

MOON STONE HENGE

2nd Phase colonization - 3rd Class architecture
January 2021

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PROLOGUE

After a long trip that lasted 5 hours finally, we have arrived!

The spacecraft in which we have traveled docked gently to the Lunar orbital elevator. It seems unbelievable... We took the EVA to our final destination! Many of us have stared at each other in disbelief, still feeling numb from the brutality of the supersonic retro propulsion! The promise of a new prosperous future. An opportunity to rethink everything, in order not to repeat the same mistakes. Beyond the polarized glass windows, the light of the EVAs and automated robots moving around in the total darkness of Shackleton crater. The illuminating glorious 3rd class architecture towers of the 3D printed Lunar stone henge modules in the circular formation reminds us of our blue home earth, surrounded by wireless antennas. A few kilometers from the ground base of the space elevator space port. We still can see the extension of the space elevator upwards.

Beyond, the land descends steeply down the south pole Shackleton crater. Beyond its vertical walls awaits a new future, promises of new land, united world working together, new future, new economy, billions are watching us in the new reality TV show with hope and joy. Thousands of poor and sick are waiting for us to bring them medicines from the new clinical labs facility working on the new low gravity 3D printed exo-medicen.

We will transcend our legacy in the new Lunar stone henge. I wonder how our ancestors thought when they build the first stone henge thousands of years ago. I have to be careful with my thoughts, any gesture from me might lead to crazy rises or fall in stock markets back on earth, every moment is captured and recorded. We have to make our sponsors happy after all... After all, certainly, they build us a 2nd phase colony that protects all the next 6 months and provides us with everything we need. Now, I'll become part of 5th industrial evolution, world peace; I will dissolve into the new world system., and join all those that give hope and future to earth, forever...





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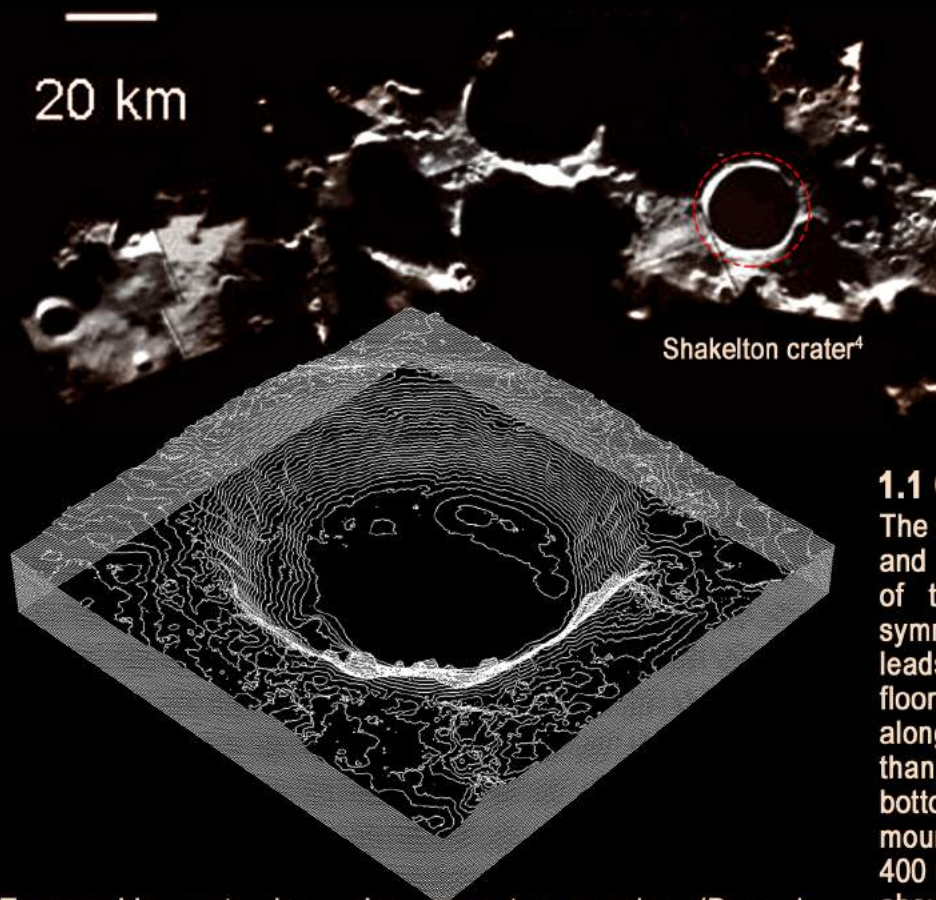


1.0 SHACKELTON CRATER site

Shackleton is an impact crater that lies at the south pole of the Moon. The peaks along the crater's rim are exposed to almost continual sunlight, while the interior is perpetually in shadow (a crater of eternal darkness). The low-temperature interior of this crater functions as a cold trap that may capture and freeze volatiles shed during comet impacts on the Moon. Measurements by the Lunar Prospector spacecraft showed higher than normal amounts of hydrogen within the crater, which may indicate the presence of water ice. Several computer models were generated as shown in the below 3D constructions to study the effect of sun and topography on the colony location.

The main reason of choosing this site for the future colony is that It is estimated that Shakedown crater contains between 10,000 ton up to 1000,000 ton of frozen water mixed with the Lunar regolith², The frozen H₂O could be used to separate oxygen and hydrogen to produce air and fuel to support life system in the new colony.

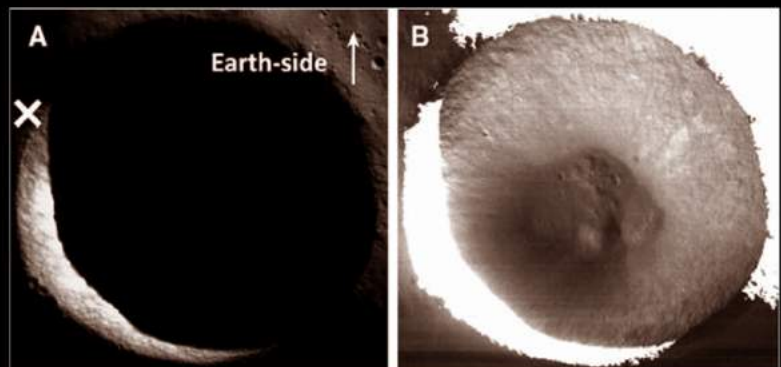
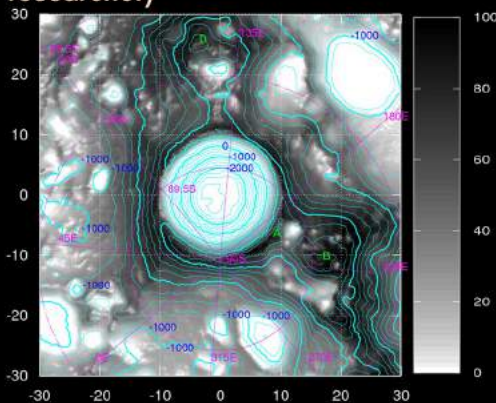
The continuous shadows in the south polar craters cause the floors of these formations to maintain a temperature that never exceeds about 100 K. For Shackleton, the average temperature was determined to be about 90 K, reaching 88 K at the crater floor.



1.1 CRATER DIMENSIONS

The crater is 21 km in diameter and 4.2 km deep¹. The interior of the crater consists of a symmetrical 30° slope that leads down to a 6.6 km diameter floor. The handful of craters along the interior span no more than a few hundred meters. The bottom is covered by an uneven mound-like feature that is 300 to 400 m thick. The central peak is about 200 m in height.

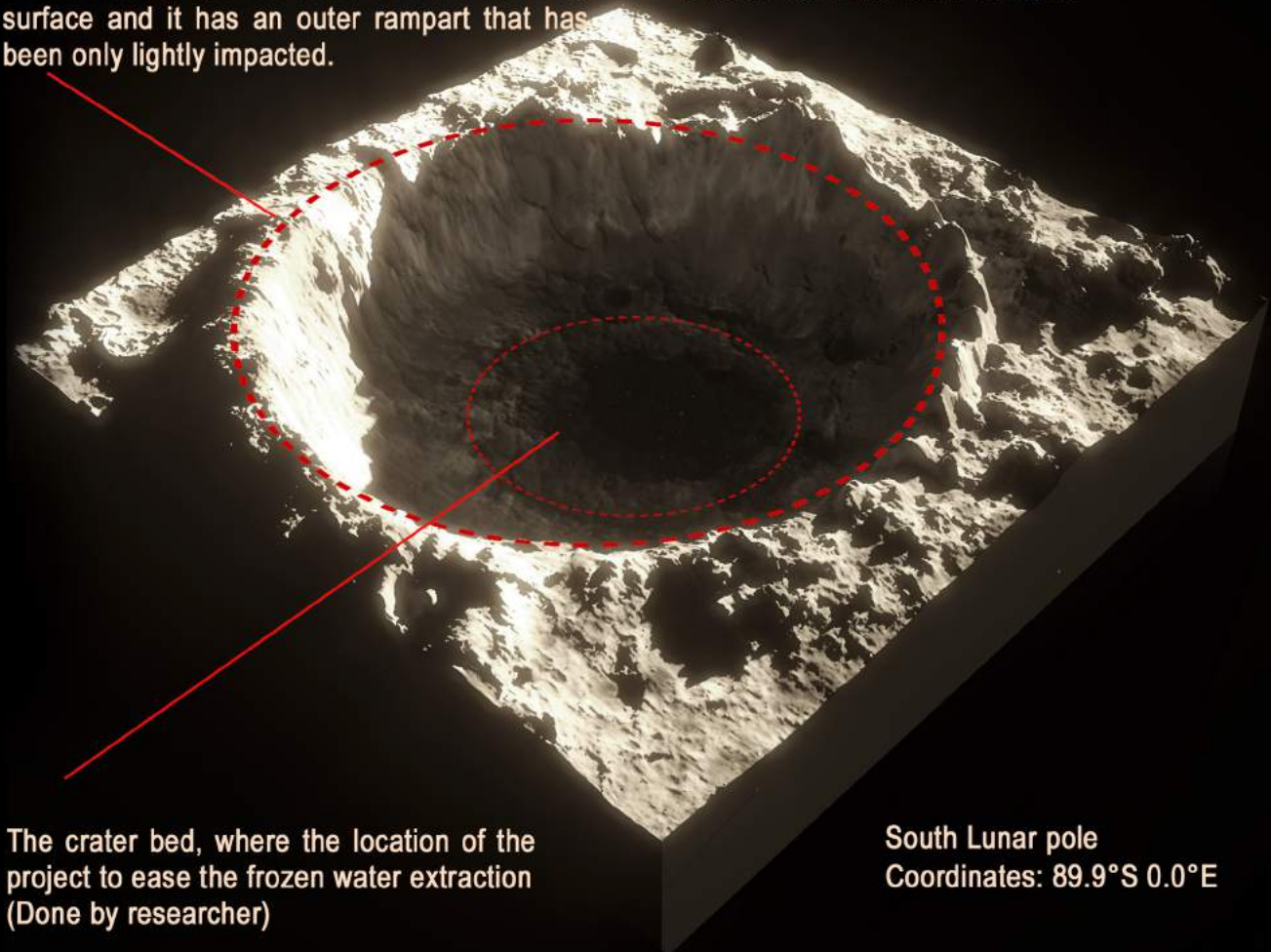
Topographic contouring using computer mapping (Done by researcher)



