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COVER STORY PAGE 6

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NECESSITY: THE MOTHER OF INVENTION

THE world has changed since RACE TECH's last World Motorsport Symposium. So has our industry and some of the challenges we face.

That's why the WMS – sometimes dubbed 'The Davos of Motorsport' – will return this December (on Thursday Dec 1 and Friday Dec 2). We hope you will join us.

From SAGE to CPAP, PPE to Omicron, our everyday language was transformed during the pandemic. Our skill sets evolved too.

In our News section, you can read how Pat Symonds, F1's Chief Technical Officer (and a co-chairman for our upcoming Symposium), believes that Formula 1 emerged leaner and fitter from these troubled times. The wider industry too, has learned to be more agile and resourceful than ever before: while office workers were adapting to remote working from their bedrooms, laptop perched precariously on their knees, motorsport companies were discovering tricks like how to deploy a wind tunnel upgrade on a different continent without even being present. Try doing *that* with your children screaming in your ear, or your Lockdown puppy gnawing at the electrical cables!

Necessity was the mother of invention in our hour of need. First, when the motorsport industry stepped up to the plate with the design of ventilators, CPAP machines and the production of protective equipment. Next, when it worked out how to get on with its own business once more, while still in the path of a pandemic.

Part of that business was a complete departure from all that had gone before in Formula 1, mandating a new breed of cars that would be able to race wheel-to-wheel. Early days, I know, but doesn't it look like those years of painstaking design and simulation have been worthwhile?

Fresh challenges lie ahead for the industry, however. Not just the issue of the technology our race championships will harness, but the technology that the fans of the future will use to experience them with.

But if there was one lesson to be learned from the pandemic, it was perhaps that the qualities we have in motorsport can be used to benefit other sectors. Not just for our own selfish gain, but because – be it improving the technology our health system uses, or helping mitigate the climate crisis – we can make a difference. RT

Mark Skewis
CONSULTANT EDITOR

Muscle on the Mulsanne

Mark Skewis says NASCAR's return to Le Mans will act as a trailblazer for its introduction of hybrid technology

NASCAR will make an emotional return to the Le Mans 24 Hours in a move that triggers something once unthinkable: the introduction of hybrid technology to top-flight stock car racing.

Two of the US series' cars last crossed the Atlantic to participate in the endurance classic back in 1976. Now, a joint venture between NASCAR and Hendrick Motorsports will bring a modified Next Gen stock car, featuring the first iteration of a new spec hybrid system, to the 24 Hours of Le Mans for the race's centennial celebration in 2023.

The project, which also includes collaborative efforts from IMSA, Chevrolet and Goodyear, will fill the Garage 56 slot – an extra starting berth that showcases innovative vehicles outside of the race's traditional classes.

"From the early days of NASCAR, it was important to my father that we played a visible role in international motorsports, and there is no bigger stage than the 24 Hours of Le Mans," said Jim France, NASCAR Chairman and CEO. "In partnering with Hendrick Motorsports, Chevrolet and Goodyear, we have the winningest team, manufacturer and tyre in NASCAR history. We look forward to showcasing the technology in the Next

Photo: GM

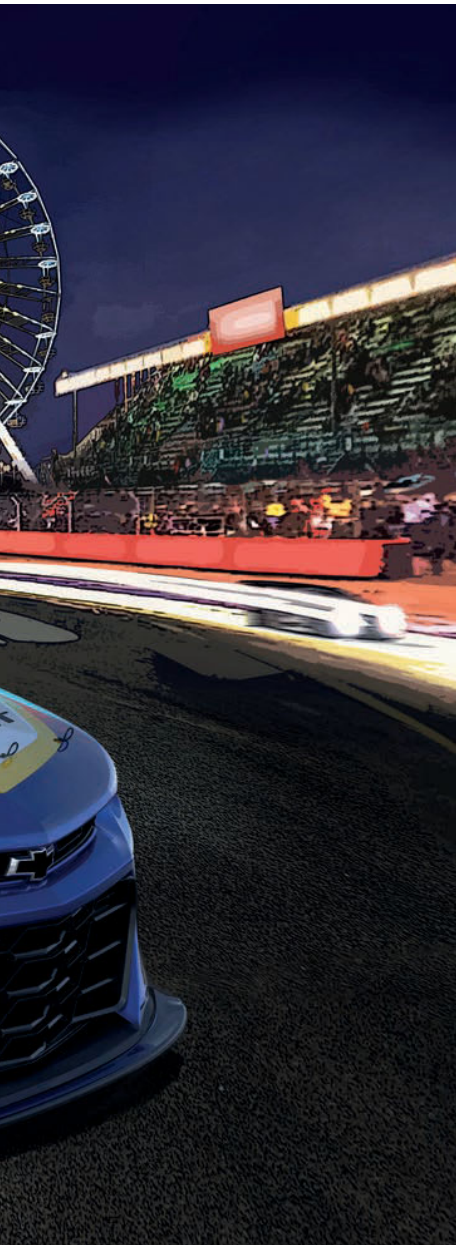
Gen car and putting forward a competitive entry in the historic race."

Although NASCAR remained tight-lipped on the technical details of the project, Pierre Fillon, Président of the Le Mans-organising Automobile Club de l'Ouest, revealed that he expected the car to run in hybrid configuration in order for it to be accepted into the Garage 56 category.

"Garage 56 is a car dedicated to innovation," he said. "This is the only car, there are no points, it is not in the championship. We need something innovative.

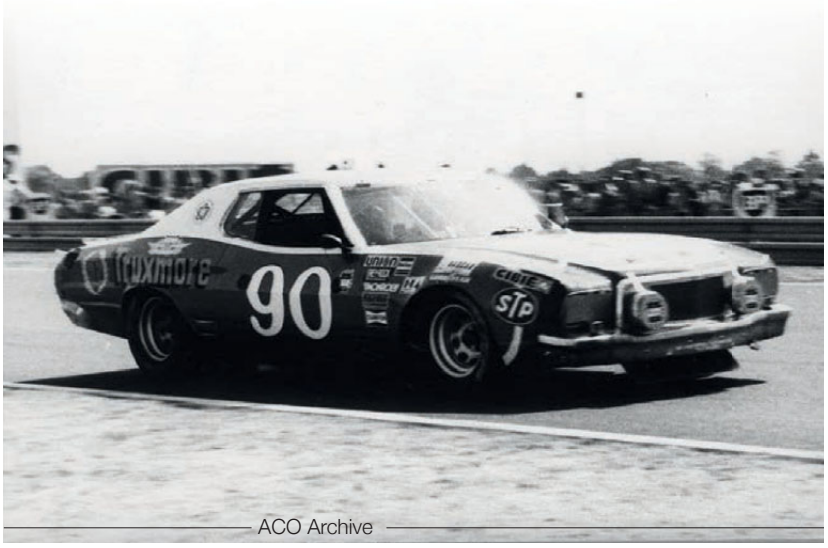
"When Jim [France] told me there will be a new generation of cars in NASCAR, using a hybrid system, he had this crazy idea to enter this car as a Garage 56 in 2023, I was immediately enthusiastic.

"I think this new generation of NASCAR with the hybrid system is innovative. This is the future of NASCAR." ▶



ABOVE RIGHT Both the NASCAR Ford Torino (seen here) and Dodge Charger retired in 1976

LEFT The "crazy idea" to take the Next Gen Camaro to Le Mans offers the perfect chance to experiment with hybrid tech



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Coming to Le Mans...

The 24 Hours poses a tough challenge but the Next Gen car boasts a stellar list of suppliers

Aero Tec Laboratories, Inc.	Fuel cell bladder
AP Racing Limited	Brake systems
Bald Spot Sports	Energy management solutions (bumper and door foam)
BBS of America, Inc.	Wheels
Dallara	Radiator ducts
Fibreworks Composites, LLC	Deck lid, hood, rockerbox, cooling ducts, underwing
Five Star Race Car Bodies	Doors, fenders, front/rear bumper covers, fuel adapter, quarter panels, rear door crush panel, rear wheel tubs, windows
Goodyear	Tyres
Hyperco	Springs
Kirkey Racing Fabrication	Bumpers
Lentus Composites Limited	Propshaft
McLaren	Digital dash, ECU
Öhlins USA, Inc.	Dampers
Pro-Fabrication, Inc.	Tailpipes
PWR North America	Oil cooler, radiator
RCR Manufacturing Solutions, LLC	Wheel nut
Roush Advanced Composites	Greenhouse, brake ducts (upright / rotor), front door crush panels, front wheel exhaust cover, package tray, roof hatch, roof flaps, spoiler base
Roush Yates Manufacturing Solutions	Anti-roll bars, shifter, transaxle mounts, uprights / wheel hubs
Schultz Engineered Products	Fuel adaptor / coupler
Sunoco	Fuel
Technique Chassis, LLC	Chassis: front/centre/rear, body mounts
Thermal Control Products	Fixed window net/ driver window net/assemblies
Tilton Engineering, Inc	Bellhousing
Visser Precision, LLC	Control arms (front/rear)
Woodward Machine Corporation	Steering rack, steering shaft
Xtrac Inc.	Clutch shaft, driveshafts, transaxle

Garage 56 highs and lows

LE MANS' Garage 56 entry was created in 2012 to provide a featured spot for inventive cars with cutting-edge technology – all outside of the race's normal classifications and its 55-car field limit.

The DeltaWing that made history as the category's first entrant differed from other prototypes in several ways. It weighed only 500 kg and its pointed nose gave it the futuristic air of a space shuttle. It fared well in the race until an accident put it out of action.

In 2014, Nissan's assault ended early with gearbox failure, but its revolutionary ZEOD RC electric prototype – which featured both internal combustion and electric power sources – still left Le Mans having reached its historic goals. The car had hit 300 km/h on the Mulsanne Straight during qualifying and in race morning warm-up it recorded a complete lap of the legendary 13.6-kilometre circuit on electric power only.

The only Box 56 entries to finish the race have centred on overcoming disability. In 2016 the Frédéric Sausset-led SRT41 programme was based around an Onroak-Morgan LMP2 car adapted to cater for quadruple amputee Fred with a system that could be installed in just 10 minutes.

The programme returned in 2021 for the first time in five years, the SRT41 team fielding a specially-adapted ORECA 07 car with hand controls for two drivers paralyzed from the waist down.

Other prospective entries, notably concepts that were to run on alternative fuels, haven't always come good. The 2017 slot was to have gone to the WR (Welter Racing) prototype, conceived to run on bio-methane, but the project ran out of finance.

Back in 2013 the Green GT H2, which featured a hydrogen-powered fuel cell, also had to be withdrawn. However, the Swiss powertrain specialist's efforts did eventually come good, providing the inspiration for the Mission H24 hydrogen class due to debut in 2025. RT

LEFT The DeltaWing (above) was the first Garage 56 entry, inspiring Nissan's ZEOD (below) which completed the first electric lap of Le Mans

A NASCAR built to be hybrid

While Fillon's assertion that the car should be hybrid might come as a surprise to some, the design of the Next Gen car was future-proofed from the outset to include the technology.

The likelihood is that all teams will eventually run a spec unit in the Cup series, probably in 2024, but as yet neither the type of unit nor supplier are finalised. However, the 2023 Le Mans project is seen as the perfect opportunity to experiment with technology that could be necessary if the Next Gen is to run at similar lap times as the rest of the Le Mans GTE field.

Furthermore, NASCAR's ownership of IMSA, the US sanctioning body for sportscar racing, gives it perfect exposure to the technical work carried out to implement a spec hybrid system in the forthcoming LMDh category. Bosch, Williams Advanced Engineering and Xtrac have already been working for some time on the new IMSA hybrid unit.

Provision for a hybrid system was one of the most significant factors in the design of Xtrac's P1334A Next Gen transmission.

NASCAR envisaged a P2 configuration, with the motor generator unit driving onto the gearbox after the input drop gears. This would allow the teams to change the drop gears without disturbing the MGU or electrical connections, while still giving a torque multiplication through the gearbox.

The structural design of the gearbox involved the evaluation of a range of hypothetical options, including up to 200 kW regeneration, push-to-pass style deployment and electric-only running in the pit lane.

The front and read bolt-on sections that characterise the design of the Next Gen car also ease the transition to hybrid technology.

"With this module of the car – with the centre section and then the bolt-on front clip and bolt-on rear clip – you have a lot of architectural flexibility there," explained Ford Performance's global director, Mark Rushbrook. "The first step with hybrid will be relatively easy in the sense that the combustion engine stays the same, the driveline stays the same; well, the transaxle in the rear, you can put on an electric motor to drive back there and a modest battery – and boom, you've got a hybrid. … For a full electric, there will be more changes

Photo: GM

ABOVE A specially-prepared Chevrolet Camaro ZL1 will fill the Garage 56 slot in the centennial 24-hour race

required, but with the bolt-on front clip and rear clip, you can then have a unique front clip for an electric motor version."

Return to Le Mans

It's not the first NASCAR foray to the 24 Hours of Le Mans. In 1976, NASCAR founder Bill France Sr and event organisers agreed to create a new Grand International class – a play on the "Grand National" name of the Cup Series at the time. That move opened the door for two stock-car entries: a Dodge Charger owned and driven by NASCAR Hall of Fame nominee Hershel McGriff with his son, Doug, as a co-driver; and a Junie Donlavey-prepared Ford Torino for drivers Richard Brooks, Dick Hutcherson and Marcel Mignon. The French media dubbed the stockers "the two big monsters," noting how they stood out among the smaller prototypes and sports cars.

"It's been almost 50 years since my father took NASCAR over to Le Mans," said Jim France. "I remember when Dick Brooks came back, he was one of the drivers. I asked him what his thoughts were on it. He said, Number one, the fans love the car. Number two, it was a fantastic experience. Number three, it was a hell of a challenge."

With the Next Gen platform moving much closer to current GT car design, albeit in heavier form (a GTE car is 1,245 kg, a stock car around 1,450 kg), developing a car for the challenges of la Sarthe is now feasible.

Chad Knaus, Hendrick Motorsports' vice president of competition, will oversee the project.

Knaus won seven Cup Series championships as a crew chief for Jimmie Johnson's efforts in the Cup Series before making the transition to Hendrick Motorsports' front office for competition. In an interview last year with NBC Sports, Knaus indicated he hoped to one day race at Le Mans, furthering the work he's done with the Action Express Racing team and Johnson's partial driving schedule in the IMSA WeatherTech SportsCar Championship.

Team owner Rick Hendrick also has a history of involvement in sportscar racing, fielding the factory Chevrolet Corvette GTP in IMSA's top class from 1985-88.

"Participating in one of the truly iconic events in auto racing and representing NASCAR and Chevrolet on the world stage is a privilege," said Hendrick, owner of Hendrick Motorsports. "Jim deserves tremendous credit for having the vision for the project, and we thank him for trusting our organization with the responsibility. Even though Garage 56 is a 'class of one', we are competitors and have every intention of putting a bold product on the racetrack for the fans at Le Mans. It's a humbling opportunity – one that will present an exciting challenge over the next 15 months – but our team is ready."

Just as NASCAR is no stranger to Le Mans, the Camaro brand has also previously encountered la Sarthe. A Camaro entered by Stratagraph Incorporated, a Louisiana oil services company owned by NASCAR driver Billy Hagan, retired from the GTO class in 1981. With Cale Yarborough at the wheel, it crashed after just 52 minutes.

"Next year I'm comin' back here with two cars and I'll blow their damn doors off," a frustrated Hagan told *Sports Illustrated* hours after the crash.

A year later, the team returned with two cars. One, with a radical nose and huge rear wing dubbed 'the snowplough', again retired. The other kept running to finish second in its class and 17th overall. Despite losing over two hours to electrical and gearbox problems, it was just four laps behind the class-winning Porsche 924 Carrera GTR. RT

World Motorsport Symposium returns

THE World Motorsport Symposium will return this year, following a two-year hiatus caused by the global COVID pandemic.

Dubbed 'The Davos of Motorsport', the WMS has carved itself a unique position as the annual international cabinet meeting that leads the conversation in motorsport and automotive technology.

The event is scheduled to take place on Thursday December 1 and Friday December 2.

It has also been confirmed that Formula 1 Chief Technical Officer Pat Symonds will join former Audi engine guru Ulrich Baretzky as co-chairman.

The pandemic might have halted the WMS for the past two years, but Symonds believes the motorsport industry can emerge stronger from these troubled times as it considers both the technology and the audience of the future.

"They say you should never waste a crisis," he points out. "As a sport we gained a lot of knowledge from our response to the lack of ventilators and PPE. We learned a lot about specific materials, but also, in a broader sense, we have had to deploy adaptability and agility more than ever before.

"Formula One has emerged leaner, fitter and more sustainable. I think the industry as a whole has learned an incredible amount too, in terms of the way we work and the qualities we have that can benefit the wider world.

"As the world strives to achieve a net zero carbon footprint, we know that yet more tests await us. The Symposium offers a wonderful opportunity to share our experiences, and our qualities, as we look to respond to those challenges."

Former Ferrari aerodynamicist John Iley, who has been a co-chairman since the event's inception in 2005, is taking a step back this year.

"Without John's expertise, passion and tireless endeavour, there wouldn't even be a symposium," commented Kimberley Media Group Publishing Director Soheila Kimberley. "I can't even begin to thank him enough. He will always be part of the RACE TECH family and we are hopeful that, even though he has taken a step back, we can persuade him to join us in December and be part of the discussions."

The event will retain its popular 'Chatham House' rules format, which enables debate without fear of being quoted in public.

The venue will be announced in due course, as will specific themes and speakers.

ABOVE F1 Chief Technical Officer Pat Symonds, here addressing the last WMS, is to become co-chairman for this year's event

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World Motorsport Symposium

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Thursday 1st and Friday 2nd December 2022

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

KIMBERLEY MEDIA GROUP LTD

Formula E investigates life beyond revolutionary Gen3

THE ABB FIA Formula E World Championship's Gen3 all-electric race car will be unveiled in Monaco later this month – but the quest for its successor is already underway.

The Gen3 car, set to race from Season 9, will be presented to manufacturers, teams, drivers, partners and other VIP guests ahead of the Monaco E-Prix. While the world will see the Gen3 race car for the first time, Formula E has its sights set further into the future of all-electric single-seater motorsport. In Monaco, Formula E and the FIA will host a roundtable event bringing together leaders from manufacturers across the automotive sector. This summit will focus on the potential innovations and technology roadmaps for the Gen4 era as Formula E affirms its position as the pinnacle of electric mobility development and racing.

"The arrival of the Gen3 is the latest momentous step of an incredible journey for the championship," said Alejandro Agag, Formula E Founder and Chairman. "We have come a long way – as electric vehicles have – in less than a decade. And we are not stopping as we bring together industry leaders to imagine the possibilities of the future of all-electric single-seater motorsport."

The Gen3 car is evidence of the relentless progress in EV development achieved in the championship. Formula E has worked closely with the FIA and industry-leading engineers and experts in sustainability to ensure the Gen3 will also set the benchmark for sustainability in high performance race cars.

The car is the first Formula car aligned to Life Cycle Thinking, with a designed second life for tyres, broken parts and battery cells. Additionally, the Gen3 will be net-zero carbon – reinforcing Formula E's status as the first sports series to be net-zero carbon from inception.

The Gen3 will be the first Formula car with both front and rear powertrains: a new front powertrain adds 250 kW to the 350 kW at the rear, more than doubling the regenerative capability of the current Gen2 to a total of 600 kW.

