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# SUITABILITY OF MANUFACTURING PROCESSES FOR IN-SPACE MANUFACTURING OF SPACECRAFT COMPONENTS

**Abstract**

In-space manufacturing (ISM) promises to alter the paradigm of space system design by enabling fabrication of components in their operational orbital environment. Similar to Earth-based manufacturing, selecting a suitable manufacturing process depends on the component to be produced. However, the premium placed on size, weight, and power for space systems means that limited manufacturing capability will be available on space missions utilizing ISM, and necessitates a tighter coupling between the manufacturing equipment itself and the design of fabricated components. With limited ISM capability, component designers will need to design specifically for the available manufacturing process in order to fully benefit from ISM. This available manufacturing process will, in turn, depend on the use case for ISM, such as for on-demand spare parts, large structures, fabrication using in-situ resources, etc.

Developing a framework to rank manufacturing processes suitable for a given mission scenario will prove invaluable for space system designers hoping to incorporate ISM into their mission plans. The same framework can also allow ISM technology developers to evaluate the impact of their developments on overall mission capabilities. Establishing such a framework first involves developing a function-based decomposition of spacecraft mission needs, which is accomplished using object-process methodology (OPM) language to describe functions such as transporting liquid or storing gas. Each of these functions can likely be provided by several instantiations of form, such as tubing, pressure vessels, etc. For each form-based definition, the suitable manufacturing processes can be determined, largely based on material, geometric, and surface finish considerations. At this point, the achievable manufacturing metrics for each process are computed using first-order manufacturing process models, e.g. computing production rate as a function of power input, which are derived from the process's fundamental physics, ground-based experience, and ISM concepts. Depending on the ISM use case under consideration, the relative importance of manufacturing process attributes, such as rate, quality, energy, and cost will vary. Ultimately, the various manufacturing processes that could be used to provide the originally desired spacecraft function can be ranked according to these computed attributes.

The results of this analysis can serve as a tool for determining the potential use of ISM for a given functional requirement as well as for evaluating the utility of a given manufacturing process as measured by the number of functional requirements met by the set of manufacturable components. Analyzing use cases represented by existing ISM projects will serve to inform ongoing development activities.