The original illumination of Shackleton crater is in total darkness versus a computer simulated lit picture³

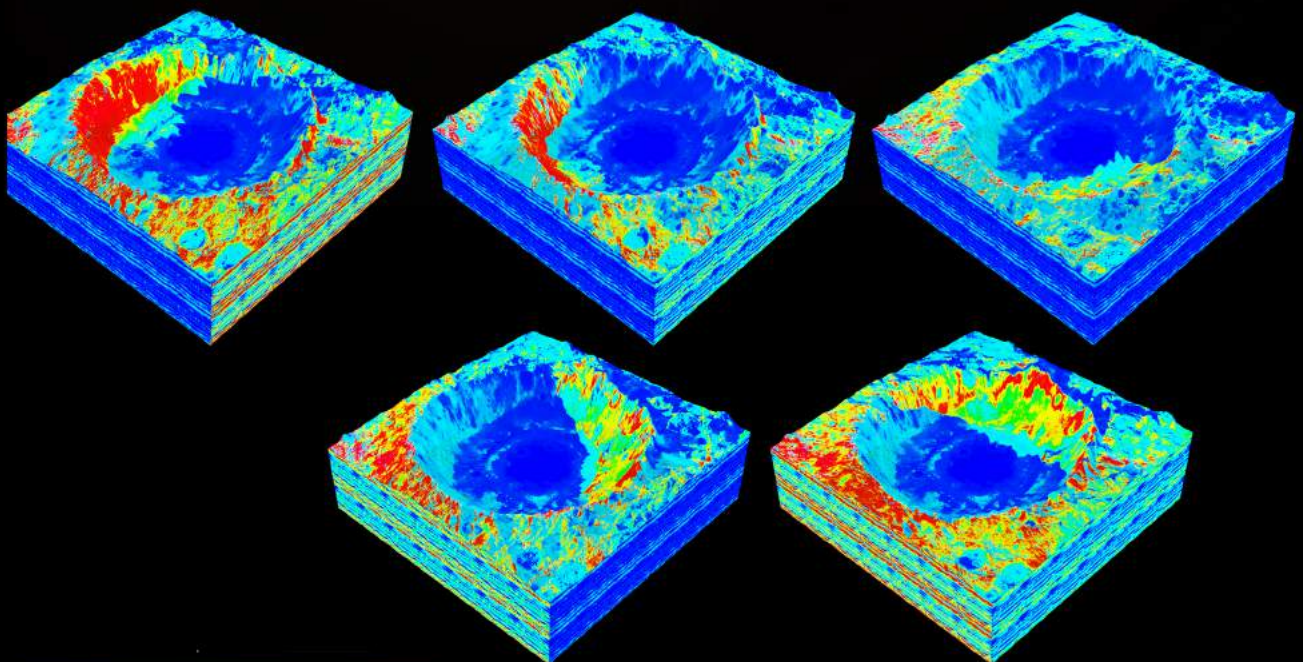
Surface crater rim, where the solar panels will be placed to receive the solar illumination to be signaled to the crater bed
The rim is slightly raised about the surrounding surface and it has an outer rampart that has been only lightly impacted.

This is a computer generated model made specifically for this project. The inner lighting was increased for study purposes. The real life situation is much more darkness.



The crater bed, where the location of the project to ease the frozen water extraction (Done by researcher)

South Lunar pole
Coordinates: 89.9°S 0.0°E



Computer Solar illumination simulation across a Lunar month showing the rim illumination which makes it a perfect candidate to place the solar panels (Done by researcher)

2.0 UNITING THE WORLD THROUGH ARCHITECTURE

The new project is a result of fusion of Digital parametric technology, Biology and genetic engineering and the ancient architecture that was sensitive toward the Cosmos. It deals with the buildings as a living organism that carries multi creatures genetic code fused all together with iconic architectural styles in a surprising and unexpected generations as a result of algorithmic formations, all will be constructed using automated 3D printing mobile robots with advanced artificial intelligence systems.

2.1 COMMUNITY CENTERED DESIGN

The Circular layout of the 10 modules is intended to unite all earth nations in harmony. Each nation represented in a module structure and all distributed equally on the circle circumference. The circle is a highly symmetric shape: every line through the center forms a line of reflection symmetry, and it has rotational symmetry around the center for every angle⁵. The circle is a universal symbol with extensive meaning. It represents the notions of totality, wholeness, original perfection, the Self, the infinite, eternity, timelessness, all cyclic movement. Each one of the modules is positioned on the circumference of the circular layout representing the edge of the known world on moon.

The primary purpose of colony is to be the core of the 5th industrial revolution. It will provide a permanent commercial, scientific, and technology development facility on the Moon.

This stone henge base will provide habitation elements that include in-situ resource utilization of several layers to offer complete protection against radiation, meteor showers and extreme thermal swings. The colony will be much more advanced in achieving self-sufficiency such as food production and regenerative life support. By placing the Habitat Core underground.



2.2 PROJECT COMPONENTS

1. Notre-Dame de la Lune module structure
2. Moon crane tower module structure
3. Bedouin Lunar dwelling module structure
4. Himeji Castle on the Moon module structure

5. Lunar Coliseum module structure

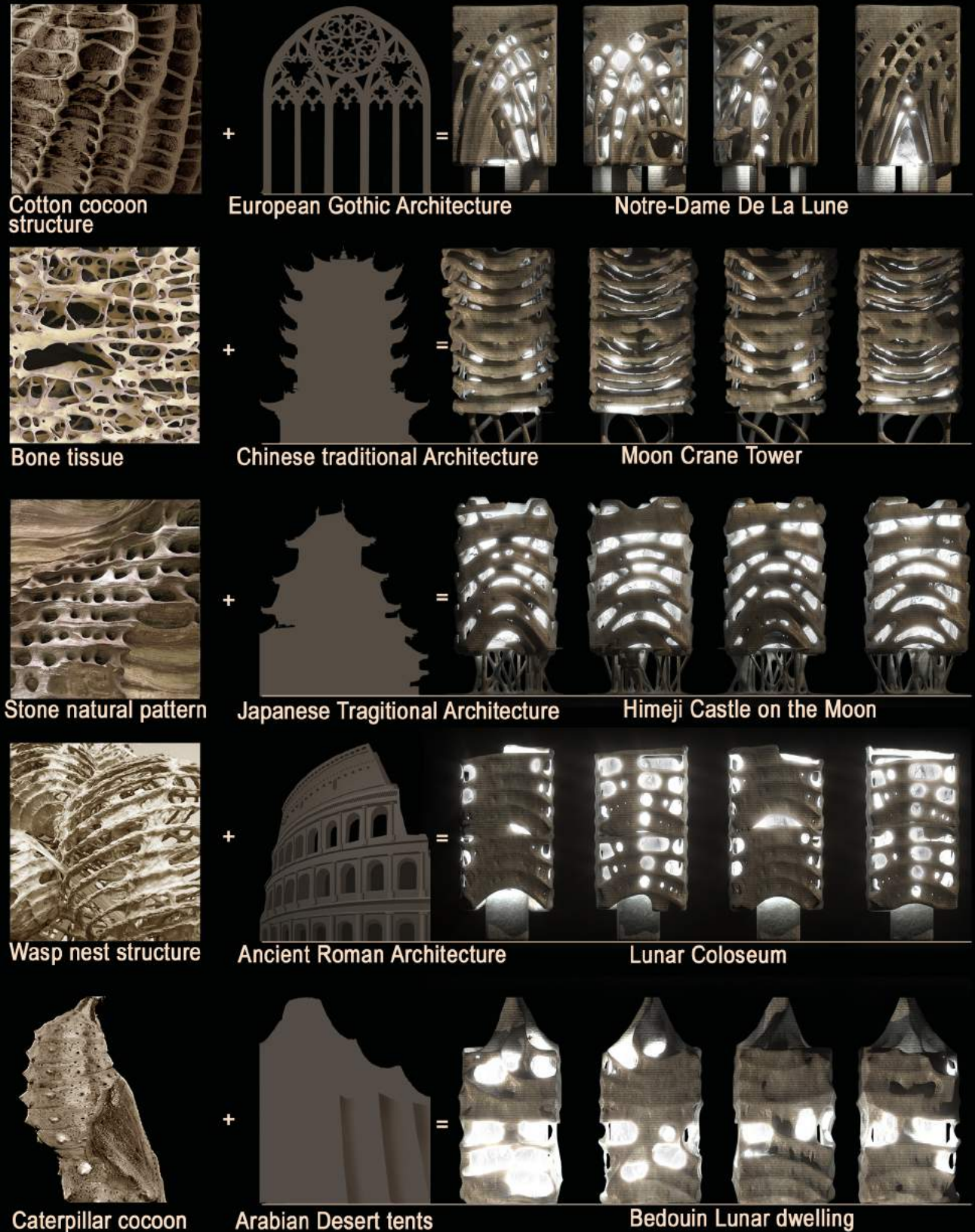
6. Tri-robot track using SLS
7. Extra vehicular activity (EVA) cars
8. Nine Nuclear closed loop reactors
9. Mobile Wireless microwave antennas



2.3 BIO-DIGITAL GENERATIVE DESIGN APPROACH

The form generation process utilized the generative design approach to blend the biological features of selected elements from nature that can withstand harsh conditions and blending them with major architectural styles to express different nations of earth in one project to unite the world through architecture. Some names of the iconic buildings were assigned to the modules. The circular layout of gathering all modules symbolizes earth including both; the nature and mankind culture. It was intended to design unique form for each nation to lay the first foundation of the new lunar culture.

The selected names of the modules will evoke the compassion of the users to their mother land.

