Department of the Navy SBIR/STTR Transition Program

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Topic # N221-074
Optimized Turbine Blade Cooling and Defect Mitigation for Additive Manufacturing
Cornerstone Research Group, Inc.

WHO

SYSCOM: ONR

Sponsoring Program: NAVAL AIR WARFARE CENTER

Transition Target: U.S. NAVY and Prime Contractors for DoD Aerospace Systems & Energy Generation

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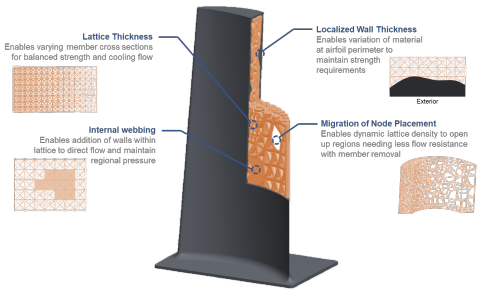
Other Transition Opportunities: A global aerospace leader and provider of jet and turboprop engines has interest in CRG's work. CRG is utilizing a provided turbine geometry that can be used as a test geometry for LattiSolve's thermal optimization. CRG will work with this company to compare CRG's optimized version of their turbine geometry to the performance of the baseline design to help guide the development of LattiSolve's thermal optimization capabilities. CRG intends to continue working with this company in future work where LattiSolve can be applied to help maximize the performance of turbine technologies while reaping the manufacturing benefits of the internal lattice structures.



LattiSolve and gas turbine blade design concept images

Notes: CRG's primary focus on this project is to optimize the cooling and structural performance of a gas turbine rotor exposed to high temperature environments. As CRG pursues this research, CRG intends to expand the capabilities of our in-house lattice optimization toolset called LattiSolve. Currently LattiSolve is capable of optimizing a lattice structure based on structural design parameters. Future iterations of LattiSolve will incorporate thermal and fluid related parameters making LattiSolve a multi-physics optimizer.

WHAT

Operational Need and Improvement: LattiSolve currently is capable of optimizing the thickness of the beams making up the lattice core along with the thickness of the surrounding shell of an arbitrary geometry using structural performance as the design criteria. The U.S. Navy is seeking to optimize the cooling efficiency, and structural performance of a gas turbine geometry intended to be fabricated using additive manufacturing. CRG is currently expanding the capabilities of LattiSolve in order to incorporate thermal and fluid modeling tools to expand LattiSolve for multi-physics applications.

Specifications Required: The U.S. Navy is requesting CRG to develop an optimized gas turbine blade designed with a complex lattice interior structure intended to be fabricated using an additive manufacturing process. Many modern gas turbine blades can experience temperatures prior to cooling up to around 3,600 deg F. The optimized blade should also be able to meet the cooling, structural, and other performance needs to maximize the blade's performance and durability.

Technology Developed: LattiSolve is currently capable of generating complex lattice shapes optimized for a given load or performance environment. The toolset is developed to design and optimize lattice structures with multi-physics applications, such as turbine blade cooling, with the intent to be fabricated using an additive manufacturing process. LattiSolve, combined with commercial additive manufacturing techniques, has been successfully used for the development of complex lattice structures for several projects including internal structure of a structurally optimized turbine blade and a mirror backplate.

Warfighter Value: LattiSolve can be used to drastically improve the lifespan and reduce the maintenance costs associated with gas turbine blades. Because of the extreme temperature conditions experienced by gas turbine blades, they are greatly prone to degradation such as corrosion or structural failure. LattiSolve has the potential to improve the cooling and structural performance of a gas turbine blade considerably improving the blade's longevity which, consequently, will reduce the maintenance costs associated with replacing damaged blades.

WHEN

Contract Number: N68335-23-C-0296 **Ending on:** Aug 11, 2025

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Demonstrate Design Capabilities	N/A	Successfully optimize the lattice structure of a sample turbine	3	3rd QTR FY23
Demonstrate Additive Manufacturing Defect Prediction Capabilities	N/A	Accurately predict defects in a sample object produced using additive manufacturing	3	3rd QTR FY23
Manufacture Sample Turbine Blade using Additive Manufacturing	Low	Successfully manufacture a sample turbine blade with a lattice core using additive manufacturing	3	3rd QTR FY23
Incorporate Fluid and Thermal Modeling in Optimization Tool	Low	Accurately model fluid and thermal properties for design optimization	2	4th QTR FY24
Optimize Cooling Capabilities of Turbine Blade	Medium	Successfully optimize cooling capabilities of turbine blade designed for real world applications	3	1st QTR FY25
Fabricate and Test Optimized Turbine Blade	Medium	Demonstrate optimization success using an experimental setup	3	3rd QTR FY25

HOW

Projected Business Model: CRG has created multiple units to provide flexibility with commercialization of our technologies. CRG Specialty Products was created to manufacture, distribute, and sell transitioned technologies (products) to both commercial and government customers. The business model for LattiSolve calls for CRG Specialty Products to operate the business post-transition. In order to facilitate effective transition, CRG created Rushlight Ventures (RLV) in 2020, a venture studio for the methodical pursuit of value creation leveraging technologies developed under government contract. RLV has developed and deployed a stage-gate process within CRG to ensure that the technical, manufacturing, and business readiness elements move forward in concert.

RLV and CRG anticipate that the mechanism for commercializing LattiSolve and optional subsequent part fabrication will be via an operating unit within CRG Specialty Products focused on serving government customers and later expanding to include serving commercial customers. This business is expected to offer both design services and design/fabrication services, producing either a design for customers to execute, or producing a finished part via internal and partner part printing capabilities.

Company Objectives: Our primary objective is to develop a highly versatile and accurate multi-physics optimization toolset for lattice-based geometries with the intention of being fabricated using additive manufacturing technologies. Our goal is to diversify the LattiSolve optimization software so that the optimization process can be applied to a large set of problems ranging from purely structural to thermal and aerodynamic such as turbine blade cooling.

Potential Commercial Applications: The combination of lattice optimization and additive manufacturing capabilities are applicable to many potential commercial applications particularly in the aviation and space industries where cooling, weight, and efficient fabrication techniques are significant to the success of their respective missions.

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