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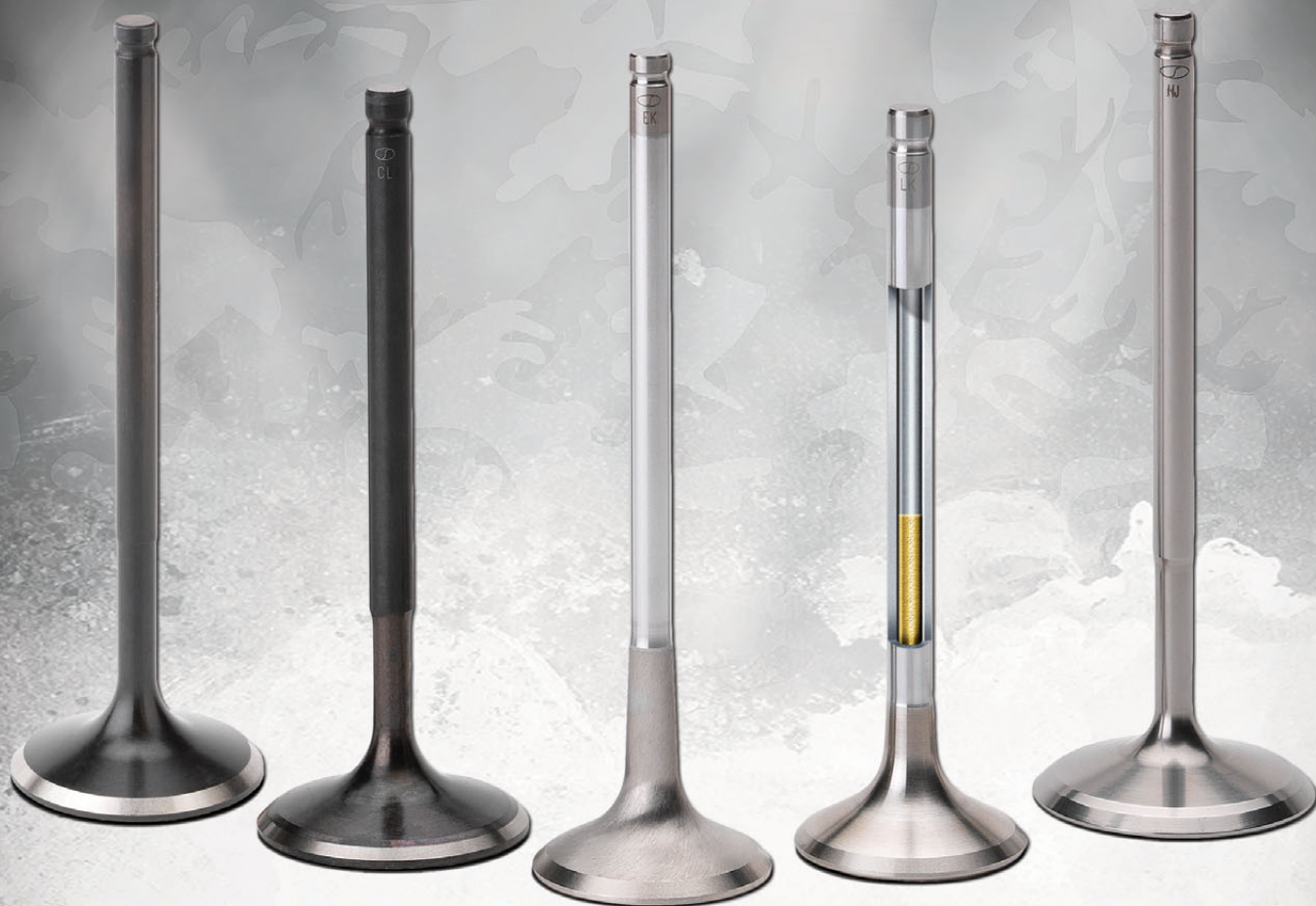
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The real future is still the internal combustion engine

THE electrification of the car is the only thing we ever hear about, at least when it comes to UK politicians and elsewhere around the world, and there's no question that city centres need to clean up their clean air qualities. To that end, motorsport can be seen to be a useful partner, with Alejandro Agag's Formula E series blossoming into what it has become in its fifth series with massive manufacturer and supplier support. Furthermore, it has spawned the Jaguar I-Pace eTrophy and soon to come Extreme E, a pioneering electric off-road racing series, that is due to arrive in 2021.

