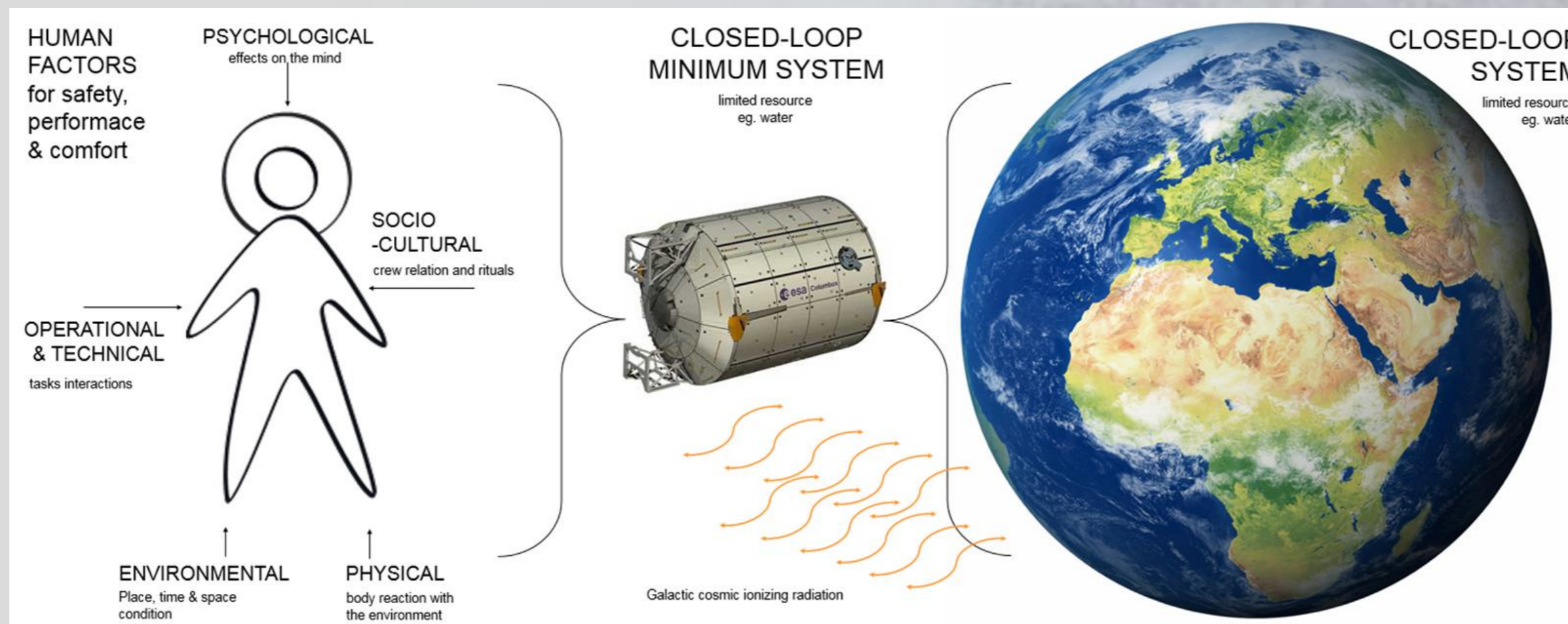


Human factors design for the optimization of a Moon station: Sustainability, affordability & performance.

Irene Lia Schlacht, Design Department, Politecnico di Milano, irene.schlacht@mail.polimi.it
Bernard Foing ESA-ESTEC & ILEWG (International Lunar Exploration Working group), bernard.foing@esa.int
Manjula Singh, Dalhousie University School of Architecture, manjula.singh@dal.ca
Giulio Ceppi, Design Department, Politecnico di Milano & Total Tool, giulio.ceppi@polimi.it
Aidan Cowley, European Astronaut Center, Aidan.Cowley@esa.int

