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THE SIGNIFICANCE OF OPERATIONS PREPARATION FOR THE SUCCESSFUL MOON
EXPLORATION**Abstract**

Numerous attempts have been made to increase the reliability of spacecrafts, however, they inevitably come with some forms of off-nominal or unexpected situations in many of those operational phases of those spacecrafts. The success of Moon exploration is not only to accomplish things as planned but also to appropriately respond to every off-nominal or contingency situation with the well-thought-through operations preparation as well as its mission concept and analysis. Little attention has been given to the importance of the operations preparation.

The Japanese Experiment Module “KIBO” was assembled in space as part of the International Space Station (ISS) in 2008 and 2009. It has been operated by certified flight controllers at Tsukuba, Japan. It was the first attempt toward human space flight operations in the history of Japanese space program. In addition to the fruitful outcomes in science and physiology areas, it also has been utilized as a testbed for the future space exploration. One example of it is a teleportation of KIBO robotic arm by flight controllers in Tsukuba. The teleoperation of the robotic arm has been successfully conducted and it now covers a broad range of services from a large payload handling to a dexterous maintenance. The operational experience through the teleoperation is expected to make a large contribution to a next space exploration program.

In the planning phase of each teleoperation of KIBO, plans to respond every off-nominal or contingency situation are well taken into consideration in advance besides the nominal operations based on the mission plans. Those plans are then documented by the pre-determined format to reach a consensus among flight control team members. Furthermore, the systematic training program has also been developed for flight controllers to appropriately handle every off-nominal or contingency situation while maintaining a good situational awareness, effective communication, timely priority handling and decision makings.

This paper summarizes the importance of operations preparation for the successfully Moon exploration focusing on the following four standpoints while discussing the lessons learned acquired through KIBO real-time operations and apply those to the future Moon exploration.

(1) Spacecraft design considering the operability of flight controllers through the KIBO operations experience (2) Reliability and Consistency of system hardware and software including a ground flight control system and operations documents. (3) Efficient flight control using a hi-operability ground flight control system (4) Systematic training program for flight controllers for Moon exploration