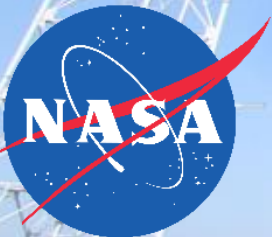


A low-angle photograph of a Space Shuttle on the Mobile Launcher Platform (MLP) being moved by a crawler-transporter. The MLP is a large, dark, rectangular structure with a grid of beams. The shuttle is oriented vertically, with its orange external tank and white solid rocket boosters clearly visible. The orbiter is at the top, with the NASA logo and an American flag. The background is a clear blue sky. In the foreground, parts of the crawler-transporter's legs and other support structures are visible.

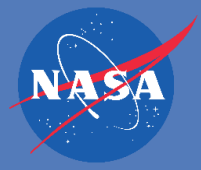
USING VIRTUAL REALITY AND MOTION CAPTURE AS TOOLS FOR HUMAN FACTORS ENGINEERING AT NASA MARSHALL SPACE FLIGHT CENTER

IAASS Conference 2019
5/16/2019

Tanya Andrews – NASA MSFC
Brittani Searcy – Jacobs ESSCA NASA MSFC

The Jacobs logo, consisting of the word "JACOBS" in a bold, blue, sans-serif font. A small registered trademark symbol (®) is located at the top right of the letter "S".

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Human Factors at NASA MSFC

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- MSFC's Human Factors Engineering (HFE) team is responsible for all worksite analyses performed for the SLS pre-launch integration activities at Kennedy Space Center (KSC).
- There is a wide variety of tasks associated with pre-launch integration activities and it is important to verify that vehicle integration will be successful early in the design process.
- MSFC HFE assess that associated tasks:
 - Can be done safely.
 - Can be performed by a 5th percentile American Female to a 95th percentile American Male.
 - ~5' 1" – 6' 1"

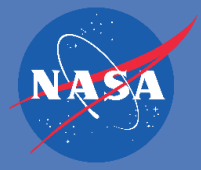


- **Virtual Reality (VR):** Virtual reality allows immersive experiences, which can be created using real-world content (e.g. pictures), purely synthetic content (e.g. computer graphics (CG) models) or a hybrid of both (e.g. CG models with texture maps)
- **Augmented Reality (AR):** Augmented reality overlays CG content onto the real world, but this content is not anchored to or part of the real world. The real-world content and the CG content do not interact with each other (e.g. the CG viewpoint does not change).
- **Mixed reality (MR):** Mixed reality (sometimes referenced as hybrid reality) overlays CG content onto the real world, and it is anchored to and interacts with the real world in real-time (e.g. the CG content scales in size as the user changes viewpoint).
- **Motion Capture (MoCap):** is the process of recording the movement of objects or people.



(source - <https://www.foundry.com/industries/virtual-reality/vr-mr-ar-confused>
 - <https://www.vicon.com/what-is-motion-capture>)

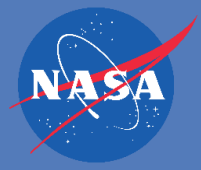




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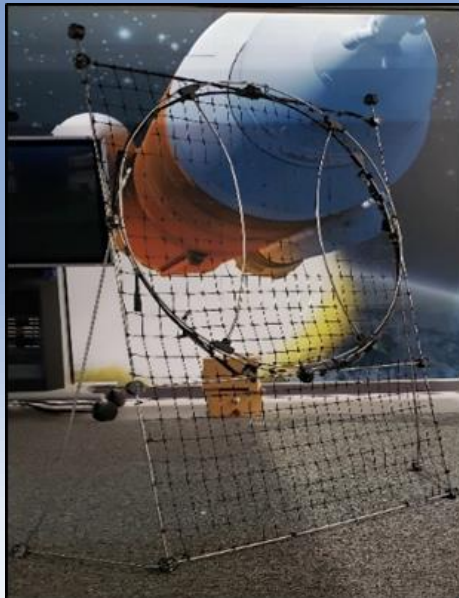




