HABOLITH

A lunar surface habitat that achieves game-changing efficiencies by maximizing use of in situ regolith without 3d printing.

‘The Inner Light’

Story & Teleplay
by
Morgan Gendel

HABOLITH

NASA INNOVATIVE ADVANCED CONCEPT (NIAC) SHORTLIST 2018

SUBMITTED BY CORNELL UNIVERSITY

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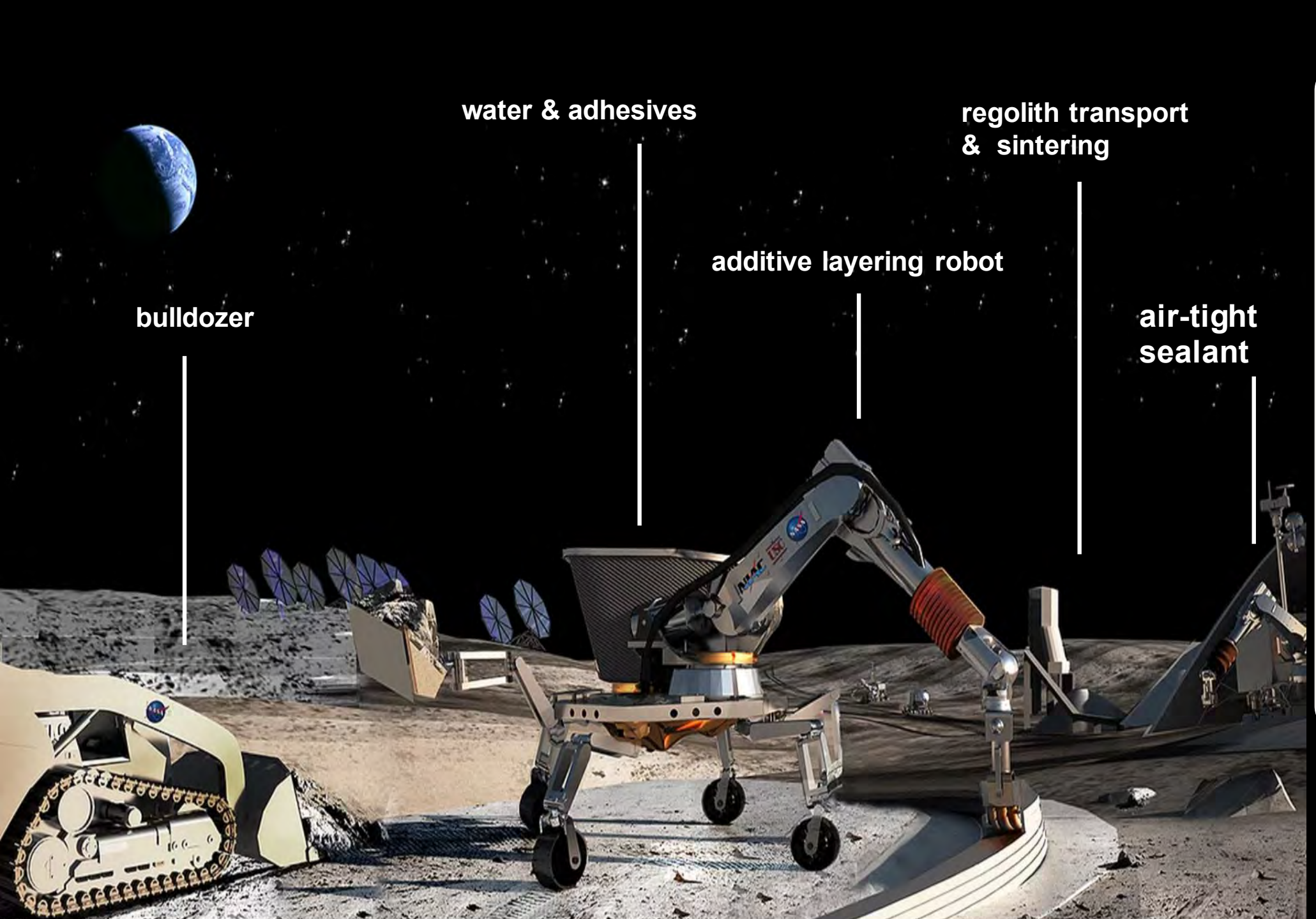
Habolith is a sealable, variable-shape surface habitat that is deployed via inserting sifted in situ regolith into integrated tubes, then compressing it to structural stiffness.

