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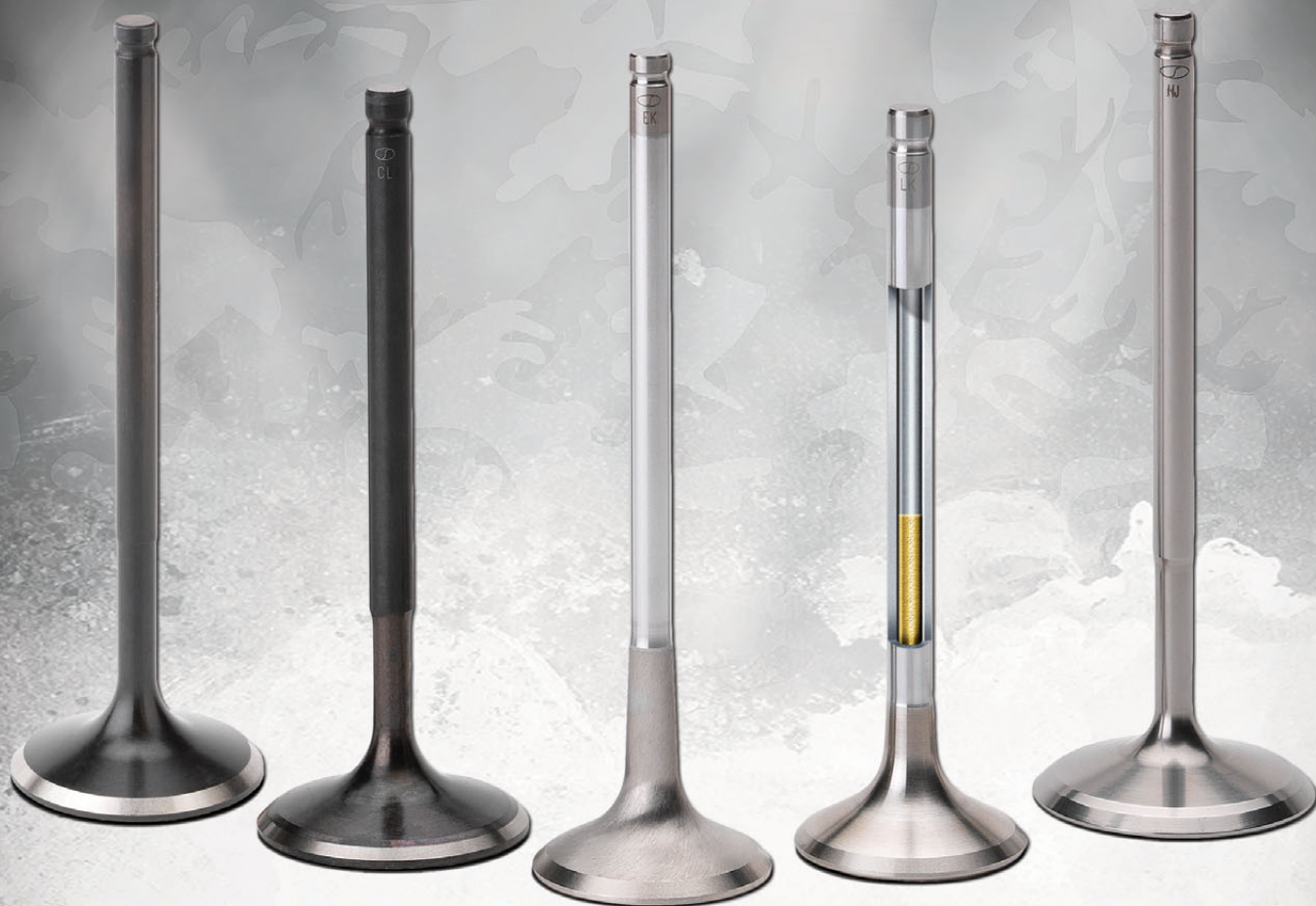


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The dawn of WRC's hybrid era

Spectacular blueprint for the future of rallying



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MOTORSPORT'S NEW MISSION

IT is as if we are still in a dark tunnel without end, but there is a chink of light, which may or may not prove to be false: motor racing is getting back to the tracks again, albeit without spectators.

Darlington on 17 May is the NASCAR Cup's target restarting date, while North Carolina Governor Roy Cooper has approved NASCAR running the Coca-Cola 600 at Charlotte Motor Speedway on 24 May, but only if health conditions do not get worse. The Governor also announced that race shops could open and team members return to work under the "essential business" definition in the state's executive orders.

Meanwhile in Formula 1, the season is scheduled to start on 5 July with the Austrian GP, followed a week later by another race, again without spectators. It has been suggested that these will be followed by two grands prix at Silverstone, again without spectators, on 19 and 26 July. Quite where that leaves Silverstone Classic, which is still scheduled to take place on the weekend of 31 July – 2 August, remains to be seen, but the event is still selling tickets.

All motorsport is in a state of flux over when the season is due to start, but one thing is for sure and that is once it resumes it will be different, certainly when it comes to the major series like Formula 1, NASCAR, endurance racing, IMSA, IndyCar and so on. The time being lost by not

racing is being spent by 'think tanks' in the various sanctioning bodies considering what comes next. I am not talking about how to react to the next pandemic that comes along, but how to race responsibly in what is bound to be a sea-change in public attitudes.

According to a report published by the UK's Centre for Research on Energy and Clean Air at the end of April, the measures to combat the coronavirus have led to an approximately 40% reduction in average level of nitrogen dioxide (NO₂) pollution and 10% reduction in average level of particulate matter pollution over the previous 30 days. This has resulted, it says, in 11,000 deaths from air pollution being avoided.

This is a fact that is going to sit with politicians who will then set punitive taxes for diesel and petrol vehicles to try and claw back some of the mountain of money they are currently spending on this and that grant. Motorsport needs to be at the vanguard of research and development in creating alternative climate-friendly fuels and then illustrate what they have achieved on the racetrack. **RT**

William Kimberley
EDITOR



The ultimate race against the clock

F1 world champions lauded for breakthrough with life-saving breathing aid

FORTY machines that would normally produce F1 pistons and turbochargers are being used for the production of a new breathing aid as F1 lends its weight to the battle against COVID-19.

The UCL-Ventura breathing aid, a Continuous Positive Airway Pressure (CPAP) device, helps COVID-19 patients with lung infections to breathe more easily, when an oxygen mask alone is insufficient.

CPAP devices are in short supply in UK hospitals. So engineers from Mercedes-AMG HPP and University College London (UCL) worked round-the-clock with clinicians at UCL Hospital to reverse engineer a device that could be manufactured rapidly by the thousands.

FULL STEAM AHEAD

Following patient evaluations at UCLH and across sister hospitals in the London area, the UK Government submitted an order for up to 10,000. Merc's entire Brixworth facility, in Northamptonshire, was repurposed to meet this demand, with the devices are being produced at a rate of up to 1,000 a day.

The breathing aid was produced, with support from the NIHR Biomedical Research Centre at UCLH, within a rapid timeframe – it took fewer than 100 hours from the initial meeting to production of the first device. Mark II of the device, which has reduced oxygen consumption by up to 70% compared to the Mark I model, has also now received regulatory approval.

Andy Cowell, Mercedes HPP's managing director, said: "The Formula 1 community has shown an impressive

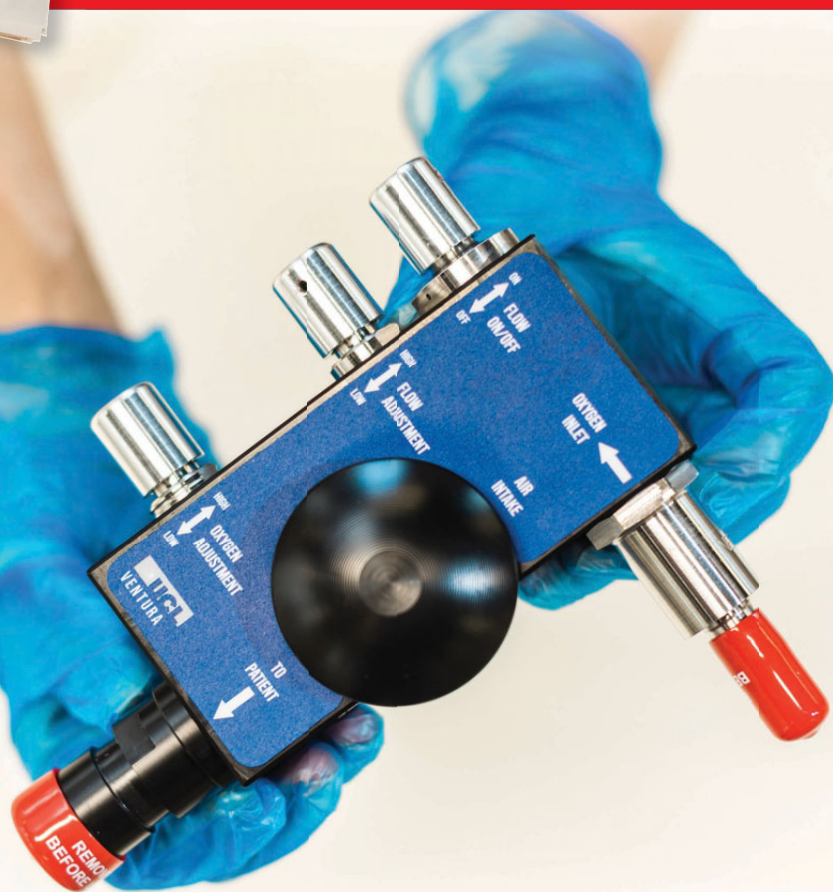
response to the call for support, coming together in the 'Project Pitlane' collective to support the national need at this time across a number of different projects.

"We have been proud to put our resources at the service of UCL to deliver the CPAP project to the highest standards and in the fastest possible timeframe."

Professor Tim Baker of UCL's Mechanical Engineering department lauded the partnership. He said: "Given the urgent need, we are thankful that we were able to reduce a process that could take

ABOVE Speed was of the utmost importance throughout the project

BELOW Production of the CPAP device at Brixworth



years down to a matter of days.

"From being given the brief, we worked all hours of the day, disassembling and analysing an off-patent device. Using computer simulations, we improved the device further to create a state-of-the-art version suited to mass production. We were privileged to be able to call on the capability of Formula 1 – a collaboration made possible by the close links between UCL Mechanical Engineering and HPP."

OPEN-SOURCE CPAP DESIGN

Crucially, the designs of the UCL-Ventura breathing aid have been made freely available to for manufacturers to download to support the global response to the Coronavirus. The licensed package includes not only the designs, but also specifies materials, tools and kit used in the rapid prototyping process, as well as the fabrication time for each part.

"Since the project was announced, we have received an incredible number of enquiries about the CPAP device from around the world," said Cowell. "Making the design and manufacturing specifications openly available will allow companies around the world to produce these devices at speed and at scale to support the global response to COVID-19."

Professor Bryan Williams (UCL Medicine), Director of the Biomedical Research



James Tye/UCL

“We were able to reduce a process that could take years down to a matter of days”

Centre at UCLH, said: "To take this, in a matter of days, from concept, through to manufacture, testing and distribution to the front line of the NHS and beyond is truly remarkable by any standard."

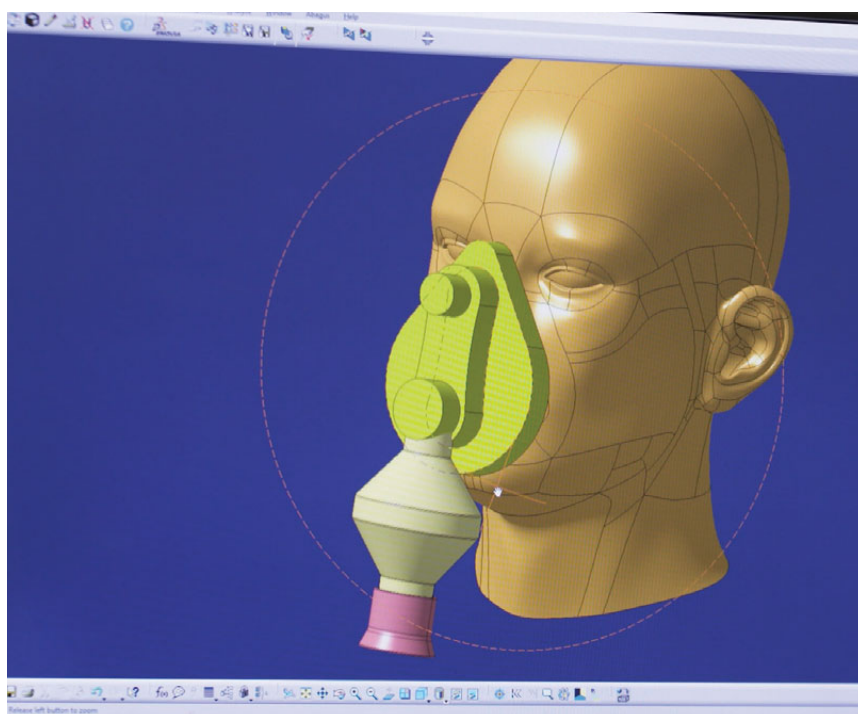
Professor Rebecca Shipley, Director of UCL

Institute of Healthcare Engineering, thanked "the brilliant engineers, business managers and team at UCLB who have come together and made this happen at a pace that would be considered unimaginable under normal circumstances."

CPAP machines are routinely used by the NHS to support patients in hospital or at home with breathing difficulties. They work by pushing an air-oxygen mix into the mouth and nose at a continuous pressure, keeping airways open and increasing the amount of oxygen entering the blood stream. Invasive ventilators deliver breaths directly into the lungs, but require heavy sedation and connection to a tube placed into the patient's trachea (windpipe).

The breathing aid has been used extensively in hospitals in Italy and China to help COVID-19 patients with serious respiratory problems to breathe more easily, when oxygen via a face mask alone is insufficient.

The other six UK-based F1 teams in Project Pitlane are also working to aid the UK's efforts to treat patients suffering from Coronavirus. Those teams are Red Bull, Racing Point, Haas, McLaren, Renault and Williams. **RT**



TOP The newly-developed UCL-Ventura CPAP device in use

LEFT Computer simulation was used to produce a much-improved second iteration of the device

F1 to start in July – but no fans

Ross Brawn explains plan to create F1 “biosphere”

FORMULA 1 is increasingly confident that it will be able to start its season this summer.

“We’re targeting a start to racing in Europe through July, August and beginning of September, with the first race taking place in Austria on the weekend of 3-5 July,” said F1 chief Chase Carey in a statement. “September, October and November will see races in Eurasia, Asia and the Americas, finishing the season in the Gulf in December with Bahrain before the traditional finale in Abu Dhabi, having completed between 15-18 races.

“We will publish our finalised calendar as soon as we possibly can.”

Formula 1 expects the early races to be without fans, which Sebastian Vettel has described as “ghost races”, but it hopes fans will be part of its events as time moves on.

One possibility is that the early events, such as that in Austria, will become double-headers with a race at the same track on consecutive weekends.

“It’s a consideration,” admitted Ross Brawn, F1 managing director of motorsports. “One of the logistical challenges is getting everyone tested and cleared to enter the racing environment. Once we do that, it’s very attractive to keep everyone in that environment, within that biosphere that we want to create, for another race.

“It’s also pretty challenging to find the right sort of races early on where we can control the environment well enough to ensure the safety of everyone. Austria fits that bill very well. It has a local airport right next to the circuit, where people can charter planes into. It’s not too close to a metropolis.

“It has a great infrastructure around it, for instance, there will be no motorhomes, but there will be full catering facility laid on that the circuit has. We can contain everyone within that environment and therefore once we are there it is appealing

to have another race the following week.”

