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DEVELOPMENT OF A NOVEL BIODESIGN APPROACH IN THE CONSTRUCTION OF HABITATS BOTH HERE ON EARTH AND ON OTHER CELESTIAL BODIES, BASED UPON THE CORE PRINCIPLES OF FUNCTIONALITY AND ENVIRONMENTAL SUSTAINABILITY.

Abstract

Humanity's negative impact on the Earth's biosphere highlights the need for more sustainable practices with regards to how the natural environment is managed. As humans prepare to return to the Moon for the first time in decades, it follows that applying such sustainable management principles to activities conducted on the lunar surface would also be beneficial in the long run. A myriad of designs and proposals have emerged in recent years regarding plans for a lunar settlement, but incorporation of sustainability remains a key design feature when resources are limited, and resupply missions are costly.

This work explores the utilization of a bioarchitectural approach to habitat design and lays out a proposed biodesign process through which more sustainable structures can be conceived. The aim of this process is to help facilitate future bioarchitectural work and to propose an initial framework in which interdisciplinary work can take place. The method comprises four phases; defining the design parameters and the environment the structure would be built in, implementing a biomimetic approach to answer some of the design challenges, identifying an appropriate biomaterial for use in construction, and optimizing the material via bioengineering, to enhance favorable natural properties or introduce new ones. This process was theoretically applied to the development of a lunar settlement and resulted in the proposed use of novel mycelium construction materials, along with the potential incorporation of radioresistant bacteria.

The conceived biodesign process has the potential to aid in the future development of eco-friendly and bio-sustainable habitats both here on Earth, and in the construction of future off-world settlements. It is the conclusion of this work that a process such as the one described here, which brings together several different fields of research, can form the basis of a sustainable alternative to many of today's current construction practices. Future goals involve the creation of an integrated web application tool that can aid in the selection procedure of all four phases of the process, with the creation of a biomaterial database and the development of a web-based bioengineering system, that can be used to help select the most appropriate genetic manipulation tools for enhancing a chosen material. Ultimately the proposed biodesign process has the potential to bridge the fields of material science, biology, architecture, and systems design in an interdisciplinary manner, aid in the cross fertilization of ideas and progress this concept into a real-world use case.