Z3.04-6074 - In-Space Assembly and Manufacturing Using Synchronized Robotics

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NON-PROPRIETARY DATA

IDENTIFICATION AND SIGNIFICANCE OF INNOVATION

Ground-based manufacturing processes are traditionally not designed with resource constraints and versatility in mind. Single-purpose, heavy machineries are commonly used to carry out a single operation in a long chain of operations. They are, for most part, not autonomous in that they do rely on skilled labor for continued operation and quality assurance. These are all luxuries that cannot be afforded in space. However, the know-how in these manufacturing processes and the processes themselves are essential to success of NASA in extending its presence into deep space. Sheet metal forming is one of such processes where in its current form, it is not ready for deployment in space. Sheet metal parts are, however, extensively used in a multitude of applications, making their processing an enabler for deep space travel. The aim here is to take an established on-ground manufacturing process and make it more accessible to NASA for both its ground-based and in-space applications.

TECHNICAL OBJECTIVES AND PROPOSED DELIVERABLES

Through its Phase I effort, Machina Labs has demonstrated the viability of robotic sheet metal forming system for various applications. Opportunity exists to i) use the robotic system for agile and cost-effective manufacturing of parts in support of different NASA and non-NASA applications, ii) deploy and test the developed modules of the robotic system for OSAM and ISRU, and iii) mature the system towards autonomy. These three items are the main objectives of this Phase II work. As such, work is planned to deliver the following:

- Focusing on rapid and flexible manufacturing of tanks, in collaboration with Michoud Assembly Facility, manufacture a range of prototype tanks. Michoud to lead required welding and associated assessments.
- Through appropriate testing and characterization validate that fabricated tanks meet desired specifications. Statistically demonstrate that using robots it is possible to manufacture highly reproducible tanks.
- Using the different capabilities of the robotic system, repurpose a fabricated tank (e.g., form channels in the exterior of the tank).
- Using a fabricated tank, design and build stringers that could be welded to the tank. This demonstrates the utility of the system in repurposing components. At the same time, stringers are necessary for managing slosh.
- Demo that learnings from collected data on fabricated tanks can guide future builds.

TRL

Estimated

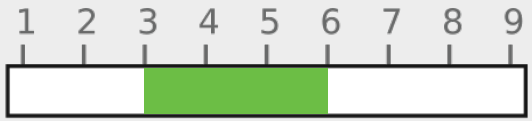
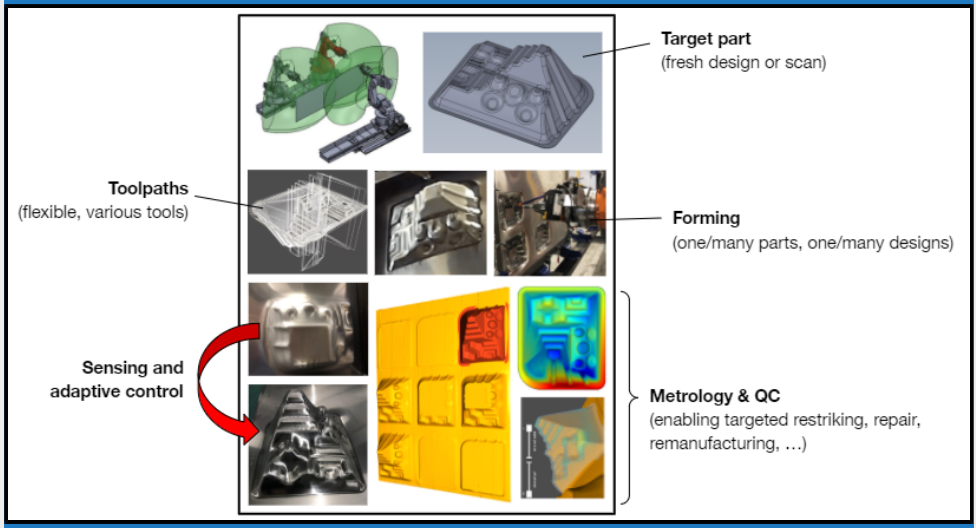


IMAGE TITLE: Machina Labs, Inc.



NASA APPLICATIONS

First, the developed software modules and control strategies can be adopted to enable in-space manufacturing and on-orbit assembly operations. Second, the robotic cell can be used to manufacture lightweight parts for various NASA programs (manufacturing of tanks is explicitly treated here). Third, the forming technology can be adopted for OSAM and in-situ resource utilization (e.g., repurposing spent upper stages to manufacture structures or molds to build habitats).

NON-NASA APPLICATIONS

The robotic forming cell will be used to manufacture and supply sheet metal parts to a multitude of industries (e.g., aerospace, automotive, energy, architecture). The system allows for rapid iteration over design/material at reduced time and cost. It also enables fabrication of parts with previously impossible-to-achieve performance. Composite mold fabrication is an application of the technology.

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