

Lessons Learned From the Robotics Operations on STS-114 (Return to Flight)

Sarmad Aziz*

Canadian Space Agency - JSC, Houston, TX, 77058

The Space Shuttle Return to Flight mission (STS-114) was one of the most complicated robotics missions executed on board the International Space Station (ISS). It presented the ISS robotics flight control team (ROBO) with significant and unique challenges during the planning and real-time execution phases of the mission. The challenges ranged from tight timelines, to the need to develop operational concepts for new and unproven mechanical interfaces, to choreographing complex payload handoff maneuvers with the Shuttle robotics system, to major changes in the ISS configuration immediately prior to the flight, to real-time changes in the mission priorities and the addition of an unplanned EVA task to repair the thermal protection system of the orbiter. The success of the ISS based robotics operations on the mission was due to many factors. They include incorporating lessons learned from previous ISS assembly flights, the detailed and comprehensive contingency planning by the flight control team prior to the mission, and the pre-mission simulations and integrated training involving the astronaut crew and the flight control team. This paper will present an overview of the ISS robotics based tasks on STS-114 along with the challenges associated with the planning and execution of those tasks. It will describe the challenges faced during the real-time execution of the mission and the last minute changes that resulted in significant updates to the robotics procedures and rules just prior to launch and during the on-orbit phase of the mission. Analysis of the events that took place during the STS-114 mission and the lessons learned from the experience will also be presented. The lessons will cover a variety of topics related to the planning and execution of complex robotics missions; such as pre-mission planning for nominal and contingency operations, pre-mission training, and real-time replanning of robotics tasks to accommodate changes in mission priorities.

I. Introduction

The planning and execution of joint ISS-Space Shuttle missions present significant challenges to the flight control teams of both vehicles. The management and coordination of complex activities involving the on-orbit crew and flight controllers on the ground require detailed pre-mission planning and extensive training. Invariably however, on-orbit system failures and unexpected events during the mission require real-time changes to the flight plan. The changes vary in complexity from simple rescheduling or deferral of activities, to major replanning of substantial portions of the mission. The success of the mission and the safety of the crew and the vehicles often rest on the ability of the flight control team to develop the plans and procedures to safely recover from unexpected events to ensure the safety of the crew and accomplish as many of the mission objectives as possible. This was especially true for the STS-114 Return to Flight mission in July of 2005.

The STS-114 Space Shuttle mission to the ISS on-board Discovery was originally intended to re-supply the orbiting post, replace a failed Control Moment Gyro on the ISS, and deploy critical spares that will be needed for the upcoming Space Station assembly missions. Following the Columbia accident in February of 2003, the context and the purpose of the mission changed. STS-114 became the Return to Flight mission charged with validating new systems designed to prevent a recurrence of the Columbia tragedy by ensuring the health and integrity of the Space Shuttle prior to its return to earth. The new techniques relied heavily on the ISS and Shuttle robotics systems to perform on-orbit inspections and repairs of the Shuttle Thermal Protection Systems (TPS). The ISS Robotics Flight Control team (ROBO) was responsible for pre-mission integration of the new mission requirements with the re-supply and maintenance objectives. This resulted in complex and highly choreographed robotics operations that had never been attempted during previous missions. In addition, on-orbit failures and changes in the configuration of the

* STS-114 Lead ISS Robotics Officer, Mission Operations Directorate, DX22 - Johnson Space Center