New Methodology for Analogue Study: Debriefing and Observation for Habitability and Quality of Life

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ABSTRACT

The International Lunar Exploration Working Group (ILEWG) EuroMoonMars campaign from 2010 to 2013, carried out at the Mars Desert Research Station (MDRS) in Utah to test exploration procedures in Analogue Moon/Mars Base Infrastructure, featured a Habitability Project. Inside the station, the feasibility and limitations of human and robotic planetary exploration were investigated by two crews of seven and six members, respectively, for a period of two weeks each. This paper presents the development of the analysis performed by the crews on safety, performance, and comfort during living and working activities. During each mission the living conditions were investigated with the "Habitability Debriefing" developed as new methodology by Dr. Schlacht. The debriefing was performed by the crew members together at the end of each mission. The methodological aim was to identify each possible problem and problem solution covering all the human factor aspects related to human space missions.

KEY WORDS: debriefing, human factor, habitability, analogue study, anonymity, quality of life

INTRODUCTION

The Mars Desert Research Station (MDRS) is a project for analogue study located in the Utah desert near Hanksville in the USA.

Figure 1: MDRS, 2010 © Irene Lia Schlacht

Every year, a rotation of several crews of up to 7 people at a time, go there to perform investigations of various kinds related to simulations of Moon/Mars exploration.
This paper presents a debriefing investigated and observed concerning the safety, performance and comfort during the rotation of EuroMoonMars campaign crews from 2010 to 2013. The first part of the paper presents the method and results of a habitability study, where common problems at MDRS experienced by several different crews were identified and solutions found.
Since psychological and stress-related problems are serious issues on long-term manned space missions, countermeasures are needed for future long-duration missions because astronauts may suffer from insomnia, depression, and stress. These negative effects may reduce crew performance (Kanas and Manzey 2008). To counter those relevant human factor effects (Schlacht 2012), the Moon-Mars habitability project was conducted during the EuroMoonMars campaign from 2010 to 2013 on 5 crews: 91, 100A, 113, 124 and 125 (Schlacht et al. 2010, Karga and Schlacht 2012, Thiel et al. 2011, Schlacht et al. 2010, Groemer et al. 2010, Hendrikse

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et al. 2010, Schlacht et al. 2010, Stoker et al. 2012, Schlacht et al. 2012). The aim of this study was to discover the needs and potentials of the environment and to improve the habitability, well-being, and productivity of the astronauts for long duration missions. Through the study from 2010 to 2012, we hypothesized that the use of music and nature sounds could be a countermeasure to stress contributors such as noise.

METHOD

The debriefing was performed by the all crew members together at the end of each mission. The methodological aim was to identify each possible problem and problem solution covering all the human factor aspects related to human space missions. (E.g. isolation, storage, food, noise, etc.) Ninety-minute crew debriefings were conducted two days before the missions ended at MDRS. During the debriefing, the main mission problems and possible solutions were discussed from the perspective of performance, well-being, and safety. Key words that were used most frequently were analyzed by the crews. Human factor aspects were investigated, with a particular focus on problems and problem solving under stressful conditions, as well as the role of music, nature sounds, and entertainment as a countermeasure.
Crew 125 was asked to bring their favorite music and personal belongings for entertainment. The duration of these activities were not pre-determined, but were decided by the commander. The analysis was performed using direct observations, interviews, and the debriefing of the participating crew members.
The results are presented with comparison analyses between the different crews from 2010 to 2013, with particular focus on the result of crew 124 and 125 from 2013.

RESULTS

a) Results on Habitability and social factors

In four out of five investigated crews, "communication" has been mentioned as a main shared topic of discussion showing the necessity of improving communication of information/procedures, communication with the control center, as well as within the crew. Other shared topics of discussion from three out of five crew members were food, with particular redundancy of the words Nutella®, interior layout, and toilet [Table 1].
In comparison in crew 124, a socio-cultural factor was mentioned as a problem: Missing personal time [Table 2].

