UCCS MOONTAIN LIONS ALMOST MARS LUNAR BASE DESIGN

Artemis Lunar Mission Operations & Surface Technology for Modular Aeronautics Research Station

Department of Mechanical and Aerospace Engineering
University of Colorado at Colorado Springs

Noble Kilman · *Paul Park* · *Dylan Hansen* · *Ronan Summers* · *Lindsey Nast* · *Douglas Wilcox*

UCCS University of Colorado Colorado Springs
PIKES PEAK COMMUNITY COLLEGE

Background

This work details the design of a first-generation lunar base camp. The base was designed as a proof-of-concept to be part of NASA's Artemis mission that will sustain a crew of four for a 45-day mission focused on prospecting in-situ resources and proving the viability of moon colonization.

Team organization included 5 essential areas: Mechanical, Operations, Electrical, Bioastronautics and Programmatics. Members were drawn from 4 UCCS departments & PPCC's Engineering Program.

The base location was chosen inside Shoemaker Crater at the lunar south pole (Fig. 1). This crater is a vast 62 miles at its maximum diameter, permanently shadowed, and has strong evidence of the presence of ice water.

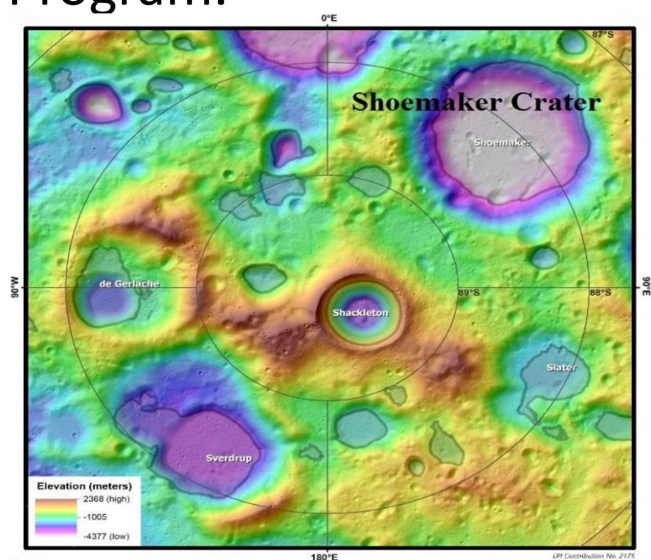

Figure 1: Lunar South pole

There will be 5 launches using the Space X Falcon 9 and Super Heavy rockets (Fig. 2). Once each launch reaches the moon, Skycranes will be used to lower the payloads to the lunar surface. The crew will follow in 2031.

