

#### Challenge

Unmanned aerial vehicles (UAVs) can provide situational awareness, precision targeting, and logistical support for ground, air, and sea forces. To enable extended missions for larger UAVs powered by gas turbine engines, the range and loiter time must be improved. One way to achieve this end is to reduce fuel consumption by using a recuperative heat exchanger. A recuperator is a heat exchanger in which hot gas from the turbine exhaust heats the compressor discharge gas before it enters the combustion chamber. However, the size, weight, durability, and cost of available recuperators have prevented their use. A new recuperator design that overcomes these challenges is needed.

#### Creare Solution

Creare has developed a recuperator design consisting of stacks of stamped metal plates. The air flow microchannels formed between the plates enable high heat transfer performance for a very compact core. Pressure losses, which impact engine performance, are minimized. The metal plates are produced using a low-cost, high-precision forming and blanking process. The process can produce plates from any formable metal, including Inconel 625, Hastelloy X, Hastelloy C-22, stainless steel, and aluminum. Use of commercial, well-characterized alloys enables us to design the recuperators with confidence for long-life at very high temperatures.

Using a computer-controlled laser, Creare engineers developed a welding process to produce heat exchangers that are durable and leak-free. This method can be used to fabricate recuperators with a variety of sizes and shapes. Thus, heat exchangers can be designed to integrate closely with engines in tight compartments. Innovative seal designs minimize thermomechanical stress for excellent durability. Our foil recuperators can be used to boost the performance of engines with power levels from 10 to 2000 horsepower.



MQ-8C Fire Scout UAV used by US Armed Forces (US Navy photo courtesy of Northrop Grumman/Released)



Creare-developed recuperator module for helicopter engine



1700-ton stamping press for producing heat exchanger plates

## Impact

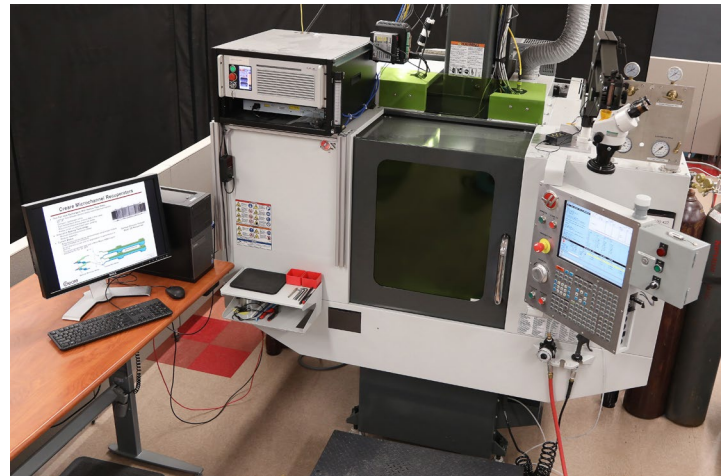
Creare has tested a full-size recuperator for a Rolls-Royce M250 gas turbine engine. NAVAIR funded this work to develop a recuperated engine that can increase mission time for the MQ-8C Fire Scout unmanned rotorcraft. Preliminary data show that a significant (~24%) reduction in specific fuel consumption will be possible in a flight engine. The recuperator weathered 100 full engine start/stop cycles with no degradation in engine or recuperator performance, no visible damage, and no changes to the weld microstructure. Creare has also fabricated prototype recuperators for UAV Turbine's UTP50R 50-hp turboprop engine. Integrated engine tests will be conducted in 2019.

Creare is also developing recuperators for:

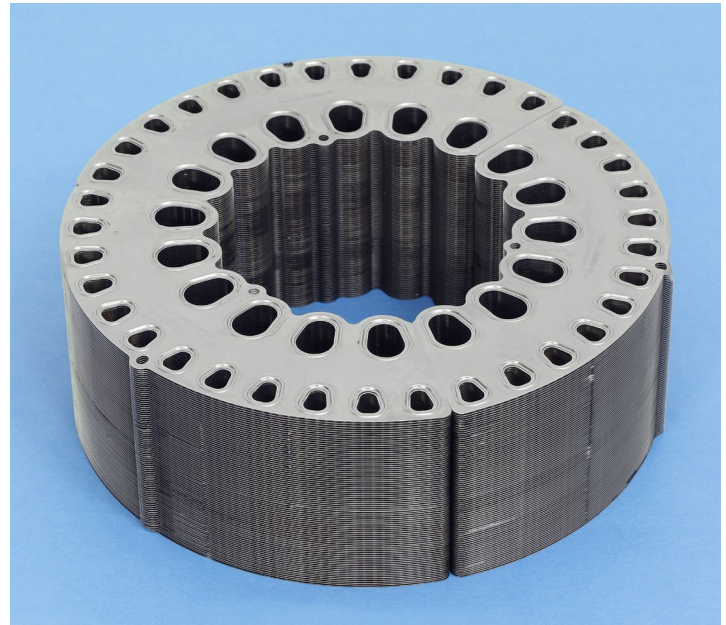
- A 200-hp gas turbine engine under the US Army's RASPS program. The first module will be produced for rig tests early in 2019.
- A 5 kW<sub>e</sub> turbogenerator for the Army's Aviation Development Directorate. Prototype tests are planned for early 2020.

## About Creare

Founded in 1961, Creare LLC is an innovative technology and product development company located in Hanover, New Hampshire. We serve government and industrial clients with engineering R&D services that include analysis, prototype design, fabrication, and testing. Our clients include large and small companies and government agencies in the aerospace, defense, medical, energy, and process industries. Creare means "to create" – we create value for our clients when we solve their most difficult problems. We also help integrate new technologies into their products, systems and processes.



Computer-controlled laser welder produces leak-tight recuperators



Recuperator for UTP-50R engine



Creare LLC  
16 Great Hollow Road  
Hanover, NH 03755  
603-643-3800 • Fax 603-643-4657

[www.creare.com](http://www.creare.com)

V1.0 2019