Table 1: Habitability debriefing mission 2010-2013

Field approached	Topics approached	Crew:	91	100a	113	124	125
All (Operational, psychological, socio-cultural, physiological, environmental)	Communication	4/5		x	x	x	x
	Food (Nutella®)	3/5	x	x	x		
	Interior layout	3/5	x		x	x	
	Toilet	3/5	x	x		x	
	Music	2/5	x	x			
	Gymnastics	2/5	x	x			
	Storage	2/5	x		x		

Table 2: Habitability debriefing mission 201, crew 124, 125

Field	Rel.	Problems: Crew 124	Solutions: Crew 124
Op. (also Psy.), IVA	7/7	Lack of information (communication). What to expect, people's responsibility, procedure	Get an up-to-date manual, more information given about people's responsibilities, better protocols, need for structure
Phy.(Op.) EVA	7/7	Condition of Helmet: a. Scratches on helmet that destroys visibility b. Helmet not good fit. Head bumps, does not protect head	a. different type of plastic better procedure to clean/polish b. Get padded helmets. Eg. get cheap motorbike helmets, that fit your head.
Op. (Psy.) EVA IVA	6/7	Overall condition of equipment. Much of the gear is near failure and poorly maintained	- Scheduled maintenance checks - Spend money on fixing things up.
Ps. (En., IVA	3/7	Missing personal Space stay, alone time	Better room design (layout) with multiple functionality to sit on your bed to have a desk
Ps. (En., S-C), IVA	3/7	Missing personal Time	Schedule a time for personal and free activities.
Field	Rel.	Problems: Crew 125	Solutions: Crew 125
Op. (ps.) IVA	5/6	Mission Support information flow (communication)	1.Psychological Screening 2. Education on support
Op. (Phy.)	4/6	EVA Suits design	1. Use modified motorcycle helmet (safer). 2. More small suits
En., IVA,	4/6	State-room temperature	1. Individual thermal control 2. Isolate heating pipes
Op.(Ps.) IVA	4/6	Outdoor Toilets (safety, psychological discomfort, wasting time)	1. Fix indoor toilet 2. Having real tunnel
Index: IVA= Intra Vehicular Activity; EVA Extra Vehicular Activity; Rel.= n. of crew members that find it relevant / tot. crew members; Op.= operational, Ps.=psychological, S-C= socio-cultural, Phy= physiological, En=environmental			

From this study, communication emerged as a key element related to the habitability and performance level in space missions. Music and food also emerged as important aspects that need more attention and investigation. In conclusion, in order to improve habitability, the needs of the crew must be investigated from operational, psychological, socio-cultural, physiological, and environmental perspectives (Schlacht et al. 2012). The results show that all those fields emerged as problem areas in every year from 2010 until 2013 (Schlacht et al. 2012, Table 2). Moreover, the Moon-Mars Habitability Project also increased the crew's awareness and knowledge regarding habitability factors and their relevance.

b) Study of music and sounds as countermeasures

During the crew 125 debriefing, noise was not mentioned as a problem. Also, socio-cultural factors were not addressed that may correspond with the increase of well-being given by sounds used and music activity performed. The majority of Crew 125 enjoyed playing music instead of watching a movie, and it was effective for group dynamics to use shorter time than a movie (Ono

et al. 2013). Therefore, the crew members could use their spare time to play musical instruments and music files, together with crew member's favorite music. Also, this crew played space science fiction movie soundtrack pieces as wake-up music. The movies and soundtracks then became a frequent topic of discussion during meal-time. Through the discussion, the crew members discovered their common interests and preferences in terms of these movies. One of the works of space science fiction became a theme of this crew. The crew's favorite soundtrack was frequently played, and especially helped encourage crew members prior to Extra Vehicular Activities.

It is here reported an example of human factors daily report of the life during the mission simulation of crew 125 in March 2013: "*The atmosphere of Crew 125 and social factors are good. Commander M., who has a lot of experiences at MDRS, was contributing to keep a good atmosphere with positive words and encouragements in an attitude of fairness. Crew members woke up with morning music. Music was always played except the specific time for experiments. When a crew member V. listened to a guitar sound from speakers at MDRS after dinner, he felt that he wanted to bring his guitar."*

Furthermore, nature sounds of streaming water with occasional bird call were played in daytime. At night, streaming water with insect noises played. The commander requested to play the nature sounds as a wake-up call for one day, and it also became a topic of discussion during breakfast. These kinds of nature sounds could help to reduce stress from noise (Ulrich et al. 1991, Kaplan 2003, Ono 2013). Therefore, our hypothesis that use of music and nature sounds as soundscape design or sound environment took on a very important role as a countermeasure to noise-induced stress in group dynamics.

DISCUSSION

Since numbers of participants are limited at 6 to 7 people, anonymity is an issue on analogue studies and space missions. This debriefing successfully solved the problem of anonymity. However, it would need further studies to determine accuracy for future space missions.

CONCLUSION

The method of this debriefing will become more important and useful for manned space missions. This research provided some baseline data and a methodology for further investigation in long duration manned space missions. Regarding the evaluation of sound environment, including music and nature sounds, a daily report by experiment coordinator from a crew was effectively used to evaluate preliminary results.

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