

## Addressing Challenges to the Design & Test of Operational Lighting Environments for the International Space Station

In our day to day lives, the availability of light, with which to see our environment, is often taken for granted. The designers of land based lighting systems use sunlight and artificial light as their toolset. The availability of power, quantity of light sources, and variety of design options are often unlimited. The accessibility of most land based lighting systems makes it easy for the architect and engineer to verify and validate their design ideas. Failures with an implementation, while sometimes costly, can easily be addressed by renovation. Consider now, an architectural facility orbiting in space, 260 miles above the surface of the earth. This human rated architectural facility, the International Space Station (ISS) must maintain operations every day, including life support and appropriate human comforts without fail. The facility must also handle logistics of regular shipments of cargo, including new passengers. The ISS requires accommodations necessary for human control of machine systems. Additionally, the ISS is a research facility and supports investigations performed inside and outside its livable volume. Finally, the facility must support remote operations and observations by ground controllers. All of these architectural needs require a functional, safe, and even an aesthetic lighting environment.

At Johnson Space Center, our Habitability and Human Factors team assists our diverse customers with their lighting environment challenges, via physical test and computer based analysis. Because of the complexity of ISS operational environment, our team has learned and developed processes that help ISS operate safely. Because of the dynamic exterior lighting environment, uses computational modeling to predict the lighting environment. The ISS' orbit exposes it to a sunrise every 90 minutes, causing work surfaces to quickly change from direct sunlight to earthshine to total darkness. Proper planning of vehicle approaches, robotics operations, and crewed Extra Vehicular Activities are mandatory to ensure safety to the crew and all others involved. Innovation in testing techniques is important as well. The advent of Solid State Lighting technology and the lack of stable national and international standards for its implementation pose new challenges on how to design, test and verify individual light fixtures and the environment that uses them. The ISS will soon be replacing its internal fluorescent lighting system to a solid state LED system. The Solid State Lighting Assembly will be used not only for general lighting, but also as a medical countermeasure to control the circadian rhythm of the crew. The new light source has performance criteria very specific to its spectral fingerprint, creating new challenges that were originally not as significant during the original design of the ISS.

This presentation will showcase findings and toolsets our team is using to assist in the planning of tasks, and design of operational lighting environments on the International Space Station.