Brawn went on to explain that while there is a real desire to kickstart the season to give the fans something exciting in an otherwise frustrating time during global lockdown, any racing can only happen if it can be held in a safe environment.

“It’s a massive logistical challenge because running a Formula 1 race is a big challenge anyway,” he said. “Running a Formula 1 race in the circumstances is something which is new to all of us and we’re working through all the requirements to make sure we operate in a safe environment for the drivers, for the engineers, for the technicians, for everyone involved in the race, and we put on the right sort of show.

“Unfortunately it will be without fans,

RIGHT Back-to-back races in Austria could kickstart a calendar F1 hopes will still feature up to 18 GPs



which is a great shame, but we still feel we can take the race out to all the fans and watchers on TV and other means.

“It’s important for us to try and get the season going,” he said. “There are many reasons for wanting to start the season. One is to excite the fans, who have all been frustrated with the delays. We have a very exciting season in front of us, but it is

a very important livelihood for thousands of people – and that is another reason for trying to kickstart the season.”

EXPLOSION OF CREATIVITY

Despite plans to get the season underway, F1 announced that in the short term it would be extending the factory shutdown period by a further four weeks. Given the unprecedented amount of time that engineers are unable to work due to the COVID-19 pandemic, James Allison, technical director at the Mercedes-AMG Petronas F1 Team, believes there will be a clear impact when the F1 teams return to their factories.

“We are of course in an industry shutdown because if we can’t race, we can’t earn; if we can’t earn, we shouldn’t spend, and so shutdown is the most sensible way for us to traverse this difficult period,” he said. “But it doesn’t mean that your brain shuts off completely, and up and down our company there will be many an engineer who is sitting there pondering how to make the car faster when we do eventually return to work.

“I think this break will prompt all sorts

of creative ideas in our team, because quite often the best ideas come when you are faced with a different challenge, when your mind is running free and doing different things. So I suspect when we get back – having had our creativity and our effort stymied by this virus – we will have an explosion of creative effort among the whole team.” **IT**

Audi withdraws from the DTM



LEFT BMW will be the only factory team left in the DTM following Audi's withdrawal

AUDI'S decision to withdraw from the DTM at the end of 2020 has caused huge ripples in the German Touring Car series, threatening its future. The German manufacturer has cited the economic challenges due to the corona pandemic as the principal reason. However, it is still committed to Formula E and customer racing.

"Audi has shaped the DTM and the DTM has shaped Audi," said Markus Duesmann, Audi's Chairman of the Board of Management. "This demonstrates what power lies in motorsport – technologically and emotionally. With this energy, we're going to drive our transformation into

a provider of sporty, sustainable electric mobility forward. That's why we're also focusing our efforts on the racetrack and systematically competing for tomorrow's 'Vorsprung'. Formula E offers a very attractive platform for this. To complement it, we're investigating other progressive motorsport formats for the future."


Audi leaves a legacy of success in DTM. It has won 23 titles, including 11 driver championships, plus 114 victories, 345 podium finishes, 106 pole positions and 112 fastest laps. Audi shaped the DTM from 1990 to 1992 and from 2000 onwards. It dominated the DTM's transition to a new turbo era last season, winning

all three titles in the most successful DTM season in the company's history.

Audi was weighing up its future even before the pandemic struck and, following the withdrawal of R-Motorsport's Aston Martins at the start of the year, it leaves BMW as the only remaining manufacturer from the end of the season.

Gerhard Berger, the chairman of DTM promoter ITR, called Audi's announcement "difficult" for the series to take. "Today is a difficult day for motorsport in Germany and across Europe," Berger said. "I deeply regret Audi's decision to withdraw from the DTM after the 2020 season."

"While we respect the board's position, the short-term nature of this announcement presents ITR, our partner BMW and our teams with a number of specific challenges. Given our common association, and the particular difficulties we all face during the COVID-19 pandemic, we would have hoped for a more united approach."

"This decision worsens the situation, and the future of the DTM now very much depends on how our partners and sponsors react to this decision. Nevertheless, I fully expect Audi to undertake its planned exit properly, responsibly and in full partnership with ITR. My commitment remains to the year ahead, and to ensuring we provide our hundreds of thousands of fans with a thrilling and competitive season. But, as soon as possible, I also want to create planning security for our participating teams, sponsors and everybody whose job depends on the DTM." 

Speedworks becomes BTCC's hybrid test partner

COSWORTH has announced that leading Kwik Fit British Touring Car Championship team, Speedworks Motorsport, has been selected as the official testing partner for its all-new BTCC hybrid system.

Speedworks, which was chosen following a competitive tender process, will work closely with Cosworth Electronics to integrate and validate the hybrid solution ahead of its competitive debut in the 2022 season.


Cosworth was formally announced as BTCC's hybrid partner in July 2019 and has been actively developing its system since August. Now in its final design phases, Cosworth will carry out bench-testing of

each element before running the system on a custom-designed test rig before it hits the ground running later in the year.

The hybrid system is expected to make its track debut at the Snetterton tyre test in July, although this will be largely

dependent on coronavirus restrictions.

In testing, Cosworth and Speedworks, which runs as Toyota Gazoo Racing UK with Ginsters, will carry out initial integration and validation of the complete hybrid system. Tests will ascertain deployment and regeneration strategies, as well as system fine-tuning, reliability and endurance.

When it comes to competition in 2022, the hybrid system will be available to drivers after the first lap of the race, either to overtake or defend their position. The precise nature of how the boost will be available and its specific deployment will be determined through the development process. 

RIGHT The two-time BTCC Independent champions were chosen as the series' hybrid testing partner



Ferrari's breath of life

FERRARI has been producing respirator valves and fittings for protective masks at its Maranello plant as one of its initiatives in support of health workers treating coronavirus patients.

The department where car prototypes are usually built is producing these thermoplastic components using additive manufacturing technology.

Some valves have been developed by Mares, a diving equipment manufacturer, tailor-made to fit their masks so as to create emergency masks to assist patients suffering from respiratory failure.

The logistics of the project were handled by Nuovamacut Gruppo TeamSystem, which also helped with the research of the different companies that contributed to the success of the project.

Other fittings are being supplied to Solid Energy, which will use them to transform Decathlon snorkel masks into aids to protect healthcare workers exposed to infection. **RT**

RIGHT & BELOW
Ferrari has ramped up its fight against COVID-19



Formula E Gen2 EVO car delayed

AS part of the plans to reduce costs, Formula E, the FIA, the teams and manufacturers have unanimously agreed to postpone the launch of the Gen2 EVO car until the 2021/22 ABB FIA Formula E World Championship.

Following an e-vote, the FIA World Motor Sport Council ratified the decision to extend the homologation period, with manufacturers only able to alter powertrain components once over the next two seasons.

Formula E and the FIA have taken a flexible and collaborative approach to decreasing spending, which will see car development costs cut by half over the next two seasons.

Teams can either introduce a new car in season seven, for a two-year cycle, or

continue to use existing technology for the next season before homologating a new car the year after for a single season.

"In these difficult times, adapting the cost structures in motorsport is a priority to ensure its sustainability," said FIA president

Jean Todt. "I encouraged the decisions regarding the FIA Formula E Championship approved by the World Motor Sport Council in this regard, which are in line with the discussions currently underway for the other FIA disciplines." **RT**



ABOVE The introduction of the Gen2 EVO has been delayed a year in a cost-cutting measure



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Existing engines to stay in WRC hybrid switch



CURRENT World Rally Car engines will be retained in next-generation cars when the FIA World Rally Championship enters its hybrid era in 2022.

The FIA's World Motor Sport Council has voted to keep the existing specification of base engine following long discussions between WRC bosses and manufacturers in preparation for the series' switch to new environmentally-friendly cars.

Measures will be put in place to reduce the development, manufacturing and running costs of the engine. They include a simplified turbocharger, a reduction in the number of engines per year and many parts frozen in current specifications.

Talks on engine specification had focused around maintaining the current 1.6-litre direct-injection turbocharged units or switching to the similar, but less powerful, R5-based units used in Rally2 cars.

The FIA has also revealed the identity of the championship's newly-selected hybrid supplier (below). "Going hybrid was on the must-have list from our manufacturers and essential to attract new ones," FIA rally director Yves Matton told Race Tech. "It was very clear that all the manufacturers wished this, which was part of the urgency of these regulations." **RT**

WRC EXCLUSIVE Page 22

LEFT Title contender Thierry Neuville had been a critic of the proposed downgrading to R5-spec engines



WRC hybrid supplier revealed

COMPACT Dynamics will be the exclusive supplier of hybrid kits for the newly-named Rally1 category, for three seasons from 2022 to 2024.

The FIA launched an invitation to tender in the middle of December last year and the German company currently supplies systems for Formula 1, the World Endurance Championship and Formula E.

FIA rally director Yves Matton said the new Rally1 category continued to gather momentum ahead of its 2022 launch. "I am convinced Compact Dynamics will bring a wealth of experience to the programme," he said.

The company's high-performance P3-topology hybrid system accommodates the motor-generator unit, control unit and battery in an extremely compact design envelope, thereby delivering maximum power density and meeting

the FIA's exacting requirements. The battery for the hybrid system is supplied by Compact Dynamics partner Kreisel Electric, based in Rainbach, Germany.

Development work on the hybrid system for the FIA is already underway, and initial vehicle testing is planned for 2021. **RT**



LEFT Development work on the high-performance P3-topology hybrid system for the FIA is already underway

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LEFT Intelligent energy deployment is at the heart of the McLaren Speedtail's incredible performance

Motorsport technology boosts McLaren Speedtail hybrid supercar

FOLLOWING the announcement that the Speedtail – the fastest McLaren ever – had completed high-speed validation tests in the US and reached its maximum speed of 403 km/h (250 mph) more than 30 times, McLaren engineers have been asked one question more than any other: 'How does Speedtail go that fast?'

The answer is that a combination of attributes, including aerodynamic excellence and low vehicle weight, delivers the hybrid Hyper-GT's astonishing performance. Fundamental to this is a race-bred electric drive system that incorporates pioneering battery technology to set a new benchmark for hybridised efficiency. This unlocks the Speedtail's intense acceleration from standstill to 300 km/h (186 mph) in just 13 seconds and maximum speed of 403 km/h (250 mph).

The M840TQ powertrain comprises a 4.0-litre internal combustion engine and an electric drive unit, which together develop up to 1,070 ps and maximum torque of 1,150 Nm. The V8 engine features technology that has evolved from McLaren's first hybrid hypercar, the legendary McLaren P1. A new lightweight air-intake system, improved cylinder head cooling and a revised piston design contribute 757 ps and 800 Nm of 'traditional' petrol-powered output to the Speedtail.

The electric motor, which uses Formula E-derived technology, generates more than 230 kW. It gives the Speedtail the highest performance installation – including cooling and integration – of any electric motor currently in use on a production road car. Power delivery is 8.3 kW/kg, which is twice the efficiency

of an average sports car.

Engineers from McLaren Applied Technologies – the McLaren Group division that focuses on virtual product development, telemetry, electrification and control – worked with the Speedtail Electric Drive Technology team to integrate its ground-breaking motorsport-developed inverter and DC/DC converter technology into the electric drive system, ensuring the levels of control and power management required for the hybrid Hyper-GT to realise its extraordinary performance.

The high voltage energy storage system is where the Speedtail truly innovates. A high-power cylindrical cell arranged in a unique array, the 1.647 kWh unit is at the cutting edge of battery technology, being extremely compact and delivering the best power-to-weight ratio of any high voltage battery available today.

As an indication of how McLaren technology has advanced, the power density of this battery is four times that of the unit in the McLaren P1, providing 5.2 kW/kg and an output of 270 kW.

The design and integration of the battery system enables the Speedtail to achieve its maximum speed by intelligent energy deployment, with these headline figures achievable because the cells are thermally controlled by a dielectrical cooling system and permanently immersed in a lightweight, electrically insulative oil which quickly transfers heat away from the cells. This system, the first of its kind in a production road car, is highly efficient and allows the cells to run harder and for longer. **IT**

National Motorsport Academy's online boom

OUT of the doom and gloom surrounding much of the motorsport industry, there is a spark of light: the National Motorsport Academy has never been busier with its online degrees.

Working closely with the industry, it has designed its courses specifically to meet the requirements of motorsport engineers. Not only will its graduates be qualified motorsport engineers with practical experience, they will also be innovative, resourceful and commercially

focused, highly desired skills within this exciting industry.

"As the race season is on hold students are working harder than ever on their studies whilst they have this free time," said Kieran Reeves, NMA's director of motorsport. "They are all employed in the industry, so they are using their time wisely to study.

"We have also seen a big jump in applications since the lockdown. Online looks like it is becoming the norm at

the moment, so we are very happy we were ahead of the curve when it came to developing online degrees. The Masters degree is going from strength to strength too. It started off really well anyway but is starting to grow exponentially now we are in the second year of delivery, as did the BSC four years ago."

All NMA courses are flexible and can be studied part-time or full-time. "Our Virtual Learning Studio (VLS) allows you to learn from anywhere in the world," said Reeves. **IT**

TOCA to salvage BTCC season

SERIES organiser TOCA has issued a revised provisional calendar for the 2020 Kwik Fit British Touring Car Championship, comprising nine events and a total of 27 races, all of which will be screened live and exclusively on the ITV network.

TOCA has taken the decision to provisionally plan events from August onwards. However, the calendar will remain conditional upon receiving appropriate government directives and approvals regarding the resumption of sporting activities.

The revised season is now scheduled to start on 1/2 August at Donington Park, which begins a run of four events in just five weekends, with Brands Hatch, Oulton Park and Knockhill completing the opening month of action. Should the BTCC be unable to resume at that time, though, the calendar will be amended accordingly.

September events at Thruxton and Silverstone are then followed by October race dates at Croft and Snetterton. Unfortunately a second event at Silverstone, originally scheduled on the

International circuit, was unable to make it into the compressed season.

The 2020 BTCC season – as originally planned – will conclude on the Brands Hatch Grand Prix circuit in Kent, but at the later date of 14/15 November.

“These are incredibly challenging times for the whole nation,” said Alan Gow, BTCC chief executive. “Through it all, we have seen the importance of being both adaptable and pragmatic... and the BTCC is no different. So it’s entirely logical to draft plans and lock-in

our provisional dates, with the ability to amend those if circumstances dictate.

“Obviously this calendar presents a hectic four months, with three separate back-to-back events and four events in the first five weeks alone. However, our teams and drivers are fully up for the challenge – there’s such enormous energy, enthusiasm and passion for the BTCC that everyone will want to just roll up their sleeves and get the action underway when the time comes to go racing.

“The over-arching element, though, will always be to ensure we have the correct procedures and protocols in place, in order to provide a safe environment. Before that time comes, though, the most important thing we can all do is to please stay safe and also protect the health of others.” **RT**

BELOW The BTCC plans a busy end to the season



WRX vision must wait

THE FIA has announced its decision to postpone the electrification of the World Rallycross Championship by one year, until 2022, due to the economic challenges presented by the COVID-19 pandemic.

The decision, which was approved by a World Motor Sport Council e-vote, was taken in consultation with IMG, the promoter of the FIA World Rallycross Championship, as well as Kreisel Electric, the approved supplier of the electrification kit, and GCK Energy, the approved supplier of energy. All parties remain committed to the original strategy built around independent teams that are currently competing in, or looking to enter the series, which was conceived with sustainability and cost control at its core.

FIA president Jean Todt commented: “While the current situation has made it necessary to defer the switch to electric by one year to allow competitors further time to adapt and to invest, the FIA remains committed to a new horizon for World RX. This will create the most cost-effective environment and demonstrate the rapidly developing performance capabilities of electric road cars in this FIA championship.”

