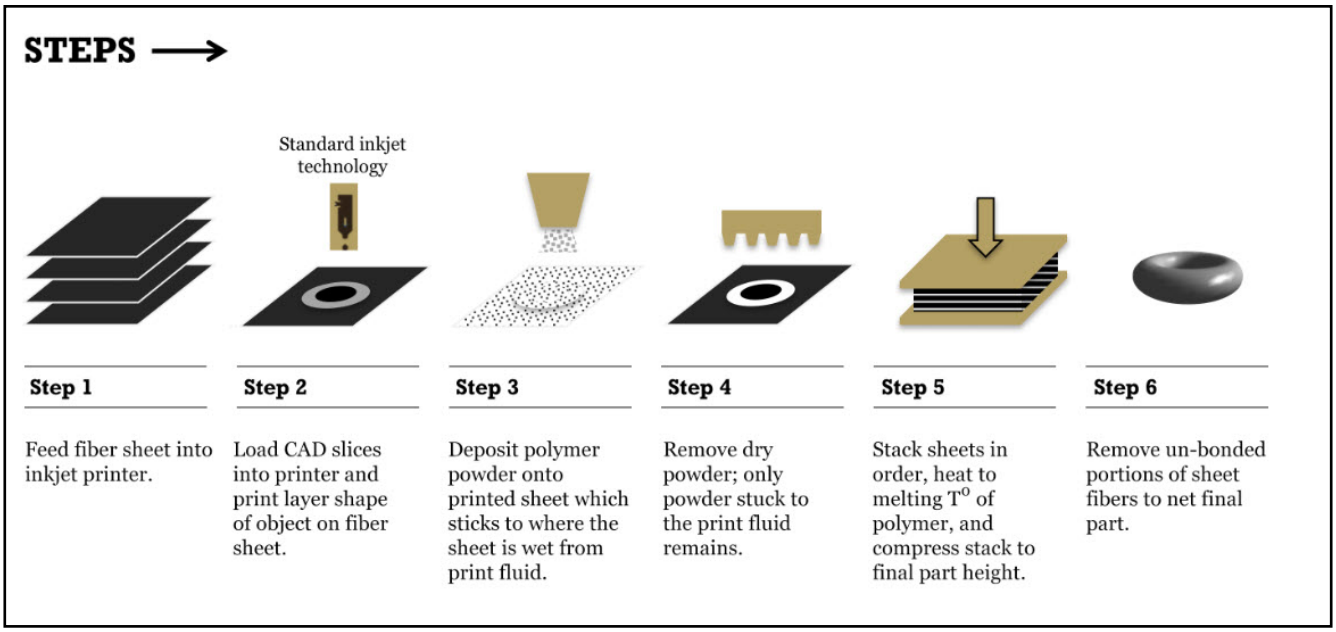
SUCCESS STORY 3015

CBAM provided method of fabricating composite parts for low-cost sustainment

Produced parts in days versus weeks and reduced part costs by at least 45%



Steps within the 3D CBAM build process.

PROBLEM

As legacy systems age it becomes more difficult to source replacement components for maintenance. Part availability issues stem from a number of root causes including obsolescence, diminishing manufacturing sources, material shortages, and unexpected failures on parts not originally planned to need replacement. These are all significant and expensive drivers for maintenance downtime in legacy systems.

OBJECTIVE

Composite-based additive manufacturing (CBAM) technology provides an avenue for overcoming the difficulties associated with maintaining legacy systems by providing on-demand composite parts fabrication to reduce costs and lead times. The objective of this project was to demonstrate the use of CBAM technology in the manufacture of low-criticality parts for USAF systems. An additional intent was to identify a transition path for the part to enter the USAF supply chain.

AMERICA MAKES TECHNOLOGY DEVELOPMENT ROADMAP

This project aligns to: PROCESS

ASTM PROCESS CATEGORY: Sheet Lamination,

EQUIPMENT: Custom Pilot One Machine

MATERIAL: Carbon Fiber plus Nylon 12, Carbon Fiber plus PEEK

TECHNICAL APPROACH

Utah Advanced Materials & Manufacturing Initiative (UAMMI) leased a composites-based 3D printer and located it close to Hill AFB. Quality checks were performed following installation and throughout the project via coupon tests. Selection by UAMMI and USAF personnel included a minimum of six parts to demonstrate the CBAM technology. The parts fall into three categories: electrical components, subsystem components, and non-structural secondary components. Two selected parts from each category were sourced from non-critical, non-structural components used in Air Force weapon systems that fit within the current CBAM build volume of 11 x 7 x 4 inches.

Parts created using CBAM must demonstrate that they meet the dimensional and mechanical requirements for the given application. Tensile and short beam shear test coupons were included with each part build. The Utah Composites Laboratory, University of Utah performed mechanical testing of the coupons with dimensional testing of parts performed at Hill AFB, First Article Test Laboratory.

UAMMI and USAF cognizant engineers and appropriate DoD/ potential vendors worked together to transition the technology. A trade study and materials and parts substitution guidelines were generated to compare the costs of using CBAM technology with other fabrication methods.

ACCOMPLISHMENTS

CBAM was used to fabricate 10 legacy aircraft parts taken from three part families: electrical components (3 parts), subsystem components (2 parts), and non-structural secondary components (5 parts). All parts were printed from carbon fiber reinforcement and a Nylon-12 matrix (CF/PA12) while a subset of parts was also printed in fiberglass/PA12 (FG/PA12). Tensile testing coupons were printed alongside the parts to provide proxy tensile performance data, creating a body of results to characterize CBAM CF/PA12. After initial failures for interlayer shear characterization, the ASTM D3846 in-plane shear test was shown to be suitable to measure the interlayer shear of CBAM CF/PA12 materials.

One part, the B-1B crew cabin first aid kit restraining strap, was printed in multiple configurations and both material combinations. A fit check was performed at Tinker AFB in April 2019. Fire, heat release, smoke density, and toxicity testing were performed on coupons representative of the first aid kit restraining strap.

The manufacturing readiness level (MRL) was advanced from 4 to 5 as the CBAM technology was demonstrated in a production-relevant environment and the technology readiness level (TRL) also advanced from 4 to 5 as this was the first widely used demonstration of CBAM outside of the printer's development phase. While more development is needed before CBAM is a go-to AM solution for the Air Force and other interested parties, it is a promising technology with the potential to create functional, end-use composite parts for low-cost sustainment.

END DATE

June 2020

DELIVERABLES

- Operational CBAM unit
- CBAM printed subsystems components
- CBAM printed electrical components
- CBAM printed non-structural and secondary components
- Assessment of CBAM parts
- Trade study analysis report
- Material and part substitution guidelines report
- Technical data package

FUNDING

$928K total project budget

($600K public funding/$328K private funding)

PROJECT PARTICIPANTS

Project Principal:

Utah Advanced Materials and Manufacturing Initiative (UAMMI)

Other Project Participants:

Impossible Objects
Lockheed Martin
Altair
TE Connectivity

Public Participants:

U.S. Department of Defense