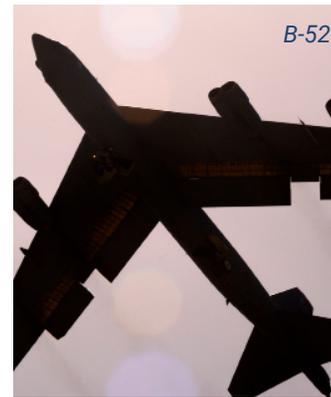
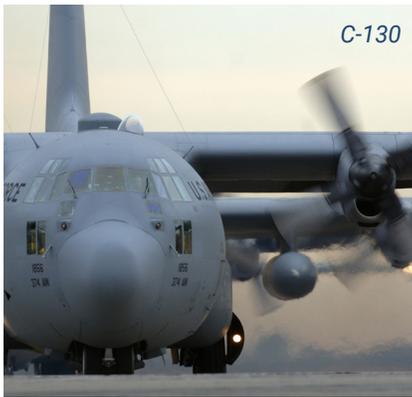


**SUCCESS STORY**
**3000 Maturation of Advanced Manufacturing for Low-cost Sustainment**
*Program enhances and improves U.S. Air Force Sustainment Operations*

# Program provided rapid response solutions to support AM technologies for low-cost sustainment.



*A wide range of USAF systems saw sustainment benefits in the MAMLS program.*

**PROBLEM**

Legacy aircraft used by the U.S. Air Force (AF) require parts that may be difficult to procure due to situations such as manufacturing obsolescence, costs to create, low-quantity requirements, poor documentation, or other availability-related challenges. Additive Manufacturing (AM) along with other advanced manufacturing technologies, such as reverse engineering, offers the potential to increase part availability at the supply chain level, depot level, flight line, and in theater, alleviating high part and tooling costs and long lead time issues, thereby enabling mission readiness. The MAMLS three-phase program was created to incorporate these advanced manufacturing technologies to provide rapid, low-cost sustainment solutions.

**OBJECTIVE**

The program enhances and improves AF sustainment operations through the development, demonstration, and transition of AM technologies by:

- Developing and demonstrating advanced manufacturing technologies related to AM that improve rapid part replacement and maintenance for legacy aircraft
- Enabling on-demand replacement of critically damaged or obsolete components that would not meet economic requirements of conventional supply chains
- Developing and demonstrating rapid fabrication of shop tools for sustainment center utilization
- Identifying technology gaps and workforce issues that need to be solved prior to effective implementation

**TECHNICAL APPROACH**

The program team included advanced manufacturing leaders from industry, academia, and government agencies working together to provide solutions to the DoD world.

A range of technologies was investigated in Phase 1:

- Reverse Engineering and Model Generation
- Assembly and Manufacturing Aids
- Metal Forming and Composite Autoclave Tooling
- Directed Energy Deposition for Metal Part Repair
- Metal Casting Tooling
- Direct Digital Part Production

Each approach provided value in the sustainment of aircraft and peripheral equipment. MAMLS was intended to prove that AM had the materials and processes in place to create nominal structural and functional performance properties for four different, complex, direct part demonstrations – a bell crank, a fuel-oil cooler, composite sandwich panels, and structural repair panels – with the breadth covering a family of each type of part, which lead to a path for qualification.

This project aligns to:



**Additive Manufacturing**

**PROJECT END DATE**

April 2018

*Advancing designs, processes, materials, and applications*

## ACCOMPLISHMENTS

The 3-phase applications program ultimately provided rapid response solutions to ongoing projects and initiated new projects to support emerging AM technologies in relation to the sustainment environment.

### *Technology Transitions*

- The casting supply chain team worked with the 910th Airlift Wing to adopt reverse engineering and AM for tooling and part replacement options such as the creation of custom 3-D printed sand molds to cast an aluminum T-Pipe header for its aerial spray systems on C-130 aircraft.
- At Hill AFB, a damaged vertical tail assembly for an F-16 was 3-D laser scanned to determine final fixture requirements for alignment and compatibility with an existing fuselage – revitalizing the damaged tail that would otherwise be scrapped.
- Other team members worked with the ALC's at Tinker AFB and Warner Robins AFB to transition advanced manufacturing techniques to affect lead time reduction, cost reduction, and flight readiness improvements, while developing organic and supply chain options for sustainment.

### *Workforce and Education Outreach*

- The team not only demonstrated the advanced manufacturing technologies for sustainment operations but is also provided focused workforce training to enable transition at an organic level at the ALC's and flight lines. Additionally, training and workforce education curriculum was developed to support the Air Force Research Laboratory (AFRL) and Air Force Life Cycle Management Center (AFLCMC) at enterprise levels.

### *Research Application Areas*

- A-10: Heads-Up Display (HUD) bracket
- B-1B: Ram air inlet scoop, refueling tee, ejection handle, bell crank qualification readiness evaluation
- B-2: Auxiliary Power Unit (APU) rear bearing housing replacement
- B-52: Hybrid fairing qualification readiness evaluation
- C-5: Composite panels
- C-17: Avionics cooling duct, cargo floor tie-down pan
- C-130: Modular aerial spray system castings, yoke cover, instrumentation mounts
- E-3: Door handle, Wing tip light, elevator tab, fuel tank adapter,
- F-15 and F/A-18: Missile launcher cylinder piston
- F-22: Structural repair parts qualification readiness evaluation
- F-16: Vertical stabilizer repair fixture, door drill fixture, F110 engine gearbox housing masking

## FUNDING

**\$27M total project budget  
Across 3 Phases**

## PROJECT PARTICIPANTS

### **Project Principal:**

University of Dayton Research Institute

### **Other Project Participants:**

National Center for Defense Manufacturing & Machining / America Makes  
Youngstown State University  
Youngstown Business Incubator  
Case Western Reserve University  
University of Northern Iowa  
Pennsylvania State University - ARL  
GE Aviation, Boeing, Raytheon,  
Honeywell Aerospace, Lockheed Martin,  
3D Systems, Optomec, BasTech, Deloitte,  
American Foundry Society, M-7 Technologies,  
National Center for Manufacturing Sciences,  
Humtown Products, SLICE Manufacturing,  
DRT Manufacturing Company

### **Public Participants:**

U.S. Department of Defense

### **About NCDMM**

NCDMM delivers innovative and collaborative manufacturing solutions that enhance our nation's workforce and economic competitiveness. NCDMM has extensive knowledge and depth in manufacturing areas—both commercial and defense—continually innovate, improve, and advance manufacturing technologies and methodologies. Our experienced team specializes in identifying the needs, players, technologies, and processes to attain optimal solutions for our customers. We connect the dots. That's the NCDMM methodology. NCDMM also manages America Makes and the V4 Institute and is the cornerstone of the Manufacturing Technology Deployment Group, Inc. (MTDG). To learn more, visit [ncdmm.org](http://ncdmm.org).