“We support the decision to delay the introduction of electric rallycross to the world championship until 2022,” said Paul Bellamy, senior vice president of motorsports events at IMG, the promoter of the FIA World Rallycross Championship. “At this stage, plans for the new FIA eRX

Junior championship remain unaffected by this decision and work towards the electrification of this category will continue for 2021, with a complete car supply and championship organisation on an all-inclusive arrive and drive format.

“While together with the FIA, teams and partners we are committed to an electric future for rallycross, we believe it is prudent to focus on health and well-being during these challenging and uncertain times.”

Philipp Kreisel, CEO of Kreisel Electric, commented: “As we have nearly completed the development of the electric race kit and have put a lot of energy and passion into this project, it is disappointing that we won’t be able to see the electrified World RX cars next year. Nevertheless, we are absolutely convinced that by remaining unified we can make the electrification of World RX a huge success when it does happen.” **RT**

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THOMAS KRAEMER, Director Motorsport Quality Management, Porsche Motorsport

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BRYN BALCOMBE,
Chief Strategy Officer, Roborace

In a changing world it is important to get unbiased thoughts from leading suppliers, manufacturers, engineers and trend-setters... The World Motorsport Symposium offers insight into different technologies from many different angles – it is a great initiative by RACE TECH to bring key people into the same room to share information and thoughts – this is extremely important for the continuing development of future energy for vehicles."

ANDERS HILDEBRAND,
Managing Director,
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The Davos of Motorsport Engineering & Technology

The Davos of Motorsport Engineering & Technology



"It was a pleasure to attend the WMS this year. As always, the quality of delegates and papers was excellent. This combined with the ever-professional running of the event made it a great success."

RICHARD BARDWELL, Director, SHARC
MARK GALLAGHER, Director, SHARC

"We really enjoyed the event and have thought a lot about it during the last few weeks. It is one of the best events of the year to strengthen our network and to be a part of shaping the future of the motorsport industry – very valuable!"

PETER WIRTZ, Customer Account,
 Bosch Engineering GmbH Motorsport



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NASCAR RETURN BOOSTS US RACING INDUSTRY

NASCAR is ready to race again after lending its weight to the battle against COVID-19. **Mark Skewis** reports

NASCAR has revealed that it will make its return to racing on May 17, at Darlington Raceway.

The NASCAR Cup Series clash will be the first of seven races – including four Cup Series rounds – for the sanctioning body over an 11-day span at two different racetracks throughout May.

The event at the historic South Carolina track will be held without fans in attendance and is slated to be NASCAR's first on-track action in more than two months since the COVID-19 pandemic took hold.

"NASCAR and its teams are eager and excited to return to racing, and have great respect for the responsibility that comes with a return to competition," said Steve O'Donnell, NASCAR executive vice president and chief racing development officer. "NASCAR will return in an environment that will ensure the safety of our competitors, officials and all those in the local community. We thank local, state and federal officials and medical experts, as well as everyone in the industry, for the unprecedented support in our return to racing, and we look forward to joining our passionate fans in watching cars return to the track."

The events at Darlington and Charlotte will be restricted to one-day shows, with the tracks chosen because they are within driving distance of the Charlotte area workshops. The races will include live pit stops but there will be no practice and a number of safety procedures have been put in place: personnel will be limited to 16 team members; workspaces will be separated unless absolutely necessary, and if a group of people works closely, that group will have little to no



ABOVE NASCAR is ready to 'go green' again

RIGHT NASCAR's R&D centre produced a prototype human head to help medics research better treatment supply options

interaction with other groups.

NASCAR officials have collaborated with public health officials, medical experts and local, state and federal officials to create a comprehensive plan to ensure the health and safety of competitors and also surrounding communities.

Other adjustments include mandating the use of protective equipment, health screenings for all individuals before entering the facility and maintaining social distancing protocols – amongst the teams' trackside 'spotters', for instance – throughout the event.



Photos: Getty Images for NASCAR

RELIEF EFFORT

If a return to racing seems incongruous with events elsewhere around the world, the series can point to the fact that the NASCAR community has come together to play an active role in America's response to the virus crisis. Many of its competitors' workshops have been transformed into impromptu manufacturing hubs, producing protective equipment for beleaguered medical staff, while absorbing the costs themselves.

The scale of the relief effort – like the ►



pandemic itself – has been astonishing: from tracks, many of which have served as virus drive-in test centres, to drivers, who have been involved with everything from fund raising to food banks and meals for healthcare workers; and from the generous donations of sponsors, to the efforts of NASCAR's three manufacturers – GM, Ford and Toyota – who have thrown resources into projects such as the manufacture of ventilators.

The teams too have all been active, making use of the 3D printers and laser cutters that many of them possess. Roush Fenway Racing, Team Penske (through its tech partnership with Stratasys), Hendrick Motorsports and Kyle Busch Motorsports have all manufactured PPE equipment, as has Technique, which supplies chassis kits for teams.

Richard Childress Racing, meanwhile, launched an auction and sale of memorabilia and other items to benefit national and local COVID-19 relief efforts.

The auction and sale include thousands of rare, hard-to-find and exclusive items from RCR's 50-plus years in NASCAR. Among items being auctioned is an original No. 3 Chevrolet once raced by Dale Earnhardt, complete with the engine. This will mark the first time Childress has parted with an

“This will boost the morale of sports fans around the world”

original Earnhardt car from his collection

The five 3D printers at NASCAR's Research & Development Center, located outside Charlotte, have been running 18 hours a day to help address the shortage of personal protective equipment for health care workers. The facility has been manufacturing face shields with its printers, and even a prototype human

head that Wake Forest University doctors and scientists are using to research better treatment supply options.

“When you get a chance to breathe and are sitting around watching the news, you think, ‘We just put this big, beautiful new machine in, let’s see what we can do and use it for something good,’” said Eric Jacuzzi, senior director of aerodynamics at the NASCAR R&D Center. “I think NASCAR is in a unique position across the industry and especially at the Cup (Series) level where you have some of the best fabricators and engineers in the world. We have all this capability to make all these parts for cars, parts for testing, so you have a high talent pool.”

BACK TO WORK

“This has been a proactive effort to put our motorsports industry back to work and boost the morale of sports fans around the world, while at the same time keeping





ABOVE The 3D printers have been running 18 hours a day as NASCAR ramped up its production of protective equipment like face shields

LEFT Carnage at 'Virtual Talladega': NASCAR has been confined to e-racing for the past two months. It nevertheless staged a coup when it lured four-time Cup Series champion Jeff Gordon "out of retirement" for the fifth race of the eNASCAR Pro Invitational series

the health and safety of all who will be on site the top priority," said Marcus Smith, president and CEO of track owner and promoter Speedway Motorsports.

"Sports fans around the world need this, a return to some sense of normalcy with live sports on TV, and NASCAR is uniquely positioned to deliver it from a competition standpoint."

"Certainly, we have backups to backups, to backups," admitted O'Donnell of NASCAR's revised schedule, "but I would say we started with about seven pencils and a lot of erasers, and it's moved to pen now."

"But until we start racing and see how things take place and until we see how this virus affects things down the road, we can't say for sure. But I do feel confident as an industry, we have a schedule that we can pull off and that we can pull off for the fans."


NASCAR officials have said on multiple occasions that the sanctioning body still intends to run a full 36-race NASCAR Cup Series slate in 2020.

The resumption of racing will be a blessing for the motorsport suppliers, although many have been keeping busy despite the lack of motor racing.

California company ARP, for example, is an important supplier to the energy, defence and aerospace industries and so has kept very busy in the first quarter of the year although its motorsport customers have also maintained a steady stream of orders for its products. It has been working closely with many teams in NASCAR, Formula 1, IndyCar, NHRA and many more as an important supplier of critical fasteners.

"NASCAR going racing again is great news and already the calls and e-mails are coming in from some of the teams," reported Chris Brown, ARP's Director of Specialty Products.

NEW CAR DELAYED

NASCAR has delayed the introduction of its Next Gen car until 2022 "due to challenges related to the coronavirus pandemic," said John Probst, NASCAR senior vice president of Racing Innovation. "The decision was made in collaboration with the OEMs and team owners. We will continue to develop the Next Gen car, and a revised testing timeline will be shared when more information is available." 



EXCLUSIVE

MATTON'S RALLYING CALL FOR WRC FUTURE

FIA Rally Director Yves Matton explains the exciting blueprint for the future of the World Rally Championship to **Anthony Peacock**

TWO may be company, but three does definitely not make a crowd. Not in the World Rally Championship anyway.

There are currently only two manufacturers in the series – Hyundai and Toyota – or possibly three, if you count M-Sport-Ford (which is technically a privateer outfit).

And that's why some urgent action was needed in terms of regulations. The original basis of the current World Rally Car rules date back to 1997, when Group A was replaced by a much more flexible formula. It allowed even manufacturers that didn't have a turbocharged four-wheel drive car in their range to build a bespoke one and go rallying.

The effect was profound: without the World Rally Car rules there would have been no Citroën, for example. And Sébastien Loeb would probably have still been an electrician in Alsace.

There was then a significant tweak to the rules in 2011, when 'B' segment cars (the size of the Ford Fiesta) replaced the 'C' segment machine that had come before them (such as the Ford Focus); engines were downsized to 1.6-litre turbocharged units (under what was called the 'world engine' scheme) from the previous 2.0-litre turbos. In 2017, there was another shake-up, with the cars gaining more power and aerodynamics.

Even though many of the extravagant technical advances made throughout the early 2000s (such as active differentials ►

RIGHT When the dust settles on the fallout from the COVID-19 crisis, a new breed of cars will emerge that are 35% cheaper than those built under the current rules

All photos: Red Bull





and even active suspension) have long been outlawed, the cost of producing a World Rally Car has been inexorably creeping upwards.

This needed to be urgently rectified, along with another complaint the manufacturers had: with no hybrid element in the engines (unlike in all the other top-tier FIA championships), the WRC was at risk of appearing irrelevant. This, for a branch of motorsport that has always prided itself on gritty realism, was unacceptable.

The man in charge of implementing these important changes for 2022 is Yves Matton: a former rally fan, team owner, team principal and now FIA Rally

be logically known as 'Rally 1' from 2022).

The dampers will be less sophisticated, for example, as will the differentials. The engine will have a simplified turbo, many current specifications of parts will be frozen, and fewer engines will be allowed in the pool per year. Centre diffs will be consigned to history, and we'll go back to five-speed gearboxes.

The emphasis is on providing marketing value to the manufacturers by removing what Matton eloquently calls "invisible spending". He points out that the fuel tank on a World Rally Car is so much more expensive than on an R5 car – "but do people stand around looking

HYBRID WAS A 'MUST-HAVE'

One of those was the hybrid system. "This was on the must-have list from our manufacturers and essential to attract new ones," points out Matton. "It was very clear that all the manufacturers wished this, which was part of the urgency of these regulations."

German firm Compact Dynamics has already been appointed as the manufacturer of the standard hybrid system from 2022 to 2024 following an FIA tender.

A bit like the early days of Formula E – when the powertrain was a spec item to



LEFT FIA Rally Director Yves Matton is a fan at heart, keen to tap into the nostalgia of the past as he builds the WRC's future

“A car that is cheaper, with the same performance, but more relevant and more attractive to manufacturers”

Director, taking charge of the day to day management of the championship as well as its future direction.

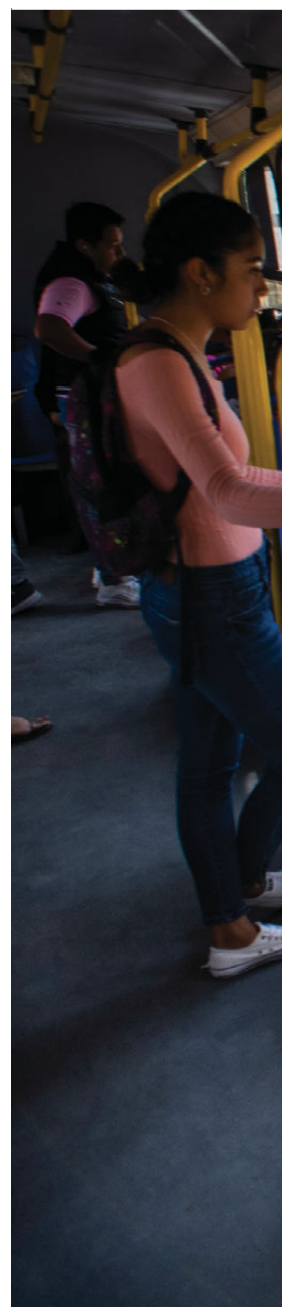
That future is going to be a much simpler and cheaper car, but one that nonetheless will be just as fast as what came before it. In total, the cost should be €500,000 per car – around 35% cheaper than the current rules.

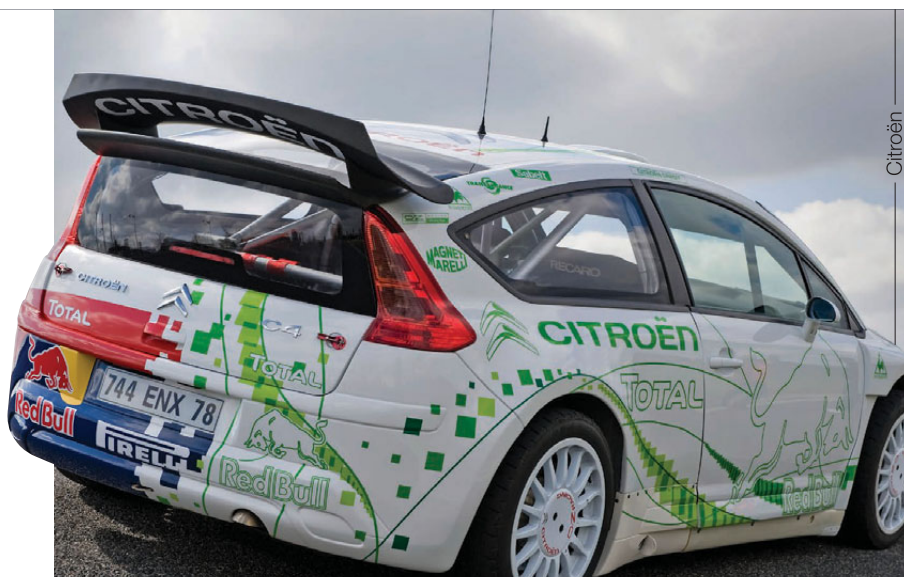
As for how all this is going to be achieved, it's about using fewer parts, more standardised parts, and making them cheaper: also by borrowing some of the thinking from the R5 category, which sits directly below the World Rally Car class (to

at it?" There will be no fresh air valve on the turbo anti-lag system too: again, that's not going to make a difference to showroom sales in the slightest.

The outlandish aero kits seen since 2017 stay however, as they evoke the spirit of Group B and make people dream. "The cars will look the same; look just as good: this is really important as it adds value." In fact they won't look exactly the same as the aero too will be simplified and strengthened, but only stamp collectors will spot the difference. Matton paints with a broad brush, focussing on the essential and the visible.

RIGHT It will send an important eco-friendly message when cars that snarled on the stages can drive quietly through towns and cities on electric power





Citroën

ABOVE Citroën added an unwieldy hybrid system to its C4 rally car back in 2009, but the next-generation WRC machines will be the first to be designed with a hybrid system from the outset

control costs, then gradually opened up – the hybrid system will initially be standard for everyone. From 2024 onwards, when the next cycle of rules will be introduced, manufacturers are expected to have more input into their own bespoke systems.

“It’s going to be exciting, because the hybrid will actually add performance: the teams requested to use the extra power in the stages,” explains Matton enthusiastically. “So we have a car that is cheaper, with the same performance, but more relevant and more attractive to manufacturers. That’s our goal and we’ve worked so hard to get it right.”

