



European Technologies For Crew Habitats and Food Production in Space

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Exploration Habitat Simulators

A sustainable human space exploration program will need habitats as an integral element of the exploration architecture:

- **In-space habitats** (LEO, cislunar space, Mars vicinity)
- **Surface habitats** (Moon, Mars)

Habitat Technologies & Simulators in Europe

- Habitat life-support technologies
- Habitat architectural technologies

Life Support Technologies

MELiSSA

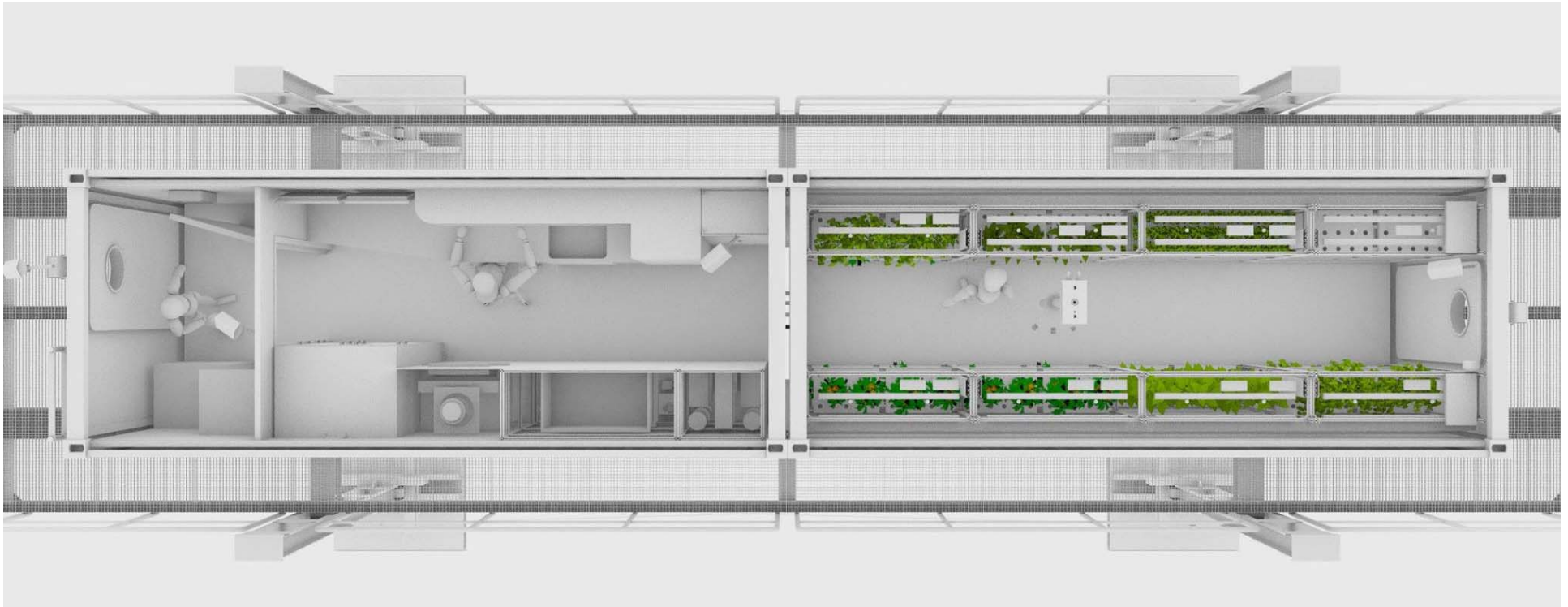
Micro-Ecological Life Support System Alternative



- A closed-loop ecosystem based on micro-organisms and higher plants
- A tool for the development of future regenerative life support system technologies enabling long term manned space missions.
- Concerned essentially with the recovery of food, water and oxygen from organic waste, carbon dioxide and minerals.
- Based on the principle of an "aquatic" ecosystem, comprising 5 compartments housing specialised bacteria colonies, higher-level plants, and the crew
- Consortium: SCK•CEN research centre, the VITO technology centre, Universitat Autònoma de Barcelona, the University of Guelph, University Blaise Pascal and SHERPA engineering, IPStar.
- Funding: ESA
- Duration: 1993 – present

