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Preparing Human Exploration on the Moon and Mars: First Test Runs at the MaMBA Laboratory

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Abstract

The next step in human space exploration is the exploration of the surfaces of celestial bodies such as the Moon or Mars. One major technological gap that needs to be closed before humankind can attempt this step is the creation of a functional extraterrestrial base. The goal of project MaMBA (Moon and Mars Base Analog) is to create such a base, with a special focus on the scientific module. Here, we will present the current design of the MaMBA laboratory module which is representative of the other modules, and the final construction of its mock-up located at the ZARM in Bremen, Germany. We will provide an overview of the experiments that were recently completed at the mock-up.

1. Introduction

Exactly 50 years after the first landing of humans on the Moon, space exploration is receiving a new push forward by many entities, including major space agencies and industry players. While most focus is on the transportation, i.e. the creation of launch systems, relatively little attention is given to how humans will survive once they reach their destination.

Project MaMBA, which is short for Moon and Mars Base Analog, aims to build the first functional prototype of an extraterrestrial base. In its basic configuration, the base consists of 6 modules and two airlocks (see Fig. 1). The modules are laid out such that if a major problem occurs in one module, it could be locked off from the other modules and the crew could continue using the (remainder of the) base.

The central piece of MaMBA is the laboraty. It is intended to be used by scientist astronauts who investigate samples collected on the Moon or on Mars. The main advantage of an extraterrestrial laboratory is that samples can be analyzed in larger numbers than if they were all to be transported to Earth. Ideally, the laboratory allows for a basic analysis of many samples, and for an informed decision on which samples should be transported to Earth for more in-depth analysis. The main benefactors of the laboratory would be the following disciplines: geology, (astro-)biology, and materials science, although the laboratory would also allow astrochemical and medical investigations.

2. The Mock-Up

We believe that the laboratory module should be the central piece of any extraterrestrial base. Therefore, we designed the laboratory module first and constructed a mock-up that will serve as the blueprint for the other modules, in particular with respect to its architectural design.

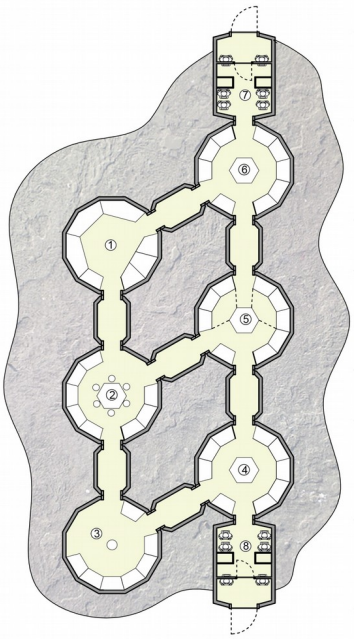

Figure 1: Floorplan of the six-module habitat: 1 - sleeping + hygiene module, 2 - kitchen module, 3 - window and leisure module, 4 - greenhouse and exercise module, 5 - science module, 6 - workshop and storage module, 7+8 - airlocks.

Figure 2: Shell of othe laboratory module during construction. The mock-up is located at the ZARM in Bremen, Germany.

2.1 Shell

Each module is an upright (rigid) cylinder, with an outer diameter of slightly more than 5m and a height of roughly 6m (see Fig. 2). Within the full base, the cylindrical modules are connected by (inflatable) modules which are docked to the cylinders via pressure-tight doors. With the configuration shown in Figure 1 each module has 2-3 doors.

The mock-up consists of a single cylinder which corresponds to the module denoted with the number 5 in Fig. 1. The mock-up cylinder has 2 of the 3 exits shown in Fig. 1, with the third door being blind.

2.2 The laboratory

The laboratory module is equipped with instrumentation for geological, materials sciences, and (astro-)biological research. The selection of appropriate instrumentation is based on the recommendations developed by representatives of each of these disciplines [2,3], with adaptions for the specific needs of the test runs.

3. Test runs

We recently completed the first of two test runs of one week duration each. During the test run, 3-4 scientist volunteers conducted experiments inside the laboratory module, particularly sample analyses related to geology, materials science, and (astro-)biology. During the test run, the scientist volunteers were monitored using a depth camera to track their motions inside the laboratory. In addition, we had a dedicated time slot during which we simulated injuries and (temporary) disabilities that are (the most) likely to occur in an extraterrestrial base. After the test run, the scientists answered questionnaires and interview questions regarding the usability of the laboratory.

In addition to evaluating the usability, we provided the scientists with a “Marvin”, i.e. a (simulated) AI that they could communicate with for obtaining information, with the purpose to identify the needs that scientists might have inside an extraterrestrial laboratory.

During this presentation, we will provide first preliminary results from this test run and give an outlook on the changes that will be made for the second test run.

Acknowledgements

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References

[1] Christiane Heinicke, Leszek Orzechowski, Rawel Abdullah, Maria von Einem, Marlies Arnhof: Updated Design Concepts of the Moon and Mars Base Analog (MaMBA). European Planetary Science Congress 2018, 16–21 September 2018, Berlin, Germany.

[2] Solmaz Adeli, Jens Ormö, Steven Jaret, Christiane Heinicke: Synergies between geological laboratory analyses on the Moon and Mars. European Planetary Science Congress 2018, 16–21 September 2018, Berlin, Germany.

[3] Christiane Heinicke, Steven Jaret, Jens Ormö, Miranda Fateri, Nina Kopacz, Mickael Baqué, Cyprien Verseux, Bernard Foing, Alberto Razeto: How a Laboratory on the Moon should be equipped. 69th International Astronautical Congress (IAC), Bremen, Germany, 1-5 October 2018.