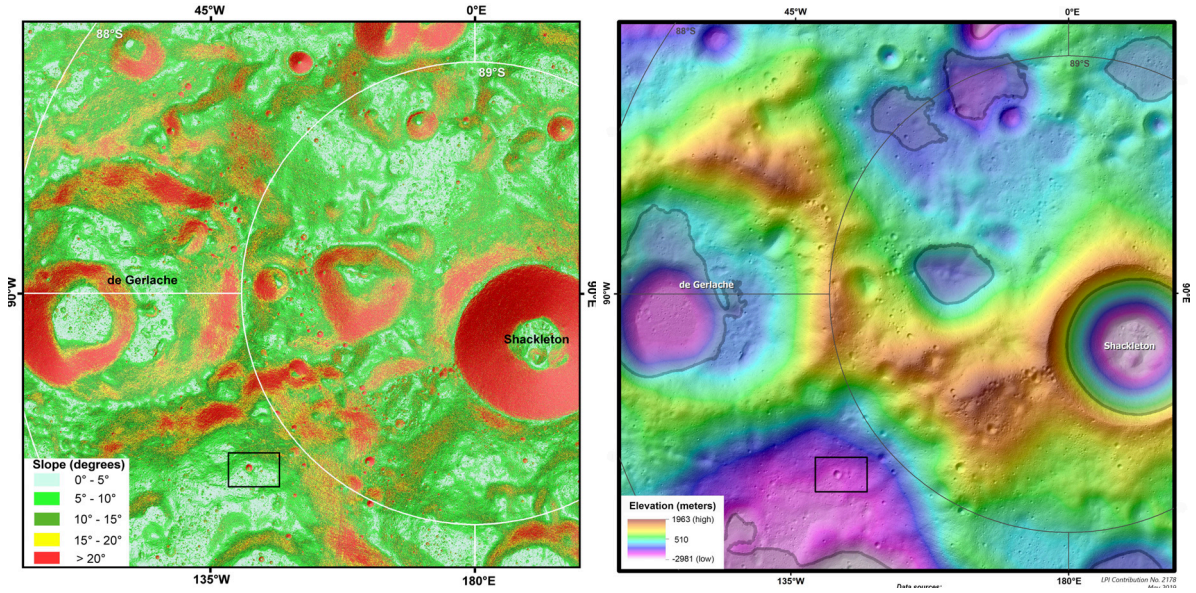
LUNASCAPE DRAFT REPORT

Maximilian **Friedmann**
Lilian **Le**
Víctor **López Leftérov**
Antonia **Sattler**
Lowie **Swinkels**

SITE ANALYSIS

The Lunar South Sverdrup-Henson crater, offers ideal conditions for a prospective lunar settlement. Its flat topography, abundant ice water supply in permanently shaded regions (PSRs), and continuous sunlight during the day make it suitable for various operations, including solar power generation and ground antenna construction for Earth communication. Terrain slopes (which are normally between 5-10º, or lower) are conducive to safe spacecraft landings and surface operations, while the area's rich mineral resources, including iron, titanium oxides, and rare earth elements, further support future exploration and utilization efforts.

The following images showcase the proposed site area and its context in both slope and topography maps:



CLIMATE ANALYSIS

The lunar environment is characterized by extreme temperature fluctuations (+127 ºC to -173 ºC), intense solar radiation (60 µSv/hr), low gravity (1.62 m/s²), and long, alternating periods of sunlight and darkness due to the Moon's 29.5-day lunar day. Micrometeoroid impacts regularly disturb the surface, exposing fresh material, while the thin exosphere contains non-breathable gases such as helium, argon, and methane.

ASTRONAUT NEEDS

Astronaut Daily Routine (to determine programmatic needs of space station)

- Wake-Up: 06:00
- Personal Hygiene and Breakfast: 06:00 - 07:00 (1 hour)
- Pre-Mission Briefing: 07:00 - 07:30 (30 minutes)
- Suit-Up and Pre-EVA Checks: 07:30 - 08:30 (1 hour)
- Lunar Surface Activities: 08:30 - 13:30 (5 hours)
- Return to Habitat/Spacecraft: 13:30 - 14:00 (30 minutes)
- Lunch and Rest Period: 14:00 - 15:00 (1 hour)
- Science and Research: 15:00 - 17:00 (2 hours)
- Exercise: 17:00 - 17:30 (30 minutes)
- Dinner and Leisure Time: 17:30 - 18:30 (1 hour)
- Evening Briefing and Planning: 18:30 - 19:00 (30 minutes)
- Sleep Period: 19:00 onwards (varies, depending on individual sleep needs)

