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AN INTERDISCIPLINARY APPROACH TO HUMAN-ROBOTIC COOPERATION IN MARS  
EXPLORATION

**Abstract**

This paper will present the conclusions of the Team Project “Human-Robotic Cooperation”, of the International Space University’s 2011 Space Studies Program, held in Graz, Austria.

For 12 hectic weeks, an international, intercultural and interdisciplinary team of approximately 35 students and young professionals will study the state of the art in human-robotic interaction in the space domain. Focusing on Mars exploration in the next 20 years, the students will describe, and conduct trade-off analyses of, scientific, technical, cultural and political aspects of the following scenarios:

1. The classical approach of an in-situ exploration of the Mars surface by humans.
2. An integrated approach in which humans explore the Mars surface robotically, from an orbital vantage point either in low Mars orbit, or on Phobos/Deimos.

As part of their undertaking, the students will identify potential improvements in mission safety and decreases in mission cost from the utilization of robots as partners to the astronauts, or as replacement for them. The students will also analyze potential incompatibilities between astronauts and robotic and automated elements and any political or cultural implications of employing robotic mission components rather humans.

Also addressed will be the design of the required human-robotic interfaces from technical, usability and psychological points of view, as well as the consequences of utilizing robotic mission components in terms of flexibility, timeliness, and reaction time, in cases of unexpected events, such as new scientific targets of opportunity.

Based on their analysis, the students will present a reference model for human-robot cooperation in Mars exploration that efficiently satisfies the identified constraints, while maximizing scientific, technical, and cultural benefit.