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DESIGNING A MARTIAN BASE FOR LONG-TERM SPACE MISSIONS

Abstract

Space Oasis Delft is a Dream Team associated with the TU Delft. In this project, disciplines work together to design a circular Martian habitat that facilitates long-term space missions. The current design enables a five-year mission of 150 crew members investigating the history of Mars' climate and so its past, present, and future possibility of sustaining life.

We take inspiration from the MELiSSA pilot plant, where individually optimised food production, waste degradation, nitrification, and air revitalisation systems are connected into a closed-loop system. We aim to expand upon this by focussing on modularity, circularity and human-centred design.

Construction and maintenance in the extreme environments of Mars require repairability and adaptation to enable a prolonged lifecycle and possible expansion. Modular elements in the architectural structure and life support systems facilitate these requirements for long-term missions.

Seeing as the distance from Earth to Mars does not facilitate a constant influx of supplies and materials, the base requires to be built and sustained using in situ resources. A circular approach in designing and maintaining the base improves the efficient usage of materials and therefore also facilitates missions on a longer time scale.

Our second point of focus is human-centred design. Long-term missions performed by humans need to protect both physical and mental health. In this, prolonged isolation has proven numerous effects on the inhabitants' state of mind. The lack of usual social surroundings and the communication delays to Earth causes increased stress and loneliness and harms work performance. Multiple simulated Lunar and Martian missions show the importance of mental well-being, for which solutions can take shape in the physical design and layout of the base and the structuring of social systems. The design of our base separates work and living by physically dividing the living modules from the central hub with its research- and agriculture facilities.

The academic year of 2024/2025 forms the second year of this project. During this period, the team focuses its research on topics in radiation shielding, life support, and agriculture to create a circular, integrated base. In the following years, the design will shrink to a crew of around seven members for a more thorough development. However, all insights and progress will be used for further research and developments in the explained topics of modularity, circularity and human-centred design.

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