IAC-15.A3.IP.43

MOON HABITAT MODULE: NEW WAYS OF LIVING IN EXTREME SPACES

Author: Ms. Elisa Cenini
Politecnico di Milano, Italy, elisa.cenini@mail.polimi.it

Ms. Elisa Desole
Politecnico di Milano, Italy, elisa.desole@mail.polimi.it

Prof. Massimo Facchinetti
Prototipi, Italy, massimo.facchinetti@prototipi.org

Dr. Irene Lia Schlacht
Politecnico di Milano, Italy, irene.schlacht@mail.polimi.it

Prof. Bernard Foing
ESA/ESTEC, The Netherlands, Bernard.Foing@esa.int

Mr. Matteo Artusi
Politecnico di Milano, Italy, info@martusiarchitecture.com

Prof. Giulio Ceppi
Politecnico di Milano, Italy, giulio.ceppi@polimi.it

ABSTRACT

Will humans be able to keep their habits even in extreme conditions such as on the Moon? Or will their habits change to adjust to new spaces?

In order to answer these questions, we decided to analyze the primary needs of humans to design to new living spaces. In extreme contexts or confined spaces, it is very hard to preserve one's emotional and psychological balance. Therefore, man becomes an actor within the space, adjusting to make it his own and changing his habits.

This is why we chose to use the philosophy of User Centered Design for our design: humans are the source of our inspiration. We aim to design a living space employing a standard container that can be used as a research station for working and living on both the Moon and Mars, or in emergency contexts on Earth. This project is divided into three equally important parts: analysis, meta-design, and technical design. We started by researching confined spaces under extreme conditions, such as military shelters, submarines, emergency housing after natural or chemical disasters, etc. Moreover, we studied space perception, proxemics, and human needs. Second, we analyzed the given space we have to design and the people who will be living there, including their work activities and hobbies. The third phase consisted of the actual designing of the space.

Our goal is to create a familiar but innovative, functional, and emotional environment to guarantee effective standards both for living and working. The design took into account every relevant piece of information found in our research. The space is multifunctional and convertible; the different areas (working station, kitchen, and lounge area) are mostly open and common, but guarantee privacy when convenient. Shapes, colors, materials, scents, and sounds are an essential part of the project.

Fig. 1 Configuration with more modules to simulate Moon Village and extreme environment settlements

In summary, this paper focuses on the design of a minimum habitat on the Moon characterized by: applicability of the design to extreme contexts on Earth (e.g., disasters); study of existing habits and human interaction in extreme contexts; proposal of a new way of living; User Centered Design; familiar spaces; sensorial interaction through materials, shapes and colors, flexible and organized spaces; and zoning.

Fig. 2: Interior front

Fig. 3: Interior back

Fig. 4 Top section of the Habitat

PAPER

When designing extreme environments, there is a strong need to take into consideration different disciplines and factors. Taking care of the structural and architectonic part is not enough. Psychological factors need to coexist with technological ones.

The E-Hab project was conceived as a housing solution that is able to meet these different factors in a subversive and efficient way. The innovative idea does not concern any construction technology but rather the out-of-the-ordinary interaction between humans and space, and humans and instruments inside the E-Hab. Proxemics, time schedule, needs, and habits in extreme environments are some of the many factors being researched. Humans are the center of this project, not only in the meta-design phase, where their needs and habits were studied, but also in the design phase. The space was conceived such that the users are able to choose how to use it by modifying and living in it according to their needs and liking.

	Permanenti	Temporanei	Per necessità	Per scelta
luogo di studio - ufficio		•	•	
ospedale - camera iperbarica	•		•	
prigione	•		•	
aereo - mongolfiera - dirigibile		•		•
camper - casa mobile		•		•
base militare	•		•	
metropolitana		•	•	
yatch - casa sull'acqua		•		•
stazione spaziale	•		•	
centrale nucleare	•		•	
sottomarino	•		•	
piattaforma petrolifera	•		•	
base di ricerca	•		•	
miniera	•		•	
monastero		•		•
casa sull'albero		•		•

