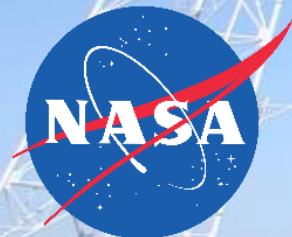




Using Virtual Reality and Motion Capture as tools for Human Factors Engineering at NASA Marshall Space Flight Center

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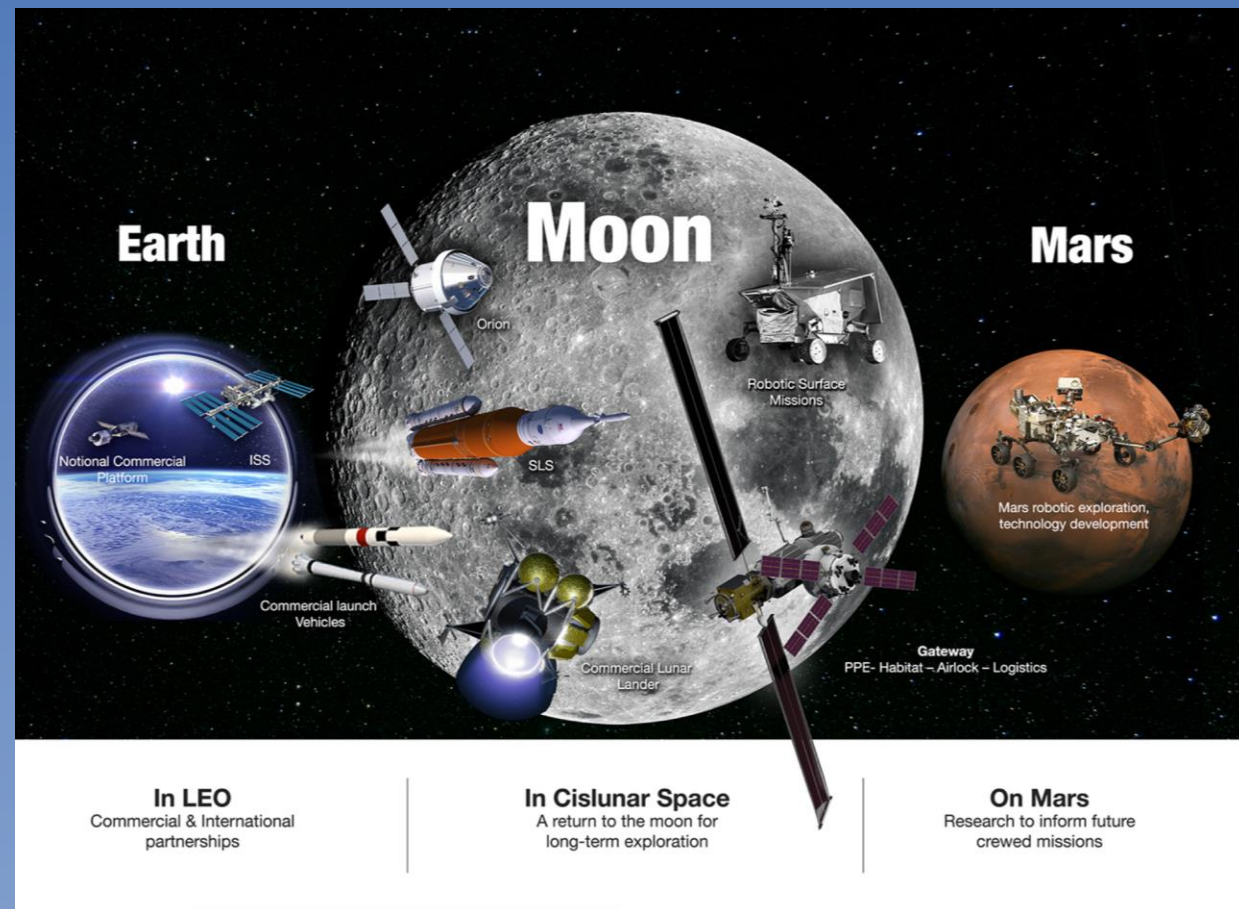


Abstract

- NASA Marshall Space Flight Center (MSFC) Human Factors Engineering (HFE) Team is implementing virtual reality (VR) and motion capture (MoCap) into HFE analyses of various projects through its Virtual Environments Lab (VEL).
- These techniques are being implemented for
 - Concept of development of Deep Space Habitats (DSH)
 - Design and analyses for NASA's Space Launch System (SLS)
- VR utilization in the VEL will push the design to be better formulated before mockups are constructed, saving budget and time.