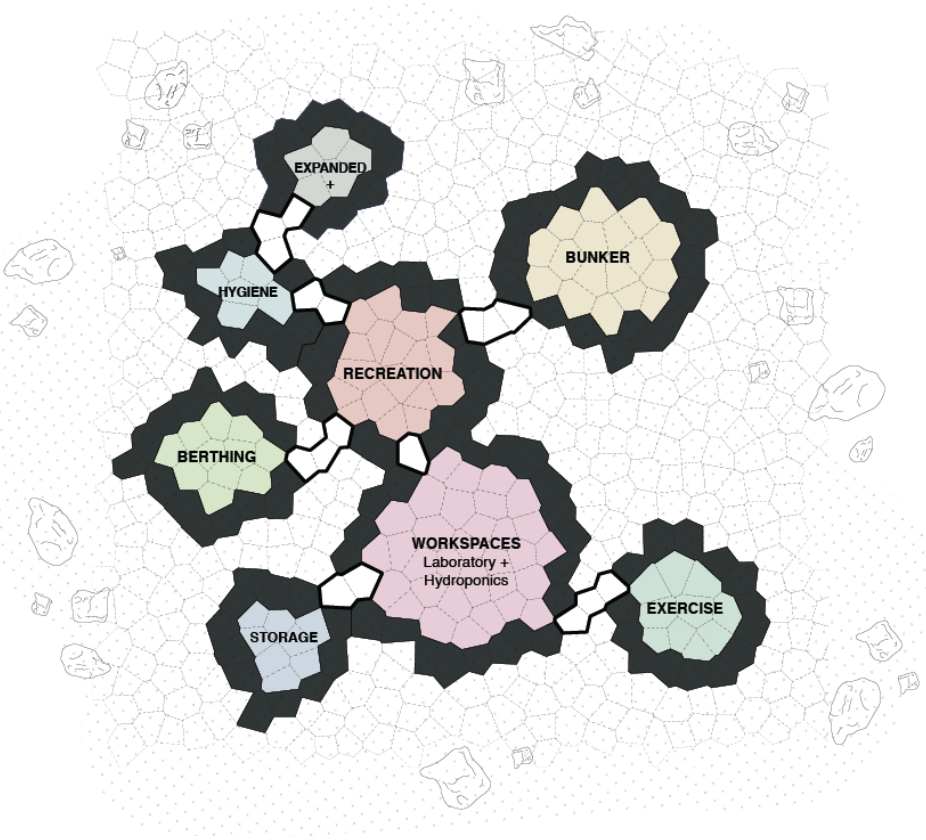
PROGRAMMATIC NEEDS + SECURITY REQUIREMENTS FOR EACH ZONE

The programs onboard the space station include Berthing, Recreation, Workspace, Exercise Spaces, Hygiene, Multi-purpose Storage, and an Underground Safety Bunker. Each program occupies a specific volume, has designated time allocations, and is either above or below ground. Additionally, each program has a varying number of exit points based on internal risks, with corresponding internal risk ratings and safety precaution needs.

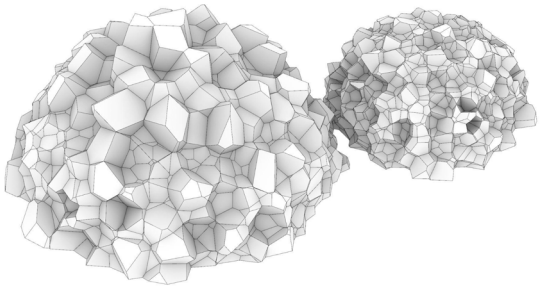
- **Berthing**: Involves docking procedures for vehicles with controlled access and secure docking mechanisms. It requires multiple exit points for emergency evacuation and has a moderate internal risk rating.
- **Recreation**: Includes private sleeping quarters, shared dining, and lounging spaces. These areas are below ground for heightened security. They have multiple exit points and are rated high in terms of internal risk, requiring stringent safety measures.
- **Workspace**: Comprising multifunctioning labs and hydroponics, this program involves controlled space usage with high-security protocols. It has multiple exit points and is rated high in internal risk.
- **Exercise Spaces**: Above ground areas for exercise, with interaction with lunar light. These spaces have two exits and are rated at a low internal risk.
- **Hygiene**: Consists of communally shared bathing and bathroom spaces below ground. They have controlled access and one exit each, with a low internal risk rating.
- **Multi-purpose Storage**: Provides secure storage with restricted access and inventory management systems. It has two exits and a moderate internal risk rating.
- **Underground Safety Bunker**: Reserved for emergencies, it has controlled access, life-support systems, and multiple exits. It is below ground and rated high in internal risk.