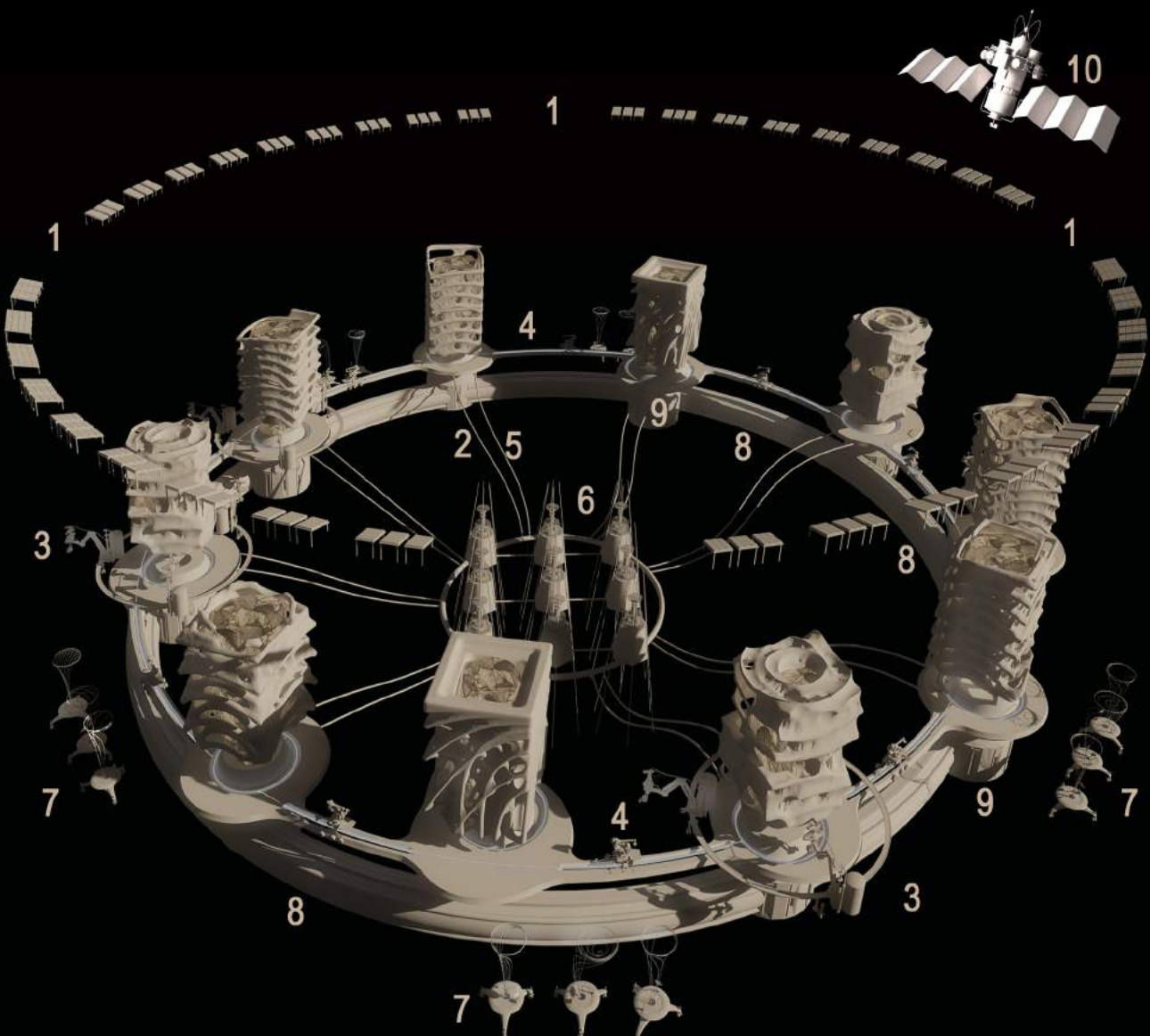


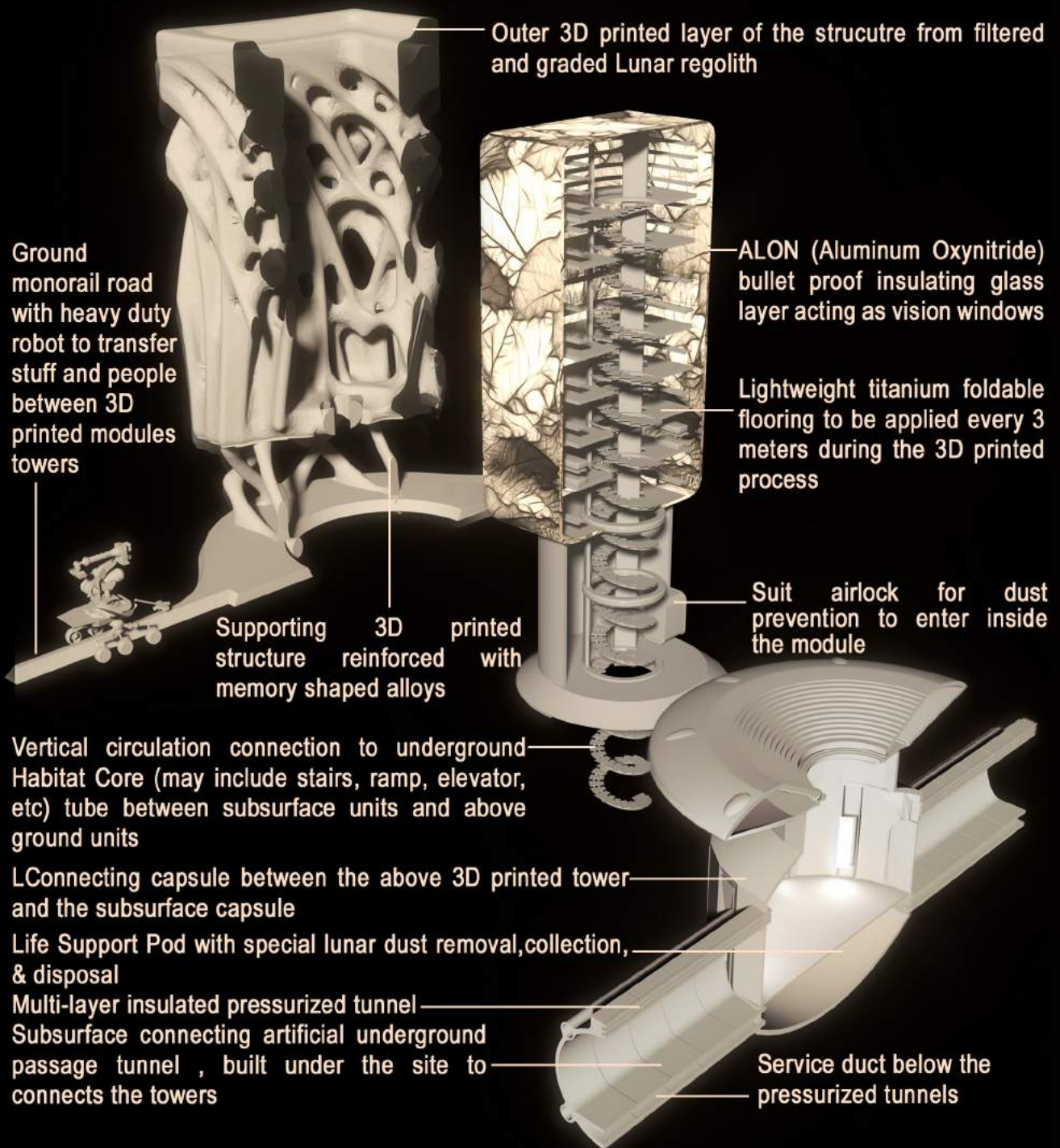
3.0 SYSTEM INFRASTRUCTURE.

The Architecture of the whole colony as mentioned earlier is composed of 10 3D printed megalithic structures modules connected via subsurface underground tunnel and above ground monorail operating a heavy duty robots dedicated for maintenance and logistics.

3.1 IN ADDITION TO THE FOLLOWING ELEMENTS:

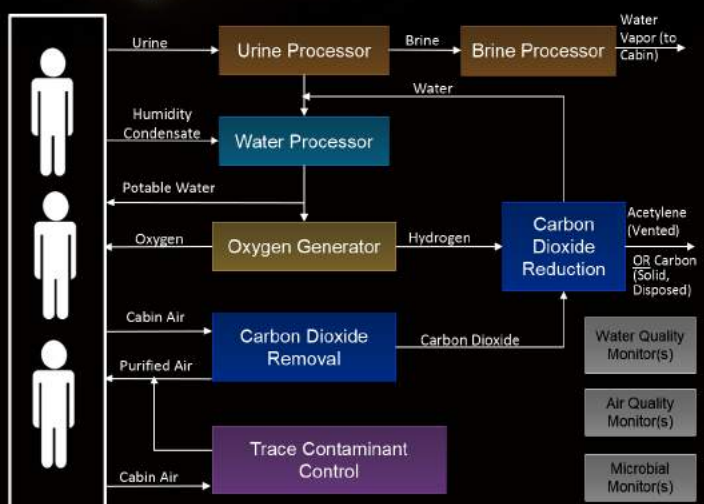
1. 120 photovoltaic solar panels placed at the top of the crater rim surrounding the site in a 360 degree and beaming its electrical energy signals to the wireless mobile antennas and the 10 Stonehenge towers.
2. High performance subsurface cables transferring electrical energy generated by the mini closed loop nuclear reactors⁶ to the towers.
3. The tri-robot for 3D building will be used for continuous maintenance for the towers damaged of any meteors or any unexpected accidents.
4. Monorail connecting the 10 towers via special transporting above surface robot.
5. Flexible high caliber pipes for water transfer to the towers.
6. Nine mini Nuclear closed loop reactors⁶ to be implanted after boring the surface.
7. Wireless microwaves mobile antennas receiving the electrical energy beams from both solar satellites⁷ and solar panels placed on the rim of the crater.
8. Sub-surface tunnel connecting the 10 modules underground compartments.
9. Underground compartment, acting as a base for the upper Stonehenge module to connect it with the other units via a circular underground tunnel.
10. Solar satellite⁷ orbiting in geosynchronous orbit.





4.0 LIFE SUPPORTING SYSTEMS

The Simplified Life Support Systems Schematic shows all of the elements of a life support system, including various processors for waste, air, and water. Environmental Control and Life Support Overview includes three components: Environmental Monitoring, Atmosphere Management, and Water Management.¹⁰



PROJECT PROGRAM

Communication and observation unit including EVA Operations Monitoring

Hydroponics and/or Aeroponics farms for feeding and nutritions, Including medical plants unit

Exterior pressurized controlled environment for manufacturing/testing materials/structure Lab systems

Cargo Bay/Airlock with Rover Port accommodates palletized cargo.