Fig. 5: Table of confined and extreme environments

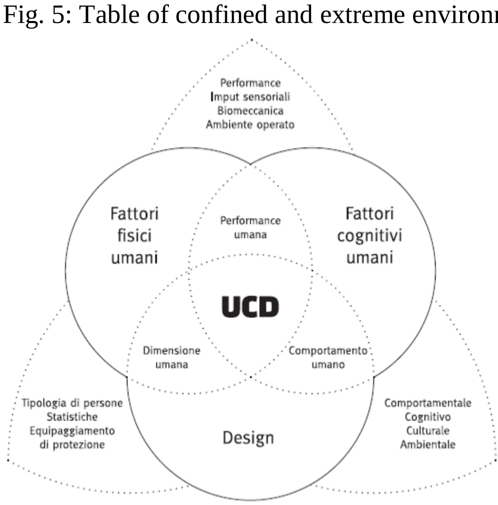

Fig. 6: User Centered Design Concept

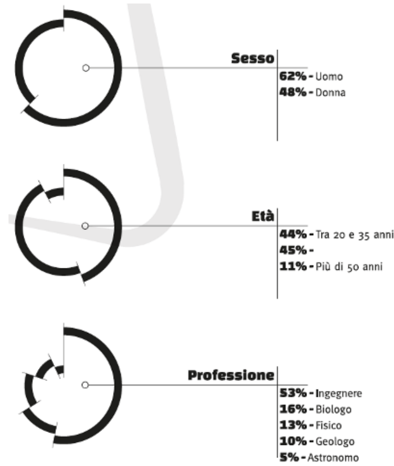

Fig. 7: Research on the user

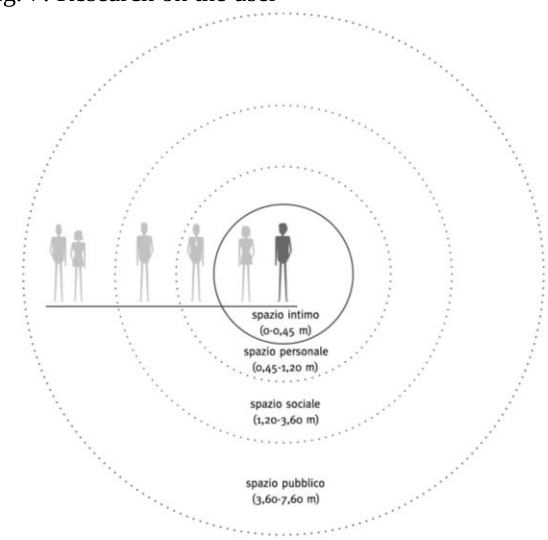

Fig. 8: Proxemics research

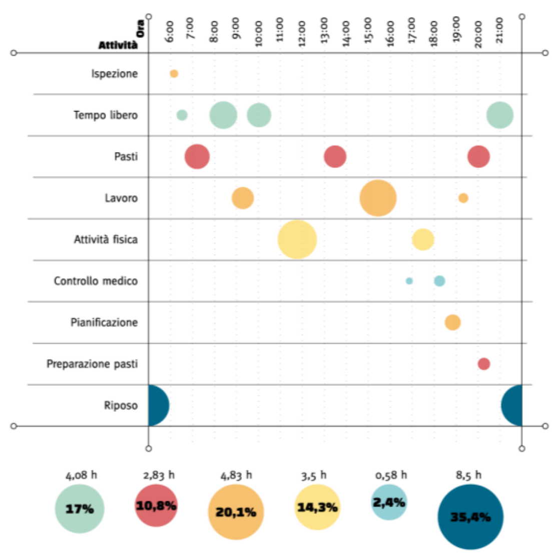

Fig. 9: Research on activities-time-space relations

This project started with the analysis of the reference environment, such as extreme contexts and confined spaces, especially taking into consideration research stations. We used the mission on the Mars Desert Research Station as an example to get information about users, research activities, and the disposition of the space they were living in in order to develop an idea that is focused on three key concepts: volume, flexibility, and osmosis.

The project is based on particular restrictions in order to be applicable in extreme environments. These restriction were to organize a living space for two scientists inside an ISO 20 container – about 15 square meters in size.