All this is helping the development of batteries, storage units and other components which are extremely useful, not just for automotive, but for other industries as well. For all this, though, Formula E and its offspring is little more than a window that allows the car manufacturers and suppliers to showcase how they are committed to the new electrified world. In other words, a marketing exercise.

However, in my view, the battery electric vehicle is a relatively short-term solution for a very small percentage of the planet. If you add up the percentage of space from side to side of every city with a population of more than a million, I would guesstimate it would add up to around 15%, probably less, but let's call it 20%, which leaves 80% of the world's surface not built up or urbanised. This is where the battery electric vehicle has no role to play. It is irrelevant and does not meet the needs of those who live there.

The real long-term future, although most politicians refuse to consider it as they are hooked up to full electrification, is all about the internal combustion engine. Not just its architecture and components, but importantly, the fuels that will power it.

Ricardo presented a paper at the Future Powertrain Conference 2019 on its work on the PaREGE (Particle Reduced, Efficient Gasoline Engines) project, a 17-partner

research programme, the focus of which is identifying the optimal trade-off between cleanliness and efficiency in the next generation of gasoline engines. The target is to demonstrate a 15% reduction in CO2 emissions under Euro 6d RDE legislation.

This is coming and coming soon.

Meanwhile, there is intensive work on both biofuels that rely on organic sources of carbon such as agricultural waste products with low CO2 values in terms of production costs, and, looking further ahead, synthetic fuels, otherwise known as efuels or electrofuels, that will be the long-term saviour of the internal combustion engine. The latter still have a way to go before becoming commercially viable, but there is no question it will come as this technology has the full backing of the German automotive industry. It offers in/out instant refuelling, which means utilising the existing infrastructure, and reduces the CO2 emissions of existing as well as new cars. It will also make an immediate impact on the environment rather than the much slower process of going pure electric, while synthetic fuels can also be used by commercial vehicles.

As Chris Ellis points out in his feature elsewhere in this issue (First, Fix the Fuels – Fast!), motorsport can play a massive role here using and promoting such fuels, which I sincerely hope that the powers-that-be are taking into consideration. The balance needs to be redressed so that it's not all about the battery electric vehicle. Formula E has stolen a march, so learn the lesson and fight back and raise the banner for the internal combustion engine because that's the real future. **RT**

William Kimberley
EDITOR





ABOVE The school run on a soggy morning might be quite fraught, but electric SUVs will encounter even more frightening territory as part of Extreme E

Extreme E: Electric racing's greatest adventure

Hal Ridge reports on ambitious plans to race electric SUVs in extreme environments to create "a sport, adventure and entertainment concept never seen before"

A new off-road electric racing concept called Extreme E has been launched by Formula E founder Alejandro Agag and Indy 500 winner Gil de Ferran.

Extreme E is set to hold rounds in "five of the most unique and remote locations on the planet". The series will feature a head-to-head race system, progressing to a knockout stage, rather than Dakar rally-style format. It is set to run for the first time between January and August in 2021, with technology developed in Formula E expected to feature heavily in new SUV-based machines.

As in the single-seater Formula E series, a single-make chassis and battery will initially be used by teams and manufacturers, not dissimilar to the cars planned to be used in

the World Rallycross Championship's switch to electric vehicles in 2021.

The chassis and batteries in the latest Formula E machines are produced by Spark Racing Technology and McLaren Applied Technologies respectively.

