Griebel_2000

M.A.R.S.2 – THE MARS SOCIETY'S ADVANCED RESEARCH STATION

Hannes S. Griebel*
And
Sven Knuth**

ABSTRACT

As part of the international Mars Society's program to study planetary habitats and surface equipment, the German Chapter of the society took on the design of a research station that shall be installed and tested in the arctic. Some areas in the arctic have similar features to those found on the surface of Mars. But any place similar to Mars may be considered for setting up a test base. Working together with the international Mars Society, such sites on Earth were identified earlier by NASA. Mock-ups of planetary bases and surface equipment shall be installed in some of these places. Procedures, the design of equipment and the design of the habitat are then subject to research, while scientists such as planetologists shall have the opportunity of using a well-equipped base for field research in remote areas.

The Mars Arctic Research Station 2 (M.A.R.S.2) is such a project, and is currently pursued by the German Chapter of the Mars Society. It's principle objectives are those of the Mars Society's first station, the "Flashline Station" which is currently being built on Devon Island, northern Canada. M.A.R.S.2 will be the successor thereof. However, the project focuses mainly on engineering and habitability aspects. Furthermore, for the purpose of various proposed exhibitions, the M.A.R.S.2 has to resemble a real spacecraft. As we stand right at the beginning of the project with just a few studies done, this report is only intended to give a brief overview of our main objectives. Please note that despite the many Mars related aspects, such a habitat would also be interesting for a human exploration of the moon, or any body that can bear such a structure, with some modification.

ABOUT THE MARS SOCIETY

Throughout the 20th Century, a number of societies have been actively supporting the idea of space travel. They have shown the feasibility of a voyage beyond our own world, and their leading members have laid the cornerstones to modern day space flight. Stepping into the footsteps of these societies, Dr. Robert Zubrin, author of "The Case For Mars" and president of Pioneer Astronautics, founded the international Mars Society in 1998 as an entirely

---

* Project Manager M.A.R.S.2 - Space System Technology and Science, Contact: H.S.Griebel, Franz-Nissl-Str. 10A, Munich 80999, Germany, Tel. # +49 89 81339350, Fax.# +49 89 81339351, Mobile # +49 172 7509455, email: hg8@usa.net
** M.A.R.S.2 - Finance and Public Relations

privately funded union of Mars enthusiasts and professionals. The long-term goal of the society is to further the exploration and utilization of the planet Mars, its public acceptance and support and to advocate the need to reach beyond the borders of our own planet. To work towards this goal, the Mars Society has identified key issues that are to be met stepwise. As a first step, the Mars Analogue Program was called into existence.

HOW WE SELECTED OUR GOALS

The Mars Society German Chapter recruits its members out of volunteers, many of them students. Therefore, we have chosen goals that are well within our possibilities, but appeared important and worthwhile to us. However, should there be offered a more elaborate and complex research goal suggested by an external party, we would be happy to cooperate.

CONFIGURATION OVERVIEW

As of now, the M.A.R.S.2 base consists primarily of a central cylinder roughly 8 meters in diameter, hosting two stories and being supported by landing legs. It will be surrounded by three individual inflatable compartments accessible from the lower level. On top of the core module, an inflatable structure shall provide room for an additional floor. The airlock was positioned in the centre underneath the lowest level. The entire structure measures roughly 10 meters in height and 18 meters in diameter. It should be able to host a crew of up to six people. Standard experiment equipment will be present.

In addition to this, the station will be equipped with mock-ups of attitude control thrusters, muck-ups of rocket engines and similar space related equipment. These are necessary for the exhibitions proposed and will probably not be installed when the station is out in the arctic for test operations.

While we do not prefer any particular Mars mission architecture over another, our general requirements and dimensions were derived from the latest serious designs, like the NASA Reference Mission or The Mars Direct Plan by Dr. Bob Zubrin. They have been chosen because they provide the most realistic scenario for a manned Mars mission today. Because we do not intend to build a fully functional spacecraft, following exact specifications is not necessary for our research. We have taken into account though that the habitat may also be used for crew transfer.

