Overcoming limitations

By Kendra Ceule

The Habitability and Human Factors Office works to answer tough questions

How do you make a space station user-friendly? That's just one of the many questions tackled by the Habitability and Human Factors Office (HHFO), which is part of the Space and Life Sciences Directorate.

In their work, HHFO team members explore many topics, such as:

- Where should the foot restraints be in the International Space Station to ensure easy access to work stations?
- Will an astronaut's spacesuit still fit in microgravity?
- How can the shuttle's computer and warning systems be made more efficient?

Overcoming the limitations of humans in space is the overall goal of the team, which strives to improve the systems that help astronauts live and work in space. Doing this increases the astronauts' productivity.

HHFO team members support both the space shuttle and ISS programs. In many cases, they do not design items for use in space. Instead, they use research data and feedback from astronauts to improve existing items. For example, the team itself doesn't make spacesuits, but it does help engineers test and critique their design to maximize astronauts' range of motion and strength.

Numerous tools are used to answer many questions. Some of the most useful tools are the team's four research and testing facilities, which are profiled here. Read on to discover how the Habitability and Human Factors Office makes space a better place to live and work.

Usability Testing and Analysis Facility (UTAF)

Overview

The UTAF collects data on the usability of various systems, such as computer interfaces. Astronauts and other system testers use the materials in the facility's subject room while being observed and videotaped from the control room.

NASA JSC 2002e08132 Photo by James Blair

Mihriban Whitmore, Ph.D., Usability Testing and Analysis Facility Manager, assesses a computer display's user interface for a payload operation. Also shown from front to back are Dan Carr, Ph.D., Vicky Byrne and Rosie Ortiz, all of Johnson Engineering.

Projects

While many systems onboard the ISS are now computerized, they don't all work the same way because several different user interfaces are currently onboard. Astronauts have often said that the differences between the computer systems make them harder to use, so the UTAF collects data on the usability of various systems in order to correct the situation.

The UTAF is also conducting a three-year study on multipurpose crew restraints for the ISS. Hand and foot restraints are more complicated than they might appear. For instance, to use the same workstation, astronauts may need restraints in different places to accommodate their different sizes, or astronauts may be working on the floor one minute and on the ceiling the next, requiring several different restraints. UTAF's goal is to design a multipurpose restraint that could be easily moved to accommodate different people or projects, while still providing sturdy support to the astronauts.

NASA JSC 2002e08134 Photo by James Blair

Johnson Engineering's Maitri Dhutia performs a rack push force test in the Anthropometry and Biomechanics Facility. Also shown is Johnson Engineering's Javier Gonzalez, Ph.D.

One UTAF project that is still in the early stages is nicknamed "Magic Windows." This technology would display Earth scenery, photographs or even television footage onto flat-panel displays, giving astronauts an artificial change of scenery. While the natural scenery from space is breathtaking enough, astronauts on particularly long missions may benefit psychologically from a visual change. Magic Windows may even allow astronauts to interact with their families on Earth in a videoconference.

Anthropometry and Biomechanics Facility (ABF)

Overview

The ABF uses state-of-the-art strength measurement devices to assess the physical capabilities of astronauts, both suited and unsuited. The facility does research in biomechanics and ergonomics to maximize the usefulness of spacesuits, and tests suits in the KC-135, Neutral Buoyancy Lab and at remote sites in Arizona and California.

Projects

The ABF takes measurements of every astronaut in several ways. First, the astronaut's size and stature are measured with a tape measure. Then, strength measurements are taken. Finally, the entire body is scanned so that a 3-D computer image can be created. These measurements are used to select the correct size of spacesuit parts for the astronaut. Averages of the data are also used by the Graphics Research and Analysis Facility to run animated trials of mission procedures.

The ABF team members help evaluate the existing spacesuit designs in an effort to maximize the astronauts' range of motion and strength in orbit. Other projects include analysis of space hardware and crew training on Hubble Space Telescope repair missions.

Graphics Research and Analysis Facility (GRAF)

Overview

GRAF uses high-performance computer graphics programs to model and animate potential mission scenarios before launch, checking for logistical difficulties before they actually occur in space.

Projects

The computer systems in the GRAF can place a 3-D animated astronaut (based on measurement data from the ABF) in an animated shuttle or ISS module and simulate mission operations. Using data from the Light Environment Testing Facility (see below), these models can simulate light availability from various sources, such as sunlight, earthshine, reflections and glares from spacecraft. Doing so indicates whether or not the light will be sufficient to perform a mission objective.

Onboard camera views can be predicted before the mission, and allow the GRAF team members to predict potential payload problems before they occur. Even mission operations, such as ISS component attachments and spacewalks, can be simulated on the computer, allowing for contingency plans if needed.

NASA JSC 2002e08135 Photo by James Blair

Jim Maida, Graphics Research and Analysis Manager, confirms a total reflectance measurement for a target to be used in an illumination modeling system. Also shown is Kim Tran of Johnson Engineering.

One of GRAF's success stories came in the early days of the shuttle program, when engineers were faced with a challenge: If the payload bay doors didn't close, the shuttle would not be able to safely re-enter the atmosphere. However, if an astronaut performed a space walk to close the doors manually, he or she would then be stuck outside the shuttle, as the airlock is located in the payload bay. The GRAF team ran through the scenario graphically until a solution was reached.

Currently, GRAF is focusing on interior volume control for the ISS, helping to maximize working and living space while allowing for arriving payloads.

Light Environment Testing Facility (LETF)

Overview

LETF uses light sources, luminance meters, colormeters, computer models and other tools to predict and analyze the lighting availability in space mission situations. This data helps the GRAF run accurate test scenarios with its computer graphics systems and train astronauts on how to best utilize light during their missions.

Projects

Lighting plays a large part in human space missions. The people onboard must be able to see their computer workstations, scientific experiments and other spacecraft in the event of a docking. LETF works closely with GRAF and supports the ISS and shuttle programs by helping them make the most of both natural and artificial light. LETF is also involved in the research of new lighting technologies, such as solid-state