FERRARI GT3

The Prancing Horse's latest weapon in the Ferrari vs Porsche Le Mans war

INTERNATIONAL

Driving Technology Into Pole Position

RACE TECH

Motorsport Engineering

NOVEMBER 2022 No. 264 UK £5.95 USA $12.75

racetechmag.com

Bernoulli

Tech experts on new Formula E era

GEN3

Ready to race

Plus

TAKING FLAX TO THE MAX!

HOW ROBOTS CRASHED A NASCAR

GREEN PIONEERS AT LE MANS

www.racetechmag.com

11

9 771356 297055


SIM
Julius Bär
29
mahindra

COVER STORY PAGE 24

Driving Technology Into Pole Position
INTERNATIONAL
RACE TECH
Motorsport Engineering

Volume 29 Issue 12
Published October 2022
The next issue will be published
in early November 2022
ISSN 1356-2975

SUBSCRIPTIONS

Subscriptions from Kimberley Media Group Ltd
841 High Road, Finchley, London N12 8PT
Tel +44 (0)20 8446 2100
Fax +44 (0)20 8446 2191

Overseas copies are sent via air mail
12 issue subscription UK: £71.40
Europe: £118, USA/Rest of World: £149
All major credit cards accepted. Cheques and money orders only in Pounds Sterling payable to Kimberley Media Group Ltd.

BACK ISSUES AVAILABLE:

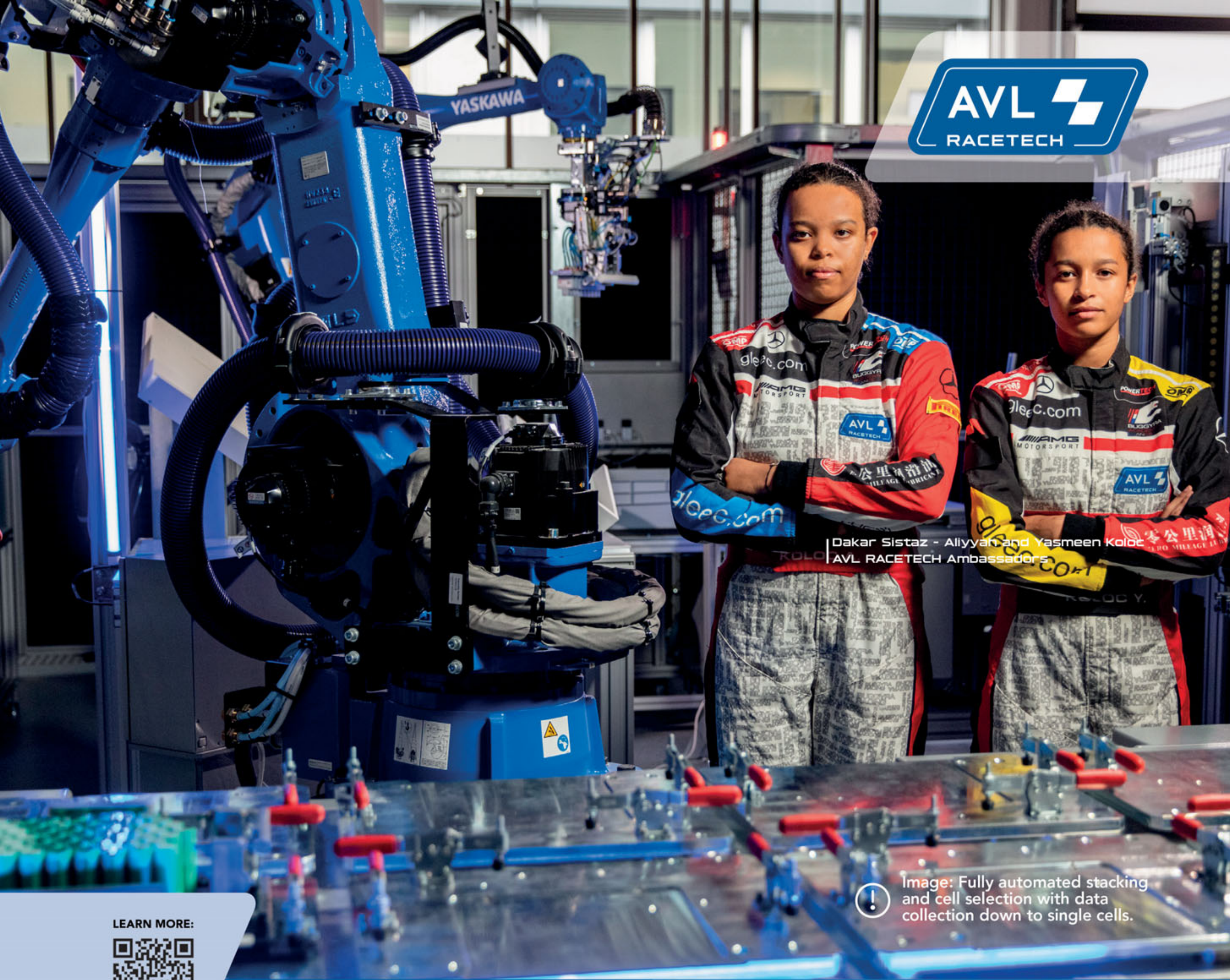
8,9,10,11,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,52,53,54,55,56,57,58,59,60,61,62,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,97,98,99,100,101,102,103,104,105,106,107,108,109,110,111,112,113,114,115,116,117,118,119,120,121,122,123,124,125,126,127,128,129,130,131,132,133,134,135,136,137,138,139,140,141,142,143,144,145,146,148,149,150,151,152,153,154,155,156,157,158,159,160,161,162,163,164,165,166,167,168,169,170,171,172,173,174,175,176,177,178,179,180,181,182,183,184,185,186,187,188,189,190,191,192,193,194,195,196,197,198,199,200,201,202,203,204,205,206,207,208,209,210,211,212,213,214,215,216,217,218,219,220,221,222,223,224,225,226,227,228,229,230,231,232,233,240,241,242,243,244,245,246,247,248,249,250,251,252,253,254,255,256,257,258,259,260,261,262,263

Price including post & packing:
UK: £5.95, Europe: £6.50, Rest of World: £7.55
You can pay by cheque or credit card but please note the minimum on Switch & Delta is £14

Race Tech (ISSN: 1356-2975) is published monthly by Kimberley Media Group Ltd.

Cover image: Lou Johnson

Design & Production: Paul Bullock, Maluma



Dakar Sistaz - Aliyyah and Yasmeen Koloc
AVL RACETECH Ambassadors

Image: Fully automated stacking and cell selection with data collection down to single cells.

LEARN MORE:

THE POWER BEHIND YOUR SUCCESS

We are shaping the future of motorsports at our AVL Battery Innovation Center. We develop innovative battery concepts for high-end racing applications and requirements. We manufacture our prototypes with the same product quality and process reliability as large-scale production. Which is how we ensure your racing success.

www.avlracetech.com

RACE TECH Motorsport Engineering

841 High Road, Finchley
London N12 8PT
Tel: +44 (0) 208 446 2100
Fax: +44 (0) 208 446 2191

www.kimberleymediagroup.com

KIMBERLEY MEDIA GROUP LTD

@racetechmag

facebook.com/
RaceTechmagazine

BEWARE OF CROCODILES!

MOTORSPORT'S ability to pioneer new frontiers has always been one of its biggest appeals.

That zest for exploration is epitomised by one of our cover features in this issue: Le Mans pioneers. In it, respected engineer Kieron Salter talks of his involvement in three of the most audacious projects ever hatched to contest the Le Mans 24 Hours: the Liquid Natural Gas-powered Chrysler Patriot; the hybrid GT1 Panoz; and the biofuelled Nasamax.

All three were attempts – stretching as far back as 30 years ago – to find an alternative to the use of 'dirty' fossil fuels.

While Kieron's tale illustrates the bravery of motorsport's trailblazers, it also prompted me to recall some sage advice I was once given: "Remember, it's always the pioneers who get eaten by the crocodiles!"

The Patriot, conceived back in 1993, certainly falls into that category. Borrowing many ideas from the Space Shuttle programme, the plan was as dangerous as it was courageous. It was eventually laid quietly to rest, justified lamely as a "technology demonstrator" by Chrysler.

The hybrid Panoz conceived at the end of '97 arguably had all the right ingredients, but was still too far ahead of its time. It would be another three years, for instance, before Toyota launched it first hybrid Prius in Europe and North America; 15 seasons before a hybrid car would triumph at Le Mans.

The phenomenal rate of progress in battery technology since then – exemplified by the Mahindra-ZF Gen3 Formula E car featured elsewhere in this issue – underlines why the Panoz was doomed to fail in those relatively primitive days. The car was dubbed "Sparky" and its obviously 'active' battery led to inevitable mistrust.

Don Panoz once recalled that the car possessed remarkably magnetic properties, which would swipe clean the credit card of anyone in the vicinity of the machine in the workshop. If some of the escapades at this time of exploration now appear slapstick, the engineering intent behind the design was nevertheless deadly serious.

Surprisingly, the third project, the Nasamax, to this day remains the only alternative-fuelled racecar to have finished the iconic race.

How far we have come since those Quixotic days. And how far still to go.

Since then, it has become evident that there is no one lucky winning lottery ticket when it comes to the future of propulsion. Instead, different technologies will suit different applications, be they BEVs, e-fuels, hydrogen or hybrid.

Whatever the energy, or medium of energy storage, surely the finest brains in motorsport should be able to assist – both in terms of improving the technology and in selling the idea to a public that will have to be convinced.

That's why this year's RACE TECH World Motorsport Symposium, hosted by the Swiss Embassy in London on Thursday December 1 and Friday December 2, is so eagerly anticipated.

So many issues to grapple with; a lot of clever brains to work the problems! See you there. RT

Mark Skewis
EDITOR

AUDI'S FUTURISTIC DESERT RACER TURNS BACK THE CLOCK

The innovative RS Q e-tron stunned rivals on its Dakar debut. Now it's even better. By **Mark Skewis**

AUDI'S quest for success at the Dakar Rally has seen it roll back the years. The latest variant of its innovative desert racer, the RS Q e-tron E2, mirrors the aggressive improvement of the legendary Audi Sport Quattro in its final development stage for Group B rallying in the 1980s.

The E2's body is completely new and features significantly enhanced aerodynamics. It helps lower the prototype's weight and centre of gravity. New operating strategies further improve the efficiency of the electric drivetrain. In the interior and when changing wheels, the driver and co-driver now benefit from easier operation.

Repeating history

The E2 moniker refers back to the final – and ultimate – iteration of Audi's legendary Quattro rally car. There were certainly echoes of the Quattro when the RS Q e-tron stunned rivals on its Dakar debut in January. The car was overweight and in uncharted territory, yet it still won four of the 12 stages – including three in the second half of the rally.

It was a performance that prompted David Richards, whose Prodrive operation powered the BRX team to second, to warn that Audi could "kill" the sport when it returned in 2023 with a more reliable car.

"It's the fastest car by a long way," Richards said. "They are 200 kg overweight and they are still a lot faster than our car. So if they had been reliable they would have won by an hour, easy."

The original Quattro's debut at the Monte Carlo Rally in 1981 had been no less sensational: after 10 kilometres of the first stage and on a snow-covered track, Hannu Mikkola overtook a Lancia Stratos that had started a minute before him.

The new car's E2 tag evokes memories of the Audi Sport Quattro S1 E2, introduced at the end of 1985 in an attempt to counter the Quattro's biggest shortcomings: its production car origins and front-engined layout. The original E2 was characterised by a striking aero package to increase downforce, but also featured a weight reduction programme. Extreme efforts were also made to improve its weight distribution, relocating the radiators and other accessories in the boot. It was an iconic machine that immortalised the Group B era.

If the Quattro E2 was the most spectacular rally car the German manufacturer has ever built, the RS Q e-tron is the most complex. The second phase of its development program has picked through every detail in meticulous fashion.

All-new body

"The Audi RS Q e-tron E2 does not adopt a single body part from its predecessor," said Axel Löffler, Chief Designer of the RS Q e-tron. In order to comply with the prescribed interior dimensions, the cockpit, which was previously narrowly recessed towards the roof, is now significantly wider. The front and rear hoods have also been redesigned.

"We are now doing away with the underflow of the rear hood to the left and right of the B-pillars. In conjunction with modified lay-ups, i.e. optimized fabric layers of the composite materials, this solution reduces weight," said Löffler.

The T1U prototypes will have to weigh 2,100 instead of 2,000 kilograms in the

BELOW LEFT The aggressive development program, like the E2 moniker, evokes memories of the Group B rally project

BELOW The RS Q e-tron E2 features improved aero, weight and centre of gravity

future. Given that the first generation of the RS Q e-tron was overweight, it was still necessary to save several dozen kilograms. This is accompanied by the lowering of the vehicle's centre of gravity.

The aerodynamic concept in the area of the body below the hoods is completely new. This section is almost reminiscent of the shape of a boat's hull: its widest point is at the height of the cockpit, while the body tapers significantly towards the front and rear. Audi has now dispensed with the part of the fenders that was behind the front wheels and formed the transition to the door. Internally, this structure was called the "elephant foot". As a result, the designers saved more weight and optimized the air flow.

"The aerodynamic aspect should not be underestimated in desert rallying either," said Löffler. Admittedly, the new cockpit dimensions mean that the body has a larger and therefore less favourable cross-section. Nevertheless, it was possible to reduce the overall aerodynamic drag by around 15 percent, i.e. the product of the CD value and the frontal area (A).

This does not change the top speed. It remains limited to 170 km/h in the regulations. Nevertheless, the improved air flow offers one major advantage. "It further reduces the energy requirements of the electrically-powered car," said Löffler. "We implemented the aerodynamic calculations entirely using computational fluid dynamics (CFD)." These computer simulations replace the time-consuming work in the wind tunnel and still deliver highly precise results. ▶

> *"The air-conditioning system works so aggressively that it could cause the coolant to freeze"*

Photos: Audi AG

Optimised energy management

The electric drivetrain of the Audi RS Q e-tron E2 comprises an energy converter consisting of an internal combustion engine and a generator, as well as a high-voltage battery and two electric motors on the front and rear axles. Energy management plays a crucial role here. The electronic control system of the complex electric drivetrain proved its worth in the first rally events. Challenges only arose in extreme cases.

At the Dakar Rally, for example, Audi noted short-term surpluses of power in situations where the wheels made less contact with the ground while jumping or on uneven terrain. The officials of the FIA, the world automobile federation, intervene at a threshold of 2 kilojoules of excess energy and impose sporting penalties.

"By way of comparison, more than one hundred times the amount of energy flows to the motors per second within the permissible limits," said Florian Semlinger, development engineer for embedded software, application and test bench. "We could have made it easy on ourselves and set our threshold several kilowatts lower, but that would have meant performance disadvantages. Instead, we put a lot of fine-tuning into the power controllers."

Two individual limits – one for each motor – are now recalculated by the software within milliseconds. As a result, it operates precisely along the permissible limit.

The so-called auxiliary consumers also benefit from optimized control. The servo pump, the air conditioning cooling pump and the fans have a measurable impact on the energy balance. In the course of the debut season in 2022, the Audi and Q Motorsport rally team gained valuable experience that enables better assessment. Take the air-conditioning system, for example: it works so aggressively that it could cause the coolant to freeze when constantly running at its maximum output. In the future, the system will run in an intermittent mode. This saves energy, yet the interior temperatures only fluctuate slightly, even over longer periods.

The operating strategy for the fans and the servo pump has also been optimized. For example, the systems can now be regulated differently for the lower loads on the liaison stages than on the special stages.

ABOVE & BELOW The E2 (left in these graphics) does not adopt a single body part from its predecessor

RIGHT The extensive review has simplified operation in the cockpit and when changing wheels

Cutting confusion

The drivers can look forward to their new workplaces. The displays are still in the driver's field of view and located in the centre console in the usual style, and the central switch panel with its 24 fields has also been retained. However, the engineers have restructured the displays and controls.

"The totality of all the functions quickly creates confusion," said Florian Semlinger. "That's why, for the first time, the driver and co-driver can now select from four system areas using a rotary switch."

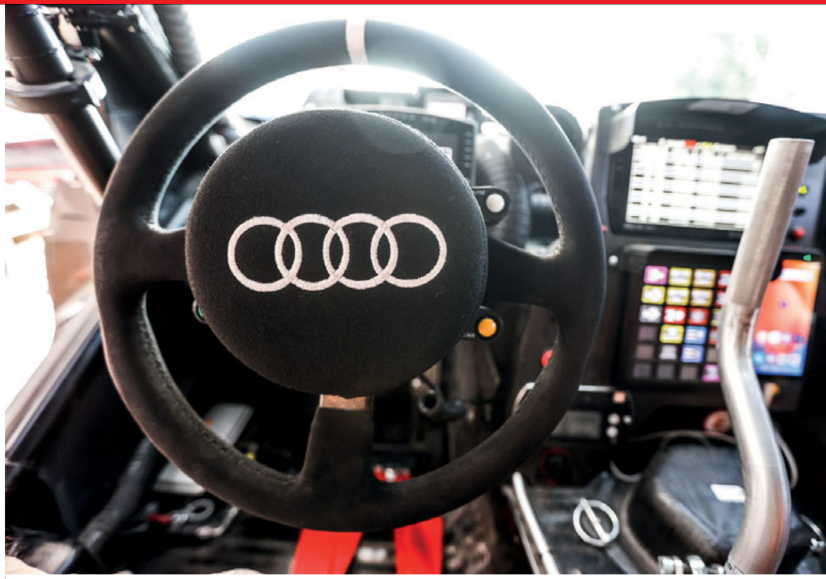
The "Stage" theme contains all the functions that are important while driving competitively – such as the speed limiter in sections with speed limits or the air jack. The "Road" part contains, for example, turn signals and the rear-view camera, functions that are often in demand on the liaison stages.

The "Error" option is used to detect, categorize and catalogue errors. The "Settings" section includes everything that is useful for the engineering team during testing or after the car arrives at the bivouac, for example, detailed temperatures of individual systems.

Crews can now work much more easily after a puncture. Simple, flat and easily removable body components replace the previous bulky covers for the spare wheels in the flanks. The new 10-spoke rims from partner Rotiform are much easier to handle. Drivers and co-drivers can grip them more easily and complete the change more safely.

"We have combined all the important lessons in a very short time," said Uwe Breuling, Head of Vehicle Operations at Audi Sport. "Our development team's determined and cost-efficient work has prepared us perfectly for our second Dakar Rally."

Following initial testing led by Arnau Niubó Bosch, Head of Test Engineering, Audi Sport unveiled the RS Q e-tron E2 in Neuburg an der Donau last month, ahead of its debut at the Rally du Maroc. RT



"The aerodynamic aspect should not be underestimated in desert rallying"

Siemens aids FIA's drive to be net zero carbon

LEFT The two parties have already collaborated on an AI project to improve rally spectator safety

SIEMENS Digital Industries Software has been engaged by world motorsport's governing body to help its sustainability push.

The Fédération Internationale de l'Automobile (FIA) has selected Siemens as "Official Sustainability PLM Software Supplier". It has adopted solutions from the Siemens Xcelerator portfolio to collaborate with F1 teams and support FIA championships, including F1, in sustainability efforts.

"As innovation and sustainability are two of the most important guiding principles of the FIA, we are pleased to welcome Siemens as an official supplier and to adopt their sustainable software solutions across our work on Formula 1 and other motorsport activities," said Mohammed Ben Sulayem, FIA President. "Innovative collaborations such as this underline our commitment to becoming net zero carbon by 2030."

Siemens Digital Industries Software is an American computer software company specializing in 3D and 2D Product Lifecycle Management software.

The FIA will begin implementing the Siemens Xcelerator portfolio to enable the design of vehicles and regulations that reduce energy consumption and emissions. Through this collaboration, it is hoped that pioneering approaches in motorsport and new technological advances could be impactful across the automotive industry.

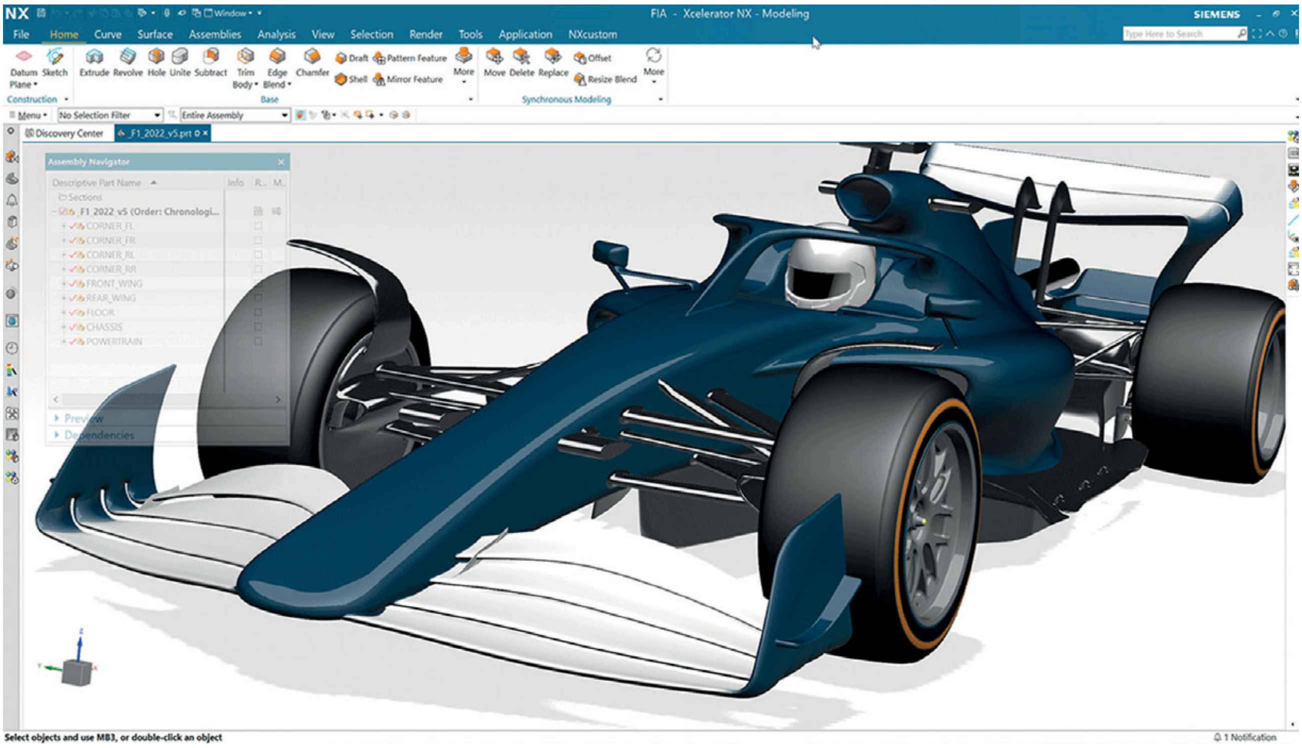
"Motorsport and sustainability sound like a contradiction. But it can be done using the right technologies. If motorsport achieves carbon neutrality, any industry can. With this collaboration, we plan to influence public perceptions and promote sustainable mobility. We are delighted to be selected as an official supplier to help the FIA meet its sustainability goals," said Cedrik Neike, Member of the Managing Board of Siemens AG and CEO Digital Industries.