In a change from conventional motor racing, Extreme E events won't be covered live, but will be broadcast as 'docu-sport' TV series, with the winner kept secret until the TV screening later in the year.

The concept has been created to raise awareness for areas of the world "which are under threat from climate change and other challenges, such as the Arctic, the Himalayas, Sahara Desert, the Amazon rainforest and islands in the Indian Ocean,"

said Extreme E at its launch in London. The series has said it plans to run on already damaged land to highlight the issues of climate change and mitigate the chance of causing additional damage.

Due to the extreme nature of the remote locations to be used for the series, former Royal Mail Ship the St. Helena will undergo a multi-million-pound renovation to be transformed into a "mobile operational base for Extreme E". The ship will also include the paddock and accommodation for competing teams.

"This is a hugely exciting project," said Extreme E chairman de Ferran. "Extreme E offers a unique sport, adventure and entertainment concept that has never



ABOVE & BELOW RMS St Helena will be used as a mobile hub for each round of the series

been seen or done before. Viewers can expect a completely new way of consuming sport, with each episode telling not just the story of a race, but the wider race of awareness and the need to protect these remote and challenging environments being explored by Extreme E."

Continental Tyres will be the new series' official tyre supplier. CBMM is also supporting the series as niobium supplier, facilitating the integration of technologically-advanced niobium products in the chassis of the all- electric SUVs.

"I've always been passionate about progressing electric vehicle technology and the impact that clean mobility solutions can have on the efforts to halt global climate change," said Agag. "I strongly believe that Extreme E can help make the world more sustainable faster, and we have a dream team to make this ambition a reality.



ABOVE Peugeot's 3008 DKR Maxi SUV conquered the Dakar Rally but Extreme E will present an opportunity for manufacturers to reinvent what were previously diesel and gasoline-powered SUVs

Gil de Ferran is a leader in the world of motorsport, and in David de Rothschild and Fisher Stevens [film maker and artistic director], Extreme E has attracted two of the best in their respective fields. Likewise, welcoming Continental Tyres as a founding partner – and CBMM as niobium supplier – is a huge boost to Extreme E and shows the strong commercial appetite for this sustainable sport and entertainment concept."

British adventurer and environmentalist de Rothschild will be the Chief Explorer for the concept. "I'm thrilled to be part of this new and exciting project," he said. "Harnessing the excitement and attention surrounding Extreme E, I'm looking forward to activating a global storytelling platform for nature that's grounded in science, innovation, exploration and optimism. The race for curating and creating an operating manual of solutions and positive environmental actions on behalf of nature has just begun." **RT**

Blue Planet meets Dakar Page 74





ABOVE Citroën is on board with the FIA's planned move to hybrid powertrains

FIA pressing on with hybrid WRC plans

THE World Rally Championship is set to make the transition to hybrid or electric powertrains, with the FIA saying the changes will be implemented after the current rules cycle, which runs until 2021.

Citroën's director of racing, Pierre Budar praised the proposal, and highlighted the importance of competition staying relevant to road offerings. "If you want manufacturers to stay involved in motorsport, you have to be able to give them motorsport support which is in line with their expectations in terms of marketing," he told Race Tech.

"We can remain with the current cars, but you will lose the manufacturers because marketing-wise, they need to focus on the

new technology because of the new CO2 regulations coming in, especially in Europe. You know how tough it is going to be for the manufacturers to reach the CO2 level requested, so they need to promote the new technology to make sure customers will be interested in it and to show our skill in this technology."

The transition to hybrid or electric powertrains has been on the cards for some time, with Citroën itself demonstrating a hybrid rally car as early as 2009. Actually including new powertrain technologies in rallying has, however, been a much slower process, with FIA president Jean Todt claiming that it was actually the manufacturers themselves that were

impeding the transition.