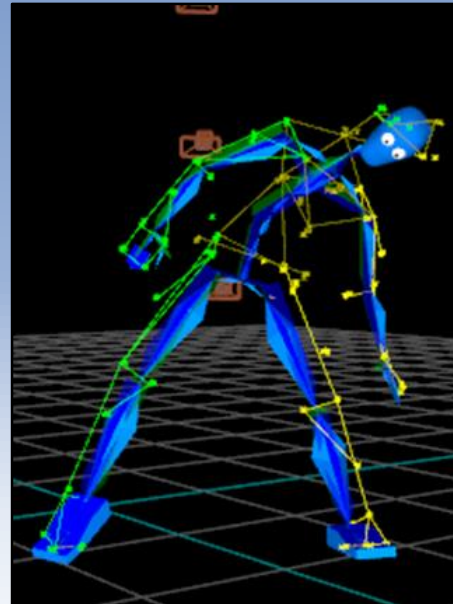
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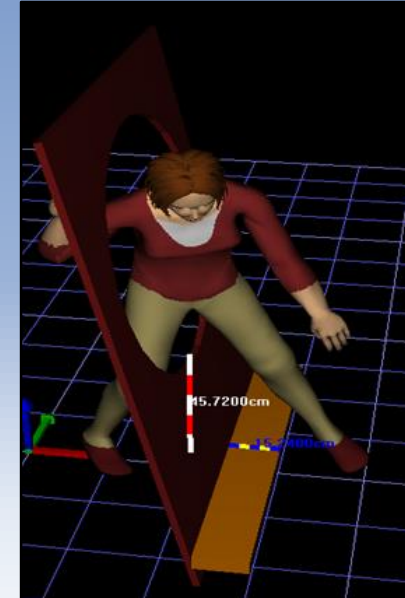
Vicon Blade Motion Capture



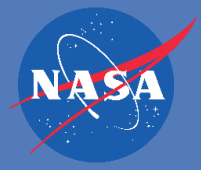
Mesh
mockup
of a
hatch



Vicon
Blade
Recording
of person
passing
through
hatch



Vicon
Blade
Recording
of person
passing
through
hatch



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HTC Vive HMD



HP Z VR Backpack Comp

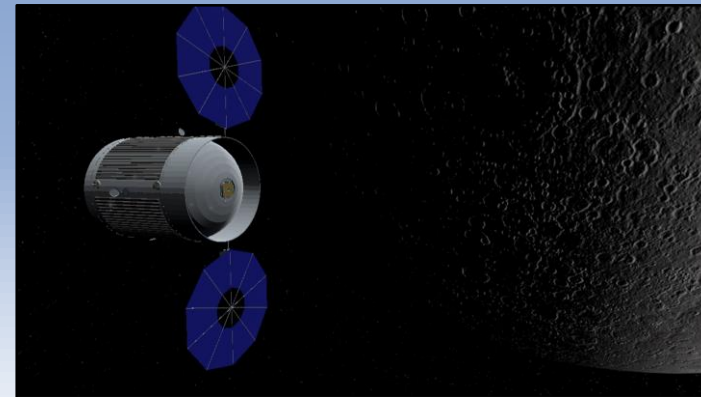
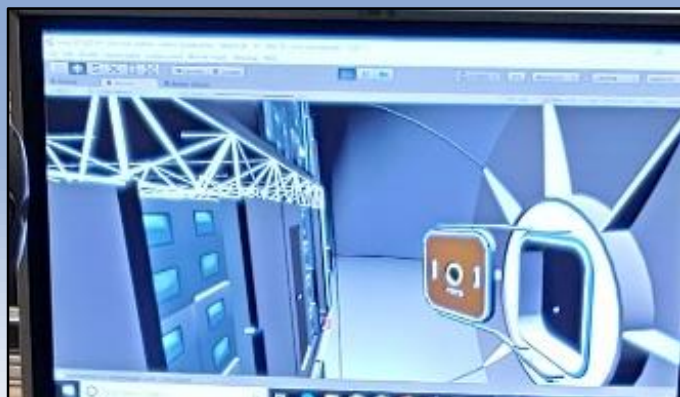