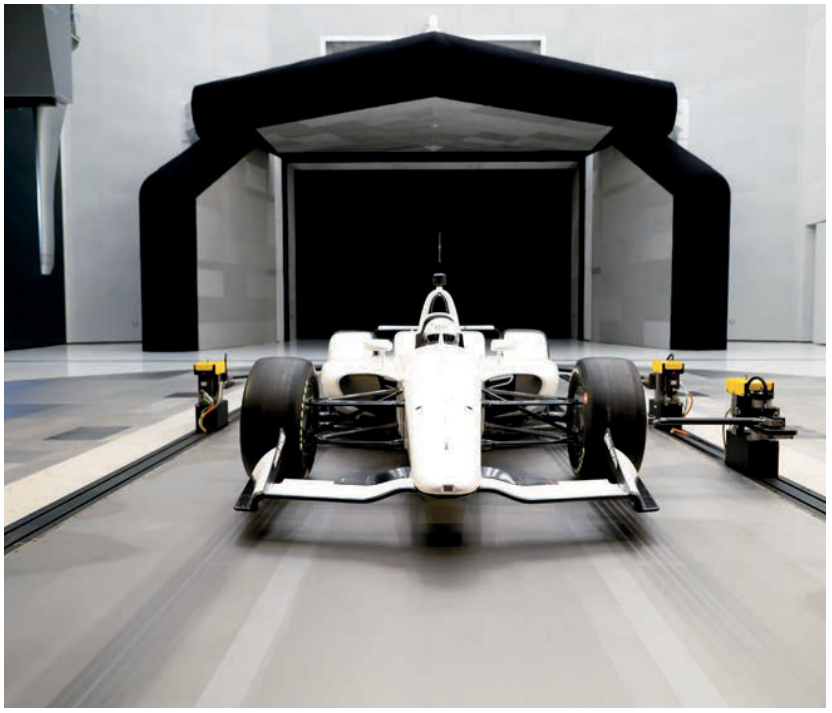
ABOVE & BELOW The Gen3 (above) will more than double the regenerative capability of the current Gen2 cars (below)

Lighter and smaller than the Gen2 to enable faster, more agile wheel-to-wheel racing, it is billed as the first Formula car that will not feature rear hydraulic brakes due to the addition of the front powertrain and its regenerative capability. At least 40% of the energy used within a race will be produced by regenerative braking.

"Formula E's Gen3 race car represents a leap forward for motorsport and electric mobility," said Jamie Reigle, Formula E CEO. "Designed to demonstrate that high performance, efficiency and sustainability can be packaged together without compromise, the Gen3 car is our most powerful, lightest, and fastest race car to date."

Seven of the world's leading automotive manufacturers have currently registered to race the Gen3: DS Automobiles, Jaguar, Mahindra Racing, Maserati, NIO 333, Nissan and Porsche.

Honda opens new $124 million wind tunnel



HONDA has opened a new $124 million state-of-the-art wind tunnel facility, ushering in a new era of development testing capabilities for Honda and Acura racecars, as well as the company's road products.

The new Honda Automotive Laboratories of Ohio (HALO) facility, located at the independent Transportation Research Center Inc (TRC) in Central Ohio, is said to be the world's most advanced wind tunnel, with three separate state-of-the art testing functions – aerodynamics, aeroacoustics, and racing – in one location.

The wind tunnel uses a unique interchangeable modular ground plane system capable of aerodynamic vehicle testing of production vehicles and race machines.

With a five-belt rolling road system designed for production vehicle development and a second single wide-belt system for testing both high-performance sports cars and purpose-built race vehicles, the tunnel can generate wind speeds of more than 190 miles per hour.

The wind tunnel can also quickly enable a sophisticated acoustic test system for an aeroacoustic testing mode that utilises a powerful system of acoustic arrays, made up of microphones and cameras, able to collect real-time data and precision measurement. This becomes even more important as an element of vehicle design as Honda moves toward its electrified future.

Without engine and exhaust sounds, wind noise will be more noticeable inside the cabin of an electric vehicle. Using the acoustic test system, Honda engineers will be able to identify the precise locations of both interior and exterior noise issues more quickly than ever before.

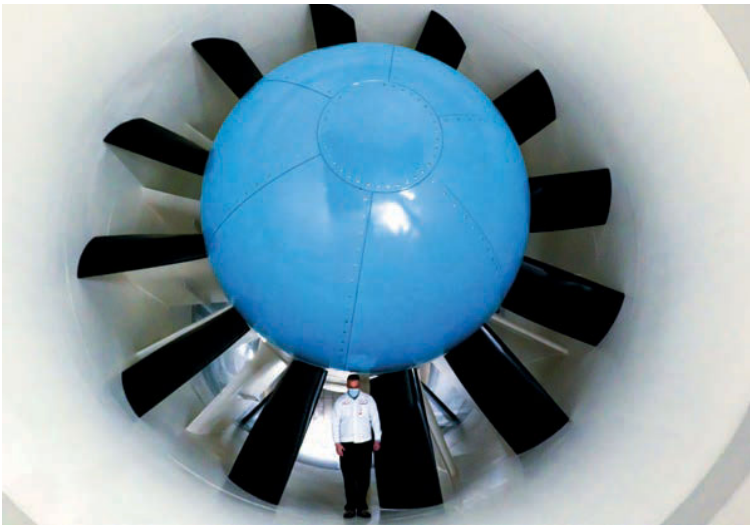
"Honda's product development capabilities will advance to new heights thanks to this investment in our Ohio research operations," said Jim Keller, executive vice president of Honda Development & Manufacturing of America, LLC (HDMA), and leader of the company's North American Auto Development Center. "With this new facility, Honda is not simply investing in an advanced technology facility but in the future of the Honda engineers and other researchers who will work here."

The new wind tunnel, coupled with the company's advanced safety research center, provides Honda's R&D engineers with two world-class facilities in Ohio; both supporting the design and development of products built in America using domestic and globally sourced parts.

Additionally, the wind tunnel's aerodynamic test capabilities will help increase the range and performance of the company's future full-electric vehicles, supporting Honda's efforts to continually advance its current position as America's most fuel efficient and lowest CO2 full-line automaker.

The HALO wind tunnel is Honda's latest major investment in Ohio, where the company has been advancing its ability to develop and build products for over 40 years – now totalling $14 billion. RT

ABOVE & BELOW
The wind tunnel will play a key role as Honda prepares for an electrified future, in motor racing as well as in its mainstream automotive products



New IndyCar engine passes first test

THE new 2.4-litre, twin-turbocharged V6 engine that will debut in the NTT IndyCar Series in 2024 underwent its first test at the end of March on the Formula 1 layout of the Indianapolis Motor Speedway road course.

Engineers from Chevrolet Performance and Honda Performance Development worked with the new powerplant in chilly conditions.

Team Penske drivers Josef Newgarden and Will Power shared testing duties for Chevrolet. Scott Dixon of Chip Ganassi Racing tested for Honda.

The engine was not tested in its final configuration. Development, testing and work to incorporate the hybrid component will continue throughout the year. The introduction of the hybrid energy recovery system was delayed due to global supply chain issues.

Chevy reported more than 600 miles of testing over the three days. "We had a very successful and productive three days with the new Chevrolet 2.4-litre engine," said Rob Buckner, Chevrolet engineering programme manager for IndyCar. "This was a big milestone as we have progressed from initial concept of the 2.4L design a few years ago and running extensively on the dyno to installing the engine into a car and now the landmark event of turning our first laps at the Indianapolis road course.

LEFT The next-generation IndyCar ICE's first track test

"We are incredibly appreciative of all the men and women at Chevrolet Performance and our partners at Ilmor for their commitment to a highly successful on-track debut for the 2.4L engine platform. We could race this engine tomorrow, which is the highest praise possible for a new engine. Special thanks to Team Penske for quickly building a reliable and safe test car along with Josef Newgarden and Will Power for looking after our prototype engine with first-rate feedback."

David Salters, HPD president and technical director, said: "A big shout out to the inspiring Honda men and women at HPD back in California, where the Honda IndyCar engine is designed, simulated, manufactured, assembled and dyno-tested. The engine ran well throughout the three days, and we completed all planned test items, thanks to Chip Ganassi Racing and Scott Dixon.

"The car ran flawlessly with great collaboration and feedback, and we learned a lot. It's great to get our new powerplant on track.

"It's great to see all this hard work roaring round the legendary Indy track, very special and certainly emotional for all of us."

The new engine will give 800 horsepower as a baseline. The addition of the hybrid system will give an additional boost of 100 horsepower. RT

BTCC ramps up hybrid preparations

ABOVE The BTCC is the first major touring car series to adopt hybrid power

THE 2022 Kwik Fit British Touring Car Championship's official pre-season programme got underway at the end of March, as Donington Park hosted the first of three Hybrid Installation Tests ahead of its season-opener on 23/24 April.

The test marked the first official outing of the TOCA Hybrid system in 2022, which sees Britain's premier motorsport series become the first major touring car championship in the world to integrate hybrid power.

All teams were in attendance, with the majority running the hybrid system during the day, while some were still in the process of completing the installation across all of their cars.

"We're all still a bit green on the hybrid side of things and when's the best moment to use it," admitted West Surrey Racing's Colin Turkington, whose BMW topped the timesheets. "It's still a lot of experimenting and we tried a lot of different solutions.

"It was my first experience of hybrid and you definitely feel a difference in terms of power once you deploy. We still have to focus on the handling and the chassis, though, that's still number one." RT

LMDh/GTP ERS tested

IT has emerged that the spec energy recovery system that will be used in the new LMDh/GTP sports car category has successfully undergone its initial track testing.

The category, which will be eligible for both IMSA competition and the World Endurance Championship, was due to officially race for the first time at the 2023 Rolex 24 at Daytona. However, extra urgency was injected into the process when the FIA World Motor Sport Council revealed that cars will be eligible to race in the Hypercar class of this year's FIA World Endurance Championship on a race-by-race basis, without scoring points, "to ensure the seamless introduction" of the category.

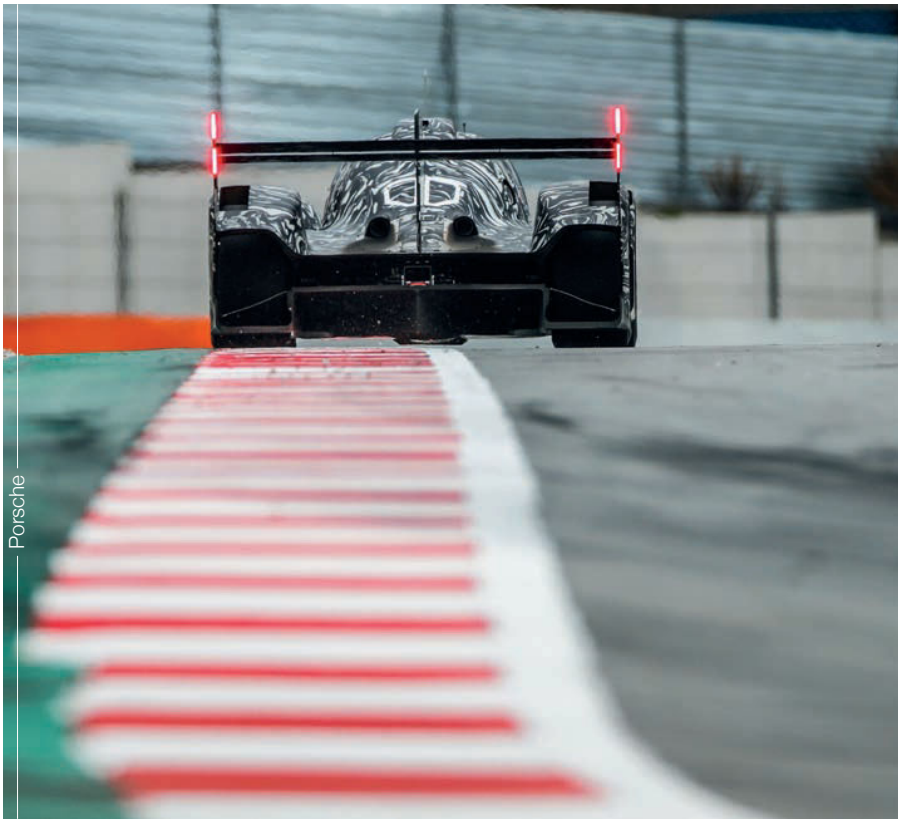
Closely monitored

With electrification of motorsport advancing rapidly on all fronts, progress with the new LMDh/GTP hybrid system – which features a motor generator unit from Bosch Motorsport, a battery from Williams Advanced Engineering and transmission from Xtrac – is being closely monitored by other series.

With most of the US manufacturers still some way off running their new LMDh/GTP cars, Porsche Penske Motorsport's hybrid has been blazing the trail with its test programme. Its prototype ran the hybrid system at Barcelona, offering the suppliers and sanctioning bodies the valuable chance to log miles on the unit.

IMSA said it was "very pleased" with the test. Teething troubles with the spec 40 hp energy recovery system, working in unison with the twin-turbo V8 that powers the Multimatic-built sports car, were described as "very small" and promptly addressed.

Combined, the MGU and battery will work with the various internal combustion engines in the LMDh/GTP formula to reach a peak of 500 kW (680 PS). RT



BELOW The spec hybrid system was tested in Porsche's LMDh

AVL RACING rebranded AVL RACETECH

THE global motorsport experts at AVL List GmbH go into the 2022 season with a new name and a broader portfolio.

The company's motorsport department will bear the new name, AVL RACETECH, to underline the fact that the 108 employees are working on and supplying technology for motorsport. The services on offer range from engineering, testing, testbed assembly and simulation, through to manufacturing. A new element comes in the form of a significant expansion of activities in the field of electrification and various hydrogen technologies.

The Battery Innovation Center (BIC), opened recently at the headquarters of AVL List GmbH in Graz, also plays a major role. The BIC allows the production of prototypes and small-batch production of the highest standard – perfect for all the demands of motorsport.

ABOVE AVL's expertise was used to develop BoP in the new-look DTM

Ellen Lohr, Director Motorsport AVL, explained: "Changing an established name is always something of a challenge. However, this is the right time to make that change. The old name sounded too much like a racing team. That limited people's awareness unnecessarily. The new name AVL RACETECH shows clearly that our core areas of expertise are in motorsport technology. That expertise is now finally also featured in our name."

AVL RACETECH currently works with customers in 17 international racing series and is represented in all the top formats. Its technical expertise covers all drive types used in motorsport. RT

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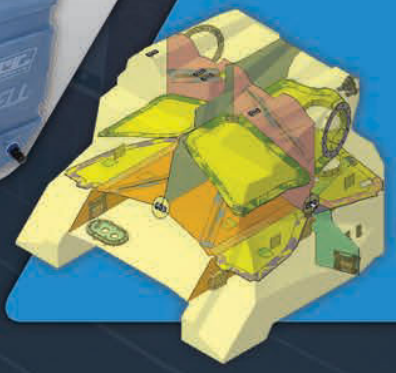

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Gen3 Supercar updates allow "attack mode"

AN updated Gen3 Chevrolet Camaro ZL1 Supercar prototype has earned praise after a shakedown at Queensland Raceway.

The Camaro prototype, complete in its new black and gold livery, has undergone a number of changes. It comes after drivers presented feedback to Supercars following four test days at the Ipswich circuit in January.

Notably, some drivers presented concerns with ergonomic and visibility issues.

ABOVE A number of ergonomic changes have improved the Gen3 prototype

Supercars has since tweaked the chassis to ensure greater driver comfort: the firewall has been moved forward, the pedals lowered and the seat reclined.

The Gen3 chassis is slightly lower than current Gen2 cars, although the aim is to have drivers in a similar angle and seating position. A fully manual sequential gearchange mechanism has also been added. All told, Erebus Motorsport driver Brodie Kostecki was pleased with the early signs.

Critically, Kostecki said the changes will allow drivers to feel more comfortable to "attack".

"A few of us struggled with ergonomic things with the car last time we were here," Kostecki said. "It's great that the guys and girls at Supercars have worked pretty hard to make sure we're nice and comfortable when we drive.

"It means we can be full attack mode when we're out there."

Kostecki also praised the stick shift system, which has been mandated for the Gen3 ruleset for its 2023 debut. The early days of prototype testing were completed with a paddleshift system.

"It seems that all the problems have been solved for me so far," Kostecki. said. "There's been a few other changes as well; within the engine, the drivability, just having the stick shift in there as well. I definitely like that the stick shift is in there; it puts more into the driver's hands.

"A few of us call it the 'Oh, shit' handle when we're going for a pass. I'm glad to see that Supercars has listened to the fans."

The Gen3 Camaro and Ford Mustang will make their racing debuts in 2023. RT

New measurement company launches in Italy

JUST five years after launching, UK measurement company Evolution Measurement Ltd is expanding into Italy with the formation of EvoMisure.

Evolution Measurement will supply specialist measurement instrumentation to industry and high-end metrology customers through EvoMisure.

Operations will be led by Giuseppe Ronciglia, a specialist in the metrology field with extensive experience of supplying and supporting complex measurement solutions across a wide variety of market segments.

Working with the likes of Guildline Instruments, Vectoflow and EvoScann, EvoMisure's instruments focus on aerodynamic and high-end metrological applications.

Commenting on his appointment, Ronciglia said, "I am really excited to combine my experience and work with such outstanding instruments. From ground-breaking pressure scanners, such as the EvoScann range, coupled with the world-leading range of flow probes from Vectoflow to high level precision resistance and current measurement instruments, these products will bring immense value and added efficiency to many applications."

ABOVE EvoMisure will be an exclusive distributor for world-class manufacturers

Paul Crowhurst, Managing Director of Evolution Measurement, added, "Having worked extensively with him in the past, we are thrilled to have Giuseppe join our business and lead our Italian operations. His vast range of metrology experience and diligent customer focus is a perfect fit. Ultimately, we are a solutions provider, helping our customers to achieve high level measurements, in order to achieve efficiency and better performance." RT

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TotalEnergies debuts first 100% renewable fuel in WEC

THE FIA World Endurance Championship (WEC) passed a major milestone at its season-opener at Sebring, where all of its competitors used 100% renewable fuel for the first time.

Produced by TotalEnergies, the fuel, Excellium Racing 100, is the product of 18 months of research and development. It is sourced entirely within the circular economy and without a single drop of oil. This biofuel draws its energy from the recycling of residual biomass from the wine industry.

Mohammed Ben Sulayem, FIA President, said: "Motorsport is not only a fantastic spectacle, but also a unique research and development platform, helping to move the introduction of sustainable technologies to the automotive industry forward and thus benefiting road users worldwide. By its nature, endurance racing is at the forefront of the innovation. Therefore, having the FIA World Endurance Championship switching to 100% sustainable fuel from TotalEnergies is an important milestone that perfectly reflects the FIA's objective of introducing sustainable energy sources to motorsport."

Pierre Fillon, President of the Automobile Club de l'Ouest, said: "Endurance is embarking on a new era. With TotalEnergies, a long-standing partner of the ACO, we are moving up a level with our shared commitment to reduce our environmental impact. Our primary goal is to cut our carbon emissions and everyone needs to get on-board to help accomplish this. We are proud to uphold our ambition of making the 24 Hours of Le Mans a testing ground for automotive technology."

"The FIA World Endurance Championship is a real laboratory for our company, a showcase for the innovative solutions we can offer for decarbonized and sustainable mobility," commented Pierre-Gautier Caloni, VP Motorsport division, TotalEnergies. RT

LEFT The entire field used Excellium Racing 100 at Sebring

EXCELLIUM RACING 100
See page 44

Sauber Group launches Sauber Technologies

THE Sauber Group has launched Sauber Technologies, a spin-off company incorporating Sauber Engineering and Sauber Aerodynamics.