But the real purpose of the hybrid will ►



be for the cars to drive through towns and cities on electric power, showing the world how eco-friendly and fuel efficient their manufacturers are. How exactly that works in terms of range is yet to be seen, but it's sure to be the start of a rapid development curve.

The roll cage too will be standardised to an FIA design: part of an overall 'safety package' set to be shortly approved by the World Motorsport Council. This is also designed to save money: only one crash test will be necessary, for example.

You'll probably see a bit less frantic activity in the service park (which should

be quieter, as the cars will drive around there on electric power), as fewer parts will also be swapped at each halt under the new regime. "You need to make the money go as far as possible," explains Matton, underpinning the ethos of the new regulations.

BIGGEST CHANGE

But the biggest change will be with the concept of the cars. Manufacturers can go down the current route of fitting a four-wheel drive turbocharged powertrain to an existing model in their range, or ►



ABOVE Potential entrants have been seeking clarity on the future direction of rallying's top tier. Now they have it



ABOVE Compact Dynamics, recently revealed as the WRC's new hybrid supplier, has a well-established technical partnership with Audi and has been involved with the manufacturer's Formula E programme

Audi

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they can fit a body onto a spaceframe chassis, which allows for some 'reproportioning' of existing models to fit the regulations.

Think short-wheelbase Audi Quattro to realise just how exciting this is and what the potential might be. It could also allow manufacturers to promote their SUV vehicles, for example (the fastest-growing sector in the market, which is all about adventure and going anywhere), whereas previously this wouldn't have been possible. Ford (or rather M-Sport) is tipped to use the new Puma rather than the Fiesta from 2022 onwards – and this could be just the catalyst that indefatigable M-Sport owner Malcolm Wilson needs to persuade the Blue Oval to come back officially again. You can be sure that he's already working on it.

"We're targeting new manufacturers all the time, but we have to build a strong



ABOVE The outlandish aero kits seen since 2017 will stay a feature of the new breed of cars

RIGHT The vision is for manufacturers to use fewer and much cheaper parts

“Remove ‘invisible spending’: the fuel tank on a World Rally Car is so much more expensive than on an R5 car – but do people stand around looking at it?”



Audi AG

ABOVE & BELOW The new option of 'reproportioning' existing models to fit the regulations is an exciting one. Think short-wheelbase Audi Quattro (above), or perhaps an SUV-inspired Puma running with Ford factory support in 2022



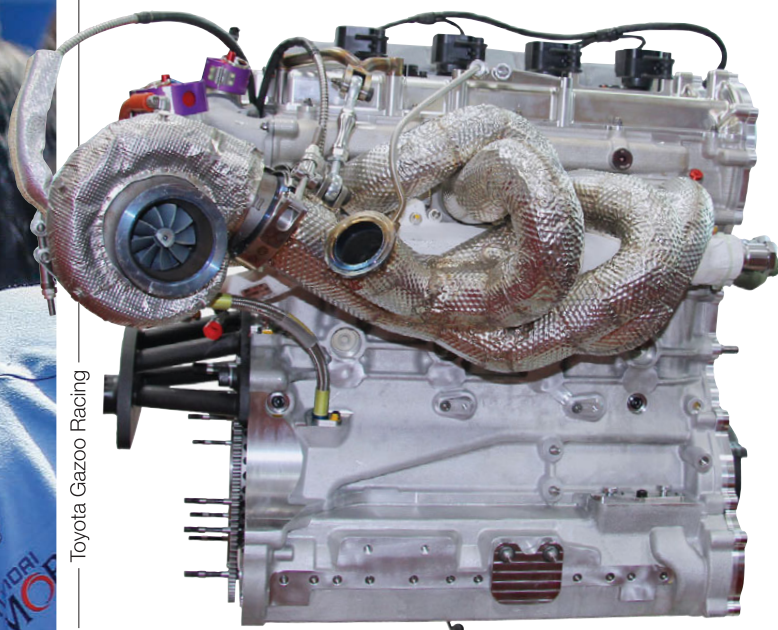
Ford





Toyota Gazoo Racing

BELOW The FIA flirted with the idea of downgrading to R5-spec engines but has decided to continue with the existing 1.6-litre turbocharged powerplants



business case for them to come,” explains Matton. “Motorsport is there for marketing, so we need to offer value to the marketing departments of all these manufacturers.”

Of course, you’re never going to please the purists. Matton’s fellow Belgian, world title contender Thierry Neuville, described the new rules as “shit”, but as many team principals – including his own at Hyundai – pointed out, he’s not the one paying the bills.

With the latest rules, Matton aims to have “three or four” manufacturers back in the WRC, each fielding four cars, so that there could be 15 or more potential rally winners. He’s tight-lipped as to who those manufacturers could be, but one possibility – and this is pure speculation – could be Opel. It’s a manufacturer with a long history in rallying, and now it’s part of the PSA Group: a company without a rally programme since Citroën’s departure, but still with a huge amount of rallying talent on its books.

Another important aspect is making these cars cost-effective for manufacturers to sell to private customers. Matton has seen for himself how effective this can be as he used to work at Kronos: the privateer Belgian squad that took Sébastien Loeb to the 2006 world title with an incongruously blue Citroën Xsara WRC. Prior to that, you need to go back to 1981 and Ari Vatanen to find the last time a private team (David Sutton Cars) won the world title.

“You remember in the 1990s and 2000s, when we had so many manufacturers competing, and giving their cars to customer teams too?” concludes Matton. “We want to go back to that. And I really think it’s possible with these regulations that we’ve created together. In the end, it’s been a big collaboration.” That’s why we might just be about to see a return to the triumphant and muddy glory days. **RT**

SINCE its inception, Formula 1 has revolved around the internal combustion engine and its fuel supply.

Across the years, there was little in the way of capping fuel consumption. And why would there be? Along with noise, it's been seen as part of the DNA of the sport: loud, fuel-hungry engines seeking maximum performance.

Only in 2014 did the FIA make steps to rein in fuel usage, harnessing a mix of capping race fuel loads and instantaneous fuel flow rates. Not without its teething troubles, the FIA homologated fuel flow meter has kept an accurate eye on things ever since. At least until 2019, when the spectre of potential team interference in the flow rate monitoring raised its head. The FIA and its

by the teams cooling the fuel and getting more of the denser fuel mass into the fixed volume of the tank.

Still, cars running out of fuel in the last laps wasn't viewed as reflecting the pinnacle of the sport in a particularly favourable light. Mid-race refuelling was allowed, and little was done to portray a more responsible environmental image to the world at large.

Later, more regulatory interventions fixed the fuel tank size by weight and policing of this area became ever more stringent. Yet still the race fuel consumption was high, and no efforts made to cap transient use of high fuel flows for qualifying and overtaking etc.

Only for the major revamp of the formula in 2014 was the fuel situation controlled

GOING WITH THE FLOW?

When the F1 season finally bursts back into life, cars will be carrying a second, encrypted, fuel flow meter. **Craig Scarborough** examines the technology involved – and the tricks it is designed to counter

FFM partner, Sentronics, acted swiftly to fend off any cunning tricks with the engine's fuel flow measurement.

POLICING FUEL USE

The quest for horsepower in F1 has always involved a race to pack as much air and fuel into the combustion chamber as possible and ignite it. Maximising this power and maintaining it throughout a race is a factor of fuel flow and fuel tank capacity.

In the Eighties some attempts were made to cap fuel load, via the tank's cubic capacity. These regulatory efforts were partly overcome

in a robust manner. Two sets of rules were implemented. Firstly, a race fuel allowance of just 100 kg was enforced. The issue with this being taken as a solution in isolation was that the newly turbocharged engines could momentarily use huge amounts of fuel in high boost mode, for qualifying and overtaking. Thus, a second rule capped instantaneous fuel flow at a maximum rate of 100 kg/hr, preventing spikes in fuel usage.

The FIA required a means to measure and enforce these fuel flow rules. The solution was an ultrasonic sensor placed in the fuel line between the tank and the high-pressure pump on the engine. ►



BELOW The finger of suspicion was pointed at Ferrari last season as it not only closed the performance gap to Mercedes, but looked to have gained a power advantage





ABOVE The never-ending game of cat and mouse between the teams and rule-makers has taken another twist with the introduction of the new 'FIA FFM' fuel flow meter (blue), alongside the existing FlowSonic Elite device (green)



Pirelli

The fuel flow meter is capable of tracking both transient and steady fuel flow, flow direction, fuel temperature and cumulative fuel usage. Being ultrasonic and therefore having no moving parts, the sensor presents no obstruction to the fuel flow. Teams acquired their own FFMs from the FIA-designated supplier and an independent third party would calibrate them against the teams' homologated fuel samples. Thereafter, the teams would be given the sensors back to install into the fuel system.

Initially the FIA tender was won by Gill Sensors, which solely supplied the FFMs from 2014 through to 2017. Then

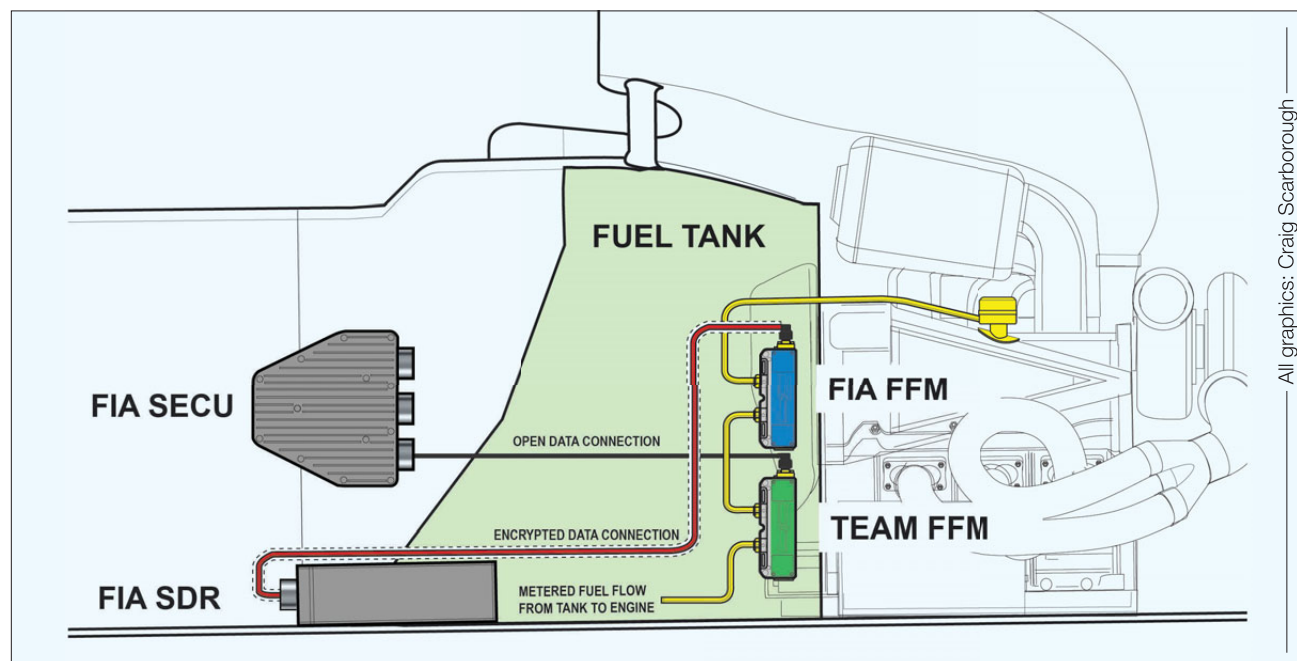
Sentronics won the subsequent tender and has been the sole supplier since 2018.

At the first race in 2014 with the new FFMs installed, Red Bull immediately fell foul of the fuel flow rate regulation in the race, resulting in a Stewards' report and a disqualification. Telemetry transmitted from the car through the GP showed the fuel flow was too high, but Red Bull decided to trust its own data and opted against heeding the FIA warning to reduce the flow rate. Since this matter was resolved between the FIA, Red Bull and Total fuels, there has been no issue with the FFMs, even when the supply switched to the new Sentronics meter in 2018.

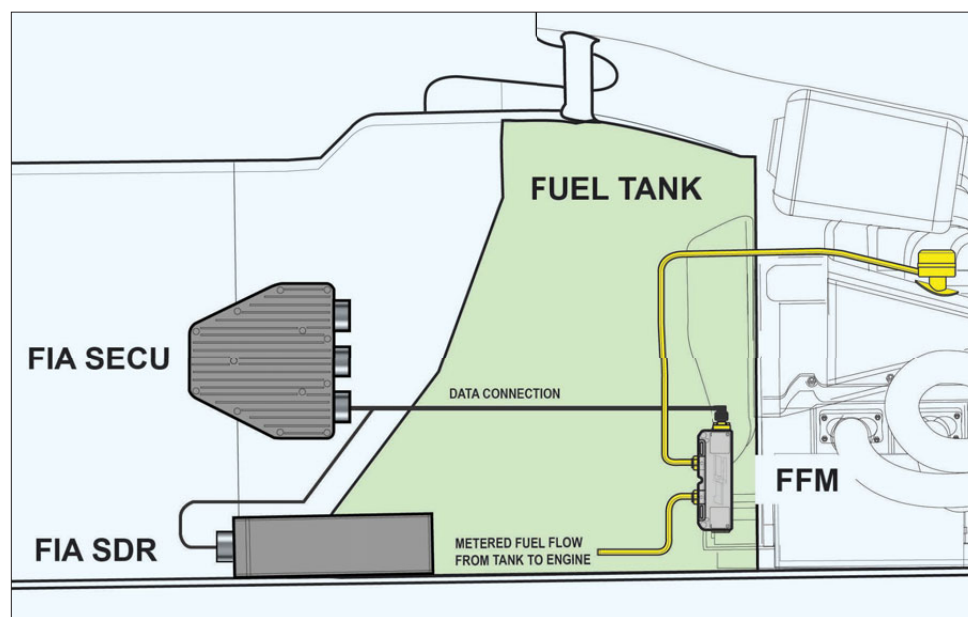
THE RACE TO 1,000 HP

The evolution of the new hybrid/ICE power units continued apace through the six seasons from 2014. For many the focus was initially on maximising the hybrid system's endurance. With an effective cap on hybrid power and energy, the focus has increasingly reverted back to the IC engine itself.

The maths is simple, with a maximum of 160 hp from the Hybrid MGU-K and a limit of the time that it can be deployed around a lap when the car is not traction-limited (in simple terms wide-open throttle time). Therefore, IC Engine output is the ▶



All graphics: Craig Scarborough



ABOVE & LEFT Both the original fuel flow meter and new encrypted version (above) were used through winter testing in Barcelona. They mark a significant step forward from the original setup (left), which teams may well have circumnavigated

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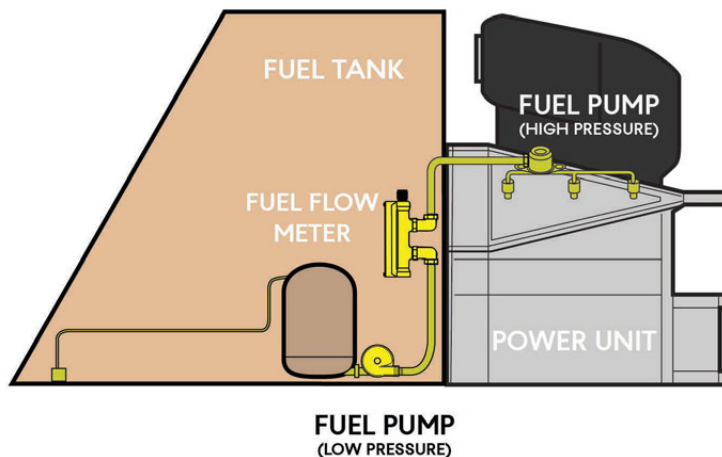
most effective means of chasing better lap times.

