MISSION VISUALIZATION FOR PRECURSOR LUNAR TELEROBOTIC BASE PREPARATION.

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Introduction: NASA's return to the Moon by 2020 calls for sustainable human presence, suggesting that crew will make use of local resources for mission consumables. Generally referred to as In Situ Resource Utilization (ISRU), lunar regolith may be mined for small scale production of hydrogen, oxygen, water and volatiles. Proving up the capability to engage in ISRU will involve robot prospecting followed by infrastructure setup prior to human crews' arrival. In 2003, Raytheon was awarded a Concept Engineering and Refinement (CE&R) project by NASA to develop a lunar architecture trade study. Raytheon commissioned DigitalSpace to produce a vision for the telerobotic precursor preparation of an ISRU lunar base. Drawing from sources including Peter Eckart's Lunar Base Handbook [1] and early 1990s NASA outer planet exploration studies and other sources we produced a complete end-to-end mission scenario in real-time 3D for distribution to evaluators via the Internet [2].

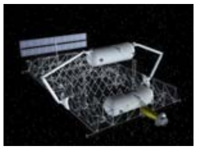

Figure 1

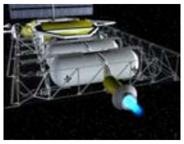

Figure 2

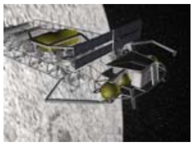

Figure 3

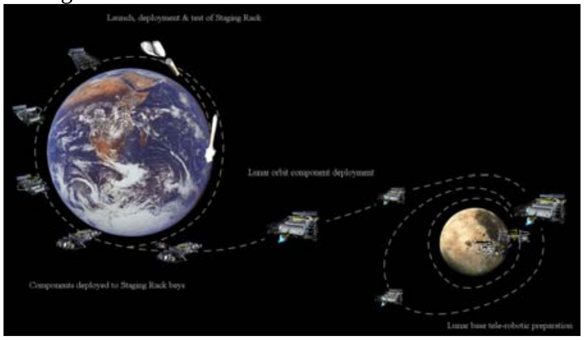

Figure 4

Results: Figure 1 above illustrates the resultant "rack" concept for an unmanned, teleoperated staging structure to be loaded in low Earth orbit with fuel, surface exploration and ISRU/construction robotics and sent to low Lunar orbit using ion propulsion (figures 2-4). Once there, the various robotic elements and human pressurized habitat are deployed and operated telerobotically from Earth. Figure 5 shows the deployment of a sinterer-excavator conceived of by Taylor et al [3] which heats and fuses the lunar surface to create a dust-mitigating stable surface for landing and trackways. The vehicle also buries the habitat for radiation protection. (figures 5-6). Teleoperated water ice/volatiles ISRU processing equipment then produces a full complement of mission consumables prior to the arrival of first crew (figure 7).

Figure 5

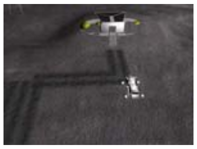

Figure 6

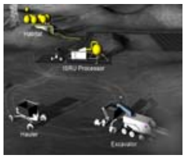

Figure 7

Conclusion: Advantages of this lunar telerobotic "rack" approach include:

1. If a single qualified ISRU source is found then this is an effective method to concentrate telerobotic resources for base preparation and ISRU utilization.
2. Single, low thrust rack delivery precludes use of multiple heavy lift launches directly to Moon and large savings in cost.
3. Rack remains in low Lunar orbit as a staging area with backup fuel and power for arrival of human crew and parking area for emergency return and on-orbit vehicles.

Risks assumed by this approach include:

4. Failure of any one element in the rack can lead to need to directly launch replacement element.
5. Radiation exposure of rack elements in Van Allen belts will last several weeks on slow trajectory.
6. Failure of rack itself will result in loss of all hardware.
7. Approach requires high readiness level in all aspects of teleoperation.

Call for Participation: DigitalSpace is calling for participation by LEAG, Space Resources Roundtable and the LPI communities to participate in future trades of this nature.

References: [1] Eckart, P. (editor), The Lunar Base Handbook, McGraw-Hill, 1999. [2] Find this mission visualization at: http://www.digitalspace.com [3] Taylor, L.A. and Meak, T.T., 2005, Microwave sintering of lunar soil: Properties, theory, and practice, J. Aerospace Engr., 18(3), 188-196.