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Five Ways 3D Printing Is Transforming the Automotive Industry

Introduction

In the span of a decade, 3D printers have moved from an optional piece of equipment for producing relatively simple prototypes to an absolute necessity — one that is transforming the automotive industry in fundamental ways. Now fixtures in automotive design studios, factory assembly lines and test tracks, 3D printers are creating complex parts, speeding up tooling cycles, enhancing measurement and testing, and providing customization solutions across all aspects of the vehicle development process.

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"Every single day, I'm surprised to find a new application discovered by a customer," said Davide Ferrulli, Stratasys® Italy-based territory manager.

Ferrulli, who has been employed at Stratasys for more than 10 years, has seen the shift toward 3D printing, firsthand. Ferrulli's clients include some of the world's largest automotive manufacturers, including Fiat Chrysler Group, Volkswagen Group and Ford Motor Co., as well as ultra-premium brands, such as Lamborghini S.p.A. and Ferrari S.p.A.

Whether using fused deposition modeling (FDM®) to create new tooling for short-run testing or production parts, customizing vehicle interiors, or making measurement and production devices such as jigs, the automotive industry is increasingly turning to 3D printing to manage tight production cycles and cut costs.

"We're going more and more into assembly plants of large OEMs (original equipment manufacturers) and discussing how these tools can support them in overcoming long rollout cycles," said Christoph Lindner, Stratasys territory manager GSC. "We are exploring how rapid tooling contributes to productivity in their plant or even on the assembly line." Lindner, who is based in Germany, works with BMW AG, Daimler AG, Ford, General Motors Corp., VW and numerous tier one automotive suppliers, as well as injection molding and rapid prototyping firms. He has been with Stratasys since 2012, but even in that relatively brief period of time, Lindner has seen significant changes across the industry.

Lindner notes that although OEM customers continue to use 3D printing for rapid prototyping to address a wide range of early-stage design and functional testing needs, the industry is exploring "cross-functionality" parts and applications. With the help of Stratasys experts, OEMs and tier one suppliers are growing in their knowledge of 3D printing applications and the capability of the materials that bring their ideas to the road.

"We are moving away from traditionally thinking (only) about rapid prototyping, and going into questions like: How does 3D printing or additive manufacturing contribute to productivity? How does it optimize costs, or even improve workflow?" said Lindner.

Here are five key ways 3D printing is changing the automotive industry, both today and in the near future.

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1. FROM SMALL TO BIG: FLEXIBLE, OPTIMIZED DESIGN

One of the key benefits of early-stage vehicle design with the assistance of a 3D printer is the ability to start small and scale up rapidly, well before assessment or the part reaches the assembly line.

One example of that capability can be found at Bentley Motors Ltd. Nearly every detail of a future production vehicle is first created in miniature using Stratasys PolyJet™ technology. The 3D process empowers designers to test multiple forms and a variety of practical functions, bringing them closer to a final design much more quickly than in the past.

The studio uses two machines, the Objet30 Pro™ and Objet500 Connex™ multi-material 3D Printers, in tandem. Designers rely on the Objet30 to model anything from tiny wheel rims to grilles, and then move to the Objet500 to create one-third scale and even life-size parts. In a single printing session, both multiple clear and opaque materials are seamlessly integrated to craft a scale model without assembly.

"The accuracy of the Objet30 3D Printer enables us to take a full-size part and scale it down to produce a one-tenth scale model," David Hayward, operations and projects manager at the Bentley Design Studio, explained in a case study. "Once we have approval at this scale, we can move on to our larger Objet500 Connex 3D Printer to produce one-third scale models, full-sized parts as well as parts that combine different material properties, without assembly."

PolyJet technology also allows companies to print translucent prototypes.

Bentley Motors designers print miniature scale models of vehicle interiors and exteriors.

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"This is an application world for itself," Lindner said. "Anything that has to do with glass, interiors, overmolding materials, such as mirrors and panels — these applications are the main drivers behind the clear material."

At Jaguar Land Rover, the Objet500 Connex 3D Printer was tasked with producing a complete fascia air vent assembly for a Range Rover Sport. It used rigid materials for the housing and air-deflection blades and rubber-like materials for the control knobs and air seal. In a single process, Jaguar Land Rover printed the complete fascia air vent as a working part. Once printed, the model was taken from the printer, cleaned and tested, proving that the hinges on the blades all worked, and the control knob had the right look and feel.