Supporting 3D printed structure reinforced with memory shaped alloys

Service duct below the pressurized tunnels

Environmental control and Life support systems Located beneath to the Surface Access Unit.

CONSTRUCTION MATERIALS

Outer 3D printed layer of the structure from filtered and graded Lunar regolith

Inner 3D printed layer interfering with the Basaltic Aluminum oxynitride glass layer

ALON (Aluminum Oxynitride) bullet proof insulating glass layer acting as vision windows

Ground monorail road with heavy duty robot to transfer stuff and people between 3D printed modules towers

Connecting capsule between the above 3D printed tower and the subsurface capsule

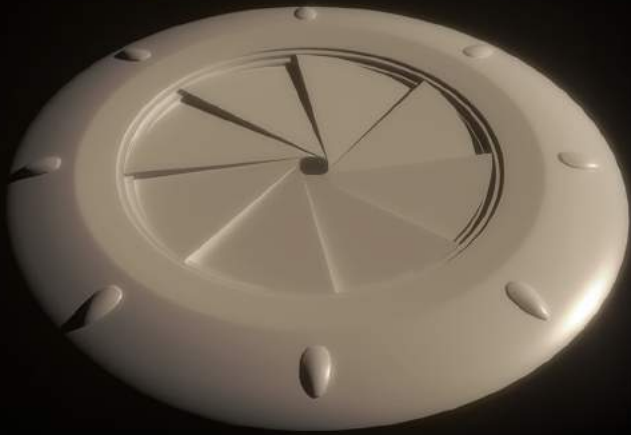
Multi-layer insulated pressurized tunnel

Subsurface walkway underground passage tunnel, built under the site to connects the towers to decrease the need of surface human walks

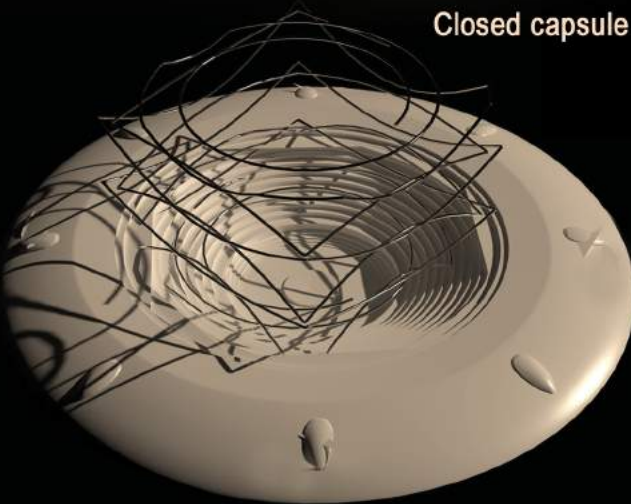
Transparent Aluminum, also known as Aluminum Oxynitride (ALON) is composed of Aluminum, Oxygen and Nitrogen, $[(AlN)_x \cdot (Al_2O_3)_{1-x}]$. Its properties allow it to have $\geq 80\%$ transparency in visible and ultraviolet light. All the basic raw components could be extracted from lunar regolith. Being a light weight transparent material leads to the strength increasing by 4 times harder than silica-glass, hence transparent aluminum this has military grade bullet proof windows which is ideal for resisting any possible small sized meteor showers. Since 400 mm thickness ALON armor defeats a 50 Cal. Bullet. It is ideal to resist micro meteors bombardment. Although this material is still currently very expensive, it has the potential to create large glass structures such as aquariums, windows, facades. The transparent aluminum will not fracture like silica glass and can be used for harsh environmental conditions⁸.

5.0 In-situ resource utilization (ISRU) 3D PRINTING construction method

1. Deploying the Shape memory alloy capsule into designated site coordinates

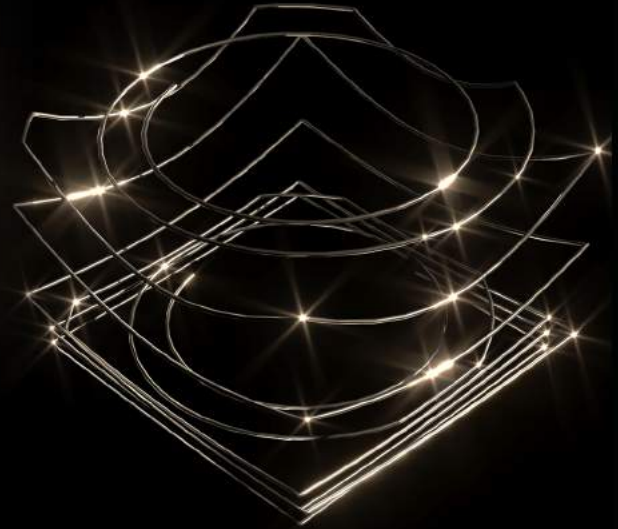


Closed capsule



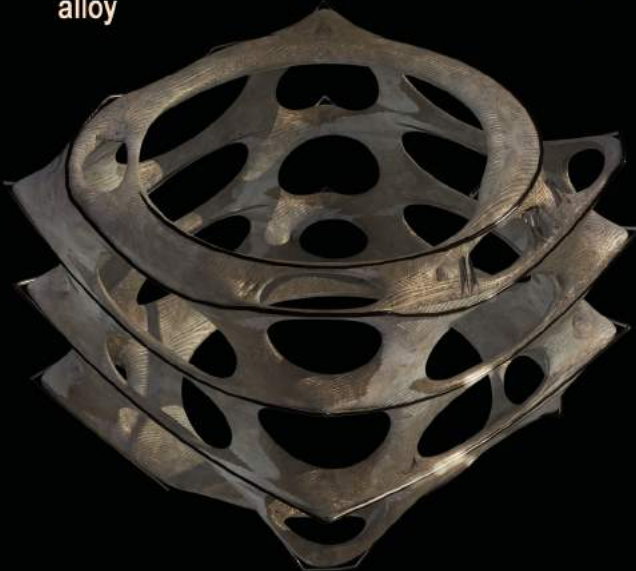
Opened capsule

2. Shape memory alloy springs expansion outside the capsule and solidification in low Lunar temperature



The inner enforcement is made of shape-memory alloy. It is an alloy that can be deformed under certain temperatures but returns to its pre-deformed ("remembered") shape when returned to its original temperature. It may also be called memory metal, memory alloy, smart metal, smart alloy, or muscle wire⁹. Reinforcement made of shape-memory alloys will be lightweight, solid-state alternatives to conventional actuators such as hydraulic, pneumatic, and motor-based systems. Their lightweight is suitable for the payload of the rockets coming from Earth.

3. Hot Lunar basalt silica dust extracted from regolith sprayed over the memory shaped alloy



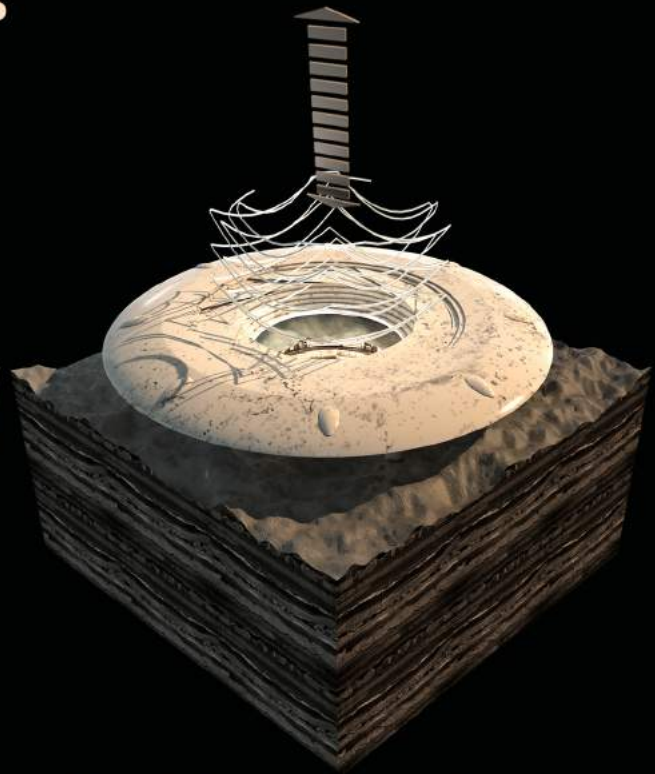
4. Full 3D printing of the final layer of molten regolith using the Laser sintering process



5.1 CONSTRUCTION PHASES

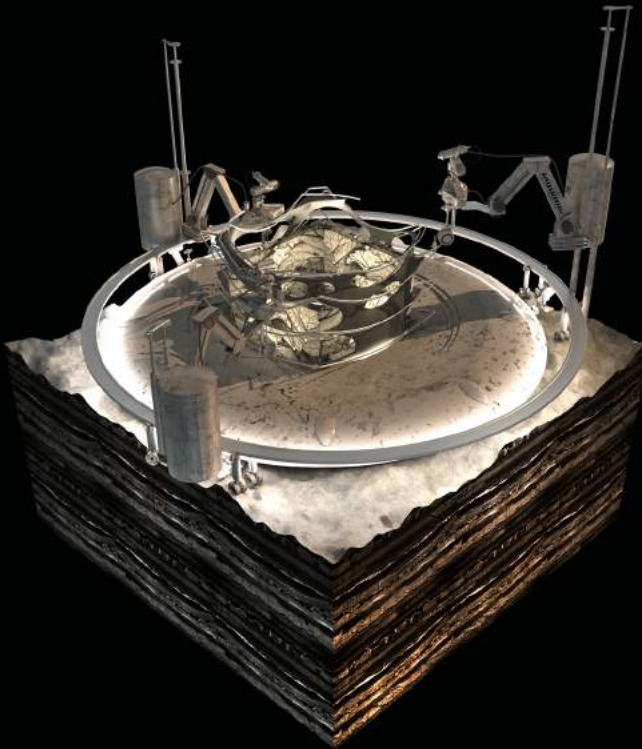


Phase 1, Deploying the Capsule according to its coordinates

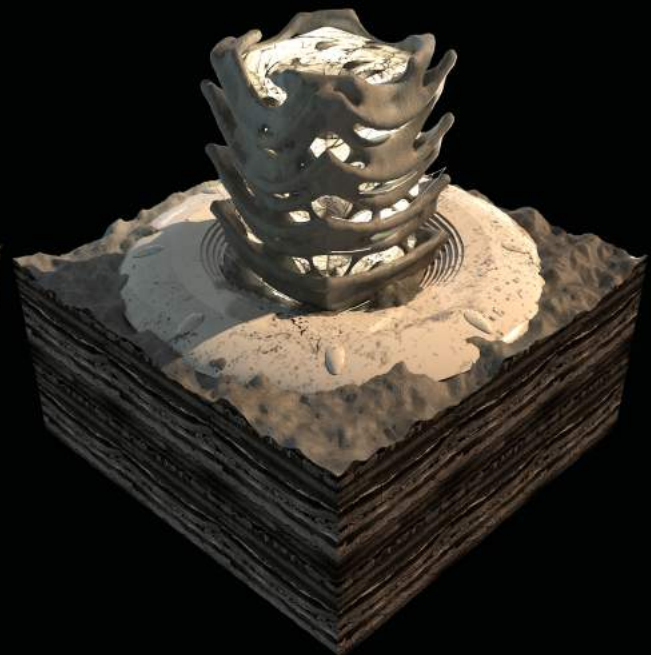


Phase 2, Opening of the capsule and expansion of memory shaped alloy

3D printing concepts that are being explored here is to turn lunar regolith into a molten ceramic. This viscous liquid is then printed out and freezes on contact with the frigid lunar environment to form the foundations, walls, and interiors of structures. This method is one possible way the ESA is planning already on building its proposed International Moon Village, a lunar base that would act as a spiritual successor to the ISS¹⁰.



