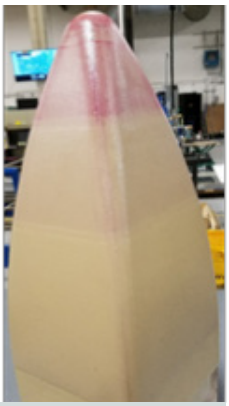
SUCCESS STORY 3008

3D-printed fly-away tools reduce lead times and costs for aerospace fairings

AM hybrid design reduces one-off costs by 34% and lead times by 50% over traditional manufacturing

ULTEM Substructure and Support Tooling

Lamination Process



Fiberglass Reinforced ULTEM Fairing (not trimmed)

Complete Hybrid Fairing

The hybrid nose cone fairing is designed to utilize a flyaway additively manufactured substructure to support the fiberglass skins during the fabrication process and stiffen the flyaway part. These images show various stages of the fabrication process.

PROBLEM

For flight tests and/or singular repairs, additive manufacturing (AM) has proven invaluable for fast and relatively inexpensive substitutions versus traditional manufacturing. This project addresses the reduction of lead times and cost savings offered by AM in a broader application space by reducing the nonrecurring expenses of point design and developing a capability for part families.

OBJECTIVE

This project objective was to transition point design production of AM aircraft fairings into a family of parts solution. The focus was on the hybrid AM approach of composite sandwich panels that could lead to the production of aircraft semi-structural fairings without the need for tooling. In this approach, the underlying fused deposition modeling (FDM) structure and printed Ultem 9085 core acted as the tool for layup of the composite skins, eliminating the tooling costs, minimizing the touch labor from layup and cure, and ultimately reducing the manufacturing span time and the overall cost of semi-structural fairings. This approach was a game changer for the aerospace industry and has the potential to significantly reduce costs for Air Force flight platforms.

AMERICA MAKES TECHNOLOGY DEVELOPMENT ROADMAP

This project aligns to:

VALUE CHAIN

ASTM PROCESS CATEGORY: Material Extrusion

EQUIPMENT: Fortus 900mc

MATERIAL: Ultem 9085

TECHNICAL APPROACH

The focus of this project was on B-52 weapon pylon fairings as demonstration articles. The design and development of the hybrid approach included choosing fairings and related parts where sustainment issues exist; identifying flight requirements for these parts; modeling to demonstrate adequate design details for the hybrid composite panels to withstand the flight requirements; fabricating test coupons; performing mechanical and environmental testing to verify part property and performance requirements; and applying AM capabilities to produce and test flight worthy composite fairings. The lessons learned from the B-52 pylon fairing family of parts were then transitioned to a larger part family set of composite sandwich panel aircraft fairings.

ACCOMPLISHMENTS

The project work proved that using an integral interior tool structure created by AM with a typical composite layover process can save time and money over the standard manufacturing methods in use. A process was developed to reinforce polymer additive parts with composite face sheets for fairings applications. This hybrid process was used to create several B-52 fairing parts including an HSAB nosecone, an SUU pylon fairing, and several sizes of finlets representing these parts for an EC-130J aircraft. All of these polymer parts replaced existing sheet metal manufactured parts and demonstrated lead time reductions of 50% while reducing the overall part cost by as much as 75%; and for the finlets, provided a weight reduction that could improve aircraft performance. The nosecone and the pylon fairing parts met the required proof testing that consisted of burst and crush pressure-at-temperature strength and dynamic sonic fatigue loading to verify adequacy for flight testing. The results of this study proved that low-quantity manufacturing using a hybrid process including AM along with a typical composite layup process can produce satisfactory parts more efficiently than conventional reinforced sheet metal manufacturing.

PROJECT END DATE

June 2019

DELIVERABLES

- An overall demonstration plan to include the design-build-test matrix and the metrology plan
- A hybrid AM standard work procedure that ensures consistent repeatable part production
- List of expected and unexpected barriers and challenges associated with the B-52 ALCM pylon fairing family of parts
- Technical data: in-situ monitoring data, materials characterization data, modeling & simulation results, etc.
- Recommendations and implementation plans
- Final report including demonstration results

FUNDING

$1.6M total project budget
($1.4M public funding/$250K private funding)

PROJECT PARTICIPANTS

Project Principal:
The Boeing Company

Other Project Participant:
Youngstown Business Incubator

Public Participant:
U.S. Department of Defense