



## CREAT3D CASE STUDY

# Markforged 3D printers exceed traditional manufacturing capabilities

## THE CHALLENGE

Produce a better performing car by enabling continuous design improvement with the freedom and speed to manufacture more complex designs.

## THE SOLUTION

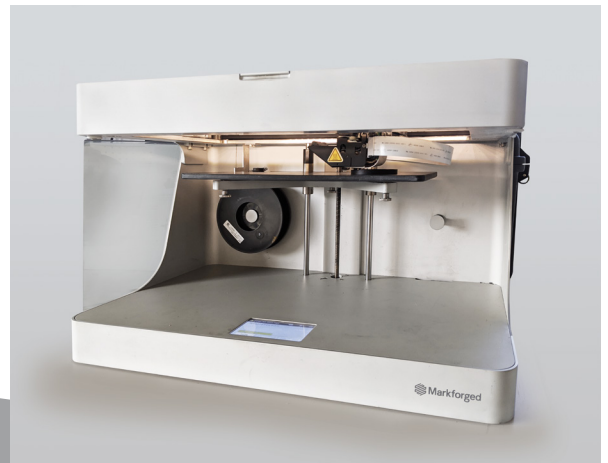
Incorporate the Markforged Mark Two CFF (Continuous Filament Fabrication) 3D printer into TBRe's design and production workflows to produce end-use components and functional prototypes.

## THE RESULTS

- Overall 60kg weight reduction on the race car
- Design team changed workflow by enabling 3D printing to produce better designs, at lower risk & lower cost of development
- Improved track car performance with better designs
- Faster speed of improvement has enabled competitive advantage and a winning race car



TBRe car undergoing design improvements using 3D printing



The Markforged Mark Two Composite 3D Printer

“With Markforged AM equipment, the team have freedom to experiment with better designs, shortening and improving the design workflow by creating end prototypes and components

## ABOUT TBRe

Team Bath Racing Electric (TBRe) is an electric Formula Student team based out of the University of Bath's Faculty of Engineering and Design. Formula Student is the world's largest student engineering competition, with over 600 universities taking part worldwide. Each year the teams are challenged to design, manufacture, test and race a formula style racing car. The team comprises of students from all academic years studying engineering, computer science and business, among other disciplines. The core team consists primarily of final year students, who take the lead roles in delivering the car. However, team members from all years play crucial roles in the project.

TBRe is the UK's best Formula Student team with an electric powertrain, having maintained the title since the 2017 competition. The team's goal is to successfully design, build, and race an electric formula style car, continue to win races, whilst enhancing student learning, skill development and experience.

Innovation is key: The team's rapid rise to success has been driven by a desire to innovate and to broaden their technical and business competencies. There is an emphasis within the team to produce custom, in-house designs to ensure that the car is optimised for the Formula Student competition and racing conditions.

*“Having the Markforged 3D printer in-house means that we can give every element on the car a design consideration from the start. AM has enabled us to be risk takers, with more and better designs, but at lower risk. If the design is not right first time, the only loss is a few grams of material and a couple of hours. Without our AM equipment, minimising risk would have to be a big focus for the team. Designers would have to be certain of their designs before machining, including allowing for the long lead times for production, so the team philosophy would have to shift to more avoiding risk, which would naturally remove our competitive advantage and speed of advancement.”*

**Bassel Ghazali,**  
TBRe Business Manager



TBRe's design office and workshop at University of Bath



Location of the 3D printed Tripod Retainer



## THE SOLUTION

### Light-weighting and improved performance through 3D printing end-use components

As part of the team's workshop, TBRe have access to machine shops, an autoclave for carbon fibre as well as Ultimaker 3D printers and now the Markforged 3D printer. Due to the functionality and robustness of parts produced on the Markforged, TBRe have shifted their design process to incorporate using this equipment to move to functional prototypes, and end-use components fitted to the race car.

The design team are now able to produce parts to be 3D printed from the start of the design project. Printing in Onyx material with reinforcement of Carbon Fibre enables strong, structural and functional parts to be produced.

## THE RESULT

### Connector Casing

Previously the car featured exposed wiring which led to electrics issues.

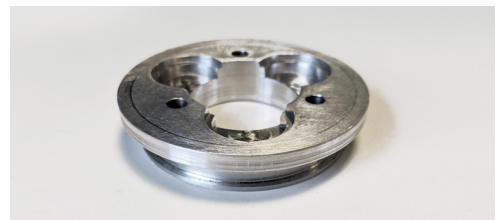
A casing is now printed in Onyx. This casing houses the wires neatly, waterproofing and protecting them from exposure and potential damage.



### Tripod Retainer

The Tripod Retainer is one of four components fitted to the rear axle, forming part of the drivetrain system. The function of the retainer is two-fold: to retain the tripod joint within its housing, and to provide a clamping surface for the sealing boot. The part was previously machined in aluminium.

The retainer is now 3D printed in Onyx with Carbon Fibre reinforcement. The part has been completely redesigned and has a weight reduction of 88g to 8.8g.



### Fast Speed of Development

The purpose of incorporating the Markforged 3D printer was to produce robust (structural and form & fit) parts, faster. To maintain competitive advantage, fast turnaround and development of design is key in such a fast-paced competition.

With this AM equipment, the design team have design freedom to experiment with better designs, shortening and improving the design workflow. Now the team will take a design consideration from the car, and advance straight to 3D printing a component. Due to the low cost of failure, the designers will print a design, and within a few hours, immediately test the new part, with any iterations made at final stage.

This technology has enabled the team to focus on improving multiple aspects of the car, rather than retrofitting existing machined parts.

3D printing has also reduced the reliance on external suppliers and machinists by reducing lead time from 1-2 weeks per part, to just a few hours.

### Exceeding Traditional Manufacturing

The Mark Two enables the TBRe design team to produce end-use parts that are beyond traditional manufacturing design limitations, through creating complex designs with enhanced functionalities, such as embedding nuts during the print process.

## Subpack Casing

The casing houses the batteries (6 per car). Previously the casings were laser cut in acrylic, assembled with chemically etched copper added

The casing now is 3D printed in Onyx, with a more complex, bespoke design geometry that enables better air flow to the battery. Furthermore, nuts are embedded during the print process which allows for a better product and a more robust casing.

The new 3D printed casing is structurally sound and lightweight, reducing the weight from 70kg to 35kg.



The Markforged equipment is not only being used for components on the car, but also bespoke tools that can't be machined, as well as jigs for welding.

*"The Markforged Mark Two exceeds traditional manufacturing. With added functions like embedding nuts, we are able to produce better designs, faster. The team can take more risks in producing designs without limitations, and it means we are no longer reliant on machine shop schedule. The printer has changed our workflow and now life without it would be tough!"*

**Bassel Ghazali, TBRe Business Manager**

CREAT3D is a TBRe sponsor, providing advice and support to TBRe, in particular assistance with DfAM (Design for Additive Manufacturing) to enhance components, and share wider applications and uses of the technology to fuel the team's advancements.

## CREAT3D

### CREAT3D Ltd

Additive Manufacturing Solutions Provider

CREAT3D offer Additive Manufacturing end-to-end solutions including: business consultation, independent buying advice, provision of 3D printers and related equipment, tailored training packages, ongoing technical support, servicing and maintenance, repair & business continuity programmes.

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## TBRe

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