Phase 3, Laser sintering and 3D printing the structure

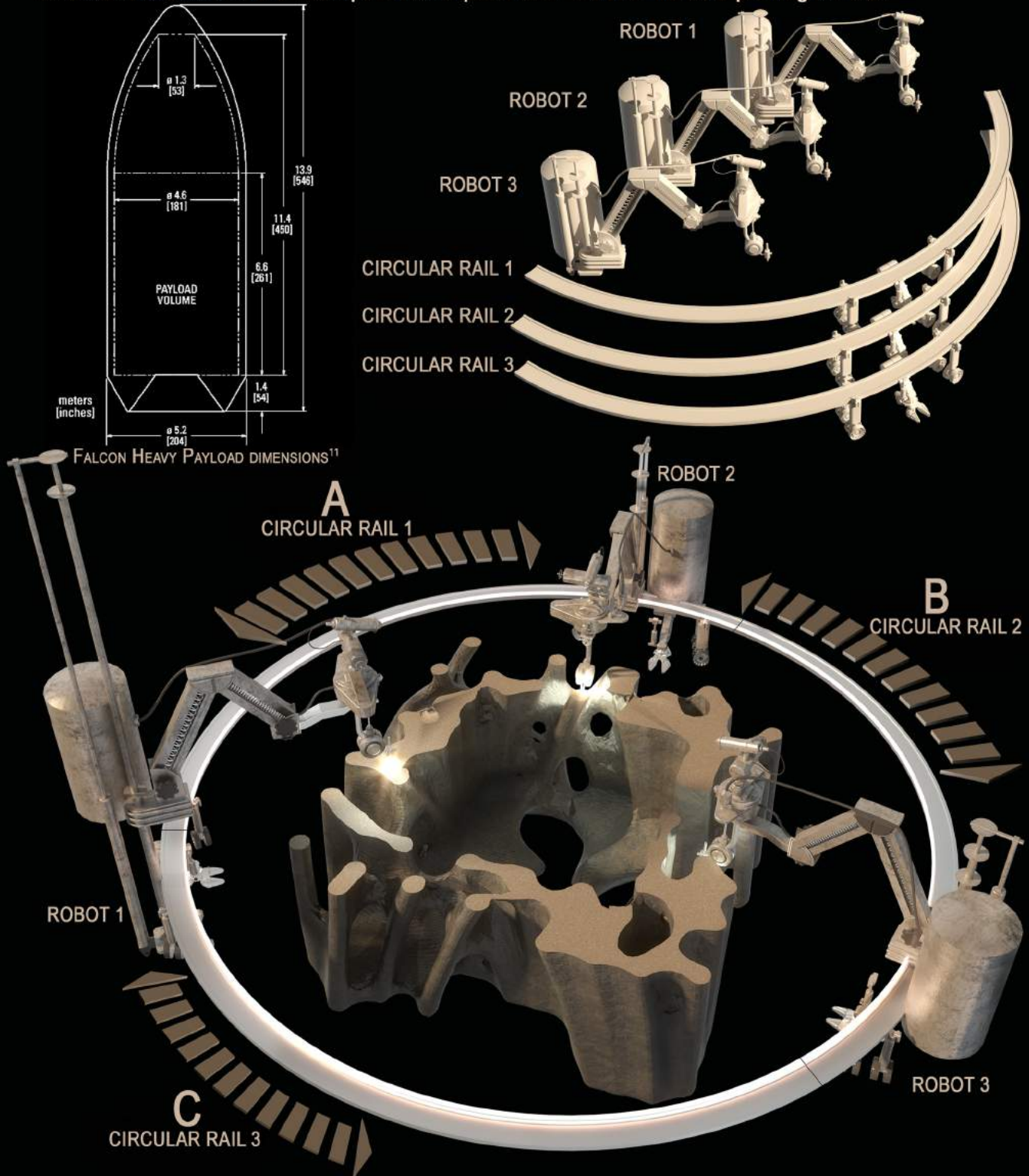


Phase 4, Laser sintering of Basaltic glass inside the structure

6.0 MODULAR ROBOTIC SYSTEM DESIGN (TRI-BOT MODULAR SYSTEM)

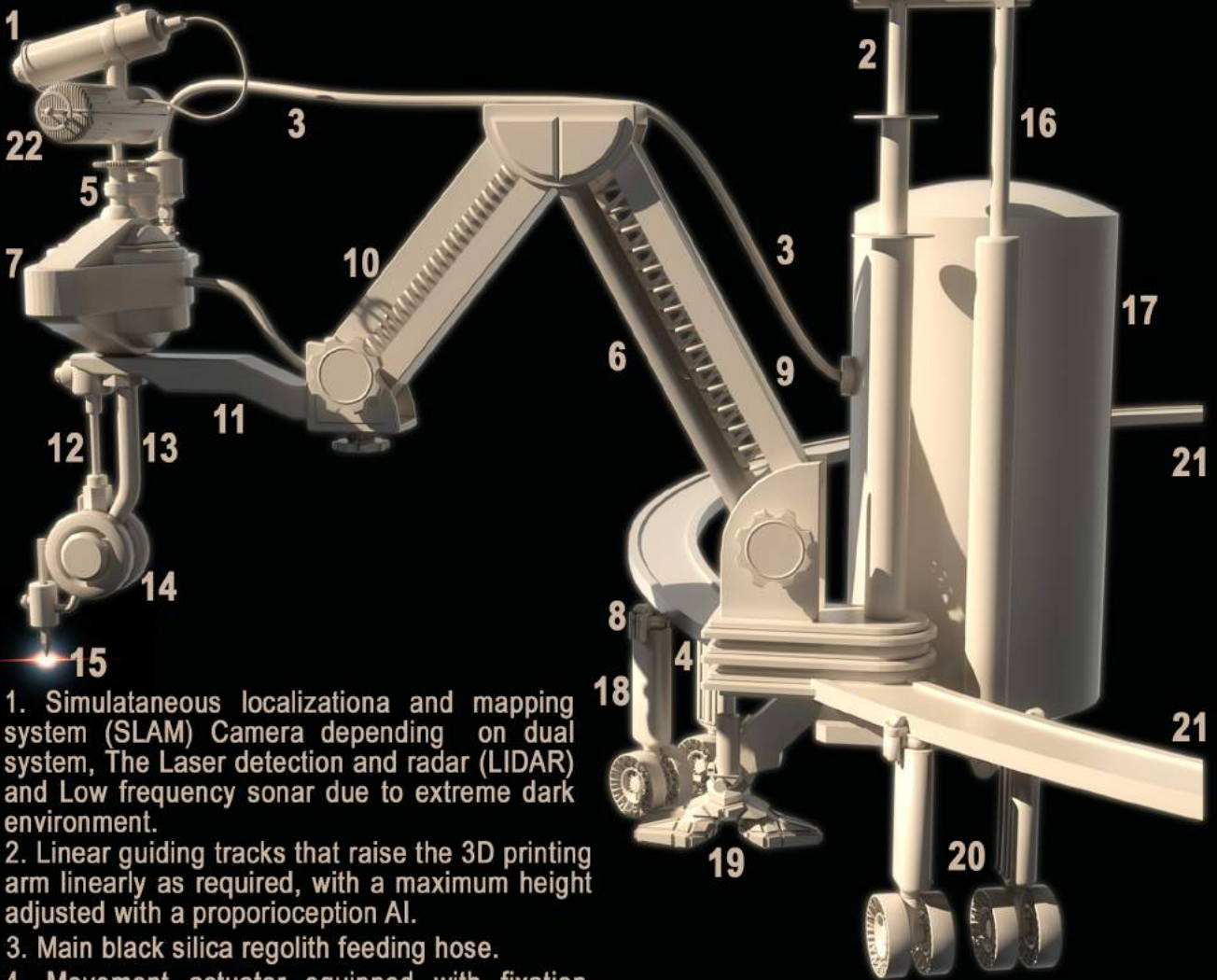
This is the conceptual design that is proposed in order to fulfill the 3D printed stonhenge megalithic structures. It is equipped with AI deep machine learning to perform the required tasks and to adapt to the variables that the robot might meet in the harsh lunar environment.

Artificial Intelligence (AI) is the leading field of science nowadays. Machines can learn and complete tasks independently. Additive manufacturing (AM) 3D printing is the only feasible way to build any extraterrestrial structure. The most developed and reliable technology is stereolithography (SLA) in 3D printing. Therefore, SLA 3D printing process has been taken as a basis for conceptualizing the proposed robot operating between artificial intelligence and additive manufacturing for finding and solving problems in the building process. The building process can use this concept to start various structures associated with the optimization process of the real-time 3D printing control.