Granular compression or “soil-jamming” is a key innovation in in-situ resource utilization: cement without fluid or adhesives.

Regolith provides structural support, radiation shielding and thermal insulation.

This focus on a ubiquitous resource coupled with deployment simplicity and versatility will help reduce reliance on Earth resources and allow limited assets to be allocated elsewhere.



Eliminates the need for:

- equipment e.g. bulldozer to build a pad
- water, gypsum, and/or adhesives
- additive layering robotics
- machines to find transport and sinter sulfurous soils.
- sealant or liner to provide air-tight ECLSS

CORNELL 2019

Course created by Morgan Gendel and Professor Mason Peck – joint effort between Dept. of Engineering and School of Architecture – examined granular compression as a tool for constructing transformable furniture.

An airtight form was filled with bean-bag beads, then the air was vacuumed out.

Earth’s atmospheric pressure imposed granular compression and a resulting rigidity sufficient for seating.

iRobot uses granular compression to create a universal gripper from a balloon filled with coffee grounds then subjected to a vacuum.

Internal gas bladder is an alt method of constricting the sheathed regolith so the granules interlock.

Compressed gas used for initial deployment.

Small amount of CO^2 scrubbed from astronaut quarters can be shunted back into the bladder for “top-ups” to maintain optimal pressure.

Sensors monitor the compression and expand bladders as needed.

Another soil-jamming technique is “lace-tightening.”

BIOSUIT is a skintight spacesuit created by MIT Prof. Dava Newman

Metal-memory coils 1mm in diameter tighten when a current is applied, constricting the suit and applying pressure directly to the wearer.

Habolith's struts are a cross-section of a demi-globe, i.e. arch. Individual wedge-shaped pockets can be molded into the formwork.

The ARCH is a self-supporting structure in which tensile stresses are transferred to compressive forces along the arch and into the ground.

Since Habolith's soil-jammed struts support only the mass of the hab itself, its rigidity is sufficient

