ROBOTIC LESSONS FROM MAUNA KEA. F J Frenzel, T Fu, J D Gammell, P E Grouchy, K T Law, E J P Earon, G M T D'Eleuterio**,** Institute for Aerospace Studies, University of Toronto**,** Toronto, Ontario, Canada**,** M Viel, S Schmidt, D S Boucher**,** Northern Centre for Advanced Technology Inc**,** Sudbury, Ontario, Canada, J Richard, Electric Vehicle Controllers Ltd, Val Caron, Ontario, Canada

In January-February 2010, we conducted as part of an end-to-end test for a deployment scenario of in-situ resource utilization (ISRU) a multiagent teaming exercise using three rovers. The deployment took place on Mauna Kea in Hawai`i. The exercises involved three rovers dubbed the *Musketeers*, which used the Juno chassis design of Neptec Design Group Ltd and Ontario Drive and Gear Ltd.

The goal of this work was to develop control technology for the autonomous operation of rovers in an ISRU setting. The eventual return to the Moon will depend significantly on robotic capabilities. Two sets of exercises were conducted at Mauna Kea. These focused on the autonomous preparation of a landing pad site. First, the *Musketeers* executed an autonomous ground-penetrating-radar (GPR) survey of the target area for the landing pad. This was to obtain a subsurface map to enable mission operators to determine whether there were any immovable impediments to the subsequent clearing task. The second set of exercises was to perform the clearing of the area and construct the landing pad itself. This included the creation of a berm on one side of the perimeter (as would be required in an actual mission scenario so that the plume of any landing craft would be deflected up and away from nearby habitat modules and other infrastructure equipment) and an access road leading to the landing pad. Three sets of autonomous excavation algorithms were tested, two based on evolved neural-network frameworks and one on a more traditional control approach.

The presentation will review the goals of the project, the development work undertaken to build the hardware control subsystem of the *Musketeers* and the algorithm development for autonomous multiagent teaming control. We will highlight the results achieved on Mauna Kea and report the successes and failures. Most important, we shall reflect on the lessons learned from the deployment and make recommendations on the direction ahead that will ultimately lead to successful operations for in-situ resource utilization on the Moon.