Based in Hinwil, Switzerland, it will be fully focused on third-party business, providing a holistic service for complex engineering problems, from the idea stage to the finished products.

Sauber Technologies staff, coming from a wide range of backgrounds, bring an eclectic set of skills that, matched with the first-grade equipment available within the company, aims to deliver world-class expertise in fields as varied as aerodynamics, lightweight design and CFK design and calculation.

The company's customers will have access to high-quality mechatronic systems design and production, fluid and thermal simulations and structural analysis, as well as a tried-and-tested approach to additive manufacturing, including prototyping and serial production, courtesy of the biggest additive manufacturing machine park in Switzerland.

"Sauber Technologies embodies the knowledge and expertise of 50 years of motorsport, matched with the latest technologies and a machine park second to none," said Christoph Hansen, COO of Sauber Technologies.

In addition to customers in traditional markets, such as transportation and motorsport, space and defence and aviation, the company envisages dealing with novel applications in the likes of mechatronics, automation and the energy sector. RT

BELOW Sauber Technologies will bring an F1 mindset to business

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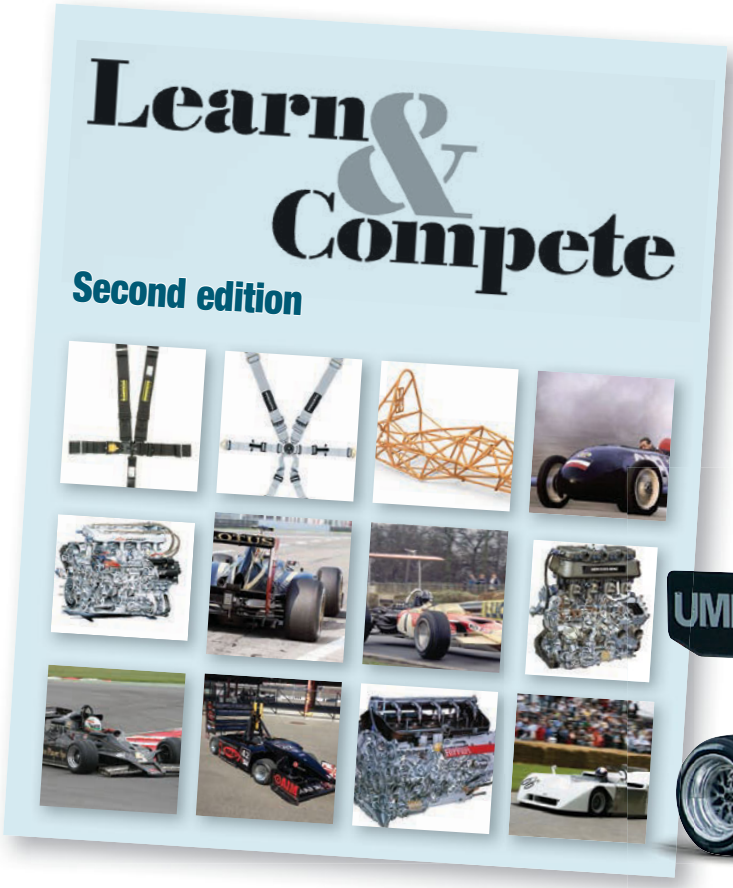

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Xtrac launches Academy

BERKSHIRE, UK-based automotive and motorsport transmission specialist, Xtrac, has announced the launch of a dedicated apprenticeship facility at its global headquarters in Thatcham.

The Xtrac Academy was officially opened by Laura Farris, MP for Newbury, at a ceremony last month. Also attending was Shelly Van Meter, head of department at University Centre Newbury and responsible for apprenticeships at Newbury College.

Farris said: "Xtrac has a rich pedigree in providing outstanding opportunities for young people in West Berkshire. The opening of the Xtrac Academy is a natural development of its successful and long-standing apprenticeship scheme. It confirms Xtrac's forward-thinking approach to its business and the skills needed for its continued success."

Xtrac has operated a popular training programme since the 1990s and has been working alongside Newbury College since 2003 to deliver its Level 2, 3 and 6 apprenticeships in advanced manufacturing.

The company felt that the time was right to invest in dedicated facilities providing hands-on manufacturing and computer-aided engineering skills training for apprentices, focused on Xtrac's unique products.

The academy will welcome the first cohort of apprentices during 2022 to its newly built CAE classroom and adjoining practical skills workshop. The apprentices will experience working in up to 16 company departments throughout their 18 to 48-month education.

Xtrac's apprentice manager, Warren Page, advised City & Guilds on particular features Xtrac needed for its apprentice programme. He commented: "The ongoing benefit of a dedicated Xtrac Academy to both Xtrac and its apprentices is the breadth of learning and practical experience they will accrue during their training. Engineering increasingly demands a flexible, multi-skilled workforce, and that is what the Xtrac Academy is designed to support." RT

LEFT The Xtrac Academy was officially opened by Laura Farris, MP for Newbury

MIA Business Excellence Awards return

FOLLOWING a two-year hiatus, the Motorsport Industry Association (MIA) presented its annual Business Excellence Awards in association with AP Racing, at the NEC Birmingham last month.

Presented by Pat Symonds, Chief Technical Officer of Formula One, the awards recognised achievements and success at all levels from within the world-leading motorsport and high performance engineering industry.

Chris Aylett, CEO of the MIA, said: "Congratulations to all our 2021 winners, during an extremely difficult couple of years you have set an exceptional standard for our industry to follow. You richly deserve this recognition from your peers, perhaps the toughest judges of all. 2022 is full of new opportunities and challenges which demand a level of excellence which I am confident our world-class motorsport industry will achieve."

The award winners were: Blaser Mills Law (Service to the Industry); Renvale (New Markets); Xtrac (Export Achievement); Reaction Engines (Technology & Innovation); Red Bull Racing (Teamwork); Evolution Measurement (Business of the Year with annual sales under £5 million); and Williams Advanced Engineering (Business of the Year with annual sales over £5 million).

The awards took place at the 19th MIA Energy-Efficient Motorsport (EEMS) Conference (in association with McLaren Applied). RT

ABOVE Red Bull won the Teamwork award

Second-life Jaguar I-PACE batteries harnessed

JAGUAR Land Rover has partnered with Pramac, a global leader in the energy sector, to develop a portable zero-emission energy storage unit powered by second-life Jaguar I-PACE batteries.

Called the Off Grid Battery Energy Storage System (ESS), Pramac's technology – which features lithium-ion cells from Jaguar I-PACE batteries taken from prototype and engineering test vehicles – supplies zero-emission power where access to the mains supply is limited or unavailable.

To showcase its capability, the unit helped Jaguar TCS Racing prepare for the 2022 ABB FIA Formula E World Championship during testing in the UK and Spain. It was used to run the team's cutting-edge diagnostic equipment analysing the race cars' track performance, and to supply auxiliary power to the Jaguar pit garage.

Charged from solar panels, the unit is a self-contained solution that consists of a battery system linked to a bi-directional converter and the associated control management systems. Available for commercial hire, the units are fitted with Type 2 Electric Vehicle (EV) charge connections with dynamic control and rated at up to 22 kW AC to allow electric vehicle charging.

Andrew Whitworth, Battery Manager, Circular Economy Team at Jaguar Land Rover, said: "This is a great example of how we will collaborate with industry leaders to deliver our sustainable future and achieve a truly circular economy. We're delighted to be working with Pramac to use Jaguar I-PACE second-life batteries to provide portable zero-emissions power and supporting Jaguar TCS Racing this season was an excellent opportunity to demonstrate what these units are capable of."

"Formula E is the world's first net carbon zero sport since inception," noted Jaguar's Formula E Team Principal, James Barclay. "Jaguar TCS Racing is always looking at improving our carbon footprint and using the storage system provides us with an innovative renewable energy solution for testing. To use second-life Jaguar I-PACE batteries completes this sustainable circle and showcases the team's Race To Innovate mission."

The partnership with Pramac is the first in Jaguar Land Rover's plans to create new circular economy business models for its vehicle batteries. As part of its commitment to net zero status by 2039, the company will be launching programmes that deliver second life and beyond uses for its electric vehicle batteries.

Post-vehicle applications exist because JLR's batteries are engineered to the highest standards and can therefore be safely deployed in multiple low-energy situations once battery health falls below the stringent requirements of an electric vehicle.

Second-life battery supply for stationary applications, like renewable energy storage, could exceed 200 gigawatt-hours per year by 2030, creating a global value over $30 billion.

The flagship system has a capacity of up to 125 kWh – more than enough to fully charge Jaguar's multi-award-winning all-electric I-PACE performance SUV, or to power a regular family home for a week. Pramac directly reuses up to 85% of the vehicle battery supplied by Jaguar Land Rover within the storage unit, including modules and wiring. The remaining materials are recycled back into the supply chain.

François Dossa, Executive Director for Strategy & Sustainability, Jaguar Land Rover, said: "The transition to an electric future, with Jaguar becoming all-electric from 2025 and the first all-electric Land Rover model expected in 2024, is integral to our sustainability strategy through the development of a comprehensive EV ecosystem from batteries to charging. This includes our effort to enable technical and business innovations for battery reuse for second life applications. Our collaboration with Pramac is a proof point in such direction, showing how it's possible to supply zero-emission power through the combination of renewables and second life batteries. Through their testing at Valencia, the Jaguar TCS Racing team have shown how we can inspire the whole ecosystem to continue to explore synergies and validate viable solutions for clean energy." RT

BELOW The unit was trialled in testing, demonstrating race-to-road-to-race cyclical technology transfer

A CASE OF THE HARE AND THE PORPOISE?

Is this order the 'new normal', or is porpoising masking the cars' true pace? **Craig Scarborough** examines the design traits – and some of the tricks employed – that have made F1 2022 such a revelation

THE CRITICS suggested that Formula 1 in 2022 would be reduced to a 'spec series', with all the cars looking the same and no change to the established competitive order. How wrong could you be?

In the first races we have seen 10 very different car designs, the once dominant Mercedes AMG F1 team falling from the lead and Ferrari back on the top step of the podium. But is this the new established order? Have some of the teams really got it right and have some really got it that wrong? Has porpoising been hiding the teams' real performance?

At the time of writing, the F1 2022 season had consisted of the three-day Barcelona shakedown, the official pre-season three-day Bahrain test and the first two GPs. While the field spread is not as great as expected, the variety in design and pace is certainly a brighter contrast that any would have predicted.

The F1 squads were faced with a complete car redesign: up from the tyres, through the brakes and suspension, to the main structures and safety systems. Even the gearbox and power units have been redesigned for the next era of F1.

Given the massive scale of this task under a budget cap and aero testing restrictions, there have already been winners and losers, those that had kept it conservative and those that have found left-field solutions. Given the wide variety in design and the change in competitive order, it's still too early to predict a winning concept, but deeper investigation into the teams' different approaches warrants analysis.

While many of the under-the-skin changes are yet to be revealed, the aero approach has been the main visual and performant differentiator between the teams. This gives us clues as to the concepts different teams are chasing. There appear to be two key variations: one chasing lower drag and one pursuing higher downforce. This split is likely to be akin to the long wheelbase/short wheelbase, high rake/low rake battleground of recent years.

Getty Images/Red Bull

ABOVE The early winners to emerge from F1's upheaval

Overall, the car will gain far more downforce from its underbody than in the last era of short diffusers. This might invite a low drag approach to the car design, making the most of the underfloor to shed drag for more time to be found on the medium- to high-speed sections of track. Conversely, having a powerful underfloor might encourage teams to trade the reduction in drag the underfloor provides and find even greater downforce with top bodywork aero. The consensus is this latter approach might bring time from its greater aero load in the slower corners.

For all of the changes, the key areas differing between the cars are the front wing/nose, floor and sidepods. Particularly in the case of the sidepods and their relationship to the floor, the variations are quite marked, giving clues to each team's overall approach. ▶

RIGHT The variety of different designs slugging it out has exceeded expectations

Getty Images/Red Bull

Front wing

Rules for the nose height, length and cross section have been largely rewritten, whilst the front wing is an all-new geometry. Both need to balance the downforce created by the underfloor/rear wing, but also be sympathetic to flow under the floor.

For the nose, the main variants appear to be the length. There is an option to run the nose tip slightly shorter, such that it stops before the front element of the wing. This results in a main plane hanging below and ahead of the nose tip. The other option is to run the nose tip full length, with its upper surface reaching to the very pointed tip of the wing.

There's a split between the teams, but even those with a longer nose appear to have hedged their bets, Ferrari having a removeable body section over the front half of the nosecone, that appears to allow them to revert to shorter nose tip and a main plane hanging ahead of it. No doubt teams with a shorter nose could equally extend theirs with a longer tip section.

Front wing design varies far less than perhaps expected. The large design volume for the wing to sit within allows a range of wing ride heights and load distributions. Most obvious of the outliers in this area is Aston Martin with a very high nose tip and wing profiles extending away from it with equally high ground clearance. With this design it's easy to see the open channel underneath leading towards the underfloor.

Most other teams have run somewhat lower nose tip and wing

> *"Two key variations: one chasing lower drag; one pursuing higher downforce. A split akin to the long wheelbase/short wheelbase, high rake/low rake battleground of recent years"*

ABOVE Daring to be different: Aston Martin opted for a very high nose tip and wing profiles extending away from it with equally high ground clearance

LEFT Beneath the Ferrari's nose there is a shorter nose to allow the main plane to hang below the nose tip

heights, but played with the load distribution to gain that ideal airflow to the underfloor tunnel inlets. Nearly all teams have chosen a mid-loaded wing design, where the outer tips are unloaded and the centre span is lightly loaded. Given the geometry of the underfloor entrance all teams seemed to have adopted, the centre span accounts for some 500-600 mm, which matches the spacing of the inlet fences in the floor's throat. This places most of the downforce production to the mid spans, different teams choosing slightly different emphasis on how they shape the wing profiles in this area, some more loaded towards the chassis or the front wheel.

Underfloor

The floor and sidepod geometry is made up of new reference volumes for the bodywork to sit within, with further geometrical bodywork limitations on radius, sections and continuity. For the floor inlet area, teams have taken a wide spread of approaches ▶

RIGHT McLaren routes air over the splitter, around the sidepods and not under the floor

RIGHT The Haas tunnel inlet fences rise up above floor level to guide airflow over and under

BELOW Williams, like all the teams, curves the underfloor fences out laterally to create downforce under the floor edge

with either shorter tunnel, but protruding inlet fences or vice versa.

In all cases the inlet fences are used to segregate the flows under the floor. Typically, three internal fences are exploited, all sweeping directly outwards to the floor edge. This creates lateral expansion of the airflow, exiting under the upturned floor edge to produce a forwards-biased load to help balance the car. The inner of these fences splits the air flow between that passing immediately sideways and that which runs longitudinally under the floor's main two tunnels. Of course, this fence also sheds a vortex to further lower the pressure under the floor. As described above, the inlet formed between the two inner fences is only around 500-600 mm wide, with the splitter and bib bodywork in between them.

An unexpected trick with these underfloor fences is to make them sit above the tunnel itself. In the regulations, there is a volume for the inlet and a volume for the fences, with the tunnel roof trimming the fence surface when joined together. However, if there is no tunnel above a part of the fence, it's allowed to reach its much higher potential height. Williams and Haas have both immediately exploited this loophole, with other teams soon following. It's clear on these cars how the fence now sits proud of the floor, allowing it to influence airflow over the floor as well as under it.

The old, much longer and wider T-tray splitter is now gone. Instead, there is a minimal splitter section, under which the underfloor plank starts. Many teams have kept this splitter area well rounded, but otherwise undeveloped. Aston Martin cleverly found a bodywork loophole to fit a vortex-generating fin to the upper bib area, seen and rapidly adopted by Ferrari!

Another variant in this area is McLaren, who have chosen to narrow the main tunnel entry even further, by adding a fence to each side of the splitter. The airflow now passing over the splitter is routed upwards to pass around the sidepod front to create further pressure over the floor edge.

From the underfloor's throat, there sits a lower/flatter mid section before the rules allow the tunnels' kick line to expand out of the rear of the car. Teams have already looked at this area and found an approach to bring the kick line further forwards, but having a double kick. There is just enough space to have a smaller kick line within the mid-floor's volume, before the usual kick line at the intersection between the mid and rear floor volumes. Many teams have adopted this, with a suggestion that the double kick makes the floor less pitch-sensitive compared to one more aggressive kick.

It can also be argued this brings the centre of pressure forwards slightly too. In terms of the diffusers themselves, every team is limited by the regulatory geometry, so a square-edged exit is as much as they can achieve; the real trick is in the curvature inside.

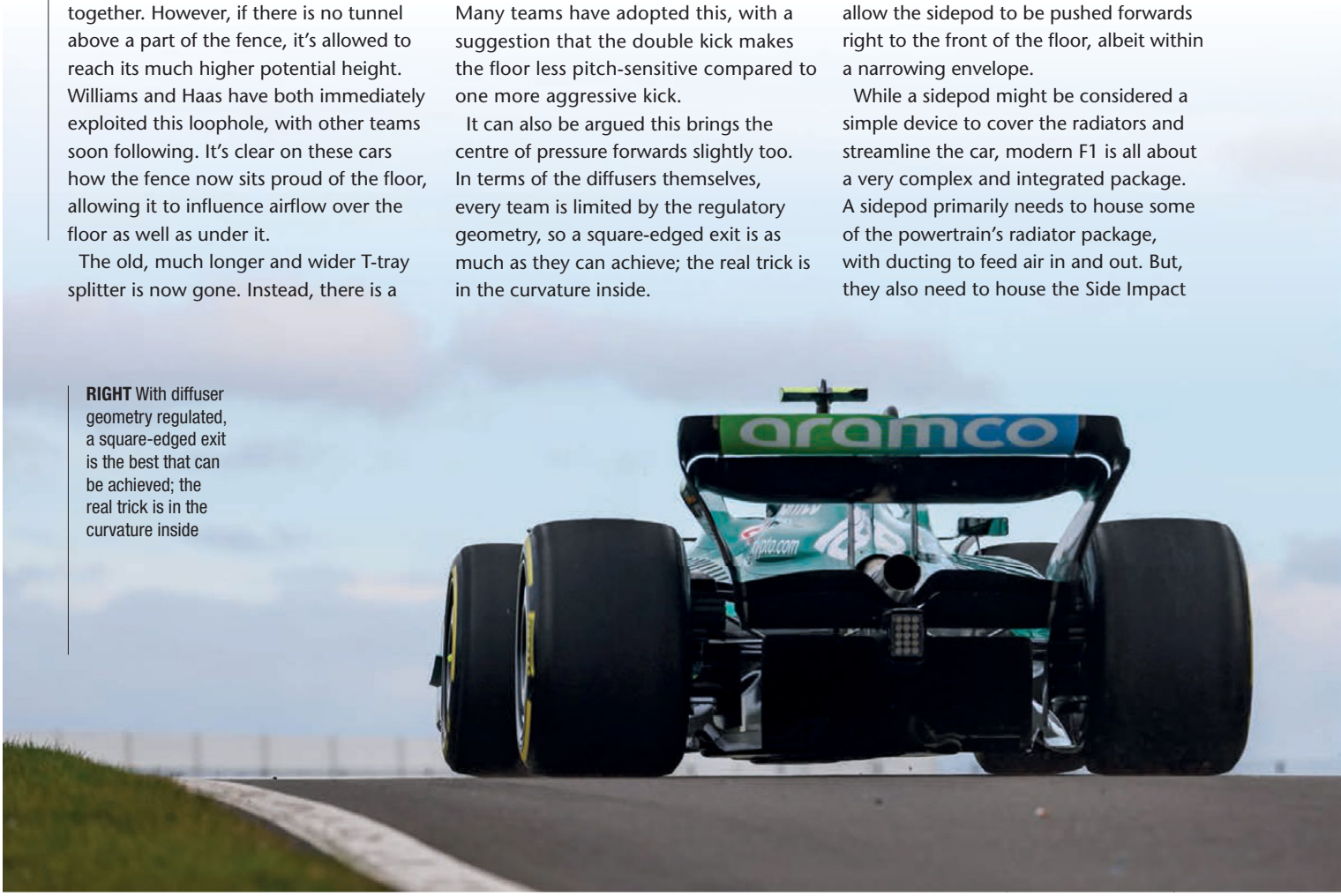
Sidepods

Sidepods aren't usually a primary performance factor; certainly this year the underfloor is the first order of priority. But sidepods have a wide effect on the car's performance and with 10 teams, we have seen 10 unique sidepod design solutions.