Jaguar Land Rover used The Objet500 Connex 3D Printer to print a complete fascia air vent.

2. RAPID TOOLING WITH ADDITIVE MANUFACTURING CUTS THE STEPS, CUTS THE TIME

A recent survey conducted by Stratasys found that 60 percent of Italian customers use Fortus® 3D Printers to perform at least one manufacturing task. Some Stratasys customers exclusively use Fortus 3D Printers for manufacturing, according to Ferrulli. And rapid tooling has become the major focus for many automotive customers, a trend that is only expected to grow in coming years.

"We see a huge adoption around having, for example, pre-series molds produced with a 3D printer and then doing the first 50 to 200 design iterations for the tooling," Lindner said.

Engineers can then evaluate the molds to determine the optimal design before creating a steel version for a final mold. Designing tooling with additive manufacturing from the very beginning removes multiple steps and untold costs compared with traditional tooling methods.

"And this can only be done with additive manufacturing," Lindner said.

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A prime example of shrinking the tooling process can be found in the 2011 Lamborghini Aventador, the sports car brand's flagship model. The $400,000 Aventador clocks in at 230 mph and owes many of its performance attributes to its carbon-fiber-reinforced composite monocoque, which makes up the core of the integrated body-chassis. It weighs 324.5 pounds, and the entire body and chassis weigh just 505 pounds.

A carbon-fiber reinforced monocoque is key to the Lamborghini Aventador's light weight.

A team used a Fortus 3D Printer with a build envelope large enough to produce a one-sixth scale model of the body and chassis in one piece. Complete one-sixth scale prototypes of the body and chassis were created in just two months, including the time to print and assemble the parts.

Under traditional manufacturing processes, it would have taken an estimated four months and $40,000 to build the tooling for the scaled part. But with 3D printing, total build and processing time was 20 days, with a total cost of $3,000, including materials, labor and machine time.

3. FAST CUSTOMIZATION VIA 3D PRINTING

Customizing vehicles, especially when it comes to interiors, is a costly endeavor for automakers. Mass production of a particular automotive feature in low-volume vehicles often proves too expensive for OEMs to justify. But 3D printing offers an economical solution to carmakers looking to provide an array of trims and options for consumers.

For example, Stratasys worked with a German automaker to create a driver-friendly feature in the cabin of the car. This option was available on just 10,000 vehicles — too few units to justify the cost of tooling and injection molding. However, such a low volume is well within reach of 3D printing technology, both in terms of costs and materials.

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Customizing interiors, particularly for commercial customers, is another major need that's being addressed with 3D printing, Ferrulli said. That includes creating low-volume, specialized instrument panels that add features such as compartments for tools and instruments, as well as flexible dashboard features, such as GPS and satellite navigation systems.

And while electric vehicles still represent a low-volume segment, the market is growing rapidly, and 3D printing could play a more prominent role.

These vehicles require lightweight, highly specialized components and parts that must be produced in lower quantities — a perfect place for FDM.

"Electromobility could be the next big thing," Lindner said.

Lindner noted one recent project in which Stratasys worked with a producer of a small commercial electric vehicle (EV). The team produced the tools for thermoforming the roof of the vehicle.

When the pieces of the roof were glued together and attached to the vehicle, the lighter roof helped achieve a nearly five percent overall weight reduction. While this is an early-stage project, and some technical obstacles remain, it shows the potential for 3D printing in the growing EV sector.

Customization lends itself to the aftermarket as well, particularly when artistry and industrial design merge.

4. VALIDATION AND ADVANCED MEASUREMENT ON DEMAND

When it comes to measurement and parts assembly, Lindner also sees 3D printing playing an increased role on the factory floor. He provided the example of a tier one supplier that worked with Stratasys engineers to develop a multi-functional tool that can measure several points on a headlight or taillight prior to final assembly in an OEM plant in Germany.

"We came up with a triangle-shaped tool that marries three different processes into one tool, and it's printed with FDM technology," he said.

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The tool measures the edges, such as where the rubber connects to a taillight, to validate accuracy of the parts and fixtures.

It not only marries three different measurement steps into one, but it also replaces tools made with steel or aluminum that have less functionality, reducing costs by two-thirds at the same time. The FDM-produced tool is light and mobile and can be carried to any station, or anywhere along the assembly line.