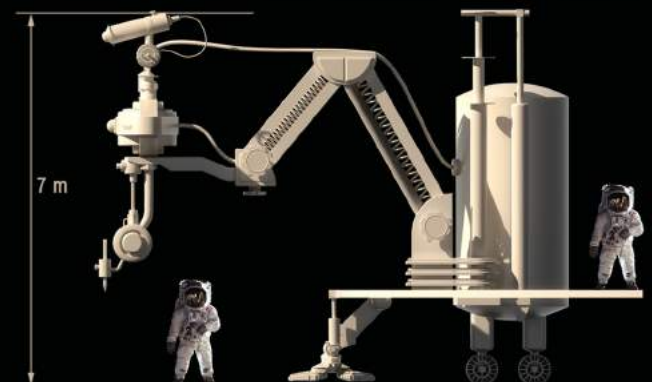
Axonometric showing the tri-robot track in a building process using SLA manufacturing technique

6.1 SYSTEM COMPONENTS



1. Simultaneous localization and mapping system (SLAM) Camera depending on dual system, The Laser detection and radar (LIDAR) and Low frequency sonar due to extreme dark environment.
2. Linear guiding tracks that raise the 3D printing arm linearly as required, with a maximum height adjusted with a proprioception AI.
3. Main black silica regolith feeding hose.
4. Movement actuator equipped with fixation jaws, fixes the robot arm on the circular track
5. Linear pivotal axes with rotational movement.
6. 2nd Axis arm for rotational movement with internal spring.
7. Deep machine learning processing unit and Storage module.
8. PID movement controller.
9. 6 axes robot arm composed of 3 parts.
10. 3rd Axis arm for rotational movement with internal spring.
11. 4th Axis arm for rotational movement.
12. 5th Axis arm for rotational movement.
13. Titanium hose with molten black silica powder extracted from Lunar regolith.
14. 6th axis Circular disc with 270 range rotational movement.
15. Selective laser sintering head for additive manufacturing technique that uses a laser as the power source to sinter powdered and filtered regolith of moon soil, aiming the laser automatically at points in space defined by the 3D model, binding the material together to create a solid structure with homogeneous crystal structure.
16. Hydraulic pistons actuator powering the linear guiding track.

17. Main Titanium regolith storage tank.
18. High performance spring based Shock absorber.
19. High performance titanium stabilizer legs.
20. Motorized Dual wheel system equipped with 360 rotational secondary motor.
21. The tri-parti circular track that enables the 3 robots to move around the 3D printed structure.
22. Motor and power battery cylinder controlling a 3 axes movement of the LIDAR



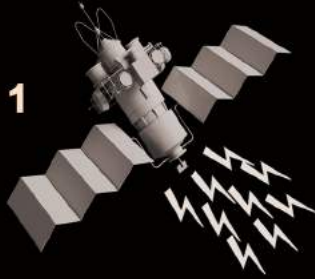
Side view of the Robotic system deployed

0 1 2 3 5m

7.0 MULTI-POWERING SOURCES SYSTEM

Powering the new Stonehenge will be operated by 3 sources of power:

1. Using solar satellites orbiting around the south pole, and securing all connection with Earth
2. The Solar panels deployed at the rim of the crater will transmit wireless microwaves also to the antennas
3. Nine mini Nuclear closed loop reactors implanted at the middle to melt the iced water and provide main operating power source for the colony

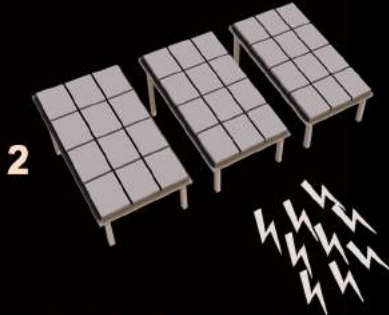


7.1. SOLAR SATELLITES

Space-based solar power (SBSB) is the concept of collecting solar power in outer space and distributing it to Moon surface through powering the array of deployed antennas surrounding the colony

7.2. SOLAR PANELS

Solar panels that will be deployed on the rim of the crater where sun light exists

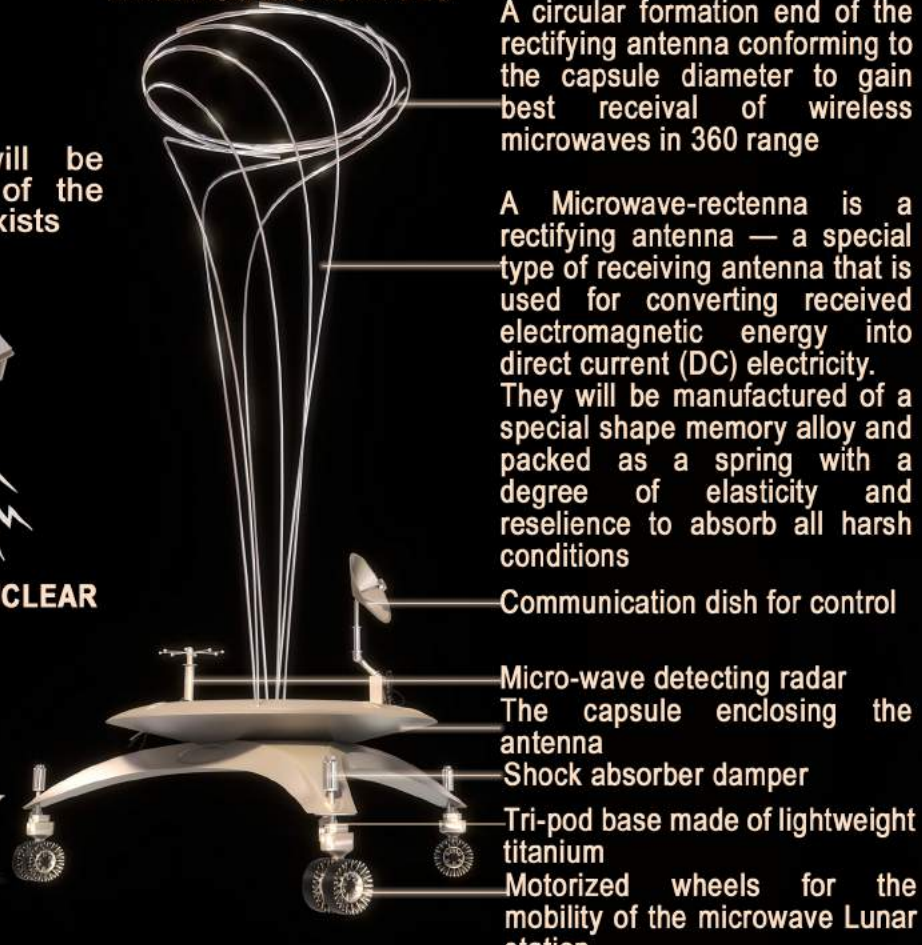


7.4. MOBILE ANTENNA STATION RECEIVING THE WIRELESS MICROWAVES

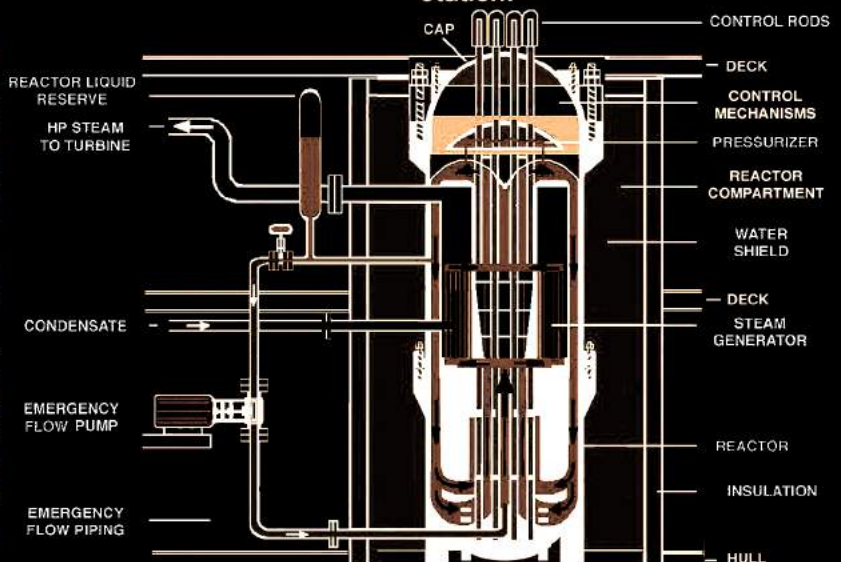
A circular formation end of the rectifying antenna conforming to the capsule diameter to gain best receive of wireless microwaves in 360 range

A Microwave-rectenna is a rectifying antenna — a special type of receiving antenna that is used for converting received electromagnetic energy into direct current (DC) electricity. They will be manufactured of a special shape memory alloy and packed as a spring with a degree of elasticity and resilience to absorb all harsh conditions

7.3. CLOSED LOOP NUCLEAR REACTORS



The 9 small sized closed loop Nuclear reactors (same as used in nuclear ice breakers)¹² implanted at the middle of the colony, They will be the last pieces to be transported after digging to power the colony for average 320 years. It will be the main source of energy to melt the frozen water for irrigation and support life. It will also power all vital equipments for the lunar colony to operate. Its small size could fit easily in Falcon heavy payload. It is also less tightly designed to simplify the use and maintenance, and thus some 50% less compact.



