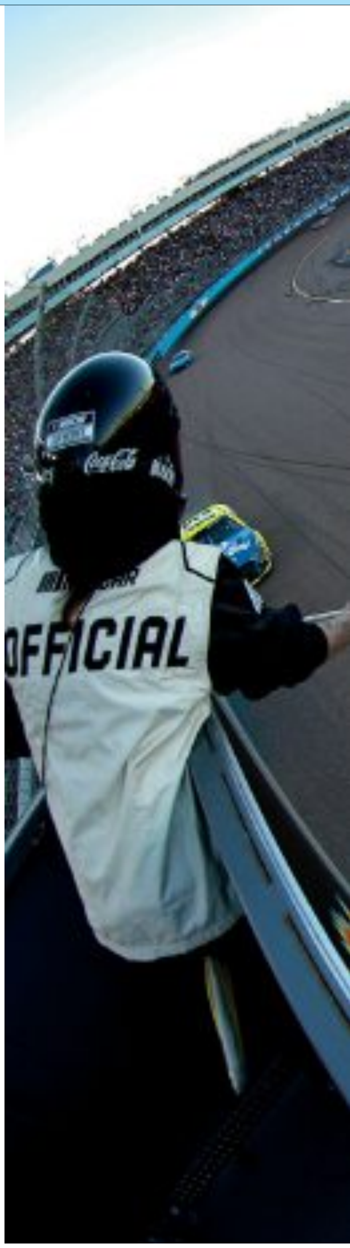
TURNING IDEAS INTO PARTS ON THE CAR – FASTER THAN EVER BEFORE

Team Penske became the first team ever to pull off the historic NASCAR-IndyCar title double last season. **Chris Pickering** discovers one of the secrets behind its success



THERE are some pieces of modern technology that feel like they belong in the realms of science fiction. No matter how many times you watch a 3D printer churning CAD drawings into physical parts, for instance, it still feels like something that would take place in a galaxy far, far away.

The reality, of course, is that additive manufacturing is now a well-established tool in the day-to-day running of a modern racing organisation. At Team Penske's HQ in Mooresville, North Carolina, additive manufacturing has been in use since 2002. During that time, its scope has expanded to cover numerous different applications, including wind tunnel parts, functional parts on the racecar, jigs and fixtures for manufacturing, prototypes for engineering components and composite tooling.

Penske uses a mixture of stereolithography (SLA) and fused deposition modelling (FDM). SLA is one of the original additive manufacturing processes, with roots stretching back to the 1980s, and it uses a tank of liquid resin that's solidified with a laser. FDM, meanwhile, works by extruding a thermoplastic filament through a heated nozzle.

Recent advances in additive manufacturing technology and materials development have seen these techniques finding more and more applications within the organisation, explains Team Penske's production manager, Matt Gimbel.

He points to the arrival of carbon fibre-reinforced nylon materials such as Nylon 12CF from the team's additive manufacturing partner, Stratasys. This combines Nylon 12 and chopped carbon fibre, which is said to provide enough strength and rigidity to replace metal in some applications.

"Nylon 12CF was a big step for us," comments Gimbel. "We're able to put stronger parts on the cars. It's often used for things like brake ducts, where we need a material that's light but strong enough to cope with use on the track."

In these applications, the FDM parts are generally replacing those that would have been hand laid in carbon fibre, he points out: "You can imagine the time and energy that used to be involved in ▶

LEFT Ford's approach to tackling the Next Gen NASCAR led to an increased workload for Team Penske – and a third Cup Series championship

