

Habitation Logistics Transportation Support for Lunar Commercial Resource Recovery,

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Introduction: Space commerce based on commercial markets may emerge in orbits around Earth and toward the surface on the moon. Based on habitation practices on resource recovery base camps in remote areas on Earth, a place to sleep and eat is always required. Habitation in commercial ventures varies greatly depending on the remoteness, labor morale, and logistics support.

The Remote Lunar Camp: The surface of the moon is 50 times more remote, with greater temperature differences, and orders of magnitude more expensive than any remote natural recovery base on Earth. An established commercial logistics for the lunar surface can provide NASA and other governments with the ability to move to other destinations and beyond. The further from our home planet, the more critical is the logistics support. On Earth vast amounts of staff are dedicated to logistics efforts. The military dedicates 9 logistics people for every front line soldier. Commercial space organizations will use fewer people, but new lunar transportation systems are emerging and propose a logistics architecture that is designed to have sustainable growth over 50 years, financed by private sector partners and capable of cargo transportation in both directions in support of lunar resource recovery. Eventually a Lunar trade route will emerge and economics will govern the evolution of the lunar trade route.

Earth's Remote Camp Experience: The paper's perspective is from the author's 5 years experience living at remote resource recovery sites on Earth and some of the problems experienced in logistics operations that didn't always work. The planning and control of the flow of goods and materials to and from the moon's surface may be the longest and most complicated logistics challenge yet to be attempted by mankind. The price paid, if a single logistics system does not work well is significant. On the Alaskan North Slope, we had four different logistics transportation systems and none work successfully all the time. Sometimes none worked for short periods in the winter. The Lunar Logistics operation should have at least two complete cargo logistics systems to insure sustainment.

Living Off The Land: The Early pioneers learned to live off the land, because an axe was easier to carry than a pallet of lumber. Cost reduction can be achieved by using mass that is already at a remote location rather than transporting the mass again. This development concept is called "Living off the Land" (LOTL) and uses existing local materials whenever possible in a cost reduction attempt to eventually become self-sufficient and sustainable. The author estimates 90% of the mass used to develop the remote Prudhoe Bay Oil Field on the Alaskan North Slope was already there before the oil companies started their first oil field. The oil companies developed LOTL operations first rather than later, because of the huge cost reductions possible. How can LOTL cost reduction applied to the lunar surface?

Lesson's Learned in the Arctic: The lessons learned from previous logistics systems will be discussed and solutions proposed. The industrial sector has, in the past, invested large sums of risk money, \$20 billion for example, in resource recovery ventures like the North Slope of Alaska, when the incentive to do so was sufficient to provide a return on the risk investment. They encouraged commercial for profit companies to spend their money by creating future realistic markets. Big Oil companies to develop resources use a number of development financing techniques. The oil companies did not spend their risk money to develop logistics services. Other commercial organizations spent their money to create and operate the logistics system used in Alaska. Stimulating an even larger private investment is needed for the moon's resource development. The development of the moon can build on mankind's successes in remote logistics bases on Earth and learn from the \$20 billion in private sector funds used to recover oil assets above the Arctic Circle.

Commercial Financing Techniques: The invested private capital grew to an estimated \$200B as commercial financing techniques expanded in the Arctic oil fields and it was all private money. The moon is different than the Earth's surface, but some of the logistics lessons learned in the Arctic can potentially work again on the moon. The proposed commercial lunar trade route of mankind utilizes existing Expendable Launch Vehicles (ELVs) that are commercially available.

Stimulating an even larger private investment in magnitudes like the development of oil fields is needed for the moon's resource development. The lunar investment required is far beyond what a government can provide, but governments can stimulate early resource markets and use other commercial techniques to accelerate the lunar surface development process. The development of the moon can build on mankind's successes achieved remote resource recovery bases and the logistics systems used to support such bases on Earth. We can learn, for example, from the \$20 billion in private sector funds used to recover oil assets from the Prudhoe Bay leases containing the oil deposits above the Arctic Circle. Big Oil didn't come to Alaska for the remoteness or the logistics headaches it created, but for the natural resource called oil, which is a marketable commodity. Lunar resources can and will finance the moon's development, just as it has financed mankind's movement around Planet Earth.

Conclusions: Lunar commerce can help accelerate and contribute funds to the moon's exploration and development.