IMPROVING LUNAR SURFACE SCIENCE WITH ROBOTIC RECON. T. Fong[1], M. Deans[1], P. Lee[2], J. Heldmann[1], D. Kring[3], E. Heggy[3], and R. Landis[4]. [1]NASA Ames Research Center, Moffett Field, CA, terry.fong@nasa.gov. [2]SETI and Mars Institutes. [3]Lunar and Planetary Institute. [4]NASA Johnson Space Center.

Introduction: When humans return to the lunar surface near 2020, three key goals will be to setup infrastructure, build a lunar outpost, and conduct science. To help achieve these goals, we are developing integrated human robotic systems, including robotic reconnaissance to improve lunar traverse science[1].

Robotic Recon: In NASA's current lunar architecture, surface missions will be spaced on six month intervals. Initially, crew will be on the lunar surface less than 10% of the time. During the 90% of time between crew visits, robots will be available to perform surface tasks to prepare for subsequent missions, reduce risk, and make surface operations more efficient.

Prior to these surface missions, spacecraft in lunar orbit will be used to map the surface. However, remote sensing data may not be of sufficient resolution, nor view angle, to fully plan surface activity, such as crew traverses for field geology. Thus, it will be important to acquire supplemental data on the lunar surface.

One method for this is *robotic reconnaissance*, i.e., using a planetary rover to scout traverses, or sites, prior to human activity. Recon is a key phase of exploration and can be traverse-based (examining stations along a route) or survey-based (systematically collecting data in a bounded area). Instruments can be used to collect data about both the surface and subsurface. The data can then be used to triage and prioritize targets of interest to improve the productivity of crew traverses.

Approach: In our work, we use two third-generation K10 planetary rovers (Figure 1). Each K10 has four-wheel drive and all-wheel steering with a passive rocker suspension.

For robotic recon, the K10's are equipped with:

- 3D lidar. Provides *cm* to *m* measurements of topography (>2x resolution of the LRO LOLA)
- Color panoramic imager (60º x135º). Provides up to 2x resolution of the LRO LROC-NA, as well as oblique, surface views.

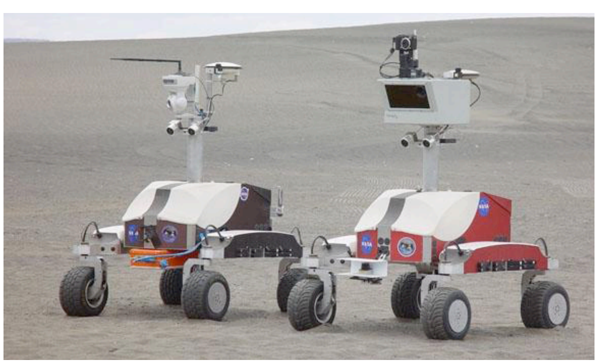

Figure 1: K10 robots with science instruments.

- Microscopic imager with 70 μm/pixel. Provides very high-resolution images of terrain.
- Ground-penetrating radar (wide-band, polarimetric, 900 MHz). Enables characterization and mapping of subsurface to 2m depth.

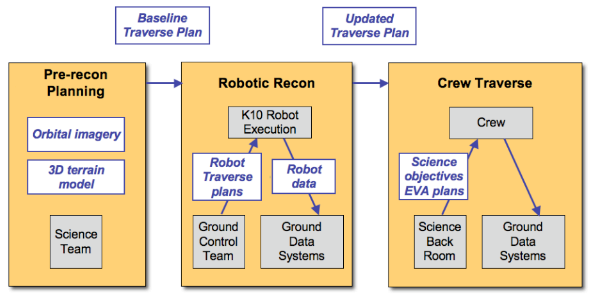

Figure 2: Traverse planning process

Figure 2 illustrates the science-driven traverse planning process that we use. Initially, a science team creates a baseline crew traverse using only orbital data and considering science objectives. Robotic recon is then performed to scout on, and near, the traverse route. Next, the robotic recon data is used to generate an updated crew traverse plan, which is then executed by crew with support from a science "backroom".

2008 Moses Lake Sand Dunes Field Test: In June 2008, we tested our robotic recon approach at Moses Lake Sand Dunes. During the test, we operated K10 rovers in robotic recon mode for four days at Moses Lake followed by a one hour crew EVA [1].

Our operations concept is derived from lessons learned by Apollo, Space Shuttle, Space Station, and the Mars Exploration Rovers [3]. Data collected during robotic recon is automatically processed by our geospatial ground data system. We use Viz[4], Google Earth, and web-based interfaces for data display.

Lessons Learned. For sites that were visited by the robot, the science team obtained detailed ground-level data that was used to improve a baseline traverse plan and briefing for the EVA crew. Overall, the test highlighted the differences between *robotic recon* and *robotic exploration*, such as done by MER. Whereas robot explorers are primarily science tools, the purpose of recon is to *high-grade* for subsequent human activity. This has a significant impact on science operations and how humans and robots work together.

References: [1] Fong, T., Bualat, M., et al. (2008) AIAA-2008-7886. [2] Bualat, M., Kobayashi, L., et al. (2008) AIAA-2006-7420. [3] Fong, T., Deans, M., et al. (2008) NLSI LSC 2142. [4] Edwards, L., Bowman, J., et al. (2005) IEEE SMC.