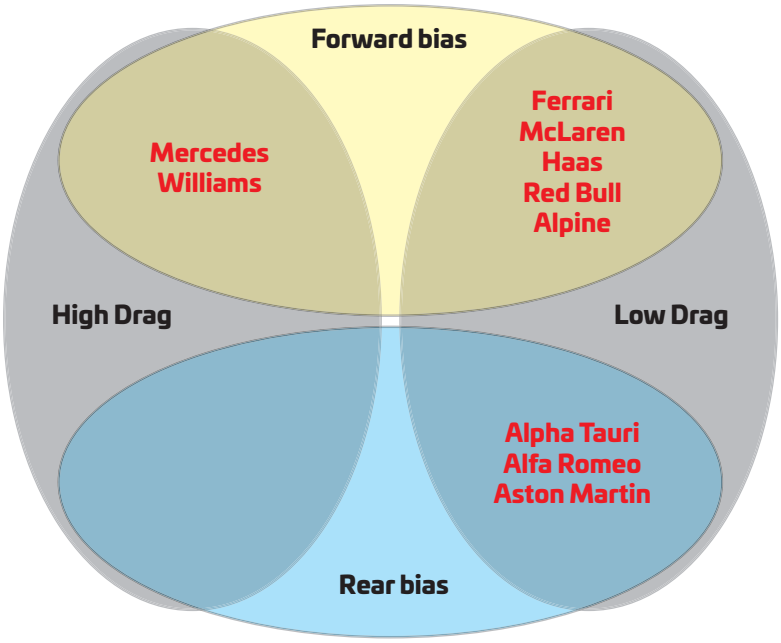
Such is the diversity of sidepod designs that they almost defy any attempt at grouping them: every team has a unique set up. This is in contrast to the recent handful of seasons where every team has largely followed the Ferrari high inlet design first introduced in 2017. This placed the inlet up high, producing a deep undercut to channel air laterally and a sloped upper surface to direct airflow over the diffuser. Sidepods and the floor beneath them were quite short, as the large bargeboard package had to sit ahead of them.

For 2022, the sidepod regulations are different. The bargeboards are gone, there's the full length underfloor and a three-section regulatory volume for the sidepods to sit within. These three sections allow the sidepod to be pushed forwards right to the front of the floor, albeit within a narrowing envelope.

While a sidepod might be considered a simple device to cover the radiators and streamline the car, modern F1 is all about a very complex and integrated package. A sidepod primarily needs to house some of the powertrain's radiator package, with ducting to feed air in and out. But, they also need to house the Side Impact



RIGHT With diffuser geometry regulated, a square-edged exit is the best that can be achieved; the real trick is in the curvature inside



The F1 2022 Venn Diagram
A compromise between requirements has led the F1 squads in different directions

Structures (SIS), some of the electronics and the primary exhaust system. Then there's the secondary function of directing the top body airflow around the car and floor: the sidepod front needs to push the front tyre wake away from the car and also direct airflow over the floor edge. Further down, the rear sections continue to help control front tyre wake, but also direct airflow around the rear tyres, over the diffuser and in between the rear tyre/diffuser gap.

This compromise in requirements has led F1 in 2022 to a Venn diagram of high drag, low drag, lateral and longitudinal airflows.

In the previous era of F1, the teams would give up drag for downforce, or dirty downforce as it became known. Super-skinny sidepods were acceptable, as they gave downforce. Now this battle between high or low drag appears to be the variable.

Starting with the lower drag designs, which are typified by the larger than required bodywork volumes. It's counter intuitive that an F1 car without any sidepods would have more drag, especially when the trend is for skinny sidepods. But the large bulk to the sidepods helps airflow around the exposed rear tyres, reducing drag.

Perhaps leader of this is Ferrari, with its flat-sided, ridge-backed sidepods. Looking under the bodywork, it's clear Ferrari have a conventionally-located and sized set of radiators, so the oversized bodywork is not enforced by them. Instead, Ferrari have sought to create some stronger effects with sidepod bodywork in areas where teams have previously chosen to slimline. The tall side faces of the Ferrari 'pods appear to manage the rear tyre drag reduction phenomenon; the wider fronts also help create the air pressure over the floor edge for front-biased downforce and pushes the front tyre wake well away from the rear of the floor.

Other teams have taken this approach, notably McLaren, but are suffering a lack of downforce which might be related to the sidepod and aforementioned floor fence/splitter arrangement. Also, we could count Red Bull, Alpine and Haas in this group, albeit without such extreme sidepod shapes.

Red Bull's sidepod isn't as bulky as Ferrari's, as the rear of the sidepod is heavily sloped to gain more performance from the diffuser, but at the front they have extra bodywork in the form of a beak-like extension to the inlet. This adds to the undercut effect, directing high pressure over the floor edge to draw more flow from under the floor. This places Red Bull very much in the low drag/forward-biased balloons of the Venn diagram.

Alpine's newly-raced solution is in similar vein to Red Bull's, with the sloped top surface. Alpine have added a bulged edge to direct the downwash towards the rear floor for added downforce.

There are a few low drag sidepod designs that give away less to the front floor edge and look for more flow towards the rear of the sidepod. Key amongst these is the Aston Martin, with its 'double floor' design. While not as radical as the Ferrari F92a double-floored F1 car, the Aston Martin also exploits sidepods raised fully from the floor of the car.

The radiators are inclined to almost horizontal to allow airflow to pass under the sidepod towards the diffuser. This design exploits the newly-allowed louvered cooling outlet section to get the hot air from the heat exchangers out of the sidepod. The resulting sidepod shape clearly diverts flow around the rear wheels for drag reduction, but lacks any lateral expansion at the sidepod front. This pushes the Aston into another corner of the Venn diagram, with low drag but rear-focused aero.

Joining this bubble on the diagram are the Alpha ▶

BELOW Ferrari's wide sidepods with a ridged top surface reduce drag around the rear wheels

Tauri and Alfa Romeo cars. Both sport what could be described as a heavily undercut sidepod, but with more conventional radiator positioning, not as extreme as a double floor. These balance the lateral and longitudinal airflows more sympathetically, but lack the strong front outwash of the teams above.

If the bulky sidepod typifies a lower drag 2022 design, then all but no sidepods sets out the opposite extreme. In this group are Williams and Mercedes, the latter with the Bahrain-spec bodywork, not the more conventional package which it launched with.

Mercedes has perhaps taken the biggest amount of attention. The zero-pod solution, as some have called it, debuted at the Bahrain test. The car boasted tiny clamshell-shaped sidepods with vertical inlets and an upper forward wing structure housing the side impact structure. It's wrong to call this a no-sidepod car, as there is clearly some bulk to the sidepods in order to clear the radiator package. What sidepod there is, is largely reduced to the minimum to clear the radiators plus duct air in and out of them. However, closer inspection does reveal some excess shaping around the front lower area, which is wider than the internal packaging demands. This low, wide shape creates the outwash effect to load the floor edge, in a similar way to Red Bull's 'beaked' undercut.

TOP Red Bull's extreme sidepod undercut loads the floor edge

LEFT TO RIGHT **Alpine** runs a bulge on the sidepod flanks to guide downwash over the top of the pods to the diffuser. The most extreme sidepod of all is seen on the **Williams**. **McLaren**'s oversized sidepods run wide at the front to create pressure over the floor edge. Although small, the **Mercedes** sidepods are wide low down to divert air around the floor edge

What remains of the upper sidepod bodywork slopes down to route air to the diffuser trailing edge. Keeping the airflow attached down this extreme slope is the separate upper forward wing section. This is allowed not as it's part of the mirror mounting, but because the sidepod front regulatory volume doesn't have to be a single section with the rest of the sidepod; inside the winglet is the Side Impact Structure. A vortex from the winglet creates downwash to keep the airflow attached to the sloped sidepod surface, making a well-considered total package to create lots of downforce.

What the Mercedes concept lacks is the bulkier sidepod surfaces to reduce the drag of the rear wheel, putting it in the higher drag side of the grid.

Perhaps the most extreme sidepod of all seen so far in 2022 is the Williams. There is very little sidepod. Indeed, what can be seen to the side of the cockpit is only half 'sidepod'. In fact, most of the radiator package has now been moved to two large, inclined radiator stacks placed over the engine/gearbox, these being fed cool air from the enlarged roll hoop inlet, ▶

similar to what Renault/Alpine have done in recent seasons. What's left inside the minimal 'pods is a small radiator in the bottom half of each side. What forms the upper half is something of an enigma: the sidepod inlet is split by the Side Impact Structure; the upper half is a duct that can be configured to direct air to the lower radiator or pass straight out the back of the sidepod through a duct. The split concept might simply be a cooling solution or something more clever, but the full explanation has yet to be heard.

What's causing the porpoising?

Elsewhere, technical variances abound but few are of a primary performance impact. The switching of different teams between push rod or pull suspension has been much discussed. Since 2009, the overwhelming trend has been for front pushrod and rear pull rod, with aerodynamics and packaging, especially with the small 13" wheels, being the prime consideration. Now with larger 18" wheels and taller rear tunnels, some teams have switched the rod orientation. Again, there is no real performance benefit, simply another reassessment of aero, packaging and ease of access.

RIGHT AMR's sidepods are raised to allow airflow beneath them. Louvres help deal with the heat from the horizontal radiators

RIGHT Alfa Romeo opted for heavily undercut sidepods aided by cooling louvres

BELOW Porpoising was initially a problem for all the teams with the quickest fix, raising the ride height, sacrificing valuable performance

> *"The bounce is not initiated by aero stall, but by the heavily-loaded suspension being unable to control the back of the car over bumps"*

However, suspension bounced into the headlines as soon as running started at the Barcelona shakedown, with porpoising. Any reader familiar with F1 in the '70s and '80s will recall the term. Porpoising is an imbalance between the underfloor aerodynamics and suspension, that sees the car pitch up and down, typically at high speed on the straights. This was immediately evident along the long straight at the Circuit de Catalunya, most cars exhibiting some of the low frequency bounce at the back – some more so than others!

Historically the causes for F1 porpoising have been the ground effect 'skirts' losing contact with the track at speed or the flat bottom stalling at very low ride heights. Both issues caused sudden downforce loss and the heavily-loaded suspension to spring back up, only for the process to restart and cycle over and over until speed was reduced.

Porpoising, like F1 itself, has evolved since the '80s and the explanation for it is now somewhat different. At first, the advent of powerful underfloor tunnels ▶

Giorgio Piola

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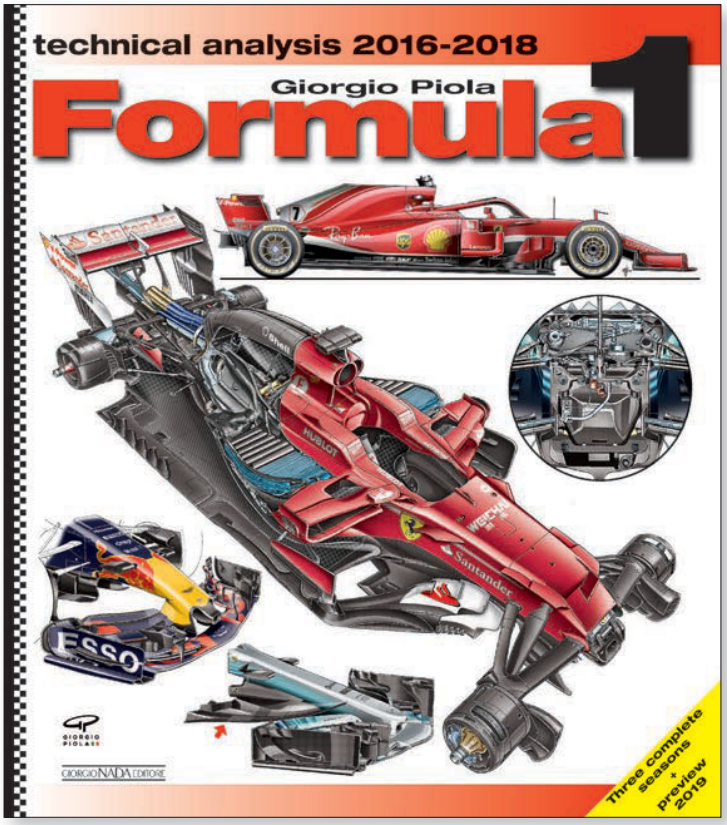

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making a comeback was the suspect: if the floor stalled at low ride heights, it could kick off the 5hz bounce along the straight. It was clear some teams were running distinctly tail down on the straights, which was at odds with initiating a stalling effect, so the cause must be elsewhere…

End of golden era for suspension

Over the winter the major rules rewrite not only affected aero, but suspension too. One day books will be written about the complex passive systems fitted to the outgoing hybrid era cars, about the gas springs, hydraulic remote links, extreme asymmetric damping, collapsing heave springs, mechanical inerters and fluid inerters. But now that all the teams can have are simple dampers and springs operated by the suspension rocker, this removes a huge area of control (and expense) and suggests where the true problem may lie with porpoising in 2022.

Equally, the ride height of the cars has changed considerably for this year. The high rake cars in 2021 were running some 150 mm of rear ride height; now the cars are once again run as low as possible, to maximise the sealing effect of the tunnels by the floor edge. So, the teams now have less ground clearance to play with and fewer toys to control it.

While few teams have spoken out about the modern issue of porpoising in F1, the consensus is it's not initiated by aero stall. Rather, that the bounce is set off by the heavily-loaded suspension being

BELOW McLaren and Mercedes had their early races disrupted the most by porpoising

> *"The teams now have less ground clearance to play with and fewer toys to control it"*

unable to control the back of the car over bumps, ripples or track imperfections.

In the past this would be well controlled by the complex suspension and excess ride height; now, though, the floor will crash into the track and rebound upwards. Initially the control issue will be the damping of the resulting jolt through the suspension. But simultaneously the underfloor's aero will react, the centre of pressure will move and the total aero load may reduce. Then both the suspension and underfloor, undamped, will fight each other until something returns equilibrium to the two, typically by lowering the car's speed. Only adding to the problem are the new tyres, with different characteristics and the large, heavy floor which flexes with the porpoising, further upsetting the car's equilibrium.

Short-term, the fix is simply more ride height: this gives room for the suspension to absorb movement without the floor bottoming, but this loses total aero performance, so isn't the full solution.

The medium to longer-term fix is match the aero and suspension, understanding the frequency that initiates the porpoising, then altering the suspension's compliance characteristics and aero sensitivity, to allow the car to once again ride as low as possible without the dreaded bounce.

To date, the porpoising has struck teams at different points during the first weeks of the season. Mercedes and McLaren were both particularly harshly affected in the first two races. Catching up is a stepped process and should not take more than a few races, but time spent on resolving these issues takes away from time spent on making the car faster. With the budget cap and aero testing restrictions, it's not simply a case of throwing money/resources at both demands; this will take more time to fully recover from beyond simply fixing the porpoising.

PORPOISE-BUILT!

Porpoising has dominated the start of Formula 1's new era. Our **Expert Witness** – an insider who must retain anonymity – uncovers some of the mechanisms that are causing the phenomenon and addresses potential solutions

WE are only six test days and two race weekends into the new, long-awaited and heavily revised Formula 1 technical regulations, changed specifically to allow the cars to race more closely.

It's perhaps still too early to draw complete conclusions. After all, more time is needed for the teams to get on top of their very different cars at the circuit. Other track layouts will also take us into new areas.

For all the questions raised by the teams' battle to get to grips with the new cars, the one stand-out surprise has been clear: the porpoising or pronounced bouncing effect that has been seen on these new format cars at high speed. So what's causing it? How bad is the problem? And what do we do about it? We knew who to ask...

Why have the car changes gone in this direction?

"The new aerodynamic regulations have deliberately moved the emphasis back to underfloor or venturi aerodynamics last seen at this scale at the beginning of the 1980s. Then, like now, this gave very high efficiency downforce as an extremely large central surface area of the car was interacting with the ground. The significant curvature of these surfaces allowed a much greater acceleration and pressure reduction below the car, making this an extremely dominant and powerful mechanism.

"This geometry and interaction are considered good for close racing as it is both more benign to the wake or dirty air off other cars while creating, coupled with other geometry, a very tidy and high wake itself, better for a car following you. The fact that this large load is acting between the wheels and managed by your vehicle dynamics is an additional bonus, avoiding any extreme loss of front or rear load and stability if there was a sudden reduction in performance. So, the logic and principles are sound."

TOP Ferrari and Red Bull have overcome the porpoising problems better than the opposition

ABOVE LEFT TO RIGHT The issue of porpoising 'went viral' at Barcelona testing. Videos captured the cars' floors choking, losing load and lifting up on their stiff suspension, then recovering and repeating the cycle

Getty Images/Red Bull

> *"Simplistically, you could run your car stiffer/higher and avoid the cliff edge of the area where the porpoising occurs"*

So if it's a good direction, what is actually creating the porpoising problem?

"As ever, it's a combination of things, but the fundamental mechanism is this. The venturi created by the floor increases in performance the closer to the track you get. Therefore, to get the most out of it, you will try to run the car at its optimum low position as much as you can. However, that load increases with the square of the vehicle speed, so in some high-speed corners and particularly end of straights you have the extreme cases of very high load and minimum or zero ground clearance.

"In this scenario, the car and floor will touch the track, sometimes excessively, which is fine so long as the venturi system remains stable. However, we have seen this has not been the case: the floors have then either choked or partially stalled in this state, rapidly losing load and lifting up on their stiff suspension.

"This cycle then very rapidly repeats: the floor recovers, gets very low again, chokes, lifts up again, recovers… In the worst cases this can occur at high frequency, affecting reliability and driver vision." ▶

Why didn't F1 or the teams anticipate and mitigate for this?

"Even with the new Liberty F1 independent research of such a different regulations format, you are looking at the principles you are trying to deliver and a geometry that achieves those. The teams then take those away and try and achieve the absolute maximum performance from them that they can achieve.

"As we have already seen, this interpretation has taken many extreme different routes, but all very floor-focused, pushing that geometry further and harder as this will become the key differentiator to car pace. Huge sidepod undercuts, 'zero sidepods', slotted and wavy floor edges etc. This probably pushes the intent of the research beyond the boundaries expected.