EDEN ISS

Evolution and Design of Environmentally-Closed Nutrition-Sources



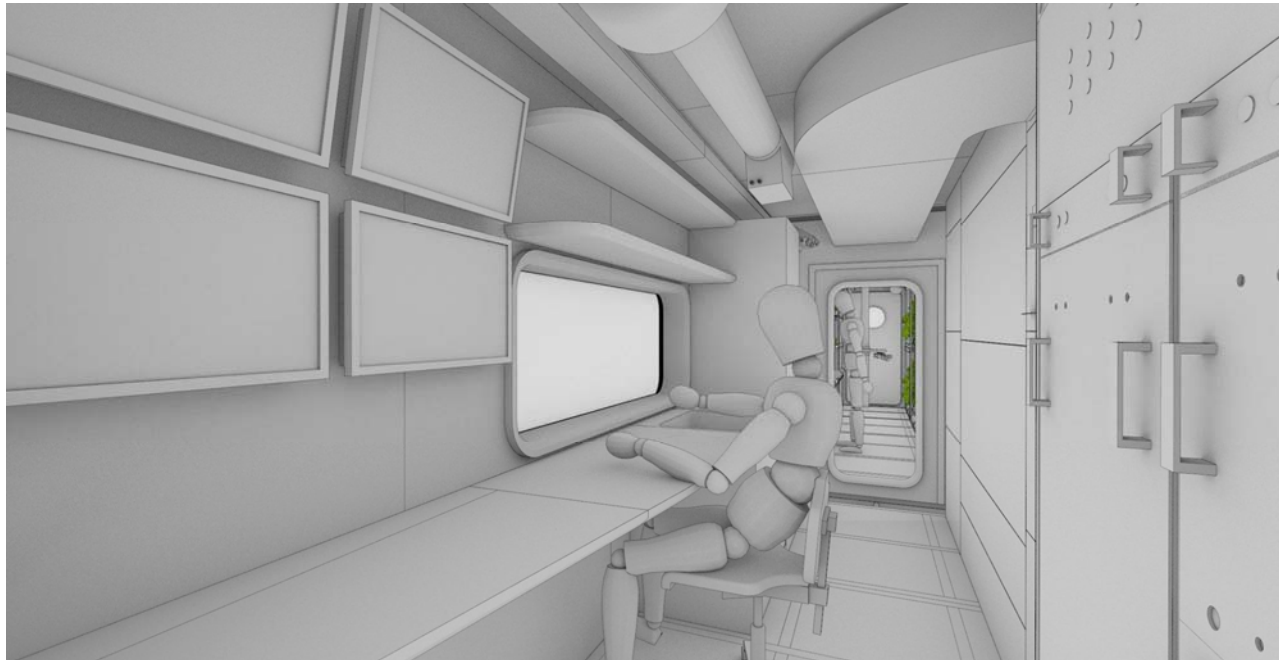
- Ground demonstration of plant cultivation technologies for safe food production in space
- Purpose: cultivate food to support dietary needs for crew members in deep space missions
- Advances controlled environment agriculture technologies in a semi-closed loop system

EDEN ISS



- Mobile container-sized greenhouse and laboratory
- Consortium: DLR + 12 European and international members
- 1-year demonstration at the Neumayer III station in Antarctica 2017-2018
- Funding: EU H2020
- Duration: 2015-2019

EDEN ISS



Main compartments of the mobile laboratory are:

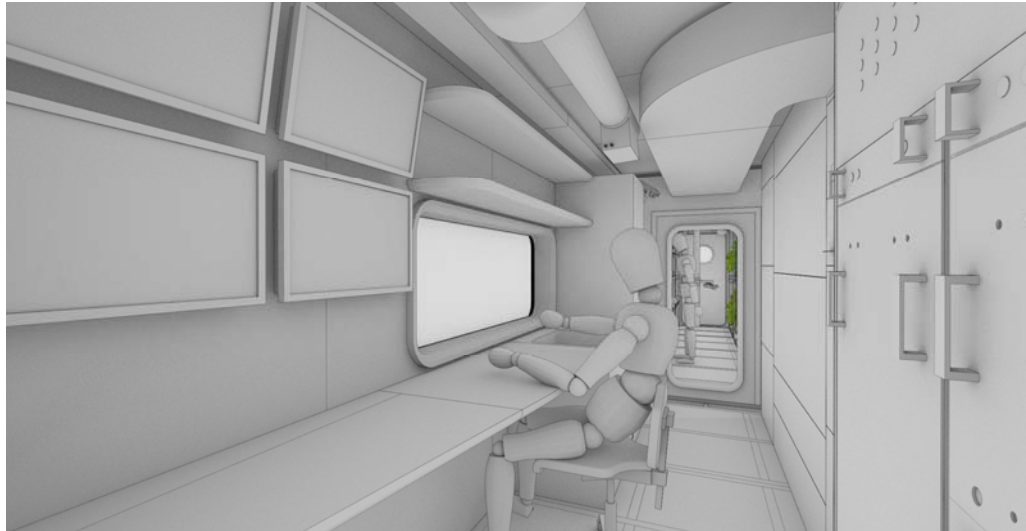
- A future exploration greenhouse
- A service module
- An entry airlock

