National Aeronautics and Space Administration

Marshall Space Flight Center

Systems Analysis and Human Systems Integration

Overview

The Systems Analysis and Human Systems Integration (HSI) team specializes in the development of modeling/simulation strategies and defines system sensitivities, critical parameters, and critical models as the design process advances. Team expertise in human factors engineering (HFE) ensures the ability to define human-machine interface requirements, utilize both virtual and physical models to help define them, and develop and verify design operability. Team capabilities include modeling and simulation (M&S), mass properties (MP), engineering photographic analysis (imagery), HFE, and integrated logistics and supportability (ILS) to confirm the development of spaceflight and ground-processing hardware at Marshall.

Core Activities

- HSI and HFE requirements development and verification
- Iterative design analysis throughout design cycles
- Worksite analyses for the design and use of ground support equipment (GSE)
- Worksite analyses for Space Launch System (SLS) pre-launch integration activities
- Virtual and augmented reality (VR/AR) assessments of hardware designs to identify areas for potential improvement
- Support to projects developing new technology for use on the International Space Station (ISS)
- Evaluation of concepts prior to official design analysis
- The development of mockups and virtual models, resulting in valuable insight and design recommendations based on requirements and team experience

The HFE team collaborates with remote partners to participate in assessments, perform design evaluations, and conduct operations planning, The team collaborates with its partners on multiple projects to produce physical and virtual mockups.

Analysis and Improvement Process

Full-scale mockups are developed with high fidelity to represent specific areas of concern, while other elements of the mockup are built to be functional, at a lower fidelity, for cost effectiveness.

Comprehensive human factors analyses are performed, involving all operations of the hardware. The hardware designers are key in this process and ensure that findings are communicated effectively. The physical mockup helps to illustrate problems clearly, allowing designers to make improvements before fabrication starts.

Full mockup fabrication — 8.4 M deep space habitat

The Systems Analysis and HSI team operates the Virtual Environments Laboratory (VEL), where a combination of multiple technologies enhances HFE assessments. The VEL allows for virtual analysis of human factors by providing real-time human motion tracking through an optical body tracking system, Bluetooth Cybergloves, and a head-mounted display system, allowing the individual to interact with a virtual environment.

Virtual reality analysis using motion capture.

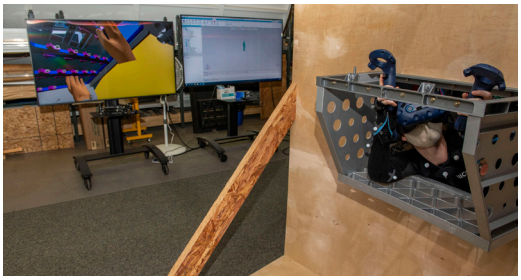
Key Features

Virtual human factors assessments allow users to interact with accurate full-scale virtual models to evaluate essential criteria for design iterations, including accessibility, work envelope, reach, line of sight, and tool clearance. The system improves assessment accuracy by allowing analysis of physical movement and utilizing motion capture to set limitations by employing millimeter precision.

Capabilities of the VEL

- VR: Utilizing VIVE Pro™ headsets, users get immersed in a virtual environment, enhancing interaction and analysis.
- AR: With Microsoft HoloLens 2™, users can see the world around them with a digital overlay, providing context to their environment.
- Motion capture: A Vicon System® tracks human movements with precision, allowing users to see their entire body with detailed interaction in the virtual environment.
- Haptic feedback gloves: These gloves allow the user to grab an object in the virtual environment and provide tactile sensations by interacting with virtual objects as if they were real.

Additionally, the VEL has the capability to integrate low-fidelity mockups and align them with their virtual counterparts, ensuring accurate representation of physical boundaries and high-fidelity virtual components.



Mixed reality assessment conducted at the VEL

Engineering Design Tool

The VEL serves as a crucial engineering design tool during the design process as it enables early assessments and computer-aided design (CAD) model redesigns, significantly reducing both schedule delays and materials costs. The ability to visualize CAD designs in 3D enhances understanding and provides insight during the design phase.

Another mixed reality assessment conducted at the VEL

Software Utilization

- Unity®: For its ease of use and functionality, Unity is the team's most used software.
- Unreal™: Focused on visual fidelity, Unreal is used for specialized applications.
- Tecnomatix® Process Simulate Human (PSH): PSH facilitates static manikin analysis, allowing analysts to import CAD models. Users interact with anthropometrically accurate human manikins in a virtual environment.

Portable Virtual Environments Lab

The team also operates a Portable Virtual Environments Lab (PVEL), a deployable version of the VEL, that allows for virtual human factors assessments in various locations, such as conference rooms or around existing mockups and workspaces. The PVEL connects remotely to the VEL, providing versatile virtual human factors assessments to meet project needs.

Advantages of using the VEL

- Rapid design layout changes can be analyzed by various departments with minimal impact to cost or schedule.
- VEL facilitates conceptual work testing within limited budgets.
- Early VR integration in design cycles saves time and resources.
- Resulting HFE analysis improves usability and safety for the technicians assembling the vehicle and the astronaut crew at launch.
- VEL enables collaboration with remote partners.

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Marshall Space Flight Center
Huntsville, AL 35812
www.nasa.gov/center/marshall

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