

HUMAN EXPLORATION OF THE SOLAR SYSTEM SYMPOSIUM (A5)
Human Exploration of the Moon and Cislunar Space (1)

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ARCHITECTURAL CONCEPTS FOR A LUNAR GREENHOUSE WITHIN THE MELISSA
FRAMEWORK

Abstract

This paper describes the space architecture research and rapid concept design of a large greenhouse module (GHM) for the extreme environment on the Moon, considering all aspects of construction and utilization from an architectural perspective. This study is made in the frame of the project "Greenhouse Module for Space System", led by the EDEN (Evolution Design of Environmentally-closed Nutrition-Sources) group of DLR Bremen for the ESA MELiSSA (Micro-Ecological Life Support System Alternative) project. This greenhouse module is one of the producer compartments of the MELiSSA loop, a regenerative closed system based on micro-organisms and higher plants to recycle organic wastes of the crew, revitalize the atmosphere, recycle water, and produce food. The greenhouse concepts are based on the required plant growth volumes for sustaining a crew of six on the Moon for two years. Three different concepts for external configuration are presented together with examples of how they can be outfitted internally with growth accommodations and supporting functional areas as well as space for accommodating subsystems. The greenhouse structures are composed of rigid, rigid deployable and flexible deployable components in different configurations optimizing volume and mass, in three concepts demonstrating the principal differences between the structural concepts. The greenhouse subsystems are estimated based on currently available off-the-shelf systems and the greenhouse operations consider both human and robotic greenhouse maintenance and are reflected in the architectural solutions. The interior layouts demonstrate different plant arrangements and different degrees of automation for compact placement of the plant growth structures, while allowing for reasonable working conditions for the astronauts. The three concepts presented in this paper are innovative outcomes of diverse requirements given by the MELiSSA project and provide different holistic views on the greenhouse design for extreme environments. They include all aspects of the space flight logistics, deployment and operations on the lunar surface and serve as preliminary architectural options for further evaluation of the different concepts.