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EDUCATION, OPPORTUNITIES AND CHALLENGES TEACHING SPACE SUSTAINABILITY TOOLS

Abstract

The sustainability engineering toolbox holds a variety of methodologies to quantify social, economic, and environmental impacts of products, systems, and designs. Sustainability research regularly provides findings that improve overall system performance while reducing negative impacts and unanticipated consequences. Life cycle assessment (LCA) is one such tool used to quantify and characterize environmental and other impacts to improve a given engineered system's cradle-to-grave performance. There are significant opportunities for LCA to guide the development of space resources technology, development, resources extraction, and use.

This paper will explore 1) the ways in which LCA can be integrated into educational degree programs, 2) the opportunities and challenges associated with applying LCA to the space industry, and 3) other potential tools for quantifying sustainability. Colorado School of Mines offers the first ever graduate degree in space resources; LCA, sustainability, and economics are integral components to this novel online degree. Students in the space resources program complete an LCA on one of three topics: orbital systems (e.g. rocket manufacture and launch), space manufacturing (e.g. comparing drug manufacture in space versus on earth), or resources returned to Earth (e.g. comparing Pt mined from near earth asteroids versus Pt mined on Earth). Mining resources from space may result in fewer environmental impacts on Earth, simply from the halt of Earth mining; LCA can quantify these benefits. This paper summarizes a range of student projects from the fully online, 8-week asynchronously taught LCA class. Student projects found that there are opportunities for LCA to inform efficient and sustainable design, support greening the supply chain, and identify unintended consequences. However, there are significant challenges to effectively employ LCA in the space industry. Namely, data availability is quite scarce, both for existing products and technologies (i.e. satellites and rockets) as well as for future activities (e.g. lunar and near asteroid mining operations). Economic input-output LCA may currently be the best approach to conducting LCAs of space activities until more process data is available. However, the LCA and space communities would greatly benefit from improved life cycle inventory data collection efforts.