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Author: Mr. Erik Kulu
Estonia

IN-SPACE MANUFACTURING - 2024 INDUSTRY SURVEY, TRENDS, ECONOMICS AND ENABLERS

Abstract

Discourse on in-space manufacturing (ISM) has been increasing, but recurring profitable production has yet to be demonstrated. Many products and materials have been proven to have better properties when made in space, but are they better enough? As of now the answer is known to be negative, but change is starting, thanks to new products, processes, and decreasing upmass and downmass costs. Thus, some companies and applications may be getting near.

Since the author's 2022 paper on this topic, an improved report was created for NASA and ISM entities have increased from 117 to over 200, thus a new manuscript is well-justified. Factories in Space (www.factoriesinspace.com) is the largest public database of commercial entities in the in-space economy and microgravity manufacturing fields and has over 900 total entries.

First part of the paper will update the in-space manufacturing classification. Destinations or locations are categorized into Earth, space, and planetary surfaces. ISM fields are divided into: advanced materials, biotechnology, large structures, microfabrication, novelty & luxury goods, pure substances and space food. These will be reviewed and the relevant entries will be listed in tables for overview.

Second part of the work will present the updated statistical data. Within the classifications, comparisons are made between the popularity, destinations, status, first launch years, geographical distribution and funding where available. Thanks to the previous paper, some trends can start to be deduced.

For a new third section, various enabling and supporting services continue to be announced for transportation, orbital platforms, space utilities and raw resources. There is currently a similar order of magnitude of service providers compared to potential customers. Thanks to the extensive database, an overview and trends of microgravity service providers will be also presented and discussed.

Fourth part of the research will take a further look into the economics of ISM and a few selected markets. Unit economics is likely the biggest challenge. However, Starship and new re-entry capsules may soon improve that. Many reports have been produced about the market analysis of ISM products and enabling services, which will be listed. Funding sources of microgravity research will be also discussed as most are grant or project-based.

New economic activities in space have the potential to speed up space technology development and the rate of activities, creating a flywheel effect for further space utilization. In-space manufacturing could be the first industry to be moved off-Earth. Which application will be the first?