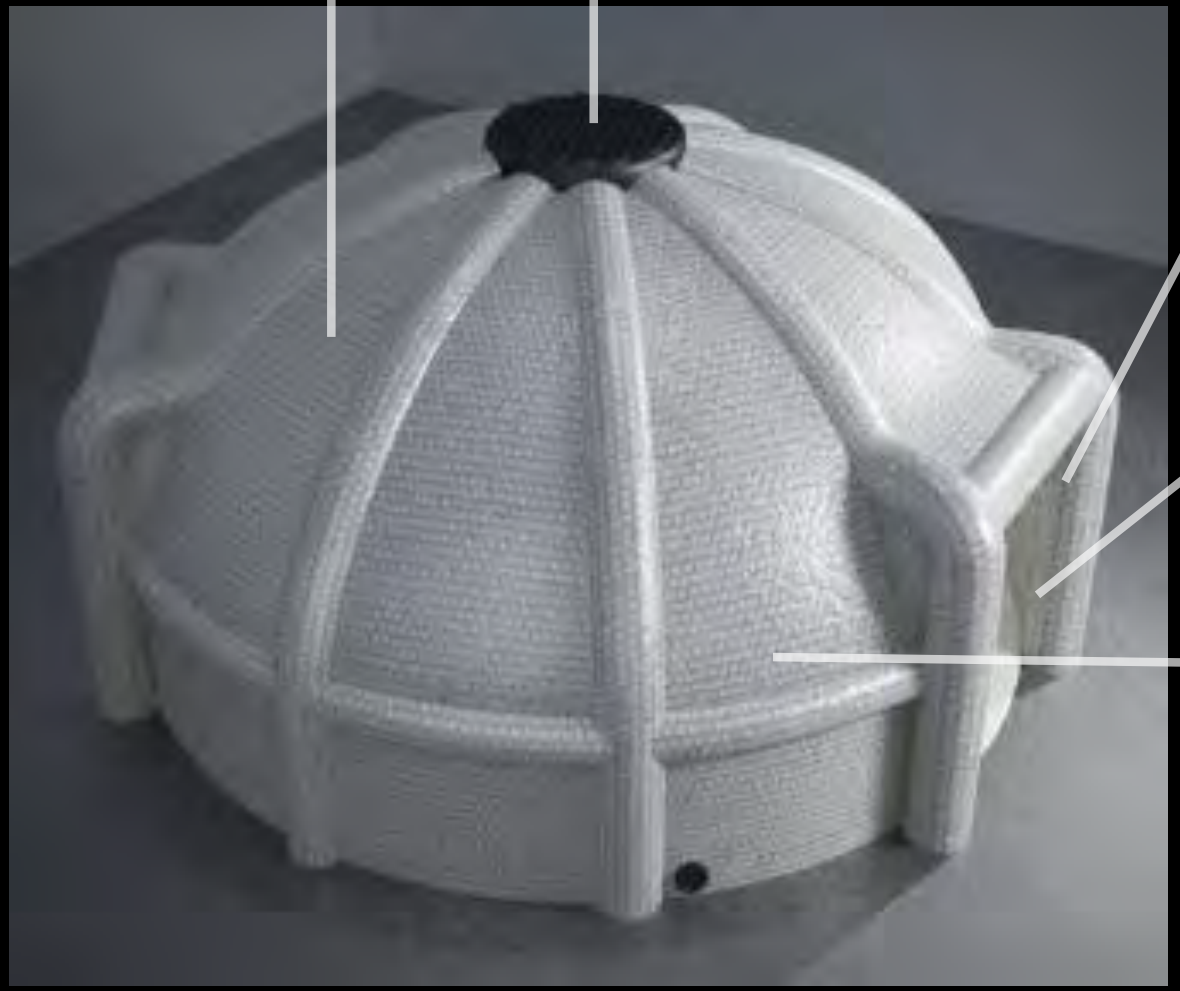
The EAS 3D-printed design applies a terrestrial design concept – a 2nd story – that is unnecessary on the moon where there is unlimited surface area.

EUROPEAN SPACE AGENCY

Exterior – Puncture-resistant combination of Nextel and Kevlar with reflective coating to mitigate against UV rays.

Top - Solar thermal cap heats a water or gel for passive heating & cooling through tubes in the floor.

Interior – Elastomer type selected for its fire-resistance and near-zero off-gassing.



Channels for water, data and electrical are built-in.

Rig bonded to openings will create either an air-lock or connector to additional units

Inter-layer volume filled with regolith creates a barrier against thermal energy (out) and micrometeorites and cosmic rays (in).

Mass production of the elastomer formwork enables multiple units to be transported from Earth with a relatively low upmass. Haboliths are readily scalable into a small connected village.

Computer-controlled hydraulics cause flexible soft robots to “walk.”

The same engineering principles could be applied to expand and re-shape sections of Habolith.

The result is a morphable structure that can maximize ECLSS efficiency e.g. by adding or subtracting space as crew size changes; or lowering the ceiling for the section used for indoor farming.

HABOLITH 2.0


‘Part of the elegance of the Habolith concept is its simplicity, which will likely translate into large cost savings for the manned space program... and provide secure accommodations for human crews on the moon, on Mars, and beyond.’
– NASA NIAC Panel Review

To be explored:

- Methodology for impelling sifted regolith into the struts
- Alt designs, e.g. vertical pillars supporting cross-strut
- Effects of temperature Δ
- Durability of constrained elastomers
- Potential for structural failure when *n* compressed struts are punctured e.g. by micrometeorites

SEEKING:

- Academic partner with expertise in material sciences for collaboration on SBIRs/STTRs
- Corporate partner to move Habolith from TRL-2 to TRL-6
- Concerted LSIC effort to promote Figure of Merits that include non-3D printing for Habitats

POTENTIAL INVESTOR: Mark Cuban, who is interested in refugee housing applications once there is a working prototype.

HABOLITH

Planetary Shelter LLC
Utility patent pending
16/750,212

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