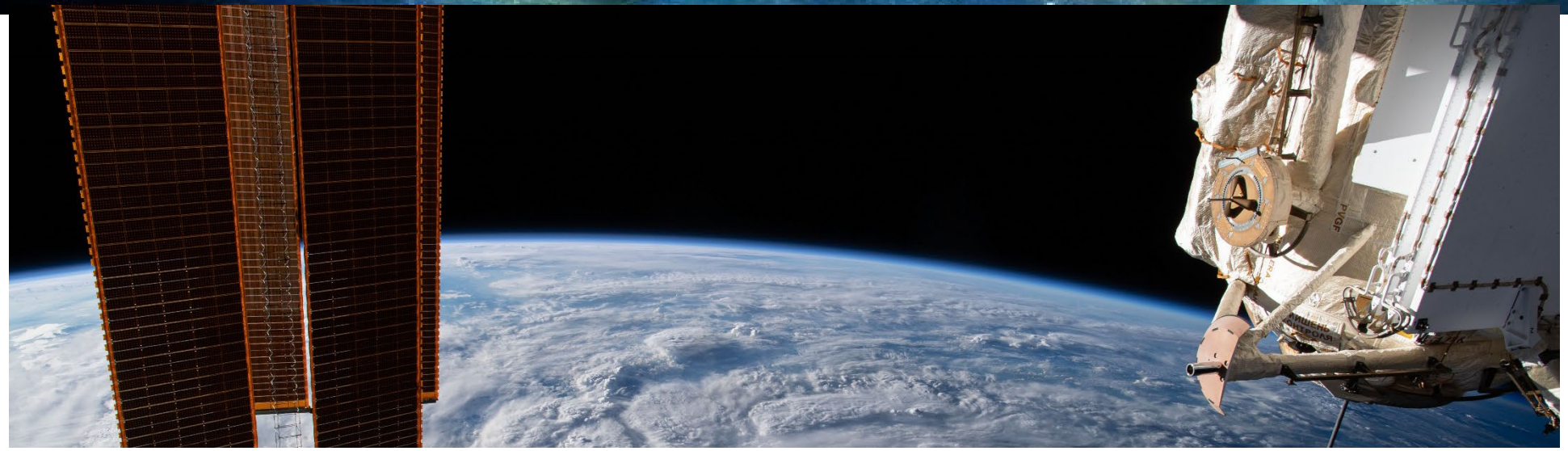


Image from nasa.gov

Implementation of HSI in NASA's Gateway Program

Sherry Thaxton, PhD, CPE

sherry.s.thaxton@nasa.gov

Jackelynne Silva-Martinez, MS

jackelynne.p.silva-martinez@nasa.gov

NASA Johnson Space Center

Agenda

- **HSI at NASA**
- **Gateway Program**
  - Program Overview
  - HSI Organization and Implementation
  - Human System Requirements
- **Challenges to Implementation of HSI**
- **Question to the audience**