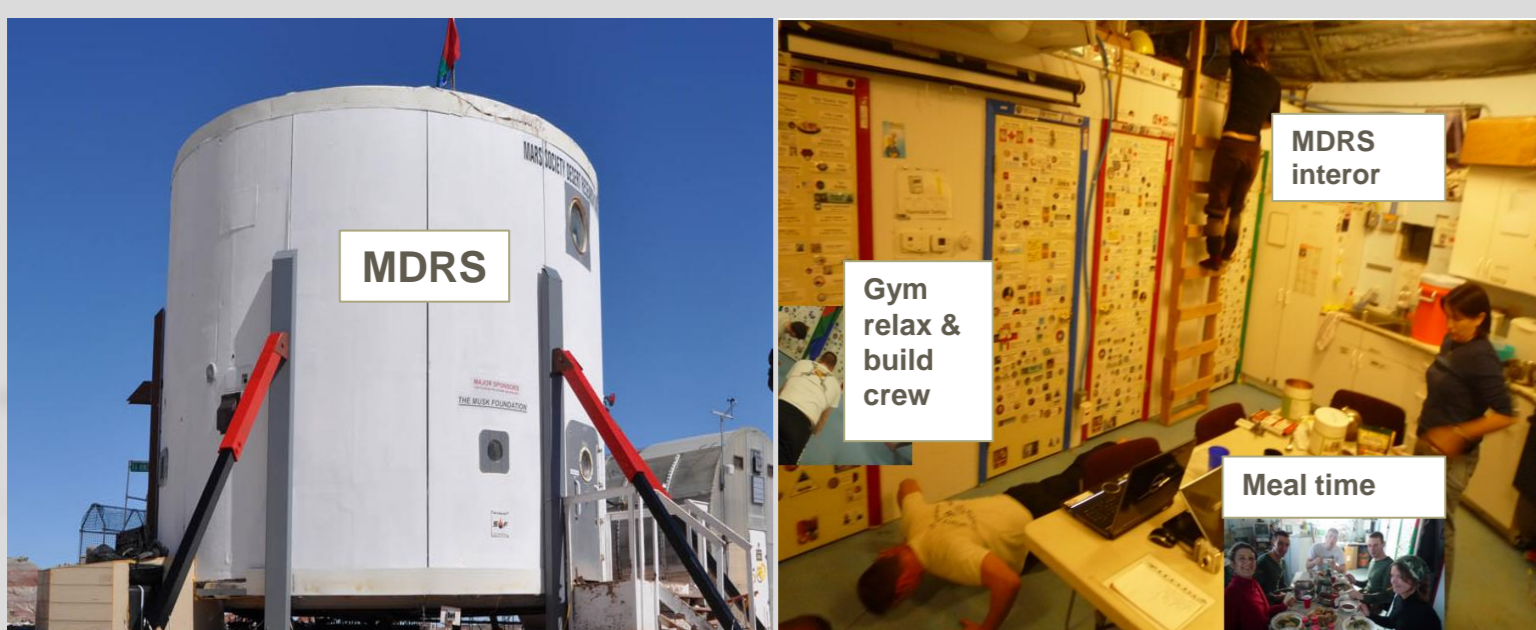
In cooperation between ILEWG, ESTEC, Politecnico di Milano, Karlsruhe Institute of Technology, DLR Envihab, EAC and other partners, we are working on the design and development of a modular Moon station that can be built with minimum cost, time, and space to support system performance and comfort. Different projects were developed, each for a specific tasks:



1. Performance & safety optimization

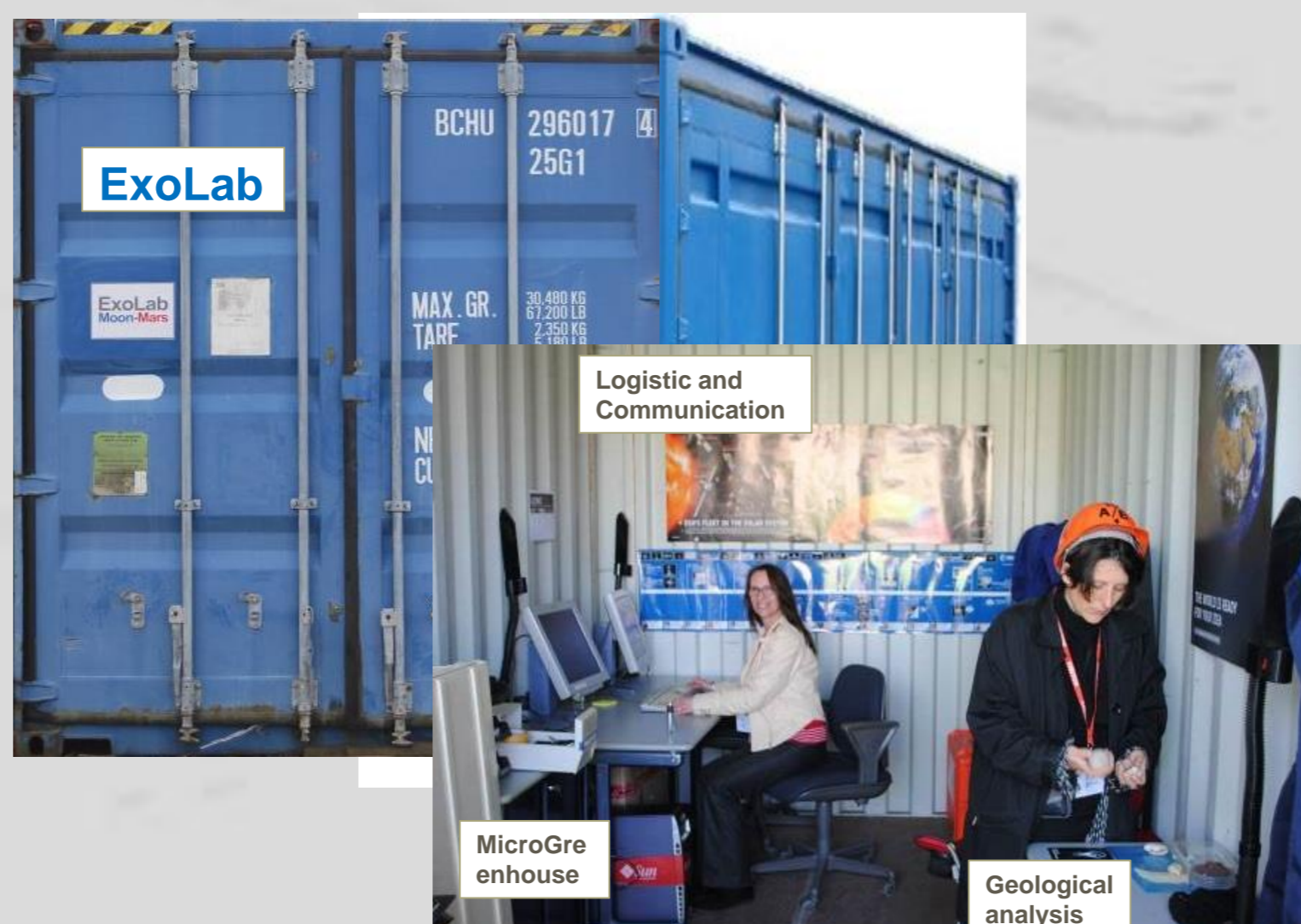
The "Habitability debriefing" during ILEWG EuroMoonMars MDRS mission simulation (since 2010: Refs.1, 2): the crew members collectively analyzed problems and solutions to improve performance. **Results:** Collective debriefing bring innovations; Not only operational problem need to be addressed but also psychological, physical, environmental, and socio-cultural; The most relevant factors are: *Communication & need of dedicate equipment.*

Refs: 1) www.extreme-design.eu/doc/IAC-12-B3-2-8.pdf;
 2) <http://www.extreme-design.eu/doc/IAC-12-D4-4-2.pdf>