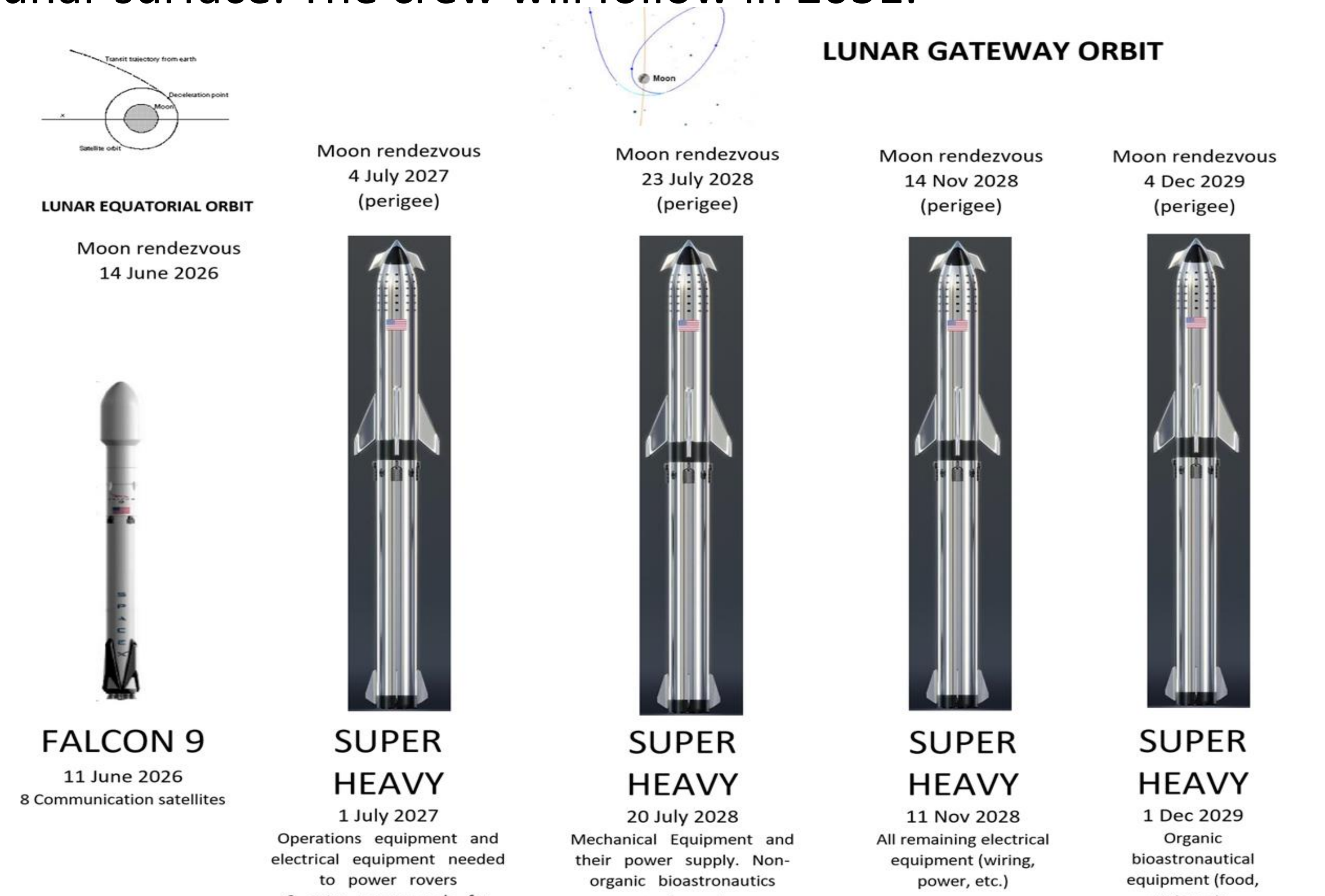

Figure 2: Launch Timeline

The total cost breakdown (Table. 1) of the base is given with a 30% margin included to account for unknown costs within the project. The theoretical first unit cost (TFC) is also shown.

Table 1: Cost Summary

Totals	$7,329,223,000
Reaming Funds	$4,670,777,000
30% margin	$2,198,766,900
TFC	$6,054,723,000

Base Camp Design

The base camp (Fig. 3) is shown as it would appear when the Artemis crew arrives for its mission. The base is designed with a lifetime of 150 years, is expandable, and is designed to support over a thousand missions.

The structure of the base consists of three modules: the habitat, a modular node designed for expanding the base in the future, and an airlock (Fig. 4).

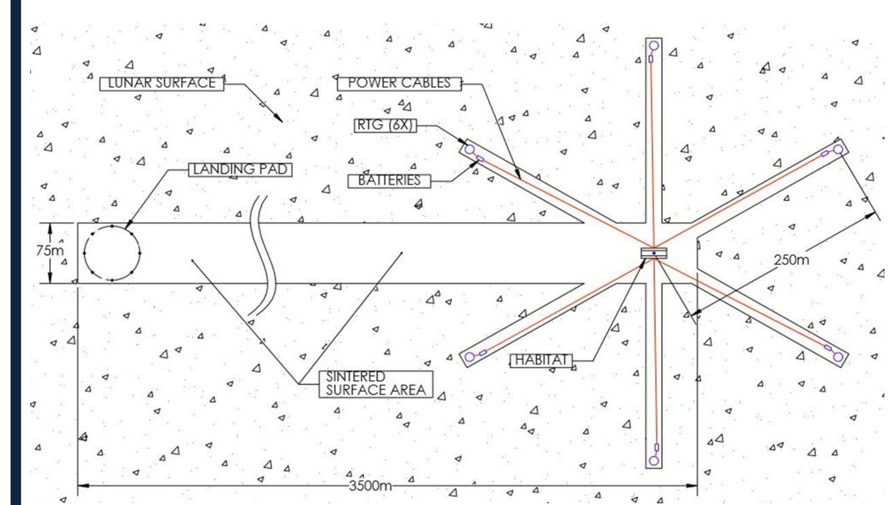

Figure 3: Base Camp Layout

The main habitat is designed as a two-floor hexagonal module with a skin-stringer aluminum frame and two connection points. The airlock will prevent the collection of lunar dust in the base.