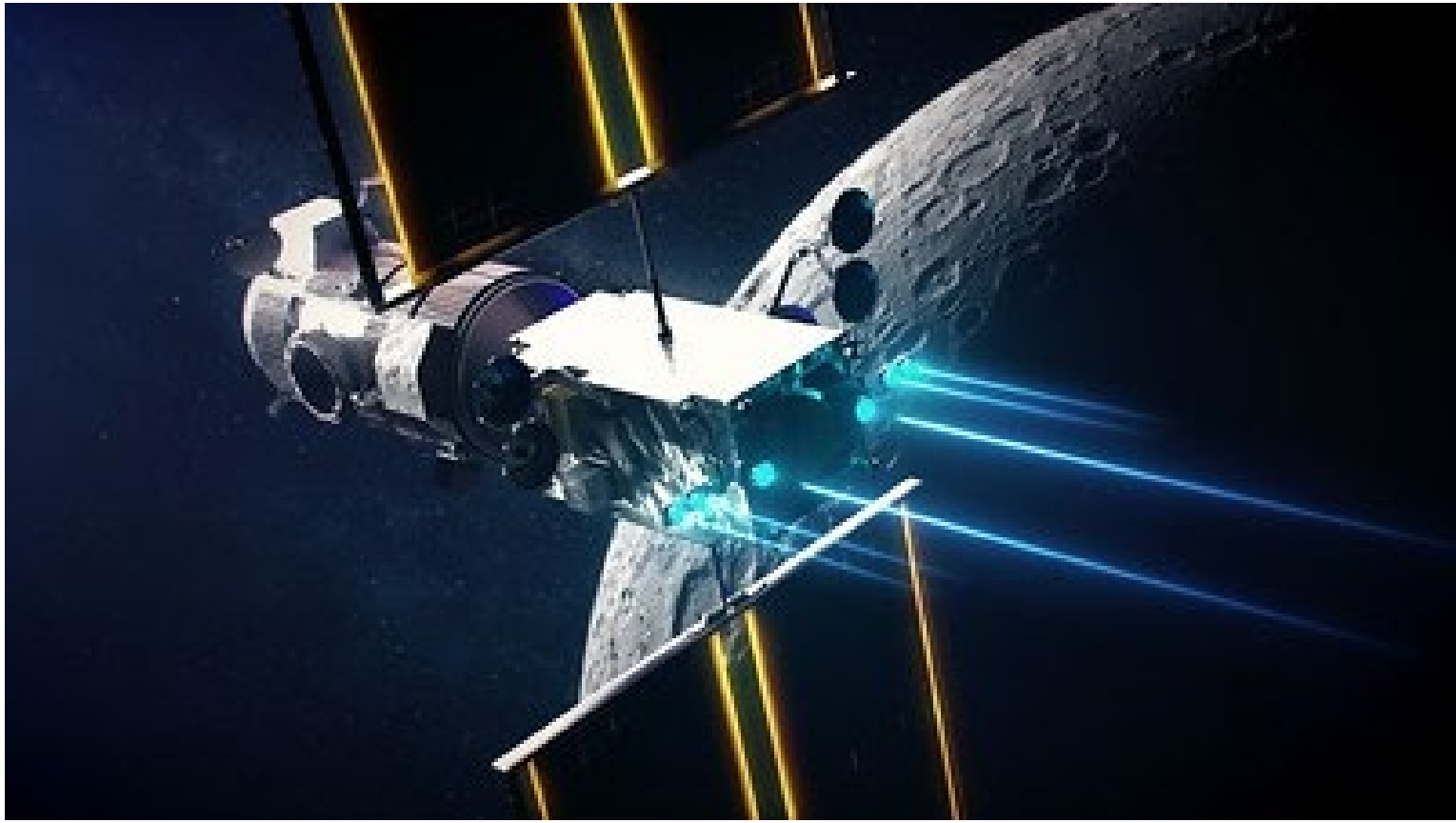


Image from nasa.gov

HSI at NASA

- **NASA defines Human Systems Integration as part of the overall systems engineering and acquisition strategy for space systems**

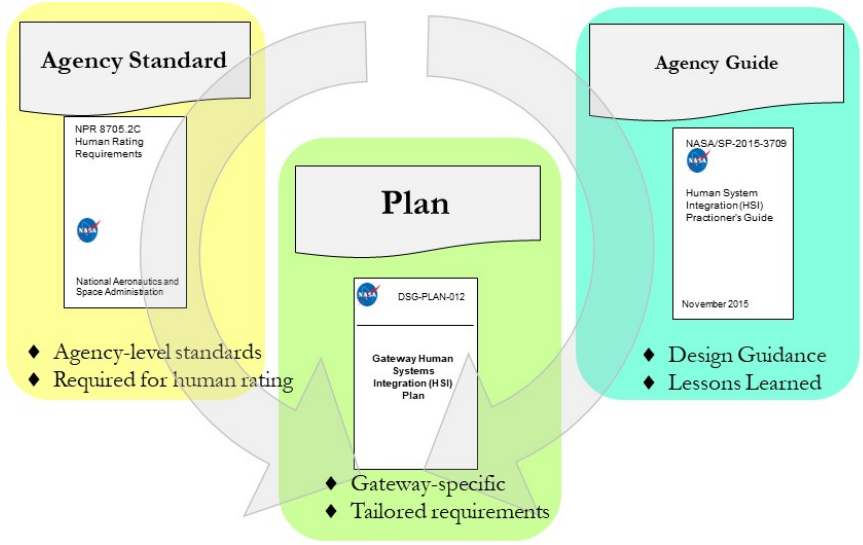
  NPR 7123.1C NASA Systems Engineering Processes and Requirements defines HSI as:

  An interdisciplinary and comprehensive management and technical process that focuses on the integration of human considerations into the system acquisition and development processes to enhance human system design, reduce lifecycle ownership cost, and optimize total system performance. Human system domain design activities associated with operations, training, human factors engineering, safety, quality, maintainability and supportability, habitability, and survivability are considered concurrently and integrated with all other systems engineering design activities.