Outline

1. Human Factors at MSFC
2. Definitions
3. Virtual Environments Laboratory
 - a. Equipment
 - b. Software
4. VR for Deep Space Habitats
5. VR for the Space Launch System
6. Conclusion



Acronyms

SLS – NASA's Space Launch System

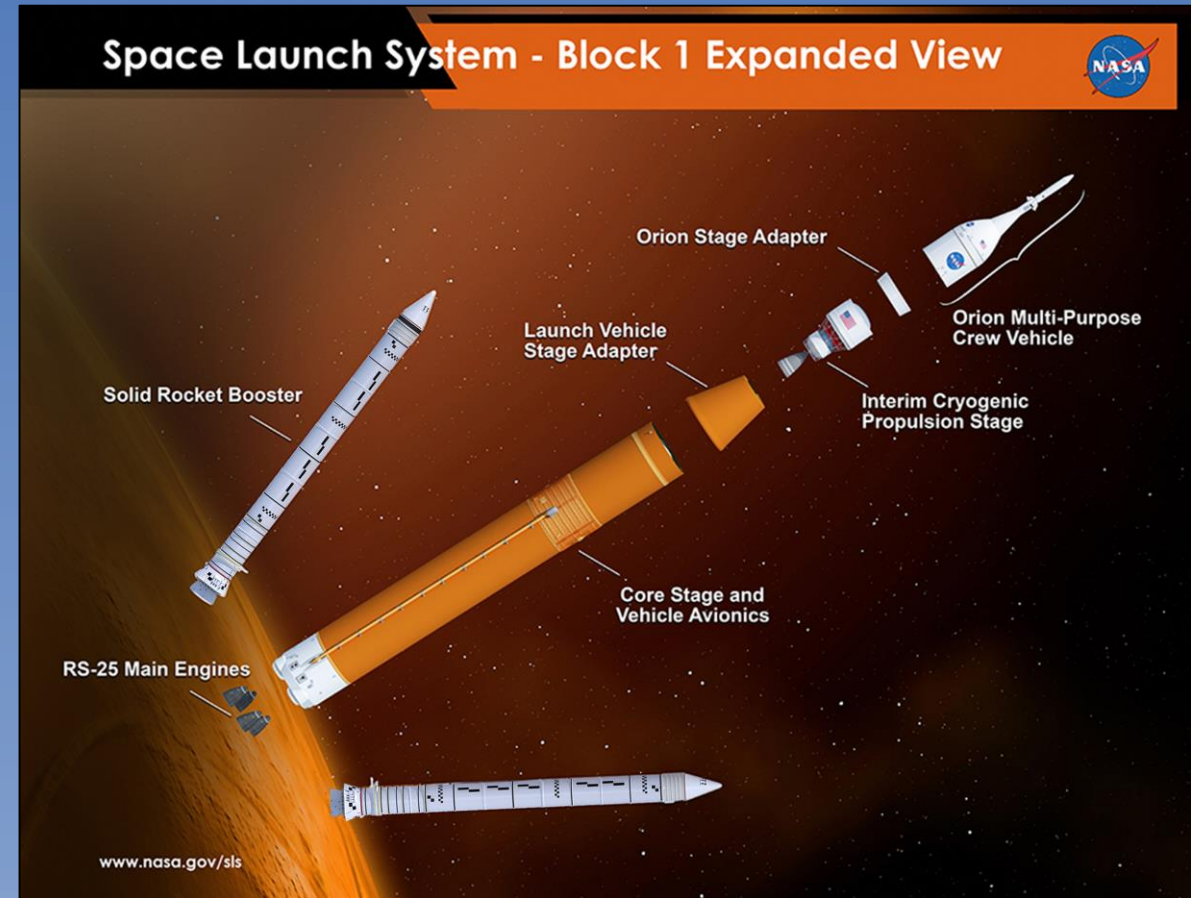
ACO – Advanced Concepts Office

DSH – Deep Space Habitat

VEL – Virtual Environments Lab

XR – term that encompasses virtual, augmented, and mixed reality

ANSUR – Anthropometric Survey of US Army Personnel



XR Definitions

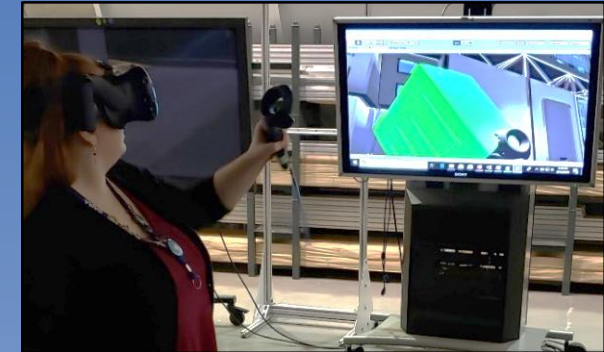
Augmented Reality (AR):

- Overlays CG with real world
- No interaction



Virtual Reality (VR):