Development has been impressive. From outputs of around 850 hp in 2014, with a hybrid endurance less than the wide-open throttle time for the lap, by 2019 all the manufacturers had an engine that produced in excess of 1,000 hp, with hybrid endurance to last the lap's WOT time.

Mercedes-AMG was the first manufacturer to really crack the ICE performance, dominating the power curve rankings from 2014 through to 2018. Partly this advantage stemmed from early investment in the new engine formula, but it also came from early adoption of pre-chamber ignition.

The challenges the new power unit formula posed the teams were combatted with various developments, some of which could perhaps be described as at the edges of what was legal. Given the fuel flow restriction, some teams opted to cache some fuel outside the fuel tank and ahead of the direct injection pump. This gives rise to the potential for fuel going from the accumulator and into the GDI pump unrecorded by a fuel flow meter and thus potentially higher than the 100 kg/hr rate. The FIA then prescribed how much fuel can sit upstream of the FFM. In 2019, this was still a generous 2,000 cc but reduced for the 2020 season to 250 cc.

Likewise, fuel development has been a major



ABOVE It's possible that teams could have tuned a fuel pump's output to harmonise with the 2.2 kHz sampling rate

contributor to the ICE output, albeit capped tightly by the regulations. This led to the non-sensical oil burning practice which has spanned the current power unit period. With teams unable to include the required additives – in particular knock inhibitors – in the fuel, they discovered that having them make their way into combustion via oil mist, routed 'legally' into the airbox, was an effective workaround. Notably the 2018 and 2019 rules rightly clamped down on this practice, so in 2019 there was little scope to boost ICE power.

However, for 2019 Ferrari appeared to have not simply closed the gap to Mercedes on ICE power, but overtaken it. Paddock rumours were running riot, from the vaguely possible through to the ridiculous: ingesting engine coolant, oil through the turbo compressor, gasses through the pneumatic valves and even hydraulic fluid, were touted as replacements for oil burning.

By mid-season, the focus for suspicion was placed by Red Bull on the fuel flow metering system. The reasoning was sound: if you can increase fuel flow without the FFM detecting it, you will get more power. This was a plausible explanation and the FIA was duty bound to investigate.

METER READING

By the end of the 2019 F1 season, a new specification for the Sentronics fuel flow meter installation was set out in a technical directive from the FIA for implementation in 2020. This opened up not one, but two cans or worms. Firstly, was the solution aimed at what Ferrari might have been doing in 2019? Then secondly came the political ramifications of how the FIA announced the resolution to the Ferrari investigation.

It's beyond the scope of this article to provide evidence to the former or a justification/explanation of the latter. Best we look at the technicalities of the FIA/Sentronics solution for 2020, then the potential 'loophole' scenarios that it counters, without finger-pointing.

In summary, the FFM installation since 2014 has consisted of the meter taking its fuel feed in from the pipework downstream of the fuel collector/pump in ►



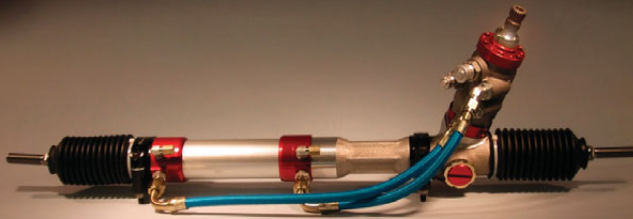
BELOW & LEFT Fuel flow metering did not get off to an auspicious start, with Red Bull excluded from second place in the first race of the new era, at Melbourne in 2014



Photos: Red Bull

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the tank, with its outlet then going outside the tank to the GDI pump on the cylinder head. Then, the meter's electronics interface with the car's loom/CANbus back to the ECU and FIA Data Recorder (SDR).

In this layout the meter's output is visible to both the team and the FIA. With the FFM taking readings at 2.2 kHz, a fuel system delivering 100 kg/hr will read as legal ('Legal or illegal' – top graph). If the fuel system over-delivers fuel, the meter will pick up the increased readings and the FIA will be able to see the transgression (second graph).

For the first five years this layout was deemed sufficiently robust to go unchanged.

For 2020, however, the new layout is quite different. There remains a Sentronics FlowSonic Elite FFM sitting in the same position with the same data connections; this has now been referred to as the 'Team

FFM', and has a blue label on its front. As the title suggests, this FFM is for the team's own purposes, but now no longer provides the FIA with its data.

Instead, there is now a 'FIA FFM', with its green label, which sits in series downstream of the 'Team FFM'. Unlike the 'Team FFM', the FIA meter has its own wiring connection to the FIA SDR [Safety Data Recorder]. The team's ECU has no access to this wiring/CANbus, making it for the

private use of the FIA to monitor fuel flow.

The details of this FFM device and its connection to the FIA SDR is the major change and counters several possible tricks teams might employ to avoid accurate scrutiny of the FFM output. The FIA FFM is still the same basic ultrasonic sensor with its machined aluminium case, but with revised electronics including anti-aliasing and encryption technology. Neville Meech, managing director at Sentronics, comments: "This new variant of the FlowSonic fuel flow meter is not only one of the most technologically advanced currently available, but is an important step forward in improving the FIA's policing of the maximum fuel flow regulations in F1. We're proud to lead the market in solid-state fuel flow meters, and to demonstrate our ability to develop world-class technology in

“If you can increase fuel flow without the FFM detecting it, you will get more power”



rapid timeframes.”

Both technological updates aim to beat any potential for a team to synchronise its fuel pump output to be offset from the meter's 2.2 kHz measurement frequency.

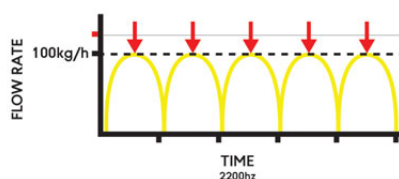
Firstly, the anti-aliasing means the sampling frequency of the FIA FFM is randomised, so that rather than a regular sampling rate at 2,200 measurements per second, the rate will be constantly changing.

Then, as if that's not enough, the meter's output is encrypted, as well as on a separate and private connection. So, even if a team could read the meter's output, the data is scrambled and thus useless to be used as feedback for a closed loop control system.

While nothing is impossible, this should close off most attempts to beat the FIA FFM, should a team seek to over-deliver on the fuel flow rate.

LEGAL OR ILLEGAL? How fuel flow measurements could have been manipulated

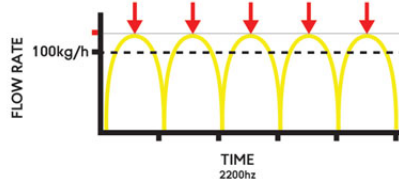
LEGAL FLOW MEASURED



FFM MEASUREMENT 100kg/hr @2.2kHz

FUEL OUTPUT @100kg/hr

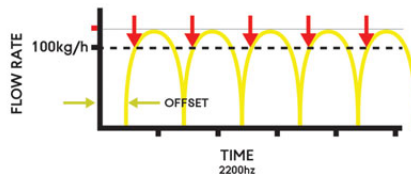
ILLEGAL FLOW MEASURED



FFM MEASUREMENT +100kg/hr @2.2kHz

FUEL OUTPUT +100kg/hr

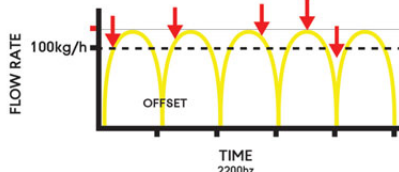
OFFSET FLOW MEASURED AS LEGAL



FFM MEASUREMENT 100kg/hr @2.2kHz

FUEL OUTPUT +100kg/hr

RANDOM SAMPLING MEASURED AS ILLEGAL



FFM MEASUREMENT +100kg/hr RANDOM

FUEL OUTPUT +100kg/hr

LEFT The Prancing Horse struggled for pace in pre-season testing, where the second fuel flow meter was introduced

WHAT TRICKS HAVE BEEN BEATEN?

So, what might teams have been doing? The fixed sampling rate and open data connection have both been changed, so these are the most likely explanations as to where a team was finding a loophole to exploit.


It's conceivable that a team could tune a fuel pump's output to harmonise with the 2.2 kHz sampling rate. If the pump's output and the sampling rate are perfectly aligned, the meter will read the peak of the flow pulses coming from the pump. With the two synchronised, the meter would immediately read any over-delivery of fuel.

However, if the pump's output is offset from the meter's, then the meter would read the rising/falling curve of the pump's output, rather than the peak ('Legal or illegal' – third graph). Thus, the meter will understate the fuel flow, allowing the pump to over-deliver the 100 kg/hr flow rate, whilst still being recorded as legal. The issue with this is that the team needs to know the timing and

measurement of the meter's output, so as to use the feedback to synchronise the pump with the sampling frequency and not get caught out. With the old layout, this feedback loop is easily accessible.

With that loophole's solution in place, if you then implement the 2020 FIA FFM installation, you no longer have the regular sampling rate and feedback. The ability to synchronise the pump to the meter has gone and the risk of getting caught over-delivering fuel is far too likely ('Legal or illegal' – bottom graph).

With any aliasing tricks now countered, that malpractice should end. The F1 season has yet to start, but winter testing has shown Ferrari to already be at a disadvantage. It remains to be seen if this performance deficit is power-related and, if so, is it fuel flow related?

There are no firm answers as yet, but one thing does seem clear: the FIA, with Sentronics, appears to have counteracted any possibility for ICE power to be boosted with fuel flow tricks. 



RARING TO RACE


Larry Holt, Multimatic's chief technical officer, talks to **Chris Pickering** about replacing Joest on Mazda's DPi programme, why IMSA/WEC Convergence can't fail – and life under lockdown in the 'turkey shed'!

MAZDA has always gone its own way in sportscar racing. From the rotary-powered 787B that won Le Mans in 1991, to the Skyactiv-D prototype that brought diesel to the LMP2 class in 2014: the Japanese manufacturer has always done things a little bit differently.

The same could be said of Mazda's current DPi car, the RT24-P, which was built to race in the top class of IMSA's WeatherTech SportsCar Championship. While Cadillac came to the series with a 6.2-litre V8, and Acura used a 3.5-litre V6, Mazda turned up with a highly turbocharged 2-litre inline four. This wasn't chosen to exploit some sort of loophole in the regulations, but rather to reflect the company's heritage of using small, four-cylinder engines in its road cars.

This approach brought more than its fair share of teething troubles. But as sportscar racing looks ahead to whatever remains of the 2020 season, there's a feeling that Mazda might finally have cracked it. The RT24-P picked up three back-to-back wins at the tail end of last season, while the beginning of this year saw Mazda's best ever result at Daytona with a second place finish for the number 77 car of Oliver Jarvis, Olivier Pla and Tristan Nunez.

This success came as Mazda's longstanding engineering partner, Multimatic, announced it would be taking over trackside operations from Joest Racing. The legendary German team had itself been brought in to replace SpeedSource towards the end of the 2017 season. Finally, though, the project appears to have achieved stability under ►



LEFT When the IMSA season roars back into life, Multimatic will be taking over Mazda's trackside operations from sportscar legends Joest

Photos: Mazda



RIGHT Mazda's RT24-P leads the Daytona 24 Hours at night. The car led for 190 laps en route to the manufacturer's best ever finish in the endurance classic

BOTTOM An early iteration of the Mazda RT24-P in CFD. It wasn't the airstreams over the car that were the problem, so much as management of the air entering the nose

the watchful eye of Multimatic's chief technical officer Larry Holt.

We catch up with Holt (over the phone, naturally) at his house in the Black Mountains in Wales. It's one of several properties he owns in the UK, as part of what is normally quite a nomadic lifestyle. ("I can't remember the last time I spent so long in one place," he muses, as we reflect on the peculiarity of life in lockdown.)

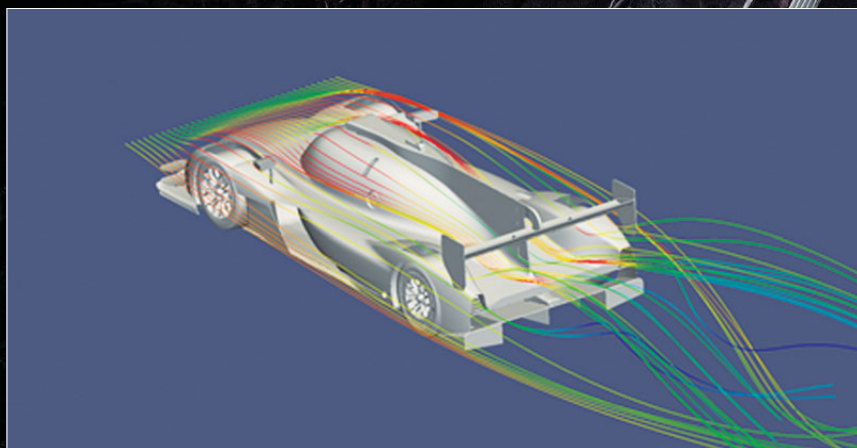
Holt's home office is in a converted barn, affectionately known as the turkey shed. It sounds like an unlikely place for some of the biggest decisions in motorsport to take place, but there again, he's no ordinary executive. Laid back, charismatic and totally unfiltered, he comes across more like an ageing rock star than the boss of an engineering company. Maybe it's the hair.

To understand the evolution of the

RT24-P, we go right back to its origins.

"When Lola went bankrupt in 2012 we bought all of the inventory and a licence to use the name," explains Holt. "We effectively took over the engineering team there led by Julian Sole and moved them into a new office just down the road from the original factory in Huntingdon. With that came the company's intellectual property, which included the LMP2 project that was being done with Mazda."

This started off as the fascinating but ill-fated Sykactiv-X diesel prototype, which struggled to make the required power and suffered from vibration issues. It soldiered on for the 2014 and 2015 IMSA seasons before the project switched to a turbocharged inline-four gasoline engine, developed by AER, for 2016.





BELOW Larry Holt is the genius behind Multimatic's engineering expertise

"We came really close to some wins with what we called the 'Mazola' [the Mazda-Lola] and then this new deal came in with DPi," recalls Holt.

Central to the idea of the new category was that it would effectively combine an LMP2 chassis with a manufacturer-specific engine and body kit. This meant that the chassis constructors would need to build an LMP2 car to take part. And that wasn't something that exactly filled Holt's heart with joy.

"I had absolutely zero interest in LMP2," he says. "If you look at the business model, you'd have to sell a lot of customer cars to make any money. You're going to spend two or three million dollars developing the car and then it's cost-capped, plus spares capped at 140 per cent; you don't

"Don't get me wrong, I think the guys sat on the wall for Joest are the best in the business. There's no hard feelings on either side"

need a very complicated spreadsheet to realise that's not going to work. DPi, on the other hand, offered the prospect of a manufacturer-backed programme."

Mazda North America's motorsport boss at that time, John Doonan – now ►



president of IMSA – was keen to continue the brand's sports car programme and saw the opportunity to introduce more road car DNA with the new DPi format. In order to enter the category, however, Multimatic needed to be selected as one of the four chosen LMP2 chassis constructors.

"It came down to a meeting over some beers in my motorhome at Laguna Seca," recalls Holt. "Bill [Riley] was vying to become an LMP2 constructor. We knew that there was only going to be one North American constructor, so for us to do the Mazda deal it needed to be Multimatic... and for Bill to build an LMP2 car it needed to be Riley. After about five beers we said 'f*** it, why don't we do it together?'"

