

The Knowledge Transfer Partnership Programme between Centurian Safety Products and Warwick Manufacturing Group (WMG) & the University of Warwick.

This project was funded by UK Research and Innovation (UKRI) through Innovate UK.

BACKGROUND

Established in 1879 with headquarters in Thetford, UK, Centurian Safety Products Ltd is a global manufacturer of total head protection products, with operations across Europe, the Middle East and China.

Centurian designs and manufactures a wide range of head, ear, face and respiratory system personal protective equipment (PPE) for the industrial and construction markets. The primary manufacturing technology is injection moulding, which enables products to be produced rapidly to a set design, material and colour.

An unrivalled understanding of its users has enabled the company to create a strong reputation with a unique brand identity in its market.

The company has differentiated itself from the competition through its sole focus on above-the-neck personal protective equipment. This focus has enabled the company to develop pioneering and innovative integrated head protection products.



CHALLENGE

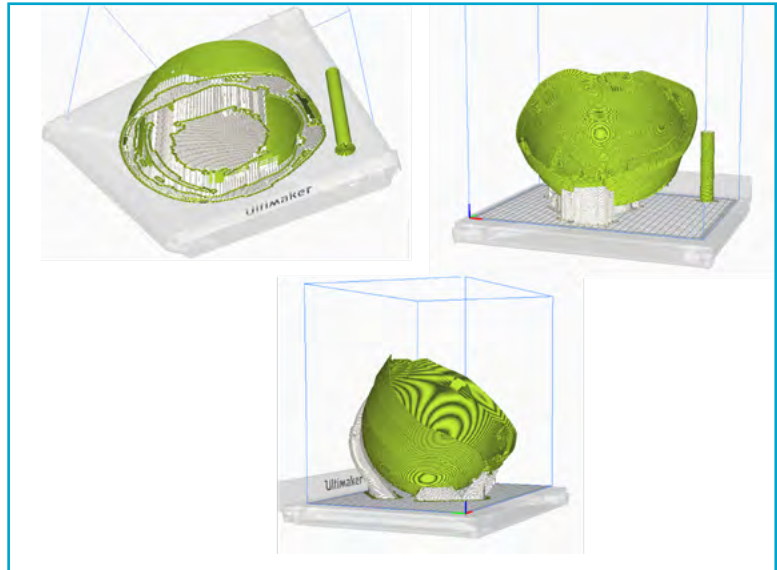
Centurion planned to reinforce its position as a leader in the above-the-neck PPE market through the exploitation and development of advanced materials and process development. Centurion's customer requirements are at the heart of new product development.

Customers are seeking mass customisation of industrial safety helmets featuring strategic strengthening for advanced performance (i.e. lighter, stronger) and the integration of new smart technologies to enable performance detection, monitoring and additional user-defined enhancements, therefore meeting the partnership-building (and differentiation) requirements.

Additive Manufacturing (AM) offers many benefits that Centurion could exploit as a future manufacturing technology that enables mass customisation and adaption. In principle, each safety helmet could be unique.

Additionally, the current injection moulding process requires huge volumes of parts to be made and stored before being deployed to the customer.

Utilising AM enables distributed manufacturing, with the flexibility to place the equipment at the customer's site and print PPE on-demand, therefore negating the need to hold lots of stock and eliminating shipping and packaging costs. The challenge for Centurion is that they had no prior knowledge of AM, what the possibilities could be, and how it could be used to meet their customer demands.



The advanced state-of-the-art AM process equipment that needed to be implemented fell within the sphere of academia. The technology had limited industrialisation and deployment in a high-volume manufacturing environment, posing multiple technical challenges and scale-up risks.

There was a significant strategic need to surpass Centurion's competition by designing and manufacturing technology to produce the next generation PPE.

The outcomes of this KTP would embed a highly novel manufacturing technology to enable creative design, mass customisation and the integration of safety features in the product.

Solution

Centurion approached WMG through a prior relationship as they knew that the University possessed state-of-the-art AM knowledge and equipment. The best mechanism through which to address this challenge was a KTP.

This would allow Centurion to offer a novel solution to the market keeping them at the forefront of PPE. The aim of the partnership was to develop and utilise new AM processes and materials. Jack Lee, an MSc qualified graduate, was recruited as KTP Associate to bridge the gap between Centurion and WMG, and deliver the knowledge needed for Centurion to overcome these challenges.

