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

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2020 ICES Lunar Daytime paper:
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 to desired independent variables in the physical living and working environment.
LUNAR DAYTIME: PURPOSE

• **Lunar Daytime** 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 DAYTIME: WHY 14 DAYS?

- **Lunar Daytime** = the half of the Moon’s 28-day diurnal cycle that receives sunlight.
- Without a nuclear power reactor on the Moon, human visits will be limited to the daylight period.
- **Lunar Daytime** addresses the intensive two week period that will become the standard of a lunar surface Mission.
- 14 day simulations will allow researchers to conduct more missions, providing larger samples resulting in more robust statistical analyses.

*ESA Lunar Workshop Habitat Concept*
VARIATIONS IN POTENTIAL SPACE
MODULE INTERIOR ARCHITECTURE

Courtesy of David Nixon, Architect

LUNAR DAYTIME:
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 (ICE).

• Objectives:

1) Create a space habitat analog research facility, specifically designed to accommodate experimental 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 for 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. PI Cohen served as consultant on the first EPSCoR.

• The expansion of the existing simulation facility is the most efficient path for realizing a true space habitat analog behavioral laboratory.

• The addition of a sixth module will accommodate a wide range of spatial and visual experimental configurations addressing various habitat design and psychosocial factors.
INTEGRATED HABITAT INTERIOR

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

Partial Transverse Section through the inflatable Integrated Habitat Structure
**UND EPSCOR 1 INTEGRATED HABITAT**

- **Lunar Daylight** P.I. Marc Cohen served as a consultant to Prof. Pablo De Leon on his first EPSCoR grant.
- **Integrated Habitat System** incorporates Spacesuits, Suitports, and Rover Analog.
• The Wide Central Habitat is the product of the first EPSCoR.
• Lunar Daylight’s sixth module will provide the capability for customizations that can address a wide range of experimental inquiries.
LUNAR DAYTIME CONFIGURATION CONCEPT

EXISTING MULTIPURPOSE RESEARCH STATION (MPRS) PLAN
UNIV. NORTH DAKOTA, GRAND FORKS, ND
NOT TO SCALE

PROPOSED RECONFIGURATION OF THE MPRS
UNIV. NORTH DAKOTA, GRAND FORKS, ND

Mark M. Cohen 14 Jul 2020
NOT TO SCALE
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 elicit 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.
HYPOTHESIS 4: PHYSICAL AND PERCEPTUAL ORDER

- A habitat with physical order and visually clean will increase work output and 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.

08/22/2020 Lunar Daytime / Space Cooperative
EXPECTED RESULTS FROM LUNAR DAYTIME

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

• The series of experiments will demonstrate the utility and flexibility of performing behavioral studies in a modifiable analog facility and begin to set new standards for space analog habitat research and design.

• 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).