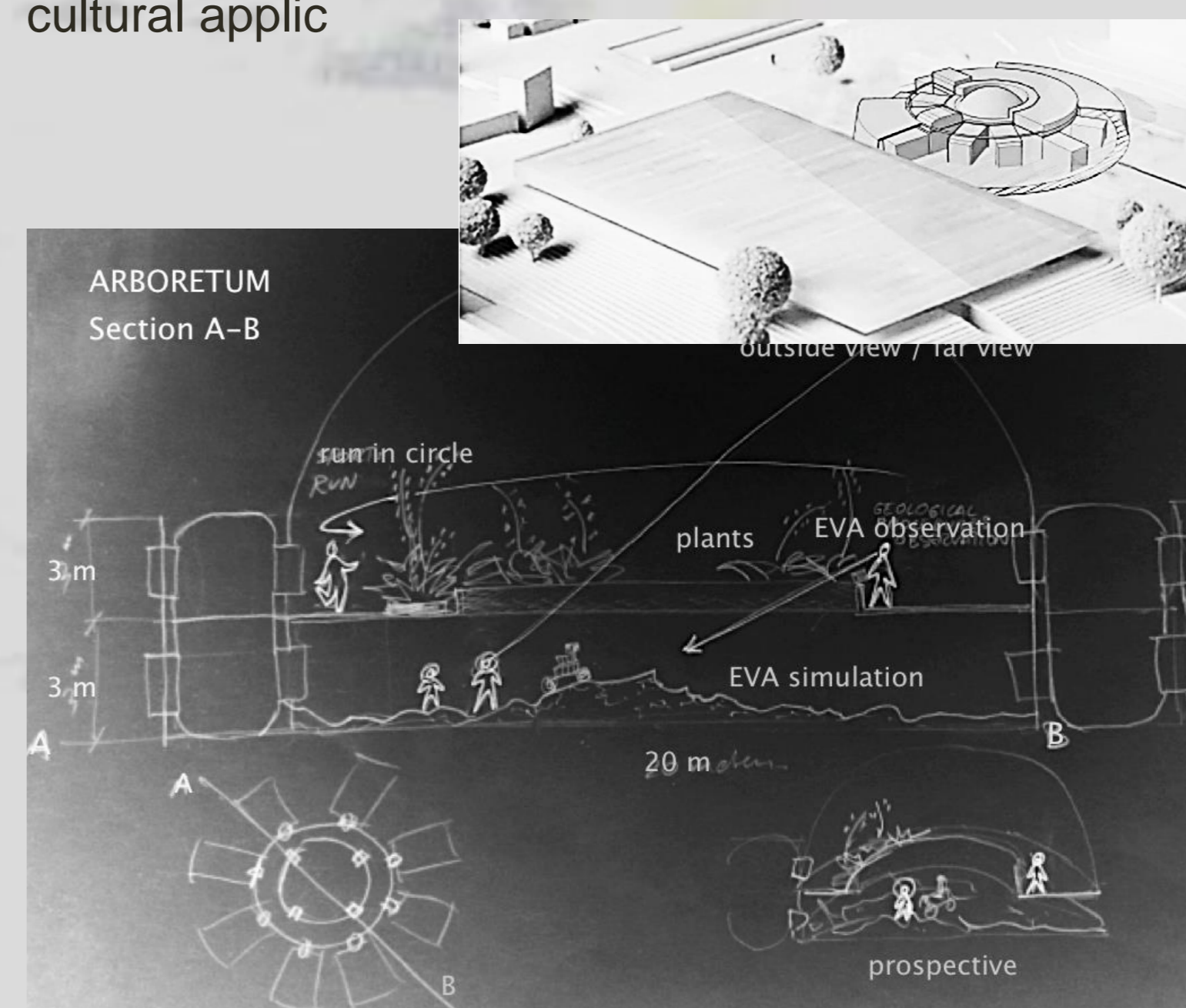
3. Sustainability & evolutive scenario

Technical Sustainability: "closed-loop system" (e.g., recycling of goods and in-situ energy production). Experiential Sustainability: qualitative user experience (e.g., through support of direct & local production and consumption of goods). **Results:** Spin-in and Spin-off possibilities Sensibilization on space mission relevance and applications