Having achieved carbon neutrality and obtaining the ISO14001:2015 certification in 2021, the FIA is continuing to explore new areas for development. This new initiative expands Siemens' relationship with the FIA and builds on previous projects driving digital transformation at the FIA and applying Siemens' expertise and innovation to help improve urban mobility, safety, efficiency, affordability, accessibility and reliability.

In 2019, the FIA and Siemens worked together to improve rally safety by exploring how autonomous vehicle pedestrian detection technology could be used to identify dangerous locations for rally spectators.

Then in 2020, Siemens helped FIA Member Clubs provide an evidence-based approach to advocate for the implementation of mobility policies. RT

BELOW Siemens' product lifecycle management software will be harnessed by the FIA




SUPERTECH
CHOOSE YOUR
WEAPON
STREET PERFORMANCE / HIGH PERFORMANCE / INCONEL / SODIUM FILLED / TITANIUM VALVE
FUSING PERFORMANCE, DURABILITY, AND SUPERIOR CRAFTSMANSHIP THERE ISN'T A BETTER CHOICE FOR PERFORMANCE VALVE TRAIN COMPONENTS. CHOOSE YOUR WEAPON AND DESTROY THE COMPETITION.
WWW.SUPERTECHPERFORMANCE.COM
SUPERTECH

Multimatic DPi Mazda runs in Catesby Tunnel

MULTIMATIC Motorsports has completed an initial aerodynamic evaluation test at Catesby Tunnel, a newly-opened aerodynamic testing facility in Northamptonshire, UK, owned by ARP (Aero Research Partners). It is the first facility of its kind in the UK and only the second in the world.

In order to perform a full correlation check, the team ran its Mazda DPi racecar through the tunnel at speeds of up to 120 mph. The results were compared to a comprehensive set of data previously gathered from 40% scale and full-size wind tunnel testing, as well as Computational Fluid Dynamics development and five years of competition in IMSA's top level championship. Initial results indicate a high level of correlation to that existing performance data.

The Catesby facility began its life as a dual rail Victorian railway tunnel, with the first steam locomotives running through it in July 1898. The tunnel still carries vestiges of soot from the coal-burning trains, which has stuck to many of the approximately 30 million bricks that were required to construct the perfectly straight 2.7-km long tunnel, boasting a massive cross-section, 8.2m wide and 7.8m high. It closed to trains in 1966 and now a multi-million-pound transformation has turned Catesby into a state-of-the-art aerodynamic vehicle testing facility.

Catesby Tunnel turns the traditional practice of using a wind tunnel on its head, as Multimatic Motorsports boss, Larry Holt, explained:

"Compared to conventional wind tunnels, this is better because it's real," said Holt. "In a moving ground plane wind tunnel, the car is stationary and the wind is blown over it by a massive fan and flow conditioning set-up, and a belt is arranged to move under the car at a coordinated speed.

"It's a very sophisticated configuration but the car is still stationary and that constitutes the not totally real piece. What Catesby facilitates is the measurement of the aerodynamic performance of a vehicle actually moving through the real world.

"The problem with a car moving through the real world is that it is subjected to influences like gusting wind, rain and other changing environmental conditions that affect air density; all of the variables that come with testing in the real world. Catesby provides the real world without the weather. You have a moving car, a real road surface, a controlled environment and we can run 24 hours a day, whatever the season. It is a perfect 2.7 kms of controlled atmosphere. That's the kind of consistency you need when you are chasing incremental gains."

Multimatic driver, Andy Priaulx, was behind the wheel of the Mazda RT24-P throughout the test.

"When you've been a racing driver for as long as I have, you don't often get to experience anything new," he said. "When it comes to pure aerodynamic testing, I'm used to engineers studying static car models in wind tunnels with no involvement from the drivers. At the start it felt a little odd to jump into a race car and drive flat out through a 2.7-km tunnel, but the team assured me that the end was very clearly marked!

"Catesby Tunnel is an incredible facility and it doesn't surprise me at all to know that Multimatic chose to be an early adopter and primary client of the facility."

Located just a few miles from Daventry in rural Northamptonshire, Catesby Tunnel is situated in the UK's Motorsport Valley and just a short drive from Multimatic Motorsports' UK headquarters in Brackley. Holt understood the advantage of the tunnel before it was completed and has locked down a significant amount of Catesby's available tunnel time for development of future race, road and the track-day cars created by Multimatic Special Vehicle Operations.

ABOVE & BELOW Multimatic's Mazda RT24-P DPi car tested in Catesby Tunnel

Ford returns to Le Mans with Mustang

FORD has confirmed it will return to the Le Mans 24 Hours with its new GT3 Mustang.

"Mustang is raced at all the great tracks around the world, but there is no race or track that means more to our history than Le Mans," said Bill Ford, executive chair, at The Stampede, the debut of the all-new seventh-generation Ford Mustang in Detroit. "It's where we took on Ferrari and won in the 1960s and where we returned 50 years later and shocked the world again.

"Mustang will go back to Le Mans. Once again, we will Go Like Hell."

Ford famously took the GT40 to the Le Mans 24 Hours beginning in 1964 and triumphed in 1966, sweeping the podium with a 1-2-3 finish. Then, 50 years later, to the day, Ford won its class with Chip Ganassi Racing and the Ford GT. Mustang previously raced at Le Mans in 1967 and 1997.

With GT3 very much hitting the sweet spot for manufacturers around the globe, Ford has its sights set on an expansive customer program. To that end it is collaborating with long-time successful chassis constructor Multimatic. The two have worked together on customer Mustang programs in the past, as well as the Ford GT and Bronco projects.

The new Mustang GT3 racer will be powered by a Ford 5.0-litre Coyote-based V8 engine developed by Ford Performance and built by long-time racing collaborator and world championship-winning team, M-Sport of Cumbria, England. The two organizations have a rich history in the FIA World Rally Championship and recently collaborated on the development and preparation of the Ford Puma Hybrid Rally1.

The new Mustang has also spawned a GT4 version. In the US the GT4 will be eligible to compete in 2023 in the IMSA Michelin Pilot Challenge's Grand Sport (GS) class and in the new IMSA VP Racing SportsCar Challenge's GSX class.

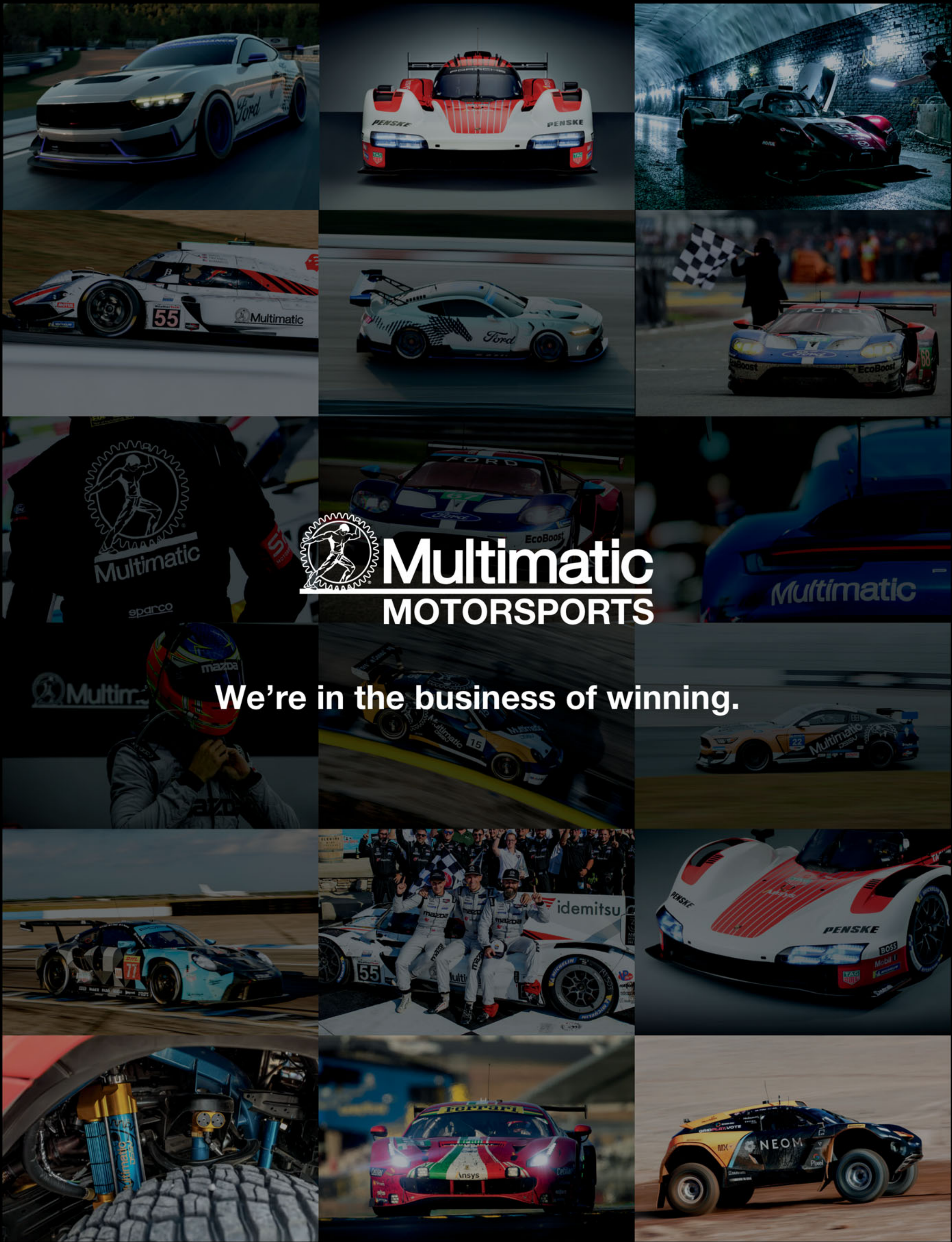
Ford Performance's announcement included the unveiling of the complete line of 2024 Mustang passenger and track-only models. Among the line is the new Mustang Dark Horse, the first entry in the Mustang performance series in 21 years that draws cues from the racing program. A special team of Ford engineers, designers and experts worked more than three years to develop the Mustang Dark Horse.

"For decades, Mustang has competed against the most premium brands on the greatest world stages and won," said Jim Farley, CEO of Ford Motor Company. "We surprised everyone, and we're going to surprise them again with a track-capable Mustang that puts a new level of performance, styling and American engineering in the hands of everyday customers who still want the thrill and excitement of a V8 sports car."

The Mustang Dark Horse was part of Ford's broader launch of six new racing Mustangs that will compete globally in a variety of series.

"We're taking this all-new Mustang to competition racing and the very definition of a 'dark horse' is the perfect fit to introduce this vehicle to the Mustang brand," said Mark Rushbrook, global director at Ford Performance Motorsports. "With our race program development underway, we're confident we have the right car for success." RT

ABOVE The new Mustang GT3 has huge world-wide sales potential


Multimatic
MOTORSPORTS
We're in the business of winning.

DTM developing "the automotive sound of the future"

THE DTM is evaluating what it claims could be "the automotive sound of the future".

The key figures of DTM Electric, one of the proposed pillars of the series' future, are impressive: over 1,000 horsepower and a top speed of up to 320 km/h. But it's not just the looks and the performance of a racecar that are the relevant criteria for fans: the sound is, too.

The lack of sound on electric race and rally machines has so far proved a potential barrier to existing fans' acceptance of the new technology. But the DTM, through its technical partner Schaeffler, is pursuing new avenues of investigation as it bids to address the problem. It is using sound synthesis software to combine current vehicle data with specific sound profiles, with Sophia Flörsch completing the first demo sound laps in the DTM Electric prototype at the Red Bull Ring at the end of last month.

"What has initially succeeded in the laboratory and was taken to the track at Red Bull Ring is absolutely breath-taking," said Michael Resl, director competition & technology of the DTM organisation ITR. "Schaeffler has succeeded in developing a sound system that takes into account the high performance potential of the DTM Electric cars and gives the cars an appropriate soundscape."

In the process, Schaeffler's engineers used the actual sound of the electric engine the company from Herzogenaurach is manufacturing for DTM Electric itself as a guideline. By means of sound synthesis software, the innovative system combines the current vehicle data like engine speed, positive or negative acceleration and brake pressure in real-time with a specific sound profile. Hardware installed in the vehicle causes the entire bodywork to be set into oscillation, giving additional dynamics to the sound and making the sound audible.

> *"The system combines vehicle data like engine speed, acceleration and brake pressure in real-time with a specific sound profile"*

"We are developing the automotive sound of the future," said Dr Jochen Schröder, head of the e-mobility division at Schaeffler. "It is not intended to mimic a typical combustion engine or sound like science fiction. Rather, we developed a sound that closely reflects the physics of an electric motor and then tweaked it to sound even cooler."

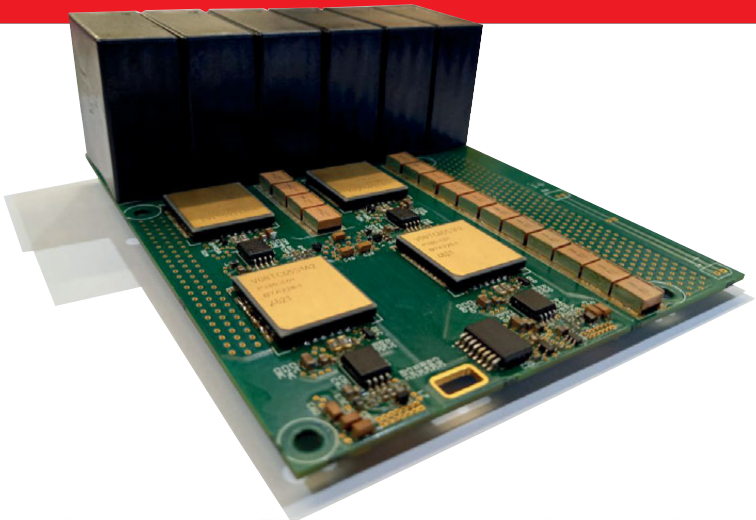
How cool this outlook on the future of motorsport actually sounds was something the DTM fans found out for themselves during the Austrian DTM round at Red Bull Ring. Sophia Flörsch, a DTM driver last year and a Schaeffler brand ambassador, drove the DTM Electric Demo Car at the 4.318 kilometres long racetrack near Spielberg in Styria.

"As a former racing driver, I am already fascinated just by the sheer performance figures of DTM Electric," said Martin Tomczyk, representative brand & sports of the DTM organisation ITR. "But as we all know, a real race car also needs appropriate acoustics.

"I am really curious as to what the car sounds like at the racetrack, but I am convinced that the Schaeffler engineers have done a good job here. DTM fans can look forward to it and I am curious about their feedback." RT

BELOW DTM partner Schaeffler has developed a sound system that gives the DTM Electric racing cars a striking soundscape

DTM



Marelli eyes GaN "breakthrough"

THE flow-down of race technology into series production underpins a new collaboration between Marelli Motorsport and the Power Electronics Innovation Center (PEIC) of Politecnico di Torino, regarding the Gallium Nitride (GaN) technology area for power electronics, aimed at electric engines.

The project is included in a wider framework research partnership between Marelli and Politecnico.

Marelli Motorsport is the motorsport business unit of the global automotive supplier Marelli, with an extensive experience in the development of hybrid and electric systems for major motorsport championships.

The collaboration is aiming at the design and prototyping of an innovative multi-level 900V high power inverter for electric traction based on GaN technology.

Gallium Nitride, a cutting-edge technology reaching unprecedented switching frequencies and low switching energy, allows a radical reduction of passive components (e.g. inductors, capacitors, transformers), while maintaining an outstanding efficiency. In recent years GaN technology has been evolving rapidly in terms of conduction and switching performance. In addition, since the lateral GaN devices are grown on standard silicon wafers, their cost is already highly competitive.

ABOVE The multi-level 900V high power inverter for electric traction based on GaN technology

GaN technology opens new horizons in the power converter design innovations, in which the collaboration has the aim to excel in terms of high efficiency multi-level architectures, optimal and robust gate driving and device parallelization, high frequency and high temperature capacitor technologies, integration of capacitors and semiconductors on PCB (Printed Circuit Board) for cost reduction, advanced cooling solutions.

"The collaboration with Politecnico di Torino is enabling a more rapid pace of development with respect to innovative Wide-Bandgap technology applied to power converters," said Riccardo De Filippi, Head of Marelli Motorsport. "In particular, GaN is proving to be very promising for what concerns high frequency switching devices, even at very high voltage and power levels. It looks like the new technology can have a bright future in the automotive electrification market."

Radu Bojoi, Politecnico di Torino, Chairman of Power Electronics Innovation Center (PEIC), commented: "The collaboration with Marelli is a further demonstration of the multiple benefits and synergies possible between University and Industry when they join forces in fast-tracking new technologies into cutting edge device development."

The concept study started back in 2021. At present it is in the prototyping phase. The GaN component supplier selected for the prototype phase is VisIC Technologies, a global leader in gallium nitride (GaN) solutions for high-voltage automotive applications.

"The project illustrates the breakthrough of gallium nitride technology in the automotive industry," said Tamara Baksht, CEO of VisIC. "It is definitely the next step for the automotive electrical driveline." RT

GCK switches to biofuel Hunter for Dakar

GREEN pioneers GCK Motorsport and Guerlain Chicherit will be fielding a Prodrive Hunter at the Dakar Rally for the next two years. It is hoped that the biofuel vehicle will help the French outfit clock up the experience it needs to achieve its ultimate aim of winning the gruelling race with a hydrogen-powered car.

GCK and Chicherit have teamed with Prodrive to race the Hunter 4WD T1+ in the 2022 Rallye du Maroc, the next two Dakar rallies and the full season of the 2023 World Rally-Raid Championship (W2RC). The vehicle is identical to the one that earned second place for Sébastien Loeb and Fabian Lurquin at this year's Dakar.

In line with his stance on ecology, Chicherit's V6 turbocharged 4WD machine will run on Prodrive EcoPower sustainable fuel, made from agricultural waste, which emits 80% less greenhouse gas than regular petrol.

GCK Motorsport and Prodrive engineers will continue working closely together throughout the year, collecting valuable data for the forthcoming GCK H2 programme, which has its sights set on a Dakar win with a hydrogen-powered vehicle.

Chicherit said: "I was happy to be back at the Dakar earlier this year. Unfortunately, we were made only too aware of the handicap two-wheel drive cars like our GCK Thunder have to deal with. So, this time, we've opted for AWD. Competition is stiff. At least 10 cars are capable of winning. But I think we are in with a chance of being out in front, especially as the course is difficult, very sandy, which is what I like, so I hope that we can clinch it.

"Whatever happens, the Prodrive programme will be beneficial to GCK Motorsport because it is part of a learning curve. The team needs to build up the confidence to take a hydrogen car to the top in the future." RT

AB Dynamics Group acquires Ansible Motion for £31.2m

ABOVE Sales of Ansible Motion's simulators were the catalyst for the deal

AB DYNAMICS plc has acquired Ansible Motion Limited, a leading provider of advanced simulators to the global automotive market. The total fee of £31.2m comprises a £19.2m initial consideration and a £12m payment subject to meeting certain performance criteria.

Ansible Motion will become part of the group's simulation portfolio supplying advanced simulation products and services to the automotive and motorsport industries. Ansible Motion will sit alongside the newly formed AB Simulation division (responsible for the Advanced Vehicle Driving Simulator (aVDS) product range) and rFpro (market-leading simulation software provider) which was acquired in 2019.

"We are now positioned to be market leaders in the sector," said Dan Clark, Managing Director of AB Simulation. "Ansible Motion is a well-established, successful business that has an outstanding reputation for driving simulator solutions. Its product offering complements our own range and creates a comprehensive family of simulator solutions."

Ansible Motion is currently experiencing significant growth, which is primarily driven by sales in its leading Delta series dynamic simulator range. The company is forecast to double its turnover in the 2023 financial year, which is underpinned by existing orders and a strong sales pipeline.

Ansible Motion's current product range includes the Delta series dynamic simulator, the Sigma series static simulator and the compact, portable Theta series simulator. They are used for the development of a range of ground vehicle applications, including ADAS, autonomy, motorsport, chassis, powertrain, human factors, Human-Machine Interface (HMI), NVH, steering systems and tyres.

Ansible Motion is being acquired from its three shareholders, Kia Cammaerts, Jonathan Walker and Robert Stevens, with Cammaerts and Stevens remaining in the business as Technical Director and Chief Engineer respectively.

"AB Dynamics' acquisition of Ansible Motion marks an exciting and pivotal moment, and we are delighted to become a part of the AB Dynamics family," said Cammaerts. "It's a remarkable fit. Both companies have always shared a common vision: to provide superlative tools for automotive product development work. Now, we'll be joining forces to better serve automotive customers worldwide, with broader and deeper offerings. Ansible Motion will continue to focus on the development of the world's most immersive Driver-in-the-Loop simulation technologies, propelled further by the business and technical expertise of one of the world's most trusted suppliers of automotive test systems and services."

"This acquisition will significantly benefit our customers by providing a broader range of products and services to enable the development of better and safer vehicles, quicker and more cost-effectively," continued Clark. "We will supply complete end-to-end simulation solutions comprising hardware, software, application and use-case consultancy, training and aftermarket support."

AB Dynamics supplies the 25 most successful car manufacturers in the world with a diverse range of track and lab testing equipment. It ranges from Kinematics & Compliance machines and ADAS targets to state-of-the-art driving simulators. RT

USING ROBOTS TO CRASH A NASCAR
AB Dynamics p66

Lamborghini LMDh to use V8 twin-turbo

LAMBORGHINI Squadra Corse has unveiled the first technical specifications of its LMDh project for its upcoming venture into the Hypercar class of the FIA World Endurance Championship and the GTP class of the IMSA WeatherTech SportsCar Championship.

