

Human Factors in Space Mission

Irene Lia Schlacht, Matthias Rötting, Melchiorre Masali, and Margherita Micheletti Cremasco

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Abstract

Living in Outer Space has a deep influence on human life. Isolation, extreme conditions and modified gravity affect the human psycho-physiologically. Astronauts have to uphold themselves on the interior design of a space habitat for their well-being and safety (Schlacht *et al.*, 2006). In weightlessness with a new dimensional cognition visual stimuli as the interior configuration are fundamental to achieve orientation because the vestibular system becomes silent (Mallowe, 2001).

In the context of a PhD study on “Habitability for Outer Space” at the TU-Berlin Human-Machine System Dept., colours, shapes and movements are the visual stimuli involved in a Human Factors investigation aimed to increase the habitability of space habitat.



Abb.1: Blue Moon Base with a square configuration. Stuttgart Universität SSDW 2009

Human Factors discipline

Human Factors is a human centred discipline aimed to optimize the interaction between a human being and a system. It is meant to design the best performance conditions to experience and increase knowledge. The concept of knowledge and experience is for the first time introduced in the Human Factors concept to exalt the need of quality in a human being life.

Human Factors apply in Outer Space

The life quality became a key factor in the context of Human Space Flight, in particular for Long Duration Mission (NASA, 2003). Applying the Human Factors concept to Architecture we are talking about the quality of habitability. In Outer Space Architecture the factors influencing the habitability are countless: First of all mission and motivation to succeed in it. Also we have to deal with crew and the social isolation from a psychological perspective. The variation of gravity has ergonomic implications on the approach within the interior design and also affects the human body physically. The living space is tiny, confined and isolated while the outer environment is the most extreme, characterized by radiation, meteorites and space dust. It creates a feeling of everyday life risks and may affect the circadian biorhythms. Feelings are also relevant as well as the habitat's atmosphere and emotions, immeasurable but important factors that interact with the overall system performances.

Holistic Human Factors

In the context of “Habitability for Outer Space” investigation both tangible and intangible Human Factors are considered to reach a holistic approach (from holos: entire, complete).

Feeling, intuition, instinct and emotion are part of spiritual and cultural experience, they are intangible factors that distinguish man from machine and are human being primary needs. As reported in the Space Architecture book a Holistic Human Factors approach need to be taken into account in the overall system design from the first stage of the project (Imhof, 2004).

During an Outer Space mission one of the astronauts from Mercury 7 NASA group made an unplanned manoeuvre using manual attitude control jets, which made the return almost impossible (Messerschmid, 2008). Why does a so highly trained and accurately selected flight pilot risk his life with an unplanned manoeuvre? The reason was to get pictures of the beautiful sunset. This clarifies that spiritual and cultural experience play a role as human’s needs to gain well-being, safety and mission success.

Human Factors project

The main goal of “Habitability for Outer Space” research is focused on the visual factor that interacts with the user in space habitat.

This kind of factor has been selected as the one that affects more the habitability and the Human Factors from an interior design perspective. The main points of the investigation are:

1. User and Needs Analysis
2. Visual perception in Outer Space
3. Holistic and multidisciplinary approach
4. Popularization of Human Centred Design requirement
5. Collection of Design solutions.

User and Needs Analysis

The User and Needs analysis has been achieved through astronauts and space industry employee interviews from 2005 (Schlacht et al., 2008). The results were astonishing. The needs of the astronauts have been misunderstood and not correctly considered or simply not taken into account other than for basic survival aspects. In particular space industry employee selected as primary need “spaciousness” when astronauts selected “privacy”. Also from personal meeting with the astronauts the storage system emerged as the biggest bag of the habitat, creating difficulties in finding instruments and pursuit activities.

Visual perception modification in Outer Space

In Outer Space the human body activates adaptation process and reaction caused by the difference of gravity which influences also the visual perception.

More than reduced gravity on moon, the completely no gravity condition affects many visual factor as visual sight and colour perceptions (Schlacht, Brambillasca and Birke; 2008). More than that, the tiny habitat can be cause of myopia. Also storage problems caused visual chaos and difficulties in orientation. Visual illusions are common (Kanas, 2003). Analysing the International Space Station (ISS) in a research from Schlacht, Rötting and Masali (2008) the inconsistency between the Russian and the English labels system are also considered as cause of visual problems.

Holistic and multidisciplinary approach

The Holistic approach means to take into account all the factors related to the human being life: the tangible factors like space engineering and the intangible factors as space art.