"The second issue is the tool sets. Until such a new car physically exists, you are reliant on aerodynamic development by the wind tunnel and CFD, which can then be virtually track assessed in the simulator. The first two interrogate aerodynamic performance of both different geometry and multiple car orientations, including ride height, but neither of these are sprung or have deflection characteristics identical to the real car.

"It is also technically unadvisable to run a wind tunnel model in contact with a moving ground at effectively zero ride height.

"You would think the simulator – with its ever-more accurate track representations, bumps, kerbs and suspension stiffnesses – would solve or predict this porpoising, but remember it too is also getting

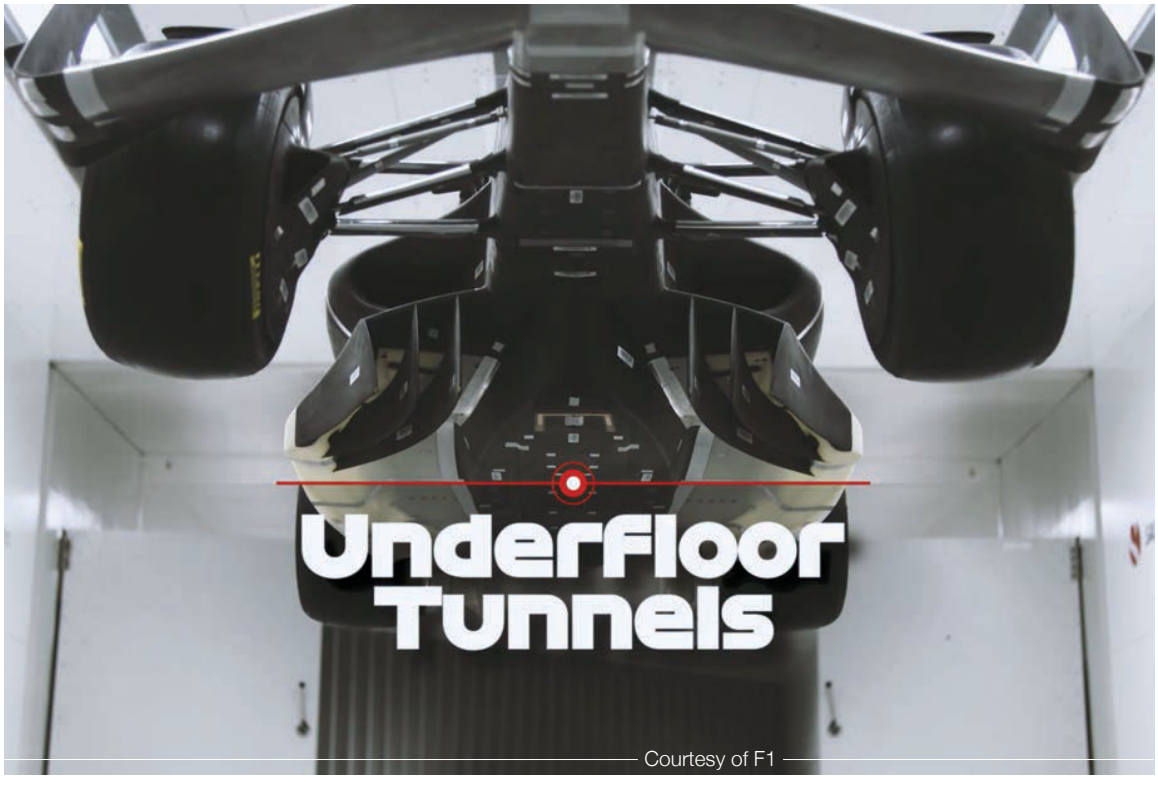
fed its initial aerodynamic behaviours from the wind tunnel and CFD. If they don't anticipate the issue and feed it into the simulator, the simulator won't see it either."

What other factors are creating the challenge?
"It's not just an issue with the centre of the car touching the ground on the straights: the floor edges were touching the ground in turns three and nine at Barcelona and turn 12 at Bahrain, the highest speed corners. This can be attributed to car roll, but also to aeroelasticity – accidental or deliberate. The long, lightweight thin overhangs of floor ahead of the rear tyre were deflecting downwards with the aerodynamic load on it. With this partially or totally sealing the edge of the floor to the circuit, this can be beneficial for increased load, but it can also potentially create an overload or stall on that side of the car.

> *"A perfect storm of different vehicle dynamics"*

"The sport has a long record of checking and controlling deflection on car components, most recently on rear wings. The regulators were also quick in this floor case to introduce the use of a single floor stay on each side of the car with a small weight concession – an increase of the minimum mass by 3 kg to 798 kg – to allow the teams to prevent these deflections. ▶

ABOVE & LEFT Such an emphasis on underfloor aerodynamics hasn't been seen for 40 years. Then, as now, there were casualties. The A2 Arrows (left) was rendered undriveable by porpoising



Courtesy of F1

RIGHT F1's return to ground effect was well simulated in advance but neither the wind tunnel nor CFD have the deflection characteristics of the real car

Getty Images/Red Bull

Mercedes-AMG F1

ABOVE & LEFT The teams' technical solutions, such as Red Bull's sidepod undercuts and Merc's 'zero sidepods', pushed the boundaries further than F1's tech team envisaged

"Another area of influence is suspension, also much simplified from its 2021 levels by the new regulations. While not achieving the fully active performance of the 1990s, the platform control of the advanced systems over the last few years were getting very impressive.

"With many of those mechanisms now restricted, allied to much heavier cars, wheels, tyres and a much lower profile tyre and different sidewall deflection, there is almost a perfect storm of different vehicle dynamics. Couple that with the very different aerodynamic behaviours and limited track time, and you get some teams' cars clearly struggling.

"We also haven't been to an extremely bumpy track yet. This will add a further input problem that the teams will have to manage and try to maintain car performance."

What are they going to have to do to solve it?

"Simplistically, very short-term, you could run your car stiffer and/or higher, further away from the

RIGHT Mercedes is one of the worst afflicted by porpoising

aerodynamic optimum and avoid the cliff edge of the area where the porpoising occurs. But this will mean you are theoretically less competitive, so not a solution anyone will want to take.

"The biggest opportunity, in parallel, is that there is now actual new regulation, real car track and pressure data to feed back into your R&D tools to improve the correlation and close the development loop. This can lead to simplistic upgrades

> *"Porpoising has been exacerbated by issues of aeroelasticity – accidental or intended"*

discovered back at base that can be implemented in the field at the next race, or even first upgrade components, aerodynamic or mechanical, that can be flown out and fitted.

BELOW Floor stays were hastily introduced in the midst of the Bahrain test to stop flexing, be it accidental or intentional

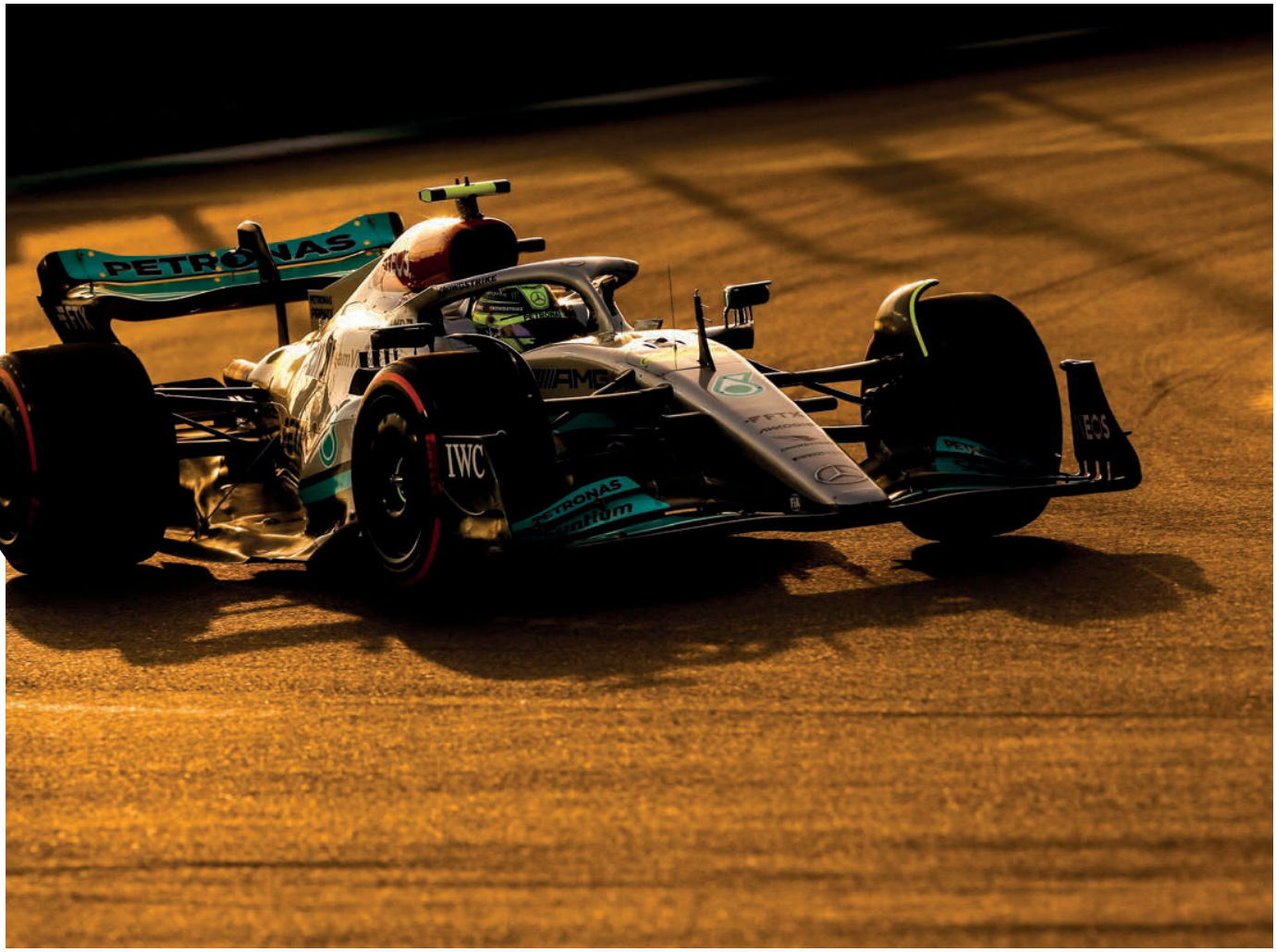
"Porpoising was present in the early eighties when F1 pushed this type of geometry previously, and in other categories with large floor aerodynamics subsequently. The tools and understanding then were far less advanced than anything currently at the


Mercedes-AMG F1

disposal of today's F1 grid.

"That being the case, I anticipate it will only be the first couple of races where we still see this condition manifesting itself. Soon, all the teams will get on top of it and have the performance and car behaviour they want, upgrades and budget cap permitting.

"If you want evidence, look at Ferrari: this was possibly the car suffering porpoising worst at the Barcelona test; but by Bahrain they were achieving a one-two result." RT



Grape residue from wine production provides the majority of components within the World Endurance Championship's first 100% renewable fuel, developed by TotalEnergies. **Chris Pickering** reports

GRAPE EXPECTATIONS

SEBRING International Raceway is a track steeped in history. The very first FIA World Sportscar Championship (as it was at the time) began here in March 1953 and since then it has become the traditional season-opener for international endurance racing.

Thanks to its special position in the calendar, Sebring has seen more than its fair share of watershed moments over the years. It was here, among the orange groves and golf courses of central Florida, that Audi's diesel-fuelled R10 TDI blew away the competition on its debut in 2006. The Hypercar era was also due to kick off here in 2021 until the COVID pandemic intervened.

There were no such issues this year (barring the thunderstorms that eventually caused the race to be red-flagged) but another landmark moment was reached, with the arrival of a new fully-sustainable spec fuel for the World Endurance Championship (WEC).

Known as Excellium Racing 100, the new fuel has been developed by French giant TotalEnergies. It's derived predominantly from waste taken from the winemaking industry (with the remainder coming from other sustainable sources) but it burns just like conventional gasoline, with no fundamental modifications required to the engines.

Although this means that the tailpipe emissions are similar to a conventional fuel, the carbon-negative process of growing the grapes means that the overall process emits at least 65 per cent less CO2, according to TotalEnergies. How much relevance this has to the cars on the track is up for debate – a study by the organisers of the 24 Hours of Le Mans last year concluded that the racecars themselves only accounted for 1.7 per cent of the event's total CO2 production – but the potential for this technology to be transferred direct to existing road cars makes it a potential game-changer.

Every single car on the WEC grid now uses this sustainable fuel, with the European Le Mans Series (ELMS) due to follow suit when its season starts in a few weeks' time. As such, Sebring marked the first opportunity for the TotalEnergies engineers to witness their new fuel in action in a racing environment, and it was an opportunity to gather feedback from the teams, as the company's motorsport technical manager, Romain Aubry, explains.

"The first shipments of the fuel went out to the teams in July last year, and of course we carried out our own test programme, so we were very confident in the reliability," he comments. "Nonetheless, it provided a good opportunity to double-check the cleanliness of the injectors, the piston crown and other areas like that when the teams inspect their engines after the race."

Material compatibility

TotalEnergies' previous tests had included studies on the long-term durability of elastomers and tank materials that might be subjected to the new fuel. In some

ABOVE The result of 18 months of research and development, Excellium Racing 100 made its debut at Sebring's World Endurance Championship season-opener

> *"The potential for this technology to be transferred direct to existing road cars makes it a potential game-changer"*

respects, the fully-sustainable fuel actually poses less of a challenge than the 10 per cent ethanol (E10) blend used last year. While bioethanol is still an intermediate step in the production process, there is no longer any neat alcohol included in the finished product. As with any new fuel, however, it still pays to check.

"We carried out a lot of material compatibility tests in our lab, but the manufacturers may sometimes use their own materials that we haven't tested for tanks, seals and other components linked to the fuel system, so it's always good to have their feedback," notes Aubry.

Aside from the LMP2 category, which uses a spec engine from Gibson Technology, the WEC is notable for its variety. There's everything from production-based cars running various naturally aspirated and turbocharged engines through to the bespoke race engines in the Hypercar class.

All must run on the same universal fuel blend, which does simplify things in some respects – it means that Aubry and his colleagues could work directly with the ACO (Automobile Club de l'Ouest and the FIA without having to set up a regulatory framework with other fuel suppliers. On the other hand, it meant they had an unusually broad range of different engines to cater for, by the standards of a ▶

top-flight international series.

"Supplying the whole championship meant that we needed to have multiple discussions with the different manufacturers," comments Aubry. "And it's especially critical with these categories, where you've got a Balance of Performance (BoP) to consider. Some manufacturers had the feeling that the fuel will have a bigger impact on them than on their competitors."

Renewable base

Despite the usual grumblings about BoP (principally around the decision to change the speed at which the Hypercars could deploy their hybrid assistance) there have been no publicly reported concerns with the fuel. Nonetheless, it's likely that some manufacturers will have adapted to it better than others.

"It's still hydrocarbons – albeit a renewable base rather than a fossil base – so it doesn't change anything fundamentally. But there are always small differences with a new fuel, just as you would have going from one fossil blend to another," comments Aubry. "All the manufacturers have spent time working on the fuel during the winter, understanding its behaviour, but I have the feeling that some have spent more time

ABOVE The biolab at the Solaize Research Center (CReS), one of the group's emblematic sites for innovation and technical excellence, has enabled TotalEnergies to bring increasingly innovative products to market

ABOVE & LEFT Milestone moment: TotalEnergies provided the first 100% renewable fuel to be used by all competitors in an elite international motorsport series

BELOW TotalEnergies' La Mède biorefinery, in the South of France, is playing a pivotal role in the group's work with the global energy transition

on that than others."

The differences are small. Compared to the previous fuel, the octane rating has fallen by two points from 103 to 101, but as Aubry points out, anything above 100 RON is generally considered to be 'comfortable' in most forms of motorsport. The energy content and distillation profile are said to be virtually the same, while the fuel density has reduced by a small amount (around 2 kg/m^3, we're told, but this isn't enough to impact the fuel flow meters on the Hypercars).

"We've moved from alcohol technology to ethers using ETBE (Ethyl Tertiary Butyl Ether) for the octane booster," he comments. "The base is a set of hydrocarbons derived from bioethanol. The biomass that we use for that mainly comes from residue from the wine-making industry; the grape marcs and lees are put through a fermentation ▶

ABOVE TotalEnergies' role in the energy revolution was underlined last month when Airbus performed a first A380 flight powered by 100% Sustainable Aviation Fuel (SAF). 27 tonnes of unblended SAF were provided by TotalEnergies, made from Hydroprocessed Esters and Fatty Acids (HEFA), free of aromatics and sulphur, and primarily consisting of used cooking oil, as well as other waste fats

process to produce the ethanol."

The bioethanol for the base blend is then dehydrated and oligomerised in a process known as Ethanol to Gasoline (ETG). Meanwhile, the ETBE is formed using a chemical reaction between ethanol and isobutene which creates the ether molecule. The other ingredient in the ETBE process is bionaphtha, which comes from TotalEnergies' La Mède biorefinery in the South of France, where it is created from used cooking oil (UCO). It's actually a by-product of the hydrotreated vegetable oil (HVO) fuel that the company supplies to the FIA's European Truck Racing Championship.

The end result is a fuel that could just as well be put into a normal road car, although Aubry points out that toning things down to create a more affordable 95 or 98 RON blend would probably make more sense for the mass market.

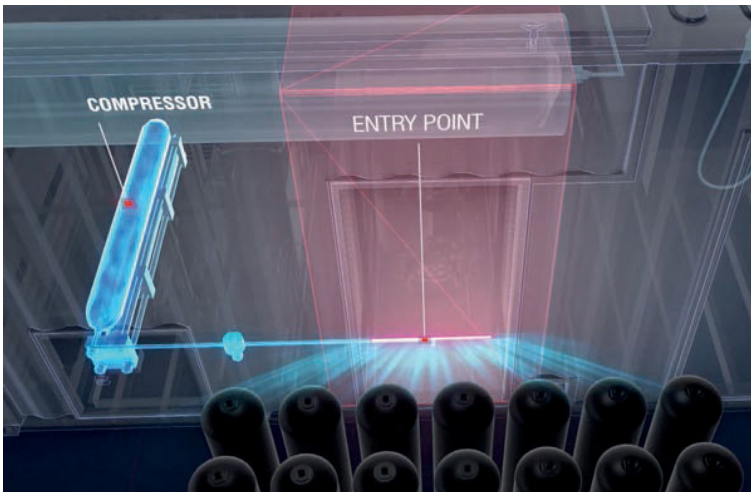
ABOVE Located near Lyon, France, TotalEnergies' biolab specialises in biocomponents chemistry

Rollout

The barriers to mass adoption of sustainable fuel for road cars are cost and production capacity. Neither are quite so critical in motorsport, but they remain the principal obstacles when it comes to rolling out this technology.

"I think [switching to fully-sustainable fuel] is something that could be done quite quickly when it comes to the major international championships," comments Aubry. "Aside from the WEC and the ELMS, the World Rally Championship has moved this year as well. We know that Formula 1 is actively looking into it, as is the SRO, so at that sort of level it's likely to happen quite soon."

He confirms that a number of other championships have enquired about making the switch: "We've spoken to a lot of people who are interested. We know we have some margin in terms of production, so it will be a discussion with the different promoters if there are tenders put out. For now, our intention is to do the WEC and the LMS and then we will see for the coming years how we can continue to expand this kind of fuel usage."