It will use an 8-cylinder, 90-degree V-angle twin-turbo internal combustion engine developed by the company's motorsport department, Squadra Corse.

Major ERS components included in the LMDh homologated standard kit cover several areas, with the electric motor (MGU) developed by Bosch Motorsport. Power Management and energy storage is supplied by Williams Advanced Engineering, while the seven-speed P1359 hybrid gearbox is developed by Xtrac.

Making the step into a motorsport landscape driven by hybrid propulsion is seen as the perfect fit with Lamborghini's transition to hybrid technologies.

The base car (spine) is engineered together with Ligier Automotive and carbon fibre elements produced in Italy by HP Composites, Squadra Corse long-term partner in GT3 and Super Trofeo platforms. RT

McLaren Applied releases 48V smart alternator

McLAREN Applied has completed the development of a 48V G Type Smart Alternator to service the needs of top tier championships running 48V systems, such as IMSA and WEC.

Developed in close collaboration with a sportscar team competing in top-flight endurance racing, it offers impressive power and minimal weight, for maximum vehicle performance.

With an increasing number of race series adopting electrified drivetrains, the component enables customers to exploit a 48V system architecture for their race vehicles now, in advance of a future move to pure electric propulsion. It ensures teams can remain competitive while contributing to sustainability efforts and reducing CO_2 emissions.

The new alternator allows users to utilise 48V alongside the traditional 12V, ensuring a hybrid motor can deliver both reduced fuel consumption and faster, smoother acceleration. It boasts a 3,120W maximum power output (65A, 48V) and operates at up to 18,000 rpm, all while weighing in at less than 3.2 kg. It is therefore ideal for customers looking to decrease the overall weight of their race vehicle.

The impressive power output is underpinned by a specially wound stator and superior-quality bearings that enable the alternator to run at high speed. High current diodes are used in the rectifier, and internal fans provide forced air cooling. The stator is pegged to the body with all screws locked. Furthermore, the units are assembled with stiff brush springs and extra-flexible wires for optimal reliability, robustness and performance.

The Smart Alternator provides diagnostic information over CAN and can be purchased in a clockwise or anti-clockwise configuration. The standard mounting method is intended for a belt drive but can also be driven directly if required. RT

ABOVE The 48V G Type Smart Alternator operates up to 18,000 RPM

FIA appoints first ever CEO

THE FIA has appointed Natalie Robyn to be the Federation's first ever CEO.

Joining the FIA in the near future, American-born Robyn is a leading international executive with over 15 years of experience in both the automotive and financial sectors. Prior to joining the Federation, she has held a variety of senior management positions at Volvo, Nissan and DaimlerChrysler.

In this new role, she will be responsible for the successful operation and financial performance of an integrated and aligned FIA administration, as well as driving the overall strategy to deliver the leadership's vision of reform of the Federation.

Robyn will also develop new commercial growth plans to increase and diversify the FIA's revenue streams, ensuring financial stability to provide more resources for its members.

Commenting on the appointment the President of the FIA, Mohammed Ben Sulayem, said:

"The appointment of Natalie Robyn as our first ever CEO is a transformative moment for our Federation. Her extensive experience and leadership will be crucial to improving our finances, governance and operations. She has a proven track record of delivering diversification and growth, as well as developing executive leadership capabilities which will be an extremely valuable asset to the FIA and our Members and I welcome her to the team."

"I am delighted to be appointed the first ever CEO of the FIA at such an important and exciting time for the Federation," said Robyn. "I look forward to working with Members, the senior leadership team and the President to deliver their vision of reform and growth with the involvement of all staff." RT

ABOVE Robyn's appointment was hailed as a "transformative moment"

RACE TECH

WMS World Motorsport Symposium

SUSTAINABLE MOTORSPORT 2030 – FROM RACE TO ROAD

Thursday 1st and Friday 2nd December 2022

At The Embassy of Switzerland in London

- Sustainable fuels
- Latest electronic technology
- Carbon neutral motorsport events
- Future materials: tyres, brakes, aero and composites

THE CHAIRMEN

ULRICH BARETZKY
Former Director, Audi Motorsport
Engine Development,
Audi AG

PAT SYMONDS
Chief Technical Officer
Motorsport Division,
FORMULA 1®

"The WMS presents a rare opportunity for like-minded engineers to discuss areas of the sport that they may not be so familar with thereby expanding each other's knowledge for mutual benefit. It is also an excellent networking opportunity."

PAT SYMONDS, Chief Technical Officer,
Motorsport Division, Formula 1

worldmotorsportsymposium.com

BOOK NOW

DECEMBER **1ST**

DECEMBER **2ND**

PRICES

- 2 days delegate pass and Awards dinner - £749
- 1 day delegate pass and Awards dinner - £595
- 2 days delegate pass - £695
- Awards dinner only - £295

limited conference places!

Don't miss the opportunity to attend; contact **sara.kimberley@kimberleymediagroup.com** to secure your place.

To order tickets scan here

"The world is currently moving very fast. To shape the future of motorsport it is essential that all people involved put their thoughts together and show that motorsport can be the enabler for new sustainable technical inventions. The World Motorsport Symposium offers the platform to be part of creating that future! It is great to see how the WMS has accelerated over the last few years and it was stunning to see that the ACO, FIA and F1 Liberty Media were using the platform to announce their new programmes and regulations!"

THOMAS KRAEMER, Director Motorsport Quality Management, Porsche Motorsport

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra
Embassy of Switzerland
Swiss Business Hub United Kingdom & Ireland

RACE TECH International – Motorsport Engineering

HISTORIC RACING & Technology

MOSIMANN'S London – PASSION FOR EXCELLENCE

KIMBERLEY MEDIA GROUP LTD

SUSTAINABLE MOTORSPORT 2030 – FROM RACE TO ROAD

• The future of the conventional powertrain • Electrification • Sustainable fuels • Hydrogen combustion and fuel cell technology • Battery technology • The increasing sophistication of aerodynamics • How we engage with modern audiences, and the push to make the events themselves sustainable.

CHAIRMEN

ULRICH BARETZKY
Former Director, Audi Motorsport Engine Development, Audi AG

PAT SYMONDS
Chief Technical Officer Motorsport Division, FORMULA 1®

THE SPEAKER

JOHN ILEY
Founder and Director, Iley Design Limited

CABINET MEMBERS (Confirmed to date)

ROMAIN AUBRY
Technical Director of the Competition Department, TotalEnergies

BERNARD NICLOT
Technical Director of the FIA

THOMAS LAUDENBACH
Vice President Motorsport (EM), Porsche AG

THIERRY BOUVET
Director of Competition, ACO

DR LEA SCHWARZ
Executive Assistant to Senior Vice President Product Line e-tron, Audi AG

THOMAS FRITSCH
Energy Engineer, Motorsport Applications at TotalEnergies

MARC HILBERT
Senior Manager, AI Strategy Lead, Toyota GAZOO Racing

DAVID SALTERS
President & Technical Director, Honda Performance Development

STEVE SAPSFORD
Managing Director, SCE Limited

DAVE GREENWOOD
Professor of Advanced Propulsion Systems, University of Warwick

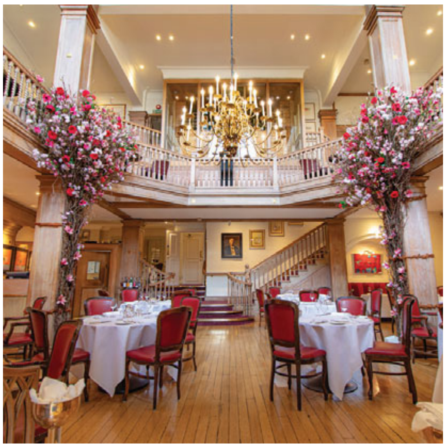
RICHARD SAXBY
Head of Motorsports Accounts at McLaren Applied

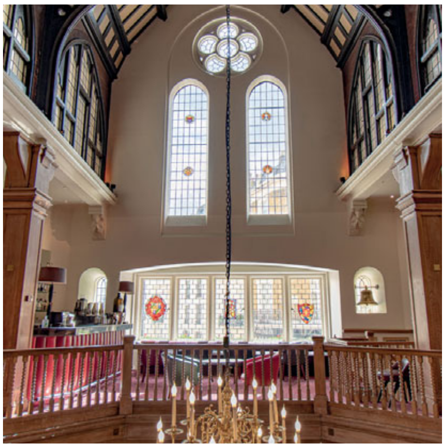
GOLD SPONSOR

McLaren Applied

SPONSORS

Bcomp® · Evolution Measurement · sharc





RACE TECH WMS World Motorsport Symposium

AWARDS 2022

To be held at Mosimann's Club. Set in a striking converted 19th century church in the heart of Belgravia, Mosimann's is one of the world's most prestigious dining clubs.

Awards nominations now open
RACE TECH's Editor Mark Skewis and his panel of industry experts are looking for ground-breaking motorsport technology that enables a positive impact on the environment. If you believe that your product should be considered, **apply by 7th November 2022** with a short brief to sara.kimberley@kimberleymediagroup.com. A member of the team will then contact you for further information.

Nominees and winners will be announced at the World Motorsport Symposium Champagne Drinks Reception and Networking Awards Dinner on the evening of Tuesday 1st December 2022 at the Mosimann's Club in the heart of Belgravia, in front of key influential leaders in the motorsport and automotive industry.

WMS AWARDS CATEGORIES 2022

- Green Tech
- Most Innovative New Motorsport Product
- Race Powertrain
- Racecar Aerodynamicist
- Mclaren Applied Female Engineer of the Year

Chris Pickering finds out how the tech experts at Mahindra Racing and ZF Race Engineering, its official powertrain partner, are preparing to compete with…

THE MOST EFFICIENT FORMULA RACECAR EVER BUILT

FORMULA E re-wrote the motorsport history books when it arrived in 2014. The Gen1 cars weren't without their limitations, but they brought a whole new technology to the sharp end of international motorsport. Gen2 brought more credible performance and proved that electric racing was more than just a passing fad, and now Formula E is about to take its next big leap with the introduction of a radically different Gen3 format.

The chassis and aero kit may still be common among the teams, as is the battery – now a smaller, lighter unit from Williams Advanced Engineering, which also supplied the original Gen1 design – but the rest of the package is open to the teams. And it promises to be a step change in performance.

For a start, there's a 40 per cent power increase to 350 kW (circa 470 hp). In reality, the impact is likely to be even bigger than that figure suggests, as the regenerative braking capability more than doubles to 600 kW (804 hp), meaning that the cars should have more available energy, despite a slightly smaller battery capacity (51 kWh as opposed to 56 kWh).

For the teams and their technical partners, this poses a whole new challenge. The

> *"We are the only team that has been net carbon zero since inception, earning us the title of The Greenest Team in Motorsport"*

biggest departure for the engineers is that they now have two powertrains on the car instead of one, with the addition of a front motor generator unit (MGU). This system, supplied by Atieva, which is an offshoot of EV manufacturer Lucid Motors, will be capable of harvesting energy at a rate of up to 250 kW.

For the time being, the front MGU will only be used for energy recovery. It recuperates energy through an open differential and a spec transmission unit. At the same time, the limit for the rear MGU has been increased to 350 kW. According to the organisers, more than 40 per cent of the energy used during a race should now come from recuperation – so much so that the cars now have no conventional hydraulic brakes on the rear and the fronts are largely there as a precaution.

"We're now losing very little energy at all into friction braking, compared to the old car," explains Lewis Butler, technical director at Mahindra Racing. "As a result of that, front-to-rear balancing is more under our control than it used to be, so that's a big challenge. The work on the rest of the powertrain that we're doing with ZF is closer in concept to the existing car. There's a bit more power and there's more pressure to reduce mass than there was with the previous car."

It may be conceptually similar, but the challenge surrounding the rear powertrain is not to be underestimated, as Sascha Ricanek, vice president of Mahindra's official powertrain partner ZF Race Engineering, points out: "It's a very big step up in power. Our key target was to accommodate that with the same level of efficiency or more, which meant we needed to rethink our engineering approach. At the same time, the weight limit for the car has gone down [to 760 kg minus the driver] which meant that the weight of the powertrain had to go down too."

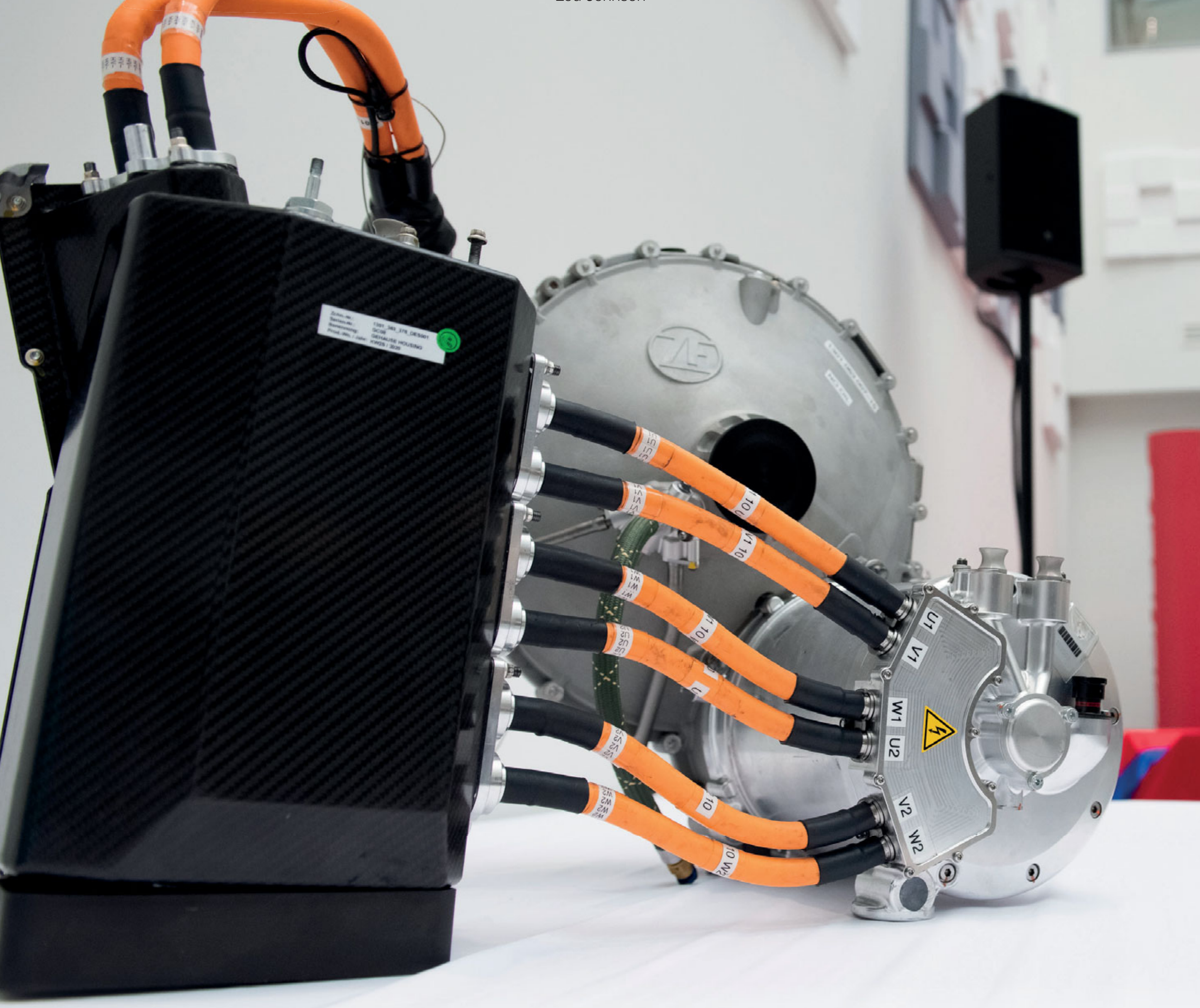
Aside from the battery, ZF supplies all the major parts of the rear powertrain, including the motor, the inverter and the gearbox. This gave the company more freedom to optimise the package as a whole, according to Ricanek.

"Designing the whole system means you have ▸

BELOW The Gen3's total regenerative capability of 600 kW is more than double that of the current Gen2

Lou Johnson

Lou Johnson



ABOVE Aerospace materials were used by ZF to save vital weight on the Gen2 powertrain

a lot of responsibility, but it's also easier for us to play around with the components to optimise the complete package," he says. "For example, we're gearbox manufacturers so we were already quite strong in that area and meeting the targets there was never an issue. But this season we've managed to use some aerospace materials that have saved weight in the gearbox that we've been able to use on the motor and the inverter."

All of these components have different power and efficiency curves. Put a little more mass into the design of the motor, for instance, and you might be able to increase its efficiency. Another example that Ricanek points to is the cooling system, where a lighter design has obvious benefits, but could result in reduced performance in very hot weather. Ultimately, the key to balancing those priorities is to apply a holistic approach.

"One of the things that we've learned through Formula E is that you can leverage those synergies far more effectively as a single supplier," comments Ricanek. "It's about the interaction of the different hardware elements in the powertrain, the software, and the rest of the car to maximise the efficiency. That's something we could apply to the front powertrain too if we were given the opportunity, and we know that other people are pushing to get access to the battery for similar reasons."

This development process also relied on close collaboration between ZF and Mahindra. The engineers working on the powertrain side were initially tasked with maximising the weight reduction and efficiency improvements on the individual components. After that, the next phase looked at the integration of the complete system within the car.

"At that point, we had a lot of discussions with Lewis and his team," recalls Ricanek. "Obviously reliability is a given, but weight and efficiency are moving targets. We'd come back and say something like, 'If you can give us half a kilo, we can improve the efficiency'. In the end, we overachieved on all of the targets that we'd set for the powertrain as a whole."

Software development

Mahindra has been in Formula E since the very first season in 2014, and ZF joined the series two years later, so both organisations have witnessed the category's evolution over three different generations. Each of these shifts has seen them on a comparable learning curve, we're told, with much of the key work during the Gen2 era focusing on software development.

This has set up a constant debate back and forth over which party controls which aspects of the software and the IP contained within. At the same time, the computing power onboard the car has gone up significantly. This helps with procedures as straightforward as exporting logged data – speeding up the process so the engineers can extract and analyse more data between free practice one and free practice two, allowing them to make better informed setup changes.

For Mahindra, the ECU in the new ZF powertrain comes with around twice the processing power of its predecessor. This provides a degree of flexibility on which functions are handled by the vehicle's central ECU and which are controlled locally by the powertrain ECU.

"The question over who has control over which parts of the system is not a trivial one. If there's a change that you can make at the track, it's about who takes final responsibility to go for it and take that risk," Ricanek points out.

Mahindra's headcount has expanded considerably since the beginning of the Gen2 era, and Butler says there's been a lot of progress in the team's trackside engineering and simulation capabilities – especially ▶

> *"We overachieved on all of the targets that we'd set for the powertrain"*

BELOW The Gen3 is the first-ever formula car with both front and rear powertrains. Here Mahindra's car runs in test livery at Abingdon

Lou Johnson

when it comes to vehicle dynamics.

"There's a lot of work going on in the chassis side at the moment to ensure that we're in a better position at the start of the new era than we were at the start of Gen2. But that will be the same across the grid. Everyone gets better all the time," he notes.

During the previous era, the Mahindras were known to use their rear tyres more aggressively than some of the cars. This is one area where increased simulation capabilities are said to have paid dividends and will no doubt be one of the topics that the team will be monitoring closely with the new car.

Energy management

The new front powertrain looks set to radically alter the team's energy management strategy, both corner-to-corner and throughout the duration of the race. On top of that, there's a new tyre from a new manufacturer, which should shake things up. "Combined, it will change everything. It won't be the same kind of racing," notes Butler.

> *"An intense focus on software development – one that has been compared to aerodynamic development in F1"*

Exactly how this new style of racing will look remains to be seen. The general premise of the championship is to lose as little energy as possible through conventional braking, and this is likely to continue. More to the point, it will have to, if the teams are going to complete the race on a smaller battery.

"The race format hasn't been entirely finalised, but it may well be that the front MGU is deliberately relied upon in a lot of situations to ensure that we are recovering as much as we can. Its efficiency isn't as high as our own powertrain on the back, but it's definitely preferable to wasting that energy in the brakes," comments Butler.

In Race mode the use of the front powertrain will depend a lot on the end-of-straight speeds and how the driver is going into the corners, he points out: "[The front MGU] has an open differential which isn't particularly helpful in terms of dynamics relative

BELOW Much of the key work during the Gen2 era focused on software development

Lou Johnson


Audi AG

to the previous car. And understanding how it overlaps with the hydraulic brakes, and controlling that to the drivers' liking, will be very difficult. The issue that we used to have on the rear when there wasn't enough regen braking will now be transferred to the front. It's always quite hard to achieve."

The control strategy that governs this blending of hydraulic and electrical braking will be broadly the same as it was on the back of the old car. However, the generic front MGU and its own limitations means that the teams won't have quite so much control as they did on their own powertrains.

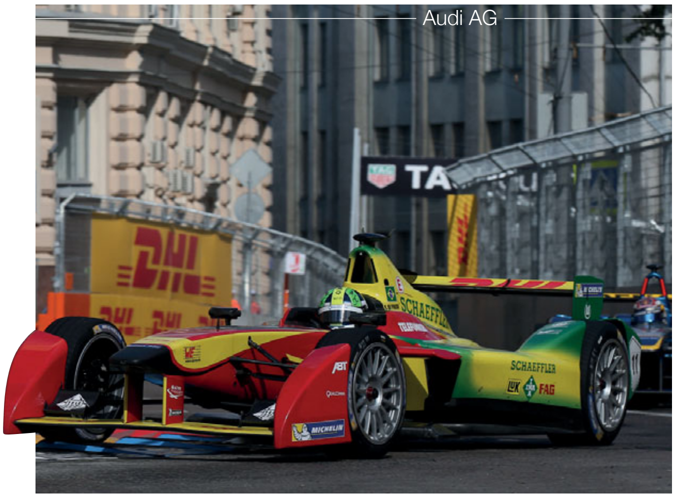
Another change for Season 9 will be the switch to a two-year homologation period. Previously, the hardware has been frozen at the start of each season, right down to the final nut and bolt, with modifications confined to the software from that point onwards. This has driven an intense focus on software development – one that has been compared to aerodynamic development in Formula 1. That shows no signs of abating, but in an attempt to reduce costs, the hardware freeze will now be extended to two seasons.