7.4.1 MOBILE MICROWAVE ANTENNAS DEPLOYMENT

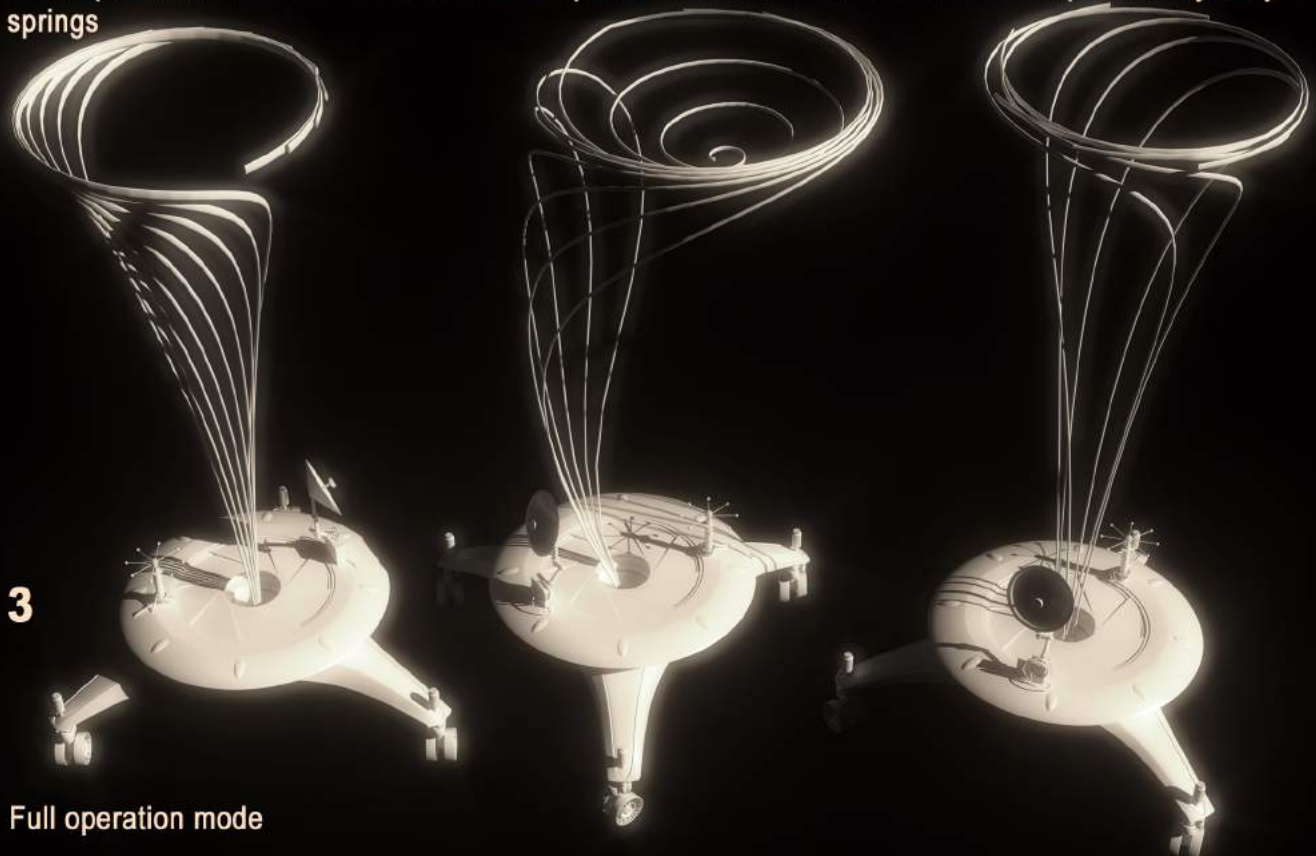
A conceptual design of the antennas that would be deployed in the site to be mobile and its main target is to transfer the electrical power gained from both the solar panels at the rim of the crater and the solar satellites to the 3D printing robots that would build the stonehenge mega structures in the second phase and later for the maintenance of the colony megalithic structures too.



The capsules are made with the diameters of the Saturn V rocket and will be transported with the 1st wave to the Crater site.

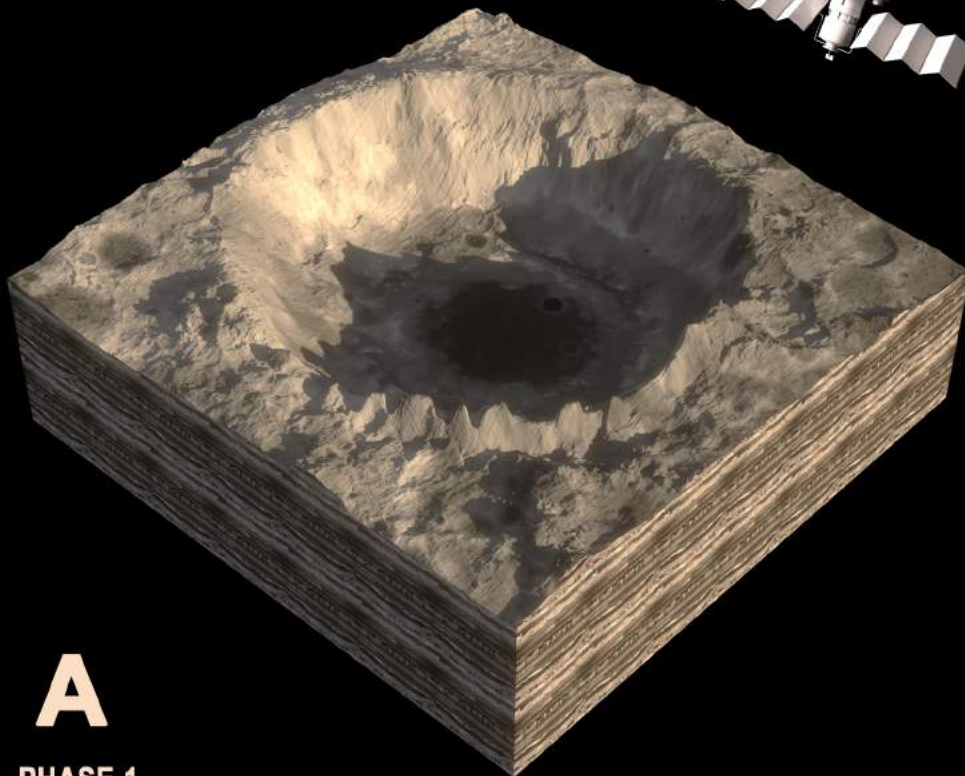


The expansion of the antennas out of the capsules, The Antennas are made of shape memory alloys springs



Full operation mode

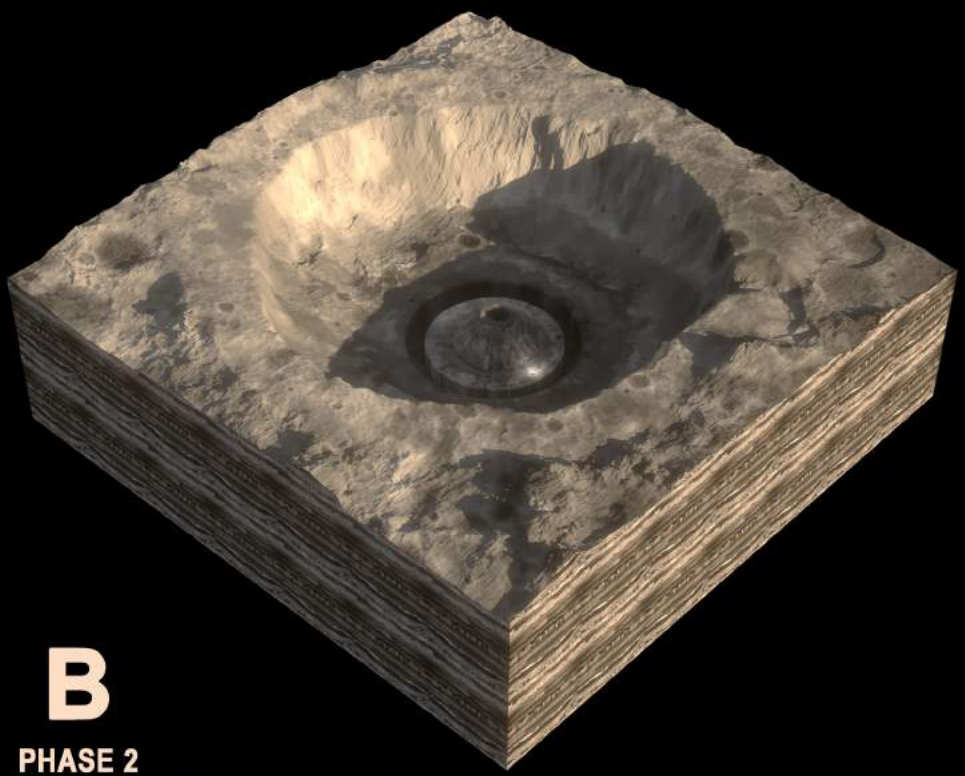
8.0 SITE PREPARATION TIME PLAN



A

PHASE 1
Site Analysis (1 Year before Humans Arrival)

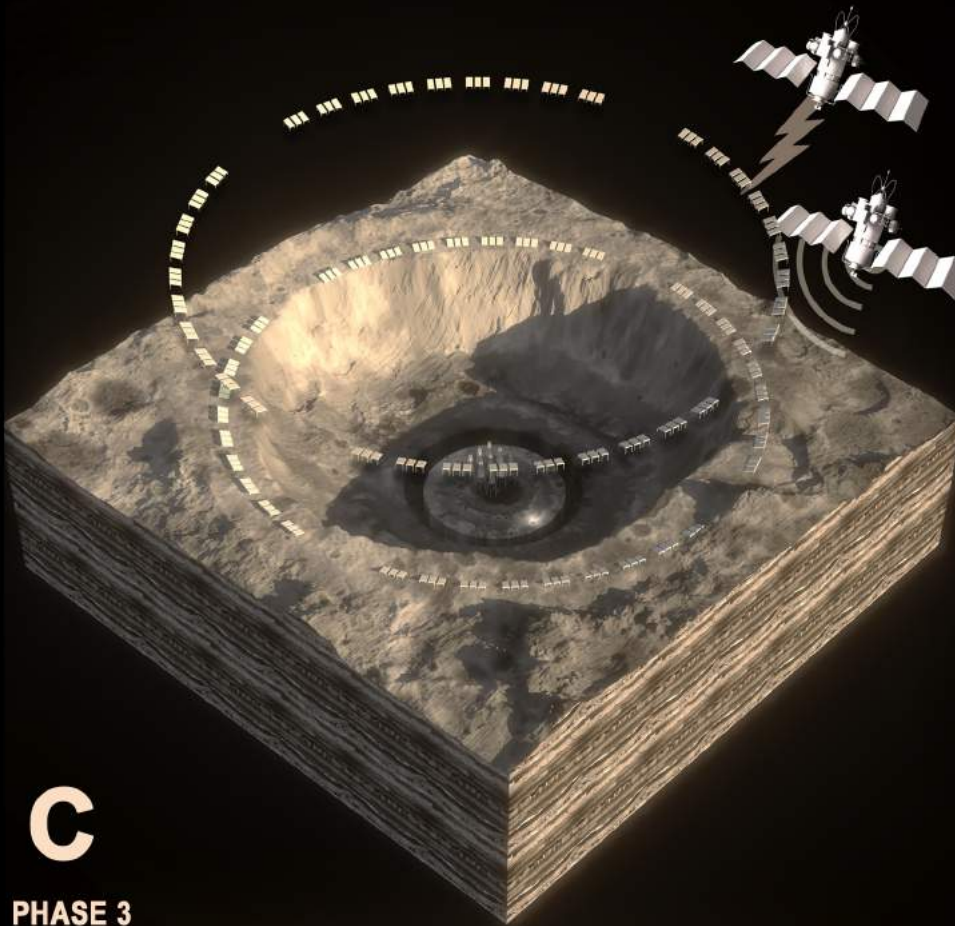
- 1.Satellites are put in orbit to make all necessary surveys and data gathering
- 2.All data is sent back to earth to adjust and tune the design of robots for the colonization process
- 3.Final blueprints are done for the colony
- 4.Final time line and strategy of colonization are settled and astronauts are trained



B

PHASE 2
Boring and Rim flattening (3 Years before Humans Arrival)