Jack started by undertaking a technology scan of all the AM processes, materials, build volumes and print speed to provide Centurion with an in-depth understanding of the technology's advantages and limitations.

He then tackled the issues around meeting the European Standards (EN) requirements of impact protection of the hard hats, undertaking a sizable study using Finite Element Analysis (FEA) modelling and physical testing to understand the suitability of AM for the application.

Supported through his Lead and Supervising Academics from Warwick, the work packages are being developed into an academic journal article. Following on from

these work packages, Jack created numerous test domes to simulate the top of a hard hat, with different internal geometries to inform him of how these performed in practice.

Finally, these small-scale results and knowledge were transferred from test domes into full-scale hard hats that were validated against the industrial standard.

The knowledge gained from Jack's work has been transferred and embedded into the design and engineering team at Centurion, informing them of what can be achieved using AM.

His work also highlighted the limitations that need to be considered, as well as an understanding of how they could be overcome through design, materials or equipment and process selection.



Impact

Centurion's engineering and design teams are now fully informed of the considerations for materials, different AM process methods, geometries and internal support structures required for AM design. The company is currently adopting the use of AM as a production method for low-volume specialist items and is technology-scanning for high-rate AM equipment that has the capability to meet minimum demand requirements.

The investigation into mass customisation of parts created a fully defined process whereby helmets could be personalised for the end user using 3D scanning technology. Techniques regularly used in other industries for good engineering practice, such as process capability studies, have now been introduced within Centurion to evaluate AM process capability and aid in the maintenance of manufacturing quality.

Dr Kylash Makenji, Academic Supervisor for the KTP explains: "The ability for UK manufacturing to access innovation funding enables businesses to be more innovative and strategic in the development of future technologies. Working with Centurion has enabled the business to exploit Additive Manufacturing as a future manufacturing process, Jack's work at Centurion has been invaluable and will pave the way forward."

In addition to delivering this KTP, Jack has also been involved with a range of engineering activities, from creating a new product development process to engineering business support. This has developed his knowledge through exposure to engineering problems and helped support the company's innovation.

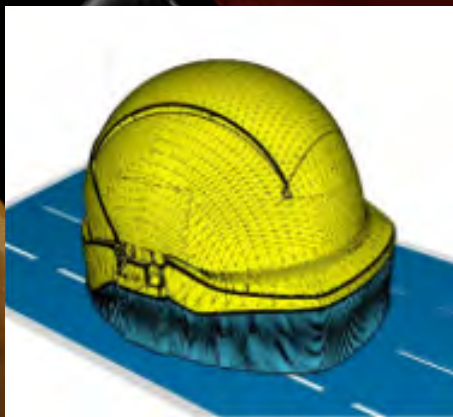
Two key projects that delivered the most impact are:

1) Supporting the design and engineering of a face shield that fits onto an existing cap, allowing the business to offer PPE that was suitable during the Covid pandemic

2) Investigating, trialling, and testing biopolymers as a suitable replacement material for the traditional polymers used by Centurion.

Jan Stringer the Knowledge Transfer Advisor for Centurion KTP commented: "One of the joys of KTPs is the flexibility allowed to adapt the project to maximise outcomes when facing unforeseen challenges. The strength of this partnership, particularly Jack's ability and resilience, has enabled us to achieve great things, despite Covid-19 restrictions hitting very early in the partnership. The support and mentoring offered by the Academics Kylash and Greg has been outstanding and a major contribution to the success."

Jack commented: "A KTP is a fantastic opportunity to engage with both the academic and industrial sectors, combining individuals and resources that otherwise may work in isolation. My own experience working between the University of Warwick and Centurion has given me access to a breadth of knowledge that really accelerated my learning and understanding within industry. It has also provided a springboard for both me and Centurion Safety Products to fully utilise the latest technologies and leading experts to advance a common goal of utilising additive manufacture as a mass production technique."



A Centurion Safety helmet 3 dimensionally rendered whilst being prepared for the Additive Manufacturing process.

The safety helmet with the internal 3D rendering of the support structures required to support the materials, during the Additive Manufacturing process.