The plant growth technologies are planned to be demonstrated on board the ISS

- A reference facility in an ISS experiment rack is included

EDEN ISS

Service Module



The Service Module provides accommodation for the main subsystems, including:

- Thermal
- Power
- air ventilation and
- nutrient/water subsystems

and it provides a work station for preparation and harvesting procedures.

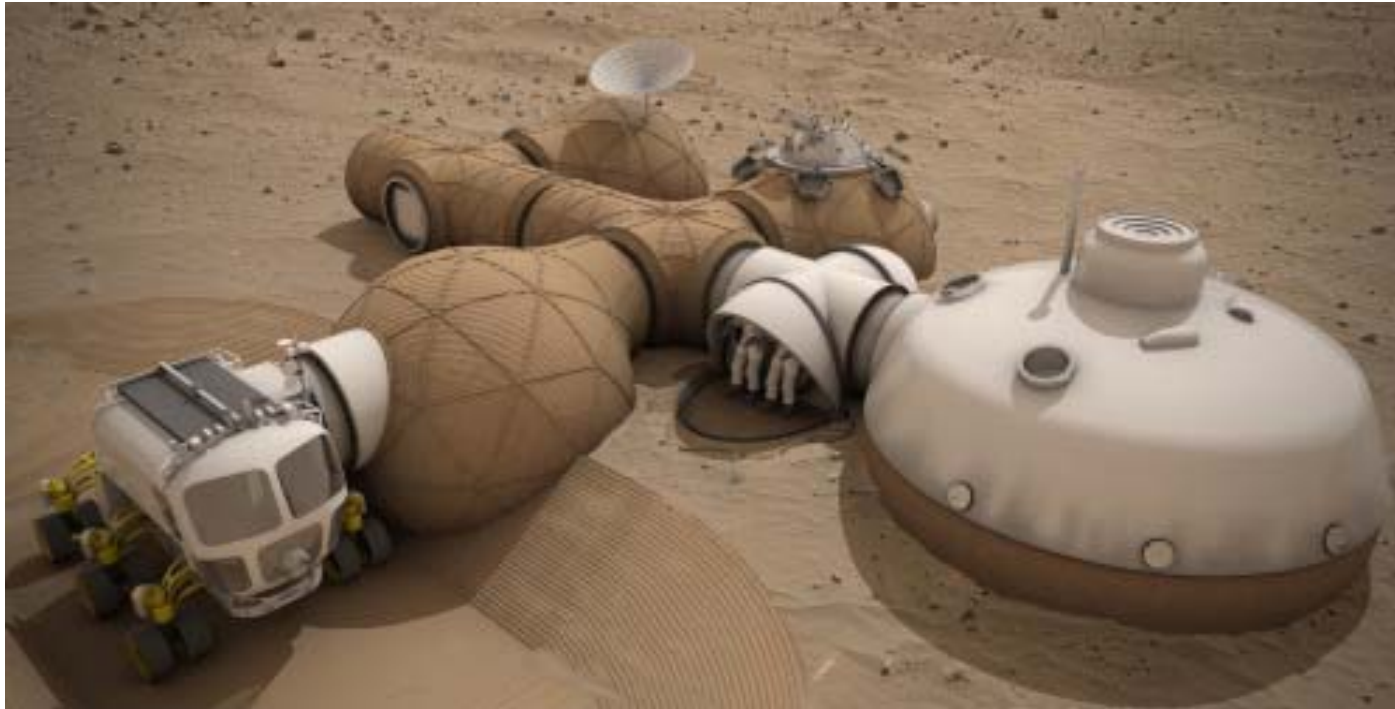
The International Standard Payload Rack (ISPR) section will contain two rack systems for plant production (similar to the rack-type used on the ISS) and the