"Clearly, the teams that had the greatest resources were able to do more work year-on-year than the others," comments Butler. "I think this is a sensible change, which allows people to finish one cycle, look at how it's turned out and then start thinking about the next car. That's the endless treadmill of motorsport, and it's something we're about to pick up now with ZF."

Development for the next car will be approached slightly differently. To a certain extent, the arrival of Gen3 is a step into the unknown for all the teams this year, which could provide an interesting shake up. The incoming cars were designed before any of the teams had run a Gen3 machine on track, whereas the next homologation cycle will see the teams armed with reams of data.

Beyond that, there have already been discussion about where the series should head for Gen4. Some teams are understood to have put forward four-wheel drive (for propulsion as well as energy recovery), slick tyres and open battery development. Top of Mahindra's wish-list, according to Butler, is a switch to identical powertrains front and rear.

"We want to ensure that we don't double up on development costs, which is entirely possible to do from a packaging perspective at the moment," he comments. "It would mean a slightly different looking car, but that's doable. I was a bit frustrated that the timelines didn't allow that in Gen3. ▶


Audi AG

ABOVE & BELOW
ABT Sportsline, the first customer for the Gen3 Mahindra-ZF powertrain, won the 2016-17 title with new Mahindra pilot Lucas di Grassi

"The way they've integrated the front powertrain is very impressive, but that's of limited interest to us as manufacturers as we don't get involved in the details. At the moment, the single biggest architectural change to the cars is common across the grid. We're effectively just customers. Using one kit at both ends would offer huge development cost savings and it means that you can share them if you have impact damage across the season. You could use less parts overall if you only needed to replace the parts that you damaged on one axle at a time."

The layout of the tracks in Formula E means that crash damage is a common sight. The added complexity of a second powertrain in the nose increases the risks of a team not being able to get one of their cars out for the next session.

"We don't know how often that will happen, but it will definitely happen," he comments. "So one operational change that I think everyone will become aware of is that there may be different driving styles and different driving risks being taken in practice to ensure that you get representative laps without taking undue risk."

All change, then. But at the heart of the new regulations is an increase in power-to-weight ratios that should see the electric championship's already-close racing take on a whole new element of drama.

Title challenge

If the omens look good for Formula E's third era, the stars certainly seem to have aligned for Mahindra Racing's bid to become FIA Formula E World Champions. The squad races into the Gen3 era with both a title-winning team and driver in its line-up.

Mahindra Racing joins Porsche and Nissan in providing powertrains to Formula E's privateer teams from next season and ABT Sportsline has been confirmed as its first customer. The German outfit was, like Mahindra, a founder member of Formula E and is making its comeback to the sport. One of the most successful teams since the championship's inception, with 47 podiums and 1,380 points to its name, it brings with it seven years of experience.

The man with whom it won the Formula E Championship in 2016-17, Lucas di Grassi, will also be in new territory: he joins current driver Oliver Rowland in Mahindra Racing's two-car team.

di Grassi is the most decorated driver in the championship's history, with a career that also includes Formula 1 and three podiums at the 24 Hours of Le Mans.

The Brazilian is excited by the potential of the new cars. "It is a huge step up for Formula E, not only in terms of power and speed, but also in terms of complexity, professionalism, maturity of the series etc," he says. "It is no longer something that is upcoming and new, it has reached a big milestone, and the technology of electric vehicles are of course improving too.

"For the teams that are staying, the complexity increases, the car becomes faster and energy management will be different. It is brilliant to see the evolution of the sport and we need to continue to evolve."

Aside from his successes on track, di Grassi is known for his intelligent, informed and passionate approach to tackling the climate crisis. As well as being an outspoken advocate of electric mobility, he is a UN Ambassador and Zero Summit co-founder, and uses his respected standing to drive forward sustainability

Tech Spec

Rear powertrain	ZF
Front powertrain	Atieva
Chassis	Spark Racing Technology
Battery	WAE
Tyres	Hankook
Brakes	Brembo
Dampers	ZF
Lubricants	Shell E-Fluids (bespoke for Mahindra Racing)

> *"Formula E is no longer something that is upcoming and new; it has reached a big milestone"*

Lou Johnson

BELOW New signing Lucas di Grassi's experience will be a huge asset on and off the racetrack and technology.

"I think the main purpose of Formula E is to accelerate the technological development of electric mobility and to showcase that to the world," he suggests. "Of course, it is also very important that everything we do alongside the racing also sets an example – recycled bottles, using less tyres etc – but this still has a very small impact compared to the amount of oil we could save by improving efficiency of the powertrains of millions of cars worldwide.

"Going forward, I want to see more and more relevancy in producing the technologies that will provide that right commercial path for the future of powertrains, and sending this message to more and more fans across the world."

di Grassi's beliefs make him a perfect fit for Mahindra, as outgoing CEO and team principal Dilbagh Gill explained after his signing: "There's no doubt that Lucas is one of the greatest Formula E drivers in the history of the sport – the stats and the silverware do the talking – but, for us, his appeal is much wider than that. We are the only team that has net carbon zero since inception, earning us the title of The Greenest Team in Motorsport, and it is fundamental to our existence that we are driving forward technological developments in electric mobility with passion and knowledge both on- and off-track. We believe Lucas is perfectly positioned to do this.

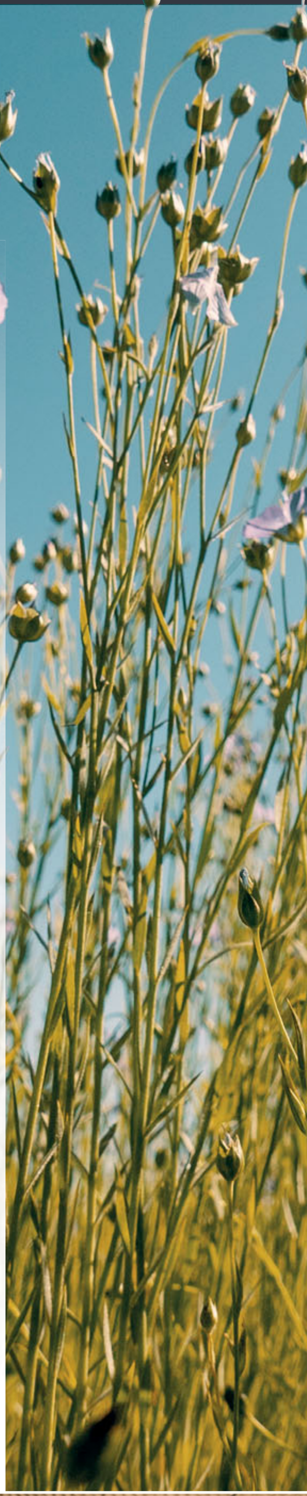
"Our ambition is for Mahindra Racing to become FIA Formula E World Champions and Lucas's experience and drive will be instrumental in achieving this." RT

Lou Johnson

ABOVE The team's trackside engineering and simulation capabilities improved significantly during the Gen2 era

BELOW With the addition of the regenerative capability of the front powertrain, the Gen3 will be the first formula car that will not feature rear hydraulic brakes

Lou Johnson



TAKING *FLAX* TO THE *MAX*

With the global pandemic having accelerated our march to sustainability, **Chris Pickering** catches up with one of motorsport's green pioneers

MOTOR racing is arguably the greatest of mankind's sporting endeavours. In its upper echelons, it boasts the physical demands of athletics, a tactical element not unlike that of chess, and a level of personal risk comparable to skiing or skydiving. But motorsport alone has the potential to change the world.

Over the years, motorsport has helped to accelerate the development of disc brakes, seat belts and anti-lock braking systems for passenger cars. Formula 1 pit crews have even been drafted in to help surgical teams speed up life-saving medical procedures. And now much of the work focuses on sustainability.

Swiss materials specialist Bcomp can attest to the benefits of using motorsport as a laboratory. The company's natural fibre materials have been used in top level series such as Formula 1 and Formula E, but they've also been embraced by no less than 10 different manufacturers on their customer GT cars, and now they're finding their way into mass market automotive applications.

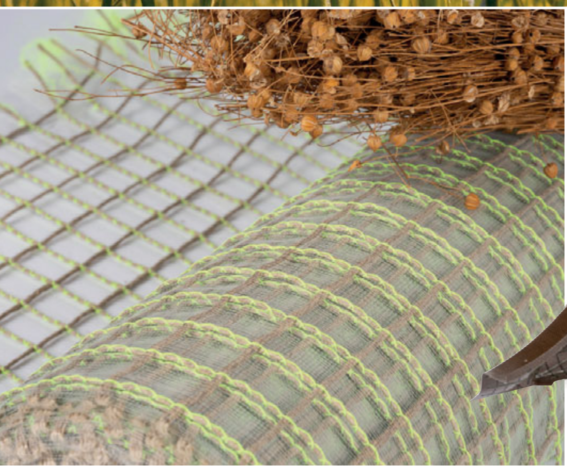
"Any sport can make itself more sustainable. In isolation, it doesn't matter whether you have a green soccer event or a green racing event, but motorsport is the only one that really allows you to take benefits to a far wider audience," comments Johann Wacht, motorsport manager at Bcomp.

"Our work with BMW is a perfect example. That started off in Formula E, so absolutely at the pinnacle of high tech, but it was one part on one car. That then transferred to the DTM, where it was used on a couple of cars, and then GT4. Now we have development parts for road cars with BMW's M division. It's the same underlying material, but each time we added in a little more development to optimise it for those new applications and larger scale."

In each case, that underlying material is made from flax fibres. Much like biofuel, the process of growing the plants from which these fibres are taken is carbon negative – in stark contrast to the production of synthetic fibres.

According to Bcomp, the Global ▶

RIGHT & BELOW Pushing the natural properties of flax fibre to the limit, Bcomp's innovative ampliTex and powerRibs technologies are bringing a new dimension to sustainability in the motorsport and automotive sectors



Photos: McLaren

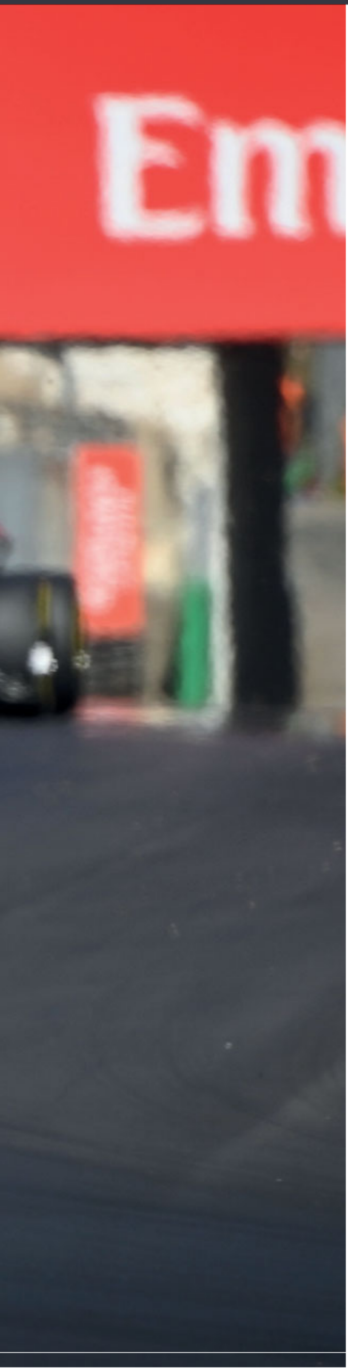
Warming Potential (GWP100) for a carbon fibre bodywork part is around 49 kg CO2 eq./ m² including materials (fibres + epoxy), processes and consumables, while a part with the equivalent stiffness with Bcomp's flax technologies results in approximately 8 kg. The flax fibre itself is hereby CO2 neutral.

"Carbon fibre is extremely energy intense to produce," notes Wacht. "You have this massive impact, due to the carbonization phase, which demands a lot of energy. And that's even more of a problem now with energy prices skyrocketing. With flax plants photosynthesising in a field, each plant effectively has its own renewable energy source."

Flax is said to require very little water to grow, and it doesn't require the use of chemicals that could contaminate ground water for its cultivation or processing. Additionally, the whole plant can be consumed for a variety of purposes, including animal feed, vegetable oil and textiles. It can also be grown as a rotational crop, enhancing the yield of other plants grown in the same soil.

With the current supply chain issues, and the environmental impact of shipping materials long distance, it also helps that flax can be grown in just about any temperate climate. More than 80 per cent of the global flax supply, we're told, comes from France and Belgium – Bcomp's whole supply and processing operation taking place within Europe.

> *"A 'sweet spot' where natural fibres can provide all the stiffness that you need with a similar weight to carbon and a much lower environmental impact"*



Using natural fibres does introduce some additional steps, however. After the flax is harvested, it can be dried on the field to begin the process of fibre extraction. Although the extracted fibres are long, they aren't continuous, so they need to be spun into a yarn. This is then woven into a fabric, which can be pre-impregnated with resin in a similar way to carbon fibre.

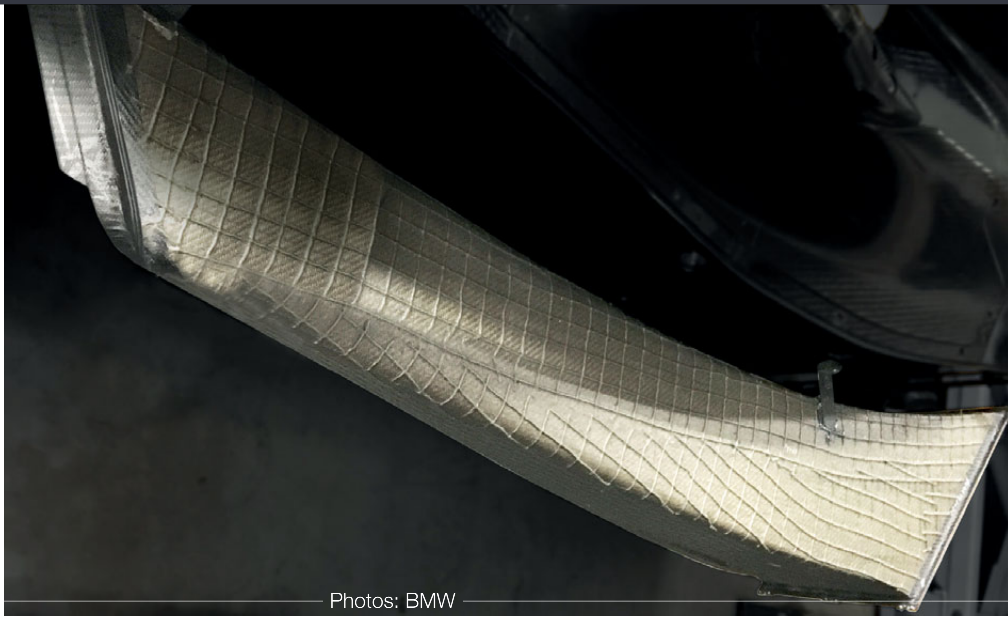
From this point onwards, the production methods are essentially the same. The resin systems and autoclaves still require energy, so the process is not without environmental impact, but Bcomp says that the overall CO2 footprint is around 80 per cent less than carbon fibre for a part, cradle to gate.

Impressive as that figure is, it's of limited benefit if it only applies to a handful of racing cars and high-end supercars (Bcomp, incidentally, is already collaborating with mainstream manufacturers on low-volume specialist road cars, but it's not allowed to say which ones). However, the real benefits come when that technology trickles into the mass market.

Two options

In its high-end motorsport applications, Bcomp's ampliTex material is laid up by hand and cured in an autoclave using a thermoset process, much like carbon fibre. As a raw fibre, it's lighter than carbon but doesn't possess quite the same tensile strength. As such, the prepreg fabric is generally used in conjunction with the company's powerRibs technology. Inspired by the veins on a leaf, powerRibs is a 3D mesh of flax fibres that provides the part's fundamental geometry and boosts its stiffness. When processed in this way, the weight ▶

CLOCKWISE FROM ABOVE "Our partnership with Bcomp has been a game-changer in helping us find new opportunities for incorporating natural fibre composites into our design and engineering," states the McLaren Racing Sustainability Report. The pit wall gantry and seats in the cars are the most visible signs of the collaboration



Photos: BMW

and stiffness of the finished composite parts are said to compare favourably to monolithic carbon fibre up to a thickness of around 1,000 gsm.

"There are some applications where you still need the outright strength of carbon fibre or a combination of the two materials, but those applications are few and far between," comments Wacht. "We often talk about a 'sweet spot' where natural fibres can provide all the stiffness that you need with a similar weight to carbon and a much lower environmental impact."

Aside from the commercial applications in GT racing, the firm's technical partner YCOM has demonstrated a frontal impact structure for a single-seater racing car built with ampliTex. Elsewhere, McLaren has run a Formula 1 seat built from the material, while Japan's Super Formula series has tested sidepods and engine covers that were made from a blend of 70 per cent ampliTex and 30 per cent carbon fibre. All proved successful in applications where natural fibres were not previously considered suitable.

For large volume applications, the same fundamental material can be used in a more cost-effective thermoplastic form. Here, a sandwich construction is generally employed, with the ampliTex fabric providing a top layer, an intermediate layer of NFPP (a short fibre matt impregnated with ▶

ABOVE & BELOW What began as a high-tech application, using flax on the cooling shaft of BMW's Formula E car (above), has resulted in mass market automotive applications such as this Door Cladding Carrier made of natural fibres with the powerRibs reinforcement solution developed by Bcomp (below)


KINSLER
We did the Lucas metering for the Can-Am: 60's thru 70's; still do. Any injection: Road race, Sprint cars, Boats, Indy 500, NASCAR Cup, Drags, Motorcycles, Bonneville, Pullers, Street, etc. EFI, Constant Flow, Lucas Mechanical
Action Express Cadillac, '14, '15, '16, '17, IMSA Champs. 2018 Won driver & Mfr. Champs, overall '20 Daytona 24 Hrs.
Hyper Racing 600cc Sprint car
1971 McLaren M8F Can Am car. Ran Kinsler prepared MacKay intake Manifold with Lucas mechanical metering.
Monster Mesh™ Filter
©
10/3 Element
EFI Injectors, all makes of Pressure Relief Valves, and Lucas Mechanical Metering units, need 3 micron protection, but 3 micron filters plug up too quickly, so most racers use10 micron, which is too coarse. We made this new element for NASCAR Cup cars: 10 micron premium paper top layer to take out 95% of the dirt, with a 3 micron precision Fiberglass lower layer.
Details: Kinsler.com home page.
K-140 Pressure Relief Valve
Used on 95% of NASCAR Cup and INDY 500 cars
sales@kinsler.com
(248) 362-1145
kinsler.com
Troy, Michigan USA


Woodward.
Euros, pounds or dollars, we give you more engineering for your money.
Power steering racks for left or right hand drive, front or rear steer, in an almost infinite variety of dimensions ...with a 3 to 4 week lead time.
WOODWARD
HYDROLINE
Download a Type CF design worksheet at woodwardsteering.com


BREDA RACING AIR JACKS
DIFFERENT ATTACHMENTS
FORMULA & LMP CARS
SPECIFIC MODEL FOR GT CARS
SPECIFIC MODEL FOR LMDH OR LMH CARS
CE CERTIFIED
BREDA RACING
racing components and equipment
for our complete equipment range please visit
www.bredaracing.com
or contact us at info@bredaracing.com

> *"With flax plants photosynthesising in a field, each plant effectively has its own renewable energy source"*

polypropylene) and the powerRibs below. Similarly, the ampliTex top layer can be left as a visual clue to the material's sustainability – as it was in the Polestar Precept concept car – or it can be lined with other finishes such as interior carpeting.

This sandwich material is placed into a preheated mould and then formed using compression moulding. The whole process is said to take around a minute, which puts the thermoplastic parts firmly into contention as a mass market offering. In contrast, the thermoset parts can take hours or even days to lay up and cure, as they would with carbon fibre.

"In these applications, the traditional alternative would be something like IMPP," comments Wacht. "Using ampliTex and powerRibs can reduce the weight by around 50 per cent for the same stiffness, so it can be a huge benefit for lightweighting. At the same time, it removes 70 per cent of the plastic and reduces the CO2 footprint [for thermoplastic parts] by around 65 per cent."

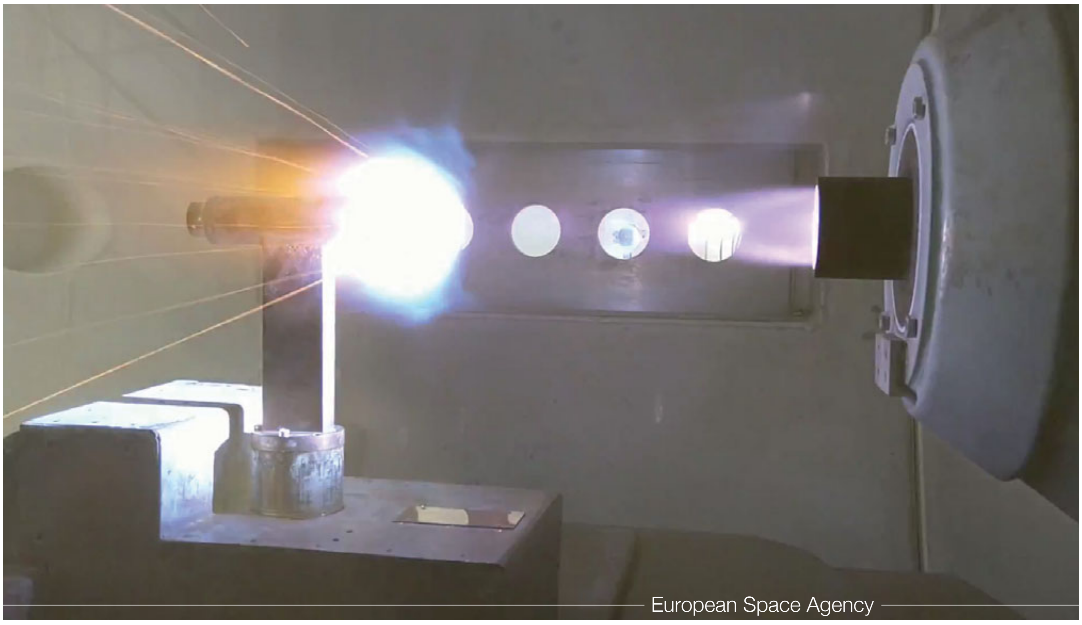
This process is predominantly aimed at mass production applications, where the volumes are higher and the mechanical properties aren't as demanding as they would be in motorsport. However, the same core technology underpins both approaches.

"The same fabric, the same colours and the same design features used on a thermoset motorsport part can be applied to a thermoplastic part. The difference is that it's coupled with polypropylene instead of an epoxy resin. So the large-scale manufacturing projects definitely benefit from the work that's done on the motorsport side," notes Wacht.