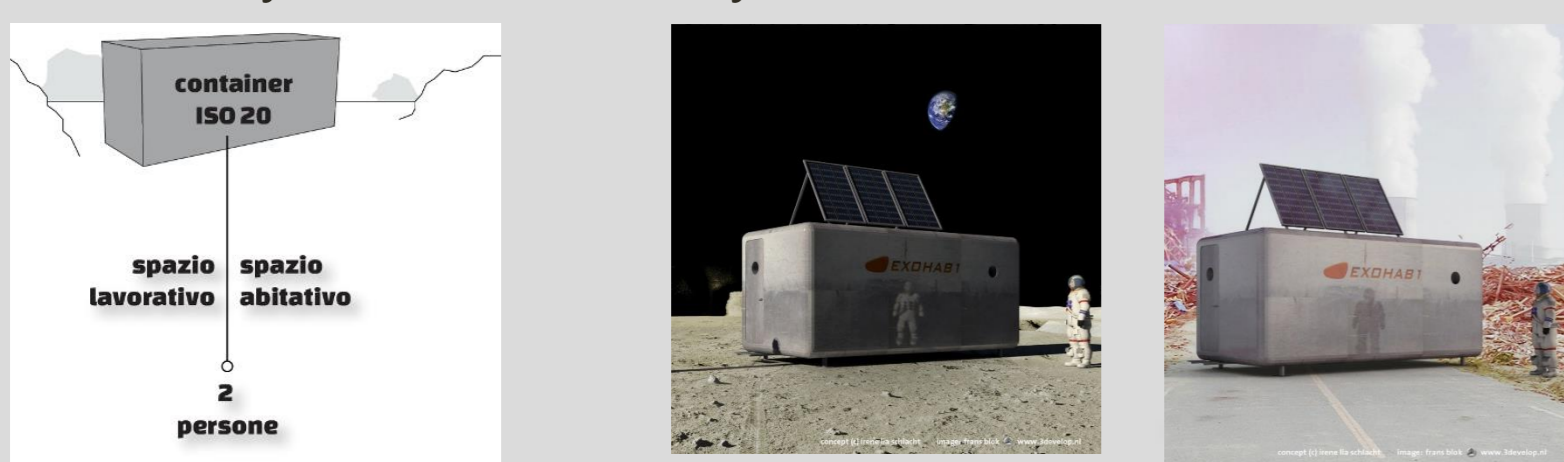
5. Dedicated simulation

ExoHab and ExoLab were configured at ESTEC with basic instruments to operate as technical Moon habitat/laboratory mock-ups. **Results:** Mission simulations were performed supporting technical and cultural applic



2. Extended application

Moon station should supports spin-in and spin-off with: Technical innovations (e.g., for emergency such as Fukushima); Socio-cultural applications (e.g., artistic expression). **Results:** Increased mission feasibility and affordability.



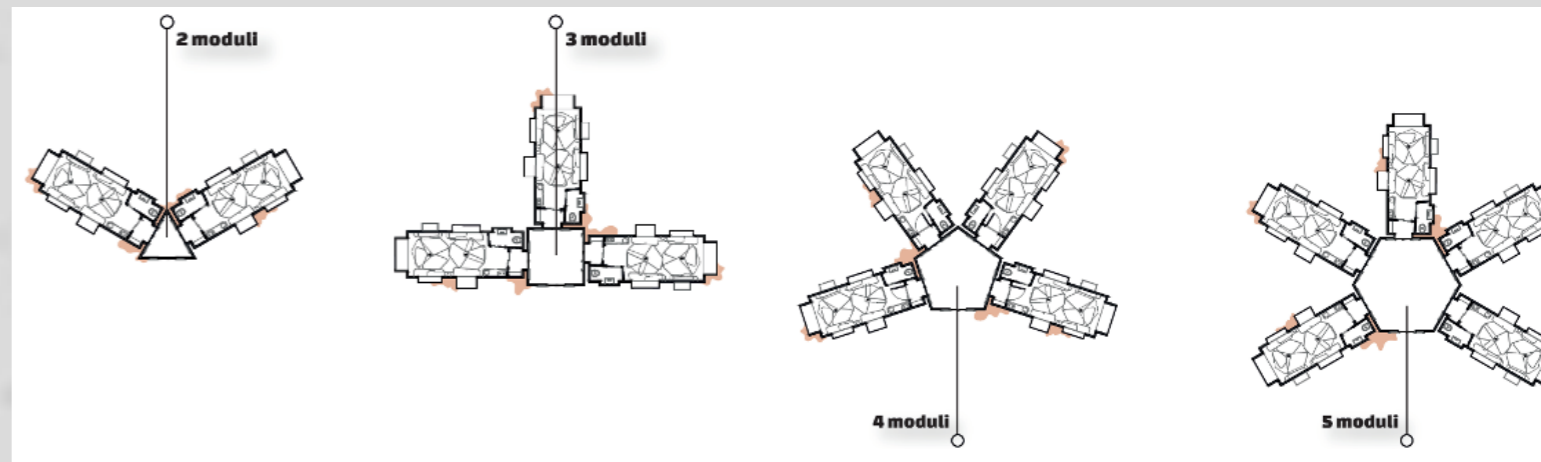
4. Minimum cost, time, and space

Design requirements: 2-3 crew members; ISO container / Columbus module as dimension limitation. **Results:** Various design proposals based on flexibility and multi-functionality of the interior structures.



6. Moon village

In cooperation with DLR and EAC, we are now working on proposal for a Moon Village and on human factors related research such as Moon walking pattern and movement interaction in Moon gravity.



During the conference, we look for feedback and explore possibilities for further cooperation . You are welcome to contact us: irene.schlacht@mail.polimi.com or bernard.foing@esa.int