- Immersive experiences
- Real-world content vs computer generated (CG)



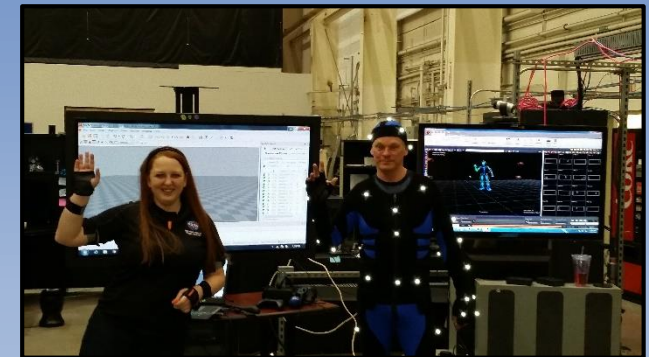
Mixed Reality (MR):

- Overlays CG with real world
- Incorporates interaction



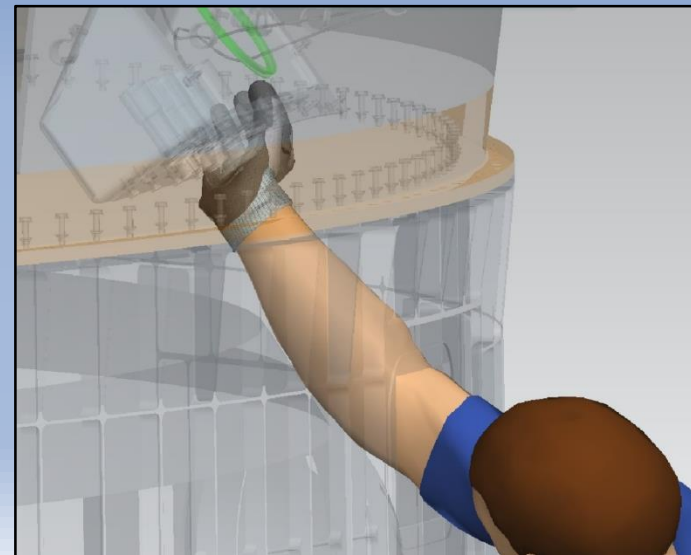
Motion Capture (MoCap):

- Records the movements of people or objects
- Translates movement into virtual format



Human Factors at NASA MSFC

- Responsibilities of HFE team:
 - Worksite analyses for SLS pre-launch integration activities
- MSFC's HFE team evaluates if tasks:
 - Can be completed safely.
 - Can be performed by most technicians
 - 5th percentile American Female (5'1") to a 95th percentile American Male (6'1")