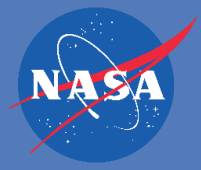
VEL Software Tools

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- Process Simulate Human (PSH)
 - For VR Visualization of Engineering Models
 - Tools like measurement and note taking
 - Models can be pulled apart for examination
- Unity
 - For VR experience
 - Can import models for examination
- HTC/Steam gaming software
 - VR HMD software
- Vicon Blade MoCap



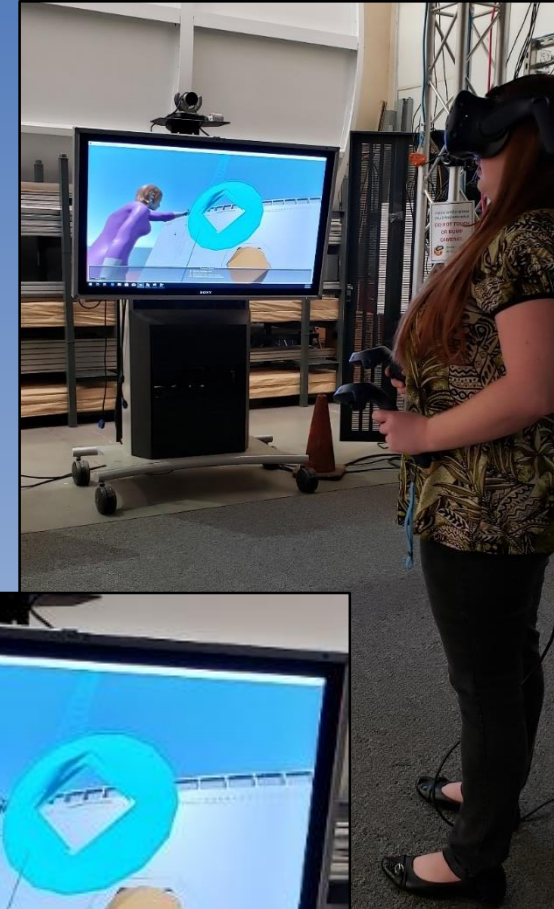
Advance Concepts Office's Deep Space Habitat in Unity

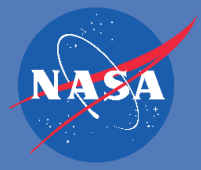


VR as an Engineering Design Tool



- Visual immersion into CAD models
- Real size comparisons, 1:1
- Can be utilized during design reviews to display and discuss design options
- Routing paths for wiring or other utilities
- Video comparisons





