

DESIGN FOR RAPID SUBTRACTIVE MANUFACTURING (DfRSM) OF ADDITIVE MANUFACTURED COMPONENTS



Establishing a best practice toolset for the design of additive manufactured components for higher volume manufacturing.

“ Additive manufacturing provides a level of freedom that we have not seen before, and it has enormous potential to change the way that products are designed and manufactured. Thanks to projects such as this and the toolset that we have created, the potential for the adoption of AM for higher production volumes to become increasingly common and possible for more businesses. By following good design practices and specialised machine tooling, manufacturers can streamline their processes in the most economical and efficient way possible to save time and costs.

Paul Trodden, Technology Manager, MTC



THE CHALLENGE

With the design freedom that additive manufacturing (AM) allows, demand is increasing for more bespoke, compact and lightweight components. For industry to be able to support this continued evolution and to make AM a more viable process, it is vital that the fundamental design rules for each manufacturing process are included as early in the design process as possible.

Similar to traditional casting processes, additive manufactured components require subtractive manufacturing to achieve the required tolerances, surface finish, or design features (e.g. threaded holes) for a given specification. These steps introduce cost and time into manufacturing, and despite attempts to achieve higher

volume manufacturing of AM components, upfront consideration for subtractive manufacturing continues to be overlooked during design.

Experts at the MTC, initiated a project to support the development of a toolset to guide designers for rapid and efficient machining of AM components. In this case, a lightweight electric motor casing with integrated cooling channels was used as an example. The lessons learnt could be applied to similar products as well as other AM projects, and when supporting members and customers on their journey from AM prototype to full volume manufacturing.

MTC'S SOLUTION


With support from the National Centre for Additive Manufacturing (NCAM), the MTC's Electrification Steering Committee and leading technology experts, the MTC conducted a comprehensive review of the advanced machining and tooling techniques used by a broad range of industries. The information collated identified a number of special-purpose tooling and fixturing techniques which were able to combine multiple finishing operations in a single step.

Utilising the results alongside knowledge and learnings from previous projects, the MTC was also able to develop a series of design guidelines, and a time savings calculator. After doing so, the toolset was tested against the existing AM electric motor casing prototype for theoretical volume production at 25,000 units per annum.

THE OUTCOME

Following testing of the new toolset against the prototype, full verification was given to the robust guidelines developed for DfRSM earlier in the design process. The result led to a potential reduction in subtractive manufacturing from 127 minutes per component, down to 2.85 minutes – a 98% reduction in time. Even when accounting for the upfront cost of bespoke tooling, a potential £2.23million reduction in costs was identified for an assumed production volume of 25,000 parts per annum.

The recommendations, whilst developed for an electric motor casing, can be applied to components and projects from any industry looking to adopt AM or net shape manufactured components.



The creation of this toolset demonstrates the value that the MTC offers to industry, its members and businesses like SMEs. We hope that this toolset will support manufacturers across industry to make simple changes throughout the design process to create components in the cleanest way possible without detrimentally impacting on the agility that a process like AM offers.

Benjamin Bollans, Technology Manager, MTC



BENEFITS TO THE INDUSTRY

AM is a vitally important process for the manufacturing industry going forward due to the design freedom that it offers. However, for AM to become more viable for high volume manufacturers, raw AM components need to reach the finished, usable product stage in the quickest way possible.

This case study has shown how implementing DfRSM methodology for AM components can lead to a number of key benefits:

- ▶ Decreased total manufacturing times for finishing each AM component.
- ▶ Reduction in the production costs due to reduced labour.
- ▶ Greater production capacity for the capital equipment required for subtractive manufacture.

The toolset developed has not only established a methodology for AM components, it can be applied into future-state machining processes and can be disseminated through training and good practice amongst the MTC and its members.