To reach this goal first of all the contribution of a multidisciplinary group of experts has been developed with the creation of Extreme-Design.eu team. The team consists of international specialists in the space field from different disciplines as: Anthropology, Architecture, Art, Design, Engineering, Ergonomics and Psychology (Schlacht & Masali, 2008).

Popularization of Human Centred Design requirements

The requirements for the interior visual configuration have been developed and proposed during conference workshops and projects (Schlacht, 2006). They follow mainly the three objectives Psycho-physiological well-being, Orientation and Activities support. The requirements are: Safety, Redundancy, Visibility, Flexibility, Variety, Customization and Naturalistic evocation. They have been supported with a Bio-mimicry philosophy, which concerns the use of local natural resource and the Earthly stimuli variations and Beauty (Ono, 2007).

Collection of design solution

During the Space Station Design Workshop 2009 (SSDW), 30 persons from all over the world were divided into two groups in competition (red and blue) and asked to design a Lunar Base. This workshop every year combines space experts and complete beginners to obtain the best ideas. Each group is composed by specialists in different disciplines to gain a multidisciplinary approach. The contribution on the moon base for Human Factors in 2009 were made by an Architect from Paris and a Human Factors student from Berlin and tutored by Irene Schlacht with the use of Human Centred Design requirements.

The final blue and red reports show a clear evidence on the use of a Human Factors Holistic approach that guided the creation of reliable innovative concepts and ideas (AA.VV., 2009).

Blue Moon Base

It is based on the long anthropological history of building habitats in a square ring configuration and using local material as regolith to protect the base from radiation. This configuration used by the old romans creates a feeling of being safe against a potential harmful environment, supporting the psychological well-being. The configuration also closes the metaphorical ring between human history and future. In the interior a dynamic multi-purpose furniture involves each individual as an active creator of his own place and space by providing the possibility of arranging the modules in almost countless combinations. This also stands out in an effective way against boredom and depression due to monotony.

Red Moon Base

The structure is not supporting windows facilities creating psychological and functional problems. Those are creatively solved with many ideas. The wall between crew quarters and walkways are made of „liquid crystal intelligent glass“ to simulate windows. In crew quarters the use of periscopes support an individual place exploration and spiritual and meditative dimension. Really interesting as well is the idea of a Camera obscura. Little holes in the wall of a dark module sealed with lenses will create the inverted projection of the external environment. But it might be monotonous, as apart from human Extra Vehicular Activities nothing happened in the last 4 billion years.

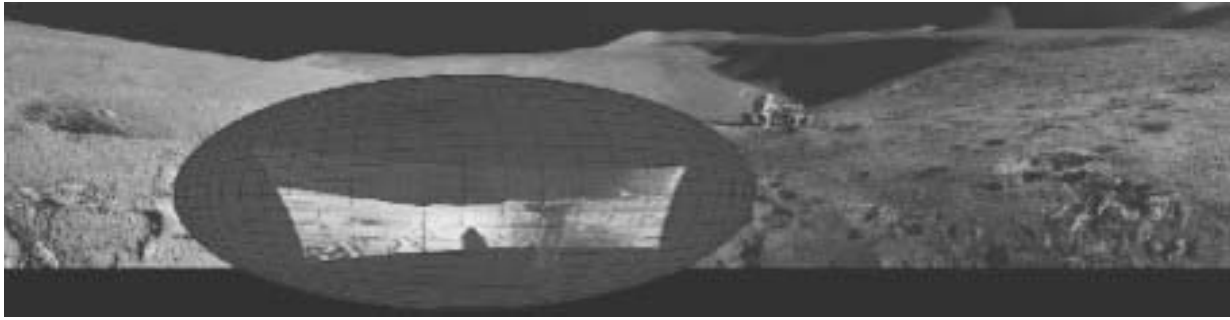


Abb.2: Moon Base Red, Camera Obscura Ambient Experience. Boeldieu L., SSDW 2009, Stuttgart Universität.

Conclusion

The place of man in space is considered the instrument by which he acquires knowledge. In the phenomena of perception and cognition it is the conscious observation that feeds cognitive process allowing the gain of knowledge.

An ideally habitat system supports the cognition from perception to memory, from unconsciousness to consciousness, it supports human's experiences (Léonard Boeldieu and Irene Schlacht communication, SSDW Stuttgart Universität, 2009).

An Outer Space Project has to refer to many elements to guarantee the mission success; with long duration mission framework Human Factors aspects have acquired a dominant importance on it. The appliance of this concept still needs, nevertheless, time to be widespread.

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