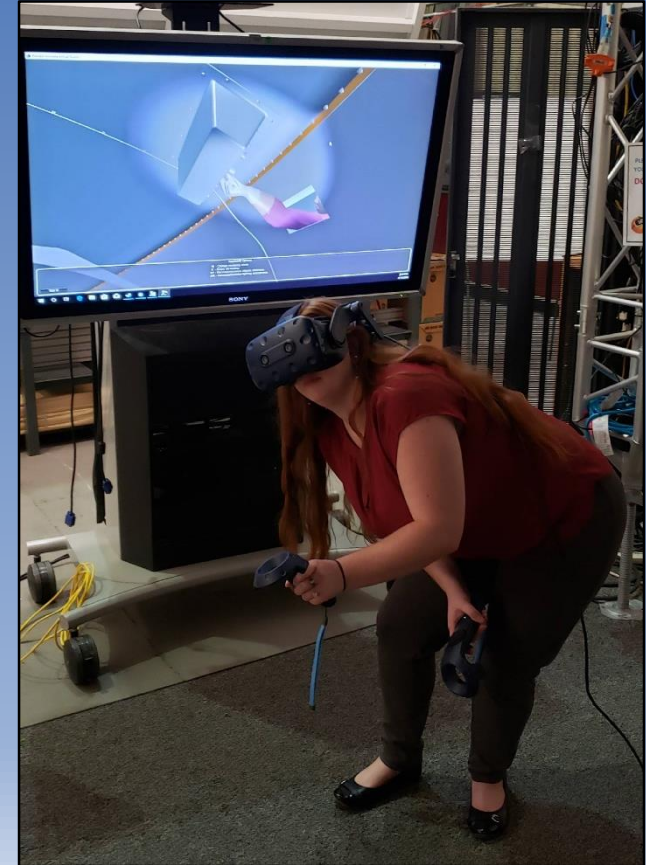
Current Processes



SLS Mockups



SLS in Virtual Reality





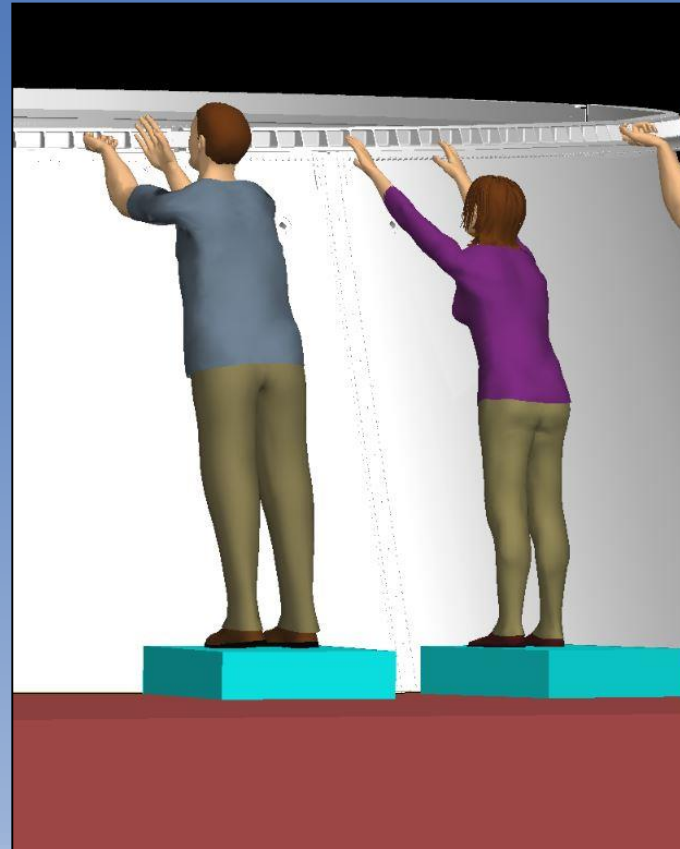
Physical Mockup vs VR

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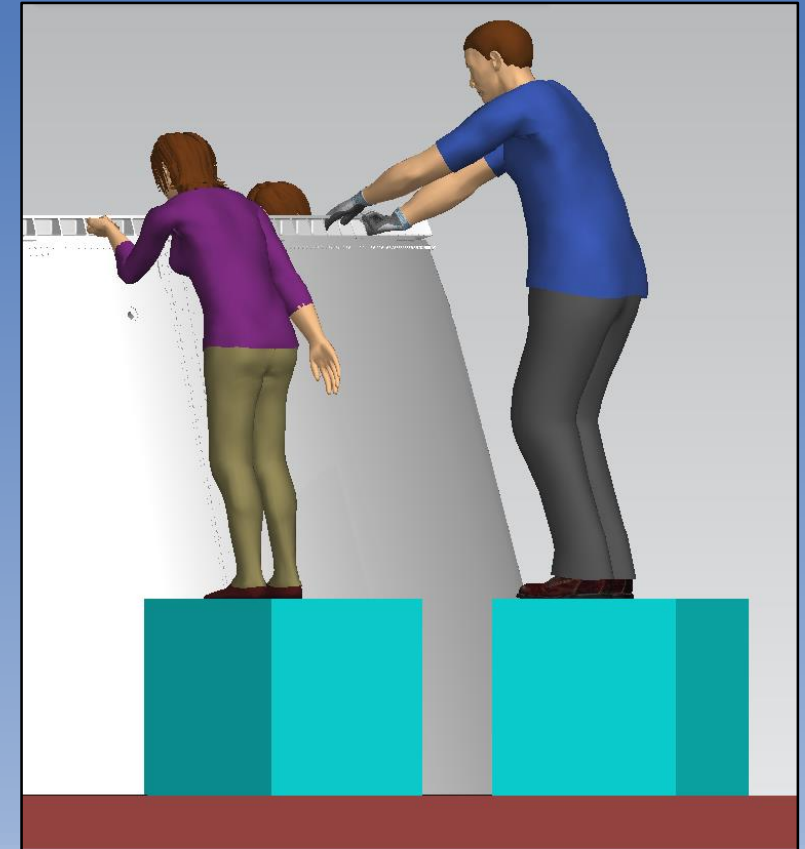