MAIN OBJECTIVES: ENGINEERING

One of the most important objectives of M.A.R.S.2 are engineering aspects and researching general configuration options. They will be described hereafter.

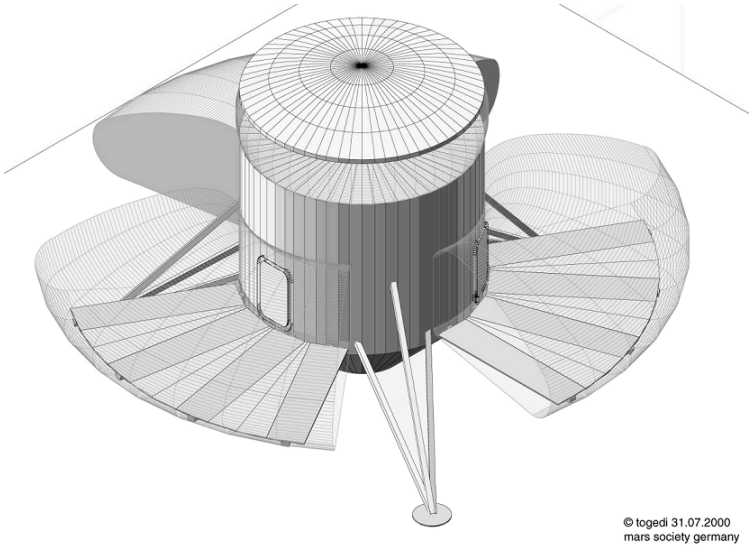

Fig. 1: The MARS2 reference design features three individual inflatable modules which fold out from the main structure and an additional inflatable rim to provide space for an extra level. (Picture by T.Dirlich)

Airlock Position

The airlock of our preliminary reference habitat shall be installed beneath the lower deck in the centre of the module. While this configuration has given rise to some serious headaches of us space flight engineers when arranging the rocket engines and propellant tanks, the advantages were considered worth a try. First, the centred airlock does not cause problems with mass balance. And even though inhabitants would have to step onto the surface in between two giant rocket engine nozzles, this step would be significantly smaller than from above these nozzles (we do not anticipate the giant leap for mankind to be less giant however, at least not therefore). Needless to say that access of the habitat in case of an emergency or the benefit of greater comfort is also a lot easier.

Inflatable Structures

Exploring the use of inflatable structures for greenhouses and dust storm covers for equipment is one of the key issues of M.A.R.S.2. They provide a comparatively large space for comparatively little structural mass, and enable the base to be larger and different in size than a launch vehicle would normally allow. There are two different types of inflatable structures that we intend to study with M.A.R.S.2:

- Structures that provide a large volume by being inflated with cabin air and thus increase the interior size of the spacecraft.
- Structures that are inflated by ambient or waste gas and simply provide a mere skeleton for an otherwise unpressurized larger structure.

The first type will be used for providing space for a greenhouse and recreational or additional work area. I would like to note here that the greenhouse is far from providing a

closed or partly closed biological life support system. However, it shouldn't escape your attention that an occasional fresh vegetable might be favourable for crew health and psychology. Thus, we consider the greenhouse worth the effort.

As described in the configuration overview, our latest version of the reference design incorporates three individual inflatable sections that will be folded out from the habitat at its lower level. This functionality is accomplished by covering the packed inflatable fabrics with four metal sheets each. When folded down, they automatically force the inflated compartment to form a shape featuring a flat floor, which comes in handy, as inflatable structures like to be spheres.

The entire assembly has several advantages. For a start, this is a very simple way to create large and useful extra space for the crew with comparatively little investment of extra mass. Should one of the inflatable compartments cease to function or loose it's ability to retain the inherent atmosphere, it can easily be sealed of by closing the door.

