CASE STUDY

Advanced Innovative Engineering

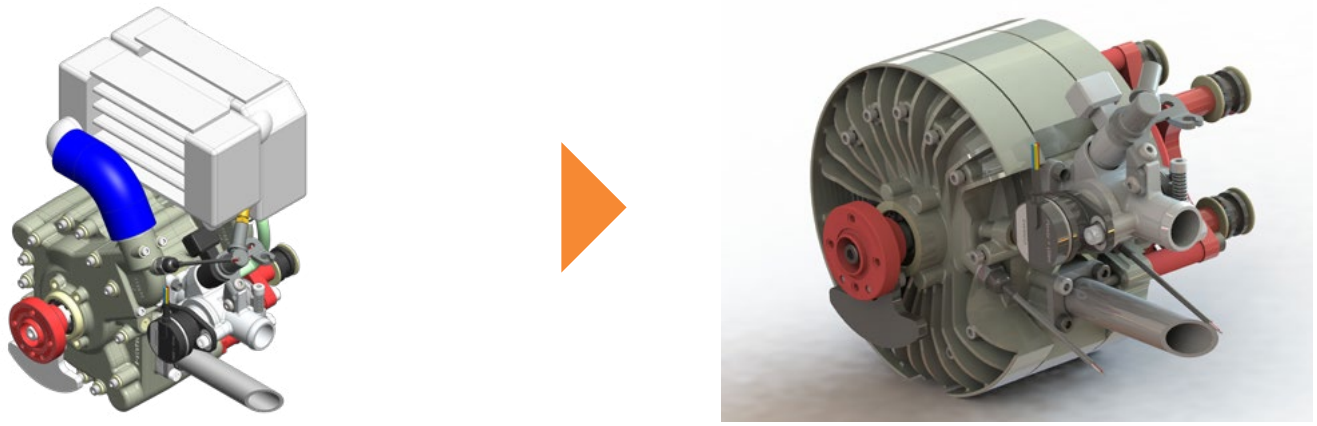
DRAMA helps Advanced Innovative Engineering to re-engineer rotary engines

THE CHALLENGE

Advanced Innovative Engineering (AIE) are the latest incarnation of a development, design and manufacturing heritage that stretches back to Norton in the 1960s and beyond. Their combined 80 year's experience in engineering research and development across a number of industries means that they offer a wealth of world-class knowledge and expertise that isn't found elsewhere. They offer a truly one-stop shop. AIE don't just build engines - they consult, conceptualise, design, develop and test solutions to customers' problems. All of their activities are based at one state-of-the-art facility in Lichfield at the heart of the UK's aerospace engineering and manufacturing industries. This fully computer-controlled world-class centre is highly flexible to provide the very highest quality R&D, testing and manufacturing precision. The unrivalled power and durability of AIE lightweight rotary engines are guaranteed through the use of revolutionary new technologies that effectively eliminate drawbacks found in many other rotary engine developments. Access to the latest discoveries from leading names in rotary engine design together with advanced manufacturing capabilities enable AIE to pass on unique benefits to their customers through patented technology.

The challenge that AIE set for this project was to investigate the suitability of AM to:

- Improve engine performance through weight reduction (including moving from liquid cooling to air cooling)
- Decrease product development and manufacturing lead times
- Decrease production costs
- Consolidate component count wherever possible



Original rotary engine (left) post-project engine (right)

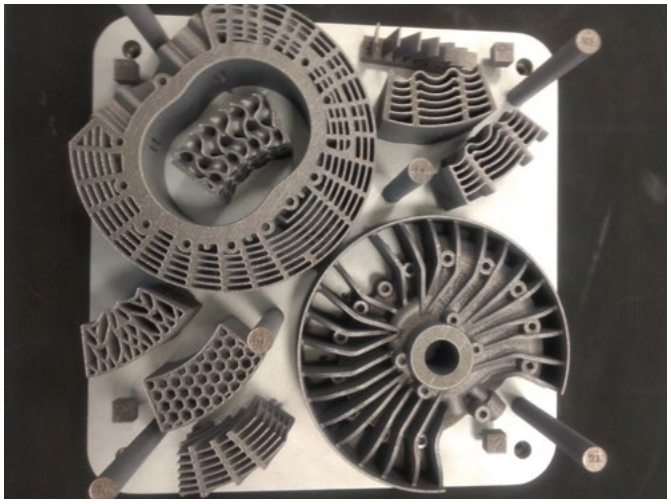
THE OUTCOME

NCAM engineers visited AIE to gain an appreciation of the products currently manufactured and the manufacturing processes involved. They then split the project into 3 distinct activities: (1) AIE Rotary Housing – Conceptual Fin Designs (2) Thermal/Structural FEA Simulation (3) AM process selection.

1. Fin designs were to be constrained to maximise heat dissipation within the motor housing, remaining within the original engine geometry bounds and minimise weight. A variety of fin geometries fell into approximate categories: Honeycomb lattice, TPMS Gyroid lattice and Algorithmic tree and each were developed within the constraints allowed. Each fin geometry was then printed to allow AIE to assess as-built surface roughness and the potential for manufacturing and functionality issues.
2. The two preferred fin designs and primary engine components (engine housing, front and rear end plates) underwent structural simulations to assess areas of critical concern for stress values below yield point criteria for aluminum under the scenarios modelled.
3. Laser Powder Bed Fusion was down selected as the most appropriate AM process. A build layout was created and demonstrator parts were printed using a Renishaw 500Q AM machine.

The results of this activity show that NCAM engineers have succeeded in helping AIE to reduce the engine mass from 6kg to 4kg, reduce component count significantly and, therefore, manufacturing costs while maintaining operational capability of the engine.

Encouraged by the results so far, AIE expect to pursue this further with a follow-on project to further explore the thermal sensitivity of the assumed input parameters as well as considering convective and radiative heat transfer interactions between surface. Further CFD studies of the fluid flow over the engine will also be undertaken to more accurately assess flow characteristics through the fin designs and better inform design for a full production version.



Build bed configuration showing fin geometries

Accessing the expertise of NCAM through the DRAMA programme has been instrumental in enabling AIE to develop an understanding of metal additive manufacturing, its potential applicability to its engine designs and the solutions it can provide over and above traditional manufacturing processes. DRAMA really has been a game-changer for AIE, reshaping our approach to product design through seeing what is possible using AM.

Nathan Bailey, Managing Director, Advanced Innovative Engineering Ltd

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DRAMA - a collaboration of eight partners
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