Critical Strategies for Return to the Moon: Altair Dust Mitigation and Real-Time Teleoperations Concepts

M.Thangavelu

Astronautics and Space Technology Division

USC Viterbi School of Engineering and

USC School of Architecture

Los Angeles, CA 90089

Two Concepts

- Addressed in the USC Engineering/Architecture Lunar Lander Proposal(Lunar Surface Systems Concepts Study –July 9, 2008)
- CONCEPT 1- Dust Mitigation - Landing Pads
- CONCEPT 2 - Realtime teleoperations module – Cabin for Teleoperations, C-TOPS(Altair Ascent Stage)
- Need for high fidelity simulations

Altair Lander Operations Effects on Lunar Surface

- Altair lunar landers will produce energetic regolith debris during approach, touchdown and ascent stage blast-off.
- Severe ballistic debris effects over landing ellipse range of 5-10km depending on terrain and approach trajectories.
- Impulse Energy / Forces directly related to mass, velocity and deceleration of Altair.

Dust and Debris Suppression Elements

- Landing Pad
  - Approach -Landing- Blast Off Area regolith stabilization
  - Circular, level and paved, dust free zone 3km dia ?
  - Lidar Assisted Precision Touchdown pad 100m dia ?
  - Aprons
- Lunar Settlement Access Road
  - 3-5 km long
- Lunar Habitat Platform and allied dust suppression structures

Some Solutions include:

- OPTION 1
- Seek out naturally occurring, dust-free regions for lander operations – See Apollo Journals

- OPTION 2*
- Curtail dust production by:
  - TBD “dust supression coat” applied on landing area
  - TBD Fabric surface deployed and pinned in place
  - Sintering
  - Tiles or other paving like Contour Crafting

*requires terrain development tools

Terrain Development

- Grading and leveling
- Regolith Stabilization

- Bulldozers, tampers and grading equipment
- Fabric Deploying Equipment
- Tile laying, coating, finishing

- Real-time Teleoperations is recommended

Realtime Teleoperations

- Cabin for Teleoperations(C-TOPS)

(Addressed in USC Lunar Surface Systems Concepts Study Proposal, July 09, 2008)

- Circumvent Earth based time delay and system latencies >> 2.77sec
- No High bandwidth Earth-Moon link necessary
- Early mission manifest – Crew Activity rationale
- Designed to be Altair modular ascent stage ?
- Reusability ?
- Modular design may allow C-TOPS transplant to lunar base after initial landing pad mission.

C-TOPS - First Assignment

- Landing pad

- build and commission

- Assisted by capable robotic terrain development vehicle

- Chariot /Lance ?

High Fidelity Simulations

- Sintering needs to be done in simulated lunar environment to correctly evaluate physical and chemical changes - directly impacts understanding of physical properties of materials and structures
- Suitable lunar dust suppression Fabric materials for roads and landing pads needs identification and rigorous testing
- Terrain development tools are prerequisite

Work in Progress

- USC is interested in teaming with agency and industry partners to study and simulate :

- Debris curtailment concepts
- Dust suppression technology
- Lunar Landing Pads, Roads and Habitat Platforms
- And associated structures and elements
- Real-Time Cabin for Teleops (C-TOPS) design