Department of the Navy SBIR/STTR Transition Program

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NAVAIR SPR-2024-0877

Topic # N21B-T022
Integrated Computations Materials Engineering (ICME) Modeling Tool for Optimum Gas Flow in Metal Additive Manufacturing Processes
Applied Optimization, Inc.

WHO

SYSCOM: NAVAIR

Sponsoring Program: NAVAIR RT&L for general warfighting requirements (GWR)

Transition Target: NAWCAD Lakehurst, NSWC Crane, V-22 Osprey, H-1 and H-53 Helicopters

TPOC: (301) 342-0297

Other Transition Opportunities: US Air Force, Army, and Space Force. Jet engine and airframe manufacturers, GE, Raytheon, Rolls Royce, Lockheed, Northrop Grumman, Boeing, Sikorsky

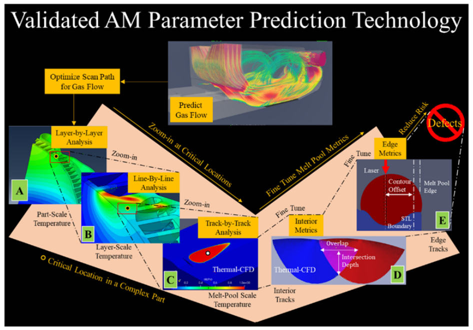

image courtesy Applied Optimization

Notes: Produce very-high quality, complex, structure critical, additively manufactured parts using physics-based modeling to predict part-specific processing parameters.

1. Account for variability of gas flow in deposition chamber
2. Optimize scan path, and minimize spatter-induced defects.
3. Compensate for hot spots
4. Attain consistent melt pool formation and solidification conditions
5. Minimize lack-of-fusion, porosity, and keyhole defects.
6. Minimize surface defects.
7. Account for up-skin and down-skin surfaces and complex features of part geometry.
8. Reduce scatter in part quality.

Significantly reduce risk in schedule and cost for operational qualification.

1. Down-select robust process parameters to determine a quality metallurgical process
2. Produce high-quality reference parts and pre-production units.
3. Attain higher mechanical properties.
4. Create scientific evidence to trust part quality

WHAT

Operational Need and Improvement: AM provides DoD-wide opportunities to produce components needed for rapid sustainment of aging systems, as well as to develop new generation systems. Current use of AM parts have been for largely nonstructural and non-critical applications because the risks of not meeting consistent mechanical properties still exists. Current practice for AM results in parts that contain gas-flow and metal-flow induced defects. Such defects, when located in the interior of the part, could be healed using hot isostatic pressing, but surface-defects cannot be healed. The need is to develop ICME modeling tools to optimize the gas flow and metal fusion during Directed Energy Deposition (DED) and Laser Powder Bed Fusion (LPBF) AM processes, and produce very high-quality components for structure-critical applications.

Specifications Required: Due to inconsistencies in the mechanical properties of AM parts, the costs of part qualification and certification are very high, making it harder to demonstrate viable business cases for the adoption of AM components. The DoD specifications for operational and process qualification are highly demanding, increasing the cost of AM components. The requirement is to enable to production of consistently high-quality AM parts that mitigate defects and hot spots to attain consistent solidification conditions across the part, achieve higher fatigue properties, and thereby help reduce the cost of qualification and certification for structure-critical AM parts.

Technology Developed: ICME modeling tool to predict processing parameters to optimize gas flow and metal fusion in AM parts to reduce defects by two-orders of magnitude compared to the current industrial practice, minimize surface defects to attain a solid seal around the interior of the part, particularly for critical regions in the part, and demonstrate higher fatigue strength.

Warfighter Value: Higher quality, structure-critical AM parts, ability to reduce part count, optimize part geometry to reduce weight and enhance performance, reduce cost and schedule risk for rapid sustainment.

WHEN

Contract Number: N68335-23-C-0121 **Ending on:** May 04, 2026

Milestone	Risk Level	Measure of Success	Ending TRL	Date
1. Mitigate gas-flow and metal-fusion induced defects in LPBF	Low	> 100x reduction in build defects	6	1st QTR FY24
2. Mitigate gas-flow and metal-fusion induced defects in DED	Low	(i) 3x reduction in spatter, (ii) minimize defects caused by nozzle debris	6	1st QTR FY25
3. Optimize process-structure properties for DED and LPBF	Medium	Consistent microstructure and reduction in scatter for mechanical properties	6	2nd QTR FY26

HOW

Projected Business Model: Implement ICME model as commercial software (AMP2: Additive Manufacturing Parameter Predictor, which includes modules to optimize gas flow and metal fusion). AMP2 automates its algorithms such that it can be used effectively by junior staff to reduce cost of modeling, schedule for part tryouts.

Company Objectives: (1) Demonstrate significant (50% or higher) reduction in the cost of qualification and certification using ICME models to design the AM process parameters to produce structure critical parts. (2) Demonstrate an order of magnitude reduction in the cost of using ICME models to predict processing parameters. (3) Establish a market niche to support the process development of structure-critical AM parts for rapid sustainment and for the development of new generation systems.

Potential Commercial Applications: Provide or license ICME modeling technology to predict AM processing parameters to produce very-high quality parts for structure-critical applications, e.g., for defense primes such as BAE System, Bell Helicopter, GE, Honeywell, Raytheon, Lockheed Martin, and Boeing. Develop add-on product to build higher-quality parts using commercially available AM equipment, e.g., by EOS, 3D Systems, GE Additive, and Renishaw. Support university-based AM programs, e.g., at Carnegie Mellon University, Pennsylvania State University, and University of Texas at El Paso.

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