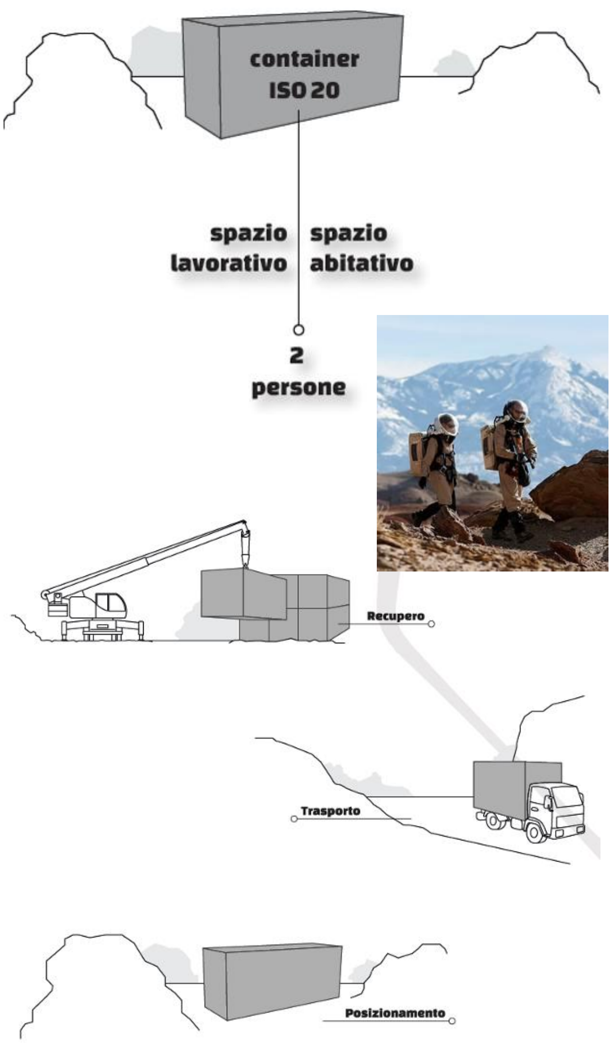

Fig. 10: Restrictions: ISO container equipped for two crewmembers easily deployable in extreme environments.

The initial idea was to consider the entire volume of the container instead of the superficial entity as we are always used to doing. This is why we divided the space into numerous levels to exploit heights.

Since the E-Hab's dimensions are very limited, it was important to create a flexible space that could continuously change, so that the pent-up users would feel like they were living in different places.

The E-Hab uses three different systems: rotating platforms placed at various heights, a ceiling rings trestle, and flippable shelves.

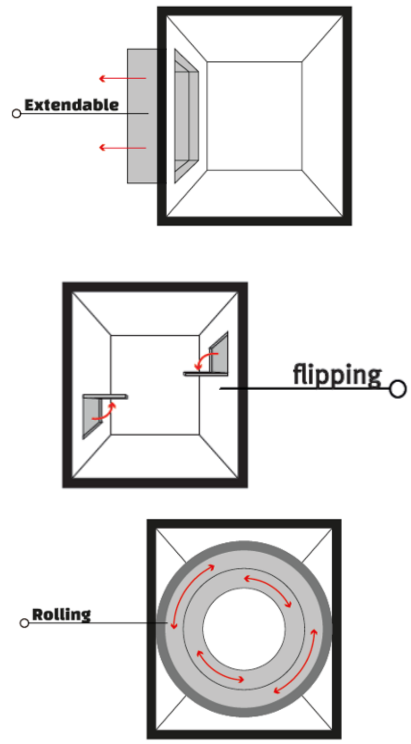

Fig. 11: Systems used

The 10 rotating platforms are divided and placed into two circular supports. The height distance from one to another is 30 centimeters, which is the chair-table distance. The rotating platform were designed to create different combinations with platforms of the same support, platforms on the other support, or with the flipping shelves.

These four shelves are placed exactly under expandable bow-windows to elongate the space even more and obtain more surface. When not in use, they can be flipped back into the walls.

The trestle is attached to the ceiling; it consists of several rings that can be used for gymnastic purposes or as support for external elements such as hammocks or other hanging elements.

