Abstract #824

English

SPACE RESOURCE UTILIZATION: TECHNOLOGIES AND POTENTIAL SYNERGISM WITH TERRESTRIAL MINING

Space Resources and Their Uses: The idea of using resources in space to support human exploration and settlement or for economic development and profit beyond the surface of Earth has been proposed and discussed for decades. Work on developing a method to extract oxygen from lunar regolith started even before humans set foot on the Moon for the first time. The use of space resources, commonly referred to as In Situ Resource Utilization (ISRU), involves the processes and operations to harness and utilize resources in space (both natural and discarded) to create products for subsequent use. Potential space resources include water, solar wind implanted volatiles (hydrogen, helium, carbon, nitrogen, etc.), vast quantities of metals and minerals in extraterrestrial soils, atmospheric constituents, unlimited solar energy, regions of permanent light and darkness, the vacuum and zero-gravity of space itself, trash and waste from human crew activities, and discarded hardware that has completed its primary purpose. ISRU covers a wide variety of concepts, technical disciplines, technologies, and processes. When considering all aspects of ISRU, there are 5 main areas that are relevant to human space exploration and the commercialization of space: 1. Resource Characterization and Mapping, 2. In Situ Consumables Production, 3. Civil Engineering and Construction, 4. In Situ Energy Production and Storage, and 5. In Situ Manufacturing. ISRU & Terrestrial Mining: There are four areas were development and utilization of space resources is highly synergistic with terrestrial needs: Food/Water Production, Mining, Construction, and Energy. When considering space resources, especially the areas of mining and processing of resources into usable commodities, ISRU developers have adopted and modified terrestrial approaches to come up with the Space Mining Cycle, or ‘Prospect to Product’. For both space and terrestrial mining, the first step is prospecting; first globally and then locally to find and characterize (physical, mineral, and volatile) the resources that exist, as well as the terrain and the geological context in which the resource is found. Once the resource has been sufficiently characterized and mapped, mining and resource processing can be begin. As with terrestrial mining, subscale feasibility and pilot operations are performed to verify that the resource can be extracted, that performance and maintenance goals can be achieved, and that the product meets quality expectations. In the last two years, NASA has focused on developing and implementing a sustainable human space exploration program with the ultimate goal of exploring the surface of Mars with humans. The plan involves developing technology and capability building blocks critical for sustained exploration, such as ISRU. The evolvable plan develops and expands human exploration in phases starting with missions that are reliant on Earth, to performing ever more challenging and longer duration missions in cis-lunar space and beyond, to eventually being independent from Earth. As these missions progress, human presence will also evolve from a few days, to weeks and months, to semi and permanent presence in space. Because the crew may not be present during space mining operations, or because ISRU products may need to be produced before the crew arrives to reduce mission risk, reliable communication for remote operations, autonomy, and high reliability are extremely important for ISRU to be successful incorporated into human mission plans. I

French

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