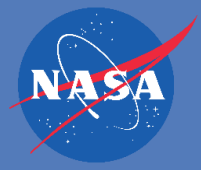
Demonstration of 5th percentile American female subject interacting with physical mockup



*Demonstration of platform heights reach study
First Height Look*

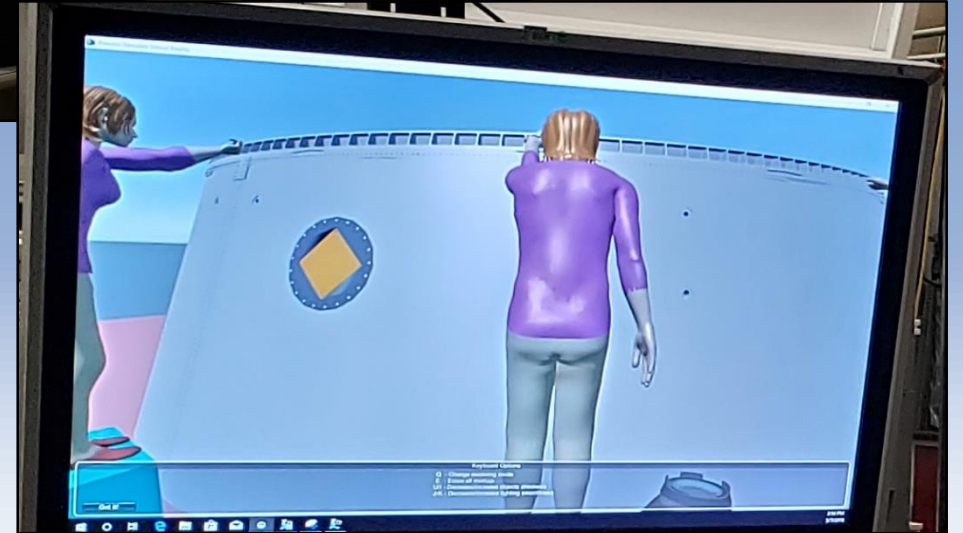
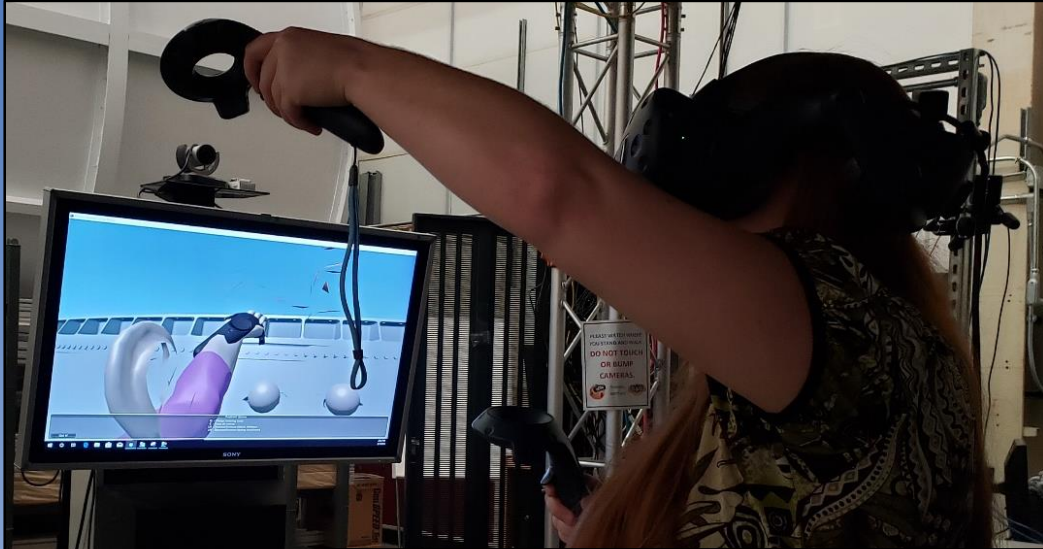


