Department of the Navy SBIR/STTR Transition Program

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NAVAIR 2017-669

Topic # A12-080

Compact, Inexpensive, Microchannel Recuperators for Small Gas Turbines

Creare LLC

WHO

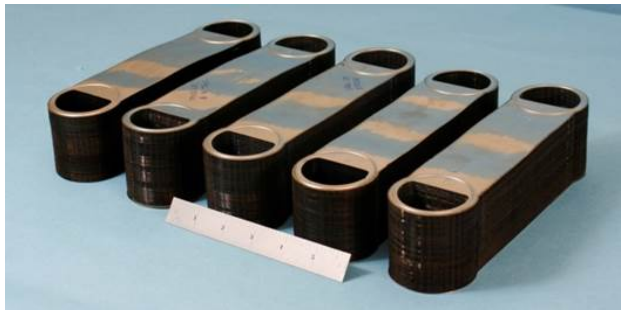
SYSCOM: NAVAIR

Sponsoring Program: PMA-266

Transition Target: MQ-8C Fire Scout

TPOC:
(301)342-0868

Other transition opportunities: (1) Recuperators for Turboprop Engines in Fixed-Wing Unmanned Aerial Vehicles (UAV), (2) Auxiliary Power Units, (3) Vehicle-Borne Directed Energy Weapon (DEW) and Radar Power Systems, (4) Fan-duct heat exchangers in turbofan engines



Notes: The photo shows five microchannel recuperator modules fabricated from Inconel 625. Twenty eight of these modules are combined to produce a recuperator that could be added to the Rolls-Royce M250 engine used in the MQ-8C Fire Scout.

WHAT

Operational Need and Improvement: The need is to reduce fuel consumed by gas turbine engines on UAVs. The approach is to add a recuperative heat exchanger (recuperator) to the engine. The recuperator transfers heat from engine exhaust to compressed air upstream of the combustor. Because the pre-heated air enters the combustor at a higher temperature, fuel consumption can be reduced significantly compared to an unrecuperated engine.

Specifications Required: The recuperator must be compact, lightweight, low pressure-drop, inexpensive, and highly durable.

Technology Developed: Creare has developed inexpensive manufacturing techniques to produce microchannel heat exchanger cores from Inconel 625. The manufacturing process uses high-precision metal forming and blanking to produce heat exchanger plates followed by high-precision welding to assemble the heat exchanger core. All steps in the process are highly automatable for low-cost, high-volume production. The heat exchanger cores feature extremely uniform microchannels for high thermal efficiency with low pressure losses. Precise tuning of the weld process yields weldments with features that promote high durability in the challenging thermal and vibration environment.

Warfighter Value: Reduced fuel consumption will extend mission duration and/or increase payload capacity. We project 20-30% gain in endurance and/or up to 500 lbm of additional payload capacity for aircraft like the MQ-8C. The recuperators will be compact and low-cost, and can be retrofit to existing aircraft with minimal changes to engine and airframe. Extended flight duration will result in fewer take-offs and landings over the engine lifetime, which can extend life-limited engine component replacement intervals. The heat exchanger core is modular and will be simple to repair. An additional benefit is reduced visibility thanks to cooler engine exhaust.

WHEN

Contract Number: N68335-16-C-0396 **Ending on:** January 20, 2018

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Recuperator Module Demonstration	Med	Validated design models and durability in simulated engine environment	4	October 2015
Engine Performance Demonstration	Med	Demonstrate significant reduction in fuel consumption using full-size recuperator	5	December 2017
Thermomechanical Durability Demonstration	Med	Demonstrate durability through 100 engine power cycles	5	December 2017
Vibration Testing	Med	Demonstrate durability under helicopter vibration conditions	6	December 2018

HOW

Projected Business Model: The recuperator will be part of a kit that can be used to retrofit existing aircraft to achieve higher performance. The kit will also include engine and airframe modification elements. We envision selling recuperators to a prime contractor for inclusion in these kits. Initial production of recuperators will occur at Creare's sister company, Edare Inc. If production volumes are high enough, we anticipate transitioning production via a licensing agreement from Edare to a high-volume manufacturer. Creare has successfully licensed several technologies to existing manufacturers, including high-torque threaded fasteners licensed to Phillips Screw Co. and cryogenic machining technology licensed to 5ME.

Company Objectives: We hope to establish connections through the STP with government program managers and technology developers who need to improve the performance of gas turbine engines in UAVs besides the MQ-8C, auxiliary power units, vehicle-borne DEWs and radar systems, and other small gas turbine applications. We also hope to find ways to apply the technology to related applications, such as the fan-duct heat exchangers in larger turbofan engines like the F-35's.

Potential Commercial Applications: Commercial applications include: (1) Improved fuel efficiency for small turboprop engines used for small commercial aircraft and UAVs; (2) Improved fuel efficiency for commercial aircraft APUs; (3) Improve the efficiency of stationary gas turbine power systems used to generate electricity for industrial processes.

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