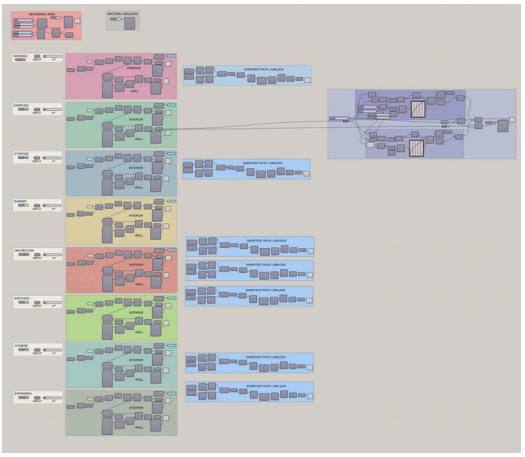
Overall, these programs are designed with safety and functionality in mind, considering the unique challenges of space environments and the potential risks involved.

BERTHING	RECREATION	WORKSPACE	EXERCISE	HYGEINE	STORAGE	SAFETY BUNKER
Docking station for vehicles	Sleeping pods (private)	Multifunctioning laboratories	Multifunctioning exercise spaces	Bathing and bathroom spaces (communal)	Multi-use storage zone	Self-contained underground bunker in case of emergency
Emergency exits	Dining space (communal)	Hydroponics				
	Lounging spaces (communal)					



GRASSHOPPER VORONOI IMPLEMENTATION

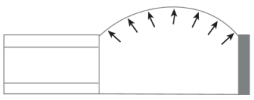




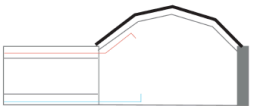
ASSEMBLY AND LIFE SUPPORT SYSTEMS

The habitat grid will follow a hexagonal pattern. The 3d printed voronoi components will be connected though airlocks and contain an inflatable membrane on the inside. Two sizes of inflatable membranes exist. The “base” membrane is large and attached to an airlock on one side and to a connector on the other side. The small membrane, the “add-on”, has two connectors on each side of the membrane. While the 3D print is still wet, the membrane can be attached to the shell with the help of the soft spikes that can be pressed into the regolith layer.The airlock modules have three entrances to connect modules and provide access from the lunar surface. They also contain the bio-regenerative life support system.

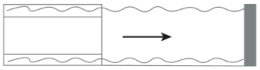
Step 0: Airlock



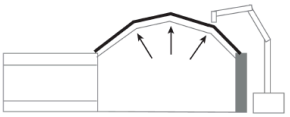
Step 2: Membrane Inflation



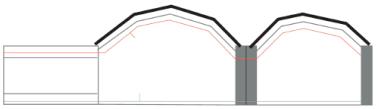
Step 4: Connecting/Launching LSS



Step 1: Opening Process



Step 3: Voronoi-Shell Printing and Connecting it to Membrane

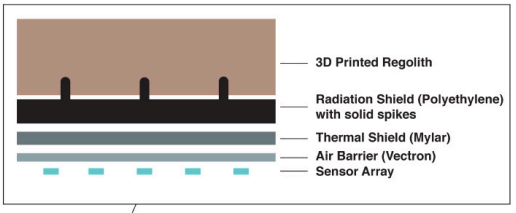


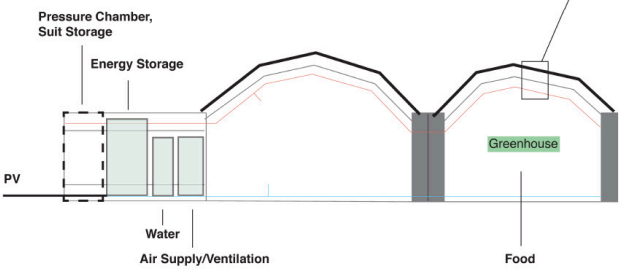
Step 4: Connecting Module 1 to Module 2 and to its extensioncables and -pipes

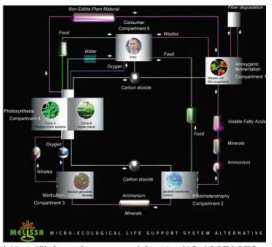
Components - Overview

Cables:
Base: 3 cables
Add-on: 2 cables

Flexible Pipes:
Base: 2 pipes
Add-on: 1 pipe







https://link.springer.com/chapter/10.1007/ 978-3-030-52859-1_3