

20th IAA SYMPOSIUM ON HUMAN EXPLORATION OF THE SOLAR SYSTEM (A5)
Human Exploration of the Moon and Cislunar Space (1)

Author: Mr. Davide Conte
Pennsylvania State University, United States

Ms. Marilena Di Carlo
University of Strathclyde, United Kingdom

Mr. Daniele Barbera
United Kingdom

Ms. Dorota Budzyn
Wroclaw University of Science and Technology, Poland

Mr. Douglas Fleming
United Kingdom

Mr. Szymon Gryś
Poland

Mr. Craig Hay
University of Strathclyde, United Kingdom

Mr. Naruomi Ikeda
Research Institute for Sustainable Humanosphere, Kyoto University, Japan

Mr. Jonathan Jamieson
University of Strathclyde, United Kingdom

Mr. Thomas Lund
University of Strathclyde, United Kingdom

Mr. Juan Manuel Romero Martín
United Kingdom

Ms. Agata Mintus
Poland

Mr. Lorenzo Teofili
University of Rome "La Sapienza", Italy

Mr. Renato Volpe
Italy

MISSION ARCHITECTURE FOR HUMAN EXPLORATION OF CIS-LUNAR SPACE VIA
TELE-OPERATED ASSETS

Abstract

The work outlined here was inspired by the result of the 2015 ESA Moon Challenge, an international student competition that took place during October-December 2015. This paper presents the preliminary design of the international space mission HECATE (Human Exploration of Cis-lunar space via Assets Tele-operated from EML2), aimed at exploring the far side of the Moon via tele-robotic activities during the 2020s and with the objective of establishing human presence in cis-lunar space. The work presented here also expands on HECATE to show its role in exploring the Moon during the 2020s and 2030s following the current views of the "Moon Village" as proposed by the European Space Agency. The exploration of the Moon's far side is realized by astronauts from HOPE (Human Orbiting Protected Environment),

a space habitat in a halo orbit around the Earth-Moon Lagrange Point 2 (EML2), a critical staging location for robotic and human missions in deep space. HOPE is delivered in three stages via commercial and NASA launch vehicles to EML2. The necessary scientific equipment and exploration rovers are also launched using commercial launch vehicles. In mid-2024, a crew of three astronauts is launched with the Orion Multi-Purpose Crew Vehicle to rendezvous with HOPE, perform tele-robotic exploration of the Moon for 40 days, retrieve samples of the lunar surface and return to Earth in June 2024. Inside the habitat, astronauts have access to tele-robotic hardware and instruments, used to tele-operate rovers and scientific equipment on the surface of the Moon. A key element of the proposed mission is the partnership of human and robotic components as well as telepresence, the tele-operation of robotic assets on the lunar surface. Tele-presence could significantly enhance the ability of humans and robots to explore together, allowing in the future the exploration of the most challenging locations in the Solar System and preparing sustainable exploration using local resources, i.e. In-Situ Resource Utilization (ISRU). Plans to resupply and maintain HOPE for future missions, using a solar electric tug, are given, making HOPE a reusable and sustainable space station in cis-lunar space. HECATE is a feasible and sustainable mission aimed at furthering the presence of humanity and HOPE represents an energetically favorable intermediate location for missions to the Moon, Mars, Near-Earth Asteroids, and beyond.