

Moon 2020 - 2030

A New Era of Coordinated Human and Robotic Exploration

ESTEC, Noordwijk, The Netherlands, 15-16 December 2015



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

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In cooperation between ILEWG, ESTEC, Politecnico di Milano 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 have been developed, each for a specific phase:

1. **Performance optimization.** During selected mission simulations on the Mars Desert Research Station (2010-2014), the crew analyzed problems and solutions to improve overall system performance. Operational, psychological, physical, environmental, and socio-cultural dimensions were considered using a holistic approach. The results were developed into key guidelines that improve system performance and enable mission success (e.g., relevance of communication and dedicated equipment).
2. **Extension of context of application.** To increase feasibility and affordability, the Moon station supports spin-in and spin-off of both technical innovations (e.g., for emergency and disaster scenarios such as Fukushima) and cultural application (e.g., artistic expression).
3. **Sustainability as design approach.** Sustainability was investigated from two perspectives: one related to achieving a “closed-loop system” (e.g., recycling of goods and in-situ energy production), the other related to the “Slow Design” approach, which uses sustainability as related to user experience to increase the quality of life (e.g., by supporting direct production and consumption of goods as a form of qualitative user experience).
4. **Design of a minimum station for Moon and Earth.** The research results achieved in the previous tasks were applied to the design of an innovative station with minimum cost, time, and space. The design requirements were: two crew members as users and an ISO container as dimension

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limitation. The various design proposals developed were based on flexibility and multifunctionality of the interior structures.

5. *Equipping a Moon station & performing dedicated simulation.* ExoHab and ExoLab were configured with basic instruments to operate as technical mock-ups in order to test the results of the previous tasks in a dedicated facility. Different mission simulations were performed to support both technical and cultural applications.

6. *Definition of a follow-up facility for studying human factors in a Moon village.*

In cooperation with DLR (German Aerospace Agency) and EAC (European Astronaut Centre), we are now working on the further development of a new facility to be used for simulation of Moon Village elements using the human factors research results from the previous study phases.

During the conference, the main results will be presented in order to obtain feedback and explore possibilities for further cooperation.

Keywords: Moon base, design, human factors, architecture, holistic approach, slow design, sustainability