"It is a big frustration for me not to see that rallying has engaged on at least some hybridisation and new technology," he said. "The reason is, I am told by people who are there to run the business, that manufacturers don't want [it]. They don't want to change the regulation."

"Now, finally, the manufacturers say we need some hybridisation, [so] the technical people at the FIA, along with the manufacturers [are] working to implement it in 2022."

In order for manufacturers to be ready to compete with hybrid cars in 2022, the FIA is set to announce details of the regulations later this year. **RT**



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FIA invites tenders for spec gearbox in F1

THE FIA has invited applications to tender for the sole supply of a standardised gearbox, to be used by all F1 teams from the 2021 season onwards. The move would mark a change from the current system, which sees teams either make their own gearboxes, buy them as part of a complete package from their engine supplier, or in the case of Toro Rosso use the gearbox from sister team Red Bull.

The fixed supply arrangement would, however, only extend to the gearbox cassette itself, and would therefore likely require teams to make their own gearbox housings, ensuring that they can continue to design their own suspension systems with unique mounting points and aero surfaces.

The primary purpose of the single-supplier

arrangement is, according to the FIA, to “retain current levels of Formula 1 gear change performance for all cars at a much reduced cost to teams, while also removing the requirement for teams to design or source their own gearboxes.”

The body also notes that having a spec gearbox cassette should save developmental cost, with the unit being able to be “carried over between seasons”. The FIA does however acknowledge that the removal of competition will also lead to some of “the most complex machining” being replaced with more “cost-effective options”, meaning the final cassette is anticipated to be around 1.5 kg heavier than today’s units.

Interestingly, the tender also offers clues to what Formula 1 cars will look like following

the major rules changes in 2021, including details of a MGU-K which is 30 kW more powerful than at present. These changes are hinted at as factors that will make achieving a minimum size and weight more difficult.

“Firstly, we need to achieve excellent reliability in the face of a life requirement of around 5,000 km. Secondly, there will be an average input speed increase of around 14 per cent from today. Thirdly, there should be some power increase for 2021 relative to today, not just because of natural development, but also because of a 30 kW increase in the MGUK output.”

Another hurdle is the time frame. The FIA is giving potential suppliers less than a month, requesting tenders by March 15 to enable a decision to be made in mid-to-late April. **TY**



ABOVE The FIA has given hints of future F1 regulations in an invite to tender

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Formula E begins recycling of race batteries

FORMULA E has teamed up with Belgian materials technology company Umicore to recycle the lithium-ion battery units used in the cars during the first two seasons.

The Williams Advanced Engineering

supplied batteries will undergo a sorting, dismantling and recycling process, which will see the valuable metals recovered.

Umicore says this process can be repeated 'infinitely', given that the metals lose none

of their properties during their use. After the batteries are dismantled in a manner that ensures the environment isn't exposed to hazardous compounds, the metals and metal alloys will be used again in new rechargeable batteries and other products.

"This is an important moment for Formula E and I'm grateful to be partnering with Umicore on this initiative," said Formula E founder & CEO Alejandro Agag.

"Sustainability is at the core of both companies, and to be able to recycle our battery cells with a closed loop approach means we're doing our utmost to limit the impact we have on the environment – while promoting a wider message of clean mobility." **RT**

BELOW Batteries from the first Formula E races are now being recycled



Opel understood to be developing R2 car

OPEL Motorsport is believed to be developing a new R2 rally car based on the sixth-generation Corsa road car, to supersede the German marque's current Adam R2 machine. Working in conjunction with Opel's 'technology partner' Holzer Motorsport, the new car is expected to be launched onto the consumer market by the end of next year and is set to make its competitive debut in 2021.

Opel will continue supporting the ADAC Opel Rallye Cup in 2019, while M-Sport's new Ford Fiesta R2 rally machine was debuted by crews competing in the single-make FIA Junior World Rally Championship last month on Rally Sweden. **RT**



ABOVE M-Sport's new Fiesta made its debut in Sweden last month



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NASCAR gets tough to allow winners to be disqualified for violations

NASCAR has revealed that it is changing its post-race inspection process for all of its national series to a more immediate process.