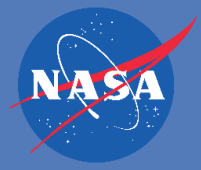
*Demonstration of platform heights reach study
Final Height Look*



Virtual Reality HFE Analyses for NASA SLS

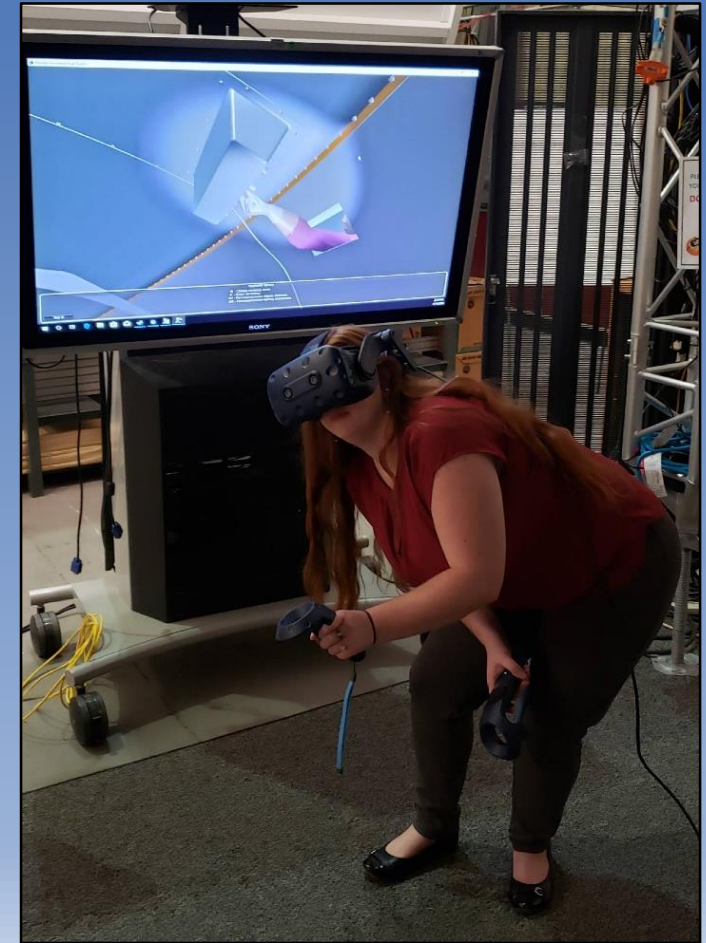
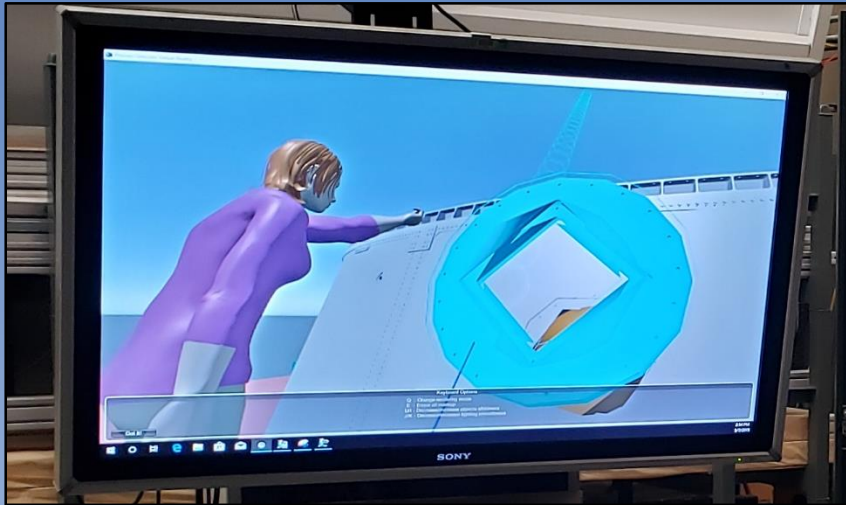
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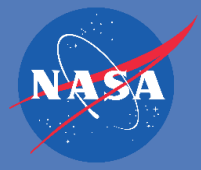




