Market Sector:
**AUTOMOTIVE**

Technology Theme:
**ADDITIVE MANUFACTURING / ELECTRIFICATION**

# DESIGN FOR ADDITIVE MANUFACTURING: ADDITIVE MANUFACTURED ELECTRIC MOTOR


Investigating the state of the art to determine current constraints and development opportunities of additive manufacturing for electric motor components

> The development of electric motors has not seen this level of focus for nearly 100 years despite being high on the priority list for many industry sectors that are seeking significant improvements in cost, quality, reliability and performance, in both gravimetric and volumetric terms. Systems engineering and integration – doing more with key components and materials - are key to achieving this and so Additive Manufacturing is a key enabler for developing complex features and forms, essential to improving the functionality and performance of electric motors, with singular and multi-materials solutions.
>
> **Steve Nesbitt, Chief Technologist, MTC**

## THE CHALLENGE

Additive manufacturing (AM) has been identified as an enabling manufacturing technology to produce power-dense electric motors in a repeatable and short lead time. Whilst additive manufacturing isn't new, its application for end-use parts and tooling has become more prevalent only in recent years, and is demonstrating its potential to change the way that products are designed and manufactured.

In academia, there are a growing number of research papers that highlight the benefits associated with an additive manufactured motor, however there are limited examples of AM in commercially developed products. The MTC's technology experts initiated a project that considered the wider implications of additive manufacturing for electric motors. The aim was to provide recommendations, based on existing limitations, for creating the next generation of electric machines.

## MTC'S SOLUTION

With support from the National Centre of Additive Manufacturing (NCAM) and the MTC's Electrification Steering Committee, the project team were able to identify the key challenges being faced by conventionally manufactured motors. Technology Readiness Level (TRL) and Manufacturing Readiness Level (MRL) assessments were conducted of additive manufacturing for key motor components. These assessments were combined with learnings from past projects and an analysis of present manufacturing techniques for each component. In doing so, the MTC was able to identify the current constraints and how, by, applying AM, these limitations may be resolved.

To demonstrate the potential benefits of leveraging the capabilities of AM, the cooling method of a commercial motor was reassessed, as a result of several iterations of a liquid-cooled motor casing.

## THE OUTCOME

The benefits that AM can provide for each component of electric motors were identified, and a research and development roadmap was created to outline a route for progressing the implementation of AM in electric motors. Consequently, the MTC was able to propose new projects that can address the challenges and constraints of using additive manufacturing in electric motors.

The redesign of the casing by implementing liquid-cooling channels allowed the motor to produce more power without overheating, a weight saving of 10% and size reduction of 30%.

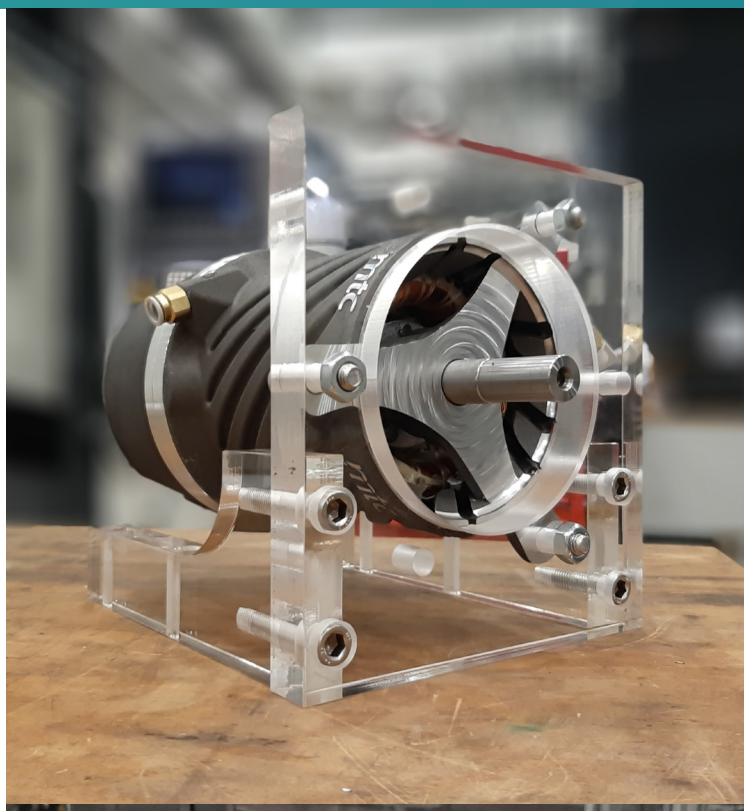
## BENEFITS TO THE INDUSTRY

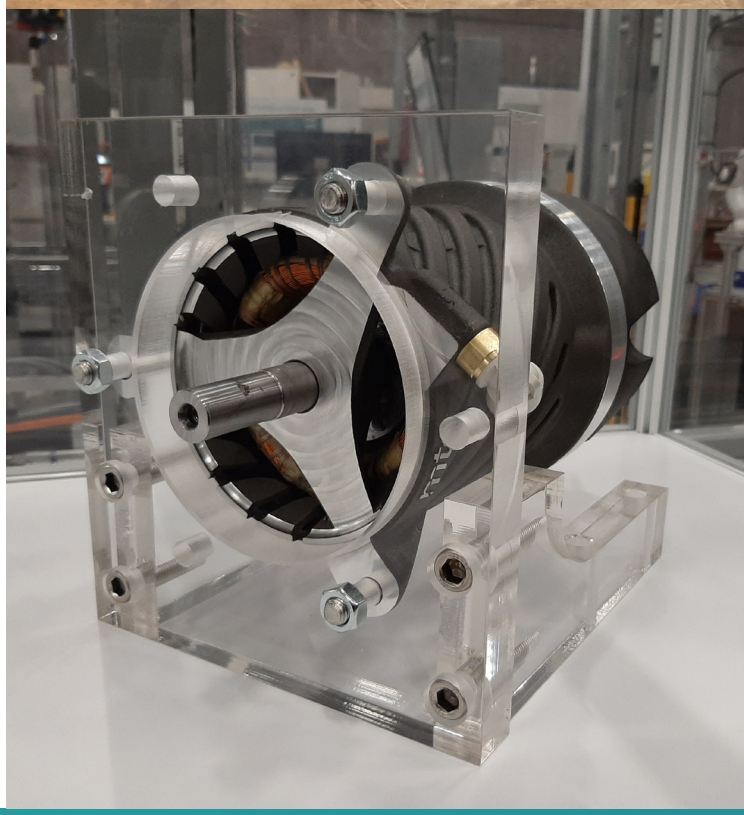
The process of manufacturing electric motors has a number of challenges to overcome; complex or manual assembly, materials that are difficult to process and can be rare and/or expensive, thermal management and lightweighting.

By leveraging the AM capabilities through the product redesign as demonstrated in the casing, key benefits were identified throughout the product and supply chain:

- Increased motor power density, resulting in a reduction in size and mass of key components
- Part count reduction, leading to simplified assembly and supply chains
- Increased manufacturing efficiency and reduced lead times
- Lower running costs
- Waste reduction
- Reduced assembly and inspection costs

The additive manufacturing motor roadmap provides a clear picture of the necessary developments required and potential challenges and constraints to introduce additive manufactured motors to industry.





> Additive manufacturing is complex, but the opportunities for businesses to improve their productivity, efficiency and cost savings – and therefore their competitiveness – are significant. This project has enabled us to identify a roadmap to support manufacturers with implementing AM technologies for electric motors, which has the potential to transform the industry as we know it.
>
> **Dan Walton, Senior Research Engineer, MTC**

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