Paper ID: 49674
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22nd IAA SYMPOSIUM ON HUMAN EXPLORATION OF THE SOLAR SYSTEM (A5)
Human Exploration of Mars (2)

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PARAMETRIC EQUATION FOR THE SETTLEMENT OF MARS

Abstract

The colonization of Mars has been addressed by many authors but there is still a lack of methodology to determine its feasibility in terms of costs and logistics. Many advanced technologies have been suggested to exploit in situ resources but it is not clear how much time, how many people and how many rockets have to be launched and sent to the planet before autonomy is achieved and the colony is considered viable. We propose a new approach to address these questions. It is based on a mathematical model of the required payload mass per year that has to be sent to Mars to sustain the life of the settlers during the long period of development of the colony that precedes the self-sufficiency capability. As the required mass is highly dependent on the available working time of the settlers, it is suggested to transform the mass estimation problem into the problem of estimation of the annual missing time to produce all objects needed for the daily life of the settlers. The annual missing time is calculated using five parameters. The first is the number of settlers. The second is the working time capacity per person. The third is an estimate of the total time per person and per year that is required to produce all objects needed for a single person. The fourth is called the sharing factor and is a function of the number of settlers. Intuitively, many objects are indeed shared by several persons (a kitchen, a power plant, etc.). The total time per person to produce all objects is therefore weighted by the sharing factor. Finally, the fifth parameter allows the conversion of the annual missing time into an annual mass of payload. Several methods are proposed and discussed to determine the values of the five parameters. The first important result is that our mathematical formula can be used to determine the evolution of the required payload mass as a function of the number of settlers. As intuitively expected, at the beginning of the colonization, there is a small number of settlers and the required payload mass quickly increases. As the number of settlers continues to grow, the total mass reaches a maximum and then start to decrease slowly towards zero (autonomy is achieved). Interestingly, different sets of parameters can be used to test different scenarios for the development of the colony.