McLaren Racing — 3D printing to get the edge on and off track

Stratasys' Neo800 stereolithography 3D printers are enabling McLaren Racing to make up to 9,000 parts per year — from full-size aerodynamic surfaces to high-accuracy embedded sensor housings — driving their quest for race wins. By bringing more production in-house and compressing development cycles, 3D printing is helping McLaren make the most of stricter design window and cost controls set by the FIA.

> "The Neo800 is very much at the heart of our vehicle development process – from design to production. We tend to make around four car sets of most components before the next iteration is released, which supersedes the previous version.

Tim Chapman
Head of Additive Manufacturing at McLaren Racing

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Case Study

With more than 180 Grand Prix wins, McLaren Racing is one of the most successful F1 teams of all time

The unrivalled appeal of speed

The final race of the 2021 Formula One season in Abu Dhabi was attended by a total of 153,000 fans, despite ongoing impacts of the COVID-19 pandemic. A further 108.7 million people watched on TV, joining the cumulative **1.55 billion** TV viewers that had followed the season to its thrilling climax. Formula One is a heady combination of extreme individual skill and bravery, teamwork and dedication, and cutting-edge technological prowess.

McLaren Racing has been part of this spectacle since New Zealander Bruce McLaren entered the M2B in the 1966 Monaco Grand Prix. It has accumulated 183 Grand Prix wins, 493 podium finishes, 12 Drivers' Championships and 8 Constructors' Championships since, making it one of the most successful teams of all time. The unrelenting pursuit of technical development and the collective passion to turn high technology into race wins continue to define one of Formula One's most enduring teams.

Regulation forces innovation

The 'formula' behind Formula One is a series of complex rules and regulations that must be adhered to by the competing drivers and teams. The rules frame a technological window within which each team must produce the fastest car, all within a maximum permissible budget.

The regulations create a fiercely competitive landscape where fractions of a gram here, a micron or two there, and the overarching speed of development separate podium finishers from the 'also rans'.

To help excel in this harsh competitive environment, McLaren deploys Stratasys' next-generation stereolithography 3D printing technology through a suite of five Neo®800 3D printers to chase the perfect design for the road ahead.

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Something in the air

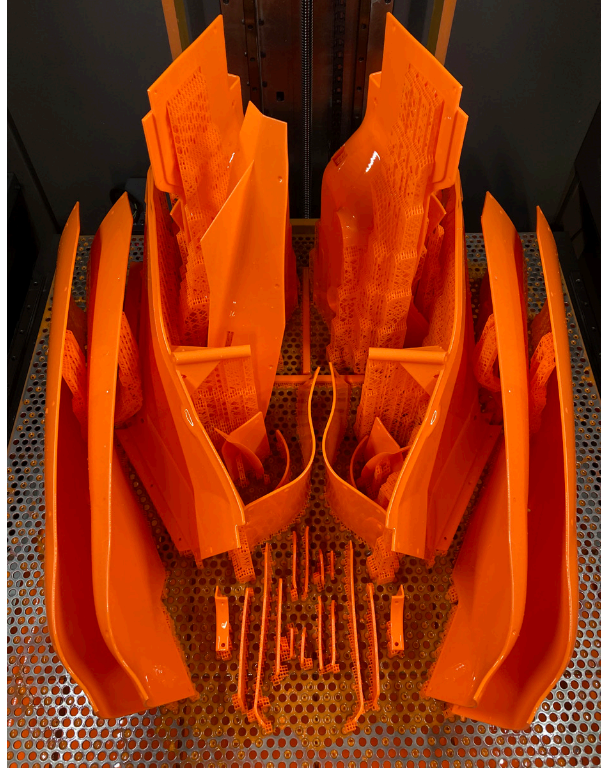
Formula One is synonymous with aerodynamics, the effect of the air passing over, under, through and away from the car being paramount to performance. While computer aided design (CAD) and computational fluid dynamics (CFD) are key to the design and development of a Formula One car, wind tunnel testing is still the gold standard when assessing how every surface works together either as an assembly or as a complete car.

McLaren uses 60% scale models of parts in its wind tunnels to optimize the aerodynamic package and find more downforce – which provides more aerodynamic grip – and balance the front and rear aerodynamic loads on the car.

Using Stratasys Neo800 3D printers and Somos® PerFORM Reflect resin material, the team is producing thousands of parts for numerous front and rear wing programs, as well as large parts of the side bodywork. PerFORM Reflect was developed specifically for wind tunnel models and creates strong, stiff parts that, when combined with the surface finish achieved by the Neo800, reduces post-processing by more than 30%. The parts combine with a machined aluminum spine to make the final 'wind tunnel ready' scale model.