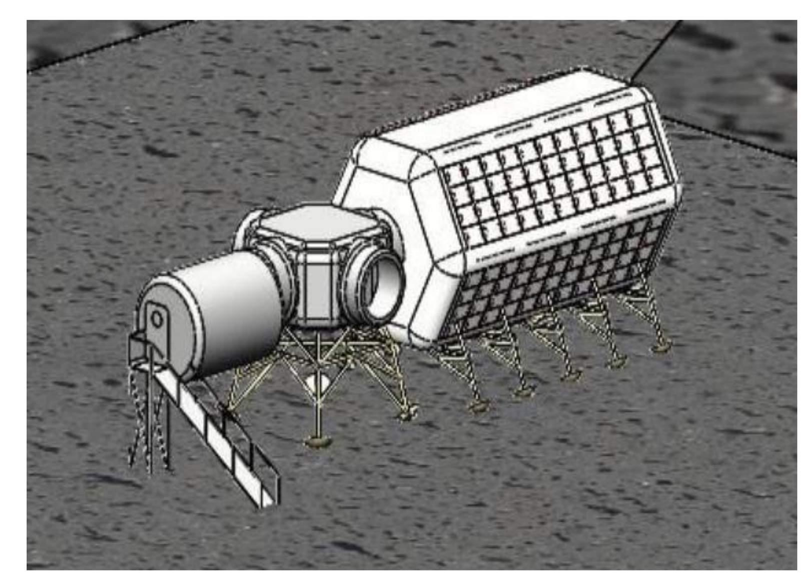

Figure 4: ALMOST MARS Base Design

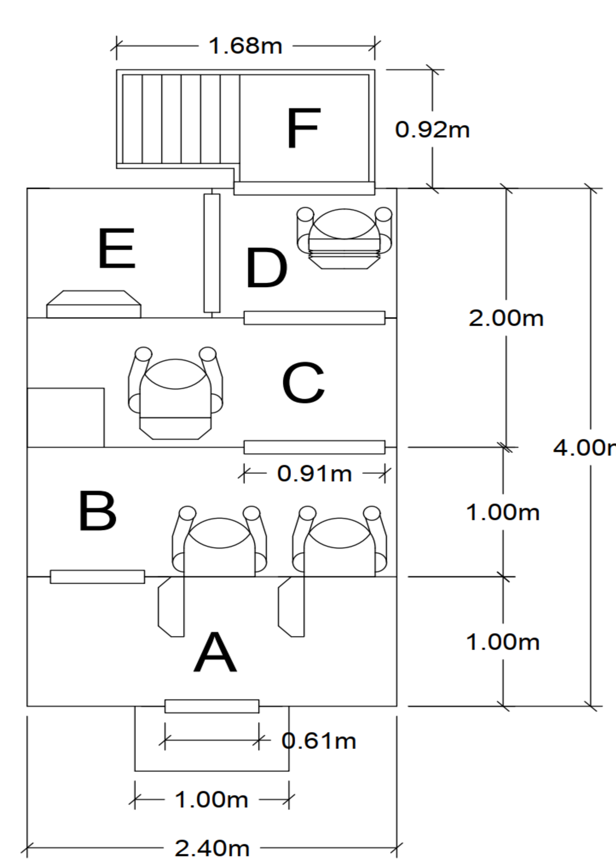

Figure 5: Airlock Floorplan

The airlock (Fig. 5) is comprised of three stages from entry (F) to habitat (A). It is equipped with exosuit docking ports (B) and dust-repellant suit covers (E). The first stage uses a pressure gradient and EM pulses to pull dust out to the lunar surface and then dust covers are removed and stored (E). The second stage is where exosuits are stored in a garage (B). Finally entry to the habitat (A)

The Environment Control and Life Support System (ECLSS) uses an integrated system to recycle the habitat's atmosphere and water and has low energy usage. Primary power comes from 6 radioisotope generators. Lithium-ion battery backup cells will be arrayed around the reactors.