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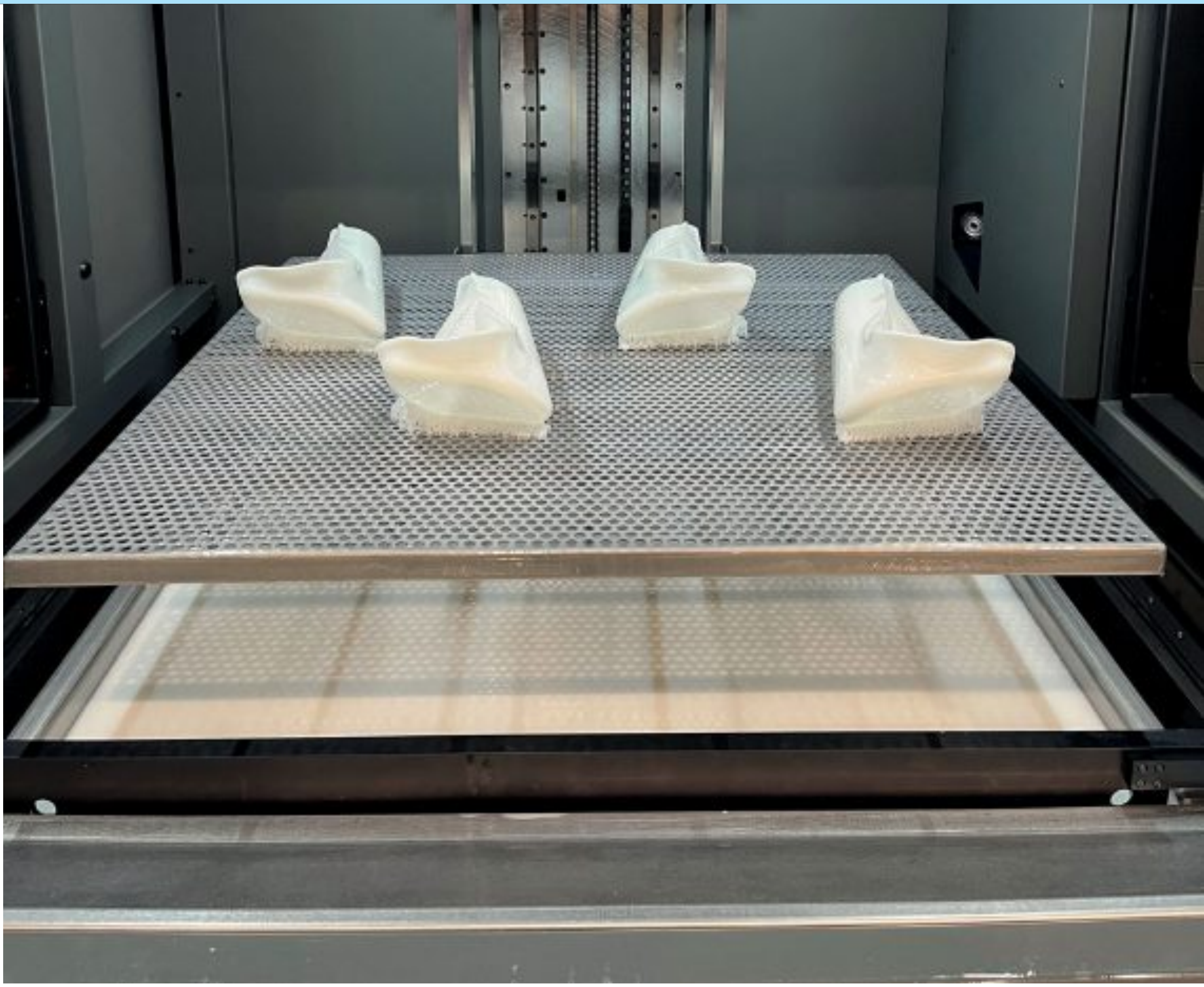
LEFT These daytime running light LED lenses were used on Penske's Acura DPi sportscars from 2018–2020. They were printed in Stratasys VeroClear on a J750 polyjet printer as part of a headlight repackaging project. Originally these lenses were made of cast polycarbonate. The team was able to eliminate mold redesigns and reduce its lead time from several weeks to eight days by printing them

RIGHT A cooling fan that the IndyCar teams use during practice sessions to cool the driver. The housing parts are printed in Nylon 12 CF on Team Penske's Fortus 900mc. Normally the units are fully painted, but for illustrative purposes half of the housing is left bare here



making a pattern and a mould and then laying up composite parts versus being able to print the same parts straight off the machine. For us, it can be the difference between getting those parts onto the racecar for that weekend or not."

New opportunities

While SLA continues to be used extensively, Penske's investment in FDM equipment has opened up new opportunities, Gimbel explains. This includes the ability to print sacrificial tooling for composite parts that's capable of withstanding autoclave conditions before being dissolved and washed out using a detergent solution. Other benefits are said to be the increased printing speeds of the latest FDM machines.

"We invested in FDM a few years ago, as we felt like we'd got as much as we could out of SLS and SLA," he comments. "We knew that there were some advantages with FDM that we weren't getting with the equipment we had at the time. One of the first projects we worked

> *"The use of additive manufacturing has been an integral part of our mindset"*

ABOVE Brake caliper ducts on the Stratasys Neo800 3D printer

on with Stratasys was some wash-out tooling for composites, and that was probably the tipping point that really highlighted the fact that there were things we weren't able to do with our old equipment."

Early applications of this included composite overflow tanks for the NASCAR programme and air ducts to direct air flow under the engine cover in IndyCar. The benefits, we're told, were principally the simplicity of the process and its speed.

SLA still has its advantages, Gimbel points out. For all its benefits, the FDM process deposits material in distinct layers, with the resolution of the geometry limited by the size of the nozzle. As such, the precision laser process in SLA still tends to be better for detailed part geometries. Plus, SLA machines tend to provide a larger build platform. ▶

Staying cool under pressure

3D printing has also improved safety – on and off the racetrack. By **Mark Skewis**

WHEN cooling emerged as one of the Next Gen car's teething issues, NASCAR used Stratasys Direct Manufacturing to print a windshield air cockpit ventilation unit.

The windshield air ducts were printed at Stratasys Direct Manufacturing in Belton, Texas on the SAF-powered Stratasys H350 3D printer. The parts were printed using Stratasys High Yield PA11, which is derived from sustainable castor oil. The parts were cleaned, finished, dyed and shot-blasted using DyeMansion post-processing equipment.

