ADDRESSING INTERNATIONAL LUNAR SURFACE OPERATIONS. M. Lupisella[1], D. Eppler[2], L. Arnold[3], R. Landis[3], M. Gates[4], S. Hovland[5], B. Foing[6], J. Olds[7], D. DePasquale[7], R. Lewis[8], M. Hyatt[9], C. Conley[10], D. Mandl[11], S. Talabac[11], K. McNamara[12], M. A. Perino[13], L. Alkalai [14] C. Morrow[15], J. Burke[15]
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Introduction: The 9th International Lunar Exploration Working Group (ILEWG) "Sorrento Declaration" recommended "*establishing an informal Lunar Surface Operations Working Group under the ILEWG, which would aid in the definition of compatibility issues, such as interoperability for both initial robotic and later human missions*" [1]. It was apparent at the Sorrento meeting that many issues raised could benefit from an international effort that looked broadly and systematically at a wide range of surface operations considerations. We will present investigations regarding a systems engineering approach and Excel-based prototype analysis tool for lunar surface operations that incorporates international considerations – informed partly by preliminary issue areas and questions that we will also present – which were formulated after last year's Sorrento ILEWG meeting.

NASA has begun to examine lunar surface operations as part of lunar mission assessments and as the Lunar Surface Systems Project is being formed within the Constellation Program. Terrestrial analog activities [2], the NASA Lunar Architecture Team (now the Constellation Architecture Team), and other related efforts have been drivers for looking at surface operations – primarily from the perspective of surface EVA activities (including some science implications) and architectural implications. Some international considerations, such as communication standards, are also being explored. However, as international issues for lunar exploration continue to be examined in more detail, a more comprehensive integrated approach will be needed.

We will first touch on potential issue areas that have been considered, for example:

- *Safety* (e.g. international crew health standards)
- *Compatibility and Interoperability* (e.g. lunar surface element interfaces)
- *International Knowledge Management and Information Systems* (e.g. international lunar database)
- *Science Integration* (e.g. sample handling standards)
- *Earth-Moon Relationship* (e.g. crew autonomy)
- *Environmental Management* (e.g. contamination)
- *International Public Engagement*
- *Mars Feed Forward*

The above considerations have informed investigations for a systems engineering and integration software tool prototype, that integrates: (a) *lunar system elements*, (b) requirements, (c) *mission scenarios*, (d) *operational metrics* such as safety, operability, interoperability, maintainability, logistics, human factors, autonomy, work efficiency index, science, environmental management, Mars feed forward, and international factors, and (d) *system, technology and operational emphases alternatives*. This "operations systems engineering" approach allows for comprehensive integrated analyses, whereby operations metrics are evaluated against capabilities of individual elements, mission scenarios and system alternatives. This approach helps capture the combined effects of multiple factors together as a system, helping to develop operations requirements and a better understanding of overall operational system interdependencies.

References:

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