9th SYMPOSIUM ON STEPPING STONES TO THE FUTURE: STRATEGIES, ARCHITECTURES, CONCEPTS AND TECHNOLOGIES (D3)
Strategies and Architectures to Establish a "Stepping Stone" Approach to our Future in Space (1)

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HUMAN MISSIONS TO MARS AND VENUS ORBIT FEATURING TELEOPERATED SURFACE EXPLORATION

Abstract

This paper presents concepts for human missions to the orbits of Mars and Venus that feature direct robotic exploration of the planets' surfaces via teleoperation from orbit. These missions are good examples of Human Exploration using Real-time Robotic Operations (HERRO), an exploration strategy that refrains from sending humans to the surfaces of planets with large gravity wells. HERRO avoids the need for complex and expensive man-rated lander/ascent vehicles and surface systems. Additionally, the humans are close enough to the surface to eliminate the two-way communication latency that constrains typical robotic space missions, thus allowing real-time command and control of surface operations and experiments by the crew. In fact through use of state-of-the-art telecommunications and robotics, HERRO could provide the cognitive and decision-making advantages of having humans at the site of study for only a fraction of the cost of conventional human surface missions. HERRO is very similar to how oceanographers and oil companies use telerobotic submersibles to work in inaccessible areas of the ocean, and represents a more expedient, near-term step prior to landing humans on Mars and other large planetary bodies. Its concentration on in-space transportation systems makes it extensible to destinations that have not been associated with human missions in the past but may be of potentially great scientific interest, such as Venus.

These missions utilize the same Crew Transfer Vehicle (CTV) design. The design is based on the requirements for a campaign of consecutive HERRO Mars missions. These begin in 2030 and span a period of approximately one decade. It is assumed that the Venus mission is conducted after the Mars campaign, starting no earlier than 2040. From a space transportation standpoint, the Venus mission is easier to achieve than the Mars mission. Although some modifications are required to accommodate operations closer to the sun, the Venus mission takes full advantage of the spacecraft and the in-space infrastructure used in the Mars campaign.

The surface infrastructure for the two options is different. The surface systems for the Mars mission consists of three sets of telerobotic elements, each composed of a long-range "truck" transporter and two finely articulated "rockhound" robot geologists. For the Venus mission, four single rover platforms are used. These platforms require significant advancement in technology in Stirling cryocoolers, radioisotope power supplies and high temperature electronics. However, it is reasonable that the necessary development could take place to meet a mission in the 2040 timeframe.