In particular, he says, the cycle times in motorsport help to push new technology: "In mainstream automotive, when something happens really, really fast, we're talking about maybe two years. Ordinarily, it's more like five years, and it could be up to seven. With motorsport, we can have a call from a customer, provide the engineering support, get the materials shipped, they build the parts and they can have them on the car in two to four weeks. ▶

BELOW Natural fibres feature prominently on Porsche's Mission R, its vision of the future of electric customer motorsport. Large parts of the car's interior and exterior are made from natural fibre reinforced composites rather than the more conventional carbon fibre composites

Porsche



LEFT Bcomp's flax-based biocomposite structural panels are finding applications in space missions. Here they are tested for demisability in simulated re-entry conditions using a plasma wind tunnel. The halo effect of collaboration with the European Space Agency proves useful for finding terrestrial customers too!

We can take knowledge from those super-rapid development cycles and feed it into high volume projects."

Creating friction

In recent years a whole industry has sprung up around so-called green tech, which is conceived specifically to reduce human impact on the environment. Wacht says companies from this sort of background shouldn't be afraid to enter motorsport.

"For green tech companies, motorsport is an opportunity to push people … to show that there is another way to be more sustainable and still provide super high performance," he notes. "I'd also love to see more green tech in general motorsports, rather than series that are sold specifically on their sustainability. Those series are important, but when you already have a consensus across the project, and everyone has set out specifically to demonstrate sustainability, there's no friction. That friction can be important, because that's when the interesting discussions happen. That's one of the reasons why we've found GT4 so interesting, and it's certainly something we'll be pushing. Race to road tech transfer isn't just a myth: motorsport really can work as a testing lab for OEMs."

This idea of competing on merit, not just on green credentials, comes back to the flax material's inherent properties. As well as its competitive weight and stiffness, another benefit that's particularly relevant to motorsport is that the fibres break with blunt edges, rather than the sharp splinters that can be found with carbon fibre. This reduces the risk of punctures, and it also makes the parts safer to handle, Wacht explains.

"Punctures due to carbon fibre debris can create their own accidents or force a car to retire," he points out. "And when we're talking about gentleman drivers in GT4, the financial cost of replacing a car after a high-speed crash caused by a punctured tyre can be quite significant too. Similarly, you quite often get people working on the car in those lower categories who aren't professional race mechanics. When it's dark in the middle of a 24-hour race and there's a lot of time pressure to replace a broken composite part, it's better if it doesn't have razor-sharp edges. The same goes for marshals and spectators who come into contact with the parts."

LEFT Bcomp's natural fibre technologies are a perfect match for Extreme E's goals of achieving the highest level of sustainable performance and safety

RIGHT BMW is taking its use of sustainable composite solutions to the next level. With Bcomp now an official BMW M Motorsport partner, the new BMW M4 GT4 features more natural fibre composite parts than any other GT racing car in series production

Ultimately, though, it's mostly that desire to make the wider world a better place that drives green tech in motorsport. Wacht believes recent events have played their part in this, but warns against becoming complacent.

"COVID was a very strange time for everyone, but particularly for those in motorsport," he comments. "On the manufacturing side, a lot of businesses just stopped, and people who'd normally be flying around the world were at home spending more time with their families. I think that caused a lot of people to take a step back and think 'wouldn't it be good if my children had cleaner air, or rivers that they could swim in without pollution', so that really pushed sustainability up the agenda.

"The overall CO2 footprint is 80 per cent less than carbon fibre for a part, cradle to gate"

"Now we're back at work and there are new challenges, the important thing is to make sure that those plans translate into action. It would be very sad if all of that turned out to be just words. But I'm positive. I think there are some strong stakeholders in the industry that are saying, 'You need to have a sustainability focus, or we're not in the sport anymore.'"

Fortunately, the motorsport industry is well placed to cope with these demands. It's already nurtured numerous technologies that have improved the safety, performance and efficiency of everyday cars. But its most important contribution may be yet to come. RT

Johannes Nollmeyer

WE HAD THIS CRAZY IDEA…

Jim Hadfield talks to Kieron Salter, a Le Mans engineer present for the birth of three concepts that would define motorsport – and the wider automotive industry – 30 years later

LE MANS is perhaps the world's most iconic motorsport event. A gruelling 24 hours of intense and unforgiving racing in purpose-built machines piloted by some of the world's best. It is a spectacle that never fails to provide tales of triumph and dramatic failure.

Drivers may recognise it alongside the Monaco Grand Prix and Indy 500 as part of the elusive motorsport 'triple crown', but the rich history of Le Mans and its many innovations is best told through the eyes of its engineers.

Following a recent move to his company's newly established facility at Silverstone Park, Race Tech joined Kieron Salter, CEO of KW Special Projects, to learn about the interesting projects – and emerging technologies – that fuelled his passion for racing and his early career as a Le Mans engineer.

Three projects informed and inspired Salter at that stage of his life, each offering incredible insight into the drive for innovation behind racing at Le Mans and the introduction of unconventional technologies that were ahead of their time. From the first 100% renewable fuel car to finish Le Mans, to the first battery-electric hybrid and implementation of the first gas-turbine 'flybrid' or flywheel hybrid system, Salter was present for the birth of concepts that would define motorsport – and, particularly, the wider automotive industry – 20 or 30 years later.

Chrysler Patriot

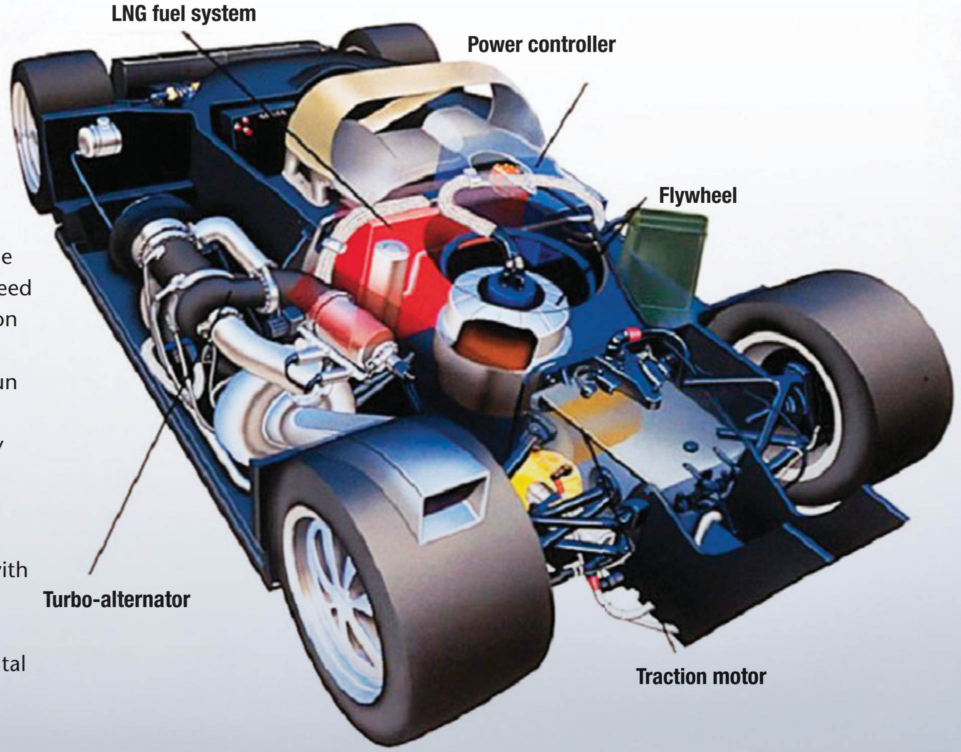
Back in 1993, Salter had just started as a graduate engineer at Reynard. Fresh from university, each day at work offered something exciting and new. One such project was the Chrysler Patriot: a hybrid-electric, turbine-powered, liquid natural gas-fuelled racing car. Reynard was involved in developing the car's chassis and Salter was taken under the wing of

Reynard's Chief Designer, Paul Brown.

"To a young engineering grad, this programme was incredibly cool," explains Salter. "While I wasn't the Chief Engineer, my young and over-enthused recollection is that the main challenges included the storage of cryogenically-cooled fuel within the chassis alongside the enormous (by F1 KERS standards) high-speed gyroscopic flywheel housed within a carbon composite vacuum chamber.

"The 520-kilogram flywheel could be spun up to 58,000 revolutions per minute and was allegedly derived from satellite energy storage systems used when photovoltaic was not available. It really was outlandish – and dangerous. Then you consider the addition of an 84 kg natural gas turbine with a 100,000-rpm high-speed setting and it seems absolutely absurd.

"The entire project was full of experimental ideas and technologies, many from space and advanced aerospace thanks to NASA's direct involvement. We had a lot of unknowns, like would the gyroscopic effects of the flywheel have an impact on vehicle dynamics? We were also using systems ▸



ABOVE The turbine wasn't used as a conventional engine, connected to the driver's throttle. Instead, the throttle was connected to the power distribution circuit. It was up to the turbine, flywheel energy storage system and battery to provide power

> *"The flywheel could be spun up to 58,000 revolutions per minute. It really was outlandish – and dangerous"*

BELOW The Nasamax DM139 was the first (and still the only) car to complete the Le Mans 24 Hours on renewable fuel. KW Special Projects was commissioned to support a restoration of the car

Tim Scott/Fluid Images


Chrysler

similar to those on power stations with vacuum enclosed contactors and high-speed separations, because if we didn't the contacts would arc as soon as you opened."

The Le Mans organisers even changed their rules to accommodate the Patriot, after Chrysler's vice-president of vehicle engineering had flown to Europe to meet them. Ultimately, though, the project was axed when Chrysler's corporate money men got spooked. It was deemed that the Patriot's objectives as a technology demonstrator had been met.

Surrounded by a myriad of other interesting projects, Salter did not mourn the programme's end, but its pioneering spirit stayed with him.

While the ideas might have seemed ludicrous at the time, we have since seen similar mechanical energy storage systems mature in both racecars and automotive, though Salter believes the Chrysler Patriot is not credited for its early – perhaps premature – attempts to prove their viability. ▶

ABOVE The Patriot would have used a 'tortoise and hare' strategy at Le Mans, making fewer refuelling stops than conventional rivals

LEFT The door to much of the technology proposed for the Patriot project was opened by the US government's push for the military to share its expertise with the automotive industry. Here President Clinton and vice-president Gore review the results of their initiative

LEFT Cryogenic fuel storage was a crucial part of the design strategy. The foams developed by NASA to insulate the Space Shuttle's fuel tanks would have enabled the running of LNG in a racecar. Far left, an exploded view of the cryogenic tank's location and the use of the polyisocyanurate coating derived from the shuttle programme


KRONTEC
HIGH PERFORMANCE COMPONENTS
WE INNOVATE MOTORSPORT INNOVATES US
FIRST CHOICE OF TOP-LEVEL MOTORSPORT TEAMS AND RACE SERIES
NEW PRODUCT 2021
AIR JACK SYSTEM
Climate neutral
Product
HYDRAULIC SYSTEM
RFC-FM20
FLOW METER
SYSTEM
RFC-89-K-LM
NEW LOCKING
MECHANISM
STEERING WHEEL QUICK RELEASE
QUICK DISCONNECT COUPLING
KRONTEC MASCHINENBAU GMBH
OBERTRAUBLING, DEUTSCHLAND
+49 (0)9401 - 52530
KRONTEC DESIGN LIMITED
SWINDON, ENGLAND
+44 (0) 1793 - 422000
FOR MORE PRODUCT INFO
WWW.KRONTEC.DE


CARTEK
MOTORSPORT ELECTRONICS
GO TO OUR WEBSITE TO VIEW OUR
FULL RANGE OF MOTORSPORT ELECTRONICS
www.CARTEKMOTORSPORT.com
POWER DISTRIBUTION PANELS
A switch panel and Power Distribution Module in one.
Our Power Distribution Panels are a fully integrated solution designed to replace all the fuses,switches and relays of your race car.
CONFIGURE CHANNELS IN 5A STEPS UP TO 30A.
CHANNELS CAN BE PROGRAMMED TO CONTROL HEADLIGHTS/WIPERS/RAD FANS/STARTER MOTORS etc.
EACH OUTPUT IS PROTECTED FROM SHORT CIRCUITS AND OVER-CURRENT.
ADDITIONAL INPUTS ALLOW CHANNELS TO BE CONTROLLED BY ECU OR SWITCHES ON STEERING WHEEL.
COMES WITH LABEL SHEETS FOR FULL CUSTOMISATION - RETRO EDITION NOW AVAILABLE.
NO COMPLEX CONFIGURATION SOFTWARE - AMP SETTINGS AND LOGIC FUNCTIONS ARE SELECTED THROUGH THE FRONT PANEL.
8 and 16 channel versions available
SOLID STATE BATTERY ISOLATORS
Cartek Battery Isolators are designed to overcome all of the problems and restrictions associated with mechanical and electro/mechanical battery disconnects.
FULLY ELECTRONIC WITH NO MOVING PARTS - COMPLETELY RESISTANT TO SHOCK AND VIBRATION.
MUCH SMALLER AND LIGHTER THAN TRADITIONAL KILL SWITCH.
MEETS NATIONAL AND FIA REGULATIONS.
STATUS LED FOR FAULT DIAGNOSIS.
SEALED INTERNAL AND EXTERNAL SWITCHES REPLACE TRADITIONAL PULL CABLES THAT ARE PRONE TO SEIZING.
MOUNTS CLOSE TO THE BATTERY FOR REDUCED CABLING.
QUICK AND EASY TO INSTALL.
BATTERY ISOLATOR XR
Designed for motorsport
ECU's/PDM's
BATTERY ISOLATOR GT
Designed for OEM
ECU's/Ignition systems

Panoz Q9 GTR-1 Hybrid "Sparky"

In the context of the modern motorsport and automotive industries, this project had all the right puzzle pieces but, again, was perhaps 20 years too early. The Panoz Q9 GTR-1 Hybrid was a ground-breaking racecar that used a petrol V8 in combination with an electric motor drive to the transmission – a battery-electric hybrid. The idea was to compete in Le Mans with a car that was able to deploy additional energy to increase power while also recovering energy under deceleration.

"It was a trend-setter," Don Panoz once acknowledged. "We had this crazy idea, after Le Mans '97, to build a hybrid. Everybody today talks about hybrids. This was the first. In 1998 none of the OEMs were interested in building hybrids. I can tell you: I went around and talked to all of them."

"This project was well ahead of its time and left an important legacy," explains Salter. "Its development brought Panoz, Zytek and Reynard together to create something entirely new. The idea of a battery-electric hybrid racecar was extremely foreign at the time: we're talking about 1998! The basic idea was that the hybrid system would improve fuel economy and power delivery, so the car would require fewer stops throughout an endurance race. It would also have increased performance on the straights, delivering a competitive advantage."

At the time, Salter was a Senior Engineer focused on the race-winning Ford Mondeo British Touring Car Championship programme, but he also worked alongside colleagues (John Piper, Nigel Stroud, Doug Skinner) on the Panoz Q9 GTR-1 Hybrid. Eventually, he would become Technical Manager at Reynard Special Vehicle Projects, inheriting the Panoz programme.

Throughout its development, 'Sparky' faced a number of obstacles.

"Sitting here in 2022 and looking back, the concept was right on the money – this is basically the technology being deployed by Cosworth in the BTCC, for example – but we were extremely limited by the battery technology

RIGHT The Panoz GT1 Hybrid was affectionately dubbed 'Sparky', but its pioneering technology used to unnerve drivers and mechanics alike

of the time," Salter explains. "While the electric hybrid system did provide additional power, it also came at a considerable cost in terms of overall vehicle mass.

"There were also issues delivering power into the transmission, as we kept breaking input shafts. Deciding where we could locate the batteries was also a problem.

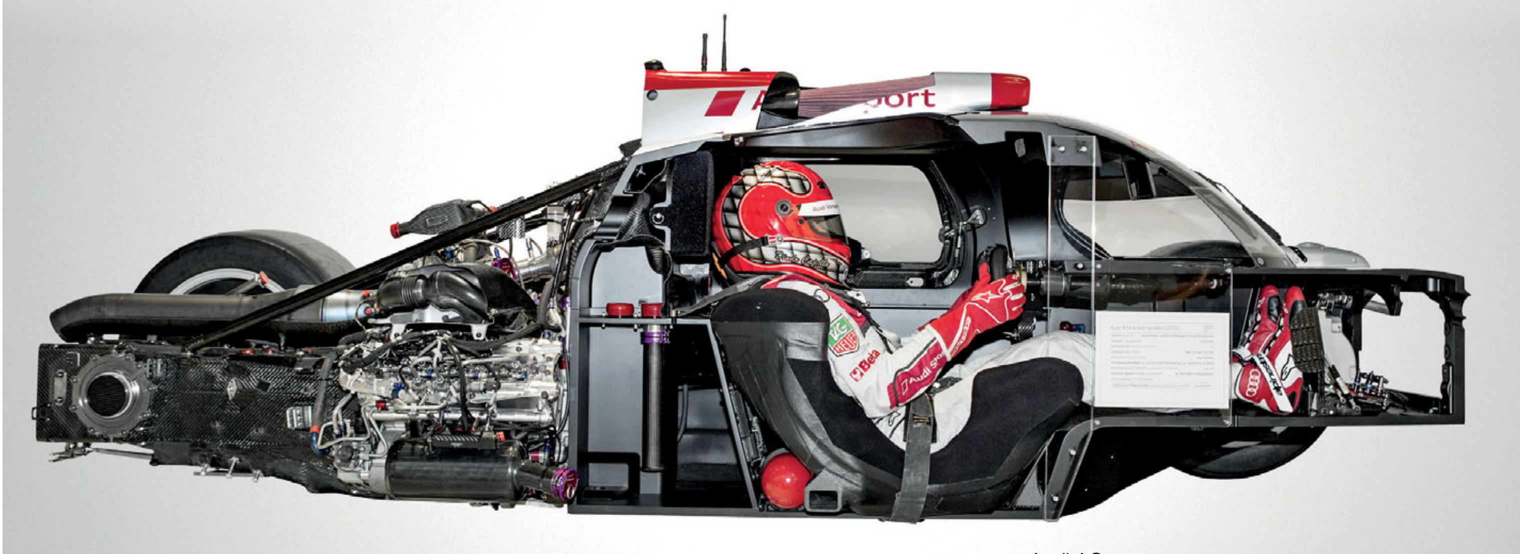
> *"The battery system was visibly and audibly 'active'. That made drivers nervous"*

In the end, the cells were mounted in the unoccupied passenger seat beside the driver (there are no passengers in GT1 cars). I vaguely recall tales of battery packs giving off gases while being rather hot and fizzy! A tad scary.

"One important takeaway for me, personally, was the integration of these systems and general proof of the concept, even if our collective implementation didn't quite achieve what we set out to. It's important to remember that this car, in 1998, had an early form of regenerative braking – that's more than a decade before its introduction in Formula 1. The hybrid tech came from Zytek, who went on to develop and exploit these systems successfully in automotive – a beautiful example of race-to-road technology transfer."

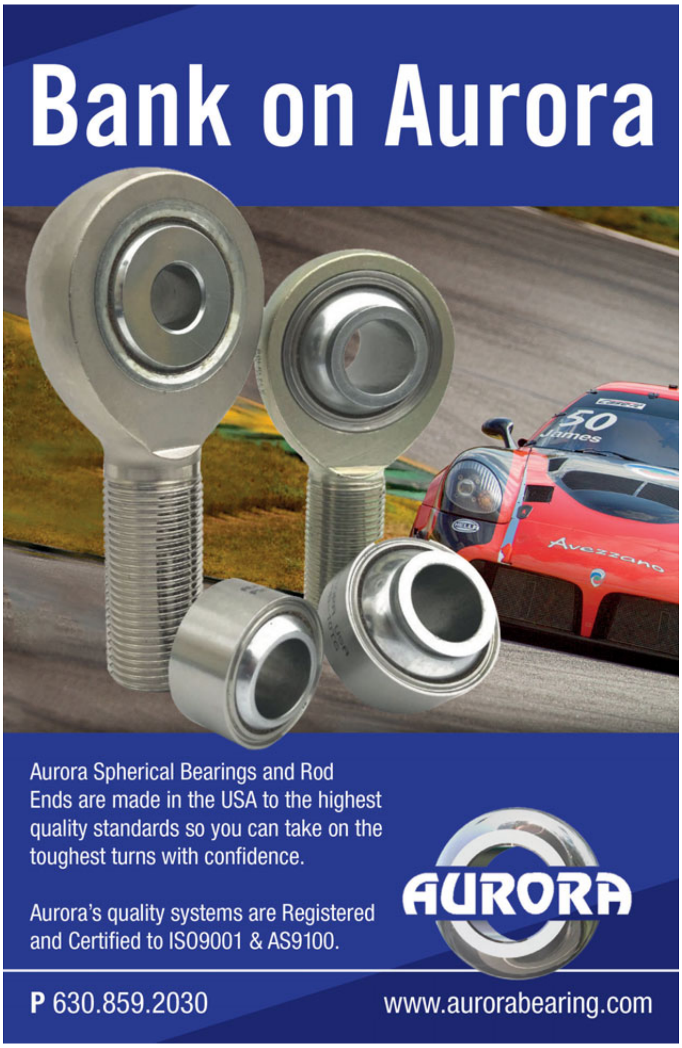
At the time, it was reported that David Brabham ▶

BELOW The Panoz hybrid was so far ahead of its time that it would take another 14 years, until Audi's R18 e-tron quattro in 2012, for the technology to triumph at Le Mans



Audi AG


Getecno
INDUSTRIAL PRODUCTS
ROD ENDS
SPHERICAL BEARINGS
BUSHING
ACCESSORIES
AURORA®
RODOBAL®
Seals-it®
PERMAGLIDE®
Broadest range in Europe!
Your demand, our efficiency
www.getecno.com
EPTDA
Member


Bank on Aurora
Aurora Spherical Bearings and Rod Ends are made in the USA to the highest quality standards so you can take on the toughest turns with confidence.
Aurora's quality systems are Registered and Certified to ISO9001 & AS9100.
AURORA
P 630.859.2030
www.aurorabearing.com


Vehicle Dynamics and Damping
2nd Edition
Jan Zuijdijk
RACE TECH
RACECAR GRAPHIC
Bernoulli
VEHICLE DYNAMICS AND DAMPING
BY JAN ZUIJDIJK
NEW AND IMPROVED 2nd EDITION
The follow-up to Jan Zuijdijk's original book that has been edited by William Kimberley, editor of RACE TECH magazine.
The author, who has been involved with suspension design and development for race and high-performance road cars for more than 40 years, writes about the evolution of suspension systems over the decades. However, this is more than just an historical book but a very practical one that will help the driver and vehicle dynamics engineer set the car up in the best possible way.
£25.00 £10 SALE NOW ON
To order visit our website at:
www.kimberleymediagroup.com
For further information please contact Kimberley Media Group Ltd e-mail: info@kimberleymediagroup.com
841 High Road, London, N12 8PT, UK, Tel +44 (0) 208 446 2100 Fax +44 (0) 208 446 2191
E-mail: soheila.kimberley@kimberleymediagroup.com Website: www.kimberleymediagroup.com
KIMBERLEY
MEDIA GROUP LTD

LEFT Don Panoz with 'Sparky'. He tried, to no avail, to interest OEMs in the hybrid

RIGHT The new 5.5-litre V10 takes traditional fossil fuel, but Judd is able to convert the engine to its original biofuel specification

BELOW RIGHT The Nasamax project was the precursor to the ACO's Garage 56 concept

refused to drive the car in the rain. Given the period, it is safe to say that none of the critical 'health and safety' measures around electric hybrid systems that are standard practice today – particularly within motorsport – were present.