- **NASA has 6 HSI Domains:**
  - Human Factors Engineering
  - Operations Resources
  - Maintainability and Supportability
  - Habitability and Environment
  - Safety
  - Training

HSI at NASA

- **NPR 8705.2C NASA Human Rating Requirements for Space**
  - Requires formation of a Human Systems Integration Team for each Program/Project
  - Identifies NASA-STD-3001 NASA Space Flight Human System Standard as Type 2 document that must be tailored for each Program/Project
    - Volume 1: Crew Health and NASA Space Flight Human System Standard
    - Volume 2: Human Factors, Habitability, and Environmental Health
- **Guidance for HSI implementation is provided in the NASA/SP-2015-3709 Human Systems Integration Practitioner's Guide**



Gateway Overview

- **The Gateway Program is one element of the Artemis mission, which is driving toward boots on the moon (BOTM) by 2024**
    - Artemis mission includes SLS, Orion, Human Landing System, Gateway, among others
- **For sustaining missions following the initial BOTM mission, Gateway will be positioned in a cis-Lunar orbit**
    - Crews of 4 for a minimum of 30 days
    - Supporting staging of other assets including landers
    - Uncrewed for extended periods of time between crewed mission

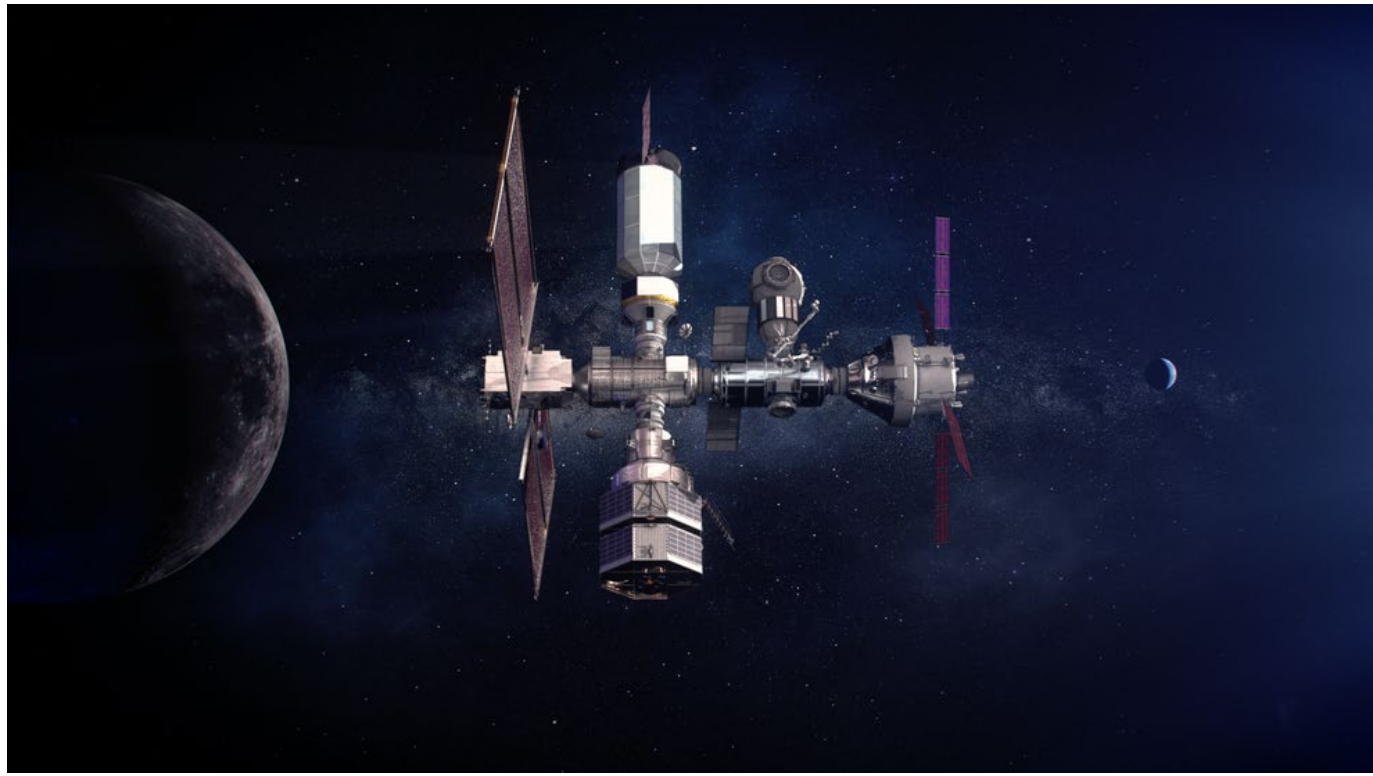
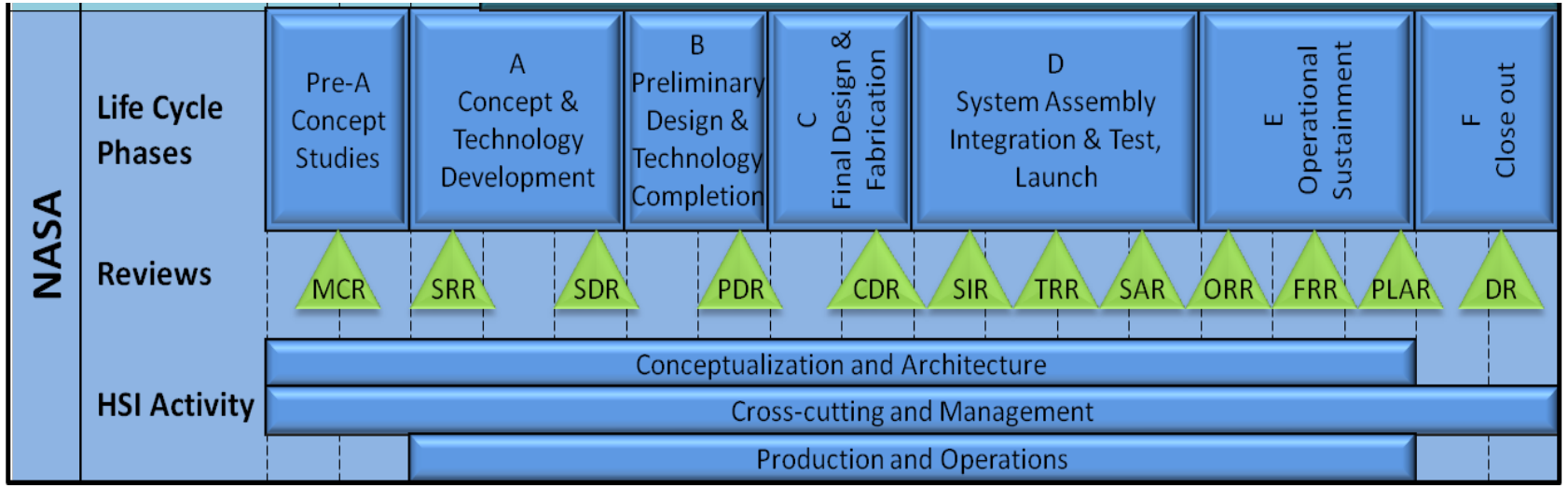