DEVELOPED IN PARALLEL

Part of the deal was that Multimatic would handle the chassis production. This would underpin an LMP2 car, badged the Riley Mk XXX, with an aero kit jointly developed by Riley in North Carolina, Multimatic in Toronto and Lola in the UK. Meanwhile, Multimatic would work with Mazda North America to create a DPi variant, known as the RT24-P. This would use the familiar Mazda AER four-cylinder turbo engine in place of the LMP2-spec Gibson V8, plus a bespoke aero kit.

Both cars debuted at Daytona in January 2017. It



ABOVE Key engineering figures like Leena Gade have made the transition from Joest to Multimatic

BELOW Revisions to the RT24-P's open nose concept were the secret to curing the car's aero instability and improving its cooling efficiency

soon became obvious, however, that not everything was going to plan. "The LMP2 car did okay, largely because Tory Flis [at Visit Florida Racing] runs an amazing team. His guys were tenacious as hell and they just pushed on. The Mazdas, on the other hand, fell apart around our feet," Holt recalls. "We spent the next few races chasing various problems, but halfway through the season we realised the main issue was aero sensitivity. We could find a window once in a while, but the car wasn't working well and it wasn't cooling properly."

Out came the beers again and it was decided that there were a number of fundamental problems that affected both the LMP2 and the DPi variants, particularly where the underbody aerodynamics were concerned. The story goes that Holt had costed the work at around half a million dollars, but Riley wasn't able to put up 50 per cent of the budget, so Multimatic officially took control of the LMP2 programme.

"You can submit a wildcard to make one change [to the homologation] but we were looking at a lot more than that ▶



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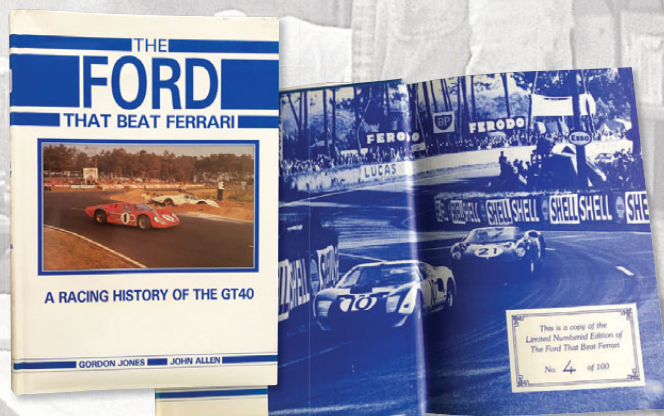
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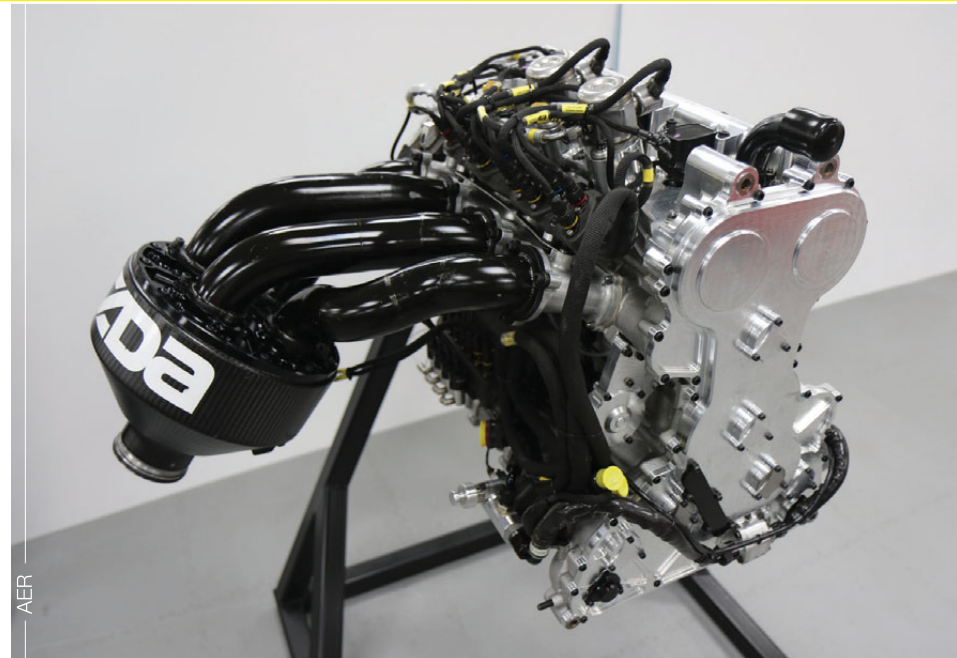
to put things right," comments Holt. "I went to the FIA and the ACO and said, 'We need to tear this car up, how far can we go with the changes?' In the end, we agreed to play it by ear. Basically, we'd keep the FIA and the ACO in the loop and they'd tell us if we were in danger of going too far. The one cardinal rule was that we couldn't modify the primary structure, which had been crash tested."

All of this was unfolding while Multimatic was also running the Le Mans-winning Ford GT programme. As such, every time Holt was in town for a World Endurance Championship

“I went to the FIA and the ACO and said, ‘We need to tear this car up!’”

(WEC) race he'd meet with the FIA and ACO advisors to update them on the LMP2 changes. In the end, over a million dollars went into the update, as well as 20 days in the wind tunnel.

"It all came down to the exit angle of the front underwing," explains Holt. "Prior to that era, LMP2 cars had all used a closed nose concept with a front diffuser. Porsche and Audi had successfully used an open nose concept in LMP1, so half of us [in LMP2] decided to follow the same approach. That means it's a true wing with air moving over the top and the bottom [rather than just being channelled underneath



in a diffuser]. The difference is that, here, the exit flow goes straight into the front of the tub, so it's not like a conventional wing working in free space. It works well until maybe three quarters of the way down its chord and then there's all sorts of mayhem breaking out further back as the air tries to exit the car. I think Porsche and Audi must have spent a lot of time on it to get that right."

In the end, a few simple changes to the front underwing were all it took to get rid of the instability. What's more, it cleaned up the air flow to the heat exchangers in the sidepods, ►

TOP It was a measure of the car's improvement last season that Mazda smashed a Daytona lap record that had stood for 26 years

ABOVE Mazda's turbocharged inline-four gasoline engine, developed by AER, now has the power and reliability to compete with the best

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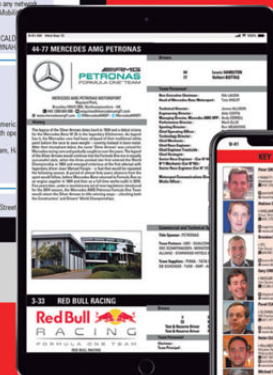
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which meant that the cooling efficiency improved dramatically.

"Having booked out 20 days in the tunnel it only took us four," Holt recalls. "Of course, engineers being engineers, the guys found plenty of things to do with the remaining time. They actually tried a closed nose and the damn thing picked up quite a bit of aerodynamic efficiency. We couldn't implement it, because it would have torn all the styling up and we didn't have time. In the end, we had to retool 72 different carbon body parts for the update that we rolled out at Daytona the following year [even retaining the open nose concept]. The chassis structure itself was unchanged – you could still run a 2017 LMP2 tub on there."

TEAM TRIBULATIONS

In the middle of all this, SpeedSource, which had initially run the car, was replaced with the highly experienced Joest Racing squad. The German team had managed trackside operations for the all-conquering Audi LMP1 programme, picking up seven wins in nine years at

Le Mans, so it came in with a substantial weight of expectation.

"SpeedSource were a great team, but their background was in GT racing. A more experienced prototype outfit could probably have mitigated some of the problems that we were having with the car. Joest brought that experience, but they needed time to ramp back up after being dormant for a while. And then we encountered all sorts of engine problems at Daytona 2018," Holt recalls.

For the next two seasons, Multimatic carried out the performance engineering behind the scenes, such as driver-in-

the-loop testing, while Joest handled the decisions on strategy and race engineering. The German team, however, found itself trying to balance the IMSA schedule with new commitments elsewhere, while Multimatic had a number of staff who were about to become available as the Ford GT race programme drew to a close. The company had also taken on several familiar faces, including Le Mans-winning race engineer Leena Gade and former Mercedes F1 engineer Michael Wilson, who now coordinates the powertrain work with AER. It meant that Multimatic was now overseeing every ►

RIGHT Multimatic has a wealth of experience on the sportscar racing scene after running the factory Ford GT effort



BELOW Multimatic will run the two-car Mazda DPi programme when the IMSA season resumes



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single aspect of the programme.

"In the end it becomes hard to manage lots of different sub-contractors; you ultimately want an organisation that can offer a one-stop shop, like Penske does with Acura," comments Holt. "Don't get me wrong, I think the guys sat on the wall for Joest are the best in the business. But some of them were starting to drop out to have kids and things. We all got together and decided by mutual agreement that Multimatic should take over the running of the cars. There's no hard feelings on either side. We were looking at a deal where maybe Joest would contract a few of their guys to us for Sebring, but the race never happened [due to the pandemic]."

“The concept of LMDh and convergence is the greatest thing we’ve seen in sportscar racing since the days of Group C and GTP. It can’t fail”

and then you have the extra drag that comes from that cooling. I'd guess that the heat rejection out of the Cadillac V8 [now at 5.5 litres] is about 20 per cent less than our two-litre four-cylinder."

In theory, there are benefits to having a smaller base engine to package. However, the reality is that a highly turbocharged four-cylinder is harder, in some respects, to accommodate than a large capacity V8.

"We had exactly the same experience with the Ford GT," comments Holt. "If you look at the bare block and heads for the 3.5-litre EcoBoost V6, you'd think you could pick it up and put it in your pocket. Compared to the old Modular Ford V8 it looks like a huge advantage, but once you've fitted

BELOW LEFT Landmark moment: After 54 starts, Mazda scored its debut prototype win in IMSA's top tier at Watkins Glen last season. It was the first overall sportscar race victory for Mazda since 2011

BELOW Heat rejection is one of the challenges of running the smaller engine



AERO CHALLENGES

Right from the start, the use of Mazda's inline-four engine was considered an integral aspect of the car's DNA – every bit as much a part of its identity as the Cadillac's thumping pushrod V8. In recent races, this unit has proved that it has both the power and reliability to compete with the best in DPi. However, there are still some unique challenges that come from running a small engine at a high specific output.

"We've got loads of heat rejection – from the water, oil and intercooler," notes Holt. "Simply getting all that heat off the car is quite a challenge

the turbochargers, the intercoolers and all of the crap that goes along with a turbo engine, there's only about a kilo and a half in it. Once you've fitted everything, the total width it takes up in the chassis is similar to a V8, so you don't suddenly liberate a load of space for aerodynamicists to play with. The one advantage is that you can get those components right down on the deck to reduce the centre of gravity. The inline-four is even smaller, but it's got coolers out the yin-yang!"

The car's greatest strength, he believes, is its handling: "From a vehicle dynamics perspective, I think we're ahead of everybody. We've got a lot of mechanical grip now and the car is extremely



driveable. If you saw Harry Tincknell racing Montoya at Watkins Glen at the end of last year, he was really able to hustle the car. The one area where we suffer is on drag. I think we could have made the car a little bit more efficient if we'd gone with a closed nose, but apart from that it's just because we've got so many damn coolers in there."

For all its challenges, the inline-four looks set to stay – at least for the duration of the current DPi technical regulations. "Mazda has gone to great lengths to ensure there's a genuine connection between its race engine and the road car engine," he says. "I can't see that changing, although I suppose it depends to a certain extent on how the LMDh rules pan out. If we needed

to run more power to equalise whatever happens in Europe, then we might struggle with the two-litre engine."

Holt is part of the committee looking into the LMDh rules and currently takes part in bi-weekly meetings to lay down the template for the technical regulations. He's unequivocal in his support for the idea of a convergence between the top-tier categories in IMSA and the WEC: "I see no way it could be a bad thing. The concept of LMDh and convergence is probably the greatest thing we've seen in sportscar racing since the days of Group C and GTP. It can't fail."

He sees the value from a commercial perspective too: "I think the LMDh franchise approach makes tonnes of sense now with a

large number of high-profile manufacturers looking to get involved. I'll take on the LMP2 side of it too, but only because I want to be involved with LMDh."

At present, it looks like these cars will make their debut at Sebring in March 2022. The larger teams – those that can afford to retain their R&D staff through the current crisis – are likely to get a head start on development, Holt predicts. As for the more immediate future, it's anyone's guess. "I'd need a crystal ball," he says. "One thing I can say is that you'll never hold racing down. John Doonan and his colleagues at IMSA are working on it 100 per cent of the time. As soon as this ends, we'll be going racing." **RT**





YOUR OIL'S BEST FRIEND – THE PISTON RING

ABOVE We take piston rings for granted at our peril

The piston ring is something that we all take for granted, but in motorsport and high-performance engines, it assumes greater significance as Total Seal's Lake Speed Jr tells **William Kimberley**

HAVE you ever wondered why automatic transmission fluid is 'fill-for-life' but the motor oil still needs to be changed every 5,000 to 10,000 miles?" asks Lake Speed, vice president of sales and marketing at Total Seal. The simple answer, he says, is contamination.

"In an engine, combustion is a powerful but dirty business," he suggests. "While combustion produces the heat energy that powers the engine, it also creates super-heated gases filled with carbon monoxide, nitrogen oxides, vaporised moisture and partially burnt fuel. Those same exhaust gases that we don't want to breathe because they can kill you, can leak past the piston rings, which we call blow-by.

These harmful gases chemically attack the motor oil."

As a Certified Lubrication Specialist, Oil Monitoring Analyst and member of the Society of Tribologists & Lubrication Engineers, Speed states unequivocally that lubricants will do exactly what they are designed to do unless they are contaminated or chemically degraded. "Guess what combustion blow-by gases do?" he asks.

"Now don't get me wrong, motor oils are designed to withstand the assault of these intruders," he says, "but the fact remains that combustion blow-by gases contaminate and chemically degrade motor oil. This is why a high-performance motor oil can contain up to 14 different chemicals and a jet turbine oil might

What is a piston ring?

INVENTED by John Ramsbottom in 1854 (before the internal combustion engine was even conceived), the piston ring is a type of seal. The job of the piston ring is to seal the combustion chamber and minimize the loss of gases to the crankcase and improve heat transfer from the piston to the cylinder wall. In addition, it helps maintain the proper quantity of oil between the piston and the cylinder wall and regulates engine oil consumption by scraping excess oil from the cylinder walls.


"When you look at the job of the motor oil to cool, clean and lubricate the engine and the job of the piston rings which is to seal, transfer heat and meter the oil, it is easy to see how they play complementary roles," says Speed. "The better the piston rings do their job, the easier it is for the motor oil to do its job, and vice-versa."

"In over 15 years of reviewing used oil analysis reports, I've never seen low engine wear when the oil contamination levels are high. In fact, the bad wear results

generally coincide with high levels of fuel dilution and other combustion-related contamination.

"However, when is the last time you thought of motor oil and immediately thought about piston rings?"

"When you think about motor oil today, the first thing that probably comes to mind is Zinc (ZDDP), and that is understandable. The issues related to ZDDP level changes in motor oil have been the headline story in the industry for over 15 years, so it is understandable to think zinc at the mention of motor oil. However, there is more to motor oil than just ZDDP – just as there are other parts in an engine besides a camshaft."

In simple terms, says Speed, the better the piston rings seal the gap between the piston and cylinder wall, the less combustion blow-by gas gets into the oil. "The bottom line is that better ring seal means better oil life and performance, which means longer engine life. That's why your piston ring is your motor oil's best friend!" 

contain only four different chemicals.

