PRELIMINARY COMMRCIAL MINING OF LUNAR SURFACE RESOURCES T. C. Taylor[1], Lunar Transportation Systems, Inc., 3705 Canyon Ridge Arc, Las Cruces, New Mexico, USA 88011-0944, Email ttaylor@totacc.com, or taylort@me.com

Introduction: As space mining evolves, a resource of sufficient value on Earth is required to stimulate commercial mining organizations to justify significant increases in their cost of mining off planet resources with potential value to specific industries on Earth. The Apollo sample returns after the initial lunar landing and over 45 years examination has failed to stimulate off-planet resource mining interest and no country or commercial mining organization has rushed to the lunar surface to get rich. Such a gold rush needs gold or a higher value recoverable lunar resource to stimulate the rush to the moon for resources. Needed is a valuable lunar resource to cover the cost and the risks involved. One resource is potentially here.

Helium3 is valuable: Lunar surface resources are more distant, tougher than Earth and more expensive to acquire, but the market for lunar resources is growing on Earth, but mining the moon still has problems requiring innovative and cost effective solutions. He3 is now a $100/yr resource market and very difficult to manufacture on Earth. New space mining requires more affordable solutions for logistics cost, innovative mining equipment and methods, plus human solutions to lunar hazards and most importantly startup financing to overcome the trade route distance, for mining in a space universe that is much larger than the Earth resource recovery industry, with distances orders of magnitude longer than Earth resource recovery mining and our current mining experience base. As mankind moves beyond the protective envelope of the Earth's atmosphere the difficulties for humans and industries multiply, the distances to be traveled increase, the human hazards increase, the mining equipment solutions become more difficult, and expensive, and the profits from the sale of the mined products must increase.

Valuable Minable Resource: Helium3 is a lunar resource capable of being mined on the moon with the future market potential on Earth of $6 to 15B per ton, when compared to the fluctuating price of oil in the generation of the same electrical energy. This future market could be sufficient to pay for the costs of recovering and transporting He3 back to Earth. He3 is not naturally occurring on Earth, but He3 is being produced in limited quantities for detectors at border crossing inspection stations to detect radioactive materials inside containers without opening each container. The current He3 market is $100m per year and sells for about $16,000 per gram, which translates to about $451million per ton. Lunar recovery processes can capture other valuable items needed to start and stimulate the growth of an emerging lunar surface economy.

Lunar Trade Route: Proposed is a cost effective transportation system of unmanned trade route cargo vehicles capable of growth and the scalable growth capabilities required for initial mining operations on the moon. This cargo transportation fleet design is potentially capable of scale up and refinement to become an affordable, reusable, unmanned two directional trade route cargo only vehicle system with reusable commercial equipment hardware and future innovation in different diameters, nodes on the transportation system and operation plus the hardware ability to expand into commercial operations as trade routes do. Trade routes tend to become more competitive overtime as competition and innovation drive the prices down as equipment becomes larger and more effective over time. LTS can, for example, grow larger in diameter with the future traffic generated to become competitively less expensive over time, a basic commercial requirement of trade route commerce on Earth and probably true of future trade routes in space. The final solution requires a number of the Earth's industrial and financial sectors to come together in some self-serving form of management and financing plan to accomplish the entire off-planet resource market development and eventual success of mankind's first off-planet recovery of resources for profit. It is a big step.

He3 is an isotope of helium that impacts the first few inches of the lunar regolith, gets mixed by impact objects and comes via the solar wind from our sun. He3 has been mixed by the millions of years of bombardment of the moon's surface and can be mined with excavation machines under development today at the University of Wisconsin at Madison and transported back to Earth for fusion power generation, instrumentation and other future uses. Oil has developed several hundred uses since the 1880s and replaced whale oil, but will eventually become scarce and more expensive, plus is already political. Mankind's resource thirst forced mankind to move around the Earth for non-renewable resources and now this same resource need by mankind will move society to off-planet solutions for non-renewable resources. This first potential off-planet Helium3 opportunity will require the innovation and development of commercially affordable transportation by Aerospace, the development and research of future He3 markets by the commercial research sector

and academic research sectors, which is now proceeding, the financial means for the recovery of He3 from the financial community, the transportation more transportation than required by Earth resource recovery and the ability to work beyond Earth by the Commercial Mining sector. the marketing/sale of the minable He3c products by the financial/mining industries.