Medusa



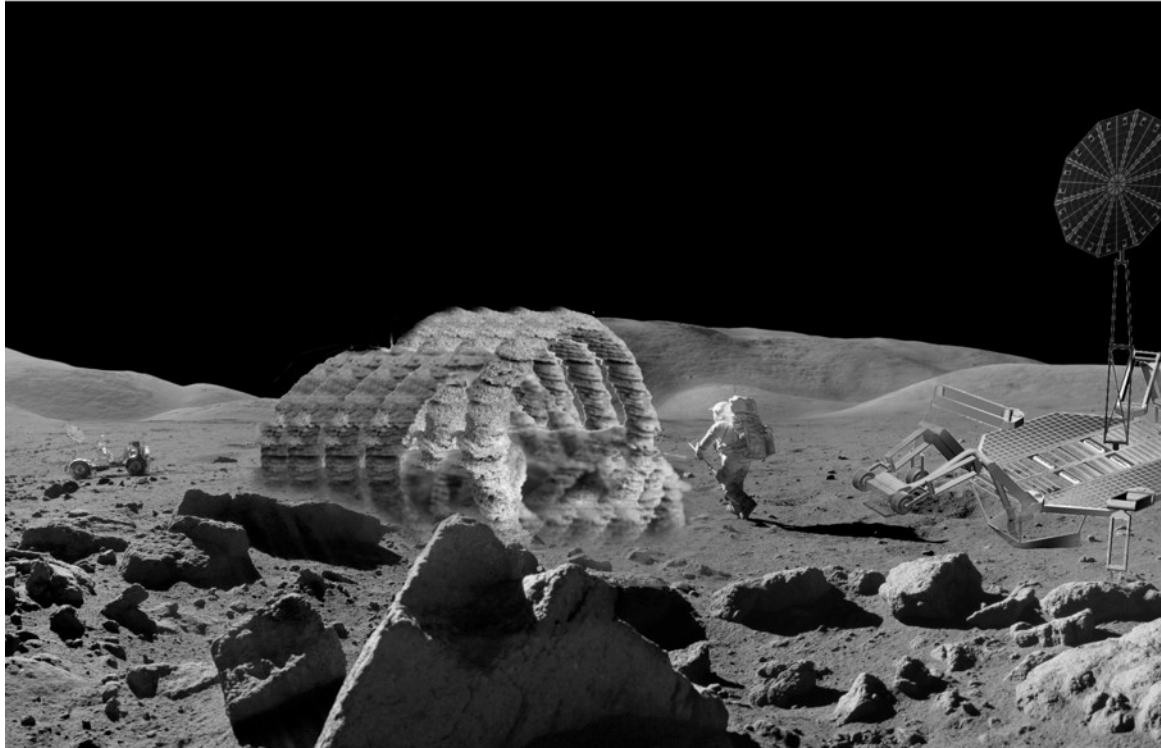
- Inflatable, underwater, analogue habitat concept for Moon and Mars missions
- Consortium: COMEX, LSG, Delft University of Technology
- Funding: internal
- Duration: 2012 – present

LavaHive



- Habitat concept for Mars missions
- Inflatable + additive manufacturing of regolith + reuse of entry module backshield
- Designed for NASA's Centennial Challenge Program for 3D printed habitats
- Awarded 3rd prize at New York's Maker Faire, September 2015
- Consortium: EAC and LSG
- Funding: ESA

