

# HUMAN SETTLEMENT ON MARS

## INTERVIEW WITH MARS ONE

About 70,000 years ago, *Homo sapiens* moved out of Africa and eventually spread across the globe. Today, humanity is ready to take the next big leap – to land on, and explore other planets. Because of its proximity and similarity to Earth, Mars is the obvious choice to start with. Many people believe that eventually, humanity is destined to be a spacefaring, multi-planetary species, spreading across the galaxy and the universe. This decade has witnessed several proposals from various agencies for exploring Mars – ranging from manned Mars missions to establishing permanent settlements on Mars. What is significant is that many of these are from private companies or foundations. This entry of private players into the fray has substantially ramped up the excitement around Mars colonisation. Mars One is one such organisation that has unveiled a plan to colonise Mars in the coming decades. The following is an interview with the Mars One team. The purpose of this interview is not to endorse Mars One's plan, but to bring out the fascinating lessons that their efforts in colonisation hold for us. – The Editor.

### Tell us something about the overall vision of Mars One?

Mars One is a not-for-profit foundation that works towards establishing a permanent human settlement on Mars. This settlement will consist of a carefully selected and trained crew. The departure of this crew will be preceded by several unmanned missions to Mars. Starting in 2020, these unmanned missions will carry planetary rovers, supplies, life support systems, and all the cargo needed to establish a habitable settlement for humans. When the outpost is fully operational, the first crew of four astronauts will depart for



Fig. 1. A view of the planned settlement.

Source: Bryan Versteeg, Mars One, URL: <http://www.mars-one.com/>

their one-way journey to Mars. They will not simply visit the planet, but live, explore and create a second home for humanity on Mars.

### How long will it take to establish a large-scale human population on Mars?

Starting in 2026, a new crew will depart every 26 months. With only four individuals to start with, the settlement will at first be very small, but with new crews of four arriving every 26 months, the community will steadily grow larger.

### What challenges does the Mars One mission face in the technology and engineering of space vehicles and human spaceflights to Mars?

Establishing a permanent settlement allows Mars One to use technology that is not substantially different from existing systems. While this technology already exists, the hardware that is specifically needed for this mission still needs to be designed, built, and tested extensively. As Mars One is not an aerospace company, it will not design or manufacture mission hardware. Instead, all this equipment will be developed by third party suppliers, and integrated in established facilities of the Mars One mission.

Mars One's mission design is currently in the early concept phase. The main requirements for the mission have been identified and discussed with established aerospace companies around the world. Possible solutions have been identified and rough cost figures discussed. In the first phase, Mars One will finance conceptual design studies by established aerospace companies for every major system required for the permanent settlement mission. The Mars One mission design will be updated according to the results of the conceptual design studies. The first studies have already been completed by Paragon Space Development Corporation and Lockheed Martin.

### How do you plan to create a sustainable ecological system on Mars



Fig. 2. Mars Lander.

Source: Bryan Versteeg, Mars One, URL: <http://www.mars-one.com/>

### – both at the macro and the micro level?

Mars One will take specific steps to ensure that the Mars environment (which we will study, and on which we will depend) will not be harmed. The Mars base will be forced to recycle just about everything, pay close attention to energy use, and minimize the leakage of materials and energy. Nutrients are scarce on Mars. They need to either be imported from Earth, or extracted from the ground or atmosphere. Solar panels, which will also be launched from Earth, will generate the settlement's electricity. All of this means that a Mars resident will have a much smaller ecological footprint than the average person on Earth.

In addition, the development and operation of the settlement itself can

greatly improve our sustainability efforts on Earth. The necessity to recycle everything on Mars will provide a high-profile boost to our recycling industry, as will the demand for lightweight solar panel technology. New methods of cultivating crops and growing plants on Mars can also teach us, on Earth, a great deal about how to improve our environment from experiences on another planet.

### How do you plan to achieve self-sufficiency of air, water and food on Mars?

Breathable air is made up of several things. About 20% of what we breathe on Earth is made up of oxygen, almost 80% is the element nitrogen, and there are also very small amounts of other gases, like argon. On Mars, oxygen can be produced by splitting water into

