Additive Manufacturing (AM) at FRC East

Advanced Technology & Innovation (ATI) Team

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Agenda

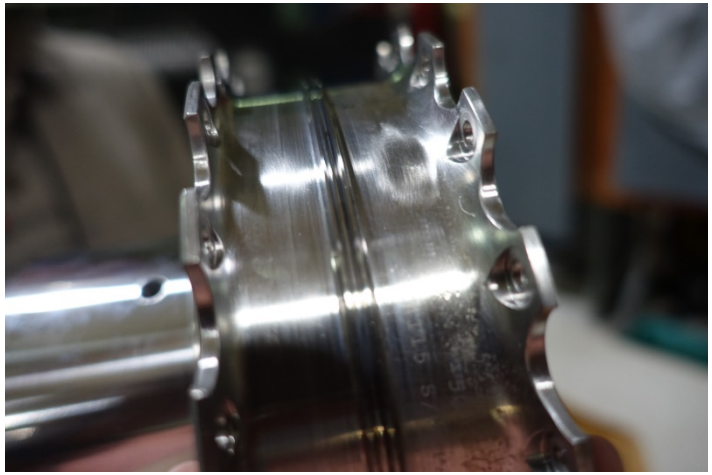
- Impact of Additive Manufacturing (AM)
  - Overall
  - Maintenance & Repair Organization (MRO)
  - Fleet Support Team Organization (FST)
- Engineering Innovation Lab
  - Overview/Purpose
  - Current Capability
- Metallic AM (Upcoming Capability)
  - Laser – Powder Bed Fusion (L-PBF)
  - Directed Energy Disposition (DED)
  - FRC-E Application Spaces

Impact

Additive Manufacturing (AM)

- AM enables the rapid production of aircraft parts, fixtures, job aids, and supporting equipment when properly integrated into an industrial organization.

- AM allows for the rapid response to immediate problems and threats by providing an agile solution for generating components that are difficult to source or are an immediate warfighter capability degrader.



Impact

Maintenance Repair and Overhaul (MRO) Organization

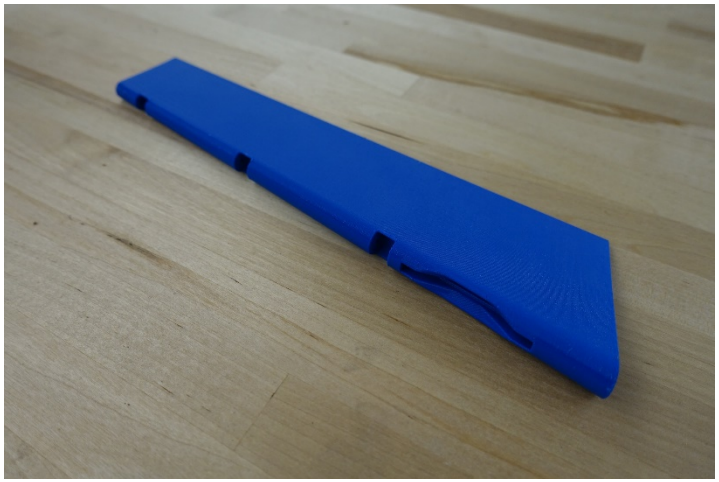
- AM unlocks the potential for “bottom-up” solutions directly from the shop floor to provide expedited solutions for problems encountered during aircraft maintenance and overhaul activities.

- AM allows MRO engineering to rapidly respond to emerging depot production issues, decreasing turnaround times and cost for engineering support of depot operations.

Impact

FST Organization

- AM allows the fleet to rapidly produce necessary components in any theatre to properly support the mission at hand.
- FST Engineering uses AM resources to develop components intended to be produced by the fleet in support of their mission.
- AM allows FST engineering to rapidly produce low-cost prototype components, decreasing turnaround times for engineering support of fleet operations.