"The car had tremendous magnetic capabilities," Panoz once confessed. "In fact, if you were in the same room, working on the car, you had to leave all your credit cards outside, because it would just swipe all the magnetic strips!"

Salter acknowledges the rarely discussed dangers of innovation: "Unfortunately, like so many new technologies, the infrastructure, knowledge and the health and safety protocols get developed in parallel to the technology itself. Often this involves mistakes and failures. We didn't have any of the modern high voltage and electric vehicle protocols helping us dictate operational safety. I recall the battery system itself was visibly and audibly 'active'. Rather understandably, that made drivers nervous.

"It's no surprise since most of the electric systems were not well understood and probably, in hindsight, unsafe by today's standards. But then remember, there was once a time in history when cars didn't have seatbelts, and racing helmets were made of resin-soaked cotton!"

Hybrid and electric racecars are now a central part of many top-flight racing series around the world, including Le Mans. At the time, Salter appreciated the idea, but the project failed to provide evidence in the concept's favour.

"It was a fantastic idea that just didn't seem to work!" he smiles. "The benefits never outweighed the disadvantages! Of course, battery technology would go on to improve rapidly and we had little clue that the motorsport and automotive industries would adopt electrification the way they did.

"Electronics and electric systems also evolved at an astonishing rate. In that period, an F3000 engine had electronic ignition systems and fuel injection, but the rate of development since that has led to racecars with ECUs, Gearbox Control, EPAS, ABS, chassis, telemetry, and CAN systems. They are complex. Not only that, but we are also using electrification for very efficient energy recovery, turbo lag reduction, braking, steering, fly by wire – it's all come on a long way."

Nasamax-Judd V10 LMP1

As a number of large European vehicle manufacturers have highlighted, electrification is not the only way to decarbonise transport propulsion. Another option that has attracted significant investment in recent years (from the OEMs) is sustainable and renewable fuels. Given the recent growth of interest and investment, it is somewhat surprising that the first and only car to ever compete at Le Mans using a wholly renewable fuel was all the way back in 2004.

The Nasamax-Judd V10 LMP1 was a pioneer of sustainable racing and biofuel tech. At this stage, the enterprising Salter had started his own business, KW Motorsport – the predecessor of KW Special Projects – following the unfortunate bankruptcy of Reynard. KW Motorsport was chosen as the constructor of the Nasamax DM139 chassis and worked closely on homologation of the bio-ethanol powertrain with Le Mans founders and officiators the Automobile Club de l'Ouest (ACO), as well as the man behind the fuel technology.

"The scientist and race engineer behind the entire Nasamax project was the pioneering John McNeil," explains Salter. "In 2003, John approached me because he had found a Reynard 01Q Le Mans racecar chassis to use as the development mule for his project. We had previously met during my time at Reynard, while I was the Technical Manager of the customer LMP racecar programme. Given Reynard had gone into administration, KW Motorsport was the perfect partner.

"John asked if we would help him to support the engineering and ACO homologation, as he had identified an opportunity to update the car, aerodynamically, for the new-for-2004 LMP regulations. KW Motorsport just so happened to have been involved in the development of these regulations with the ACO. So, we put together a programme of converting the 01Q Reynard chassis to the new LMP regs with a modified Reynard 02S rear end and also updated the powertrain to a Judd V10 and Ricardo transmission."

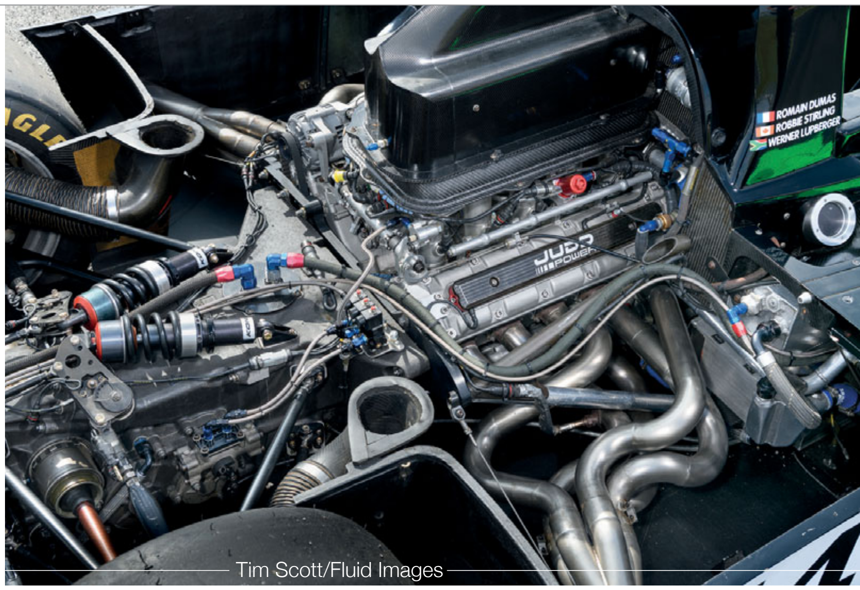
The project was not without its challenges. From a chassis perspective, running 100% ethanol meant that many of the materials used in conventional gasoline systems needed to be changed to those compatible with ethanol, from the fuel tank bag to lines and seals. Perhaps more significantly, the lower volumetric energy density of ethanol meant the car would consume more fuel per lap than a gasoline equivalent. In order to be competitive and make a similar number of stops to the conventional Le Mans field, the car would need to carry more fuel onboard.

This requirement for additional fuel created two issues. The first was convincing the ACO that the car should have a concession to carry more than the regulated 90 litres; the second was to find somewhere in the chassis to store the additional fuel, an anticipated 30 litres. Importantly, this use of an alternative fuel also led to a concession to run outside of the regulations, as an experimental technology. This eventually led the ACO to create an entirely new Le Mans category, Garage 56.

"The ACO would not concede the additional fuel capacity without convincing themselves of the facts, so, we had to race the 2003 chassis with just the 90 litres," recalls Salter. "It was an educational process and took some time to get them on board. We needed to demonstrate why we needed to carry more fuel and mitigate concerns around the potential for significant performance advantages it could introduce.

"Fundamentally, though, the ACO was extremely supportive. That is one of the things that makes Le Mans endurance so unique: there is an appetite for experimental technologies and innovation.

"The ACO accepted our requirements for 2004, with the DM139 chassis equipped with a secondary fuel cell mounted in the passenger side of the cockpit in its own carbon composite crash structure. This was a packaging challenge as, traditionally, that is also where most of the racecar's electronics were located.



Tim Scott/Fluid Images

> *"An appetite for experimental technologies and innovation"*

"There was also the logistical challenge of the ACO providing our fuel. In the end, garages at the end of the pit lane were used for non-gasoline race fuel storage. I believe that it was actually garage number 56, and that's how it began!

"Refuelling during the race was all done using standard equipment and in a similar manner for all intents and purposes. A similar approach was used when Audi started to use diesels."

The car performed well at Le Mans in 2004, particularly given its experimental nature, recording the highest overall top speed on the Mulsanne Straight that year. This was partly to do with a restrictor benefit resulting from the new-for-2004 aerodynamics regulations. Unfortunately, the car's race pace was soon hampered by an electrical issue that resulted in a misfire.

Salter notes that they spent too much time trying to identify and resolve the issue, eventually opting to continue running and losing a number of places throughout the night.

Not only was the Nasamax-Judd V10 LMP1 well ahead of its time, but it simultaneously made Le Mans history and changed Le Mans itself. It managed to complete the entire race on bio-ethanol and remains the first and only car to ever do so, a clear demonstration of the technology's potential almost two decades ago. Its success also led the ACO to create the Garage 56 category for experimental and new technologies, a ▶

Tim Scott/Fluid Images

platform for all manner of innovations since.

In an interesting twist to the tale, KW Special Projects was commissioned to support a restoration of the car just four years ago. As part of the restoration, the engine was upgraded to the S2 variant of the Judd V10, including different chassis mounting. Given the logistical difficulties of running on biofuel, the decision was made to (reversibly) convert the car over to conventional race gasoline – a worthy compromise to keep this piece of history running. For those with deep pockets, the car is currently available for purchase.

Visionaries

It is interesting to consider the visionary individuals and organisations behind these projects. It also raises questions around the link between technological innovations, racing and the potential for broader applications. Salter's exposure and involvement in these projects played a role in the way he views the connection between technological innovation and racing. Indeed, some of the individual components, systems, and novel ideas can be directly mapped forward to what we see today in Formula 1, at Le Mans and in the automotive sector.

"I think they all played a part in, at the very least, raising awareness of these technologies," muses Salter. "In some cases, I think they were a technological demonstration that was important in shaping the motorsport and automotive technologies of today. For example, we have seen Formula 1 with KERS, Porsche setting lap records with the KERS-equipped 919 Hybrid, top tier series declaring roadmaps to alternative fuels alongside hydrogen and hybrid technologies.

"The only technology that has not made it to racing (yet) is the Patriot's gas turbine concept, though gas turbines and micro turbines have seen development as range extenders within automotive such as the Delta Cosworth-equipped Ariel Hipercar 2."

Given the emphasis on transport decarbonisation and the view that motorsport is something of an R&D platform for the automotive industry, the push for cleaner propulsion has never been greater. Given that Salter, alongside his fellow engineers, has been working with and understanding these technologies for far longer than the latest automotive 'megatrends', what are his insights into the role of new propulsion technology in the real world?

"A crucial contributor in developing the transport decarbonisation technologies of today"

He believes that there are two distinct components of the problem: the energy itself and energy storage.

"As we all know, batteries, supercapacitors and flywheels are just energy storage – but so are gasoline, hydrogen, and bio or synthetic fuels," he reasons. "I'm of the opinion that we need to find the most efficient and practical way of storing energy for each specific application. There are many different priorities: sometimes it is energy density, or cost, or speed of deployment, or logistics – these are all major considerations for matching technologies with applications.

"Unfortunately, our most familiar fuel, gasoline, is very good in many of these respects – that's why it has been so popular for so long. While I personally drive a BEV every day, I don't necessarily believe that batteries are the be-all and end-all, nor is hydrogen. Then there is the matter of lifecycle and supply chain. Regardless of the propulsion technologies we choose, in order for it to be truly sustainable we need to look at the entire lifecycle, from cradle to grave.

"So, hydrogen or biofuels will all need to be produced using sustainable renewable energy. Fundamentally there is no such thing as a sustainable fuel unless the entire production and supply chain is."

Here, in 2022, the internal combustion engine is a highly refined masterpiece of engineering – the work of countless innovators and incredible minds. The thermal efficiency of modern Formula 1 engines is phenomenal and at the same time, we can produce ICE and gas turbines cost effectively and with a much lower embedded carbon footprint than batteries, for example.

Salter suggests that the most time-efficient and accessible solution at this time is alternative fuels with contemporary internal combustion technologies.

"I am not convinced the perfect transport solution for every application will be plug-in electric, due to the long-term impact of battery manufacture on the planet," he says. "The energy density and service life of cells is not there. Though investment is substantial, so, who knows what new chemistries and innovations we will see. At the end of the day, however, it all counts for nothing if the grid itself is not vastly powered by renewables.

"The advantage of biofuels is that we can largely utilise existing developed ICE technology and fuel transportation infrastructure. Of course, it's a complex problem with many solutions and just as many challenges. For motorsport, particularly endurance racing, I see a large role for alternative fuels, alongside other technologies to improve performance or efficiencies.

"Thinking about heritage and classic cars, are we going to convert these all to EV? I don't mind the occasional EV retro-fit restomod, but surely not all of them. So, I think an alternative fuel that can be used in ICE engines needs to be the answer, assuming the energy we use to make it is renewable."

Focus on alternative fuel

Salter's company, KWSP, has built its foundations as an advanced engineering business with a focus on alternative fuel and energy storage. Taking many of the experiences and lessons learned throughout his career, KWSP now delivers niche vehicle programmes for road and track, as well as facilitating horizontal technology transfer between sectors.

Beyond the unique projects already discussed, Salter, KWSP and its predecessor KW Motorsport, have a rich history of Le Mans competition.

"Throughout my career, there have been many 'conventional' Le Mans projects alongside those already outlined," he observes. "My first exposure to Le Mans engineering was with the Panoz GTR in 1998 and Reynard customer LMP racecar – the 2KQ – in 2000. Le Mans development in 2000 saw Reynard with five cars on the grid for LMP900 and LMP675, the latter being the most successful, particularly with VW powertrains. This combination won its class for three successive years: 2001, 2002, and 2003.

"The 02S was then introduced in 2001 as a 'clean sheet' approach to LMP675. But when Reynard went under, the project was continued by the 02S Chief Engineer Will Phillips and I, working alongside Zytek to debut the car at Petit Le Mans in 2002. This was the origin of KW Motorsport.

"KW Motorsport went on to develop the car for Creation Autosportif through LMP1 and LMP2 variants, including aero development. Eventually, it became a complete new car for 2007, the KW Motorsport CA07, which raced at Le Mans for the final time in 2009."

With his roots in motorsport and Le Mans, Salter has a strong desire to remain at the forefront of state-of-the-art technologies, where the worlds of automotive, motorsport and novel propulsion combine. The business – as KWSP – has recently relocated to an all-new 28,000 square foot 'Skunk Works for OEMs' facility at the heart of motorsport and advanced vehicle technology in the UK, Silverstone Park.

The move is part of the company's ambitious growth plans and co-locates it with another of Salter's businesses, the Digital Manufacturing Centre (DMC) – a 20,000 square foot world-leading commercial additive manufacturing facility. This is yet another project focused on efficiency – in this case, efficient manufacturing and applications, such as lightweighting.

ABOVE The move to Silverstone was crucial for the business

LEFT Salter's ambitions include an involvement in another Le Mans hybrid programme

"KWSP has gone from strength to strength in recent years and this move is crucial for the future of the business," he suggests. "Not only will we be closer to the DMC, but this location is an important part of our return to motorsport development and the pursuit of race technologies, alongside OEMs. We have been involved in some fantastic projects and continue to work towards a Le Mans hybrid programme in the future, as an engineering partner, as a team, or both.

"We also intend to invest in the future of alternative fuels, like biofuels and e-fuels. While we are not totally invested in the concept of battery EVs, our interest in efficient manufacturing process and digital deposition has resulted in us leading two INNOVATE UK R&D projects into battery cell manufacturing, using a novel process for solid state and lithium-ion polymer batteries.

"I think the motorsport and automotive industries have a very exciting future ahead," he predicts. "Not only the rate that technology is moving, but also the shifting and evolving opinions as well as adoption behaviours. I want KWSP to keep up with that and we will continue to drive the business towards such opportunities."

As he looks back across these projects and his career, Salter highlights the types of creative minds and forward thinkers that motorsport attracts. A trait that has made it a crucial contributor in developing the transport decarbonisation technologies of today.

Spurred by fierce competition and the thrill of success, the ability of motorsport to generate ideas and innovation seems invaluable. While the 24 Hours of Le Mans may be a single race, held just once a year, it is important to consider the feats of engineering it has inspired and the role these are now playing in the greatest challenge of our time. RT

UNLEASHING THE PRANCING HORSE

Easier to drive, simpler to work on, Ferrari's new 296 GT3 has been meticulously designed in every detail and from every angle. **Anthony Peacock** reports

All photos: Ferrari

THE very first Ferrari to win a race, back in 1947, was the 125 S: a gorgeous V12-engined two-seater, complete with headlights, that triumphed at the Rome Grand Prix. It was a race car – which ultimately became a road car – because Enzo Ferrari was obsessed with racing: but he wasn't fixated on circuits, neither was he synonymous with single-seaters. He just thought, in his own words, that "there is no car that cannot be improved with competition."

This is how important GT racing is to Ferrari; or 'Gran Turismo' to give the category its proper Italian name. For Enzo, it's where the whole story started; the essence of motoring, and therefore racing.

His eponymous Italian firm makes a

ABOVE The new Ferrari 296 GT3 testing at Portimão in Portugal in readiness for its race debut at the 24 Hours of Daytona hotly anticipated return to the top class of sportscar racing in 2023 with the introduction of its Le Mans Hypercar for the World Endurance Championship, but that doesn't mean GT racing is taking a back seat at Maranello. Far from it.

Next year will also be the debut for the Ferrari 296 GT3, which will represent the Prancing Horse not only in the category's established headline series such as the Intercontinental GT Challenge and GT World Challenge, but also the WEC and Le Mans 24 Hours, which will use GT3 machinery as the basis of their GT class from 2024 onwards.

Based upon the 296 GTB sportscar that hit the road earlier this year, the new car will replace the 488 GT3 that has been campaigned for the past seven seasons – and in its latest evolution triumphed at the Spa 24 Hours in 2021.

> *"The new 296 gives us all a lot of confidence in oversteer situations; it's also very predictable at the limit"*

And there's a special symbiosis between road and track that makes this car a particularly thoroughbred.

Ferrari's GT racing department was involved in the road car's development from the beginning with its own competition goals in mind. This extends to the similar engine architecture of the two cars – a mid-rear-mounted three-litre turbocharged V6 with a 120-degree vee – as well as the positioning of the turbos inside the vee for more compact packaging. The engine is located further forward and lower down than in the road car to ensure a lower centre of gravity, while the gearbox has been designed specifically for the racecar.

All this has been done in the pursuit of one important goal: to make the race car as easy to drive as the road car, enhancing the ability of any driver. Hardwired into the DNA of endurance racing is the Pro-Am philosophy: the slightly alarming concept that somebody even like myself, if armed with the appropriate licence, could compete at high-level endurance ▶

ABOVE From the front splitter to the rear extractor, which has a diffuser with a sophisticated three-dimensional design, the 296 GT3 design aims to achieve the lowest possible drag races, in the esteemed company of people who know what they are doing.

People such as factory driver Davide Rigon, who has been associated with Ferrari since 2011 and is also a simulator driver for the team in Formula 1.

Confidence game

"I've always said that a car that is quick for professional drivers is still easy to drive for gentlemen drivers," he points out. "It's also a question of set-up; the car can be set up to have more stability at the rear, whereas professional drivers often prefer to have a more 'pointy' car. For us, if the rear end moves, it's not a problem – whereas gentlemen drivers sometimes have more issues when it comes to controlling oversteer. But we've got a base car with the new 296 that gives us all a lot of confidence in oversteer situations, and it's also very predictable at the limit. I think the engineers have done a great job at delivering confidence at every level and transmitting feeling. So I think gentlemen drivers will have a good feeling with this car straight away."

On the outside, the 296 GT3's purposeful looks also follow the simple form of the road car but with striking aerodynamic details that generate 20 per cent more downforce than its predecessor. As Rigon mentions, every successful GT3 manufacturer has to strike the right balance between the outright performance craved by professional factory drivers and accessibility for amateur or gentleman drivers. Ferrari's engineers have worked to reduce ride height sensitivities with the goal of improving handling and driveability.

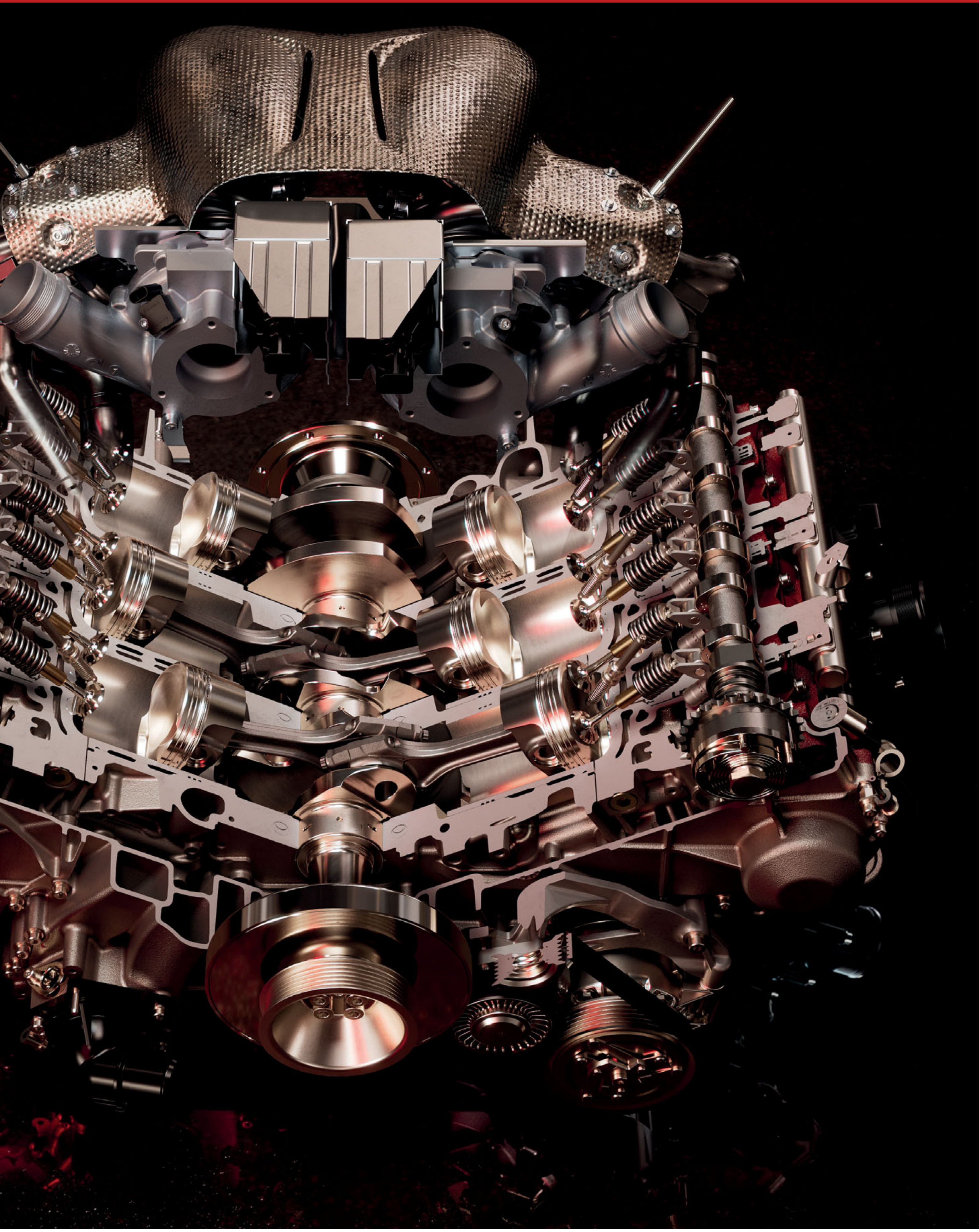
LEFT Both ends of the car are built up on detachable subframes for ease of maintenance

RIGHT The wide-angle configuration of the engine will allow the turbos to be housed inside the vee for more effective packaging

> *"Striking aerodynamic details that generate 20 per cent more downforce than its predecessor"*

This has also been aided by the wheelbase being 60 mm longer than the road car, the maximum permitted by GT3 regulations. A new double wishbone front and rear suspension has been designed to offer maximum grip even at high speed and limit the stresses on the tyres in order to extend their life and performance: an integral part of race strategy in the longer endurance encounters.