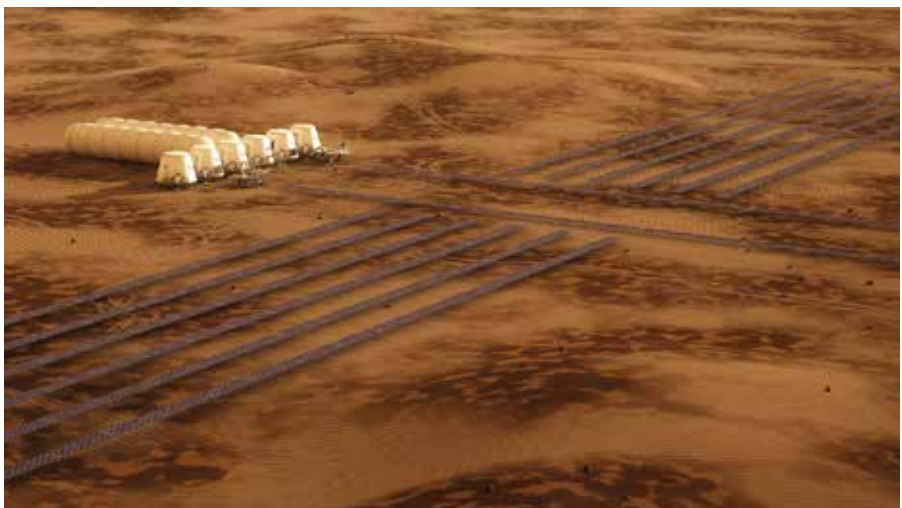


Fig. 3. Solar panels.

Source: Bryan Versteeg, Mars One, URL: <http://www.mars-one.com/>

hydrogen and oxygen. This oxygen will be used to provide a breathable atmosphere in the living units. Since the settlement uses solar panels to generate power, a portion of oxygen will be stored in reserve for conditions when there is less power available, for example at night and during dust storms. Nitrogen and argon will be extracted from the atmosphere of Mars and injected as inert gases into the habitable space for humans.

Water can be extracted from Martian soil. Mars One will send a rover to a certain area where there is water in the soil, and the rover will select the exact location for the settlement based primarily on the amount of water content in this area. We expect this region to be at latitude between 40 and 45 degrees North. The rover will scoop up soil with water ice in it, and deposit it into a water extractor in the life support units that generate energy, water, and breathable air for the settlement. The water extractor will heat the soil until the water evaporates. The evaporated water will be condensed and stored, the dry soil expelled, and the process repeated to extract more water. About 1500 liters of reserve water will be stored in each life support unit, to be consumed during periods of low power availability. Since Mars has gravity, water can be used in the same way as on Earth. Each astronaut will be able to use about 50 liters of water per day. The water will be recycled, which takes much less energy than extracting it from the Martian soil. Only water that cannot be recycled will be replaced by water extracted from the soil.

The astronauts on Mars will be able to produce their own food, in a greenhouse. Mars One will investigate the volume requirements for food production in a simulation outpost on Earth where all crew members will be trained to operate greenhouse equipment. To ensure that the first crew has food waiting for them when they arrive on Mars, stored food will be sent from Earth on a supply mission, before human landings. This stored



**Fig. 4. Mars-One Farm.**

Source: Bryan Versteeg, Mars One, URL: <http://www.mars-one.com/>

food will be used sparingly to ensure that a large part of it can serve as emergency rations. Approximately 80m<sup>2</sup> of the habitat will be available for plant growth. The first crew will also be able to use the habitat of the second crew to grow food because the hardware for the second crew lands only a few weeks after the first crew lands. Food production will occur indoor under artificial lighting. A thick layer of Martian soil on top of the habitat will protect the plants (and the astronauts) from radiation. CO<sub>2</sub> for the plants will be available from the Martian atmosphere, and water will be available through extraction from the soil on Mars, or recycling from other purposes. Nutrients for the plants could be imported from Earth or from recycling human waste. Non-edible parts of plants will be recycled, or stored until more advanced recycling equipment is shipped from Earth. Apart from fresh crops, it is likely that algae and insects will also be part of the regular human diet on Mars. Any plant production surplus will be stored along with food shipped from Earth as emergency rations to survive until the next supply mission arrives.

**What are the physical and health challenges thrown up by low gravity, and how do you plan to address these?**

Astronauts will face the effects of reduced gravity both during space-flight missions and upon landing on Mars (62% less gravity than Earth). The reduced gravity during spaceflight missions of extended duration can result in astronaut de-conditioning – including a decrease in muscle mass and performance, reduced aerobic capacity and losses in bone density – in addition to several other physiological changes. When Mars One astronauts first arrive on Mars, they will, in theory, be stronger than an astronaut returning to Earth's gravity after a mission on Mars. A recent study of International Space Station (ISS) astronauts, with mission durations ranging from 4–6 months, showed a maximum loss of 30% muscle performance (and maximum loss of 15% muscle mass).

Mars One aims to lower these numbers through a program of well-structured and scientifically valid countermeasures, including but not limited to exercise, pharmaceuticals and nutrition that have been shown to mitigate these effects. Continued research and advancements in this area will surely produce even more effective countermeasures within the ~10 year period of preparation prior to the first human launch. Mars One will also take advantage of the decade prior to

A great example of the effectiveness of in-flight exercise countermeasures in maintaining astronaut health and performance is illustrated by American astronaut Shannon Lucid's 188 day stay aboard the Russian MIR space station, during which time she relied heavily upon the use of exercise countermeasures. When her mission came to an end, she was able to walk unassisted within 24h.

