LUNAR DAYLIGHT
BEHAVIORAL EXPERIMENTS IN A SPACE ANALOG
LIVING AND WORKING ENVIRONMENT

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THE LIMITATIONS OF HABITAT ANALOG BEHAVIORAL RESEARCH

- **The great challenge** to environmental behavioral scientists and architectural researchers in conducting research in space habitats or habitat analogs is to **produce scientifically valid results**.

- **Historically**, habitability researchers have been **limited** largely to qualitative surveys.

- Instead, *Lunar Daytime* will demonstrate the efficacy of a **modifiable environmental analog** as a **behavioral laboratory** capable of **producing** empirical, measurable, and **quantitative data sets**.

- To measure effects in crew behavioral responses in relation to environmental settings, **researchers must be able to make and control changes in the physical living and working environment as an independent variable**.
LUNAR DAYLIGHT: PURPOSE

- **Lunar Daylight** will **overcome** the historical **limitations** of analogs.

- It will demonstrate the efficacy of a **modifiable habitat analog** as a **behavioral laboratory producing** empirical, measurable, and **quantitative data sets**.

- To measure effects in crew behavioral responses to environmental settings, researchers must be able to **make and control changes** in the physical environment as the **independent variable**.

- The effects on crew behavior, mood, and performance constitute **the Dependent Variables**.
LUNAR DAYLIGHT: WHY 14 DAYS?

- **Lunar Daylight** = the half of the Moon’s 28-day diurnal cycle that receives sunlight.
- Without a nuclear power reactor to the Moon, human visits will be limited to the daylight period.
- **Lunar Daylight** addresses the intensive two week period that will become the standard of a lunar surface Mission.
- 14 day simulations afford more runs for a much larger n and greater statistical power.

ESA Lunar Workshop Habitat Concept
VARIATIONS IN (ISS) SPACE MODULE INTERIOR ARCHITECTURE

Courtesy of David Nixon, Architect

LUNAR DAYLIGHT:
TWO MAJOR OBJECTIVES

• None of the existing analogs allow for the modification necessary to experimentally address the critical issues surrounding the optimal habitat for isolated, confined environments (ICEs).

• Objectives:
1) Create a space habitat analog research facility, specifically designed to accommodate desired modifications in the physical and perceptual living and working environment, and
2) Demonstrate the ability of such an environmental behavioral laboratory to investigate and address critical factors that we believe play important roles in human health and well-being in ICE.

Bigelow Aerospace
Lunar Base Concept
THE SIXTH MODULE

To that end, the LDT will build a module in the Multi-Purpose Research Station (MPRS) at the University of North Dakota (UND) in Grand Forks.

MPRS currently consists of a five-module lunar/planetary habitat analog complex built from two NASA EPSCoR grants.

The principal modification will be to design, build, and install a sixth module as a space habitat analog behavioral laboratory.

This module will be designed specifically to accommodate a wide range of spatial and visual customizations.
INTEGRATED HABITAT INTERIOR

Early Integrated Habitat Interior showing hatch, galley and group activity area.

Partial Transverse Section through the inflatable Integrated Habitat Structure
• **Lunar Daylight** P.I. Marc Cohen served as a consultant to Prof. Pablo De Leon on his first EPSCoR grant.

• **Integrated Habitat System** incorporates Suits, Suitports, and Rover.
The Wide Central Habitat is the product of the first EPSCoR Lunar Daylight will add a sixth, customizable module.
DEMONSTRATION HYPOTHESES

• The LDT team posits several possible validation studies representing the types of investigations needed to advance environmental and architectural space habitat research which the proposed facility can easily address.

Regolith-covered ISS-type lunar module, courtesy of Gary Kitmacher
HYPOTHESIS 1: PRIVACY OF SLEEP QUARTERS –

- Providing individual private quarters will produce better outcomes (e.g., lower stress, reduced interpersonal conflict, higher well-being, more positive moods, more restful sleep) than shared or common sleep quarters. Configurations to be tested include: individual, twin, and all-in-one/common sleeping arrangements.

- Cross-Section through the inflatable SEIM lunar-planetary habitat module.

- The private sleep compartments appear in the upper left and upper right.

- Courtesy of Constance Adams and Georgi Petrov
HYPOTHESIS 2: WINDOWS

- Digital display “windows” will provide reductions in stress and the sense of confinement. Proposed characteristics to be tested include: geometry, size, and location.
HYPOTHESIS 3: CIRCULATION PATTERNS

- A module traffic pattern that creates a circulation loop will create functional and crew interaction differences from a non-loop “tree” pattern. These differences include increased social interaction (positive or negative), and efficiency in response to emergency egress and access, and normal operation.

Mir: Single Path, Dead End “Tree” Pattern

Space Station Freedom circa 1986 “Racetrack” Circulation Loop
HYPOTHESIS 4: PHYSICAL AND PERCEPTUAL ORDER

- A habitat with physical order and visually clean will promote positive effects in crew function, mood, performance, and productivity.

Lockheed Martin “NextStep” Cislunar Habitat Mockup for Lunar Gateway

ISS: US "Destiny" Lab, Hawaiian Shirt Day. The shirt is the most orderly and visually readable item.
EXPECTED RESULTS FROM LUNAR DAYLIGHT

- We will validate the fully operational, modifiable space analog behavioral laboratory.

- The series of experiments will demonstrate the power and flexibility of utilizing a modifiable behavioral analog laboratory and begin to set new standards for space analog habitat research.

- It will also facilitate a new paradigm of behavioral research that moves beyond passive observation and “expert opinions” that have dominated past surveys and quasi-experiments, bridging the results from qualitative and descriptive studies with quantitative ones.

- It will provide a, heretofore, unavailable degree of physical manipulation of the living environment that will lead to more definitive and complex mission simulation research as well as provide for synergies between joint interdisciplinary efforts (e.g., space architects and behavioral researchers from sociology and psychology).