Mission Concept: Lunar Eden

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Addressed Problems for Solution

From a scientific perspective, Lunar habitation is important to begin understanding the potential of created a permanent habitable living environment on a celestial body that is not Earth. This lunar habitat could potentially serve as a starting point for creating permanent habits on celestial bodies further away such as Mars, by testing new technology such as construction and life support systems without being too far away from Earth, should something bad happen were by the habitants need to return immediately. As for scientific research, the far side of the moon is shielded from electromagnetic interference from earth making it an ideal location for an astronomical telescope. Finally, the low gravity environment is ideal for research into biological experiments in low gravity such as plant growth studies.

Mission Description

-Main objective

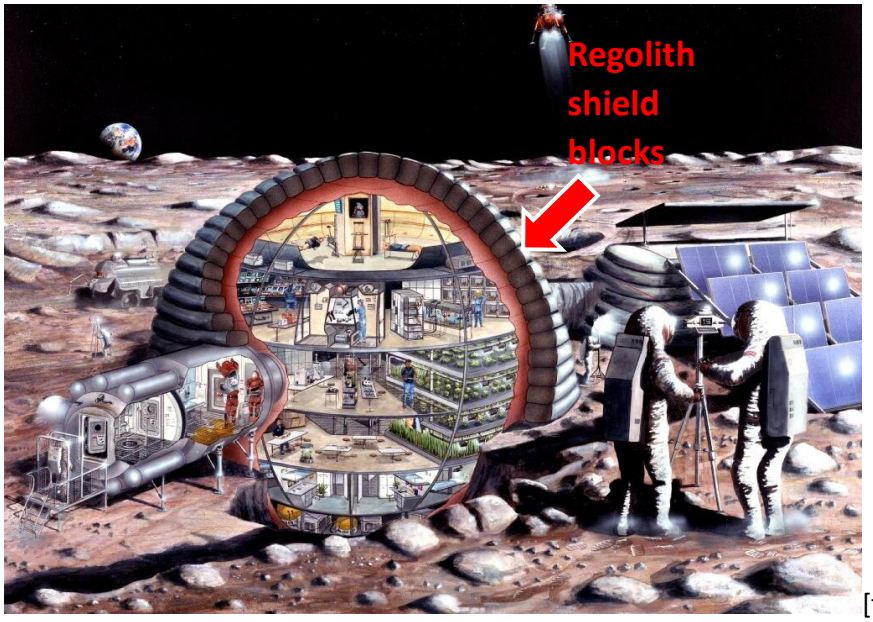
To begin construction of a lunar habitat, with access to lunar ice for water and a functional constructed life support system. Lunar regolith with be 3d printed to shield from radiation and structurally support the habitat.

-Approach

Phase 1, Launch an unmanned robotic mission to initialize construction of the habitat on the northern near side of the lunar surface and begin locating and extracting lunar ice with a Cryobot.

Phase 2, Launch a manned mission to finish construction of lunar habitat with the addition of a functioning life support system.

Phase 3, Finalize lunar ice extraction and sourcing for life support system. Then begin biological plant growth research with lunar ice, in a dedicated biolab.



[fig1]

Justification for a Space Solution

Proving permanent human habitation is possible on another celestial body other than Earth is only possible on a celestial body that is not earth, a lunar habitat is needed to prove that lunar ice can be used to support life of the moon. Successful lunar habitation could potentially be the start of solving Earths overpopulation issues. The closer distance from Earth is justification as to way lunar habitation was chosen over Martian habitation. According to Nasa, “Thanks to nearly 20 years of continuous human habitation on the ISS, future Mars- class life support systems can be designed with a 36% reduction in mass”, with continuous lunar habitation is could potentially be reduced further. Similarly, developing ways to use local lunar resources could inspire more efficient resource utilization on Earth.

Existing mission concepts

There a few existing mission concepts like this, these include Nasa’s Artemis program which aims to send astronauts back to the moon and establish a sustainable presence there by the end of the 2020’s. It also includes plans to build a lunar gateway which will be a space station orbiting the moon containing a laboratory and habitation module as well as cargo hold for robotic rovers. ESA’s moon village is a plan to build a global scientific community to share knowledge and capabilities for lunar research.

Technical requirements

Orbital/flight requirements

This mission will require multiple launches to moon. A heavy lift launch rocket will be used to escape Earths gravity and set the rocket on a (TLI) trans-lunar injection, about the rocket reaches earths orbit it will burn towards the moon. Once near lunar orbit the rocket will perform another slowing burn, (LOI) lunar orbit insertion to enter lunar orbit, the descent to the lunar surface can now begin, the chosen location will be in the Northern near side of the moon as studies have suggested that the northern pole may contain the most ice.

Major components

Lunar habitat Construction equipment and materials, including a 3d printer for lunar regolith construct radiation shielding for the habitats, strong and light materials like aluminum will need to be on the phase 1 launch to provide structural integrity to the habitat. The 3d printed lunar regolith blocks could then be shaped around the habitat similar to an igloo type construction.

The Cryobots, will have a large, tethered cable acting as power source and a acting as a tube to melt and extract the lunar ice relaying it back to the lunar habitat. The Cryobot will have a hybrid reactive system allowing it to effectively navigate around the terrain and avoid damaging obstacles.

 [fig2]

The Life support systems will most likely need to be installed on the astronaut's arrival these will include functioning heating, water recycling units, breathable air filters.

Communication requirements

Communication from Earth to the moon will need to be high speed with the use of lunar and earth satellites being linked, a near real time connection/operation of construction robots can be used from earth to build the habitat in phase 1.

Fuel/power requirements

The habitat will need to be powered primarily with solar power so many solar cells will need to be installed in and around the habitat.

 [fig3]

Multiple launches I different phases will be needed so a modern fuel efficient high-lift rocket will need to be chosen as to minimize fuel consumption and cost, SpaceX's Falcon Heavy could be used as it is fairly fuel efficient. The falcon Heavy costs around £70 million could use around 1.4M KG of Liquid oxygen/kerosene (RP-1) propellant.

Size considerations

The mission as a whole is a large one and will use a combination of small and large devices, phase one will require smaller spacecraft for the unmanned initialization phase, while the manned phase will require a much larger spacecraft to house the astronauts. The tethered Cryobots will be relatively small and lightweight, whereas the habitation modules will need to be larger to provided adequate astronaut living space.

Potential costs

The SpaceX Falcon Heavy launch will cost around $90million. Looking at the Artemis program it is estimated that it will cost tens of billions over its lifetime. For further perspective the ISS has cost over 150 $Billion. It is expected that this mission could cost around $30-40 Billion, for the first decade, then potentially more should it continue.

Critical assessment

This mission does contain many potential challenges for example, lunar ice is not abundant and is highly likely that not enough will be extracted. The reliability of the working life support systems is the most important factor in this mission as they could easily fail and cause catastrophic loss of life. The construction of the lunar habitat and use of 3d printed regolith while theoretically possible has not been extensively tested. Finally, the costs of launching multiple heavy lift rockets and constructing functioning habitats would be far greater than any previous space mission, it would be currently impossible to fund, however, it could potentially be in the future. Future Political

implications could be a problem, although there aren't any current policies stopping lunar habitation this could change as the exploitation of lunar resources is essential to this mission. While ambitious this mission with further developments in space science and engineering, and world collaboration is entirely possible in the near future.

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