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AN INTEGRATED ECONOMICS MODEL FOR ISRU IN SUPPORT OF A MARS COLONY—INITIAL
RESULTS**Abstract**

Previous work by us focused on creating an ensemble of specialized models intended to explore the commercial potential of mining water on Mars. This ensemble starts with a formal systems architecting framework, based on DoDAF 2.02, to describe any Mars Colony and capture its artifacts' parameters and technical attributes. This database, the Mars Colony Architecture Model (MCAM), is then linked to a variety of “downstream” analytic models. In particular, we integrated an Extraction Process (i.e., “Mining”) Model, an Infrastructure and Integrated Logistics Support (ILS) Model, and an Economics Integration Model. The Extraction Process Model focuses on the technologies associated with in situ resource extraction, processing, storage and handling, and delivery. For each mined resource, which may involve multiple cooperating In Situ Resource Utilization (ISRU) systems in a given architecture, the Extraction Process Model computes the production rate as a function of the systems' technical parameters and the local Mars environment. As with our earlier work, this model focuses on the extraction and processing of Mars water/ice. The Mars Infrastructure and ILS Model simulates the fundamental sustainability relationships associated with establishing and maintaining a Mars Colony of population LM. The model covers both the in situ infrastructure needed to support the Mars Colony (e.g., habitation, transportation, ISRU systems, etc.) as well as the interplanetary supply chain necessary to maintain and grow that infrastructure. The Economics Integration Model brings together market information (prices), investment, and operating costs as functions of time for various in situ resources, along with measures of market uncertainty, with an objective of determining the profitability of commercial in situ mining operations supporting the Mars Colony. To this end, the CDF of Net Present Value is estimated using Monte Carlo techniques. All told, over 50 market and technical parameters can be varied from MCAM in order to address “what-if” questions. Further, by introducing alternative ISRU technologies for water/ice (i.e., different mining equipment and processes), one can develop an Analysis of Alternatives (AoA). Other significant trades can be performed by, for example, changing the Mars Colony's location or degree of ECLS closure. In addition to the canonical DoDAF Viewpoints, the ensemble of models is extensible, allowing for a variety of other complex Viewpoints/Views to be produced for a given Mars Colony architecture.