The changes mean that a winning car or truck could now be disqualified at the track following the completion of a race, rather than the process being carried out the following week at the NASCAR R&D centre.

Race winning teams which, after inspection, are found to be in major violation of the series' ruleset will be disqualified then

and there, will receive last-place points, no stage points and will only receive last-place prize money. Furthermore, the team will also lose any additional benefits that come with a win, such as playoff eligibility or advancement in the playoffs should the failure occur in the post season.

Inspections will be carried out on the first and second-placed finishers, as well as another randomly selected car. If either of the top finishers' cars should fail the

inspection process, then all the cars below it in the finishing order will be moved up.

"Our industry understands the need to focus on what happens on the racetrack," said Steve O'Donnell, NASCAR executive vice president of competition and racing development. "We cannot allow inspection and penalties to continue to be a prolonged storyline. Race vehicles are expected to adhere to the rulebook from the opening of the garage to the chequered flag." **RT**



ABOVE New inspection rules can lead to immediate disqualifications

Galli tests second-gen Kia Rio WRX

ITALIAN rally star Gigi Galli has begun testing the second-generation version of his GGRX team's Kia Rio World Rallycross Championship Supercar. Galli debuted the first iteration of the machine in his home round at Franciacorta in 2015 and after only a handful of events sold the machine to Hungarian driver Lukacs Kornel for the 2017 season.

The second evolution of the Korean machine has been improved across the board, with only the Unic transmission remaining in the same specification as in the previous version of the car, featured in RT181. The water radiator has been moved to the front to accompany the intercooler, like in the title-winning Volkswagen Motorsport-built Polos of the last two seasons.

The two-litre engine continues to be built by Lehmann, but is now based on a Kia block rather than using 'custom' engine rules.

"To be honest the whole car is completely different, starting with the kinematics, roll centre, weight distribution and the balance is completely different," said Galli. "For instance, the uprights are a completely different design, made for this car. In the last car we used an existing upright from an R5 car, now they are better for rallycross and are less weight. The only thing I didn't change is the transmission, because I was happy, but even this is in a different position" **RT**



ABOVE Gigi Galli has started putting his second-generation Kia Rio through its paces

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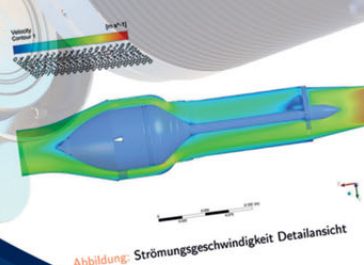


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IndyCar set to implement new cockpit protection device

INDYCAR has announced the planned introduction of the latest device to improve cockpit safety for drivers in its flagship single-seater series.

On April 24, during the open test on the oval at the Indianapolis Motor Speedway, all cars will be fitted with a titanium Advanced Frontal Protection device, which they will use throughout the rest of the season. The AFP, which is made by Dallara, stands around three inches tall and averages three-quarters of an inch in width and is designed to deflect debris away from the driver. The device, which has undergone the same strength tests as Dallara's roll hoop, will be positioned directly in front of the driver on the vehicle's centreline.

Different versions of AFP have been

investigated since 2012 in both on-track and simulator testing, but until recently it was not a practical option.

IndyCar has considered different solutions to cockpit protection, with a Halo-style device, as used in multiple FIA series, dismissed as it cannot be fitted to the current IndyCar chassis. There are also concerns that the banked nature of many IndyCar circuits means a Halo-type device would block the driver's sightline.

The series has also done extensive testing with a windscreen developed in conjunction

with PPG Aerospace, including on-track sessions at ISM Raceway and Indianapolis Motor Speedway in 2018. Although no drivers involved in the testing reported problems, recent testing at PPG's facility in Huntsville Alabama has shown that further work remains before the windscreen devices will be suitable for use in IndyCars.