Virtual Reality HFE Analyses for NASA SLS

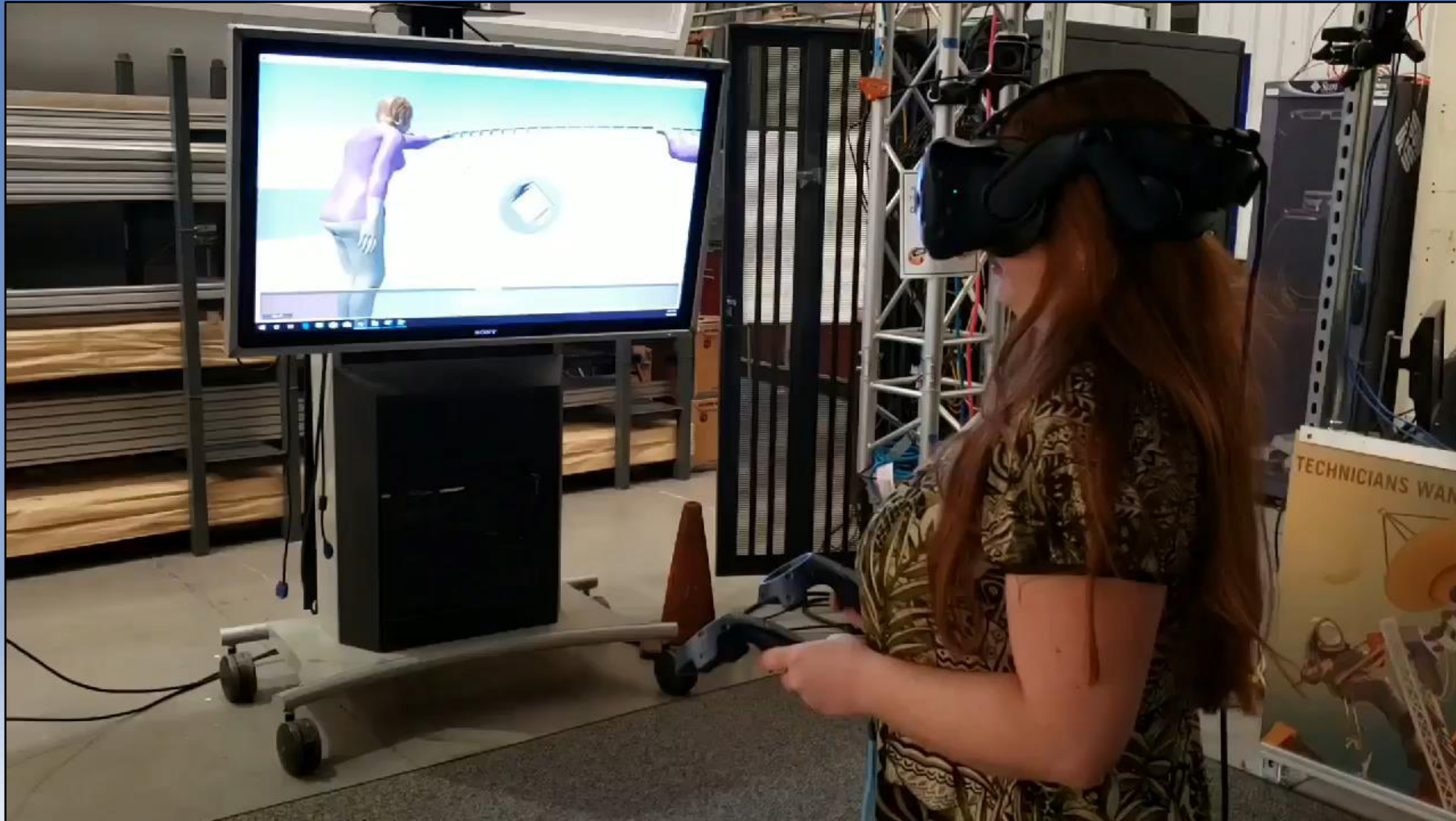
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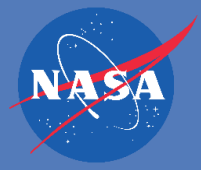




Virtual Reality HFE Analyses for NASA SLS

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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.
- 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