Source: NASA, Wikimedia Commons. URL: [https://commons.wikimedia.org/wiki/File:Shannon\\_Matilda\\_Wells\\_Lucid\\_1978.jpg](https://commons.wikimedia.org/wiki/File:Shannon_Matilda_Wells_Lucid_1978.jpg). License: Public Domain.



a specific team dynamic to be able to handle this and it is Mars One's job to find and prepare those that are best suited for this challenge.

On Mars, it will help to keep the crew busy – and it is certain that they will be. They will improve their habitats, and extend it with new units sent from Earth and with local materials. They will be involved in research – both their own, and the gathering of data for the research of others (for example, universities). They will also prepare the settlement for the second crew that lands two years later. Additionally, recreation will be important, this can be mental, physical or creative, such as sports, arts, games, etc. With a new crew arriving every two years, the settlement will slowly become a small village and an attractive place to live, for more and more people.

the launch of the first colonization mission to observe and select the most suitable astronauts and countermeasures to ensure a safe and successful mission. Once on Mars, astronauts will be able to take advantage of the force of gravity to assist them in the reconditioning and adaptation process, resulting in bone re-modeling to help strengthen their bones.

### Will there be any psychological impacts of loneliness on the initial colonisers? How do you plan to mitigate these?

The men and women that will make this journey will need more than technological advances to see them through: while technology will get them there, teamwork will be what ensures they survive the journey and that they will be able to successfully start building a society on Mars.

We have discussed our plan with experienced and respected psychologists. One of Mars One's team members is Dr. Norbert Kraft, who has worked on astronaut selection at NASA and JAXA (Japan Aerospace Exploration Agency). His primary area of expertise is developing physiological and psychological countermeasures to combat the negative effects of long-duration spaceflight.

The key to successful survival on Mars will involve a very careful selection procedure and extensive training program where group training will play a very important role. Mars One isn't looking for the best individuals, but for the best crew. There are many people who would not be suitable for a Mars mission. During the journey to Mars and upon arrival, they will spend 24 hours a day with each other. It is during this time that the simplest things may start to become bothersome. It takes

### Are there any interesting scientific experiments that are planned in the low gravity, low atmospheric pressure conditions on Mars?

There will be a great deal of research conducted on Mars. For example, the astronauts will research how their bodies respond and change by living in a 38% gravitational field, or how food crops and other plants grow in reduced gravity using hydroponic plant production units or other technologies. Research will also include extra- settlement explorations



Fig. 5. Mars-One habitat.

Source: Bryan Versteeg, Mars One, URL: <http://www.mars-one.com/>



**Fig. 6. Mars-One Habitat – a closer look.**

Source: Bryan Versteeg, Mars One, URL: <http://www.mars-one.com/>

to learn about the ancient and current geology of Mars. Of course, much research will be dedicated to determine if life was once present, or currently exists on Mars.

If the colonisation of Mars succeeds, eventually babies will be born on Mars. Will conditions on Mars cause health issues in these children?

The human ability to conceive in reduced gravity is not known; neither is there enough research on whether a fetus can grow normally under these circumstances. Additionally, the Mars settlement will certainly not be a suitable place for children to live. The group of astronauts living on Mars will be very small, all of whom will be very busy with the necessary work on the outpost; and the human settlement will have very basic medical facilities. Therefore, Mars One will advise the first inhabitants of the settlement to not attempt to have children. However, in order to establish a true permanent, self-sustaining settlement on Mars, Mars One recognises that having children will be vital. Therefore, this will be an important area of research.

### Is there a plan to make Mars One commercially viable?

Establishing the first human settlement on Mars is likely to be the defining moment of the 21st century and the most exciting event in our lifetime. People from around the world would like to support this mission and are contributing by donating to our human mission to Mars. Mars One receives donations from over 100 countries every month. Although we expect revenues from donations received till our first unmanned mission lands on Mars to contribute substantially to our mission, this will not be enough to finance the entire mission. This is why a large part of Mars One's mission will be financed by investments from the private sector. In order to accept investments, the Mars One Foundation has established Mars One Ventures which is a for-profit entity that allows investors to buy shares. Mars One Ventures holds the exclusive media and intellectual property rights to Mars One's mission and will monetize it to enable the mission and to provide shareholders a return on their investment. That return on investment will come from several revenues streams,

including media exposure, brand partnerships, intellectual property rights, merchandise, and several other business cases.

### Any partnerships with national space research organizations?

At this moment, there aren't any partnerships with national or international space organizations, but we've had several initial discussions with NASA about potential future partnerships.

### How can a school teacher in India help this initiative?

School teachers in India can help by discussing Mars One's mission plans in class. This will help spread the word and create awareness. This is not only important for Mars One but for developments in the space industry in general. Teachers can have a very positive impact on the development of students and can inspire young boys and girls to chase their dreams and become engineers, scientists, and astronauts themselves!



**Note:** Credits for the image used in the background of the article title: Settlement camera, Bryan Versteeg, Mars One, URL: <http://www.mars-one.com/>.