Collaborations between EnginSoft and ESA within the MELiSSA project

MELiSSA was initiated to develop a regenerative life-support system for manned space exploration. The project aims to recycle water and oxygen completely and reduce the need for food resupply drastically; thus settlements on Moon or Mars become feasible in the long run.

14 partners in science and industry from 8 country work together to reach this ambitious goal, deepening the understanding of our ecosystem every day.

Micro-Ecological Life Support System Alternative

EnginSoft has been involved in different activities within MELiSSA:

- ➔ **ALISSE | Advanced Life Support System Evaluator**
  Development of the software framework
- ➔ **SCALISS | SCAling of LIfe Support System**
  Development of the software interface
- ➔ **FC1 | Food Characterization phase 1**
  HVAC study of MELiSSA Pilot Plant at Barcelona
- ➔ **GMSS | Greenhouse Module for Space System**
  HVAC study of moon greenhouse concept
- ➔ **HySSE | Hydroponic SubSystem Engineering**
  Development of a hydroponic system
- ➔ **ENRUM | space ENergy Resources Utilization Mapping**
  Development of a tool for simulation and mapping of energy sources

Figure: MELiSSA loop

HYSSE — HYdroponic SubSystem Engineering

Background & Goals: The project has the intent to contribute with the development of a nutrient feeding equipment for the growth of higher plants within the compartment IV of MELiSSA loop.

Overview: A hybrid solution involving a deep water culture with a variable level was selected.

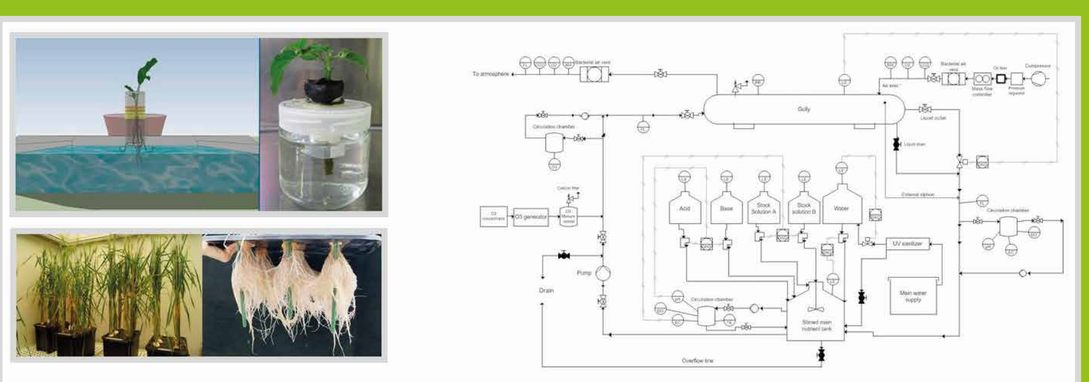

Figure Left: Plant-gully interface concept, hydroponic cell and fundamental tests. **Right:** P&ID.

Fundamental tests were carried out for seeds' disinfection and germination, de-contamination, and nutrition. A parametric model of the gully was developed supported by CFD simulations to obtain uniform and homogeneous flow nutrition delivery scenario. Hence a breadboard was manufactured in order to validate the main new features of the proposed design. Potato and durum wheat full life tests were performed: plant growth proceeded successfully and the hydroponic systems performed well.

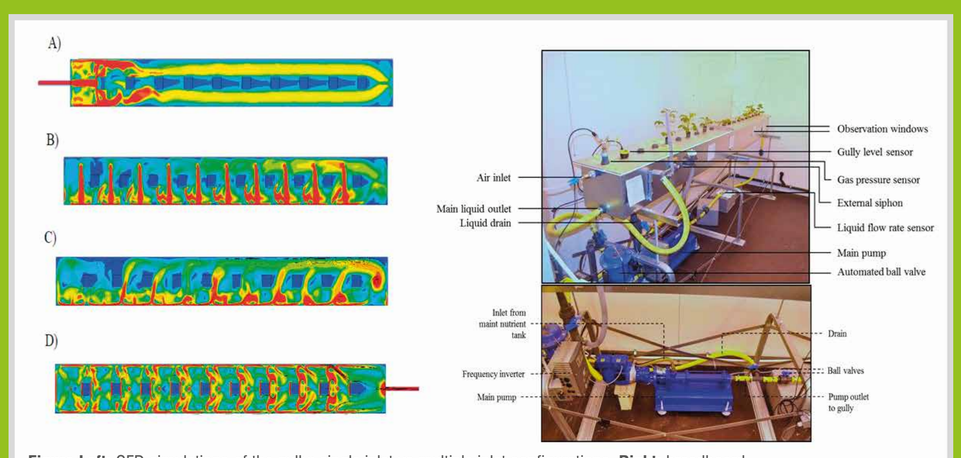

Figure Left: CFD simulations of the gully: single inlet vs multiple inlet configurations. **Right:** breadboard.

