Mars Habitats

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Habitation Duration

- Orbital Mechanics will generally encourage architectures favoring either short stay (~few to tens of days) or long stay (~hundreds of days) habitation
  - **Conjunction class** trajectories minimize propellant required but require wait time at Mars before returning to Earth
  - **Opposition class** trajectories typically use a higher-energy trajectory (more propellant) for the return leg; result is longer in-space transit time but significantly shorter stay time in Mars vicinity; total time away from Earth can be significantly less than conjunction class
- An architecture can be developed around only one (short or long stay), or can be developed to be capable of supporting both types of crew missions in different crew expeditions

Short Stay Habitation

- Generally (not always) associated with opposition-class missions
- Surface crew duration may reduce the required infrastructure, but may also limit performance / capabilities / functionality
- Many possible variations - can be a fixed outpost, a mobile asset, or a combination
- The NASA Mars Architecture Team is currently assessing short stay habitation
- Will look at results from a mobile analog based on the NASA small pressurized rover (SPR) field tested during Constellation
  - Cabin 1A and 1B – two prototypes of the SPR used at Desert Research and Technology Studies (DRATS)

SPR DRATS Field Testing

- 2008 Field Test
  - UPR (unpressurised rover) vs. SPR 1-Day Test proved superiority of pressurized rover over unpressurized (scientific productivity and human factors)
  - SPR 3-Day Test: Habitability, human factors, and performance characteristics evaluation
  - Test led to inclusion of pressurized rover in Constellation architecture
- 2009 Field Test
  - 14-day mission; habitability and usability evaluation of Cabin 1B
  - Conducted 24-hour rescue of incapacitated rover – used Cabin 1A as the disabled vehicle
- 2010 Field Test
  - Two 7-day partial simulations with two SPRs, two Portable Utility Pallets, one habitat

SPR as a Habitat

- Forward cockpit area heavily utilized by the crew
  - Worth noting that while the crew could sit down throughout the cabin these were the only “traditional” seats in the rovers
- Driving and Science Observation
  - Often one would focus on driving and navigation while other crew member focused on science observation
- Office Work
  - When not driving, crew would often use the cockpit for computer-based work (could work elsewhere if desired)

SPR as a Habitat

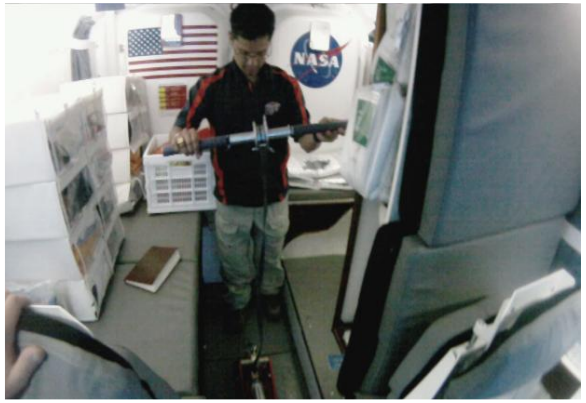
- Mixed use of cabin for crew meals
- Standard dehydrated and shelf stable food used for meals
  - Water dispenser located beneath starboard bench
  - No thermostabilized food (rover prototypes did not include food warmers)
- Some continued to use the cockpit area for crew dining, while others moved aft to eat from the benches

SPR as a Habitat

- Stowage located throughout cabin
  - Original stowage under floor and in benches
  - Additional stowage (blocking hatches) needed to extend mission to 14 days – did interfere with hatch operations
- Some crew neater than others
- Stowage volume included trash compartment
  - Crew removed trash from vehicle periodically
  - Field data suggests 2-3 days was approximate limit crew was willing to tolerate (result on odor mitigation used in prototype – cannot be extrapolated to flight systems but should influence testing)

SPR as a Habitat

- Aft section of cabin used for non-duty activities
- Benches used like sofas for movie watching and relaxing
- Crew exercise, hygiene, and waste management in aisle
- Medical care not evaluated in 2008-2010 DRATS but med kit stored under bench
- Deployable curtains used for waste and hygiene privacy and to form private crew bunks



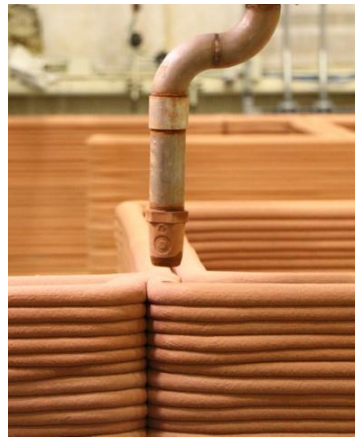
Long Stay Habitation

- Generally (not always) associated with conjunction-class missions
- Crew on the surface for hundreds of days – surface stay time may exceed longest US ISS crew rotation
- The historic NASA Design Reference Missions utilized long stay habitation
- No human experience with long surface stays; limited guidance in existing standards
- Many possible variations – often modeled as a fixed outpost, usually with some form of mobility assets
- Will look at an analog test that will begin in the fall