Engineering Innovation Lab

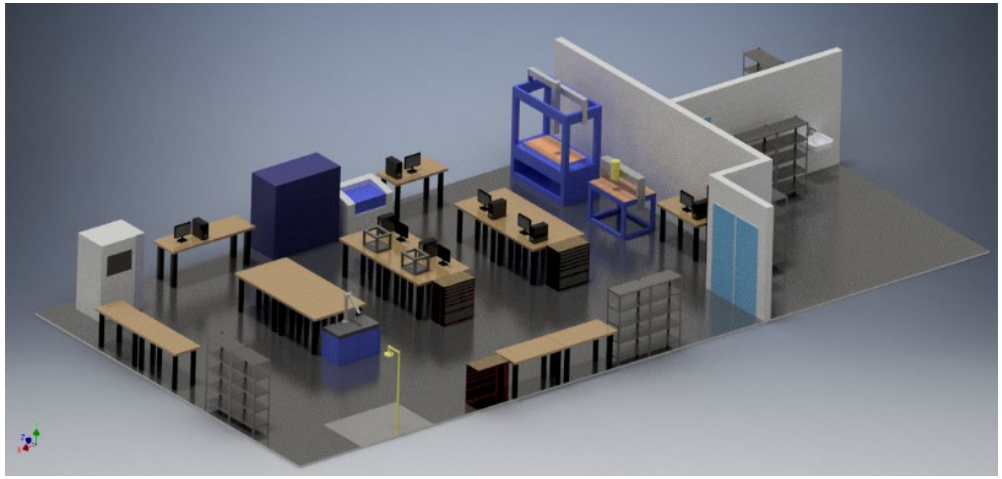
Lab Overview

Purpose

The FRC East Innovation Lab is the primary prototyping space for both MRO and FST engineering groups. Intended to be a “professional makerspace”, this lab was built to allow engineers to design and produce quick-turn prototypes without the need for impacting depot production workload.

This space is also used for development and support of fielded AM components to be 3D printed by fleet activities.

Consolidating engineering owned prototyping equipment into a single space allows for the optimization of workload across all AM assets and provide all engineering groups with access to the latest prototyping equipment. Prototype designs can be developed, tested, evaluated, and revised in the lab without being impacted by depot shop workload delay times.



Innovation Lab AM Capability

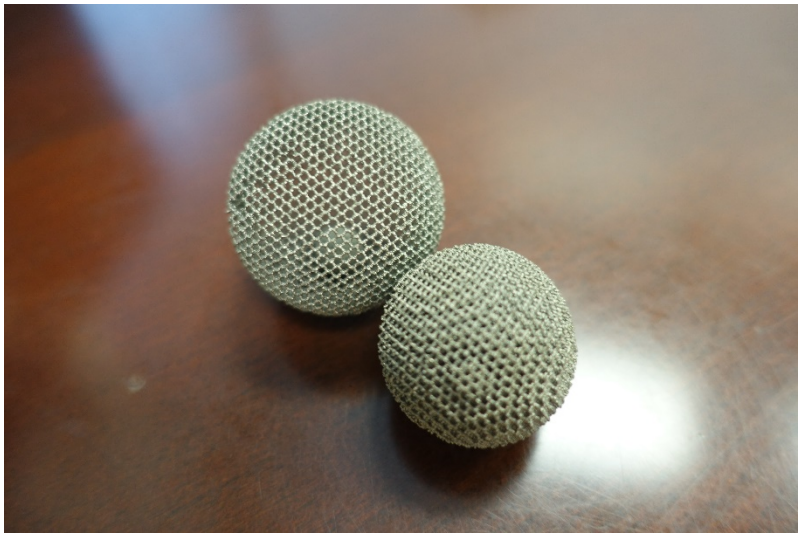
The Innovation Lab is home to both consumer-grade and industrial-grade AM equipment to include:

- Stratasys 450mc
- Stratasys F770
- Stratasys F370
- Stratasys Origin One
- Markforged X7
- Markforged MetalX
- Ultimaker S5
- Lulzbot TAZ6

Metallic AM
(Upcoming Capability)

L-PBF Process Overview

Laser Powder Bed Fusion (L-PBF):
Metal additive manufacturing process that uses a high-power laser to selectively melt metal powder in a specified pattern, layer-by-layer, to "print" a part.

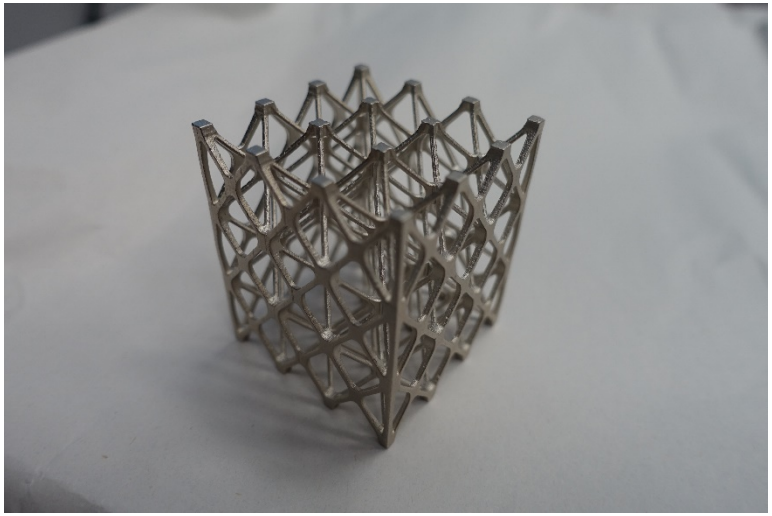


Key capabilities:

- Produce complex geometries not suitable for traditional "subtractive" manufacturing (i.e. machining or casting)
- Provide rapid, cost-effective production option for prototypes and limited-run components
- Capable of producing hard-to-source, flightworthy components to sustain fielded platforms

L-PBF Cont'd

- LPBF produces fully-fused metal parts with properties approaching wrought metals
- Commercial LPBF systems have robust design for production environment, proven capable of producing airworthy components
- FRCE will leverage ongoing R&D and collaborative efforts across DoD
- Airworthiness requirements for part purity necessitate single material per machine. Primary alloy of interest: AlSi7Mg/AlSi10Mg
  - This alloy family is suitable for wide range of SE and aircraft components
  - Excellent choice to replace hard-to-source legacy castings with AM substitutes
- Build Volume: 10" x 10" x 13"

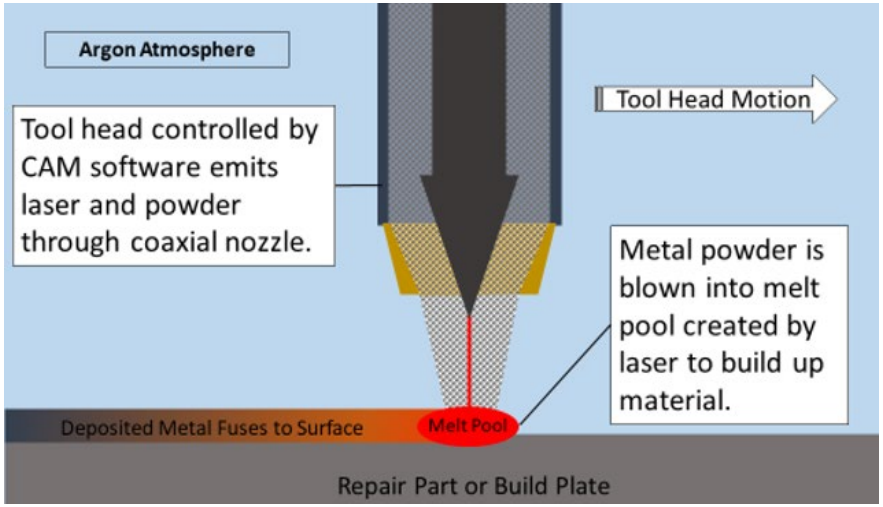


DED Process Overview

Directed Energy Deposition (DED) :

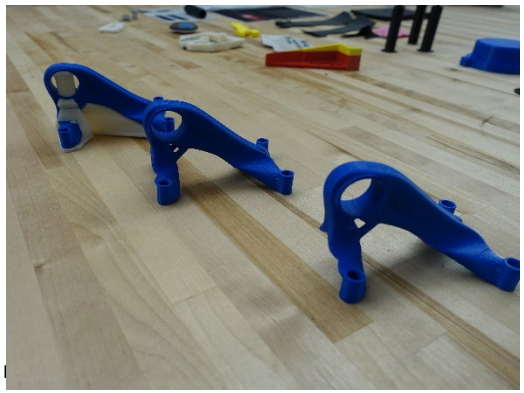
Metal additive process in which metal powder is blown from nozzles attached to a deposition head which also emits a laser beam. The blown powder stream and laser converge on a part or build plate to create a melt pool and fuse the blown powder filler metal to the substrate. The deposition head is controlled via a CAM digital tool path and can be used to additively manufacture parts from scratch, add features to parts, or restore surfaces damaged during service.

- DED is the leading metal additive technology for **repair**:
  - Selectively add material to restore dimensions to damaged components
  - Ideal for thin-walled components not suitable for traditional weld repairs
  - Fully-fused, metallurgically bonded deposition



DED Applications

- Two primary use cases at FRC East:
  - Repair components by selectively adding material to restore dimensions to worn and damaged features including thin-walled components not suitable for traditional weld repairs
  - Support Equipment Manufacture
- Primary repair applications for current and future FRC East workload:
  - Wear around fastener holes
  - Knife Edge Seal Teeth
  - Engine Blades and Blisks Tip/Edge Repair
  - Corrosion Pitting/Fretting on Flanges
- Primary Support Equipment Applications
  - Disassembly/Assembly Jigs
  - Calibration Adapters
  - Forming Blocks
  - Drilling Templates and Guides
  - Test Stand Hardware and Fixtures
- Build/repair volume: 32” x 24” x 24”
- Materials: Ti, Inconel, Steels, CoCrMb, etc.

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