Paper ID: 52862
oral
student

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

Author: Mr. Shamil Biktimirov
Skolkovo Institute of Science and Technology, Russian Federation, shamil.biktimirov@skoltech.ru

Ms. Anne-Marlene Rüede
Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland, anne-marlene.ruede@epfl.ch
Prof. Anton Ivanov
Skolkovo Institute of Science and Technology, Russian Federation, A.Ivanov2@skoltech.ru

NEAR-EARTH ASTEROIDS MINING AS INTERPLANETARY ECONOMY SUPPLY: DESIGNING AN AUTONOMOUS MARS COLONY

Abstract

The expansion of mankind to other planets will require supplying colonies with materials. This paper describes a concept for supplying these colonies with resources extracted from asteroids and proposes the optimisation of an interplanetary economy (IE) including Earth, Mars and asteroid groups. We refer to prospective Mars colony design reference architecture (DRA) to define needs to be covered by IE, and specify requirements for supply missions and target asteroids. Near-Earth asteroids (NEAs) were frequently considered as a source of water and precious metals for Earth's needs. On Mars, in-situ resource utilisation (ISRU) can support the most essential of the colony's needs. Indeed, regolith, water at the Polar cap, oxygen, carbon, nitrogen, and some metals, such as aluminum, iron and silicon are present on planet's surface, and could be used to support an initial Mars base. However, a variety of materials are difficult to access on Mars. These include water, depending on the location, and metals. Therefore, when considering a sustainable colony, additional resources will be required for the production of fuel, plastics, metal alloys, and electronics. While comparing direct supplies of Mars by Earth with the supply by NEAs, the advantages of asteroids-based supply have been identified. It has been calculated that using ISRU on NEAs could significantly increase amount of materials to be transferred to Mars, as well as reduce the quantity of propellant required for resources transportation. To model IE with colonies on Mars and mining factories on asteroids, a methodology consisting of three parts has been used. The first is the selection of target asteroids. Supplying Mars colonies with specific needs for a 20 years duration campaign, starting in 2050, and cargo spacecraft with payload of 1 ton and maximum Δv capability of 6.0 km/s for transporting resources between nodes of the network have been considered. The second part is flight opportunities calculation for ensuring Mars colony supply. For each mining site, Δv maps are created for the transfers to and from Mars. From these, a list of local minimums below a maximum Δv capability has been compiled. The third part is devoted to the supply schedule optimisation according to specific cost function. Thus, we demonstrate the methodology and tools for designing and optimising interplanetary infrastructure for extraterrestrial colonies supply. The modelling results allowed to evaluate the feasibility of the Mars colony DRA and to propose a technology roadmap for a new level of human spaceflight missions.