Current Processes

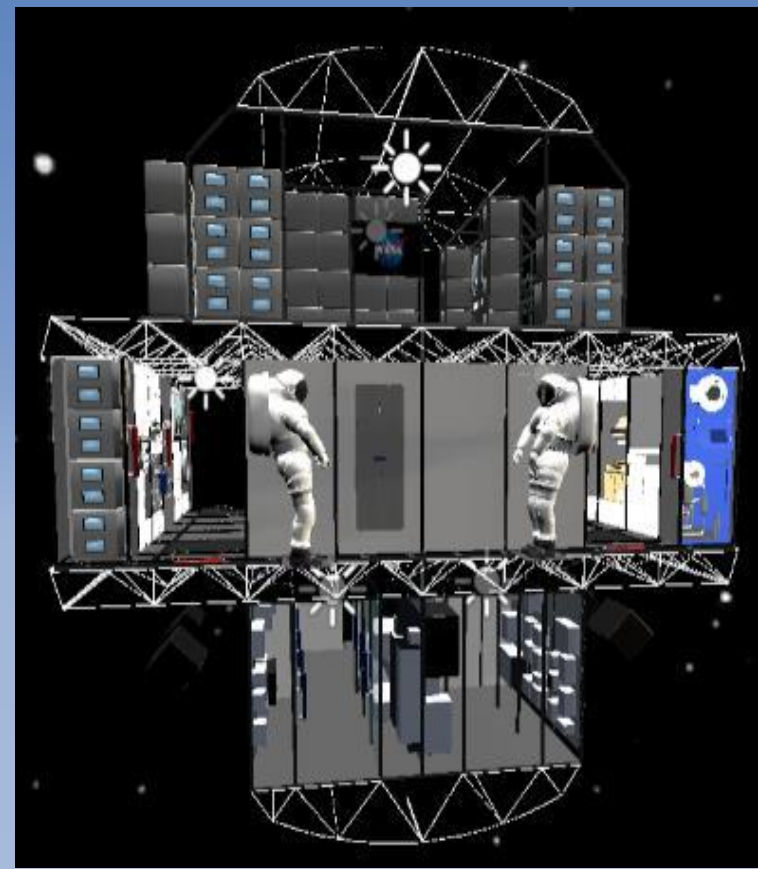
Physical SLS Mockups



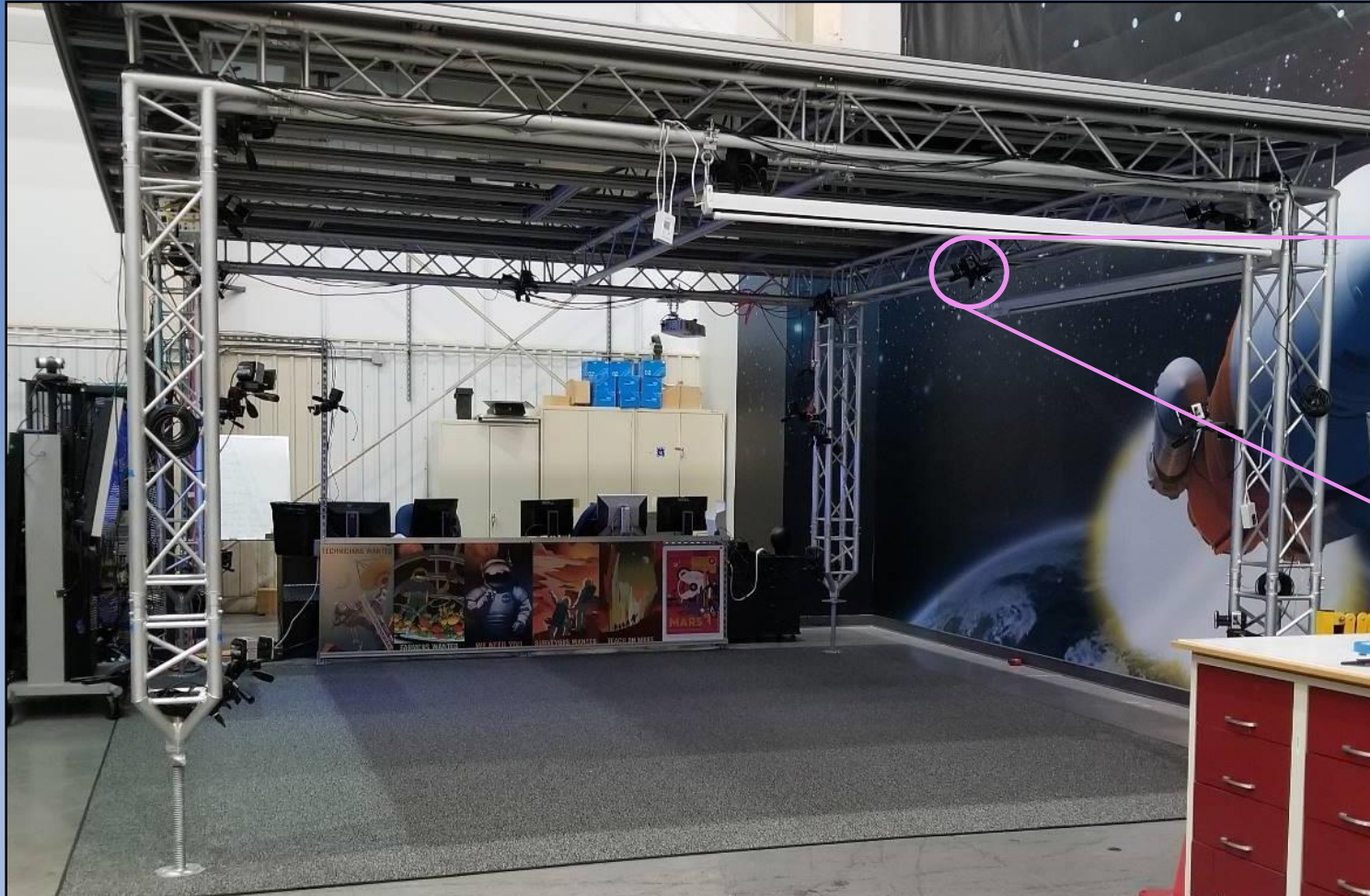
NASA's SLS in VR



Deep Space Habitat in VR



MSFC's Virtual Environments Lab



16 Vicon MoCap Cameras

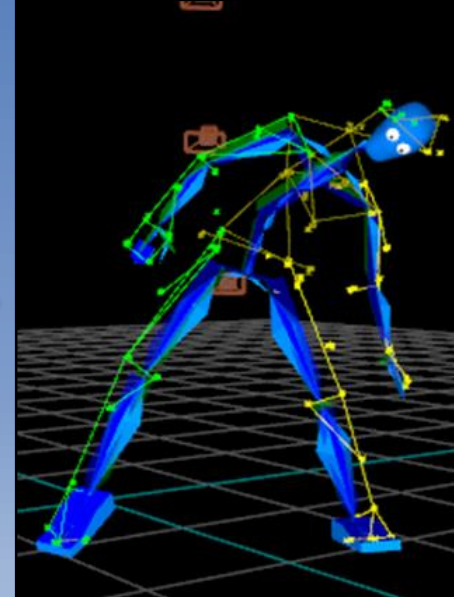
Vicon Blade Motion Capture



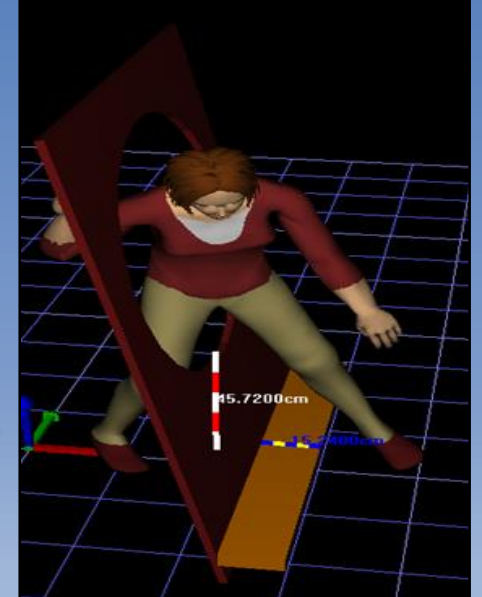
Participant in MoCap
suit with 53 IR
reflective markers