Project conclusions & innovation: Engineering approaches were applied to the design and development of the hydraulic part of the PCU. Separation between canopies and roots zones, mass balance calculations, and nutrient solution uniformity in the gully make the system suitable to collect data to improve plant modelling.

Project coordinator: EnginSoft

GMSS — Greenhouse Module for Space System

Background & Goals: As bio-regenerative life support system, a greenhouse module has become a fundamental part within every concept of stable and independent base for future space missions. GMSS is a feasibility study to develop the primary structure of greenhouse module for a lunar base.

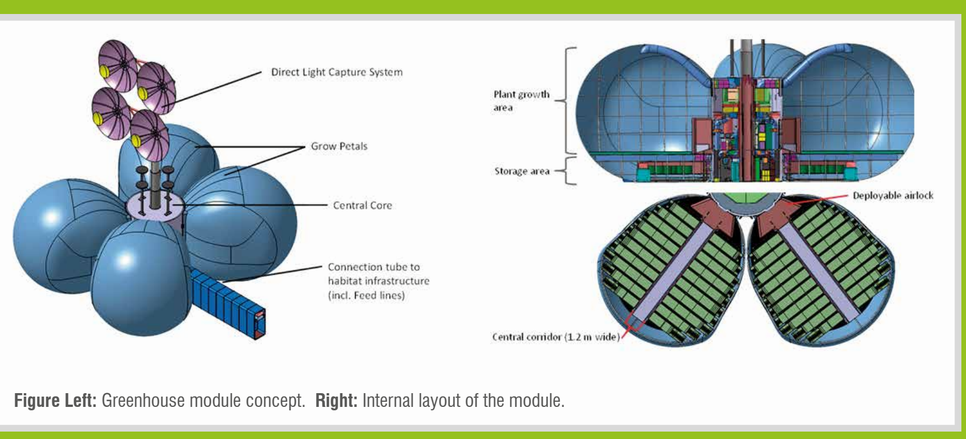

Figure Left: Greenhouse module concept. **Right:** Internal layout of the module.

Overview: All the relevant issues related to a complete bio-regenerative systems are investigated: the choice of the plants, the grow area, the illumination system, the air conditioning system, the global energy demand and the structure of the module. A final layout of a greenhouse module has been developed including the calculation of mainly power, mass, thermal, dimensions and equipment lists for each system. The selected design is called petal design, connected by two independent corridors to the habitat infrastructure. The central rigid multi-level core of the greenhouse module is connected to four inflatable grow petals.

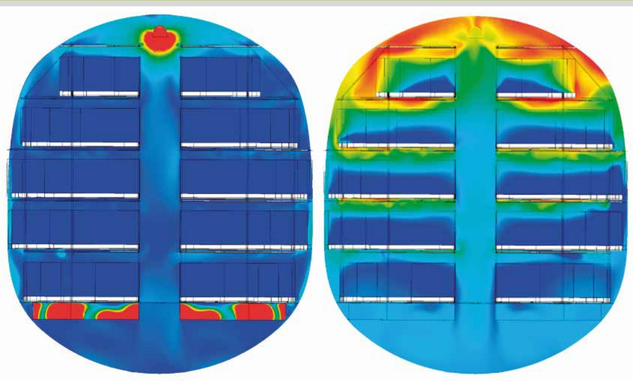

Figure Left: CFD simulations of the greenhouse module: velocity distribution.
Right: Temperature distribution.

Project conclusions & innovation: A CFD model of a growth chamber has been created to check internal climate of the petals: these simulations has allowed to calculate pressure, velocity, temperature, local concentration of O_2/CO_2 and humidity level. This has enabled the establishment of recommendations on the design layout and component sizing for the future developments of the project.

Project coordinator: DLR