ILEWG EXOHAB & EUROGEOMARS CAMPAIGNS: HABITABILITY & HUMAN OPERATIONS

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Abstract: We studied concepts for a minimal Moon-Mars habitat, in focussing on the system aspects and coordinating every different part as part an evolving architecture [1-3]. We validated experimentally the Habitat and Laboratory ExoHab concept constraints during EuroGeoMars campaign in Utah desert research station (from 24 Jan. to 28 Feb. 2009). We discuss from the ILEWG ExoHab concept studies and field simulations the specifics of human exploration, with focus on habitability and human performance.

Moon-Mars outposts: concepts and preparation

In the ExoHab pilot concept project (supported by ILEWG, ESA & NASA), we justify the case for a scientific and exploration outpost allowing experiments, sample analysis in laboratory (relevant to the origin and evolution of planets and life, geophysical and geochemical studies, astrobiology and life sciences, observation sciences, technology demonstration, resource utilisation, human exploration and settlement).

In this modular concept, we consider various infrastructure elements:

- core habitat,
- Extra Vehicular activity (EVA),
- crew mobility,
- energy supply,
- recycling module,
- communication,
- green house and food production
- operations.

Many of these elements have already been studied in space agencies' architecture proposals, with the technological possibilities of industrial partners (landers, orbiter, rovers, habitats …). A deeper reflection will address the core habitat and the laboratory equipment, proposing scientific and exploration experiments. Each element will be added in a range considering their priority to life support in duration [7]. Considering surface operations, protocols will be specified in the use of certain elements.

Lunar outpost predesign modular concept.

We give a pre-design of a human minimal Moon-Mars outpost (Fig.1) to allow human presence on the Moon and later Mars, and to carry out experiments.

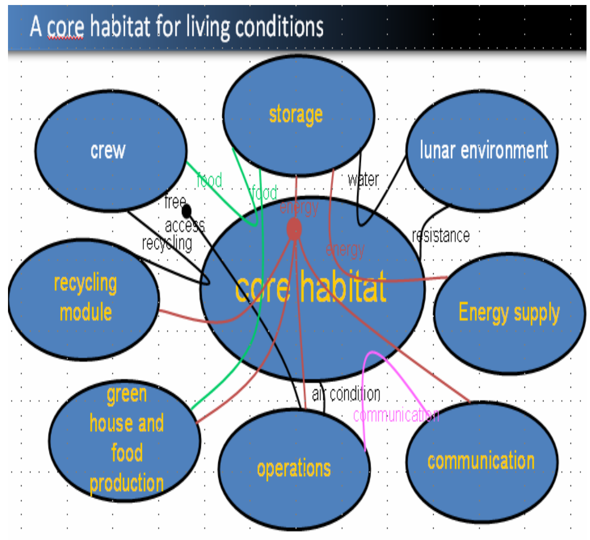

Fig. 1: Functional diagram for ExoHab outpost (Boche-Sauvan & Foing 2008)

A polar lunar outpost can serve to prepare for a Mars outpost: system and crew safety aspects, use of local resources, operations on farside with limited communication to Earth, planetary protection protocol, astrobiology and life sciences [6].

We focus on the easiest and the soonest way in settling a minimal base immediately operational in scientific experimentation, but not immediately autonomous. It will prepare the next permanent lunar base by assessment of its technologies, and give scientific results about the environment. The autonomy will be gained in the evolution of the base, and added equipment.

Through a modular concept, this outpost will be possibly evolved into a long duration or permanent base. We will analyse the possibilities of settling such a minimal base by means of the current and near term propulsion technology, as a full Ariane 5 ME carrying 1.7 T of gross payload to the surface of the Moon (Integrated Exploration Study, ESA ESTEC [1,2]).

A lunar outpost in a polar region would allow missions longer than 14 days (period of possible return to an orbiter anywhere else), and a frequent addition of equipments. Moreover, a polar outpost will get both advantages of far-side for communications and darkness for observations. The low solar rays incidence may permit having ice in deep craters, which will be beneficial for the evolution of the outpost into an autonomous base. After a robotic sample return mission, a human presence will allow deeper research through well chosen geological samples.

EuroGeoMars campaign

We investigated experimentally the ExoHab concept (Moon-Mars habitat and laboratory) and operations constraints during EuroGeoMars campaign in Utah desert (from 24 January to 28 February 2009) .

The goal of the mission was to demonstrate instruments from ExoGeoLab and ExoHab pilot projects [8], support the interpretation of ongoing lunar and planetary missions, validate a procedure for surface in-situ and return science, study human performance aspects, and perform outreach and education projects [9-10].

The EuroGeoMars campaign included:

- a technical preparation week (24-31 Jan): instrumentation deployment and technology field demonstration;

- 1st rotation – crew 76 (1-15 Feb): further deployment and utilization;

- 2nd rotation – crew 77 (15-28 Feb): further science exploitation and in depth analysis.

The EuroGeoMars campaign had 4 main objectives:

1) *Technology demonstration aspects:* a set of instruments were deployed, tested, assessed, and training was provided to scientists using them in subsequent rotations

2) *Research aspects:* a series of field science and exploration investigations were conducted in geology, geochemistry, biology, astrobiology, astronomy, with synergies with space missions and research from planetary surfaces and Earth extreme environments.

3) *Human crew related aspects* [10]: (a) evaluation of the different functions and interfaces of a planetary habitat, (b) crew time organization in this habitat, (c) evaluation of man-machine interfaces of science and technical equipment;

4) *Education, outreach,* multi-cultural communications and public relations

We docuemented from the ExoHab concept studies and EuroGeoMars field simulations the lessons for future human habitats, research laboratories and operations. We acknowledge support from ILEWG, ESA, NASA and partner institutions.

Fig.2: Habitat geochemical laboratory with XRD and Raman spectrometer for geochemistry/ astrobiology

Fig.3: EVA simulation for instruments and sampling

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