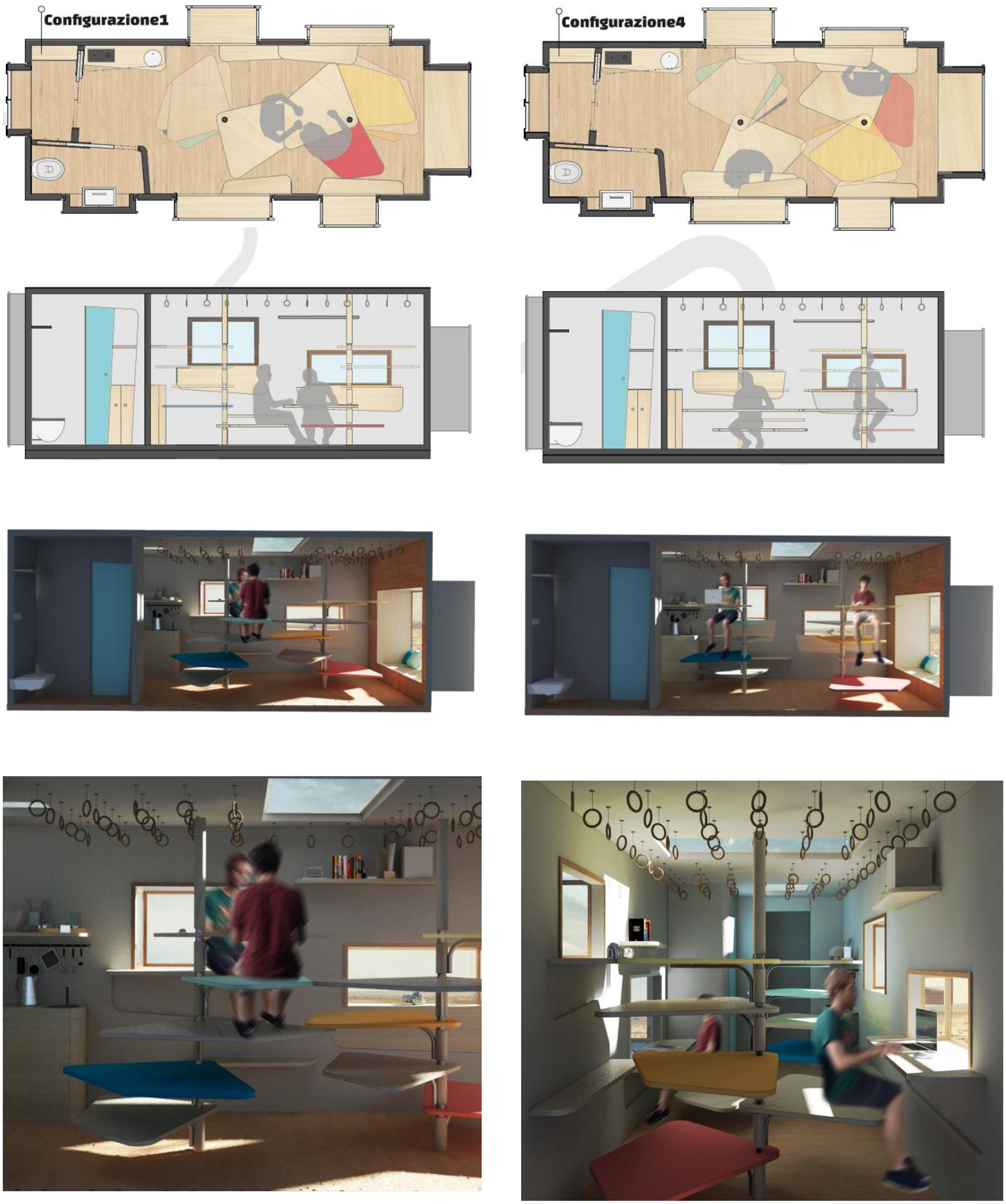

Fig. 12: Configurations for working together and separately

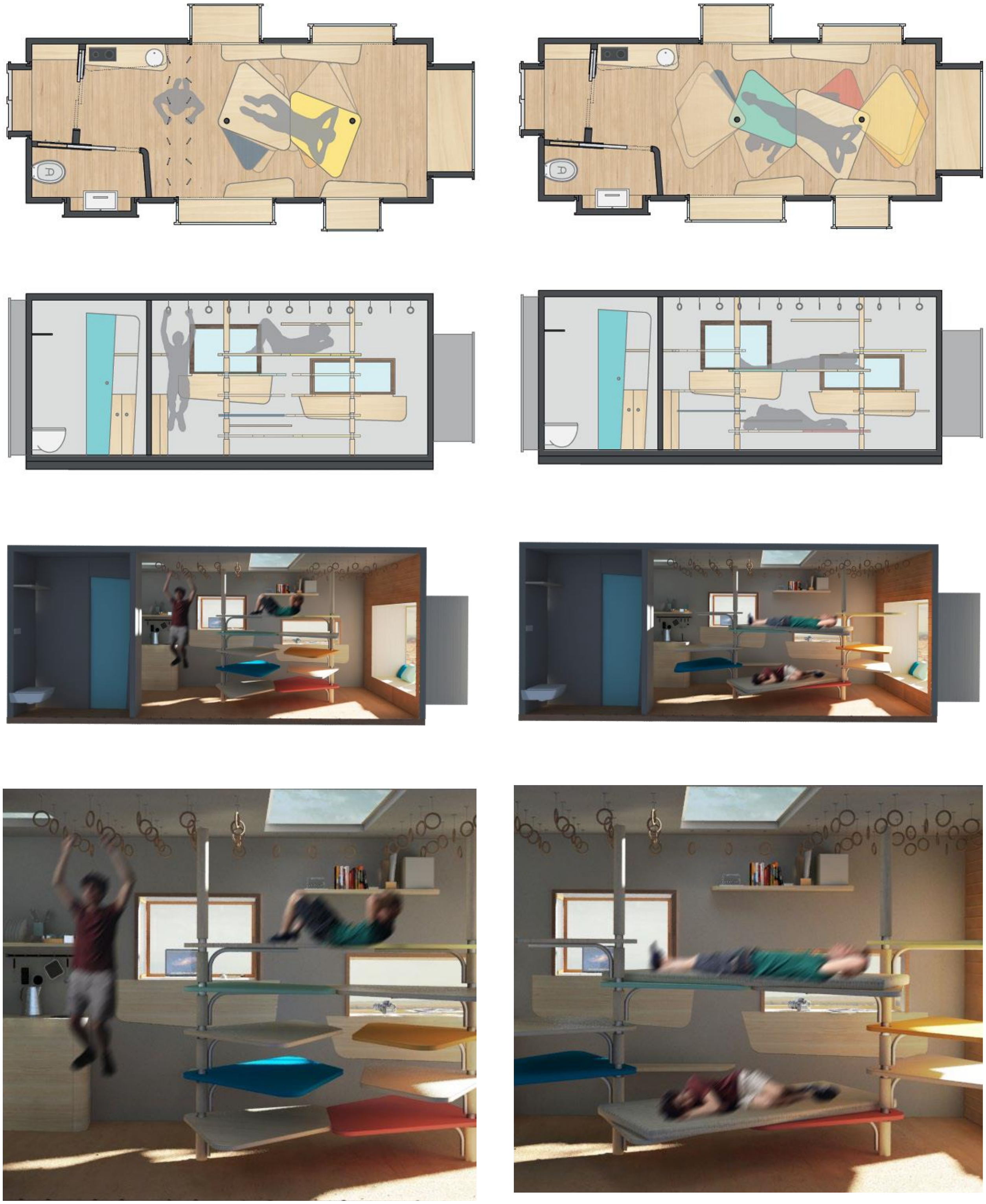

Fig. 13: Configurations for gymnastics and sleeping

Fig. 14: Configurations for eating and relaxing

Last but definitely not least, we wanted to create an interrupted field of view between the exterior and interior environments.

The osmosis between these two environments is created through five windows that can be expanded externally – to get more space and to receive as much sunlight as possible.

These windows are equipped with smart glass and OLED technologies to counteract the fact that the users cannot leave the hab. In fact, these technologies allow users to recreate different places and atmospheres instead of experiencing what could be an unpleasant reality.