IndyCar president Jay Frye said that the AFP was the "latest step in the evolution" of cockpit safety, and added that "Safety is a never ending pursuit," while "there are more details to come" about the phases that follow. **RT**



BELOW Dallara has designed and tested the Advanced Frontal Protection device

Chris Beatty Design

Firestone extends IndyCar tyre partnership through 2025

FIRESTONE is set to remain the official tyre of the IndyCar Series and the Indianapolis 500 until 2025, following a five-year partnership extension.

At the announcement, Bridgestone, which manufactures the Firestone brand, announced plans to build a new, state-of-the-art manufacturing facility in Akron, Ohio, which will serve as the future home of Firestone's race tyre manufacturing.

The history of the current agreement between IndyCar and Firestone stems right back to the first running of the Indy 500, when Ray Harroun was successful using tyres from the company.

"Champions have relied on Firestone tyres for more than a century, and racing has always been the ideal proving ground for new technologies that help us evolve and advance our company's passenger tyre offerings," said Philip Dobbs, chief marketing officer, Bridgestone Americas

Tire Operations. "As the NTT IndyCar Series continues gaining momentum, we are introducing new fans to the Firestone brand and strengthening our relationship with the drivers who use our durable, dependable Firestone tyres."

IndyCar president Jay Frye added that "Firestone has long been a great IndyCar

partner and is making a huge investment to the NTT IndyCar Series with its new facility in Akron.

"This extension also reflects Firestone's commitment to helping to shape IndyCar's paddock-wide, five-year plan."

In addition to providing IndyCar with tyre technology and on-track support, Firestone will also continue to be a key partner in the marketing and promotion of the IndyCar Series, with season-long activation including fan engagement, sponsorships and signage at multiple venues. **RT**



ABOVE Firestone is set to continue its relationship with IndyCar



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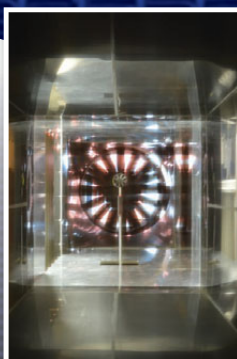
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H24Racing team launched to campaign hydrogen power



ABOVE H24Racing is looking to compete with a hydrogen-powered car at Le Mans in 2024

AS part of the Automobile Club de l'Ouest's plan to introduce hydrogen-powered cars into the World Endurance Championship and the 24 Hours of Le Mans in 2024, it has formed the H24Racing team alongside GreenGT.

The new team aims to run its electric-hydrogen-powered prototype, the LMP2H2G, as soon as possible in a yet-to-be named championship, with the ACO aiming to have a category dedicated to hydrogen-powered racing prototypes on


the Le Mans 24 grid, racing against cars with combustion engines. Regulations for the new class will represent the first time hydrogen has been used as a fuel source at this level of competition.

The formation of the H24Racing team follows on from the successful premiere of the GreenGT hydrogen-powered car on track at Spa Francorchamps last year.

"A new team spells excitement, enthusiasm, expectancy and promise. I have

to admit a sense of fulfilment in announcing the arrival of H24Racing. With this team, we are making our project real. GreenGT's accomplishments in research, development and implementation in fuel cell technology are unprecedented," said the ACO's president, Pierre Fillon.

"Last September, the ACO and GreenGT launched MissionH24, to promote hydrogen power and zero-emission solutions and draw attention to how fast this energy is progressing. The aura of Le Mans will help raise the profile of the technology

"H24Racing is the result of the ACO-GreenGT partnership. With this team, our joint venture becomes a truly sporting endeavour with a tangible demonstration of our intentions. We'll be putting our new technology to the test, on track, pitting it against other fuels and power trains. The realisation that 2024 is just around the corner and the 24 Hours of Le Mans will soon have a hydrogen car on the grid is particularly gratifying. But, make no mistake, we are well aware that this is just the beginning of an immense challenge. Today H24 Racing is setting out on a long journey." 

