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SPACE EXPLORATION SYMPOSIUM (A3)
Mars Exploration – Part 2 (3B)

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INSPIRATION MARS 2021 MISSION DESIGN

Abstract

Throughout the Mars nodal cycle there are periods where a mission can be designed in which the spacecraft, once sent on an Earth departure trajectory, is able to fly a 'free-return' around Mars returning back to Earth with little more maneuver requirements than Trajectory Correction Maneuvers (TCM). Recently, a mission design study was commissioned under the Inspiration Mars name and a 2018 opportunity identified as a candidate mission. Subsequent to the 2018 mission study, a similar opportunity for a Mars 'free-return' has been found in the late 2021 timeframe. The Boeing Company's Space Exploration Division, in collaboration with other industry stakeholders, investigated the 2021 opportunity and the potential support of this mission design by the Space Launch System (SLS) and the Orion. This paper explores the strategy of that investigation and provides insight into the challenges and results of designing the 2021 mission for a crewed mission around Mars. We present research findings regarding the use the SLS with a Large Upper Stage (LUS) and the Orion spacecraft, along with a habitation module, which show the viability of performing the mission at the 2021 opportunity, utilizing technologies which are available within the appropriate timeframe in supporting the mission. The key success criteria is in the development of the SLS and Orion, and the integration of existing technologies, such as a hybrid propulsion system and habitation systems, into a end-to-end mission design that enables humans to travel to Mars and return back to Earth. A unique difference between the 2018 Mars free-return opportunity and the 2021 opportunity is the Earth departure energy required to send the spacecraft on its way. The 2021 holds much greater promise for a successful mission design as the energy required can be provided within a single SLS launch in a configuration with a LUS, assuming four RL-10 engines. In the paper, the authors step through the investigation and analysis in such a manner as to reveal the results that could lead to one of the greatest human spaceflight missions of all time, using assets and technologies which are achievable in the requisite timeframe.