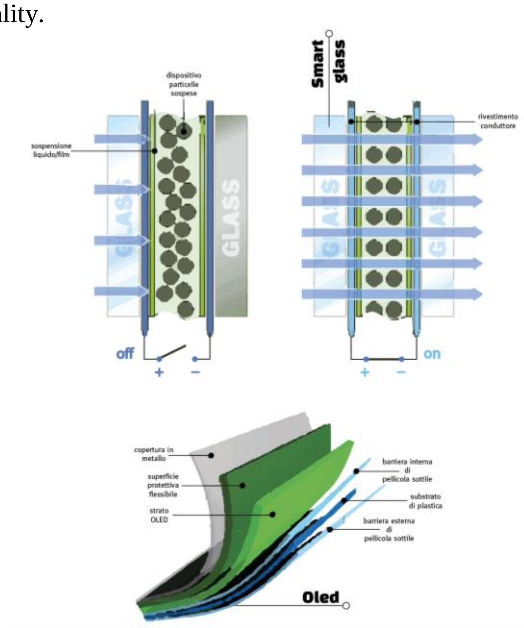

Fig. 15: OLED technologies

Fig. 16: Windows with smart glass and OLED technologies

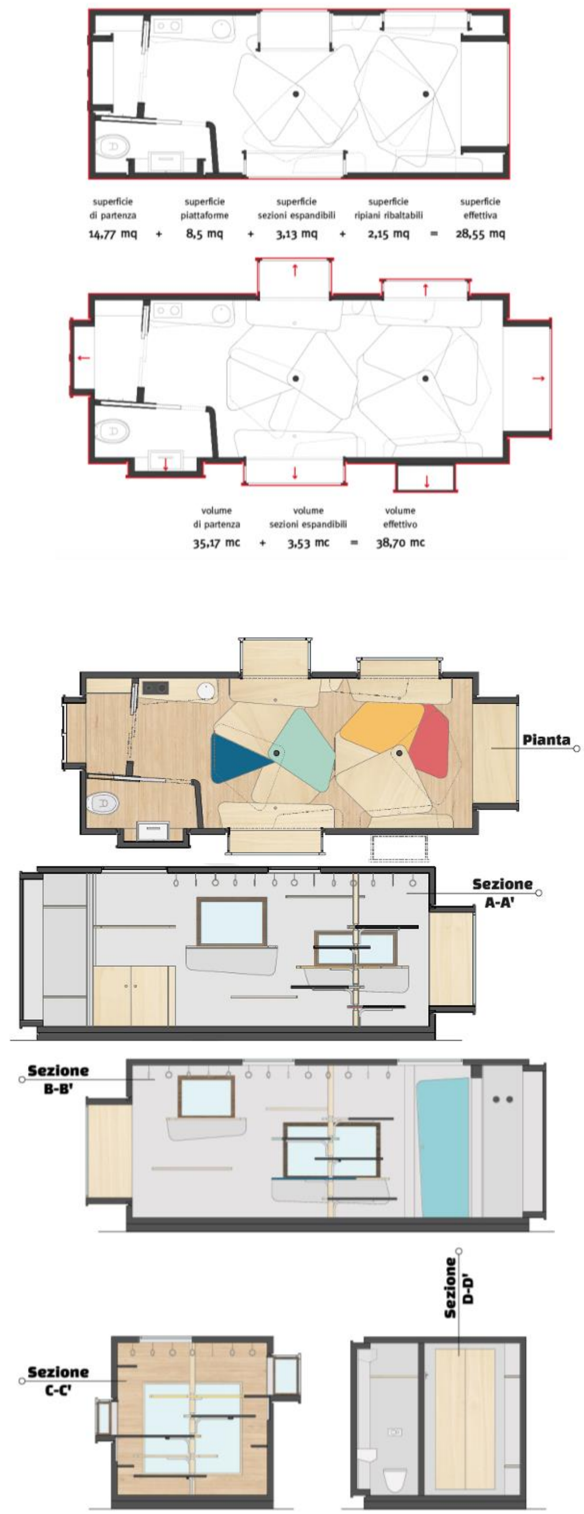

Fig. 17: Space arrangements

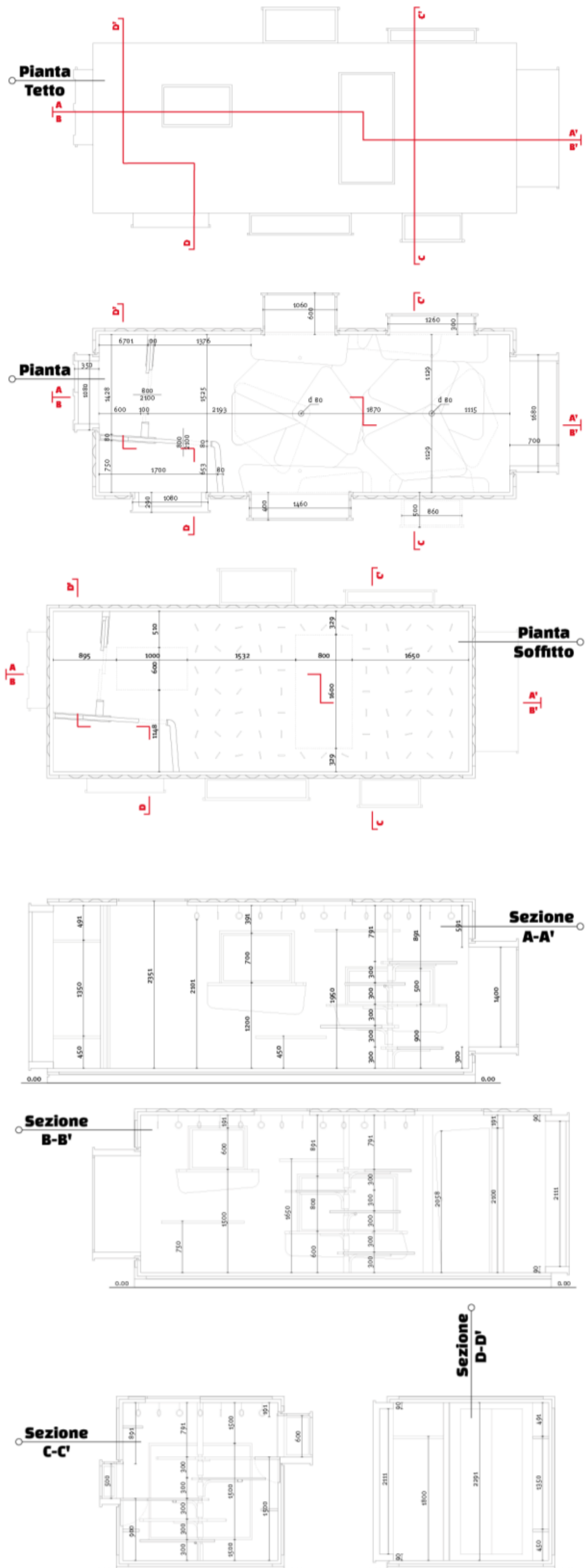

Fig. 18: Technical drawings

The space is arranged following the logic of placing the entrance on the short side of the container, where we also put the airlock as a filter to protect the interior.

Inside the hab on the right, there is a small bathroom and on the left side is a kitchen area that opens up to the remaining space where all of the technologies are located. That space is where the majority of daily activities happen.

The hab can be combined and connected with other habs to create a "Moon Village".