“It can serve as an assistant in the zero-tolerance car process, to assure quality control,” Lindner said. “And that’s something no one considered before in the measuring process.”

The tool will be produced by a supplier serving the plant, which produces several hundred thousands of cars per year, Lindner said.

Increasingly, Fortus 3D Printers are being used to produce jigs used in the assembly process.

When it comes to measurement applications, PolyJet Tango™, a rubber-like material, is used to avoid scratches when measuring door gaps during assembly.

Fortus 3D Printers on a factory floor.

5. REAL WORLD FUNCTIONAL TESTING: DISCOVERING WHAT WORKS

Nearly 10 years ago, experts at Stratasys showed Fiat how to create door and body panels with FDM technology. Ferrulli recalls that managers at the Italian automaker were impressed by how large, yet thin, the panels were, as well as how easily the parts fit together. SLA and SLS technologies cannot produce parts as large without warping. But FDM parts hold their shape over time, Ferrulli said.

“When Fiat saw the capability of FDM technology, they were surprised because they were finally able to do something with the technology they were not able to do before,” he said.

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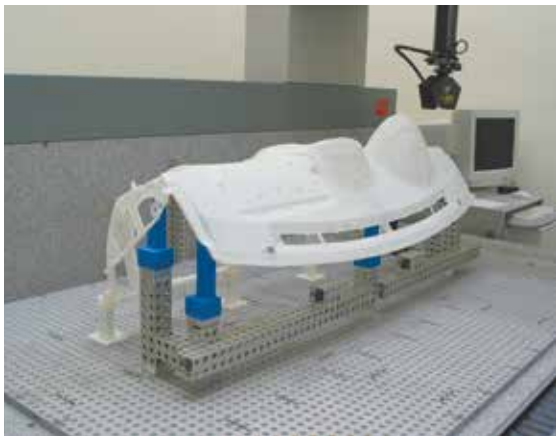
Since then, Chrysler Fiat Group has purchased several Fortus 3D Printers, creating parts with even more functionality.

“They are able to build complex parts (for the engine compartment) that would withstand the functional tests … (for) resistance to chemicals and heat,” Ferrulli said.

One of the most popular thermoplastics, ULTEM™ 9085 resin, a flame-retardant, high-performance thermoplastic, is the go-to material for complex parts that go in the test vehicles, including inside engine compartments. The weight-to-performance ratio is similar to some aluminum alloys used in these applications, and it is resistant to temperatures up to 186 degrees Celsius. Another popular material for automotive parts is ULTEM 1010 resin, which has higher resistance to temperature than ULTEM 9085 resin, as well as increased rigidity, and can withstand temperatures as high as 214 degrees Celsius.

But using FDM technology isn’t just a way to confirm what designers believe will work; it can also reveal what isn’t working — well before a part or a whole assembly goes into production. For example, original and aftermarket equipment maker Hyundai Mobis relies on prototyping for design verification and functional testing, using a Fortus FDM system to help evaluate components such as instrument panels. Specifically, Hyundai Mobis produced a prototype instrument panel in ABS plastic for Kia’s Spectra and precisely scanned it with a coordinate measuring machine to ensure accuracy to the original design. However, that original design, mounted as a prototype in a cockpit mockup and connected to sub-assemblies, contained 27 flaws that would have added cost and time delays, or could have hampered fit and finish.



Hyundai Mobis 3D printed an instrument panel in ABS plastic to measure component fit.

SUMMARY

The automotive sector has long been one of the most fast-paced and complex industries. But the industry arguably has never faced more challenges — or very promising opportunities — as it does today. A host of obstacles, from the demand for vehicle electrification to diverse consumer preferences, to tighter environmental regulations, all have contributed to tightened vehicle production schedules and shortened vehicle life cycles. These pressures directly affect every OEM and every supplier throughout the value chain. They require creative approaches to speed up the design process, increase quality and cut costs — all at the same time.

3D printing technology is proving vital in the design studio and factory floor alike. As a cost-effective solution for improving measurement, functional testing, vehicle customization, optimized design and rapid tooling, adopting and optimizing 3D printing is critical for engineers, plant workers and designers of all kinds, wanting to stay ahead of the competitive field. And with new applications being discovered, tested and implemented virtually every day, 3D printing technology's potential to impact the industry is just beginning.

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