. Furthermore, because it is both piloted and tele-operated, it is the single solution for continuous EVA even for the infrequently occupied lunar Gateway. The purpose of this paper is to describe the emerging era of SPS operations. It complements the Conference theme drawing on power of past through the heritage of the Manned Maneuvering Unit propulsion while pointing to the promise of the future as a platform for new technologies. Methodologies used for quantifying benefits of SPS include a Gateway EVA trade off analysis coupled with key development tests results. Trade analyses compared the SPS to suited EVA for safety, mass, efficiency, delivery, consumables, and cost. Development testing included neutral buoyancy ingress/egress, pressure testing of a proto-flight crew enclosure, dome impact testing, and the performance testing of cold gas thrusters. Results demonstrate the SPS to be safer because there is no risk of the Bends, it provides radiation and micrometeoroid protection, has a lower fire risk, and there is no life-threatening loose water in the helmet. Without an airlock, SPS mass is between 582 and 6033kg less than suited EVA. Also, it is 40 times more efficient while using fewer consumables, and for Gateway, the cost to the government is over 600M dollars less. In conclusion, the SPS is within reach offering exciting new capabilities never conceived possible with suits. Integral propulsion means it can go where suits cannot and spend more time on the job. SPS provides servicing to aging life-critical ISS systems, the lunar Gateway, Mars transit vehicles, satellites and application for space tourism.