This is how the E-Hab meets the requirements and demonstrates how to create a flexible, volumetric, and osmotic living and working environment.

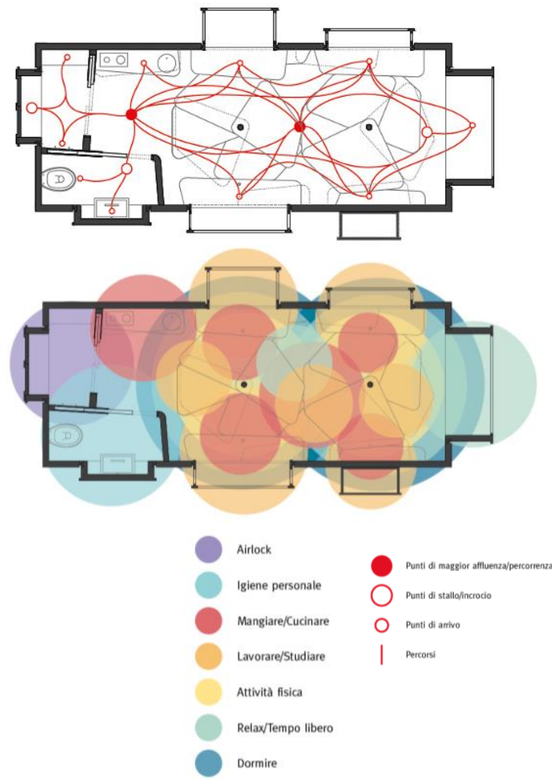

Fig. 19: Zoning and movement paths

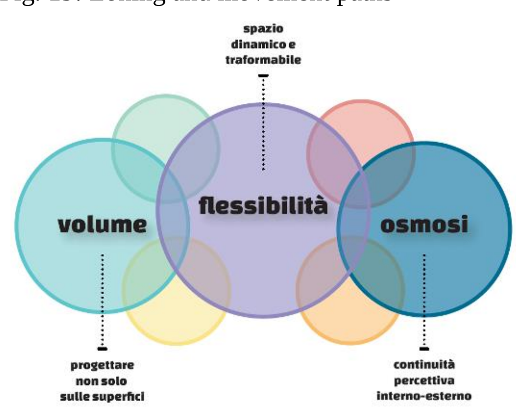

Fig. 20: Flexible, volumetric, and osmotic living concept

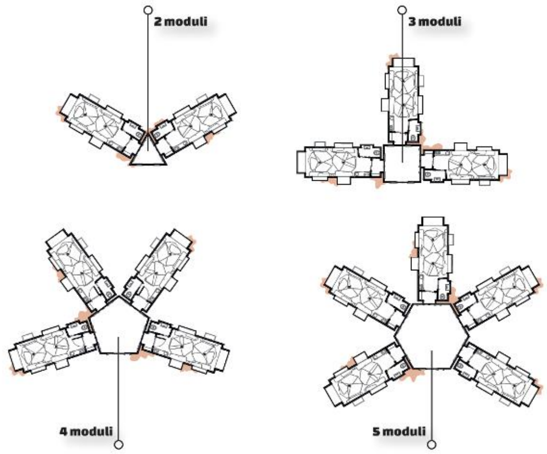

Fig. 21: Moon Village configuration

REFERENCE

P. Bertola, E. Manzini, Design multiverso. Appunti di fenomenologia del design, Edizioni Polidesign, 2004.

M. Bertoldini, A. Campioli, B. Ferrari, G. Grandi, E. Guastaroba, M. Lavagna, A. Zanelli, Progettare oltre l'emergenza. Spazi e tecniche per l'abitare temporaneo, 2009.