Wind tunnel testing will regularly see multiple iterations of front and rear wing designs, sidepods (including large swathes of bodywork to the rear of the sidepods themselves) as well the complete top-body of the car.

Tim Chapman, Head of Additive Manufacturing at McLaren Racing, explains: "Our new Neo series of 3D printers have dramatically helped to reduce the lead times of our aerodynamic wind tunnel components and projects. The large bed size of the Neo800 allows very large parts to be built quickly and to a very high level of detail, definition, and repeatability. We find the high-definition components from our Neo machines require minimal hand finishing, which allows much faster throughput to the wind tunnel. Finishing cycle times have been reduced dramatically,"



Using Stratasys' stereolithography 3D printing technology can help reduce lead times on aerodynamic wind tunnel components and projects, says McLaren

Compressed cycle times

The process for creating a 60% scale top-body from start to finish is also now much faster. With its next-generation stereolithography 3D printers, the McLaren team can turn a top-body project around — from receiving the CAD data to delivery of the finished part — in just 3 to 4 days.

"Previously, to produce a 60% scale top-body, we would have first glued up the tooling block and rough machined this to the approximate top-body shape. Then using hand shaped templates from a technical drawing, we would have hand finished the top-body shape, effectively creating a pattern, before shuttering up the edges and taking a carbon mold from this pattern.

"Once the carbon mold had been autoclaved and removed from the pattern, the actual carbon component (i.e. the model scale top-body surface) would then be laid up in the mold and autoclaved again. This component once removed from the mold would form the top-body for the scale model Formula One car. In contrast, the Neo800s allow us to completely sidestep that tooling and carbon fiber manufacturing process and 3D print the modular parts instead.

(Part) size isn't everything

The large bed size of the Stratasys Neo800 3D printers (800 x 800 x 600 mm) allows for either large single parts, or a multitude of much smaller ones. The process means intricate details are always preserved with industry-leading repeatability and reliability.

Around 50 or 60 air pressure housings are embedded within McLaren's car to enable air pressure readings of the various surfaces. This information is then fed back to the race engineers to aid development. The small pressure tapping running through these components means that they need a highly accurate and high-definition 3D printing process. After post-processing, these parts are integrated directly on the car.

Using its Stratasys Neo800 3D printers, the McLaren F1 Team produces around 9,000 stereolithography parts per year

Cost cutter

McLaren's Technical Partnership with Stratasys has been instrumental in reducing cost as well as time. With the sport facing uncertain times and no income coming in during the Covid pandemic, the FIA decided to bring the budget cap down from $175 million to $145 million for its first year of operation in 2021, then down to $140 million for 2022 and $135 million in 2023.This significantly focuses teams on the efficiency of the design to production processes, and McLaren tries to manufacture in-house wherever possible.

With the Neo800 3D printers, McLaren can now manufacture all aerodynamic wind tunnel models at its base in Woking, UK, which saves costs on subcontractors and the associated quality assurance. The team can also 3D print jigs and templates, and small molds that would have previously been machined from metal billets. Not only does the speed of the Neo800 stereolithography process save considerable time, it saves on costly metal material by not wasting large amounts of swarf removed from the subtractive machining process.

This improved speed and lower cost makes it easier to run a responsive feedback loop where new iterations can be produced in response to design issues at any point in the season. With its Neo800s, McLaren can create new parts without the need for re-machining tooling blocks or carbon fiber molds – all of which are time consuming and costly processes.

Beyond prototyping

As stereolithography 3D printing technology and materials have evolved, so have the ways in which McLaren exploits the technology. While wind tunnel models and prototypes are still a key use case, the team also produces a lot of full-scale components and production tooling. For example, using Somos DMX SL-100 resin with the Stratasys Neo800 3D printers, the team is printing sacrificial tooling to allow the composite lay-up over the mold. Then, through a unique extraction process the resin is removed after autoclaving leaving the cured composite part ready for use. This allows designers to realize hollow or convoluted composite parts easily without the need for costly and time-consuming complex molds and core manufacturing.

"The Neo800 is very much at the heart of our vehicle development process – from design to production. We tend to make around four car sets of most components before the next iteration is released, which supersedes the previous version. This is why 3D printing is so good for many components; you can make parts extremely quickly, and remove the need for tooling and molds. This is vital in Formula One with super tight deadlines to deliver cars to the next race, and the smallest design iteration can make all the difference between winning, losing or making up positions on the grid," concludes Chapman.

According to McLaren, the ability to 3D print parts extremely quickly is vital for Formula One, with the smallest design iterations making the difference between winning, losing or making up positions on the grid

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