

# Implementing Large Format Additive Manufacturing in Aerospace Tooling

AMERICAN  
INDUSTRIAL  
PARTNERS

## BUSINESS PROBLEM

Ascent Aerospace designs and manufactures a diverse array of customized aerospace tooling, creating a low-volume/high-mix production environment where precision is critical. As a result, Additive Manufacturing (AM) stands to provide Ascent a significant competitive advantage by reducing lead time, cutting costs, and enabling the rapid production of novel tooling solutions. Ascent recently installed a Large Scale Additive Manufacturing Machine (LSAM) to exploit this opportunity. This project explores the deployment of this new technology via process integration and finite element analysis (FEA) of print performance.

## DATA SOURCES

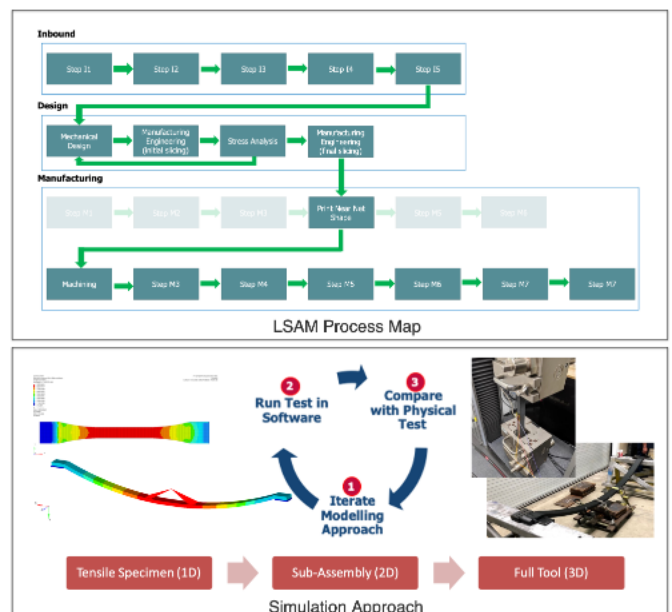
Data pertaining to the process map, including cycle times and costs, were gathered from existing ERP software and conversations with management. Data about the LSAM's performance were gathered from manufacturer specifications and active testing on-site. Data pertaining to the printed material's performance was developed with internal processes and a third-party testing laboratory.

## Data Types and Format

Resulting of third-party laboratory testing and internal laser-tracking were used to generate and validate the FEA model.

## APPROACH

First, an understanding of the current-state, traditional manufacturing process and the LSAM's capabilities was developed to define an integrated, future-state process. Next, in order to improve design cycle time, reduce rework, and improve quality, an FEA model of LSAM-printed tools was developed and compared with results of physical tests. These results comprise a framework for LSAM integration.



## IMPACT

Operational integration of the LSAM into Ascent's manufacturing processes enables Ascent to reduce lead time, cut costs, and serve new markets. Whereas the traditional process can require a double-digit number of weeks to produce a finished tool, the LSAM requires less than 3 weeks at a lower cost basis. However, these gains are only possible and scalable with deliberate process planning and tailored simulation solutions. A test plan and operational improvement initiatives were developed to establish the LSAM's functionality, reduce variability in its operation, and capture best practices. Using this information, an accurate process map of the LSAM's manufacturing process was developed to inform production planning once the machine is capacitized. Additionally, a methodology for testing LSAM-printed materials was developed and implemented on a representative feedstock. This methodology could be used to on-board any new feedstocks. The results of these tests were used as inputs to an FEA simulation model. Effective simulation allows production to scale more rapidly by decreasing reliance on operator expertise and enables more optimal designs. These designs can be made safer and higher quality via simulation. Abstracted away from the Ascent-specific context, many of the processes and approaches developed in this project could be used by other manufacturing operations to efficiently integrate large format additive manufacturing.

### DRIVERS

Most aerospace tooling manufacturers have significant metalworking expertise. They are typically able to meet tolerances of a few thousandths of an inch over surfaces on the order of hundreds of square feet in area. However, this precision comes at a cost: long lead times, design needing to be locked in far in advance of delivery, exceedingly heavy tools, and thin margins in an increasingly commoditized industry. AM can address these issues.

### BARRIERS

Introducing a new tool in an industry with such exacting precision can lead to understandable resistance. Deliberately educating the company and its customers on the LSAM's capabilities was critical to overcoming these cultural hurdles. Exogenous headwinds in the wider commercial aerospace industry and the Covid-19 pandemic also made it substantially more difficult to iterate and create common understanding across dispersed teams.

### ENABLERS

Executive-level emphasis was critical to providing resources necessary to execute this project (and implement AM within a company, more generally). Additionally, Ascent's LSAM team was exceptionally welcoming. Without their support, the project would have undoubtedly failed.

### ACTIONS



This project's timeline coincided with the installation of the LSAM at Ascent. As a result, we were actively involved in implementing and improving processes from day one. Multiple continuous improvement initiatives, capacity utilization tools, and design guidelines were produced. The FEA model was designed in conjunction with the Stress Analysis team, such that they have a full understanding of its capabilities and limitations.

### INNOVATION

Developing a testing procedure for validating new feedstocks that is easily replicable was an important innovation. Ascent can now on-board new material types quickly and validate the machine's output at-will. The FEA simulation approach was a novel compromise between naive homogenous modeling and full print-process simulation. This project showed that an intermediate modeling approach using Ascent's existing software could be sufficient.

### IMPROVEMENT

Ultimately, efficient integration of the LSAM unlocks multiple millions of dollars in annual revenue opportunity. Effective use of the process integration tools and FEA simulation approach generated by this project could substantially improve margins compared to traditional tooling solutions.

### BEST PRACTICES

- Gain executive-level support
- Create a cross-functional core team when implementing LSAM to conduct initial iteration
- Educate people in other business units about the LSAM's (or AM's more generally) capabilities and limitations early and often
- Validate FEA simulation against physical tests

### OTHER APPLICATIONS

The general framework for integrating large format additive manufacturing (not just the LSAM, specifically) could be used in any manufacturing organization looking to leverage this technology. Similarly, the FEA simulation approach should be generalizable to other carbon-fiber reinforced thermoplastic feedstocks and extrusion-based printers.