Long Way to Mars:
An Evaluation on Mars Colonisation in the Next 50 Years

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Abstract

The aim for this article is to perform a qualitative analysis on the possibility of human colonisation on Mars within the next 50 years. We started with understanding the necessary conditions to sustain a colony under ideal situations and evaluating the use of generators, MOXIEs, atmospheric condensers, hydroponics, and Martian concrete for achieving such conditions. We then evaluate the possibility of constructing and supporting colonies with robotic automation. In the final part, we analysed the potential for reducing operation costs using Luna colonies and large scale orbital stations. Through these analyses, this article demonstrates that we would meet the technological requirement for establishing Mars colony in the immediate future.

1 Introduction

With rising environmental problems as well as heightening socioeconomic disparities, the onlook of interplanetary expansion has never been brighter. The promise of resources, novel conditions for scientific experimentation, as well as the possibility to reach for the stars has motivated many to seek out the possibilities of Mars colonisation. This article aims to address the aforementioned goal in terms of its technological possibility within 50 years.

2 An Initial Colony

One must assume that total terraforming of the planet is a pipe dream in the immediate future, as the Martian atmospheric density is simply insufficient.[1] And given the logistical difficulties, In-Situ Resource Utilisation (ISRU) is a must. However, using hydroponics for food, atmospheric condensers for water, Mars Oxygen ISRU Experiment (MOXIE) machines for oxygen,[2] generators for electricity, and Martian concrete or caving techniques for shelter,[3] we fully satisfy the five fundamental needs for human survival.

Therefore, we establish that there exists a colony that can sustain human habitation. This is not to say that one could expect to breath the martian air under open sky anytime soon, as the term colony, in this case, merely refers to the habitable space constructed on Mars, just like that of the McMurdo Station in Antarctica.

3 Achieving Self-Sufficiency

Like all outposts in Antarctica and the naval vessels, the core issue of their operations resides in the problem of self-sufficiency. A nuclear submarine can only stay out for as long as the rations would last. How to be self-sufficient? Considering the Earth-Mars transfer window, it is only advisable to launch for crewed missions once every two years. For cargo supply missions, such limitations do not apply, as packaged goods, materials, and equipment, when shielded properly, are not subject to the suffering of a five to nine month transfer orbit travel time,[4] with no worry about losing bone density due to lower gravity, or that of the psychological impact of sustained isolation.[5] It is therefore wise to push for large scale unmanned cargo drops to the targeted colony area to build up deposits of readily available resources, many years prior to the arrival of crewed missions.

Now, to build the base, one could implore the automation techniques readily found in large scale factories worldwide. The idea is to deliver enough infrastructures, either as prefabs or that of fleets of robots for the initial industrialization of Mars, to establish power generators, industrial infrastructures, and life-support modules. Industrial 3D printing, caving Martian surface for habitation, or outright utilising the prefab modules to assemble an initial habitat are all viable options for robots, for the immense workload could be eaten up progressively throughout prolonged operation time.

One could simply drop in a batch of robots, and as long as a significant portion of the said robots survives the drop, the remaining robots could gather, refine, build-up, and eventually fabricate new robots on Mars. The onlook is that when the crewed missions do arrive, an established habitat could be ready to sustain manned operations. To further elaborate on the previous subject of robotic automation, one must establish redundant systems in case of failures. Operation centres on Earth that are upkept with constant human monitoring, as well as communications satellites on the Mars synchronous orbits, effectively creating man-in-the-loop processes to guide the automation efforts.

4 The Economic Option

In the previous sections, we have established that the current human technologies would allow for the construction and upkeep of an initial colony with cargo missions and ISRU industries.[6] One must therefore consider the means for reducing operating cost in order to make the continuous support of Mars missions sustainable.

Compared to Mars, Luna is a much closer object, and to prospect and establish human colonies on Luna would therefore be relatively easier. During the timespan of initial cargo missions to Mars, repeated crewed missions, along with cargo drops on Luna, would allow for immediate establishment of Luna colonies. It is expected that the Luna missions would further refine the techniques needed for large scale colony development on Mars. The prospect of industrialising Luna and having her serve as the forward operating base for Mars colonisation indicates that many missions to Mars could route through Luna for refuel and resupply, cutting down the reentry fuel costs.[7] Similar arguments can be said about orbital stations. Consider establishing a large-scale station in Earth orbit, low or high, to take advantage of the low gravity environment to construct large scale spacecraft needed for interplanetary transfers.

5 Conclusions

Under ideal circumstances, the current human technology has sufficient capacity to provide for a comprehensive, small scale, scientific oriented Mars colony, paving ways for future endeavours to commercialise and industrialise Mars. This article also assumed that large scale terraforming projects are not the immediate concern of the initial colony. And the current limit presented in the lack of efficient propulsion technology for low-cost, rapid transfers between Earth-Mars orbits, making regular, manned crew rotations an unlikely scenario.

It is also debatable on how far the existing technology would evolve, such that the efficiency and reliability of the industrial infrastructure would guarantee the prosperity of a Martian colony. However, with the proposed pre-mission supply drops at targeted landing zones as well as regularly scheduled unmanned launches outside of Earth-Mars transfer windows could bring in sufficient supplements for colonial success. It is for these aforementioned analyses that we believe that the establishment of an initial Mars colony by 2072 is technologically achievable.

References

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