Society's resource thirst and continuing ability to recover can market these resources to support the doubling of human population every 90 years. The research to use what mankind finds in our near universe can provide incentive for the aerospace industry to provide the design innovation and cost affordability in transportation plus the expertise to permit humans to survive in societies within off-planet environments.

Mining Off-Planet: The mining industry is capable of the off-planet recovery of the resources, plus the development of marketable resource products and are experts in using this revenue to finance their mining cost from the sale of their mining products. This paper suggests one He3 resource, can be mined off-planet at a profit by 4th generation He3 bucket wheel mining excavators for use on Earth and other elements can grow an emerging lunar surface economy.

Astronaut Geologist Experiences: This approach has been suggested and championed by Astronaut Harrison (Jack) Schmitt, the only geologist to visit the moon and the University of Wisconsin-Madison research staff developing a mining process. The mining industry can adapt an evolving fourth generation excavator into a workable lunar mining solution. The author also suggests an off-planet two way transportation system capable of becoming a resource trade route system with expandability, cost effectiveness and adaptability at the resource end of the trade route and the economy of the vehicle can kick start the lunar mining industry and stimulate recovery elsewhere in space. Commercial aerospace transportation hardware can support the lunar surface economy including the adaptive reuse of the transportation hardware at the lunar destination. The aerospace and other commercial industries need to expand their thinking beyond our one planet and to move into other expanded survivability, commerce, habitability, transportation modes and industrial process markets within near off-planet cities, each evolving from initial resource recovery camps on other celestial bodies. When one thinks about it, that is how many of our Earth cities got their start in the gold rush days or other mining locations.

Commercial Expansion & Innovation: The paper, explores one unmanned reusable trade route transportation hardware and its trade route expansion in size, transported mass, vehicle diameters to 10 meters including an ability to deliver and recover mass between the lunar surface and lunar orbit without the use of propellant, plus short summaries of the issued patents. The development of a surface economy from the multiple other products recovered at the same time as He3 during the two-stage temperature process and are valuable enough to jump start a lunar surface economy.

Long Term Evolution: The need for longer lunar human stay times can stimulate the evolution of habitable solutions under ground with increased protection from radiation and impacts for longer periods of lunar surface work. Underground technology cities lasting hundreds of years and serving dozens of industries can function like Earth in creating these cities. The learning and evolution of living on another celestial body, plus an emerging lunar surface economy can bring resources and to Earth will be discussed with a difficult to inhabit surface environment changed by the introduction of new He3 related industries available on the moon and Earth including the ability to power cities with He3 power generation from plants within the city.

Conclusions: Long term mining and living on the moon gives rise to the permanent underground solutions for lunar living and expansion beyond mining to long term living underground in the form of multiple purpose cities with the increased protection from space radiation and impacts. Tourists, for example, visited us on the North Slope at Prudhoe Bay before the oil flowed and lunar adventure tourism could be one of many future industries. Research on He3 power generation in the lunar hard vacuum might accelerate He3 power generation unit size reduction and take advantage of the non-radioactive He3 aspects, on the moon and Earth. The anticipated trillion dollar cryogenic electrical grid on Earth may no longer be needed, because He3 power generation can be close to humans and vary in size. The He3 electrical power generation advantages could include a size reduction of power generation equipment, allowing large transportation equipment like ocean liners, trains, airplanes, space ships or maybe eventually automobiles to be powered by smaller He3 devices. Purchase your car and fuel at the same time and petroleum is only needed for lubrication purposes.

The Earth has had around 6 previous life extinguish events and humans in our currant form would have not survived any of them. Mankind must become a multiple planet species to insure our survival and have an ability to survive and repopulate after the future life extinguishing events.