Mesh mockup of
a hatch



Vicon Blade
Recording of person
passing through hatch



Human Factors
program recording of
person passing
through hatch

VR Equipment in VEL

HTC Vive HMD



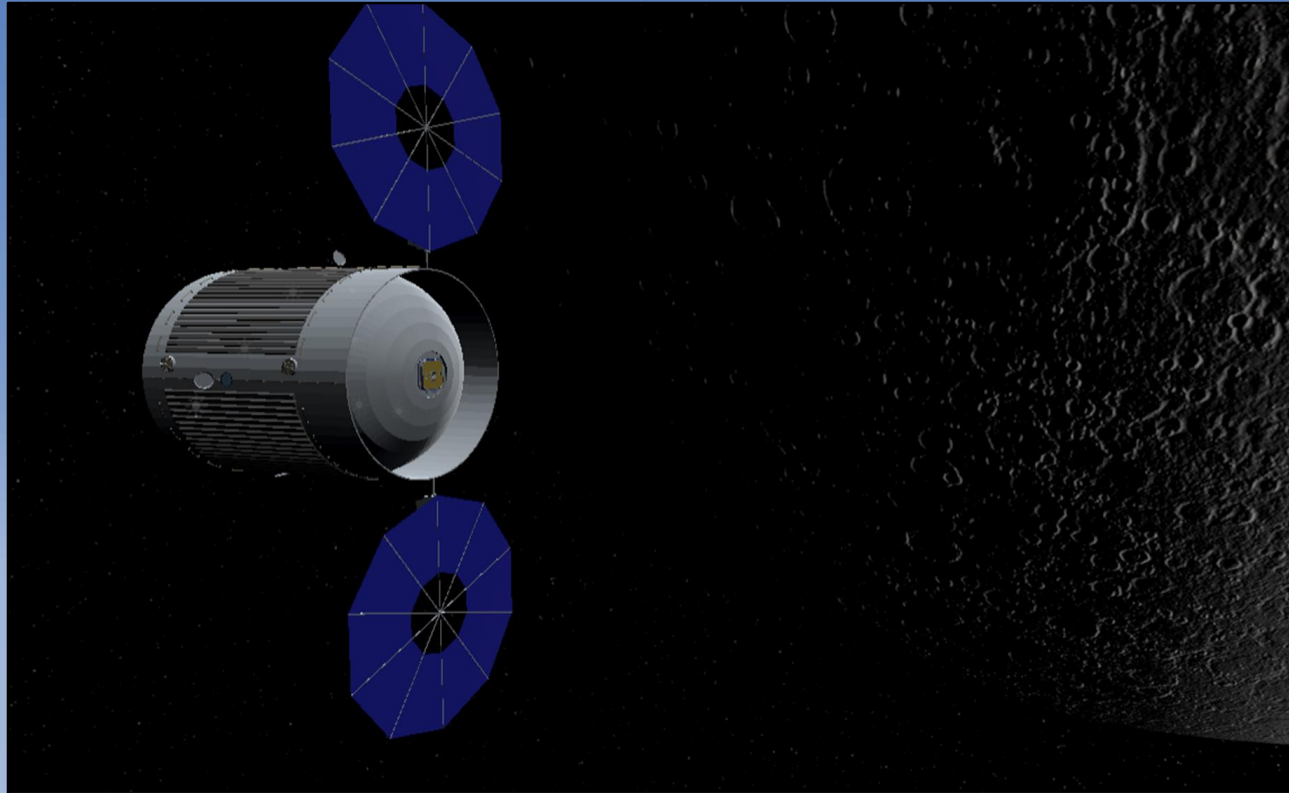
HTC Base Station



HP Z Backpack Computer



Advanced Concepts Office's Deep Space Habitat



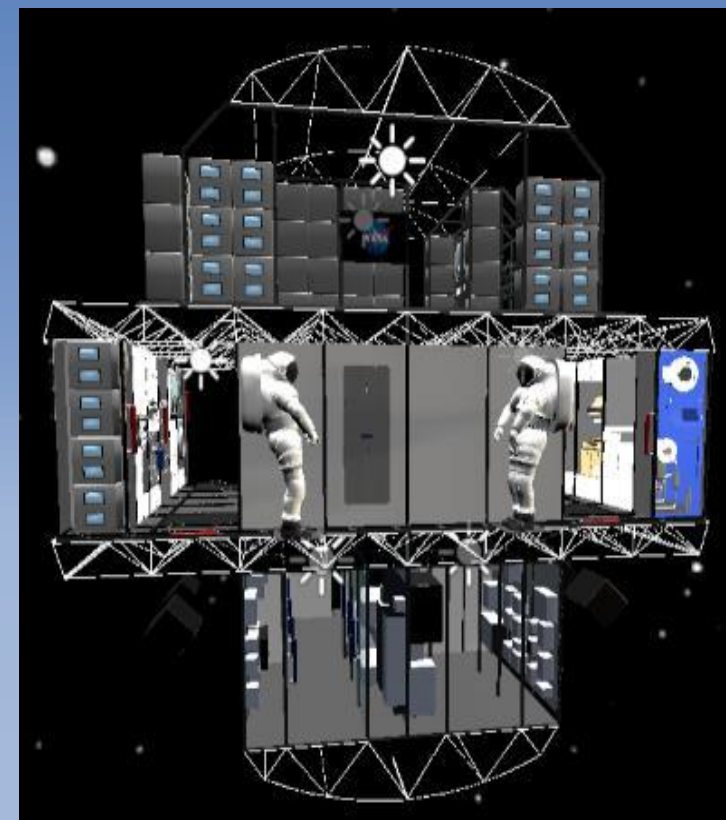
