Paper ID: 83689
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IAF HUMAN SPACEFLIGHT SYMPOSIUM (B3)
Utilization & Exploitation of Human Spaceflight Systems (3)

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STUDY ON PARASTRONAUT INGRESS AND EGRESS OF ORION AND BOEING CST-100 STARLINER SPACE VEHICLES

Abstract

This preliminary investigation aimed to observe and evaluate crew accommodations needed for individuals with disabilities participating in the ingress and egress procedures of Lockheed Martin's Orion and Boeing's CST-100 Starliner spacecraft. Motivated by the aspiration for inclusivity in space programs and the introduction of the first parastronaut within the European Space Agency (ESA), NASA funded the present study, which utilized motion capture and video analysis to study the entry (ingress) and exit (egress) processes in detail. Data encompassed total time taken, phase interval duration, steps executed, missed steps, and various kinematic factors related to balance during walking. The study comprised eight participants: three fully-abled individuals formed the control group and five with leg amputations formed the experimental group. Among the experimental group, there were two individuals with left leg amputations, both below the knee; two with right leg amputations, one above the knee and one below the knee; and one individual with bilateral above-knee amputations. Several significant findings emerged from the analysis. On average, the experimental group completed egress from the capsule environments in less than fifty seconds, taking 7.7 seconds longer than the control group for ingress and 9.19 seconds longer for egress, with a notable increase in the utilization of balancing mechanisms during both procedures. The data indicated that parastronauts should feasibly ingress and egress the capsule in a 1G environment safely within sixty seconds, which is currently a requirement levied by NASA to protect for emergency egress scenarios. However, it was observed that these processes required more movements, suggesting compensation for the mobility limitations of prosthetics and additional accommodations needed in and around the capsule hatches to provide stability for egress. Despite slight variations in mobility sequencing, participants with prosthetic limbs completed the tasks within acceptable timeframes. They adeptly navigated through unfamiliar environments without tripping or colliding with any elements. Notably, the participants were novices to the capsule environment, indicating that highly trained parastronauts should be capable of safely performing ingress-egress operations.