Another major advantage we found in the fact that these sections are elevated from the ground. First, it is not necessary to clear the covered area from large boulders and obstacles alike in a lengthy EVA before the structure can be inflated, as compared to numerous other suggestions for inflatable habitats [see R.Horden, A.Vogler, B.Imhof et al]. Another bonus of this configuration arises from the fact that it provides mass to first hide underneath when approaching the habitat. Such a structure is thought to come in handy if the radiation environment changes to the disadvantage of a living organism faster than the later might be able to return to the habitat and climb the steps, open the airlock, operate it, undo the space suit and so on and so forth. Even though the inflatable section does not provide adequate shielding for solar flares, there is at least something to diminish radiation for the benefit of some extra time (see the synergies section for additional description). In addition, the entire structure may help to support the dustcover described later.

On top of the core module, an inflatable rim shall be installed lifting a solid cover above the main pressure dome to provide space for a third level. In packed condition during interplanetary cruise, the non-inflated upper level may be used as storage space for equipment not used during that phase.

The second type will be used as part of a dustcover for protecting equipment and vehicles from the aggressive Martian dust. It would otherwise be deposited in groves and joints or sensitive devices by violent dust storms occasionally roaming the surface of the planet. The plan is to inflate a large skeleton by using compressed ambient air or waste gases, supporting the cover itself, which is made of some fabric. The feasibility of using the descent parachutes as the cover is an option we would like to research.

Development and test of materials for inflatable structures is planned to be conducted in close cooperation with Dr. Zurab Gogava of the Georgian Space Institute and his colleagues. They have already had a major influence in preliminary design studies.

Synergies

Another major area of our engineering research will be the feasibility of synergies. They are considered important by us because many of them can be researched comparatively easily and are a necessity with current weight limitations. One of them is using water as a shielding material.

At times, the sun features gigantic "storm" conditions within its magnetosphere. The violent radiation bursts associated with these events, also known as Solar Flares, cause unprotected living beings to have their life expectancy shrink to a few hours. To countermeasure this unpleasant effect when leaving the protective environment of the Earth's magnetic field, adequate shielding is required. We have therefore designed our reference habitat to store potable water, hygiene water and wastewater in tanks around the living quarters. Water is a very good shielding material and needed anyway on board, thus keeping additional shielding mass low. Even though we are not going to build a real spacecraft, we are researching the feasibility of such devices. In our configuration the living quarters would act as a solar storm shelter, for covering the entire habitat would be too heavy.

Another aspect is that the metal sheets covering and supporting the inflatable structures could be used as heat radiators during interplanetary cruise and on the surface, when required. To do this, a coolant liquid (which could be water for simplification) would be routed through the sheets. At the same time, this liquid would enhance the radiation shielding effect of this structure more or less for free. Check the "Inflatable Structure" section why we have considered this to be desirable.

Equipment

Interior component configuration, layout and arrangement shall also be subject to research. Amongst them are primarily experiment equipment and facilities. One of the research goals of M.A.R.S.2 is to determine how experiments are conducted best on Mars. Even though this is left to scientists in the end, we would like to know how the best configuration and design is to be achieved; optimised with respect to safety, efficiency and comfort. Standard experiment equipment should be provided on M.A.R.S.2, such as an oven, a spectrometer, a centrifuge and other laboratory equipment. Furthermore, a sample airlock (or a functional mock-up thereof) will probably be present.
We are currently planning to have a standardized and modular architecture to provide easy installation and exchange of equipment.

MAIN OBJECTIVES: HABITABILITY AND DESIGN

To cite the words of Prof. Igenbergs of the department of astronautics at our university, the technical university of Munich: "Human space flight should become humane." Following these words, architectural students of our university have been working successfully on space architecture. There has been close cooperation with the department of astronautics, and most recently with the German Chapter of the Mars Society. Building upon

this experience, fully functional mock-ups of their designs shall be installed into M.A.R.S.2 to research their usefulness. Amongst them are the following:

- Beds and sleeping cabinets.
- Modular and multifunctional furniture.
- Exercise and training equipment.
- Interior colour selection and equipment design.
- Lighting arrangements.
- Hygiene facilities.
- Galley.