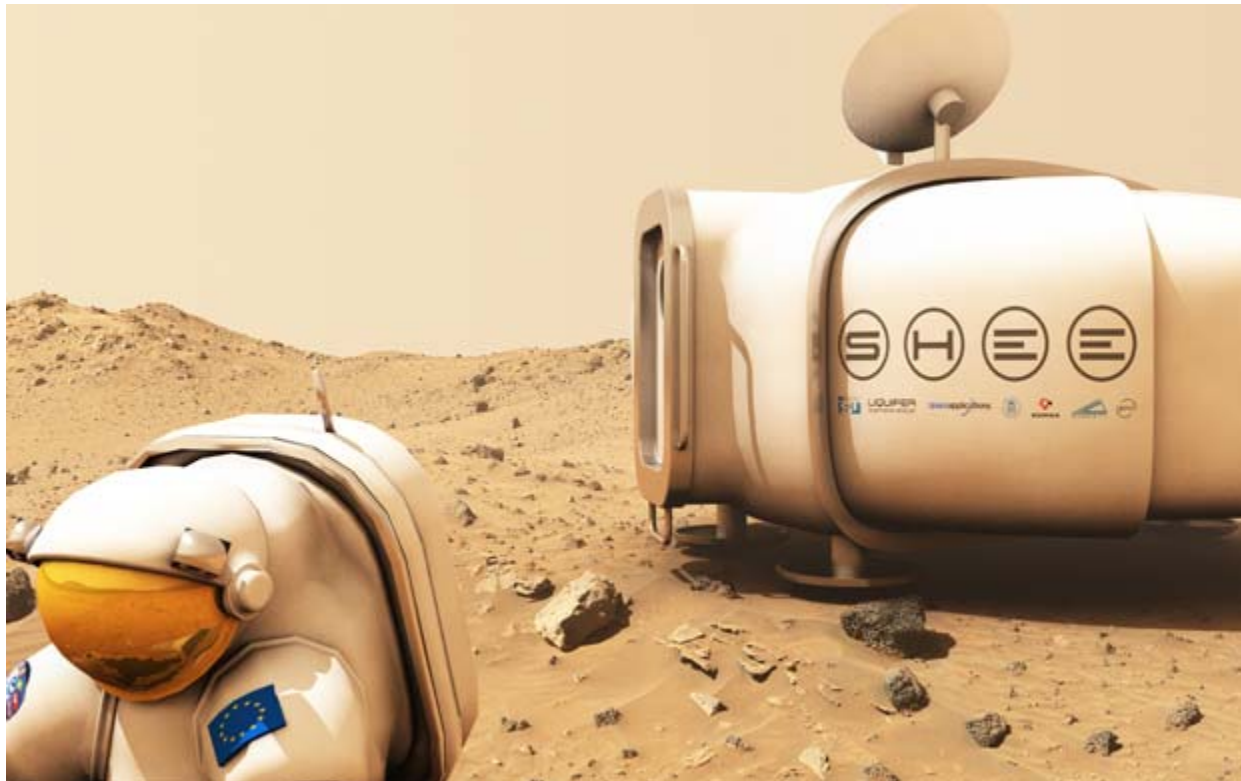
RegoLight



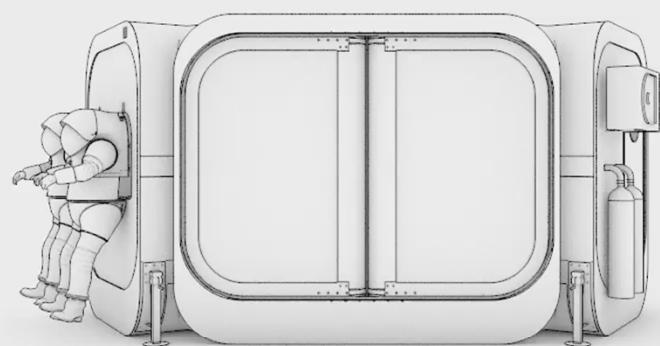
- Concept for lunar surface habitat
- Additive manufacturing of regolith by sintering of simulants with solar light in a vacuum chamber
- Consortium: DLR, SAS, LSG, COMEX, Bollinger Grohmann Schneider
- Funding: EU H2020
- Duration: November 2015 – October 2017

SHEE

Self-deployable Habitat for Extreme Environments



- Planetary habitat testbed for terrestrial analogue simulations
- Adaptable accommodation for a crew of two with workspace, private crew quarters, hygiene facility, galley, crew mess area.
- Consortium: ISU, LSG, SAS, COMEX, Inst. of Tech / U of Tartu, Sobriety, Space Innovations
- Funding: EU FP7
- Duration: 2013–present



EDEN ISS



- The Future Exploration Greenhouse consists of a highly adaptable multi-shelf plant growth system, capable of maintaining a number of different environmental settings.
- Key controlled environment agriculture technologies include:
 - nutrient delivery system
 - high performance LED lighting system
 - a bio-detection and decontamination system
 - food quality and safety procedures and technologies

A Possible Next Step (one of several)



- SHEE is now available for further technology demonstrations
- The work spaces in SHEE could be adapted to accommodate scaled-down
- Versions of EDEN ISS plant growth systems
- The provision of fresh food in an exploration habitat analogue would enhance the fidelity of simulated missions



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