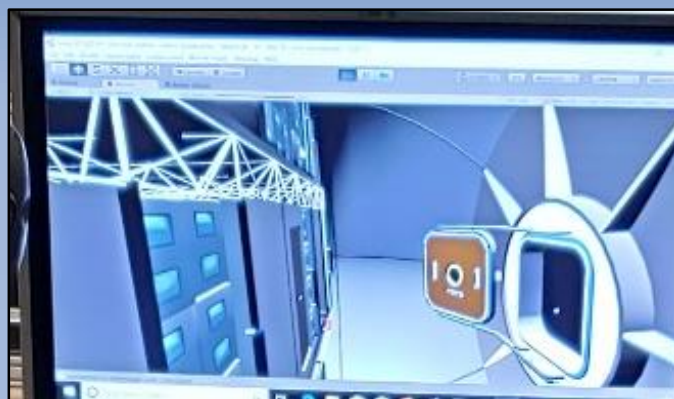
- Deep Space Habitat
 - 3-story habitat
 - Conceptual test bed



Deep Space Habitat in VR



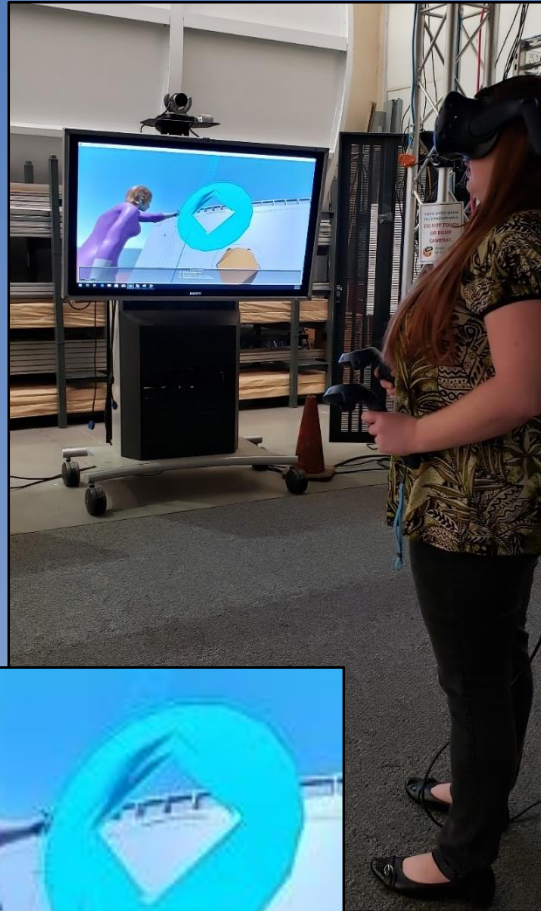
- Conversion to VR
 - Lightwave 2018 to Unity 3D
- Advantages of VR for DSH
 - Full configuration
 - Less-funding required
 - Microgravity simulation