As with experiment equipment, we are trying to stick to a modular and common architecture, so that individual items can be removed or added more easily. When it comes to training equipment, it is important to note that due to the weaker gravity on Moon or Mars, the ceiling must be higher. Simply to minimize the risk of injuries. Even though testing in weaker gravity lies beyond our capabilities, we would like to take this issue into account when designing the rooms. Especially for the exercise area a dome is currently considered. Refer to the "Inflatable Structure" section of this document for greater detail.

ROVER

The M.A.R.S.2 Project is conducted in close cooperation with the Austrian chapter of the Mars Society, which is building a mock-up of a pressurized Mars Rover. It will also be tested in the arctic. Please refer to the Austrian Chapter of the Mars Society for further details on the rover.

PUBLIC OUTREACH

Due to the tremendous response we got from major TV stations, magazines and radio stations, extensive media coverage is expected. As mentioned before, an exhibition is proposed, and thus M.A.R.S. 2 will hopefully increase the attention focused on human space exploration. In Addition to this, we are planning to stimulate interest by organizing workshops at schools and public events. However, negotiations with various media companies are currently taking place, and public outreach activities have just begun.

MARS2 has tremendous significance when it comes to public outreach. Why? There are several reasons. To understand these let's take a brief look on publicity work. Creating Publicity means attracting the attention of a couple of journalists, who then literally spread the word, reaching hundreds of million people through various media.

However, in Germany alone hundreds of institutes, societies, companies and individual people all into space flight in some respect compete for attention. Most of them promote far-fetched plans like the Hopper-Project that never make it much further than the conceptual stage. They create plenty of news and plenty of hot air.

Should the Mars Society Germany eventually manage to built a second research station we would distinguish us significantly from the other groups. We would prove that we could not only talk but also act, thus gaining a lot more public attention. This again is important to get future projects financed.

FUNDING

MARS2 shall be completely privately funded. To do this only little choice exists. Effectively our possibilities are reduced to donations, advertisement contracts and probably selling media rights. A minor part could also come from investigations done for aerospace companies, investigations that could be conducted in conjunction with the MARS2 project.

Donations

We will mainly be able to collect donations done by private people, in case we can convince them that they can personally support science and technological research. However, we do not anticipate getting major funds from this.

Advertisement contracts

MARS2 offers various opportunities for advertisement. Like with the Flashline Station, the simplest of these would be to print a logo or text on the habitat's hull. However, we will also offer sponsors the opportunity to provide some of the interior items, which they can use for advertisement after paying a certain fee. Currently negotiations are pending with a company producing beds and one producing kitchen supply.

Media rights

Like with FMARS we also hope to be able to sell the media rights, and talks are going on with just one major European television broadcasting company. We are at a very early stage though, and thus hope that our chances improve once building has begun.

Investigations for third parties

Talks will take place with Astrium in September this year. This major German space flight engineering company might be interested in solutions developed for MARS2. This could be done under contact with Astrium, including the testing of items developed, and thus help funding the project. It would be necessary to develop equipment for zero or low g.

Other possibilities

We have also thought of other possibilities to finance MARS2. At this early stage however we are not able to tell if they are really feasible, only after the Toronto convention will we check each one of them. For one thing, there is the chance of raising venture capital,

and for another a lottery has been taken into account. The lottery has been successfully used in Germany to fund the first airships, the famous Zeppelins.

MANAGEMENT STRUCTURE

The project management was split in two to share workload according to our main goals. While the architecture and design segment is managed by Mr. Thomas Dirlich, a student of architecture at the University of Munich, the space flight technology and science segment is managed by Mr. Hannes S. Griebel

CONTACT

Please feel free to contact us whenever you like. The M.A.R.S.2-project is managed for the German Chapter of the Mars Society by:

Thomas Dirlich
Project Management Architecture and Design
Tel.# +49-179-2110008
e-mail: mars2@frontiers.de

and

Hannes S. Griebel
Project Management Space Systems Technology and Science
Tel.#+49-172-7509455
e-mail: hg8@usa.net

Project updates can be found at the following webpages:

www.marssociety.de
www.marssociety.at
www.marssociety.org