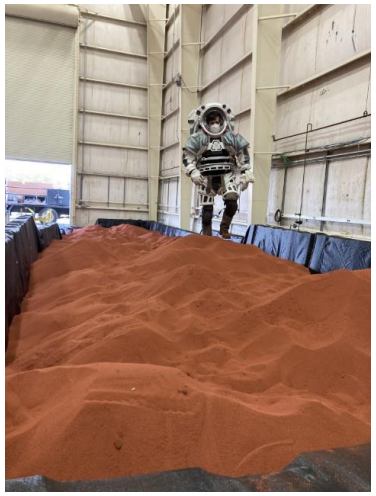
CHAPEA

(Crew Health And Performance Exploration Analog)

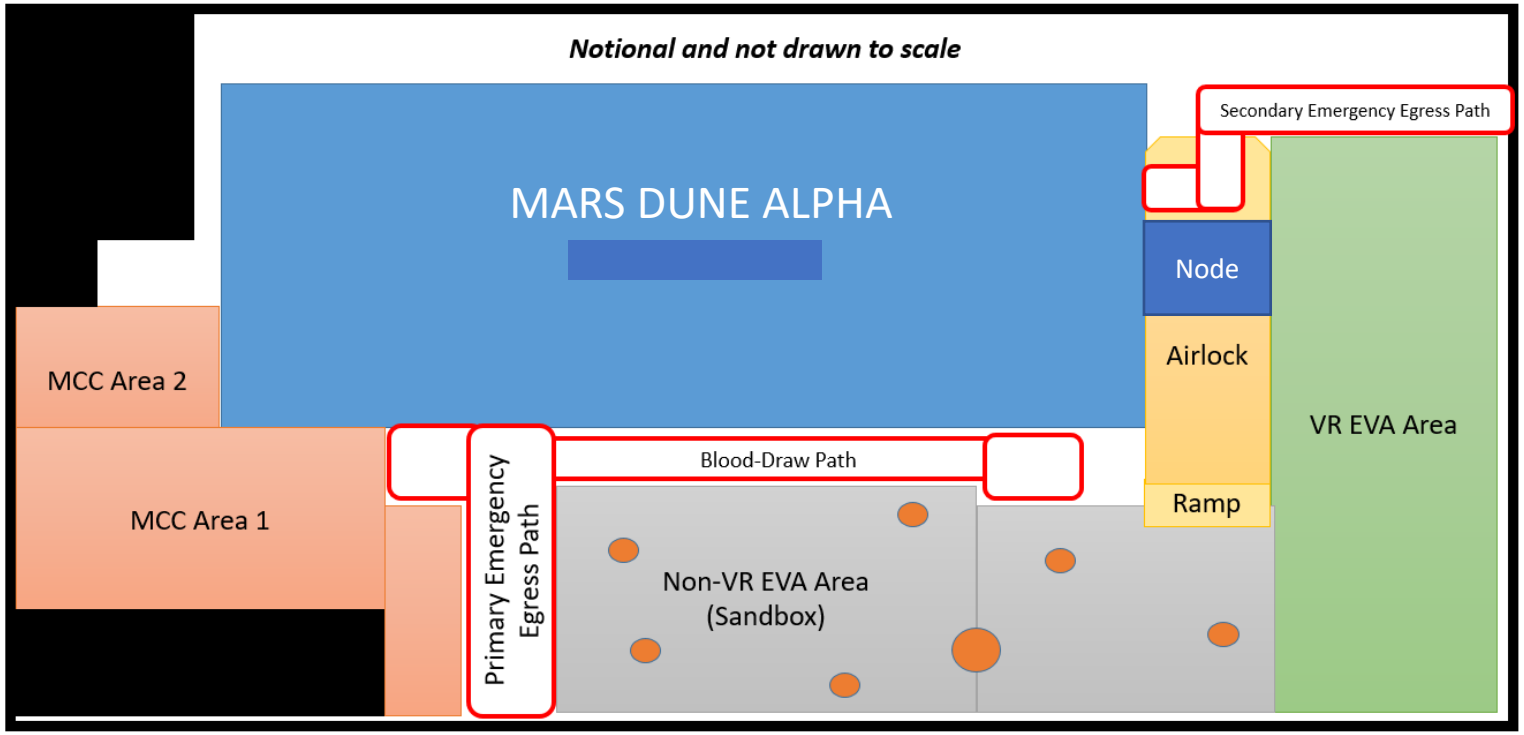
- 3D Printed habitat representative of a Mars surface habitat
- A four-person crew will begin living in CHAPEA October 2022 for a roughly one-year mission
- Two one-year missions will follow
- Mars-like time-delayed communications
- Analog goals
  - Validate the adequacy of the planned exploration food system design
  - Inform NASA standards and associated vehicle mass and volume requirements for long-duration exploration missions



CHAPEA Facility Components



- Mars Dune Alpha
  - This is where the crew will spend the majority of their time during the analog mission
- Airlock and Node
  - The airlock and node mockups will allow the crew to exit the habitat for EVAs, staying in simulation by carrying out simulated pressurization and depressurization activities, suit donning and doffing, etc.



- Mission Control Center
  - This is the base for the ground support team
- Virtual Reality EVA Area
  - This is where the crew will carry out VR EVAs, outside the habitat
- Non-VR EVA Area
  - This is the sandbox where the crew will carry out non-VR EVAs, outside the habitat

CHAPEA Internal Configuration

- Four private crew quarters
- Two private waste and hygiene facilities
- Kitchen
- Dining Area
- Recreation / Lounge Area
- Plant Growth Chambers
- Exercise Facility
- Laboratory / Maintenance Work Area
- Teleoperations / EVA Monitoring / Control Center
- Medical Facility