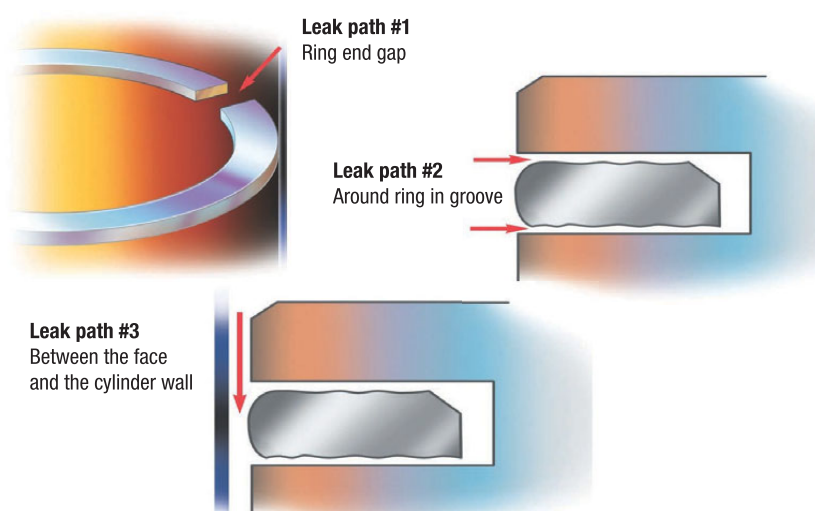
"In fact, the same base oil used to make motor oils is also used to make stationary turbine engine oils. While a motor oil might live 10,000 miles in a 4-cycle engine, these turbine oils will live more than 10 years!

"What is the difference? Turbine engines never expose the lubricant to combustion gases. Both internal combustion engines and turbines generate lots of heat, but only internal combustion engines expose the lubricant to combustion blow-by gases."



LEFT Combustion blow-by gases contaminate and chemically degrade motor oil


Piston ring leak paths



What this all means, says Speed, is that piston rings are your motor oil's best friend: "Motor oil is the lifeblood, the sole source of lubrication for your motor."

Speed then lists the jobs of the motor oil as follows:

1. Cool the lubricated parts in the engine
2. Clean the lubricated parts in the engine
3. Protect the lubricated parts in the engine
4. Transfer power in the hydraulic parts in the engine

Fuel dilution, moisture, soot and heat all affect the motor oil's ability to do its job, so it pays to keep your motor oil cool, clean and dry, says Speed. "With that said, your piston rings are the only line of defence between combustion gases and your motor oil." 

LORD OF THE RINGS

What is Tribology – and what does it have to do with piston rings? **Lake Speed Jr** explains all

TRIBOLOGY: this strange word is the study of friction, wear and lubrication. You also might be wondering what Tribology has to do with piston rings? Beside the fact that piston rings operate on a thin film of oil, there's quite a bit of tribology related to them. Let me explain.

The highest source of friction in an engine comes from the contact between the cylinder wall and the piston ring. Research from both Ford Motor Company and the US Department of Energy concluded that roughly 45% of all engine friction comes from the

BELOW A better ring seal translates into improved oil life and performance

piston ring to cylinder wall interface.

Because a piston has to change direction with each stroke of the engine, the piston rings accelerate and decelerate 250 times each second at 7,500 rpm. The constant changes in speed and load (due to the changes in cylinder pressure with each of the four engine cycles) create a unique and interesting phenomenon – a piston ring experiences all three forms of lubrication during each engine cycle.

The three forms of lubrication are Hydrodynamic, Mixed Film and Boundary. Let me explain each in more detail.

If you have ever been water skiing, you know that the skier is down in the water when the boat is not moving. As the boat begins to accelerate, the skier comes up partly out of the water. As the boat comes up to speed, the skier comes fully out of the water.

The change in speed affects the relationship between the skier and the water. The same is true for engine lubrication.

When the boat is stopped, there is no oil film, which is boundary lubrication. Flat tappet camshafts and pushrod tips experience this form of lubrication. There is no oil film to protect the parts, so the additives in the oil provide the protection.

When the boat is accelerating, that is like mixed

“Piston rings accelerate and decelerate 250 times each second at 7,500 rpm”

film lubrication. Because the wheel on a roller follower can trap a small amount of oil between the wheel and the cam lobe, roller camshafts operate in the mixed film condition.

When the boat is at full speed, that is like the hydrodynamic state or full-film lubrication. Engine bearings operate in hydrodynamic lubrication. The oil film separates the bearing from the journal of the crankshaft.

Again, you are probably wondering what this has to do with piston rings!

Well, as the piston rings cycle back and forth in the cylinder, each cycle takes the piston ring through all three stages of lubrication.

This cycling produces those high levels of friction that rob horsepower from your engine. Fortunately, understanding how this occurs unlocks the secrets to reducing that friction, which, in-turn, unlocks hidden horsepower.

As a tribologist, we use a tool called the Stribeck curve to engineer low-friction piston rings. The ►



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Stribeck curve utilises the formula $\text{Viscosity} \times \text{Speed/Load}$ to generate the lubricant film parameters. Thinking back to our water-skiing analogy, the viscosity was the water, the speed was the velocity of the boat, and the load was the weight of the skier.

Following the logic of the Stribeck curve, as the piston nears top dead centre on the compression stroke, the piston rings experience the highest load (from increased cylinder pressure) and lowest speed (as the piston comes to a stop). As a result, this is a source of high friction and higher wear.

As the piston begins to move down and accelerate (like the skier coming up from the water), both friction and wear decrease as the lubrication regime transitions from boundary to mixed film and then to hydrodynamic.

Near mid-stroke the piston reaches maximum velocity (in some engines, this can be in excess of 100 feet per second). Due to those high speeds, friction begins to increase again as the lubrication parameter moves to the far right end of the Stribeck curve.

Taking all of this into consideration, Total


Seal develops piston rings designed to overcome these frictional challenges.

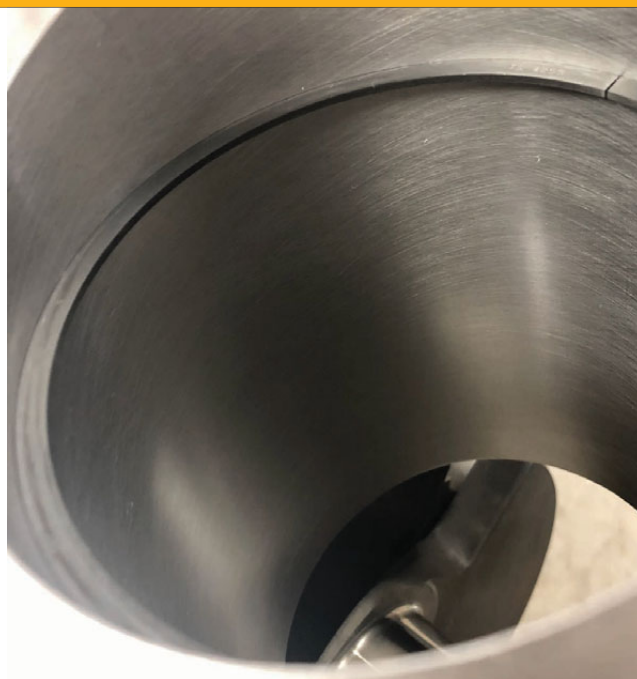
First, utilising PVD applied thin film coatings on the face of the ring lowers friction in the boundary lubrication regime. The low friction coatings not only reduce friction, but they also reduce wear in boundary lubrication conditions.

Next, smoother surface finishes increase load-carrying capacity, which speeds the

transition from boundary to mixed and then to full film lubrication.

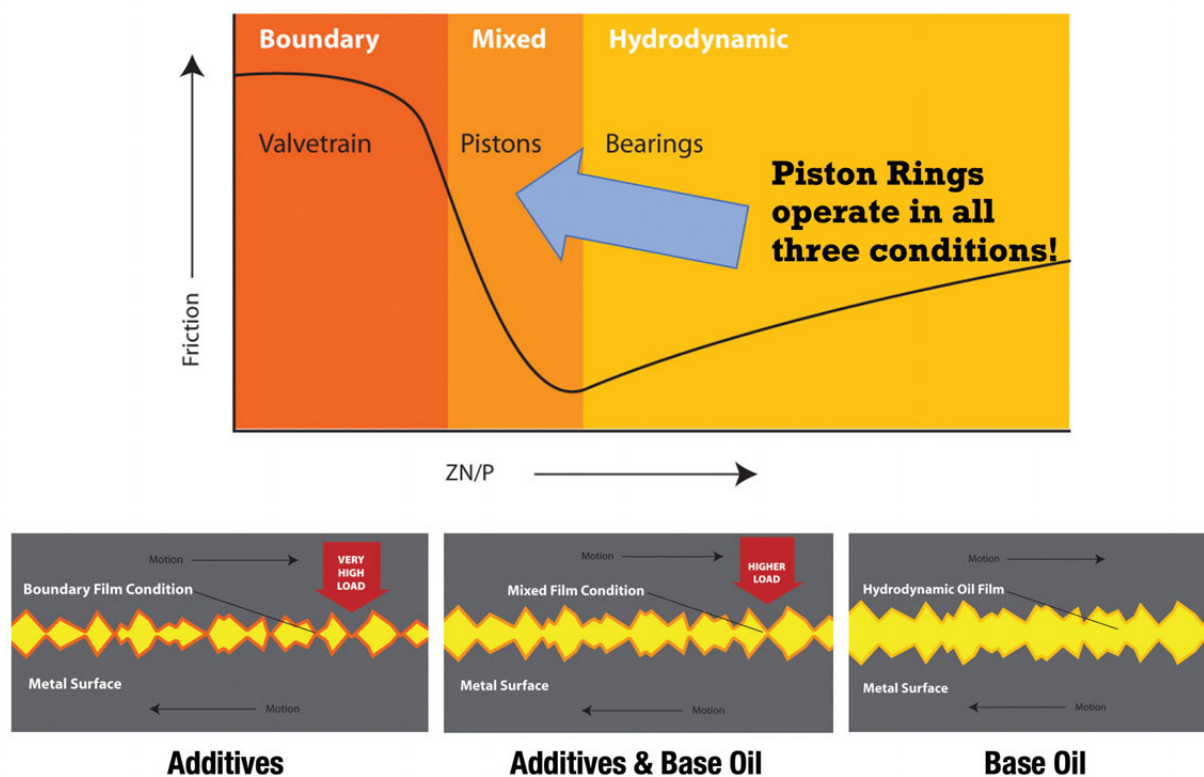
Finally, thinner ring profiles provide less hydrodynamic drag.

As you can see, tribology and piston rings go hand in hand, and ultimately, that means tribology affects engine efficiency. So, the next time you pick up a piston ring, take a moment to consider what a remarkable tribological device it is. 



LEFT Roughly 45% of all engine friction comes from the piston ring to cylinder wall interface

The three stages of lubrication

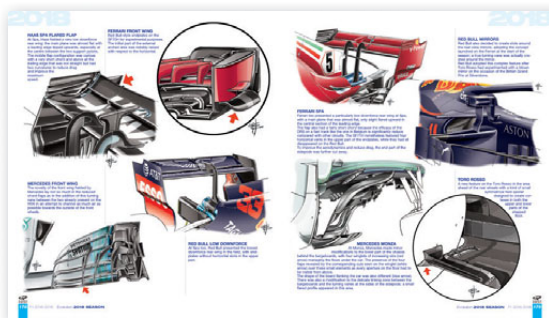
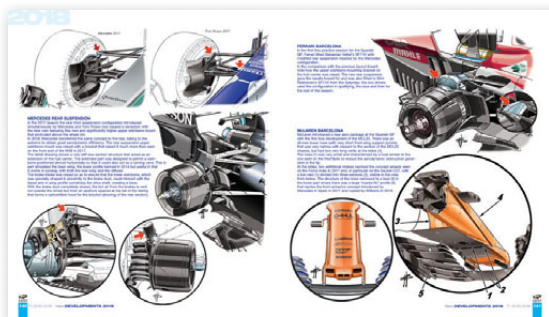


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ABOVE The car boasts a striking new aggressive look, courtesy of bonnet vents designed to improve cooling



EVOLUTION OF A REVOLUTION

M-Sport Poland recently revealed its new Fiesta Rally4 car despite its predecessor, the Fiesta R2T19, only being on the market for 15 months.

Toby Jennings finds out why

THE FIA revealed its new 'Rally Pyramid' at the end of 2019. The move ushered in a new era of rallying, introducing a new class of rally car and re-aligning the nomenclature of each category.

The new structure features five tiers, ranging from Rally1 (future WRC cars) to Rally5 (entry-level front-wheel drive cars). Rally4 replaces the outgoing R2 category. Although Peugeot was quick to announce it would be producing a Rally4 car in the middle of 2019, M-Sport Poland pipped it to the post to become the first manufacturer to have a homologated Rally4 car in March this year.

Before jumping straight into the new Rally4 class, it is worth noting M-Sport Poland updated its R2 car at the end of 2018 with the Fiesta R2T19. The car was based on the latest iteration of the Ford Fiesta road car and was a brand-new machine compared to its predecessor, with major improvements across the board.

The FIA's announcement of the Rally Pyramid also came with clarification that 2019 R2 cars would be eligible to compete in the Rally4 class. This led most to naturally assume that 2020 rally stages would see a battle amongst

the junior classes between the M-Sport Fiesta R2T19 and Peugeot's all-new 208 Rally4, which had spent much of 2019 in development. It seems M-Sport wasn't too keen on that idea though, revealing it had homologated a Fiesta bang up to date to Rally4 standards. The question it raises is: Why would any manufacturer update and rebrand a car less than 18 months after the release of the outgoing model?

"The visual differences between the new Rally4 and preceding R2 regulations are really marginal," explains M-Sport Poland managing director, Maciek Woda. "The main visual difference on the outside is the addition of bonnet vents which are now permitted on Rally4 cars, which helps us a lot with the air cooling of the engine and the air intake."

"Despite the relatively small change in regulations, it did present us with a very good opportunity to develop our R2 car. We supplied a total of 110 cars and conversion kits for the latest R2 model and received a lot of feedback from our customers," Woda adds.

In addition to the stream of customer cars that M-Sport Poland built, the Krakow-based outfit entered its Fiesta R2T19 in the European Rally Championship (ERC). A fleet of cars also competed on the world stage thanks to the one-make Junior World Rally Championship (JWRC). ►

"We were able to learn a lot ourselves by running cars too. Thanks to that, we were continuously communicating with the drivers about the weak points of the car," explains Woda. "We thought: 'OK, there is a new class starting in 2020 with some new competition arriving on the market too, so why not develop it?' It would allow us to improve from an already excellent foundation and ensure we have a car that is right up to date with the FIA's Rally Pyramid."

When quizzed on the timing of the development and why the Fiesta Rally4 has been brought to market so soon after its predecessor, Woda says: "The moment you stop thinking about improvements, you are effectively moving backwards so we were constantly looking into how we could make the car better. We had done quite a bit of analysis and comparisons; there was a lot of data when you consider the number of cars running around the world. Our engineers did a really good job of identifying what we should improve and what direction we should take."

“The moment you stop thinking about improvements, you are effectively moving backwards”

Woda expands on the significant changes that were made to the Fiesta R2T19 to create the Fiesta Rally4: "The biggest technical achievements we made on the Rally4 were in two areas. The first was the overall reliability, as one of the weakest points of the 2019 R2 was the driveshafts. We implemented different driveshafts and CV joints, with some modifications to the hubs in order to be able to transmit the power to the ground with less issues."

"The second area of major improvement was performance, with a specific focus on grip. To improve the grip, we tested different rear beams with combinations of damper shims in cooperation with Reiger Suspension."