Image source: nasa.gov

Gateway HSI Organization

- **HSI practitioners have close collaborative relationships across NASA organizations, Technical Authorities, and Program subsystems.**
- **HSI practitioners participate throughout the systems engineering cycle:**
  - Concept development
  - Requirements definition
  - Design development/assessment
  - Testing and evaluation
  - Sustainment/closeout



Gateway HSI Organization

NASA supports HSI processes in Gateway through in-line teams assigned to the Program as well as a chartered Gateway HSI Working Group

- In-line teams:
  - Human health and performance team supporting the Health and Medical Technical Authority
  - Engineering teams focused on computer human interfaces, life support functions, and vehicle system management
  - Operations teams focused on operational scenarios, automation, and training
  - Safety and mission assurance experts
  - Maintenance experts to ensure stowage and logistics considerations are taken into account during design development

- HSI Working Group:
  - Collaborative forum that coordinates the integration of human considerations into Gateway Program acquisition and development, implementation, and operations processes
  - Representation from in-line teams to represent all domains of HSI
  - Provides integrated recommendations to Program management and/or NASA Technical Authorities

Gateway Human System Requirements

- **A key factor in HSI implementation is the establishment of appropriate requirements for interactions between the human and the vehicle and its subsystems**

- **NASA-STD-3001 Vol. 1 and Vol. 2 are tailored for Gateway's design reference mission**
  - Requirements reside in multiple documents throughout the Gateway requirements space, including a central Human Systems Requirements document and more than a dozen hardware and software subsystem specifications

- **Maintaining a clean trace from the standard to these requirements is critical to the Human Rating Certification Process**
  - Health and Medical Technical Authority must assess risks to human health and performance based on this requirements set

Challenges to Implementation of HSI

- **By its nature, HSI spreads across multiple systems and spacecraft modules**
  - Gateway is tightly coupled with multiple other NASA Programs including Orion and Human Landing System
  - Risks to the human cannot be neatly divided amongst subsystems or even Programs

- **Formalized approach to HSI is relatively new to NASA**
  - There can be hesitancy to adopt HSI as a process, and challenges associated with certification of heritage hardware and the use of traditional procurement approaches
  - This applies for both internal to NASA and module providers

- **Budget and schedule are incredibly constrained for Gateway**
  - Anything perceived as a “nice-to-have” is under close scrutiny

- **HSI practitioners must bring a clear and convincing story to management to justify the benefits of practicing HSI**

Questions for the DoD HFE TAG

The hope in attending this TAG is to gain insight into some of the following questions:

- What is DoD's overall approach to HSI? How is it evolving, and is it widely accepted, or does it face similar challenges as NASA?
- Where does HSI reside within organizations and Programs in DoD?
- What are some approaches to requirements and verifications that are compatible with decreased government implementation (changing oversight/insight models)?
- How does DoD set HSI up for success during procurement processes?

National Aeronautics and Space Administration