

## Inserting New Technologies into Human-Computer Interfaces for Future Lunar and Mars Missions

Plans call for human cislunar operations and lunar surface access, to prepare for eventual Mars missions. NASA will also develop new opportunities in lunar orbit that provide the foundation and act as a gateway for human exploration deeper into the solar system. Current human spaceflight is complex and requires as many as fifty people to support the International Space Station (ISS) Mission Control Center (MCC) in Houston, Texas. These flight controllers in the front and back rooms of the MCC, serve as an extra pair of eyes overseeing the numerous station systems. Deep space missions - to the moon, Mars, and beyond - will be more complex and place challenging mission constraints on the crew. As the round-trip communication delays increase in deep space exploration, more on-board systems autonomy and functionality will be needed to maintain and control the vehicle. These mission constraints will change the Earth-based ground control approach and will demand efficient and effective human-computer interfaces (HCI) to control a highly complex vehicle or habitat system. All of this necessitates a different approach to designing and developing spacecraft and habitats.

In the beginning of new human spaceflight programs, focus is typically on launch vehicle and uncrewed spacecraft design and development. The reasoning behind this focus to enable flight testing of an integrated launch vehicle and spacecraft system to ensure it will be safe enough to allow humans on board. This is an essential process for new spacecraft, however, the practical effect is a lack of funding for the spacecraft's human interfaces development. It can be many years before the human interface development begins, putting it late in the spacecraft lifecycle, when almost all other spacecraft systems and subsystems are already in place. This forces the usage of existing and proven technologies for the HCI interfaces. We posit that putting the human first in a spacecraft design process will yield a more effective spacecraft for exploration and long duration missions. NASA Human Research Program (HRP) has identified inadequate HCI as a risk for future missions. New tools and procedures to aid the crew in operating a complex spacecraft will be required. This paper discusses ongoing activities in the development of the next generation HCI components and systems, and a new approach toward human interfaces for spacecraft.