

"Modeling Lunar Partnerships for the NASA Emerging Space Office"

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A rich set of public-private partnership (PPP) tools are available that could help NASA attract commercial interest in lunar infrastructure, locally-derived products and supporting services, potentially accelerating the return of humans to the lunar surface. The right kind of public-private joint venture could reduce human exploration operational risks, while also directly stimulating space commercialization by planting the seeds for new industrial processes while also creating new markets in space.

Under contract to the NASA Emerging Space Office, our team is modeling a commercial lunar ecosystem to provision propellant, life support consumables and other materials to NASA as one customer among many, using conservative assumptions and published parametric relationships to solve for the variables that matter most to private investors - risks, return on investment and timing. Embedded in the model are 'dials and switches' that emulate incremental steps that government could undertake as a joint-venture partner. The addition of private capital, industrial technology and management experience (combined with a healthy dose of market competition) could potentially increase the robustness of NASA's human space exploration missions by providing sustainable, affordable, complementary options that to reduce NASA's science, spaceflight, infrastructure, logistics and operations costs. A commercial-off-the-shelf or COTS-type approach as outlined in the Evolvable Lunar Architecture study (Miller, 2015) could also lower the risk of NASA program cancellation as well as the requirements creep that typically accompanies cyclical regime change – a problem that is especially troubling for long-duration programs. Indeed, a lack of fully-considered congressional, executive and commercial economic factors may have been the leading historic cause of programmatic failure.

The primary objective of the study is quantitative evaluation of partnership scenarios. The work started by updating prior in-situ resource utilization (ISRU) technical and economic models jointly developed by NASA and Colorado School of Mines more than a decade ago in order to simulate emerging elements of lunar resource development. A new framework has emerged, enabling the simulation of multi-commodity ISRU supply combined with a multi-year demand forecast as a framework for PPP comparison and scenario analysis. Conservative scenarios are being modeled to estimate the effect of both supply and demand side stimulation through PPP elements, providing a quantitative estimate of the degree of schedule acceleration and risk reduction as well as returns for commercial lunar enterprise. This work also draws upon comparisons to terrestrial mining activities, where byproducts can generate profits that augment the primary commodity produced.

A successful lunar industrial development program would be good for the country, offering a path to revitalize the US economy by opening up whole new worlds of resources while increasing national employment in aerospace and other high technology sectors. Future work could examine secondary synergistic effects to illuminate the potential for utilizing prior infrastructure to enable incremental investments that could generate leveraged economic benefits. These secondary opportunities can showcase the value of longer-term investment in expanding products and markets under specific scenarios, extending the evaluation and payback horizon to include Mars exploration and more advanced space infrastructure, products and services. The tool could also be expanded to create a framework that could evaluate the contribution of near-term prospecting and ISRU technology demonstration missions toward generating commercially useful results.