Of course, biofuel is just one piece of the puzzle. Hydrogen (whether that's for fuel cells or combustion) and e-fuels are also on the agenda. TotalEnergies is working on both, along with battery electric projects. Notably, the French company is a technical partner in the MissionH24 project that's aiming to bring hydrogen fuel cells to Le Mans.

ABOVE & BELOW
TotalEnergies devised the world's first mobile refuelling station for hydrogen as part of its ongoing work with the Mission H24 Le Mans project

Mission H24 - Thierry Gromick

But these technologies are not as mature as biofuel, Aubry points out: "We've been working on biofuel for more than 10 years now, so we know that it's coming to the market and we know that the capacity is available. E-fuel is still quite new in comparison and the capacity is still very low. It's also a more complex challenge, because the first product that you produce with e-fuel is methanol. Unless you're running a dragster, you need to process that further to produce gasoline."

This technological head start puts biofuel in a better position for now. It's harder to predict how the balance between the various energy sources could shift in the future, but Aubry believes it's likely to remain a combination of existing technologies.

Three main technologies

"I think battery electric, sustainable fuels for combustion, and hydrogen will continue to be the three main technologies that we see on track," he comments.

The challenges with these technologies don't just relate to the fuels themselves but to the refuelling apparatus.

> *"Although the tailpipe emissions are similar to a conventional fuel, the carbon-negative process of growing the grapes means that the overall process emits at least 65 per cent less CO2"*

"The main point which needs to be answered for fuel cells or hydrogen combustion in endurance racing is the refuelling situation," he notes. "Can we carry that out in a pit lane or paddock environment?"

It's an area where TotalEnergies has already made significant inroads. As part of the MissionH24 project, the company developed the world's first portable hydrogen refuelling station for motorsport use. This made its debut when the GreenGT team participated in the free practice sessions for the Michelin Le Mans Cup event at Spa in 2019.

But while these alternative concepts remain at the cutting edge for road car design, sustainable fuel is a comparatively mature technology, which is compatible with century-old engine designs. It's an idea that probably deserves to be taken more seriously than it currently is by the EV-obsessed road car industry. And for endurance racing, where energy density and fast refuelling are critical, some form of liquid fuel is arguably the only sustainable option at present. RT

WHY ARE WE WAITING?

Cleaner fuels could remove 130 million tonnes of CO2 in Europe by 2030, by reducing greenhouse gases by up to 80 per cent. So why aren't they used more widely? **Chris Pickering** talks to the experts at Coryton Advanced Fuels

MOTORSPORT has always been a proving ground for new technology. In the first five years that it was recorded, the Land Speed Record progressed through a series of cars powered by electricity, steam and internal combustion. In some respects, we're seeing a throwback to that era now, with a diverse range of different technologies all aiming to eliminate our dependence on fossil fuels.

All these concepts have their own pros and cons, but when it comes to the very high energy densities required for long-distance motorsport, it's hard to argue with sustainable liquid fuels. In theory, these give you the best of both worlds. They promise the same drama and performance as any other internal combustion engine, but with a vastly reduced carbon footprint – one that's potentially lower than that of a battery electric vehicle once the manufacturing process is taken into account.

So, job done, then? Well, not quite. The concept of sustainable fuel covers a broad range of different technologies, from simplified alternatives that may require some degree of compromise, through to sophisticated 'drop-in' fuels that provide a direct substitute for high performance gasoline. There are also numerous processes and feedstocks to consider. The biggest issue at the moment is simply investment, explains Andrew Willson, CEO of Coryton Advanced Fuels: "Most of the technologies that the industry is looking into for sustainable fuels have been viable for 40 years or more. Until very recently there simply

LEFT & INSET A scientist at work at Coryton Advanced Fuels. The company recently launched Sustain, a new sustainable fuels offering

wasn't the appetite to use them, but that's now changing fast. The last few years have seen a major push to get plants up and running that can produce sustainable petrochemicals."

Coryton specialises in producing bespoke fuels. Over the past decade or so, it has been involved with numerous areas of motorsport including Formula 1 and the World Endurance Championship. Recently, its sustainable fuel powered the Prodrive Hunter T1+ to a podium finish on this year's Dakar Rally, proving itself to be a true alternative to the fossil fuels used by the other teams.

"In much the same way that electrification isn't the only solution to CO2 reduction, there are many different technologies when it comes to sustainable fuels," comments the company's business development director, David Richardson.

> *"We want to demonstrate that sustainable fuels can perform at the very highest levels, so the public start asking, 'Why isn't this available to us as well?'"*

Dakar blend

The Prodrive ECOPower fuel developed for the Dakar combined four of these technologies: second generation bioethanol, produced from agricultural waste; e-methanol, produced by combining carbon captured directly from the atmosphere with hydrogen from renewable electrolysis; an ethanol to gasoline (ETG) process that creates hydrocarbons by dehydrating the bioethanol and reforming it as more complex molecules; and a methanol to gasoline (MTG) process that applies a similar treatment to the e-methanol.

In total, around 30 per cent of the fuel comes from methanol and its MTG derivatives, whereas 60 per cent comes from bioethanol and ETG, with various ▶

additives comprising the remainder.

The subtly different components produced by these processes can be blended to produce different hydrocarbon structures. This is similar to the oil world, Richardson points out, where a North Sea Brent crude might offer different yield to an Assam crude from India.

In the case of the Dakar fuel, the percentages used in the blend were partly a result of the FIA safety regulations. These cap methanol at a maximum of three per cent – above that level, the alcohol can split the surface tension of the foam used in conventional firefighting equipment and render it ineffective.

But methanol does bring its own advantages. Like ethanol, it has a high

ABOVE & RIGHT With Prodrive's Hunters using a bespoke fuel, created by global specialists Coryton, this year's Dakar Rally marked a major milestone for sustainable motoring. It was calculated that 28 tonnes of CO2 emissions were saved during the event

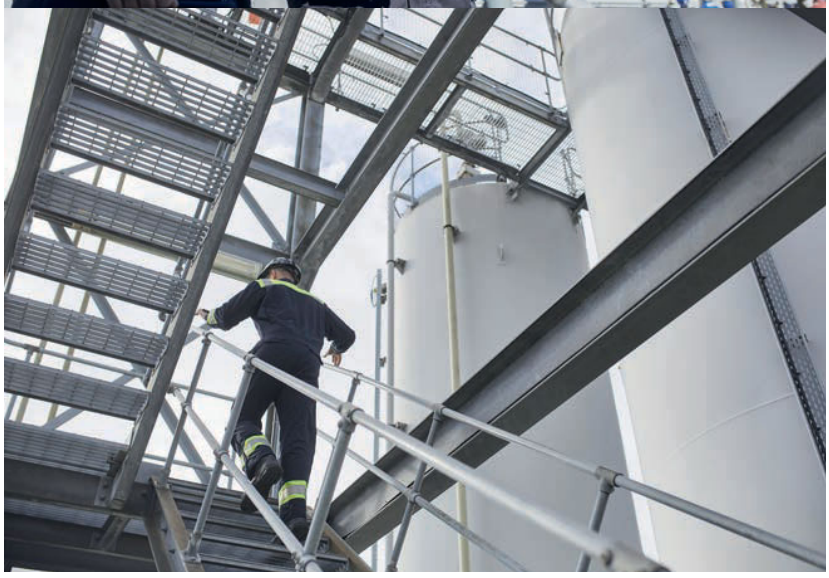
oxygen rating that can help to offset some of the less desirable characteristics of the ETG and MTG components (much as ethers and methyrs would be added to fossil-derived fuels for the same purpose). However, the two alcohols provide subtly different properties, so to maximise its benefits, Coryton used the full FIA allocation of three per cent methanol, along with around 16 per cent ethanol.

Typically, around 100 different molecules are available to chemical engineers when they're creating a fossil-derived blend. At present, the palette is rather more limited when it comes to sustainable components, but Richardson says things are changing: "We've had 160 years of chemical engineering with fossil fuels, and the industry has got pretty good at it. Now that alternative fuels have become a major topic, we're starting to see facilities opening up that will give us all these different chemistries back, but in a sustainable fashion."

> *"The same drama and performance as any other internal combustion engine, but with a vastly reduced carbon footprint"*

The same applies to other materials taken from the petrochemical industry. Everything from drinks bottles to clothing relies on chemicals that are currently derived from fossil sources, so there's a big incentive to move towards sustainable alternatives.

The definition of sustainability is open to interpretation, but there are already measures in place to prevent so-called greenwashing. Coryton is covered by the International Sustainability and Carbon Certification (ISCC) . Likewise, all of the company's suppliers are covered by either the ISCC or the European Union's RED II directive. What this means is that the full supply chain is audited for CO2 emissions, right back to the original feedstock. This includes transport of the raw materials, and even things like the energy used by the suppliers' offices. ▶



Scaling up

According to Richardson, second generation bioethanol and e-methanol are already available in millions of litres per year. Considerable upscaling is still required to supply industries such as aviation, but the technology is well on its way.

Other e-fuels remain a lot scarcer, but new facilities such as Siemens' Haru Oni plant in Chile are working towards addressing this shortfall. The Siemens plant is aiming to produce 130,000 litres of e-fuel this year, increasing to 55 million litres a year by 2024 and 550 million litres by 2026. Other facilities are understood to be targeting similar volumes, which could see e-fuels emerge as a large-scale option.

However, it's not just about the theoretical availability of the fuels, Richardson points out: "In terms of the amount of fuel that's available, I have absolutely no doubt that the whole of motorsport could be fully sustainable by 2024, but that's not necessarily feasible from a cost perspective. What I think we can expect is for most motorsport series to begin transitioning to sustainable fuels in that sort of timescale.

ABOVE As the momentum grew for the introduction of sustainable fuel, the Coryton Advanced Fuels site has played a behind-the-scenes role in top motorsport projects

"We're not necessarily advocating the idea of flicking a switch and going 100 per cent sustainable overnight. Instead, I think it's better to get more series using these fuels, and then slowly transition them through the technology progression, so everyone is on fully sustainable fuel by 2030."

The reasons for this switchover are twofold, according to Willson: "The promoters and the governing bodies recognise the fact that there is a lot of attention on motorsport's climate impact. For them, it's about minimising the emissions on the track. But for us, it's more about using motorsport as a showcase. We want to demonstrate that sustainable fuels can perform at the very highest levels, so the public start asking, 'Why isn't this available to us as well?'"

He emphasises that sustainable fuels are intended to work alongside other low-carbon technologies:

> *"The whole of motorsport could be fully sustainable by 2024, but that's not feasible from a cost perspective"*

"We are absolutely not against electrification. I think it's going to be one of the most significant contributors, going forwards, and has a very big part to play. Not least in terms of creating a clean air environment in inner city areas where electric vehicles absolutely are the best option.

"But what we're trying to say is that there isn't one single solution. There are a number of technologies, which when combined together as a package can have a far greater impact in terms of CO2 reduction than any one concept on its own. Our approach is that we should be adopting all of those technologies to get the maximum benefit in the shortest possible time."

One of the main arguments for liquid fuels is that they can be stored and transported easily, using a well-developed existing infrastructure. That includes e-fuels, where the energy can be taken directly from renewable sources. Doing so is less efficient than putting it directly onto the grid or into a battery, but the great advantage is that e-fuels plants can be located in remote areas where neither would be practical.

Richardson adds that he sees hybrid powertrains as part of that philosophy: "Firstly, a hybrid allows you to combine zero tailpipe emissions in urban areas ▶

LEFT A glimpse of the future: Sustain by Coryton

BELOW Inside the lab at Coryton

with the convenience of an IC engine. But perhaps more importantly, you can build batteries for eight to 12 hybrid vehicles for the same volume of rare and precious metals that would go into a single EV."

Designer fuels

Much of the focus is on delivering drop-in blends that can be used as a direct substitute for existing fossil fuels. That covers a very broad range of powertrain types when it comes to road cars, so the fuels are designed to be equally accommodating. In professional motorsport, however, almost all engines are developed with specific fuel qualities in mind, whether that relates to the spec fuel mandated by a series or a partnership with an individual team. Some applications are inevitably more demanding than others, and these are where the learning curve is likely to be steepest for suppliers embracing sustainable technology, notes Richardson.

"F1 and motorcycle racing have traditionally posed extra challenges due to the engine speeds involved," he comments. "When you're trying to combust a fuel at very high RPM, you need a very light fuel for it to atomise and combust in the short space of time that's available. If not, it doesn't ▶

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combust, it finds its way over the piston pack and into the oils. And that leads to durability problems."

To make matters worse, he explains, the heavier end of the spectrum is also where the octane is found. If that octane fails to atomise and combust, it won't provide the required levels of detonation resistance. As such, a lot of the work in motorsport-specific fuel development is about removing the heavy 'back ends' of the blend and developing a light fuel that will deliver the required characteristics. This is another area where sustainable fuels will improve as more chemicals become available in synthetic or bio-derived forms.

But it's not always a case of optimising the fuel to work with the available powertrains. Sometimes, it's very much the other way around. In the past, large oil companies are understood to have worked with powertrain manufacturers to investigate alternative engine designs that would be able to run on lower quality 'cuts' from the distillation process that aren't in demand for other applications.

Similarly, Scania has produced heavy duty trucks

> *"The best of both worlds, with a footprint that's potentially lower than that of a battery electric vehicle"*

BELOW The World Rally Championship is the latest high-profile series to switch to sustainable fuel

WRC / Red Bull

ABOVE Siemens' Haru Oni plant in Chile is aiming to produce 130,000 litres of e-fuel this year, increasing to 55 million litres a year by 2024 and 550 million litres by 2026

BELOW A Coryton blend operative recording a product movement in the ERP system

that run on virtually pure ethanol (ED95). This was originally piloted in an area where there's a lot of forestry work, providing a ready source of wood waste to use as bioethanol feedstock.

Philosophical shift

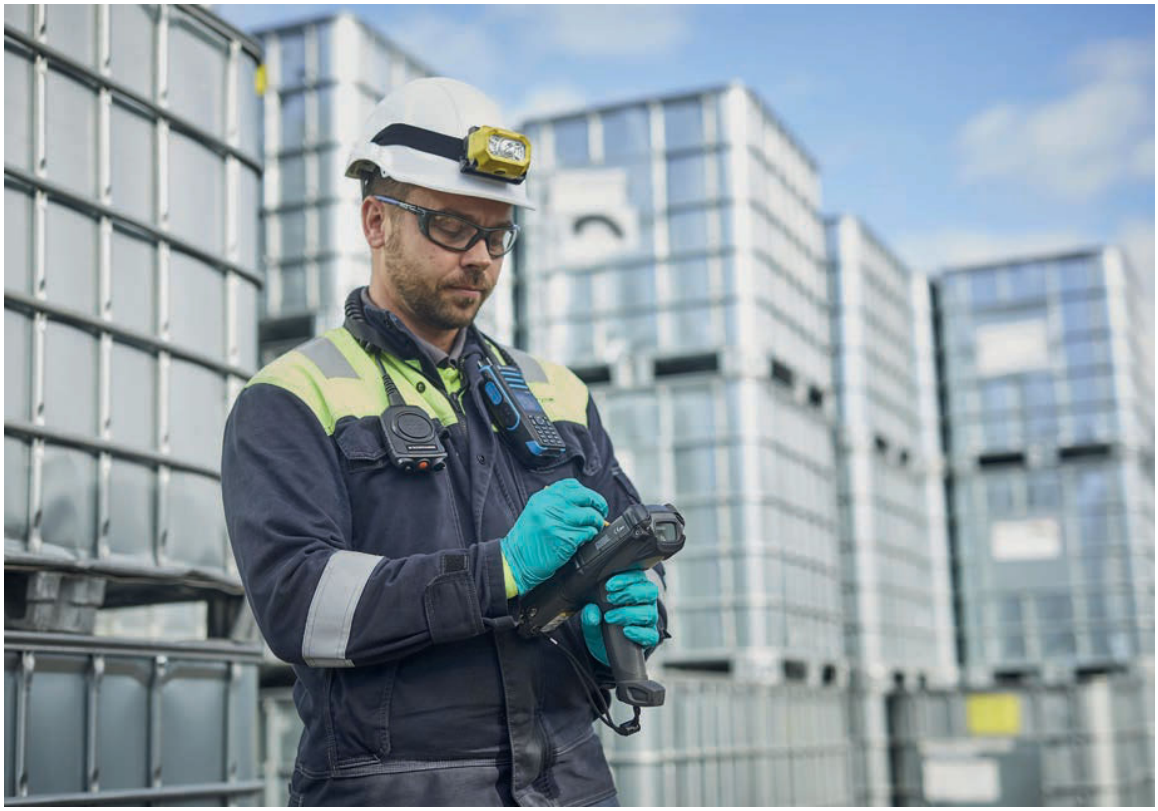
There's a parallel there to motorsport, Richardson says: "It's normal for manufacturers in motorsport to optimise their engines to run on the fuel that's available. The idea of doing that [to run on other sustainable fuels that aren't a direct drop-in replacement] is an extra step away, but it's only a small step."

With that would come a philosophical shift, he admits. Unlike a drop-in fuel, a more radical solution may involve a reduction in power or other compromises that could raise tricky marketing issues. Nonetheless, it's an intriguing prospect.

In theory, you could halve the 300 hp/litre specific output that Formula 1's naturally aspirated V8s were producing a decade ago and still get 450 hp from a three-litre engine. That might not sound like a lot in an era of 2,000 hp electric hypercars, but placed in a lightweight, aerodynamically-efficient car, it would almost certainly prove faster than an EV over the duration of an hour-long race. The visceral aspect of a grid full of big V8s or V12s running on a simplified biofuel certainly has its own appeal.

Ultimately, it's likely to come down to the individual applications. A six-lap rallycross sprint may well favour the high power density, low energy density and road-relevance of an electric drivetrain. Conversely, a 70-lap grand prix or a 5,000 km rally raid may well be permanently tied to liquid fuels of some description.

In some cases – notably the Dakar's own T1 U class – there's the potential for these disparate technologies to overlap. And that will surely only add to the technical intrigue surrounding motorsport.