Like its rivals, Ferrari has also focused on how easy its car is for teams to run and manage, especially in the middle of a 24-hour endurance race when every second spent in the pits counts on track. For this, it has taken lessons from its Formula 1 team as well as the development of the Hypercar prototype. Most significantly, the front and rear portions of the car can be swapped within seconds, an ▶



LEFT The outgoing 488 GT3 achieved the remarkable feat of 500 victories with success in the DTM at Spielberg

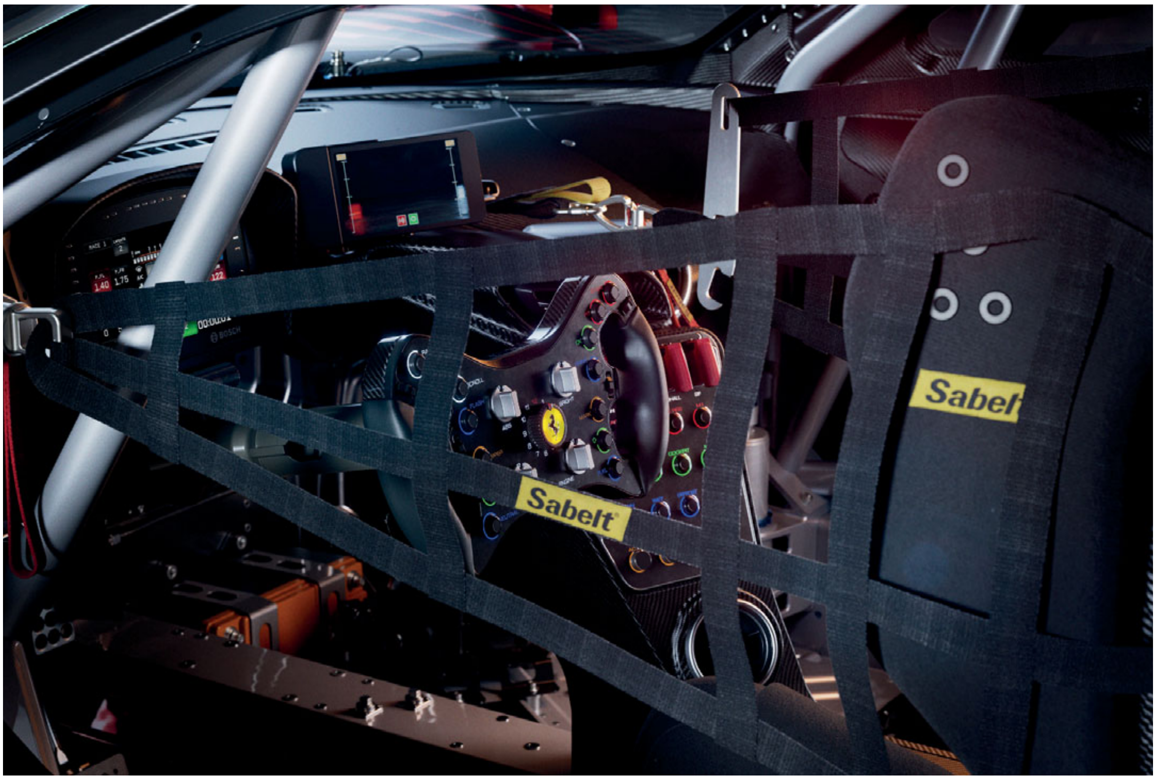
innovation that has the potential to keep the 296 GT3 in contention even in the event of mid-race damage. Mechanical and electrical components are more accessible and setup changes can be made in less time.

The attention on ease-of-use during long-distance races is not limited to servicing or the way that the car handles or performs. The cockpit has been completely redesigned based upon feedback from factory and gentleman drivers. Drivers of different sizes and statures are more easily accommodated with adjustable pedals and steering, with a seating position that provides optimal visibility. Many controls have moved to a new F1-inspired steering wheel, while the air conditioning system has been designed to aid the driver's concentration in all conditions.

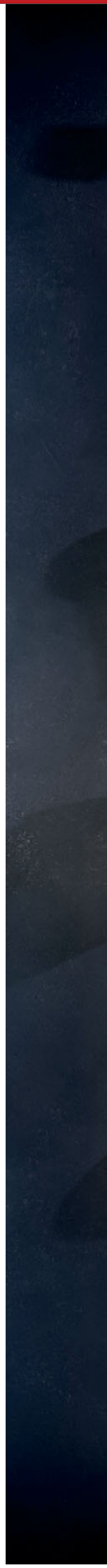
> *"Many controls have moved to a new F1-inspired steering wheel"*

"There are many differences compared to the old car," adds Rigon. "The one you notice most is the increase in reactivity when it comes to direction changes, as well as braking and also stability under braking. All these changes mean that you get a very good feeling straight away."

Following its first shakedown at Ferrari's famous Fiorano test track in April, the 296 GT3 has undergone tens of thousands of kilometres of testing ready for its competitive debut. It is the first GT3 car to have been developed entirely in-house at Maranello, with French firm ORECA having been selected to take



LEFT Many controls and functions have now been moved to the steering wheel



RIGHT The modular design enables bodywork sections at the front and rear to be removed in one piece

over assembly and customer support from long-time Ferrari collaborator Michelotto. According to Rigon though, this car isn't a revolution: instead, an enhancement of an already competitive package.

"When it comes to the overall feeling with the car, there's a small step in every direction that adds up to give more confidence to the driver, and you see that in the lap time," he says. "As always, those last tenths are the hardest ones to find, but this is a car that immediately takes you to a very high level of performance in a way that is easier than the outgoing 488."

Porsche rivalry

The racing debut of the 296 GT3 will come in January's Daytona 24 Hours, the first round of the IMSA SportsCar Championship where GT3 cars already took over as the premier GT class this season.

ABOVE Rotiform has developed an all-new forged wheel homologated specifically for the 296 GT3

Ferrari expects five or six examples to already take part in that first race, where it will go head-to-head with the similarly new Porsche 911 GT3 R. Both cars were unveiled to the racing world before this year's Spa 24 Hours, and while most eyes next season will be on the two companies' new Hypercar creations, the next chapter of the Ferrari versus Porsche rivalry in GT racing – surely the stuff of a feature film one day – will be just as significant in a category with such visible connections to its flagship road cars. That's why all these companies go racing, after all.

The battle for supremacy in the GT3 category has never been tighter, with Lamborghini and Mercedes also figuring prominently in this year's Spa 24 Hours, while in the shorter races that make up the bulk of the GT World Challenge Europe, Audi has been the car to beat. Which will come out on top next year is impossible to tell – but this is Ferrari's most serious effort yet when it comes to endurance racing in every category and at every level. RT

WHERE THE RUBBER MEETS THE ROAD

With the understanding of tyre behaviour more crucial than ever, a new simulation approach significantly advances tyre modelling within rFpro. **Chris Pickering** investigates

FOUR rubber contact patches – each roughly the size of a single page of this magazine – are all that stand between success and disaster on a racecar. You might have an engine that produces 1,000 hp or an aero kit that gives you 1.5 tonnes of downforce, but ultimately, it all comes down to the tyres' ability to manage those forces at the point where the rubber meets the road.

This behaviour can be complex to simulate, and it involves the interaction of several different components. You need digital models for the track surface, the tyre and the vehicle physics, each sharing data with the others. Generally, these come from different providers, so there is the potential that intellectual property will be shared alongside the data itself. As such, the way this information is exchanged is critical to both the effectiveness of the simulation and the IP security of the project.

Simulation specialist rFpro has developed a new system for embedding third-party tyre models directly into its road surface model software, known as Terrain Server. This gives the tyre model access to highly detailed surface information without compromising confidentiality.

"The whole ethos of rFpro has always been to detach our simulation environment as much as possible from the vehicle model. That means we don't need to see any more data than is strictly necessary from the customer's vehicle model and we don't share any more data from the track model than we need to either," explains Nick Harrison, development director at rFpro.

Essentially, the vehicle model requests information ▶

ABOVE The new development gives tyre modelling providers encrypted access to the road surface model from the Terrain Server about what's underneath each of the four wheels at any given moment in time. Under the existing system, the Terrain Server will analyse the track data for each of the contact patches and send back a set of values such to describe the surface at that point. These are averaged across the contact patch of the tyre to produce a single set of figures. For instance, the highly detailed surface data may show a change in the coefficient of friction (mu) across the contact patch, but this will be averaged out to a single value.

For a lot of simulation applications, this averaged approach provides more than enough detail on the surface characteristics, and it has the key advantage that it keeps the raw data of the track model separate from the rest of the system.

"What we don't want to do is allow completely open access to the raw data," comments Harrison, acknowledging the question of intellectual property.

These days, professional track models are captured by LiDAR scanning the road surface in minute detail. That means there are typically three main stakeholders in the process – the circuit owner who allows their surface to be scanned, the firm that carries out the scanning and the software company that post-processes it into a useful format. All three are invested in the track model to a certain extent and rFpro is very aware of its responsibilities to the track owners and LiDAR scan providers to keep their valuable data in a protected form. Harrison likens it to

LEFT Matt Daley, rFpro Operations Director

BELOW An impending ban on the use of tyre blankets means that understanding and optimising tyre behaviour will take on even greater significance music: you could take a bootleg recording of an album, but it's still the band and the record company that own it.

A dark art

The background to this problem lies with the famously dark art of tyre modelling. Chassis engineers used to joke that tyre manufacturers used voodoo to understand the almost-mystical inner workings of these complex systems. The reality, of course, is that it's all just physics, but the complexity and non-linearity of tyre modelling puts it in a whole different ballgame to, say, modelling the dynamics of a suspension spring.

"Tyres are a particularly difficult problem to deal with. You've got the pressure and temperature effects, and then there's the micro and macro roughness underneath the tyre. And that's before you look at the structural deformation of the tyre as it loads up through the corner," comments Harrison. "There's also the mu of the surface and how it rubbers in across the race. Plus, in NASCAR you've got friction-modifying compounds like the PJ1 spray that they use to create different 'grooves' in the track."

There are two approaches to capturing this behaviour. You can use empirical data to map the tyre's behaviour – for instance, the amount of lateral force that it will develop for a given temperature, pressure, vertical load and slip angle – or you can simulate it from first principles.

"We know that some teams want to simulate the physical behaviour of the tyre – in other words, generating a model that you then validate against the data rather than generating a model to fit the data," notes Harrison. "We model the contact patch within rFpro with a cylinder that intersects the surface. And that's where we take this set of averages across the contact patch. Most of our customers are absolutely happy with that, because they're not particularly focused on this topic.

"But we do talk to people who are spending the vast majority of their time thinking about tyre behaviour, and for them it's useful to understand the surface characteristics in more detail."

Outside of motorsports, customers often focus on comfort rather than performance. Road car vehicle dynamics deal with lower speed scenarios and are interested in ride rather than obsessing over edge of the envelope grip levels.

The ride characteristics of a vehicle must be modelled accurately to make sure that, for example, passengers in an autonomous car are not subject to extreme loads. A human driver might instinctively avoid a pothole or drain cover; a passenger in a self-driving car will lose confidence if their AI driver is unaware of these road features, which are inherently communicated to them via the tyre contact patch.

This detailed information on the surface interaction is perhaps most likely to be of interest where small changes in the tyre behaviour could yield a decisive advantage. Harrison, who worked as a strategist for several Formula 1 teams before joining rFpro, points out that a smaller team could potentially jump five or 10 grid places during qualifying by tapping into the category's elusive tyre window. Categories where development is off-limits for significant parts of the car, such as Formula E and NASCAR, could also drive this additional scrutiny in the tyre behaviour, he suggests.

> *"The joke was that voodoo was used to understand the famously dark art of tyre modelling"*

"If you're modelling your tyre physically, you can effectively turn individual effects ▶

Red Bull

RIGHT Using a more advanced tyre model during simulations provides a better understanding of the tyre behaviour and improves correlation with the real world on and off in the simulation," notes Harrison. "So you can model a super consistent qualifying lap where the tyre behaves the same way throughout the session, or you can model a 24-hour race where the temperature changes, the tyres wear and the track rubbers in."

Technical shake-ups could also drive additional scrutiny of the tyres. Formula 1, for instance, has finally pledged to make good on its long-rumoured plan to phase out tyre blankets, with a reduction in temperature next year, followed by an all-out ban in 2024. This means that understanding and optimising the tyre behaviour will take on a whole new degree of significance.

Another possibility is that high resolution surface data may help those looking to model loose surfaces. At present, driver in the loop simulation is not thought to be widely used for vehicle dynamics applications in rallying or off-road racing due to the challenges of simulating the interaction between the dirt and the tyre, but it's possible that could change in the future.

Secure access

Opening up access to this detailed surface information comes back to the challenge of IP security. To overcome that, rFpro has devised a secure plug-in for the Terrain Server that allows the tyre model to extract encrypted data direct from the surface model.

The concept has been around for a number of years but was first taken up by vehicle dynamics specialist Megaride, which provides its own proprietary tyre ▶

ABOVE The top 10 OEMs that were early adopters of rFpro technology have already launched road cars which started their development, not on a test track, but in a virtual environment such as this highly accurate model of the Applus IDIADA proving ground (top). rFpro's 'digital twins' are used extensively by Autonomous Vehicle developers (above)

BELOW A smaller team could potentially jump five or 10 grid places by tapping into the category's elusive tyre window

KIMBERLEY
MEDIA GROUP LTD

OUT NOW

Learn & Compete

Formula SAE®/Student book

Second edition

Written by respected judges

From aerodynamics to engines, and suspension to simulation, with project management, sponsorship and everything else you could possibly need in between, this is the most comprehensive book yet published on how to prepare your Formula Student/SAE car.
To order online scan here:

FORMULA STUDENT
Institution of MECHANICAL ENGINEERS
FORMULA SAE

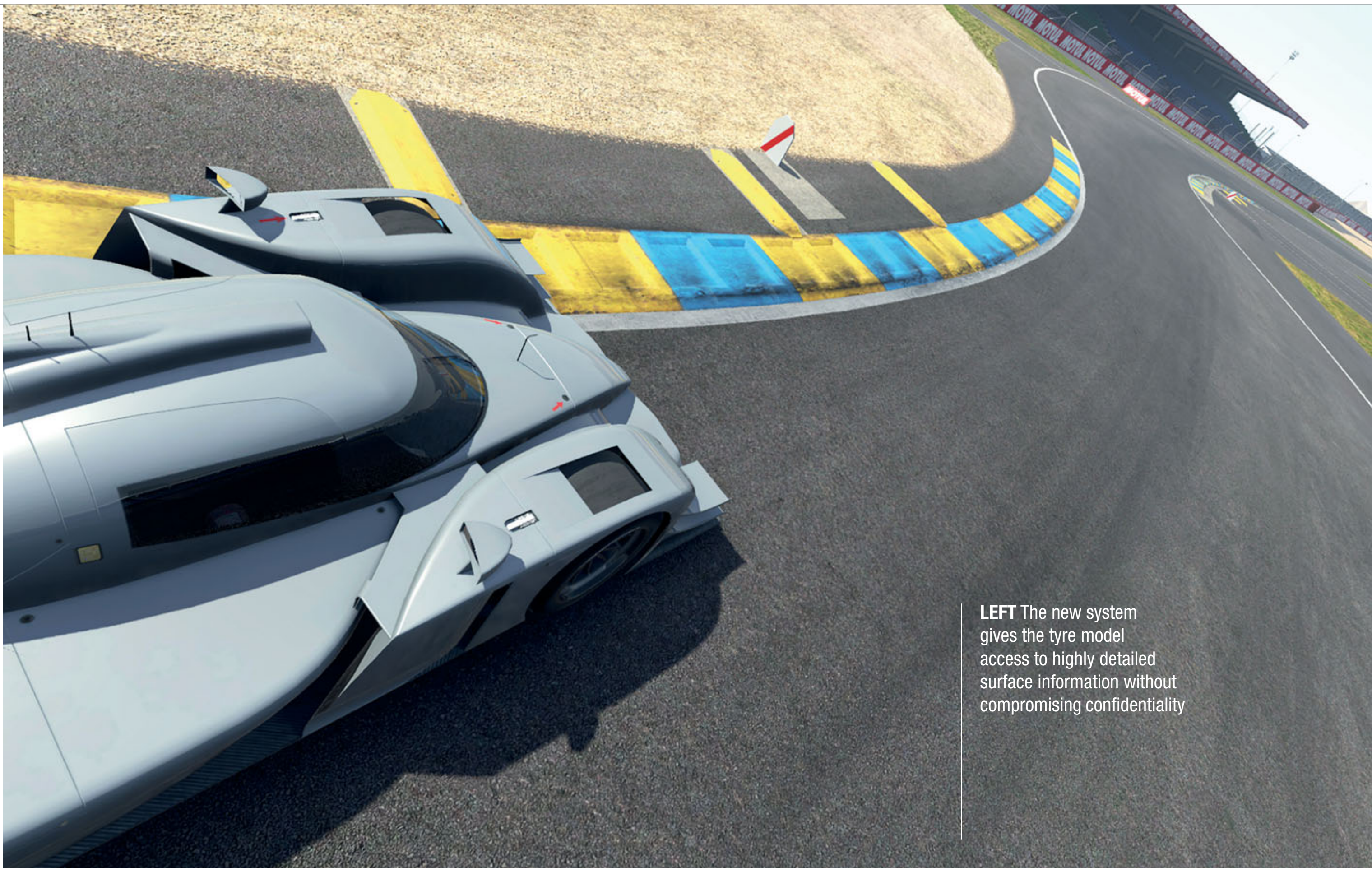
Published by Kimberley Media Group, producers of RACE TECH and Historic Racing & Technology magazines and organisers of the RACE TECH World Motorsport Symposium

kimberleymediagroup.com

RACE TECH WMS World Motorsport Symposium
worldmotorsportsymposium.com

RACE TECH Motorsport Engineering
racetechmag.com

HISTORIC RACING & Technology
historicracingtechnology.com



LEFT The new system gives the tyre model access to highly detailed surface information without compromising confidentiality

models to a number of well-known motorsport teams. rFpro is already in conversations with other tyre modelling companies to expand the number of built-in integrations, and individual teams are expressing an interest as well.

"It's a very private thing," comments Harrison. "We're not privy to exactly how the tyre modelling teams use that information, but we know it's useful to them, so we've provided a secure development environment. With that, they can develop and validate the model, which can then be statically integrated into our software."

A tyre model, such as Megaride, can now be given access to specific information about each of the points that are laid out on a 1cm x 1cm grid across the contact patch. This high-fidelity data can be used to calculate accurate values for the overall behaviour of the tyre rubber in contact with the relevant area, producing a representative height, mu and normal vector.

Due to the way the system works, it's impossible to reverse calculate the raw surface data from these values, which means they can be shared with the rest of the tyre model and therefore the

> *"Several thousand setup iterations are generally evaluated before a human driver is brought in to gauge whether or not they will work in the real world"*

vehicle dynamics model. Only the tyre contact patch model has raw access to the (otherwise encrypted) high-definition surface data.

It makes no difference to the Terrain Server whether it's being run with a driver in the loop or as part of an offline simulation. In fact, most of the number-crunching is handled offline, with several thousand setup iterations generally evaluated before a human driver is brought in to gauge whether or not they will work in the real world. These can include sweeps of downforce settings, tyre pressures, weight distributions and countless other parameters.

"Back when I was working in race teams, every offline simulation would be quicker if it was set up in a way that made the car very unstable," notes Harrison. "We'd generally take a pre-recorded racing line as the base input and then ask the computer to follow that line, sticking as close to the car's maximum lateral and longitudinal G as it could manage. The computer can react a lot quicker than a real driver, so you then needed to check that your best theoretical setup was actually drivable for a human being. To do that, you need to ensure there's a strict correlation between the offline simulations and the driver in the loop runs."

At present, most motorsport users are content with rFpro's default contact patch calculations. Interest from road car development is certainly growing. As processing power increases and the models themselves become more sophisticated, Harrison and his colleagues believe it will become a more mainstream approach. After all, it's those four little bits of rubber that ultimately dictate how fast and how long the car will go around a track. RT

JUST ANOTHER DAY IN THE OFFICE *for a robot!*

Chris Pickering discovers how NASCAR's Next Gen racecar was taken into unknown territory with a robot-controlled crash test

LAST year, an engineering team from NASCAR did the unthinkable. They took a new Next Gen car to Talladega Superspeedway, accelerated up through the gears along the pit road and then deliberately drove it into the barriers on the outside of Turn One at 130 mph.

Needless to say, the only occupant was a crash test dummy, but rather than winching the car passively into the barriers – or sticking a brick on the accelerator and hoping for the best – the experiment was conducted using a robotic driving system.

Developed by British firm AB Dynamics, the robots are typically used for repetitive tasks as part of durability testing and ADAS development. They've been a common sight in the road car industry for several decades, but this test is believed to be the first of its kind in motorsport.

