

SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)  
Going To and Beyond the Earth-Moon System: Human Missions to Mars, Libration Points and NEO's  
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Author: Mr. Jonathan Battat

Massachusetts Institute of Technology (MIT), United States, jabattat@mit.edu

Prof. Oleg Alifanov

Moscow Aviation Institute, Russian Federation, o.alifanov@yandex.ru

Dr. Robert D. Braun

Georgia Institute of Technology, United States, robert.braun@ae.gatech.edu

Prof. Edward Crawley

Massachusetts Institute of Technology (MIT), United States, crawley@mit.edu

Dr. John Logsdon

Space Policy Institute, George Washington University, United States, logsdon@gwu.edu

Prof. Lev M. Zelenyi

Russian Academy of Sciences, Russian Federation, lzelenyi@iki.rssi.ru

Prof. Mariel Borowitz

Georgia Institute of Technology, United States, marielborowitz@gmail.com

Mr. Emanuele Capparelli

Skolkovo Institute of Science and Technology, Russian Federation, e.capparelli@gmail.com

Prof. Alessandro Golkar

Skolkovo Institute of Science and Technology, Russian Federation, golkar@skolkovotech.ru

Dr. Bradley Steinfeldt

Georgia Institute of Technology, United States, bsteinfeldt@gatech.edu

COOPERATIVE SCENARIOS FOR HUMAN EXPLORATION BEYOND LOW EARTH ORBIT

**Abstract**

There is an international need to define a concrete strategy and plan for the initial human exploration missions that will extend beyond Low Earth Orbit (LEO). The current long term objective of global human space exploration is eventual long duration presence of people on the Martian surface. Along the pathway between current activities in LEO and eventual Mars outposts are a variety of preparatory exploration missions and intermediate goals. Over the last decade several different initial steps beyond LEO have been proposed. It is important to build international consensus on such a plan soon because future missions require near-term investments for new capabilities and no single nation can achieve an ambitious program on its own. A group of academic experts from the United States and Russia are working together to address this complex multidisciplinary planning problem. The goal of this work is to enumerate and evaluate options for missions beyond LEO that achieve incremental development of human exploration capabilities.

The approach of the group is to build upon the goals and objectives described by the International Space Exploration Coordination Group (ISECG). An initial evaluation of different mission options by several figures of merit includes programmatic and technical risks as well as the exploration objectives satisfied by each mission. In addition to high-level technical analysis, interviews of industry members and other experts (?) involved in current and future exploration operations were conducted to capture the strategic rationale for potential contributions to future human spaceflight from different industry and

national perspectives. Results of the interviews include likely contributions from partnering nations and strategies for developing capabilities along the way to Mars. This paper will summarize the overall results of the study by presenting a set of scenarios for future human exploration missions. Synthesized scenarios presented include which actors may contribute to a cooperative program, how specific elements can be allocated to participating nations, and the rationales for various nations to commit to these contributions.