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VR as an Engineering Design Tool

- Visual Immersive experience into CAD models
 - 1:1 model size
 - Adds depth to design reviews
- A variety of tools within VR programs
 - Routing paths for wiring or other utilities
 - Video comparisons



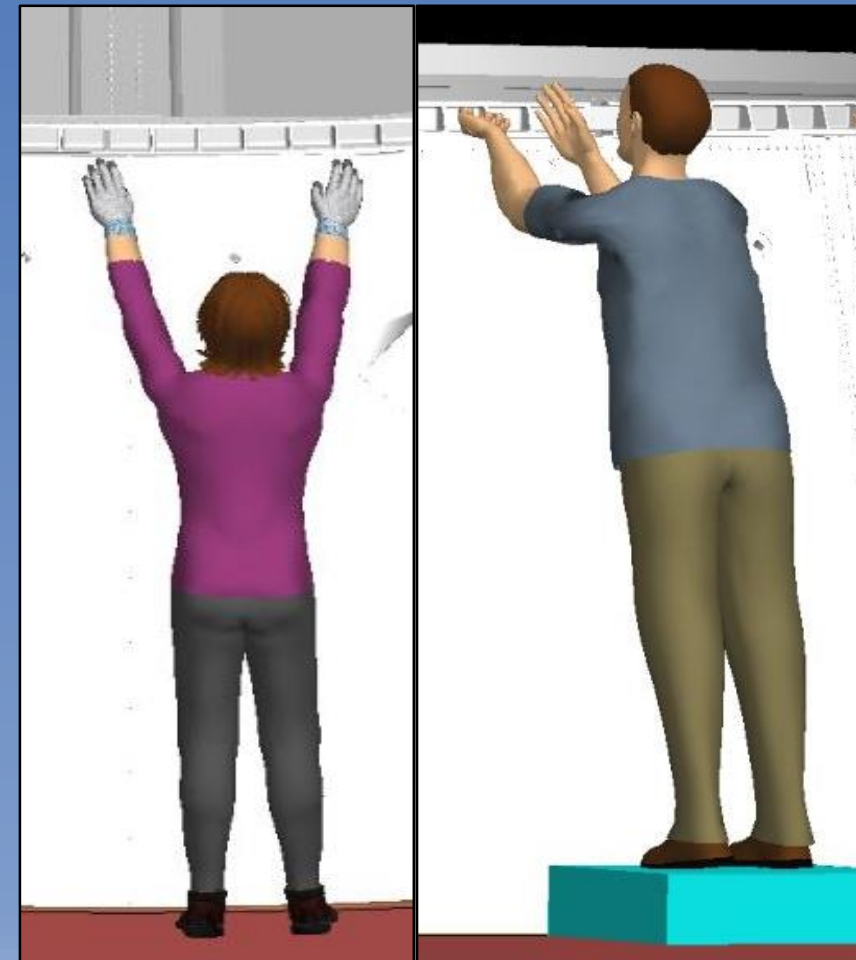
- Process Simulate Human (PSH)
 - For VR Visualization of Engineering Models
 - Tools like measurement and note taking
 - Models can be pulled apart for examination

Physical Mockup vs VR

- Physical mockups take time and materials to build and assess.
- Offers haptic/physical feedback



- In the human factors program multiple mannequins can be created to ANSUR anthropometry database.
- Multiple versions of a design can be assessed faster.