S. Maffei, User Centered Design e Participatory Design, Corso di Metodi&tecniche per il Progetto

Maurizio Boscarol, Cos'è lo User-Centered Design (UCD), n.p., Maggio 2007. Web.

Costa, M., Ricci Bitti, P.E. Fra me e te. Messaggi dallo spazio personale. Psicologia contemporanea, 2003. 35-44.

G. Sgalippa, Quando il prodotto diventa luogo. I microambienti come scenari del design e contesti dell'innovazione tecnologica, 2002.

Messerschmid, E., Bertrang, R. (1999). Space Stations: Systems and Utilization. Springer

Haeuplik-Meusburger, S. (2011). Architecture for Astronauts: An Activity-Based Approach, Springer.

Perriccioli, M. (a cura di), Abitare Costruire Tempo, Libreria CLUP Milano 2004

Schlacht I.L. (2012). SPACE HABITABILITY: Integrating Human Factors into the Design Process to Enhance Habitability in Long Duration Mission. Doctoral Dissertation, Technische Universität Berlin, Germany.

RELATED PUBLICATIONS

Foing, B. et al (2010), ILEWG ExoGeoLab & ExoHab Team: ExoHab Pilot Project & Field Tests for Moon-Mars Human Laboratories , http://adsabs.harvard.edu/abs/2010EGUGA..1213688

Foing, B. H., et al (2011), Field astrobiology research in Moon-Mars analogue environments: instruments and methods, 2011, Int J Astrobiology.10141

Haeuplik, S. (2005) Moonwalker Lunarbase One. International Astronautical Congress. IAC-05-D3.2.05.

Schlacht, I.L, Foing, B (2014). Lesson learned from space hab for disaster management lab: spin-in/out of technology and knowledge for disaster management facility. International Astronautical Congress. IAC-14.E5.P.2. (http://www.iafastro.net/download/congress/IAC-14/DVD/full/IAC-14/E5/P/manuscripts/IAC-14,E5,P,2,x26469.pdf).

Schlacht, I.L., et al. (2014). Practical design examples for human habitats in space, off-grid, and in low-impact communities. International Astronautical Congress. IAC-14.E5.2.1 (http://www.iafastro.net/download/congress/IAC-14/DVD/full/IAC-14/E5/2/manuscripts/IAC-14,E5,2,1,x26609.pdf)

WEBSITES

http://mdrs.marssociety.org
http://www.iafastro.org
http://www.dezeen.com
http://theownerbuildernetwork.co/house-hunting/tiny-homes/demarkies-mobile-home-bohtlingk-architectuur/
http://www.archdaily.com/7638/final-wooden-house-sou-fujimoto
http://www.lot-ek.com/MDU-Mobile-Dwelling-Unit
http://www.microcompacthome.com/company/?con=ts
http://www.archdaily.com/60921/roll-it-experimental-housinguniversity-of-karlsruhe/
http://www.detail.de/inspiration/transportablerwohncontainer-106582.html
http://www.designboom.com/architecture/gary-chang-onurbanism-
and-his-metamorphic-apartment/
http://www.esa.int/ESA
http://www.cleaf.it
http://www.ncscolour.com/en/design-architecture/work-digitallywith-ncs/ncs-navigator/
http://www.risorseumanehr.com/blog-hr/la-piramide-dei-bisognidi-maslow
http://www.oldhouseweb.com/how-to-advice/windows/smartwindows-high-tech-residential.shtml
http://www.extreme-design.eu/publications.html

REFERENCE OF THIS PAPER

Cenini, E., Desole, E., Facchinetti, M., Schlacht, I.L., Foing, B., Artusi, M., Ceppi, G. (2015). Moon habitat module: New ways of living in extreme spaces. IAC-15.A3.IP.43. 66th International Astronautical Congress 2015 (ISSN 1995-6258 Magazine E214844.

Contact Persons:

Prof. Bernard Foing (Presenter at IAC)
Bernard.Foing@esa.int

Dr. Irene Lia Schlacht
irene.schlacht@mail.polimi.it