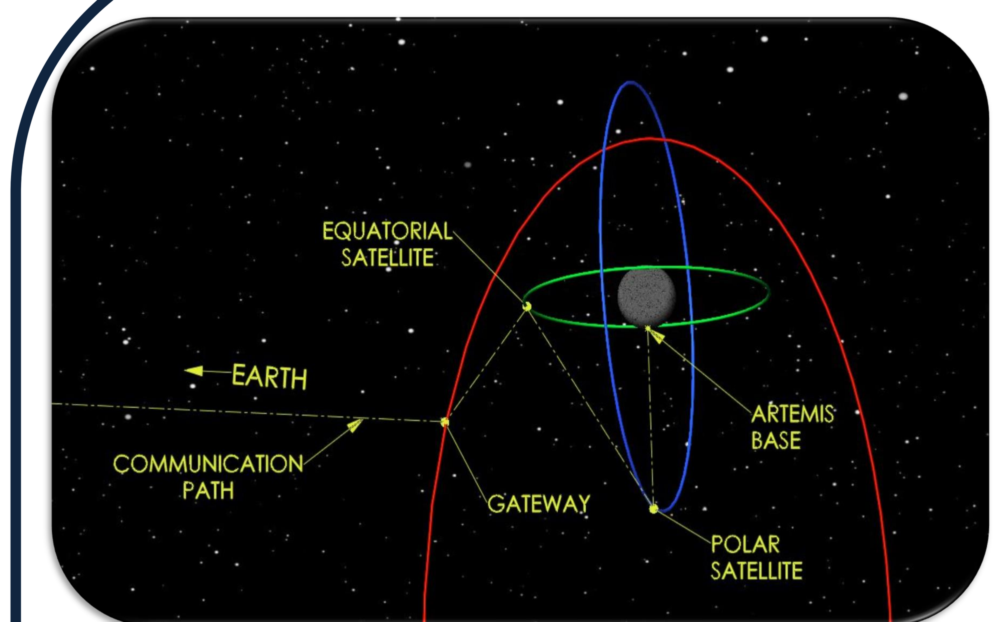

Figure 6: Gateway Communication Concept

All communication between the lunar base and Earth will be handled through Gateway (Fig. 6). A 99.999% uptime is maintained with a series of small satellites.

Trade Studies

Trade studies were performed to choose essential systems. Each sub-team lead used decision matrices (ex. Fig. 7) to qualitatively select final components.

Protection System	Level of Effectiveness	Set-up	Experience with the System	Maintenance	Compatibility	Power Requirements	Cost	Transit Weight
Bury Under Regolith	Best	Bad	Bad	Best	Bad	Best	Okay	Best
3D Printed Regolith Shell	Best	Bad	Unacceptable	Okay	Okay	Best	Bad	Best
Superstructure Regolith Layer	Best	Bad	Bad	Okay	Best	Best	Bad	Okay
Polyethylene Plating	Best	Best	Best	Best	Okay	Best	Best	Bad
Water Layer	Best	Best	Best	Best	Best	Best	Best	Bad
Electrodynamic or Plasma Shield	Best	Okay	Unacceptable	Okay	Best	Unacceptable	Unacceptable	Okay

Best | Okay | Bad | Unacceptable

Figure 7: Radiation Protection Trade Study

Conclusion

This project approach was the development of a centralized working team with a web of sub-teams to thoroughly address each essential system necessary to support human life and exploration in-situ via support from a constructed lunar base by the year 2031. Key design components from a systems engineering approach including detailed trade studies with consideration of risk and cost in order to make the most reasonable choices to ensure project success and future expansion. Future work would focus on the integration of all the base systems, as well as, fine-tuning operating procedures and the effective adaptation of exterior base systems to the lunar environment.

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Advised by
Dr. Lynnane George, *Department of Mechanical and Aerospace Engineering*
Mark Pizzolatto, Graduate Student, *Department of Cybersecurity*
Cammie Newmyer, Graduate Student, *Department of Mathematics*

For questions and feedback please contact Project lead Noble Kilman nkilman@ucce.edu Faculty Advisor Dr. Lynnane George lgeorge2@uccs.edu