SLS VR HFE Analyses



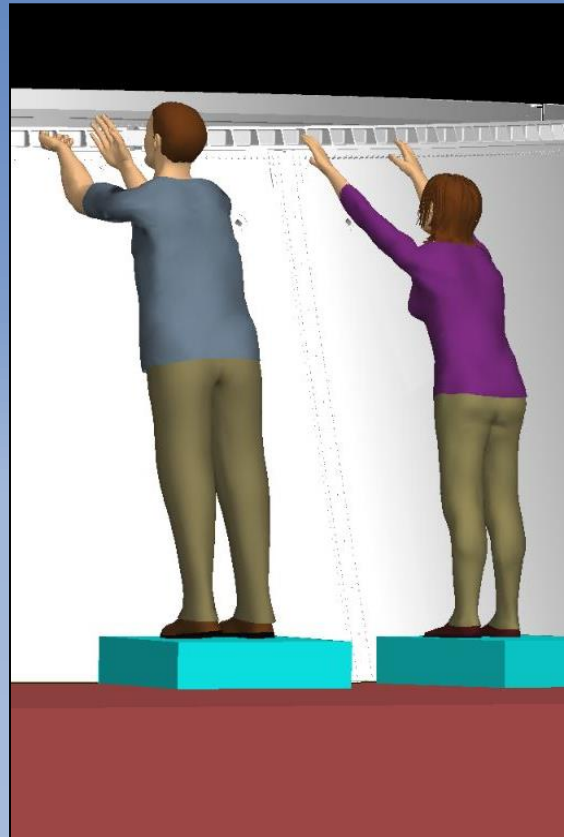
Assessing tool clearance, fatigue, & reach analysis in early stage of design

SLS VR HFE Analyses

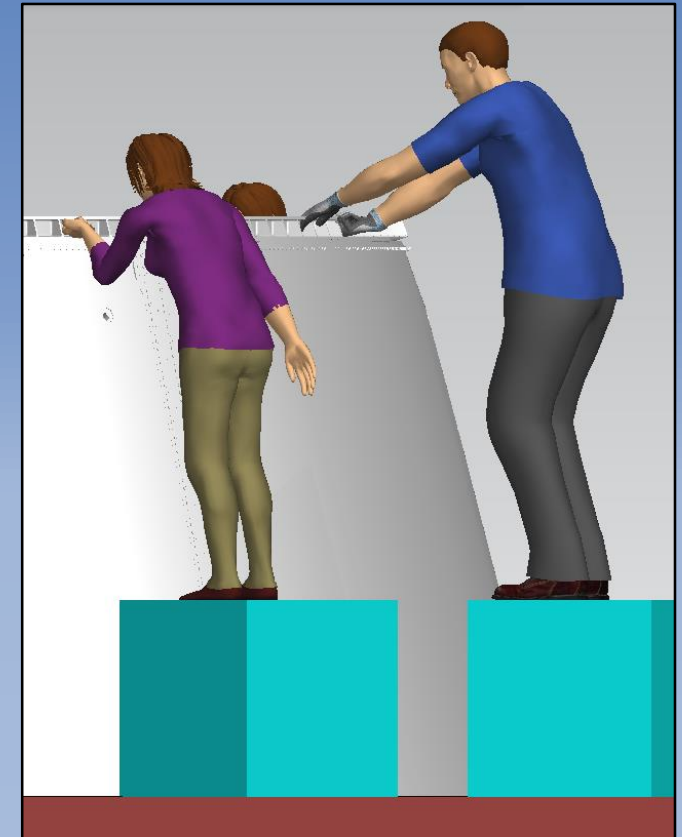
Demonstration of 5th percentile American female subject interacting with physical mockup



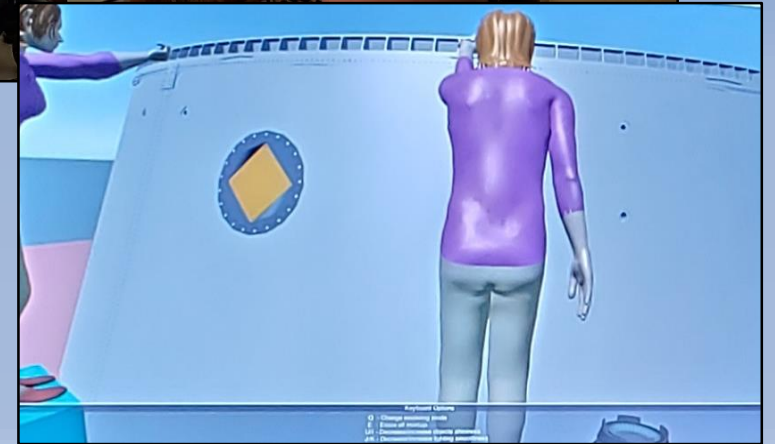
*Demonstration of platform heights reach study
First Height Look*



*Demonstration of platform heights reach study
Final Height Look*



SLS VR HFE Analyses



SLS VR HFE Analyses



Ability to
move/rotate
parts



Ability to
move/rotate
parts

Ability to use
flashlight in
darker areas



Conclusions and Questions

- The VR work performed by the HFE team at MSFC has allowed fast changing layouts to be analyzed by various departments with minimal impact to cost or schedule.
- Using VR with the DSH allows for more conceptual work to be tested within a limited budget.
- Implementing these methods for SLS allows for VR use in early design cycles, saving time and budget.
- Utilizing the resulting HFE analyses improves usability and safety.
- Ultimately, the goal is to provide a safe environment for the technicians assembling the vehicle and the astronaut crew at launch