Additionally, the team at NASCAR designed and 3D printed an underside NACA duct for engine cooling at its research and development facility in Concord, NC with the Stratasys Fortus 450mc 3D printer.

"It is exciting to see the evolution of how NASCAR has used additive manufacturing across their vehicles. We've helped them move from 3D printed prototypes to end-use production parts on their high-performance race cars," says Pat Carey, Senior Vice President, Strategic Growth for Stratasys.

"The Next Gen car could not have been completed without the collaboration with NASCAR Competition Partners like Stratasys and Stratasys Direct Manufacturing," says John Probst, Senior Vice President, racing innovation, NASCAR. "During testing, we realised we needed an additive manufacturing solution that could withstand high temperatures and needed the parts delivered quickly.

"We approached Stratasys Direct, and they delivered not only as a supplier but as a consultant on this project. They provided us with strategic direction on design, materials, and the right additive manufacturing technologies to use."

The gestation period of the Next Gen NASCAR Cup car was delayed by the COVID pandemic. Even though the racing stopped, NASCAR's 3D printing machines did not: they played a key role in the fight to produce Personal Protective Equipment (PPE) for health workers. RT

LEFT Brandon Thomas, NASCAR Next Gen car designer, holding the 3D printed windshield air cockpit ventilation unit

> *"An engineer can send CAD drawings and we can have those parts printed and sat in their hands within a few hours"*

Additive culture

Over the years, additive manufacturing has become engrained at Penske, Gimbel explains: "I've been here 16 years and throughout that time the use of additive manufacturing has been an integral part of our mindset. Once we added FDM it gave the design engineers an additional element to their toolbox. An engineer can send us a few CAD drawings, and we can have those parts printed and sat in their hands within a few hours."

Much like working with traditional composite materials, it's important that the design engineers have a feel for the materials and the manufacturing processes. Penske has implemented its own set of drawing standards, which act as guidelines to ensure that the manufacturing engineers have all the information they require when a part comes through. The designers also need to be mindful of the part geometry and build orientation, as some of these materials are quite directional in their properties – just like traditional carbon fibre.

Similarly, it's the additive manufacturing department that adds any support structures required to facilitate the production of the design, but sometimes this has to be a collaborative effort with the design engineers.

Aero testing

Recent projects have included wind tunnel parts produced using SLA to support Ford and Penske's NASCAR activities.

"The introduction of the Next Gen NASCAR car certainly brought a lot of change," comments Gimbel. "With the way the rules changed, the teams really weren't allowed to develop their own cars anymore. That was pushed to the OEMs. So, instead, Ford made a concerted effort to really take the resources of the Ford teams and combine them together and start working towards ▶

ABOVE Production manager Matt Gimbel discusses the installation of a 3D printed wingmirror housing

RIGHT Parts produced for a NASCAR fuel rail insulation project: the green parts are printed prototype parts for mock-up; the white parts are drill jigs; the yellow is the printed mold; and the resulting carbon part is shown bottom right

BELOW The advent of carbon fibre-reinforced nylon materials, such as Nylon 12CF, has enabled more 3D printed components to be used directly on the car

the goal of a unified aero programme. That certainly brought a lot of work for us, because we were now printing parts for different programmes that Ford was developing, along with aero mapping and understanding the car."

This can include almost anything on the top side of the car, along with occasional parts for the underfloor. The geometry is broken up into a mosaic of 16x16-inch tiles that can be assembled to create full panels.

"One of the big benefits to us from the SLA side is just being able to print new parts, get them tested in the wind tunnel, and then figure out what the change does, how it affects the car, and get that information to the race teams as quick as possible," comments Gimbel. "Back when the aero configurations were changing in IndyCar, we did more work on the SLA side. These days it just tends to be supporting aero mapping – wickers and things like that."

> *"As the technology develops, the incentives to choose additive manufacturing over traditional technology increase"*

Busier than ever

Standardised aero kits in IndyCar and the homologated Next Gen design in NASCAR may have brought a period of stability and less work on the aero side, but Penske's additive manufacturing department is now busier than ever. "Our partnership with Stratasys remains a strong and important one, especially as we continue to develop and test models for use across all the different racing series we compete in," says Chris Wilson,

Director of Marketing, Team Penske. "The addition of the NEO 800 machine provides us with one of the best 3D printing machines on the market, and along with the amazing technical support from the experts at Stratasys, our production program continues to make gains year-over-year.

"Last year was one of the most successful seasons that Team Penske has had, culminating in the ultimate success, winning both titles in the NTT INDYCAR SERIES Championship and the NASCAR Cup Series Championship. These results wouldn't be possible without our partnership with Stratasys."

As the technology develops, the range of applications and the incentives to choose additive manufacturing over traditional technology continues to increase. And it still feels like a little slice of the future brought into the present day. RT