Gecko Mobility Aids for a Common Habitat Architecture

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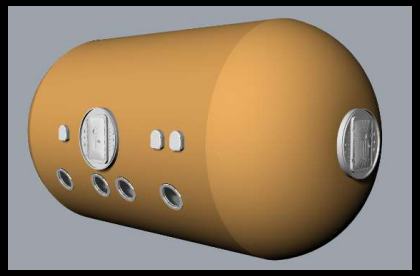
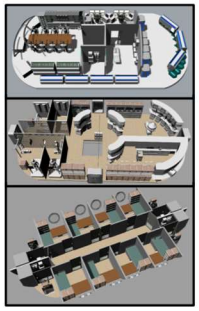


Common Habitat Architecture

Background

- Common Habitat is based on the use of the SLS core stage liquid oxygen (LOX) tank as the primary structure for the pressure vessel
- Design is equally applicable for use in microgravity, 1.6g, 3/8g, and 1g.
- Common Habitat has a horizontal orientation divided into three decks, an upper deck, mid deck, and lower deck, with sufficient habitation accommodation for a crew size of eight

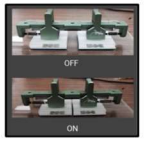


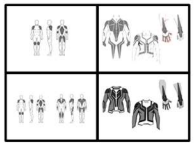
- Handrails and footrails not ideal for the Common Habitat
  - Limited to specific placement and cannot be everywhere a crew member might venture
  - Possible injuries: back pain, shin splints, stress fractures, tendinosis or tendinitis, and compartment syndrome.

  - Callouses, red marks, soreness and other discomfort even to the point of blistering and bleeding.
  - Unsafe (trip hazard) when Common Habitat placed in a gravity environment (Moon and Mars surface)
- ISS crew comments suggest risk of catching foot or wrist in awkward position with risk of fracture.
  - Possible loss of mission if occurs near end of transit to Mars
  - Possible loss of crew if shortly before Orion splashdown (unable to safely egress capsule in a contingency)

Gecko Grippers

- Developed by JPL, fabricated from a space-rated silicon polymer, and intended for use as robotic end effectors
- Biomimicry of gecko foot pads
- Uses Van der Waals forces to stick to objects when subjected to a shear force
- Test article demonstrated on the International Space Station
- Astrobee robots equipped with grippers used them on ISS to perch on surfaces
- Grippers applied in this research to crew clothing as a restraint and mobility aid





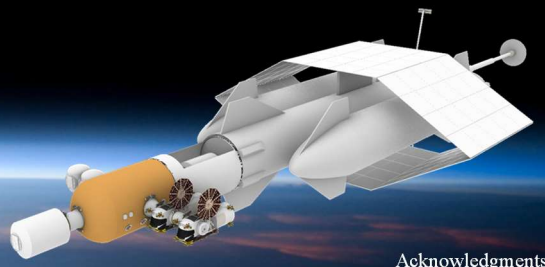
- Glove proof of concept demonstrator created
- Initial design concepts for complete uniform
- Prototypes developed under ICA funding
  - JPL gripper pads adhered to commercial clothing items
  - Long sleeve, short sleeve, shorts, trousers, gauntlets, gloves, finger cots, booties (3 styles)

1g Test and Results

- Tested postures or crew motions using gecko-equipped clothing to detect presence or absence of adhesive forces
- Key lessons learned:
  - Very light forces difficult to perceive in 1g and did not interfere with motion in gravity environment
  - Finger cots annoying to don/doff – need a device to assist or inferior to gloves/gauntlets
  - Footwear needs coverage on toes, ball of foot, and heel; coverage on arch also useful; walking in microgravity probably possible but could easily be knocked off feet
  - Crawling possible with combination of gloves/gauntlets/finger cots and footwear
  - Grippers on backside of gauntlets support crawling when hands needed to hold something
  - Loose clothing interferes with the function of the gecko grippers (shear force not maintained)
  - Lining elbow and knee pads up with body correctly requires precise fit
  - Shirt is only useful when in combination with other clothing (cannot create shear by itself)
  - Trousers (preferable over shorts) and shirts work well in combination
  - Thigh pads more useful on trousers and shorts than buttocks pads
  - Works best on smooth, hard surfaces

Full paper available at https://ntrs.nsas.gov

The Common Habitat is not part of the current NASA reference architectures for exploration of the Moon and Mars. It is instead an ongoing study of potential options that – should viability be demonstrated – could potentially be applied to human exploration programs.



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