THE NUMBERS GAME

Data remains king in F1 but, as **Chris Pickering** discovers, technology transfer between various markets is fuelling the constant development of newer and better instrumentation

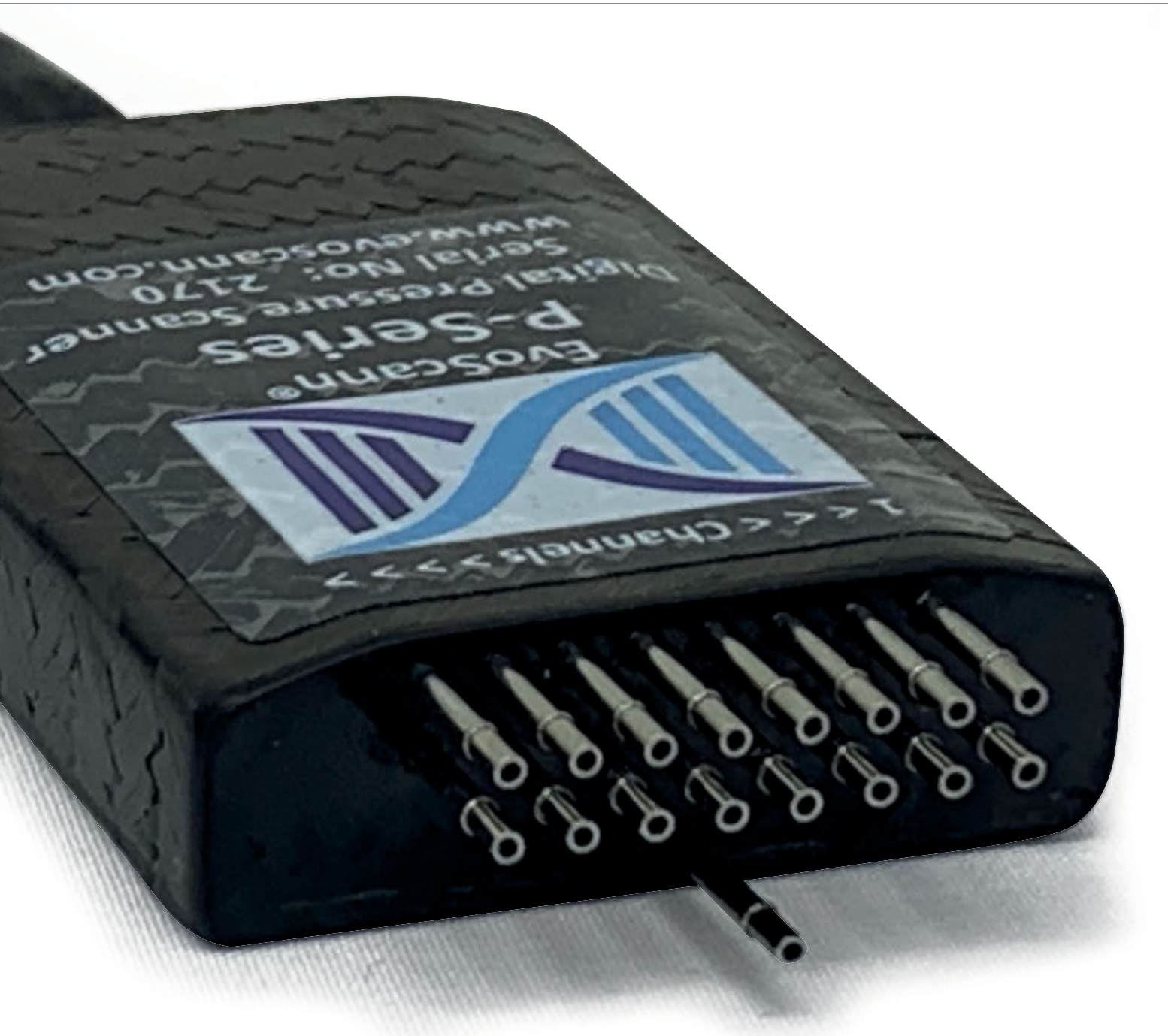
PROFESSIONAL motorsport is an industry driven by data. That's particularly true when it comes to aerodynamics, where accurate, quantifiable measurements can be key to understanding the car's behaviour and backing up observations from CFD.

Early attempts at this were sometimes crude and bulky, but modern instrumentation has become incredibly sophisticated. During testing, it's common to see Formula 1 cars sporting aero 'rakes' – an array of Pitot tubes that use pressure sensors to deduce the flow velocity at various points across the flow field. But what's less obvious is the array of built-in sensors that are used across the car during normal running.

Hampshire-based Evolution Measurement is one of the companies that is pushing the boundaries in this

RIGHT The P16-D pressure scanner delivers 16 channels of true-differential measurement

LEFT The focus on underfloor aerodynamics with the new breed of F1 car plays to the strengths of pressure scanners, which are often traditionally mounted on the floor anyway



> *"The new regulations placed far greater emphasis on underbody aerodynamic performance, which is an area where pressure scanners excel"*

field. Its EvoScann P16-A scanner provides 16 pressure measurement channels in a unit weighing around 15g and roughly the same size as a USB memory stick.

"When we first got involved with Formula 1 our core product was an eight-channel absolute pressure sensor called the EvoScann P-8A. After about a year of reliable use that had proved its worth and people started asking about our proposed 16-channel version," recalls Iain Gordon, export sales manager at Evolution Measurement.

This led to the development of the P16-A, which fits 16 channels into practically the same packaging envelope as its 8-channel counterpart. Thanks to its compact size and light weight, it can be mounted in locations that were previously out of reach.

The brake ducts are a good example, says Gordon: "In the past, the teams couldn't really measure the pressure around the brake ducts. But having something so small means that you can mount the sensor on the duct itself, put some little Keil probes inside the duct and then connect it with a little bit of tubing. The other end of the system is a CAN bus connection that provides power in and data straight out to the car's own network. A typical Formula 1 car might have 12 or more of these units onboard."

And that's just the car itself. The 'rakes' mentioned earlier typically contain something like 25 separate 16-channel sensors, giving 400 channels of data.

"There's been a lot of developments in the rakes, and these are getting lighter and smaller and more complex," comments Gordon. "Additive manufacturing is really changing the ▶

Pirelli

picture on that. A lot of the teams have gone away from the traditional fabricated struts brazed together and replaced them with carefully optimised 3D printed sections."

Going differential

In terms of the evolution of the sensors themselves, the next step was to produce a true differential pressure sensor. This measures the localised pressure at a specific point in the flow field relative to the barometric pressure that a static probe would record under the same conditions.

Traditionally, differential pressure has been calculated once the absolute data is processed – either by using a separate channel to take a baseline measurement or by applying some other form of correction factor.

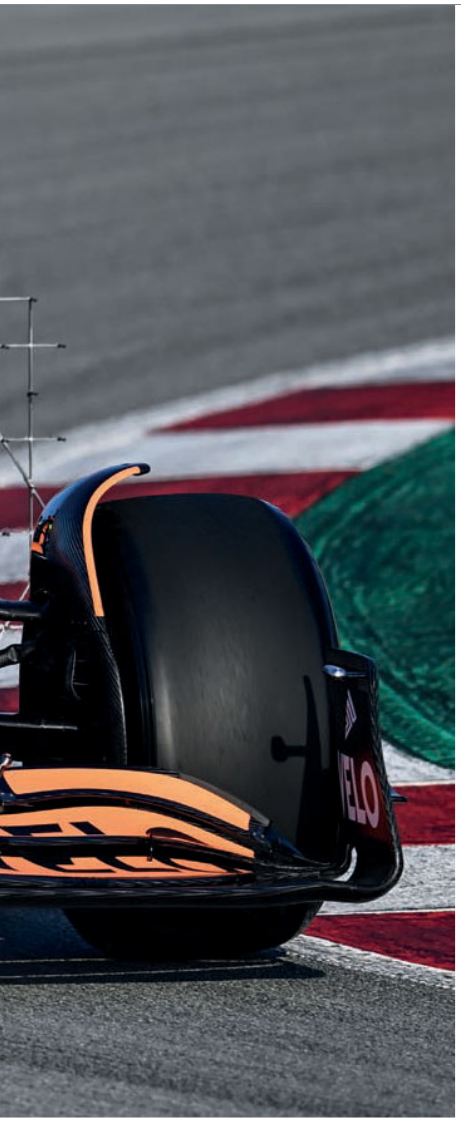
This approach has its benefits, but manually comparing two sets of data also has its downsides. For a start, the individual sensors all have their own accuracy characteristics. On their own, these errors are generally insignificant, but combine two channels to calculate a differential pressure and you're effectively multiplying the offsets.

> *"Clamping down on the aero regulations has actually led to more analysis rather than less"*

That's where the concept of a true differential pressure sensor comes in. Instead of comparing absolute readings, each of the P16-D's channels features a manifold-type arrangement; one side of the sensor manifold reads the barometric pressure, which is shared across all 16 channels using a manifold within the body of the scanner, while the other side reads the local pressure. The manifold is still fed from an external tube, which can go to a static pressure source on the car, but the same barometric pressure is physically applied to the individual sensors with no lag and no additional errors.

"We've found that the improved accuracy, sensitivity and response of the P16-D is especially useful when the pressures are lower," observes Gordon. "We've found much interest and opportunity with many EV manufacturers. And of course, they're not going as fast as a racecar. They're typically most interested in the public road speed range, where the pressures are a lot lower and any change in barometric pressure may become a more significant factor."

When it comes to road cars, it's not just the push to optimise conventional aerodynamics that's driving more aero research, Gordon notes, but the uptake of active aerodynamics. Concepts such as moveable spoilers and active cooling vents have now trickled down from high end applications into the mainstream.



"One of the biggest areas is under-bonnet aerodynamics," he explains. "Once the air gets through the grille, it can result in a massive amount of drag around the engine. So a lot of road cars now have active vents that close off that area at high speeds – when there's a lot of airflow – and then open up again at lower speeds."

In these applications, differential pressures make sense. The same applies to motorsport applications such as touring cars and closed-top sports cars, where it's usually possible to get a reliable static measurement inside the cockpit.

"The bottom line is that you'd probably choose to go for a differential pressure sensor anywhere you knew that you had a good, reliable means of sampling the barometric pressure," notes Gordon.

Absolute F1

The reason for using differential pressure is that the barometric pressure can vary substantially from one point on the circuit to another. Head to somewhere like Spa or the Nordschleife, and it's possible to find it raining on one part of the circuit and snowing on another, such is the elevation change. This level of variation in the ambient conditions absolutely needs to be taken into account one way or another.

In theory, it's easier and more accurate to do this with a differential pressure measurement than by comparing absolute readings. However, that relies on having a suitable point to take the barometric reading – and being able to transfer it to the scanner without offsets relating to temperature, vibration or g-force along the way.

"Once it's at the sensor we can measure the pressure very accurately, but it's whether you trust where that static is coming from. That comes down to whether it's good enough quality and whether it's stable," comments Gordon. "Formula 1 teams tend towards absolute pressure [rather than a true differential measurement] due to the challenges of obtaining that barometric reading."

New regs

Now, of course, is a particularly apt time to be talking about Formula 1 aerodynamics. The new regulations have thrown things up into the air. In particular, they've placed far greater emphasis on underbody aerodynamic performance, which is an area where these pressure scanners excel, Gordon points out.

"Traditionally, most of the scanners would be in the floor anyway," he comments. "We normally have one or two in the nose, and one or two in the rear wing, but most of them will be in the floor and the diffuser ▶

TOP RIGHT Evolution Measurement's passion for aerodynamic excellence was recognised with the Business of the Year award at the recent MIA EEMS Conference. The accolade was accepted by Sales Manager, Iain Gordon

ABOVE LEFT This year's pre-season testing continued the trend of using ever more complex aero 'rakes'. These typically contain as many as 25 separate 16-channel sensors, giving 400 channels of data

RIGHT On-vehicle pressure measurement is becoming a bigger topic in motorcycle racing, especially MotoGP

(plus the bargeboards and the turning vanes under the old regulations). So, the teams will be doing a lot of work on CFD correlation to ensure that the underbody flow on the real car is behaving in the way that the simulations predict."

In effect, the more sensors the team can embed in the floor, the higher the resolution on their array of readings will be – like adding more pixels to a screen. This is particularly important in the underfloor area, where it's generally difficult to capture the flow characteristics any other way.

"The new F1 rules have focused a lot of the aerodynamic development into an area of the car that you can't actually see," notes Gordon. "And it has an impact on the way that people think about the design of the cars. We've noticed on Formula Student cars that the teams tend to develop the aero in the areas that they can see and measure. Even if you have no other instrumentation, you can cover the top of the car in tufts of wool and then drive it down an airstrip, but you can't do that with the underfloor. The only way you can really measure that in the real world is with pressure scanners."

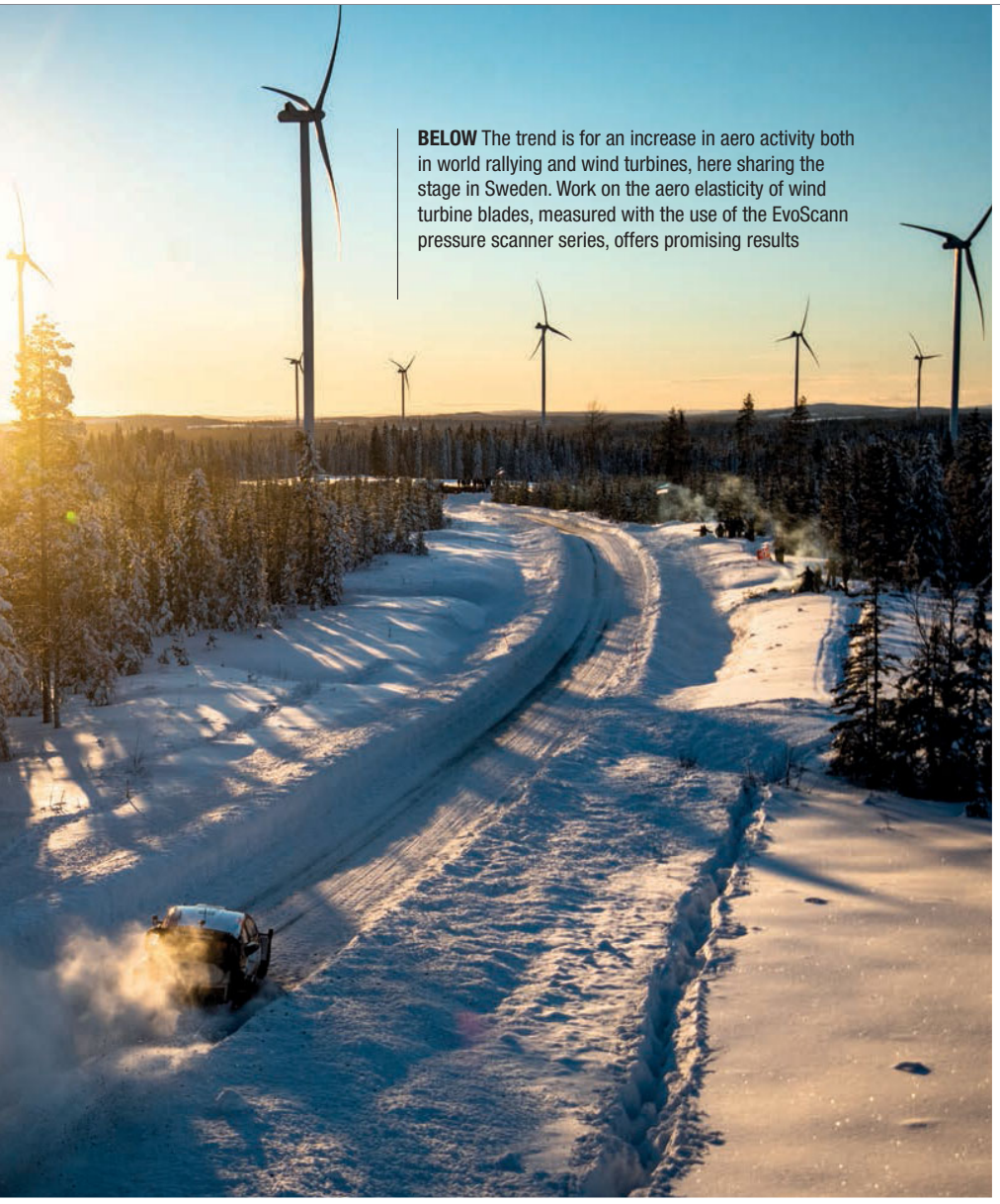
Elsewhere, the F1 regulations have been simplified in some respects, with limited scope for development on some of the traditional aero battlegrounds. As often happens in motorsport, however, Gordon believes that clamping down on the aero regulations has actually led to more analysis rather than less, as the teams scrabble to extract a competitive advantage in the remaining areas of freedom.

"We definitely see an increase in demand for pressure scanners in F1," he comments. "In the last couple of years, with the budget caps coming in, what we've found is that the teams have moved away from just discarding the used instrumentation at the end of the season towards servicing it. When the units come back to us, we generally find that they're still performing to their original specifications, but a 'winter service' on the scanners just gives them peace of mind of the measurement integrity without having to simply replace scanners."

There's also been a trend towards running more instrumentation during the race. While previously the teams – especially those with larger budgets – tended to swap the fully instrumented floors used in practice for a minimal version during the race, they now tend to leave all the sensors in place.

TOP LEFT Evolution Measurement worked on the bespoke pressure scanners used in the aerodynamic testing stage of the EU-funded CleanSky2 programme. The first demonstrator test flight took off last month

LEFT The P16-D has the same rugged exterior as the rest of the range. This allows the scanner to be subjected to high operating temperatures and strong vibrations, making it perfect for on-vehicle use



BELOW The trend is for an increase in aero activity both in world rallying and wind turbines, here sharing the stage in Sweden. Work on the aero elasticity of wind turbine blades, measured with the use of the EvoScann pressure scanner series, offers promising results

"In the past, the teams were very conscious of the weight and also the possibility – however small – that a sensor could upset the rest of the car somehow and cause a reliability issue," comments Gordon. "Now, the sensors have been proven to be very reliable and they're so light that it makes more sense to leave them on, especially with the increased weight limit that they have now."

For the sensors to be run during qualifying and the race, as well as practice and testing sessions, Evolution had to submit them to the FIA for analysis, along with details of all the hardware and software inside. Part of the reason for this is to make sure that the CAN-connected sensors can't be used to hide any illegal software or control functions, and are truly a passive measurement device.

For the F1 teams, every chance to collect data is worthwhile, so every track kilometre or minute is used to gather data for further analysis. This measurement time is even more important as track time and wind tunnel time becomes ever more restricted.

Other applications

Formula 1 continues to lead the sport when it comes to data gathering, but it's a philosophy that's becoming more established in other areas too. Categories such as IndyCar, Le Mans Hypercar, Formula E and the World Rally Championship are all seeing an increase in aero activity, according to Gordon.

On-vehicle pressure measurement is also becoming a bigger topic in motorcycle racing – and especially MotoGP – he explains: "The bikes have more than enough power, and the challenge is now more about getting that power to the track. The teams have found that one of the most effective ways of improving that is with downforce, so they're taking aero a lot more seriously these days."

> *"The improved accuracy, sensitivity and response of the P16-D is especially useful when the pressures are lower"*

MotoGP's original protruding winglets were banned in 2017 on safety grounds, but the teams quickly responded with specially shaped fairings that provided a similar function. More recently, integrated wings have been allowed back under stricter rules, along with other aerodynamic devices, such as the 'chin' spoilers found on the bikes' swing arms.

"We're supplying several of the major teams in MotoGP, and we've noticed a number of senior F1 aerodynamicists moving over to that area," Gordon confirms.

There are numerous growth areas outside of motorsport too. One of these is rail vehicle transportation design, Gordon explains, with train operators looking to improve high speed stability and reduce energy consumption.

Another is wind turbines. Traditionally, these have been analysed predominantly in the wind tunnel and CFD, but the compact size of the latest sensors mean that they can now be placed on the blades themselves.

"The idea of measuring straight from a wind turbine blade is still in its embryonic stage at the moment," comments Gordon. "The manufacturers are starting to get some good results back and see how accurate it can be with this approach. In particular, there's a lot of work going on around aero elasticity for wind turbine blades; they change shape as the wind speed increases and the engineers can use this to their advantage. But to do that you need to start with accurate data."

So, motorsport clearly isn't alone in its quest for numbers. But there's an active technology transfer between these various markets, which is fuelling the constant development of newer and better instrumentation. And that will surely be music to the ears of the F1 data engineers. RT

THE TYRES BEHIND RALLYING'S WINTER EXTREMES

The remarkable traction offered by Pirelli's full studded tyre propelled this year's Rally Sweden into the top 20 fastest WRC rounds ever run. **Mark Skewis** discovers how the feat was achieved

WHEN Pirelli was selected as the official tyre supplier for the World Rally Championship from 2021 onwards, the Italian giant was tasked with producing a family of tyres for gravel, asphalt and winter events, all to a high standard from a performance and reliability standpoint.

