

14th HUMAN EXPLORATION OF THE MOON AND MARS SYMPOSIUM (A5)  
Long Term Scenarios for Human Moon/Mars Presence (2)

Author: Mr. Daniel Schubert  
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany

Mr. Leigh J. Glasgow  
Cranfield University, Germany

Mr. Markus Dorn  
HTW Dresden, Germany  
Prof. F. Schröder  
Germany

NEW GREENHOUSE CONCEPT FOR PLANETARY RESEARCH BASES

**Abstract**

Thoughts and discussions about human exploration of the solar system are as old as spaceflight itself. Nevertheless, most of today's space programs are limited to human transportation into Low Earth Orbit (LEO). Because humanity has plans to explore further in space, by building habitats on the Moon and Mars, several concepts have been developed to create bases with bio-regenerative life support systems. These concepts aim for decreasing the resupply mass by regenerating essential resources for humans.

The paper presents the latest research results of the Institute of Space Systems at the German Aerospace Center (DLR), which were conducted in the institute's Advanced Study Group (ASG). The goal of this research effort is to design an automated production facility for Higher plants under mass production principles, while system constraints exist to minimize system mass dimensions as well as power demand. A greenhouse system (functioning as a subsystem of a habitat) can not only produce continuously food for the crew, but can also fulfill other tasks like grey water purification, Oxygen production, waste management and even psychological crew health support.

The designed greenhouse module considers all functions and subsystems needed for the plant life cycle for a variety of different plant categories (e.g. grass-, tuber- and tree-like). An analysis of environmental conditions (e.g. low gravity, hypobaric and radiation levels) is necessary in order to understand the biological behavior of the plants, foreseen to be produced in the greenhouse module. Different individual parametric plant bio factors (e.g. morphological, physiological and ecological) serve as design drivers and as constraints for the system study.

Building up on key findings of the former greenhouse projects, as well as investigating present research efforts in this field, the paper presents a holistic system study on greenhouse procedures in a space environment. Here, the paper gives an overview of the latest developments within the DLR Advanced Study Group (ASG), showing different greenhouse module design trade-offs, preliminary system calculations and possible spin-off applications.