WILLIAMS

Facts

Challenge
Simpler, quicker, more economical construction of design prototypes for the front wing cascades of Formula 1 racing cars

Solution
Additive manufacturing of front-wing-cascade mock-ups for evaluating different designs with the EOSINT P 760

Results
- Efficient: short production times enable more iterations during product development and reduce costs.
- Simple: expensive mold making is only required for final part.
- Functional: exact simulation of the characteristics of the actual component.

Innovation leads to shorter lap times and more points (source: Williams Grand Prix Engineering Limited)

Additive Manufacturing Delivers Prototype Perfection at Racing Speeds

eos

Innovative technology puts Williams Martini Racing's Formula 1 Team on the podium

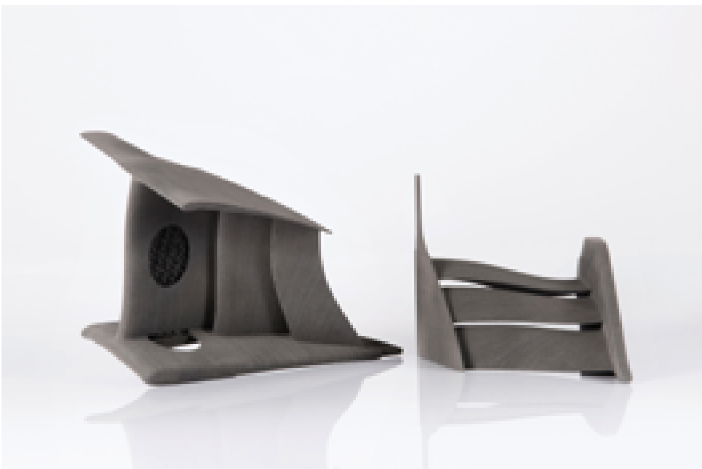
Short profile
Williams Martini Racing is one of the leading racing teams in motor sport's Formula 1 series. Since its founding in 1977, the team has won the Formula 1 Constructor's Championship nine times and drivers have won the Formula 1 Driver World Championship seven times behind the wheels of Williams racing cars.

Further information
www.williamsf1.com

Whether measured by the accolades of adoring fans, the distribution of prize money, or the eternal passion for driving full throttle, success and speed count in Formula 1 as they do in no other sport. Having won nine constructor titles and seven driver world championships, it is fair to say that the Williams Martini Racing F1 Team understands its craft. The fact that speed is also important off the track can be seen in the racing team's development department. There, the engineers have successfully applied additive manufacturing using EOS technology to construct exterior parts of the front wing's assembly for their 2016 racing car.

Challenge
Work begins on designing a new car long before an F1 season ends. While working to continually improve the performance of the current car out on the track, the teams of engineers are simultaneously designing and testing its successor. This fact increases the need to optimally use and deploy available resources—whether in terms of personnel or materials. In the construction of Formula racing cars, teams must stay true to a complex set of rules while finding the best possible balance the golden ratio of high speed, solid reliability, low weight.

Each season, the team sets itself this challenge anew. The development crew at Williams Martini Racing is based in Grove, Oxfordshire, in the United Kingdom. Like their competitors, they have used carbon-fiber composites for many years now. These materials have proved their value in Formula 1 because they deliver extremely solid stability at very low weight. Having said that, they represent a problem, and not only for the Williams Martini Racing developers, in that they are very expensive. Their use requires the costly and complex construction of molds and tooling. The work is time consuming and represents a key issue when it comes to the need to produce individual components for manufacturing prototypes to strict deadlines.



Optimized components thanks to perfected prototyping: Front wing cascade (on the left with internal lattice structure to save weight) of the Williams Martini Racing car. (source: EOS GmbH)

The racing team has historically taken a rather conservative approach when it came to the work of its engineers. At the same time, the team from Grove had always backed up its belief in innovative technologies. Following this principle, the technical department set about integrating additive manufacturing into the development processes of its prototypes for the multi-part front spoiler. The component is one of the car's aerodynamic centerpieces, ensuring that the tires retain optimal grip through the track's fast curves.

Solution
Computer simulations support the calculations for the front wing design. Wind tunnel tests nonetheless need to take place under live conditions at a certain point because the calculation models' performance is limited despite all the intelligent IT algorithms. This is where the concept of "trial and improvement" begins whereby Williams Martini Racing team members examine a number of design variations. Since carbon-fiber

materials are, as mentioned, difficult to work with, Williams Martini Racing has decided to additively manufacture prototypes for the wing to test the shape.

Two machines come into play at this point: the EOSINT P 390 and, in particular, the EOSINT P 760 with its large build volume. Both are suitable for using laser sintering technology to produce plastics. Williams Martini Racing engineers use CAD software to initially design a number of front wing cascades. Each design features intricate geometries implementing the ideas and simulations for high down-thrust and optimum tire grip. The team's members transfer these early designs to the EOS system, which then produces the mold prototypes to the greatest precision. The relevant experts further evaluate the part as soon it leaves the build chamber. Once the construction team has drawn up a short list of potential designs, the complex building of appropriate molds takes place for the actual carbon-fiber-composite components, which will ultimately be tested on the racetrack.

"We regard EOS as leading the field in laser sintering technology—and we always want to work with the best," says Richard Brady, Advanced Digital Manufacturing leader at Williams Martini Racing. "We are firmly convinced that additive manufacturing brilliantly complements our production processes and greatly reduces our product development cycles. In the case of the air-deflecting components on the exterior of the front wing, this has already been an impressive success. We are very satisfied with the complete process of the prototype construction, from the manufacturing itself, through to the cooperation with EOS."

Results

The complex design of the individual parts presents no particular problems when using the additive manufacturing process. The extreme flexibility of design is perhaps the greatest of the many advantages that this technology offers. The EOS machines also achieve the necessary component mechanics and dimensional tolerance with ease—to the extent that it was almost clear from the outset that the fundamental prerequisites defining a successful outcome would be achieved. But was this the case with the central requirements of simplification, faster production, lower costs?

The answer is unequivocal: "We were able to continually reduce the production times because we were able to design the complete manufacturing process in a much simpler, more efficient way," confirms Brady. "For the first time, it is now possible to test the components without the need to carry out complex, time consuming and expensive mold construction for designs that are ultimately rejected." The manufacturing speed also means that achieving many more design iterations is possible within a given time period. Where a deadline might previously have allowed only enough time for one production run, the technology now makes multiple repetitions possible.

The total saving of development time resulting from this translates into cost reductions. Success on the track also supports the team's revenue streams. Components optimized in this way deliver results in the races—and the F1 governing body, FIA (Fédération Internationale de l'Automobile), distributes funds from the racing series' advertising revenues for every point won in the driver and constructor tables. Sponsorship also increases when cars and drivers outperform the competition. Simply put, the Williams Martini Racing Formula 1 team scores points through innovation!

"Carbon-fiber composites offer weight advantages over polymer materials that are used in additive manufacturing. Yet we literally pay a very high price for these advantages, and they are only worthwhile in the battle on the track where a thousandth of a second can make the difference in achieving pole position. The additively manufactured components stand in contrast, with their lower manufacturing costs and high stability. These qualities mean that we are able to quickly test a variation of different designs at a low cost."

Richard Brady, Advanced Digital Manufacturing leader, Williams Martini Racing

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