It was a crucial mission in terms of global reputation. Because if you can make a tyre to go rallying, you can make a tyre to go anywhere. In terms of crossover with the real world, rallying is about as relevant as it gets.

But the biggest challenge in developing those tyres was nothing to do with driving. Instead it was the global COVID-19 pandemic, with so many processes – from materials procurement to global shipping – interrupted at various points from 2020 to 2021.

ABOVE & LEFT
Monte master Sébastien Loeb knows better than anybody that being on the right tyre, at the right time, is the key to success in rallying's most famous event

Lockdowns and travel restrictions also made it difficult to test prototype tyres in the wide variety of extreme conditions required, which is why Pirelli did the majority of its gravel testing closer to home, in Sardinia.

That's also where Pirelli's rally activity manager Terenzio Testoni comes from, who has been a familiar face on rallies since the 1990s. You won't meet anybody who is more immersed in the sport than Terenzio, who heads up Pirelli's WRC programme. "When we came into the sport as sole supplier again last year, COVID was a big challenge in terms of getting all the testing done," says Testoni. "But we did it – after a very big effort – with a view towards creating an even better tyre for the brand new formula of World Rally Car."

Now with an extra year of performance and reliability data to fall back on, Pirelli has been able to improve its rally tyres further for 2022 and adapt them for the new generation of hybrid Rally1 cars.

This includes its Sottozero range for winter rallies seen on the first two events in 2022 and available in two main variants: the Sottozero Snow STZ-B – which comes either with or without studs – and the Sottozero Ice J1B tyre for more extreme winter conditions, with a full complement of 384 tungsten-tipped studs.

Into the Arctic Circle

Usually, the only time to see the unique characteristics of the full studded ice tyre in competitive action is at the WRC's traditional winter stop, Rally Sweden. But the event's cancellation due to COVID in 2021 meant that this particular Pirelli product actually first appeared in ▶

the even more extreme winter conditions provided by Arctic Rally Finland, held as a one-off replacement inside the Arctic Circle (next to the home of Santa Claus).

By contrast, Rallye Monte-Carlo – known for the unpredictable mix of dry and wintery conditions found on the roads of the French Alps every January – offered drivers a wide array of different rubber to choose from, depending on the weather forecast. This includes Pirelli's regular P Zero asphalt rally product (in soft and supersoft compounds to suit the low temperatures) as well as the two variations of the Sottozero STZ-B.

With drivers needing to pick their tyres for a whole loop of stages, the versatility of these options was key, which is why Monte Carlo is the closest that rallying comes to three-dimensional chess.

Versatility

Ordinary motorists though don't get to choose which tyres they use for every surface they drive on, so that versatility seen on the 'Monte' is why rallying is so relevant to any tyre company. In the end, the STZ-B has to do the job of any high performance road car tyre: ensure adaptability to a wide range of different surfaces, which can vary from dry to wet asphalt, to ice and snow, sometimes all in the same stage.

So how does this tyre do it? According to Pirelli, the dense sipes – the small grooves that are cut across larger tread elements – in the centre blocks of the tyre are there to ensure strong traction and braking capabilities on slippery surfaces, while the noticeably robust shoulder blocks increase the overall stability of the tyre. Between these, the

ABOVE Some of the Monte stages threw up the challenge of dry asphalt changing to snow – and back – within the space of just a few kilometres

RIGHT The tyres feature dense sipes to ensure strong traction and braking capabilities on slippery surfaces

intermediate tread blocks are where the optional studs are found, each one protruding a maximum of two millimetres from the tread.

With these shorter studs, the contact patch is strong enough to provide performance and safety on asphalt while offering the grip and stability needed for snowier conditions. As a result, the STZ-B tyre offers drivers eye-opening levels of grip in mixed snow and asphalt conditions – the most challenging cocktail that rallying can serve up, and one that's not uncommon in Monte Carlo. A stage often starts on bone dry asphalt, then as it climbs up the mountain goes from slush to snow to ice, before drying out on the way down, with occasional patches of black ice for good measure.

> *"It was a crucial mission in terms of global reputation: if you can make a tyre to go rallying, you can make a tyre to go anywhere"*

BELOW Terenzio Testoni heads up Pirelli's WRC programme

It pays to be on the right tyre at the right time, but the multiplicity of different tyres opens up opportunities for drivers to be more adventurous with their strategies, to try and make a difference.

The 2022 Rallye Monte-Carlo was a great example, with WRC legends Sébastien Loeb and Sebastien Ogier playing a game of cat and mouse over which tyre to pick for the final set of stages on the penultimate day. Having matched his rival's choice, Ogier was able to take a considerable amount of time on tyres that were not the ideal pick for the conditions, although it was Loeb who had the upper hand in the end.

As has always been the case with tyre choices in Monte-Carlo, there was also a bit of gamesmanship, with the drivers showing off tyres on their cars that they didn't necessarily mean to use, and some last-minute deliberate changes of opinion.

In the case of the more extreme Rally Sweden – which this year was moved further north to Umea in a bid to ensure frozen conditions – ice tyres were the only option, with grip always at a premium.

One of the fastest rallies ever

The remarkable traction offered by the full studded tyre is such that this year's Rally Sweden, won by Kalle Rovanperä, joined the 2021 Arctic Rally Finland inside the top 20 fastest WRC rounds ever run: a list otherwise dominated mostly by Finland's summer 'Gravel Grand Prix'.

The asymmetric design of Pirelli's J1B tyre is specifically targeted at snow-covered and icy surfaces, ▶

LEFT The asymmetric design of Pirelli's J1B tyre effectively gives the driver two sets of contact patches

ABOVE The Sottozero Ice J1B tyre features 384 tungsten-tipped studs

essentially giving the driver two sets of contact patches to bed the car into the ice and provide the grip needed for effective cornering and traction.

The internal tread blocks play their part, providing longitudinal traction while offering braking performance. The external tread blocks, however, are the most important ones.

The orientation of the blocks, along with their patented studding process, is designed to offer maximum stability when driving at high speeds on the slippery stages. The studs protrude up to a maximum of seven millimetres to bite into thick layers of ice.

But it's the all-important process of vulcanisation – thanks to some patented technology from Pirelli – that provides the Sottozero J1B Ice tyre with its most important feature: the retention of those studs. The perennial problem on all snow and ice rallies is keeping the studs in the tyres, with loose gravel just waiting to rip them out.

In the vulcanisation process, after the materials have been brought together to produce the 'raw tyre', it is placed into a specially-prepared mould to be cured in a way that shapes and solidifies the structure. Following this step, a membrane moistened with extremely hot water

– using pressure – brings the material towards the walls of the mould.

The 150°C heating process does the rest of the work – the true vulcanisation part of the process – in which the tyre acquires its elastic and performance properties. This system locks in the tungsten studs on the Sottozero, rather than them being inserted after the heating process (as is the case with other suppliers).

"Vulcanisation is at the heart of our process with the Sottozero tyre, and it's what makes the difference between our tyres and other tyres," says Testoni. "Essentially it's a chemical reaction between rubber and the other elements in the tyre that is caused by heat, to end up with a product that is stronger, yet more resilient and elastic than how it started off. It's thanks to this patented process that the studs stay in place: we saw on the Rally Sweden this year that the tyres kept their studs even in the most demanding situations, and that is thanks to the unique production system we have had in place since the early 2000s. In the end it's a chemical process, with the tyres going from a mix of elements to their final solid state."

Technology transfer

The same trusted technology is used when producing the consumer versions of this tyre, providing that elusive direct link between motorsport and road product that all manufacturers are constantly seeking.

There are two variants of the roadgoing version. The Winter Sottozero 2 is designed for pure performance in snow and ice conditions, fitted to cars of a sporty persuasion. The Winter Sottozero 3 is designed more for safety and control in similar conditions, for those who aren't looking for out-and-out speed.

But both have their origins in the rally tyres that the best drivers in the world use over the most demanding stages. This means that increased safety on winter roads is a direct by-product of the evolving development found by competing at the highest level of motorsport. The intense competition of the WRC and the desire of teams to find performance gains, as well as Pirelli's own research and development, only speeds up this rate of innovation.

Which is why the Monte-Carlo and Swedish rallies benefit everyone's day-to-day driving life. Even the people who aren't rally fans… RT

ABOVE The studs protrude up to a maximum of seven millimetres to bite into thick layers of ice

TIME TO RETHINK THE DRS

Sergio Rinland argues that Formula 1's 'insurance policy' of the Drag Reduction System is no longer necessary with the new cars

WHEN we weighed up the new-for-2022 Formula 1 rules a few weeks ago, we made two comments:

The new rules left the Drag Reduction System in place just in case they did not achieve all that was expected in terms of wheel-to-wheel racing.

The jury was out, but we wouldn't have to wait very long for Judgement Day.

Well, in the opening two grands prix, we were delighted to discover that the tireless work behind the scenes over the last few years had paid off. The racing was fantastic. We were treated to plenty of wheel-to-wheel battles and overtaking opportunities in the traditional areas helped by the car behind being capable of nearly full performance when running close to another car. Well done to the FOM/FIA technical team! Your design works as intended.

From what we saw, the 'insurance' DRS feature left over from the previous regulations is no longer necessary. Hence I believe this is bound for a revision.

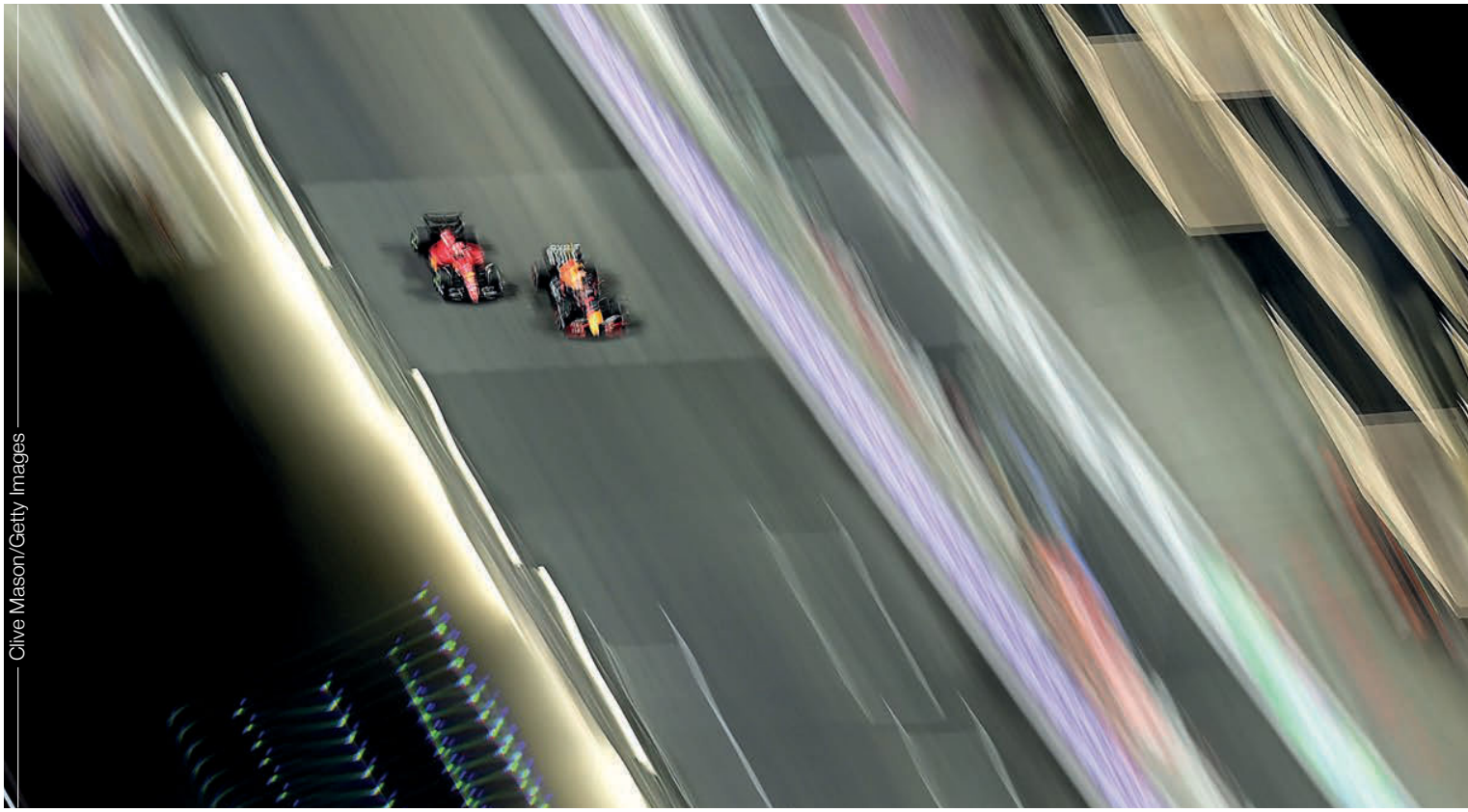
We even witnessed a situation in the last few laps of the Saudi Arabian GP where the DRS actually ▶

RIGHT The DRS almost got in the way of the contest in Jeddah, with the drivers quickly learning to hold back when approaching the detection zone

Getty Images/Red Bull

> *"DRS is the equivalent of tying one arm behind the back of one of the boxers in a prize fight"*

BELOW Can the new cars race wheel-to-wheel? Verstappen and Leclerc deliver the answer



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> *"In motorsport, every problem is an opportunity in disguise"*

tampered with the results of the race. The fight between Max Verstappen and Charles Leclerc was fantastic and both drivers were using DRS in an intelligent manner until Lance Stroll and Alex Albon came together in the final moments of the race. Then, when it was Leclerc's 'turn' to benefit from the use of DRS, a yellow flag was out and DRS deactivated.

Would Leclerc been able to beat Verstappen? Probably not, because the Dutchman was 'on a mission'! But it deprived the Monégasque of the opportunity.

This comment brings me back to the crucial point: do we need DRS?

Personally, I never liked it. The fact that the device gives the opportunity for the driver behind to attack the driver in front with a faster car, and the one in front be unable to defend, is anathema to what motorsport (or any other sport) is all about. I accept that with the way F1 cars developed over the last few years, it was a necessary evil. But now, is it really necessary? I would say no.

I am not suggesting that we go back and leave the wings fixed, because the knowledge is there, the mechanism and its controls work very reliably, so I would leave the device. But now either put it under the driver's control, or enable it to automatically deploy on the straights to reduce drag and save energy.

DRS to the rescue

After the pre-season tests in Barcelona and Bahrain, we commented on the porpoising phenomena that had caught everybody by surprise. Some teams seem to have found a way round it to reduce it a bit. Others, like Mercedes, have not, so they have to run higher than intended with the consequences of giving away performance. Here, the idea to leave the DRS as a free choice could help solve this problem. When you run DRS, the car is higher exactly where the porpoising is at its worst: the middle to end of the straights. This will improve performance without any detriment to wheel-to-wheel racing and a good spectacle.

As we learn in motorsport, every problem is an opportunity in disguise. So here is a way where the FIA/FOM technical team could add another notch to their growing good reputation by helping the teams to reduce a phenomenon that could be seen as dangerous. It would increase performance, reduce energy consumption and improve the spectacle by allowing the drivers to race and fight for position on equal terms.

Not as it is now and in the recent past, where a driver is given a tool to overtake to the detriment of their opponents, who are helpless to defend their position. As we noted some time ago, DRS is the equivalent of tying one arm behind the back of one of the boxers in a prize fight. RT

ABOVE Verstappen passes Leclerc – again. The F1 tech team behind the new cars deserve a lot of credit

RIGHT As the Alpines demonstrated, there were overtaking opportunities galore in Saudi Arabia


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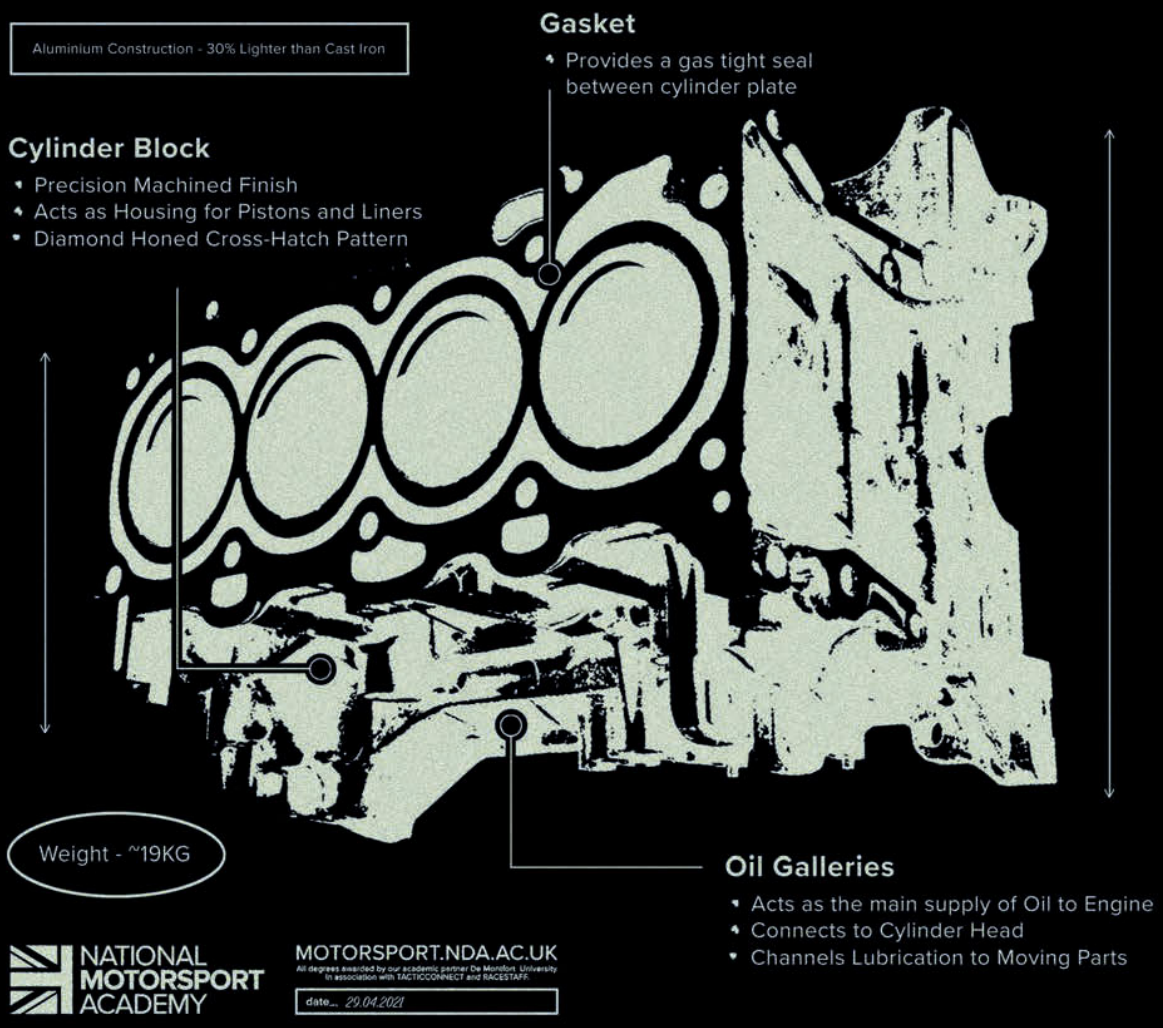

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