Extravehicular Activity Technology Development—Suit Technologies

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The Space Suit Assembly Group performs the functions of providing a habitable environment in hazardous conditions to enable a crew member to perform meaningful work outside of a vehicle. The Extravehicular Activity (EVA) Technology Development Team, which is within the Crew and Thermal Systems Division at NASA Johnson Space Center (JSC), is developing critical technologies and suits to enable future exploration missions.

Gloves

Gloves are the primary means by which a crew member performs EVA tasks, and thus are an area in need of continual improvement and development. Recent activities have focused on increasing the operational life of gloves and improving glove mobility. A joint cycle model, created through collaboration with the Anthropometrics and Biomechanics Facility at JSC, was generated. The model simulated a long-duration lunar mission. The team performed life tests, which used this cycle model and a busy board to simulate EVA tasks, employing Phase VI gloves to benchmark life performance of these state-of-the-art gloves (figure 1). Tasks included activities such as using a joystick, brushing the suit (to remove dust), and picking up samples from the ground. A lunar regolith simulant was deposited between the glove bladder and the thermal micrometeoroid garment to provide a more representative testing environment in an effort to provide similar abrasion to the abrasion that would be seen during a lunar mission. Areas of high wear were identified and analyzed using a digital microscope.

Suit Port Compatibility

The concept of using a suit port for rapid vehicle ingress and egress impacts the development of a spacesuit in several ways. The team undertook a number of development tasks to assess these impacts and overcome the technical challenges associated with them. First, suit port operations dictate that an exploration spacesuit be donned and doffed through a rear-entry hatch with a suit port interface plate—i.e., the surface that makes a pressure seal with the vehicle and is clamped by the mechanisms within the suit port. A rear-entry upper torso with a suit port interface plate is under development and will be completed in 2011. Donning a suit via a suitport also means that the crew member will be entering a suit that is already pressurized. This provides additional challenges associated with making sizing adjustments to the suit because all adjustments would be made in opposition to the suit pressure. NASA developed proof-of-concept designs for gloves and boots in which sizing adjustments could be made while the suit was pressurized.

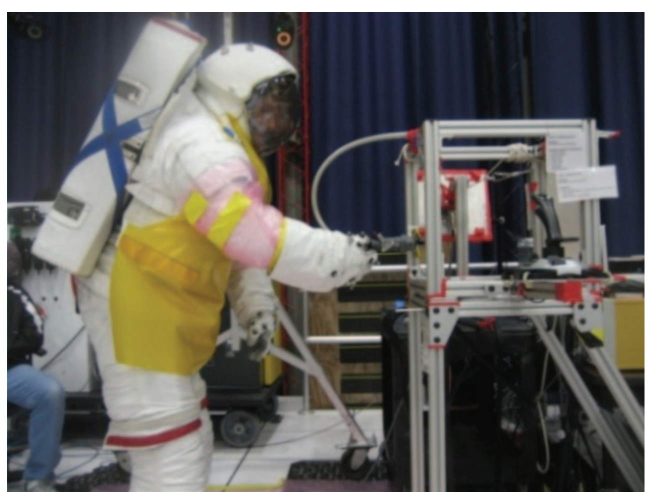

Fig. 1. *Phase VI glove life testing.*

Bio-contamination-resistant Materials

Bacterial and fungal growth during long-duration missions is a concern for future exploration missions. Crew members sweat when performing an EVA, and the crew-worn suits must subsequently be stored for periods of time that could range from days to months. A team from NASA performed a trade study of commercially available materials that could reduce resulting biological activity. The team selected, purchased, and evaluated several materials. In addition to these new materials, materials and material layups from the space shuttle extravehicular mobility unit and the Advanced Crew Escape System were also included in the test as a benchmark. The test matrix included samples that were inoculated with specific bacteria or fungi commonly found in spacesuit applications (figure 2).

Fig. 2. *Biological testing of spacesuit materials.*

Soft Mobility Elements for Launch Entry Abort Suits

Spacesuits are needed to protect crew members from hazardous conditions that could occur within the cabin of a vehicle during specific mission phases. Crew members are at risk from mission scenarios that could include cabin depressurization or the release of toxic chemicals. Therefore, crew members primarily wear suits to provide protection from these conditions during mission phases with large accelerations such as launch, atmospheric reentry, or mission abort. These large accelerations increase the likelihood of injury to the crew member due to the potential of coming into contact with hard elements within the suit-like bearings. A zipper entry I-suit was modified with two different soft shoulder designs and a soft hip (figure 3) to minimize this injury risk. The team tested these new joints to demonstrate acceptable pressurized mobility for a launch-entry-abort-type mission.

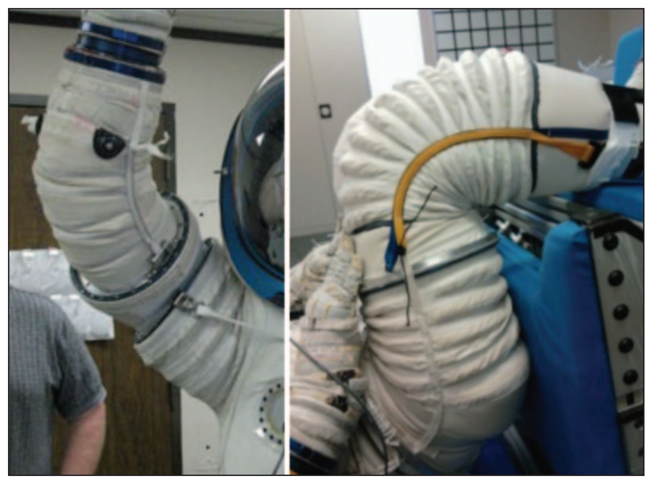

Fig. 3. *Zipper entry I-suit shoulder and hip.*