"It's the first time we've done anything like this with a competition car," comments Jeremy Ash, sales director at AB Dynamics. "We had a project with an OEM in Europe, six or seven years ago, which was broadly similar, but at a much lower speed. In that instance, they wanted to bounce the car off a barrier at an oblique angle to test an active safety system that was designed to prevent the car from being deflected into oncoming traffic after the collision, but that was at 12 or 15 mph, not 130 mph."

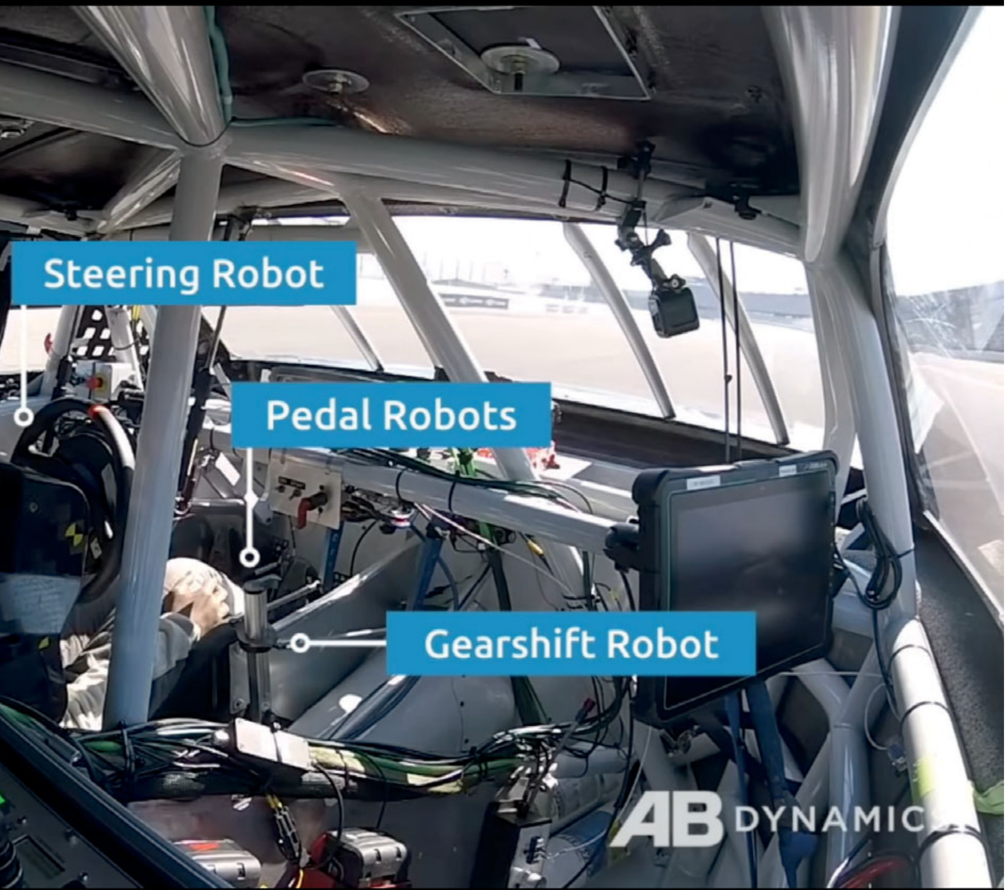
NASCAR approached the company via its North American office with a brief that the car would have to be driven into the barrier at a speed of 130 mph and an angle of 24 degrees. Where things got tricky were the tolerances for these parameters, which were set at ±1 mph and ±1 degree respectively.

High loads

"The purpose of the test was to validate simulation work that had already been done by NASCAR, so the physical crash had to match the simulation criteria as closely as possible," explains Joel Blyth, senior project engineer at AB Dynamics. "The techniques they'd used in the past weren't capable of replicating the test conditions so accurately, so they were

ABOVE Three off-the-shelf devices from AB Dynamics were harnessed to control the steering, pedals and gearshift

RIGHT The vehicle was positioned to within 2cm of theimpact point



searching for an alternative solution, which is when they contacted us."

A plan was hatched to use three off-the-shelf devices from AB Dynamics to control the steering, pedals and gearshift. Blyth and his colleagues were confident about meeting the tolerances laid down by NASCAR – which were generous in comparison to some of the OEM specifications that they deal with – but they were conscious that the installation itself represented a step into the unknown.

"There were some challenges that only really became apparent as we started

> *"Crashed at 130.015 mph, within two centimetres of the designated impact point and within one degree of the prescribed angle"*

looking at installing the robots inside the vehicle. We've not done a NASCAR before, and it's quite a challenging environment due to the noise, temperature and general complexity of the vehicle. It's the first time we've worked with a sequential gearbox like this too," notes Blyth.

The robots are designed to be fitted into just about any road vehicle, from two-seater sports cars, to trucks and buses. Generally, they're installed without any drillings or special brackets, but given the high loads involved in this test, the engineers elected to fabricate their own bracketry. In all other respects, however, the robots are said to have been standard items.

"The access into the NASCAR, with no doors, was harder than a normal production car, but otherwise it wasn't a particularly difficult installation," comments Blyth. "It's definitely something we could do again if it was something like a touring car or a GT car. A single-seater would be harder, but I think we could engineer something to work there too."

Climbing the banking

The company's standard claim is positional accuracy to within two centimetres (0.79 ▸

inches) but the change in gradient from the pit lane to the turn posed an additional challenge. Reaching 33 degrees at its peak, the Talladega banking is among the steepest in NASCAR (in wet weather, the Air Titan trucks used to dry the track have been known to slide down the hill).

In order to maintain the correct speed and angle, the robot would need to adjust both the throttle and the steering as the car climbed onto the banking. This was essentially a path following exercise, where the vehicle would track its location relative to a predetermined route. Any lateral error would be fed into a PID control loop and corrected with a steering input.

The heart of this system is a GPS-equipped inertial measurement unit (IMU), which is typically accurate to around one centimetre (0.39 inches) anywhere in the world, and samples 100 times a second. To map out the course, the AB Dynamics engineers defined

Reports of the dummies' death have been greatly exaggerated!

With social media in overdrive, NASCAR steps in to quash rumours

FOLLOWING the original crash test in June 2021, reports started to circulate that the crash test dummy had been 'killed' by the impact. This fuelled speculation that the structure of the Next Gen car was too stiff and was unable to adequately dissipate energy in a crash.

NASCAR responded to these rumours, with the organisation's senior vice president of competition, Scott Miller, stating at the time: "There's a lot of fiction out there. We see absolutely nothing in the data that's alarming, but we want to have a comprehensive report and I have no idea how all of the rumours started that it didn't go well, because it did go well."

An official memo sent to the drivers said that, "Preliminary review of the dummy data from the test indicates good and comparable performance when compared to other right frontal dummy data". It also mentioned that the team was "re-running the models [and] identifying additional cases".

The same robotic driving technique was employed when the revised car was tested in October 2021, ensuring a high level of repeatability between the two tests, as well as the computer simulations.

BELOW Austin Dillon's Chevrolet spins into the wall after an on-track incident during the NASCAR Cup Series Coca-Cola 600 at Charlotte Motor Speedway. Safety was of paramount importance throughout the gestation period of the Next Gen car

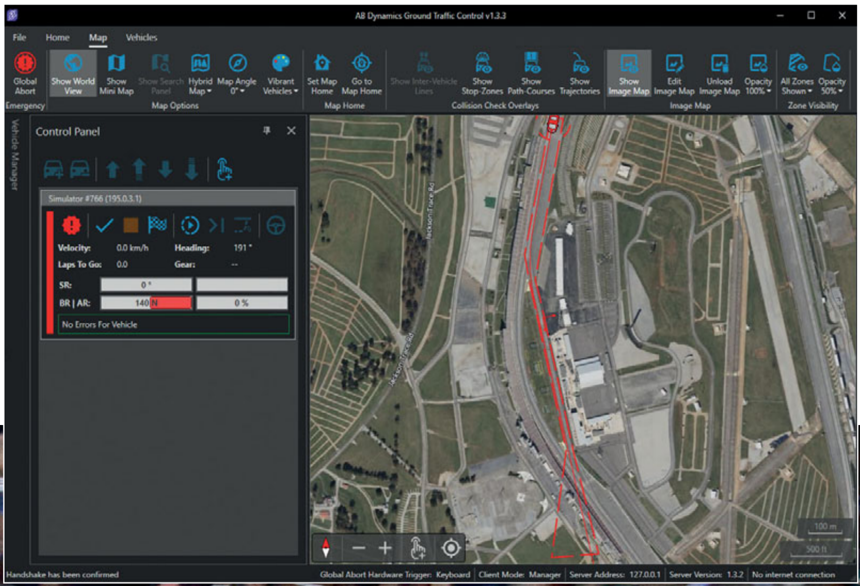
RIGHT A series of waypoints were mapped in X and Y coordinates, each with a time stamp to track when the vehicle should reach them. The solid line shows the planned path of the vehicle. The dashed lines represent the driverless boundary

Jared C. Tilton/Getty Images

a serious of waypoints, mapped in X and Y coordinates, each with a time stamp to track when the vehicle should reach them. This was then fed into the robot control software that translates these waypoints into a series of inputs for the various actuators.

Robots on the test bench

"Before we went ahead with this proposal, we developed the path in simulation in our location in the UK. That was played out with the robot to test out ▶



the logic and make sure that our gear robot was capable of sequentially making its way through the gears," notes Blyth. "One of the main challenges we faced was getting the vehicle to pull away at the start. But once it was moving, our PID controller was adaptable enough to pick the right gears, manage the clutch during the gearchanges and hold a steady state speed."

This process began with the robots running on the test bench and a vehicle dynamics package used to mimic the inputs for the GPS and the IMU. Once the AB Dynamics engineers had travelled to the test site and installed the robots into the car, the next step was to carry out a dry run with the vehicle up on jacks – again using the simulation to provide the feedback data.

Calibration

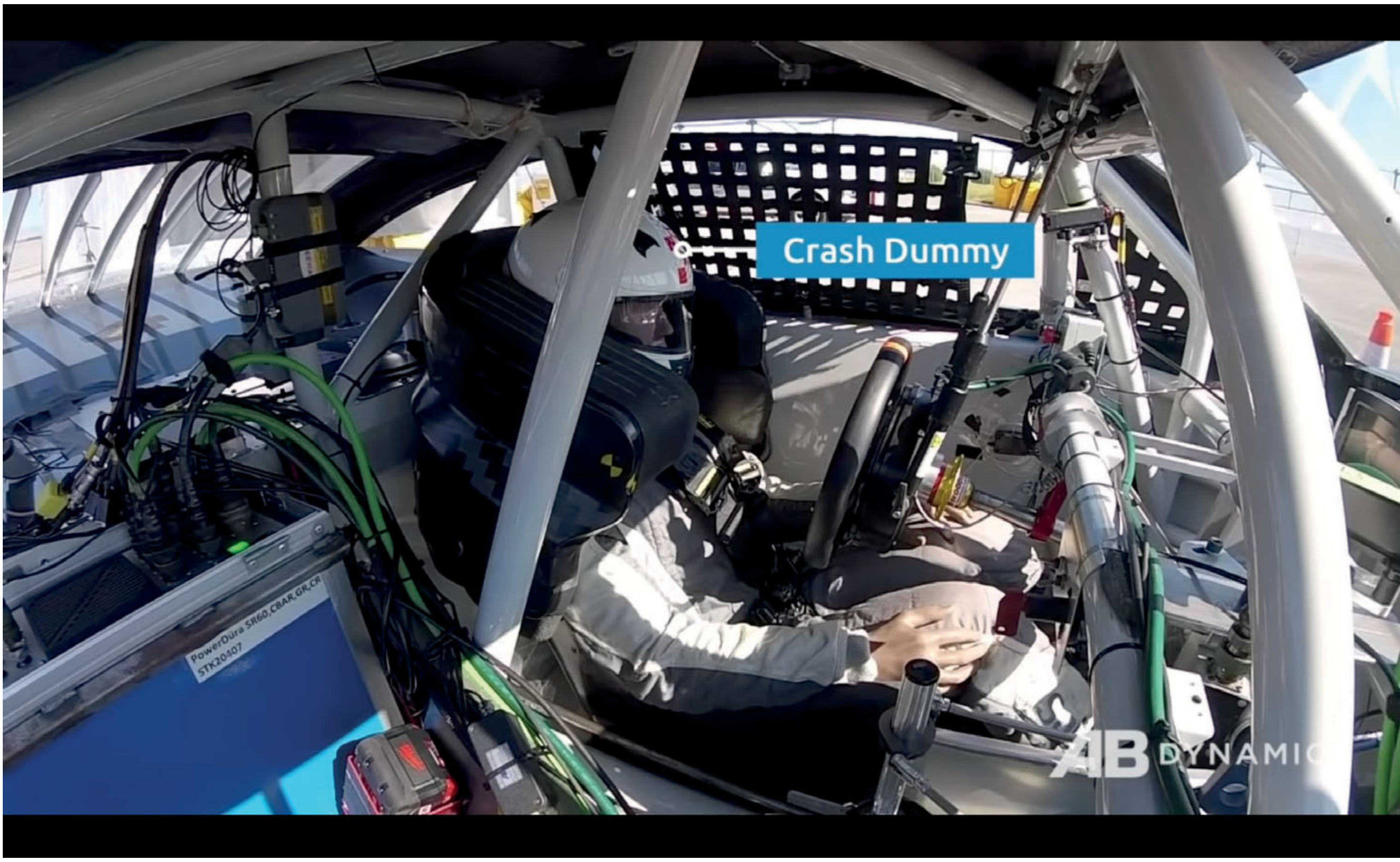
Before the real tests could begin, the robots needed to go through a calibration phase. This allows the software to learn precisely how factors such as steering angle and clutch actuation impact the control of the car. A series of manoeuvres were also carried out by a driver to further understand the behaviour of the vehicle. For tests where precision is less critical it's often possible to skip these steps and use generic values, Blyth explains, but in this instance it was important to be accurate right from the start.

The next stage was to put a human driver back into the car, but with the robot controlling the steering. This configuration was used to perform a series of runs in path following mode, starting at very low speeds, where the driver would control the ▶

> *"A GPS-equipped inertial measurement unit which samples 100 times a second"*

BELOW The race car hit the wall at precisely 130.015 mph

BOTTOM Fitted with a suite of sensors and a crash test dummy, the car was sent on its final voyage into the wall



speed of the car and bring it to a stop just before the wall. At that point, the position and heading of the vehicle was checked to make sure it matched the intended collision point.

After that, the robots were put into driverless mode. Initially, these runs focused on the pedal robot's ability to match the speed dictated for the test. Again, the planned test route was followed for the start of the run, but this time the robot would steer away from the wall rather than coming to a halt. The speeds were increased in increments of around 20 mph, including one run at the planned test speed of 130 mph.

Next came the big one. Fitted with a suite of sensors and a crash test dummy, the car was sent on its final voyage into the wall. In the end, the robots performed faultlessly, sending the car into the SAFER barrier at precisely 130.015 mph, within two centimetres of the designated impact point and within one degree of the prescribed angle.

"The intention was to show that this was a crash that a driver could walk away from, so we knew it wasn't likely to be too severe in the context of a human being with all the correct safety gear. But there are sensitive electronic components inside the robots that, frankly, weren't ever designed to be used in crash testing,"

RIGHT The Talladega banking, which reaches 33 degrees at its peak, is among the steepest that NASCAR races on. It posed additional challenges for the creation of the simulation

James Gilbert/Getty Images

> ***"The robots have shown that they can not only do what's required, but also survive the impact and be used again"***

comments Ash. "When we budgeted for the test, we assumed that there was a high probability that the electronics would be written off, but in fact we just needed to carry out a few small repairs. Once those had been done, the same robots could have gone again."

The project has highlighted the potential for robots to be used for specialist tests like this in the future, he says: "There are probably still better ways of doing conventional frontal impact tests and those impacts might be more severe. But when it comes to these unusual scenarios, the robots have shown that they can not only do what's required, but also survive the impact and be used again."

In fact, that's exactly what happened. The engineers at NASCAR are said to have been happy with the original test in June 2021, and its correlation to their simulations. However, a series of refinements were introduced to the design, which was retested in October of that year. Again, the robots proved their worth. The test footage is available on YouTube, and the sight of the barrier looming up at 130 mph is enough to make a human driver flinch. For these robots, however, it's just another day at the office. RT

LEFT The day job: AB Dynamics' driverless robots have also been employed to showcase the upcoming Emergency Steering Support (ESS) Euro NCAP protocol

THE SOUND OF SILENCE

The DTM's trials have highlighted the contentious issue of noise – or, rather, the lack of it – in electric racing. So what does **Sergio Rinland** think?

FOR racing fans, engine noise is music. Even V10 F1 engines, which were painful to the eardrums, were music for some. The best sound ever was perhaps the Matra V12: *pure* music!

For more than a hundred years, ICE, exhausts, noise (and pollution!) were part of the motorsport attraction. You might recall that the Formula 1 hybrid engines provoked a lot of criticism when they first hit the tracks because their engines were less noisy.

In France, there was a racing publication called '*Echappement*' (Exhaust in French), that perhaps epitomised the ICE/noise/fumes culture; tuners used to sell 'open' exhausts for 'boy racers'. Not anymore. The world is changing, and we are changing with it.

Early 20th century city dwellers welcomed the smoky, noisy cars of the day as a great substitute for the manure smell left by horses on the streets. A hundred years later, we welcome electric cars so we can stop breathing those fumes and give our ears a rest from noisy cars.

That was in the last century, when environmental pollution did not show up on our racing radars. Now we are in the 21st century, 22 years already into it, with a clear idea of the effect of global warming and environmental pollution – where electric mobility is part of the solution and electric motorsport as a logical derivative.

BELOW The Schaeffler DTM Electric demo car is equipped with special technology that causes the entire body to vibrate, producing the new sound of the DTM

Schaeffler/Daniel Karmann

Attraction or distraction?

Noise is also pollution, so another advantage of electric vehicles is that they are nearly silent. Which is a great thing, particularly in urban areas.

Some weeks ago, I tested a high-performance electric car and the dealer offered two options: double gazing, so you don't hear the external air noise; and, as a contradiction, you can have any 'engine noise' you want to accompany the performance mode. Which for me is like adding a dummy exhaust pipe at the back to look 'racy', artificial and ridiculous. Some people perhaps want to drive an electric car while hearing a V8 ICE; not me.

All this brings me to the announcement made by the DTM and one of its partners that they are evaluating the use of artificial noise for the forthcoming DTM Electric category. The prototype now features an enhanced electric motor noise so that fans can hear the cars as well as see them.

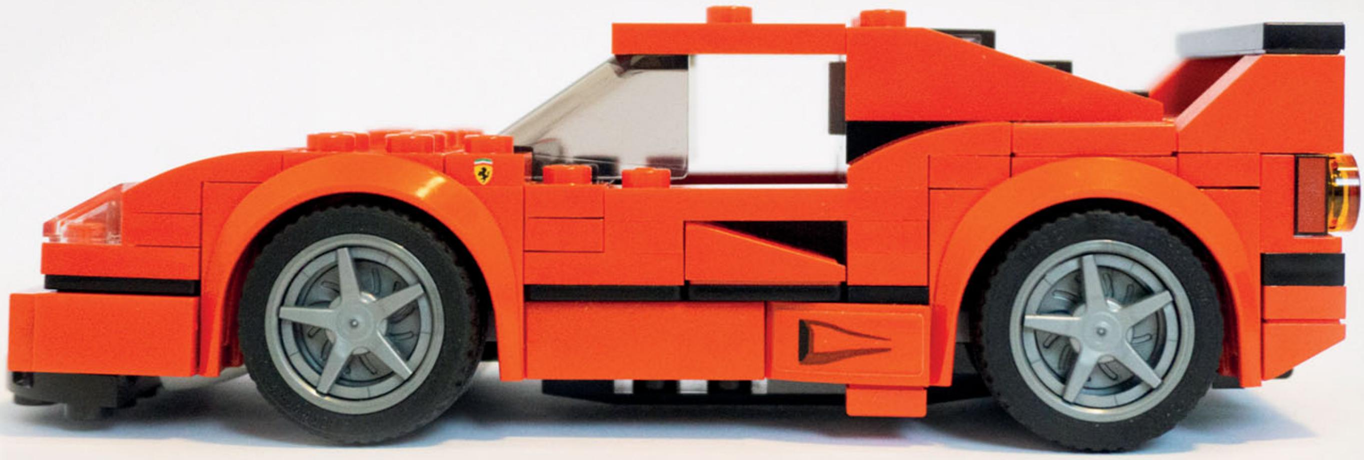
If that is what fans want, good, give them the noise, but I don't think young fans actually want that. One of the most popular e-sports these days is drone racing. Do they sound like old helicopters? No, and they have a huge following amongst young people.

> *"One of the most popular e-sports is drone racing. Do they sound like old helicopters?"*

If I were the DTM management, I would think twice before adding artificial noise to their electric racers. It is not genuine, and it is certainly not innovative, just an unnecessary gadget.

There are other noises cars make, which have been masked by the engine noise in the past: tyres, air, and why not the bangs when the drivers go bumper-to-bumper or door-to-door? Perhaps that is as much fun as ICE noise? RT

NATIONAL MOTORSPORT ACADEMY



Make Your Childhood Dreams a Reality.

The National Motorsport Academy's online motorsport engineering degrees allow you to study flexibly from anywhere in the world, making them the degree of choice for top-flight engineers in F1, WEC and WRC. All courses have been designed by motorsport engineers for motorsport engineers so you can be sure that your qualification is industry relevant and up to date.

The world of motorsport is fast-paced which is why we make our courses as flexible as possible. Choose your own start date and fit your studies in around your work and family life.

Don't put your career on hold! Accelerate your chances of promotion, bring your skills up to scratch or retrain with the National Motorsport Academy's online motorsport engineering qualifications.

BSc (Hons)

Motorsport Engineering

Get your motorsport career on track with the world's first online degree designed for motorsport engineers.

Final Year Top-Up

Motorsport Engineering Final Year Top-Up

Take your existing skills and qualifications and make them motorsport ready with our 1 year Top-Up Degree.

MSc

Advanced Motorsport Engineering

Become a Master of Motorsport Engineering with the world's only online, motorsport specific Postgraduate degree.

All degrees awarded by our academic partner De Montfort University.
Make your Childhood Dreams a Reality.

motorsport.nda.ac.uk
+44 (0)1159 123456