The Fiesta Rally4 uses Reiger adjustable dampers with Eibach springs, with the front and rear three-way and two-way adjustable respectively. Woda continues,



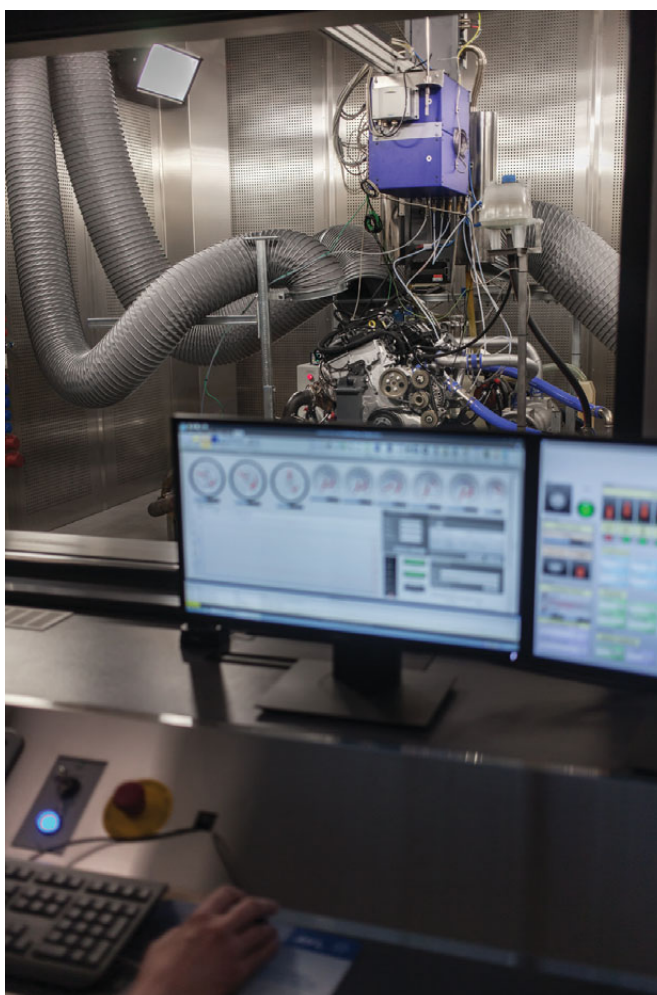
"Relative to the 2019 rear beam, we were able to reduce the weight and introduce some flexibility to the unit for the Rally4. We saw the 2019 car had a tendency of snapping the rear out when in deep ruts. The new beam provides a much more neutral position, making it a lot easier to drive. It gives the driver a lot more confidence and grip. It's the standard rear beam that we modified by introducing

a small reinforcement and a flange to mount the hubs and Alcon brake callipers and discs to."

M-Sport Poland's investigation into improving the grip of the Fiesta R2T19 led Woda and his team to look into how they could realise gains through changes to the Sadev five-speed sequential gearbox. "We were able to increase grip thanks to changes to the transmission too, which ►

ABOVE The outgoing Fiesta R2T19, seen here in action on Rally Sweden earlier this season, can be upgraded to the Fiesta Rally4 by way of a conversion kit

RIGHT M-Sport Poland performed engine development and dyno work in-house at its Krakow headquarters



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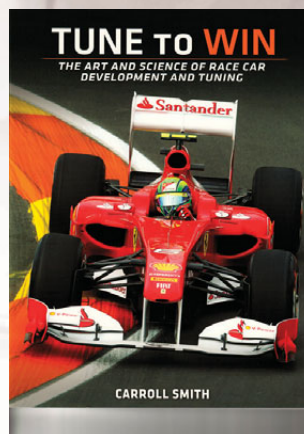
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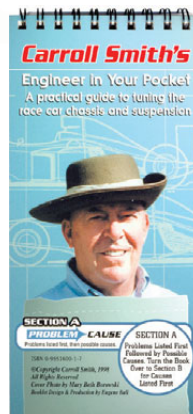
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we worked in close collaboration with Sadev on," he says. "We noticed we were wheel-spinning on both Tarmac and gravel in first, second and third gear. To improve this, we changed the length of the gear ratios, but we had to be very careful. Recirculation for the turbocharger isn't permitted in the Rally4 regulations,

so you have to be sure not to have ratios that are too long because you can get significant turbo-lag.

"We found a nice compromise to make the first, second and third gears longer in order to have less wheelspin and less gear changes as each gear change results in a time loss. We reduced the length of

the fifth gear after analysing how much time was actually spent on the rev-limiter in fifth gear throughout all of the rallies we went to in 2019 – and it was a lot of rallies. The thinking behind it was we could afford to spend a bit more time on the rev-limiter in fifth gear but at the very same time we would be accelerating

Specifications

Engine	Turbocharged 999 cc Ford EcoBoost. 12-valve, 3 cylinders in line. Alloy head and iron block
Power	210 HP at 6,500 RPM
Torque	315 Nm at 4,000 RPM
Transmission	Upgraded Sadev five-speed sequential gearbox with new gear ratios and plated limited slip differential. Electronic detent control. Three possible differential ramps: (23/57), (27/57), (32/77). AP Racing two-disc plate clutch
Suspension	Reiger adjustable dampers with Eibach springs. Front: 3-way; Rear: 2-way adjustable. Upgraded flexible rear beam. Optional springs (Hard/Soft). Optional anti-roll bar (Hard/Soft)
Brakes	Alcon competition callipers. Ventilated AP Racing front discs (Gravel 285 mm, Tarmac 310 mm). Rear Alcon solid discs 280 mm. Hydraulic handbrake with Alcon master cylinder
Exhaust	Upgraded lightweight exhaust
Steering	Electric power-assisted steering, column-mounted
Wheels	OZ Racing – Gravel 6x15"; Tarmac 6.5x16". 5-stud hub
Electronics	Life Racing F88 Engine Control Unit and Digital Dashboard. 3-stage Anti-Lag system. M-Sport Power Distribution Unit. Upgraded mapping
Dimensions	Length 4065 mm, width 1735 mm, wheelbase 2490 mm, minimum weight 1030 kg

ABOVE The Rally4 takes shape at M-Sport's Polish base. M-Sport plans to have representation on every level of the rallying pyramid

RIGHT The 999 cc turbocharged Ford EcoBoost engine has been upgraded to raise power levels to 210 bhp and torque to 315 Nm

faster. It's a package I'm really impressed with as the Sadev gearbox should work well for both slow rallies, where you won't need to change gear that much in the corners, and the fast rallies where you get more acceleration in fifth gear."

The changes to the transmission weren't the only improvements made to the overall powertrain. M-Sport Poland's Fiesta Rally4 uses the same one-litre turbocharged engine as its predecessor but it boasts a hike of 10 HP in power and 25 Nm of torque. Woda points out the origins of these improvements, revealing: "We had been doing some analysis for the FIA regarding the engine performance. In




“We found we could afford to spend a bit more time on the rev-limiter in fifth gear”



ABOVE M-Sport Poland managing director, Maciek Woda

LEFT M-Sport managing director Malcolm Wilson says the car underlines the company's commitment to the sport's future stars

that analysis together with BorgWarner, we came up with a better turbo inlet which benefits turbo and engine performance. We left no stone unturned when looking to unlock more performance from the car. We completed all of the engine work in-house on the dyno here at M-Sport Poland in co-operation with BorgWarner who were very, very helpful."

While every cloud has a silver lining, it could be said every silver lining is not without its clouds. This cloud comes in the form of COVID-19, which at the time of writing is causing a great deal of uncertainty in almost every industry. It does mean, however, that excitement and anticipation build with each passing day as the world does draw closer to some sort of business as usual. "We haven't had a chance to see the car in competition yet, as its first planned outing, ERC Rally Azores, was postponed," notes Woda. "I am really excited to see how it performs against its rivals when we can resume action later on this year." 

EMPTY GRANDSTANDS, NOT EMPTY PROMISES



The spectator areas will be deserted when F1 resumes, but **Sergio Rinland** believes motorsport should grasp the opportunity for a fresh start after the pandemic

It is difficult to escape the theme of the moment, COVID-19. We are all affected by this virus on a global scale not seen before in our lifetime, except perhaps by Captain Tom, the outstanding 100-year-old gentleman who raised more than £30 million for the brave NHS. A sign of the times.

Last month we said that when this situation is over, we will be in a different 'normal'. We are starting to witness what may be coming.

A few days ago, it was reported that the city of Milan, where Monza is based, and the capital of Lombardy, one of the worst places hit by the Coronavirus, will modify 35 km of their streets to limit the number of cars circulating and promote extended pedestrian and cycling lanes. They have seen how clean the air is in the city, which is well known for its high pollution. The Milan government want to bring the 2030 target forward to 2020, this summer! Milan is not alone: New York and other cities are working on the same lines.

This will have an enormous impact in the automotive Industry, which was already having a difficult time before the pandemic. This, subsequently, will have an impact on motorsport.

We are all changing our lifestyles: many of us are learning that it is possible to work from home. Jean Todt, the president of the FIA, said in a message to the automobile clubs and members that now he is going to think twice before jumping on a plane to have World Council meetings on the other side of the globe. He is learning that he can conduct such meetings via the web. He also hinted that the way F1 and the whole of motorsport have been working and behaving in the last few decades, will not be the same.

This brings me nicely into tackling today's topic: how is motorsport adapting to these difficult times of having no live spectators? This will be the case for the foreseeable future, at least until we have a vaccine. I am optimistic that the lessons learnt during this time will modify the way we attend live events.

Before this pandemic, the smaller F1 teams were having difficulties in maintaining competitiveness due to the current spending levels of the 'Big Four'. The solution to this situation that is being discussed looks at using this opportunity of the

business recession caused by COVID-19, by revising plans for a 'Budget Cap'.

I am not a big fan of a budget cap. It is something that, in my opinion, is very difficult, if not impossible to police. This unprecedented situation should be used as a unique opportunity to look further into Technical and Sporting regulations to achieve the budget reduction as a consequence of 'diminishing returns' of technical development and the lavish racing logistics of the last few years. Formula 1 teams are reported to be losing U\$2 million per race that is cancelled or postponed, a situation which if not reversed soon could be catastrophic for small teams. Formula 1 is not alone; the rest of the motorsport community is suffering too.

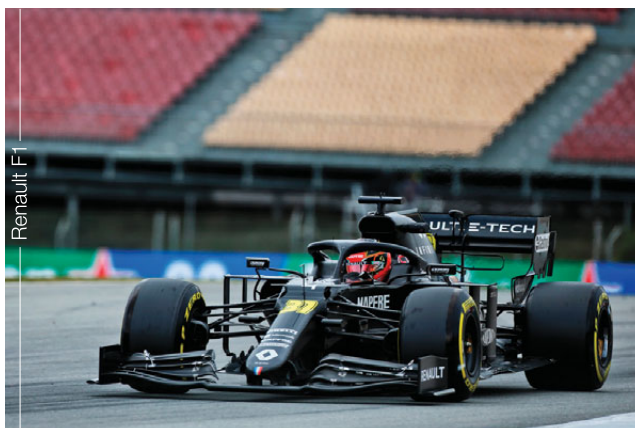
It has been announced now that the Formula 1 season could start on July 5 in Austria, but without spectators, behind closed doors and with a reduced number of paddock personnel. Starting in Europe and by December venturing to the Middle East, Formula 1 is planning still to hold 15 to 18 races, perhaps two per weekend – an ambitious target.

Simultaneously, it was announced that following the race in Austria, we will have the British GP on July 19 under a similar format. I hope this becomes a reality for the good of the whole motorsport community, with the view to allow spectators in as soon as the pandemic is under control.

I am not 100% sure these Formula 1 plans will be doable by July, but we hope they are. Safeguarding the safety and health of all team members must prevail though.

This is a good opportunity to see how Formula 1 could be shaped to be more sustainable in the future, spending less on superfluous luxuries and making it more accessible to fans. I hate to say it, but as it used to be few decades ago. **RT**

BELOW F1 plays to empty grandstands during pre-season testing. Deserted circuits could be the 'new normal'



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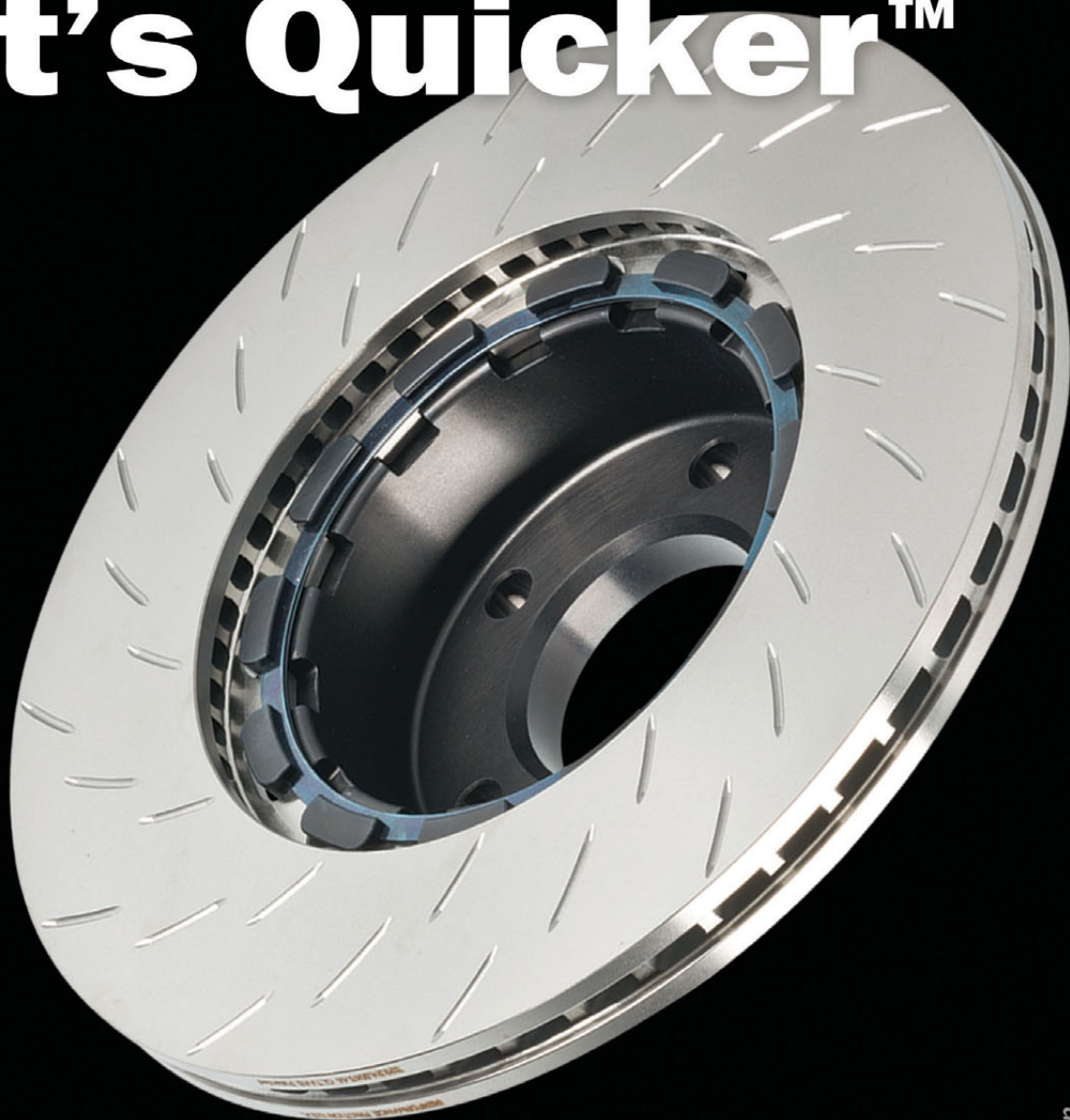


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