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ORPHEUS - ORBITAL RECONNAISSANCE AND PHOBOS EXPLORATION BY HUMANS: A FEASIBILITY STUDY OF A SHORT STAY MISSION TO THE PROXIMITY OF MARS.

Abstract

The ISECG Global Exploration Roadmap (GER) has identified the need for manned missions to Mars to advance our exploration of the solar system. In order to establish a manned base on Mars, one of the first steps is to better understand the martian environment, and develop technology that allows humans to travel and survive there. In order to achieve these goals a feasibility study of a mission to the proximity of Mars has been performed. This was done over six months by twelve international students as part of the SpacE Exploration and Development Systems (SEEDS) Masters Course.

Orpheus is a 602 day return mission to the vicinity of Mars, comprised of two manned Phobos landings and three robotic Mars surface probes. It proposes the use of two spacecraft: a manned Crew Interplanetary Vehicle (CIV); and a cargo vehicle, the Mars Automated Transfer Vehicle (MATV). Scientific advancements, technological progress, increased public interest and international cooperation are the main objectives of this mission. An innovative configuration of the CIV was designed to sustain a crew of six for the mission duration. The CIV is considered to depart from LEO in 2036 using cryogenic propulsion

for Trans-Mars injection (TMI). Once in Mars proximity, the primary manoeuvres are performed using nuclear thermal propulsion and a bi-propellant chemical system for the minor manoeuvres. The CIV has a calculated IMLEO of 3981 tonnes, comparable to that of the ISS construction mass, considering the 37 shuttle launches. In order to perform some preliminary science analysis and landing sites investigation the MATV would arrive two years before the CIV. It would use a low thrust trajectory, transporting the Phobos Lander, an Orbital Laboratory- for initial sample analysis - and three planetary rovers for providing a distributed Mars surface analysis network. The MATV will stay in Martian orbit after the CIV departs, providing a communications relay for the surface probes.

Significant challenges to the design, such as the integrated radiation dose received by astronauts and the propellant boil-off problem were investigated: proposals for mitigating them are provided in the paper. In addition a detailed trajectory analysis was performed, and innovative propulsion systems and inflatable habitable modules were considered.

The result is an innovative concept of a manned mission to the vicinity of Mars, leading to outputs which can help to pave the way for the future of manned space exploration.