- 5.Specialized Robots are deployed to flatten the Crater's rim to prepare it for solar panels arrays
- 6.The crater lower bed is flattened and boring are done for the nuclear batteries
- 7.The regolith gathered from the boring is separated to glass silica containers, fine 3D printing regolith and H₂O for water in tanks
- 8.All mining processes are analyzed for establish circular Lunar economy



C

PHASE 3

Energy Powering (5 years before Humans Arrival)

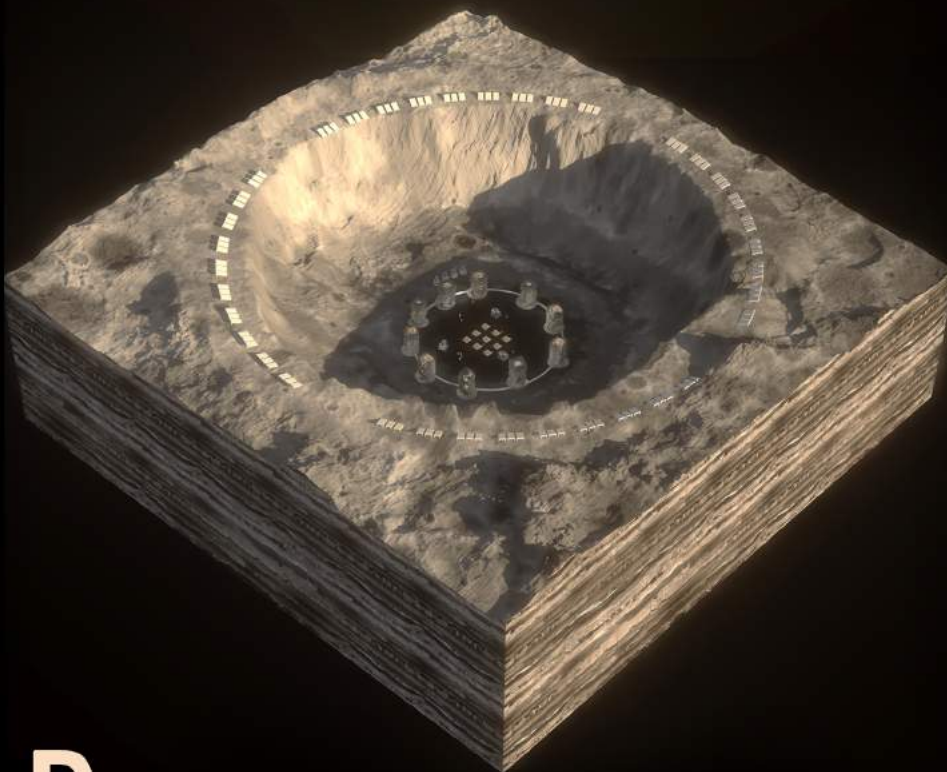
9. Solar satellites are put in orbits to power the colony

10. Communications satellites are also put in orbit to link the colony to earth

11. Arrayes of solar panels are deployed around the rim to signal theil wireless microwaves to the bottom of the crater antennas

12. Nine nuclear batteries are deployed in the bottom of the crater to power the colony

13. Landing site is decided and all minig outputs are defined to be exported back to earth



D

PHASE 4

Project 3D printing (12 Years before Humans Arrival)

14. All cables are set in their positions

15. Infrastructure are built for the colony

16. Full automation of the colony and first wave to astraunots arrivals

9.0 LUNAR ECONOMIC MODEL

The new colony will be the first seed of the 5th industrial evolution (Space economy). In general the Lunar economy will be divided into two economies the internal and external economical model.

9.1 LUNAR INTERNAL ECONOMY:

The Lunar economy will depend on trade between the different colonies (or nations later on) on Moon

9.1.1 LUNAR FARMING:

AI operated precision farming Vertical farming using hybrid aeroponics and/or hydroponics systems.

The main 5 categories of planting are in each colony:

- Medical and Pharmaceutical Plants
- Oxygen Bombs
- Construction Plants (Bamboo, cotton...etc.)
- Biofuel plants
- High nutrition fruits and vegetables (Genetically engineered)

9.1.2 LUNAR MINNING:

Helium 3, At \$1400 per gram, one hundred kilograms (220 pounds) of helium-3 would be worth about \$140 million¹³.

One hundred kilograms constitutes more than enough fuel to potentially power a 1000 megawatt electric plant for a year when fused with deuterium, the terrestrially abundant heavy isotope of hydrogen and could be used in fusion reactors even on Moon

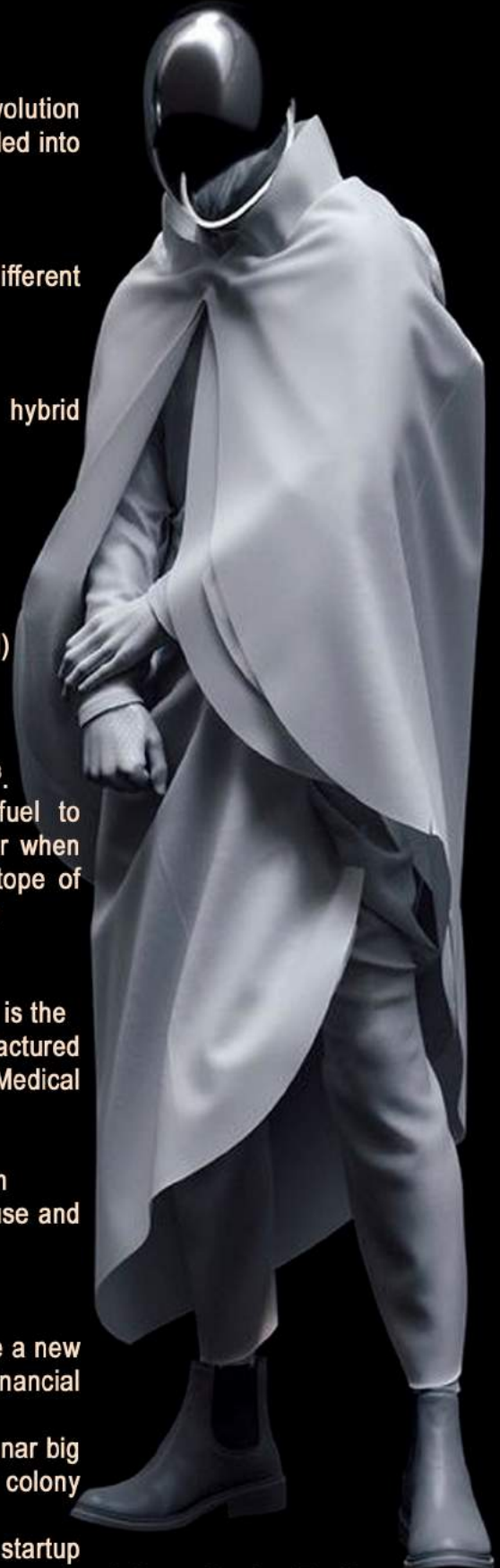
9.1.3 LUNAR INDUSTRIES:

- One of the main new industries that carries huge potentials is the low gravity 3D printing, rare earth industries could be manufactured on moon and sent back to earth (Human organs 3D printing, Medical equipment and certain medicines).
- The 4 elements of food, water, clothes, plastics, wood, paper, rocket fuel are oxygen, carbon, nitrogen, and hydrogen and all could be extracted and produced in Moon for local use and as supplies for Mars missions.

9.1.4 LUNAR TOURISM

The creation of a Lunar culture and identity will help promote a new opportunity for Space economy which in return will secure financial cash flow for the mission through:

- TV reality shows conveying the astronauts daily life in a Lunar big brother show that will build popularity and promote the new colony and hence pay some of the expenses of the mission.
- Promoting space tourism through Some space tourism startup companies that would offer tourism on or around the Moon.
- Establishing subsidiary industries and startups back on earth that would support the mission both financially and culturally including but not limited to Movie industry, Motion picture, Documentaries, Art exhibitions and performance arts based on the Low moon gravity.



Cyber Punk Fashion concept character design by Mark Change for Oppo is a sample of new fashion trends that will help promote the new extraterrestrial culture¹⁴.

4. The exporting of lunar resources as Helium 3 to earth .
5. The scientific funding to conduct research in lunar environment related research.

9.2 LUNAR EXTERNAL ECONOMY (INTERPLANETRY):

9.2.1 LUNAR EXOMEDICINE INDUSTRIES:

A unique Lunar Medicine industry will evolve in Moon due to a set of reasons like the Low gravity and Sterilized surface and thin atmosphere with low pressure

- 3D printing on molecular or cellular scale will be developed by the time we go to Moon.
- Using low gravity industries (3D printing human organs)
- Using low gravity medicine manufacturing

9.2.2 LUNAR ASTEROID MINNING:

Moon will be used as a base station for all heavy industries mining missions that will power and supply all future missions to Mars and beyond.

9.2.3 LUNAR HEAVY INDUSTRIES (LONG TERM PLANS):

All earth polluting industries that produce greenhouse effect will be transferred on moon starting a new 5th industrial revolution by building several other colonies that will contribute in new investments and occurrence of the new space trillionaires.

9.3 LUNAR AQUA-CRYPTOCURRENCY:

- One of the most precious commodities will be water in the Lunar economy. (Water is the new gold reserve on Moon)
- The Aqua-Cryptocurrency will be the new Lunar currency to allow free trade between the five colonies.

10.0 LUNAR GEO-POLITICAL SYSTEM

- This colony will be the first one of several colonies (nations) in different places, giving them different cultures, identities, functions and habits establishing a unity within diversity relationship
- This is a first prototype of colonies that could be duplicated in another locations to reach the minimum viable population (200 person)¹⁵
- It is vital to make the other different colonies in 5 different locations to survive through any probable extinction level events and to grow different local culture and unique identity for each colony.

10.1 LUNAR GOVERNING MODEL

The Governing model will be a hybrid of Democracy and technocracy¹⁶, it is a hybrid system of governance in which candidate representatives are selected on the basis of their expertise in a given area of responsibility, particularly with regard to scientific or technical knowledge. The Leadership skills for decision-makers are selected on the basis of specialized knowledge and performance, rather than political affiliations at least for the few first starting generations to face any survival challenges. The president of the Lunar government should be elected based on genocratic¹⁷ democratic model. Limiting the candidates of best 3 representatives that are the best skillfully in their trades.

10.2 EARTH COUNCIL

There should be a legal structure and a regulatory regime that guarantee collaboration between political bodies of nations and Private industries (Profit driven enterprises) to resist resources curse and avoid consequences of chaos due to conflicts between science, economy and politics. Where there are 3 forces that would go into conflicts on Mars. Scientific expeditions, Economic enterprises and political greed. Granting powers to corporations should be very cautious at the first few decades.

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