All-new 3 Series to do battle in the BTCC

BMW has confirmed that it will be bringing its best-selling model back to the BTCC for the first time since 2012.


The 3 Series has a long and distinguished history in the premier British motor racing series, taking five drivers' titles and two manufacturers' crowns between 1998 and 2009. The 3 Series was replaced by the 125i M Sport in 2013, which added another two drivers' trophies and another three manufacturers' championship wins to BMW's tally.

BMW is hoping to collect more silverware this year with the new 330i M Sport, which is set to make its debut in the opening round of the BTCC in April at Brands Hatch. The car will be driven by three-time title winner Colin Turkington and new signing Tom Oliphant, and will be fielded by long-time BMW partner West Surrey Racing. A third 330i M will also be piloted by 2013 Champion Andrew Jordan, who will operate out of the same WSR stable but under the

BMW Pirtek Racing banner.

Commenting on the news, BMW UK CEO Graeme Grieve expressed his excitement at seeing the 3 Series back on track. "The

BMW 3 Series has had a rich and successful history competing in the BTCC and we are extremely proud to see that tradition continue," he said.

"This all-new BMW 3 Series is the road-going dynamic benchmark and we have a great track record working with our partners at West Surrey Racing, so 2019 looks set to be a very exciting year for us in the BTCC." 



ABOVE An artist's rendering of BMW's brand new 3 Series Touring Car



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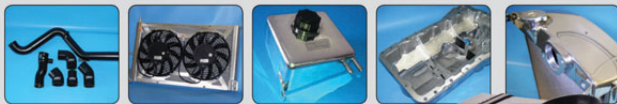


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NETWORK | DISCUSS

The WMS was well organised and delivered on all fronts, papers and discussions with some lively discussions in between that will help shape developments in motorsport going forward. The exhibition area was well organised and there was plenty of time to talk with industry colleagues and prospective clients on a variety of topics. Evolution Measurement had a great first visit!"

Paul Crowhurst, Director, Evolution Measurement Ltd

Another milestone symposium with so many of the world's motorsport decision makers and insiders there, giving unparalleled open discussions about future roadmaps. I particularly loved this one. The discussions opened so many strategic directions"

Willem Toet, F1 Aerodynamics
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The Davos of Motorsport Engineering & Technology

The Chatham House rule implemented throughout the two days means that all the speakers, panellists and audience can give open and honest opinions freely allowing much more debate and discussions. Governing bodies also use this opportunity to make announcements and set rules and regulations going forwards.

"To shape the future of motorsport, the World Motorsport Symposium is a must for all key people in the motorsport industry"

Thomas Kraemer, Manager Engine Design
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“Making decisions less than ONE MONTH before implementation date would, in most business circles, be regarded as DEVASTATINGLY INCOMPETENT”



Alan Stoddart quizzes Motorsport UK chairman David Richards on the implications of Brexit

THERE are some events that are so enormous, that have such wide-ranging implications and such a profound impact that they become milestones. These are the incidents that future historians will form narratives around and reference as the catalyst or culmination of societal, economic and international political upheaval.

Events like the reunification of Germany after the Cold War, the September 11 attacks and the 2008 financial crisis were all so significant that they shaped, and in some ways, are still shaping the world we live in today. There are many who think we are approaching another of these world-changing occurrences at the end of March, although given the indecision and political disarray, it is proving hugely difficult for anyone to say with any certainty what the eventual repercussions of Britain's departure from the European Union will be.

A PANOPLY OF PROBLEMS

This inability to be definitive about what Britain's future role and its relationships outside of the EU will be, means that forecasts range from suggestions that the split could have very little impact on the way motorsport teams work, to there being an almost catastrophic impact on British, or even international motorsport.

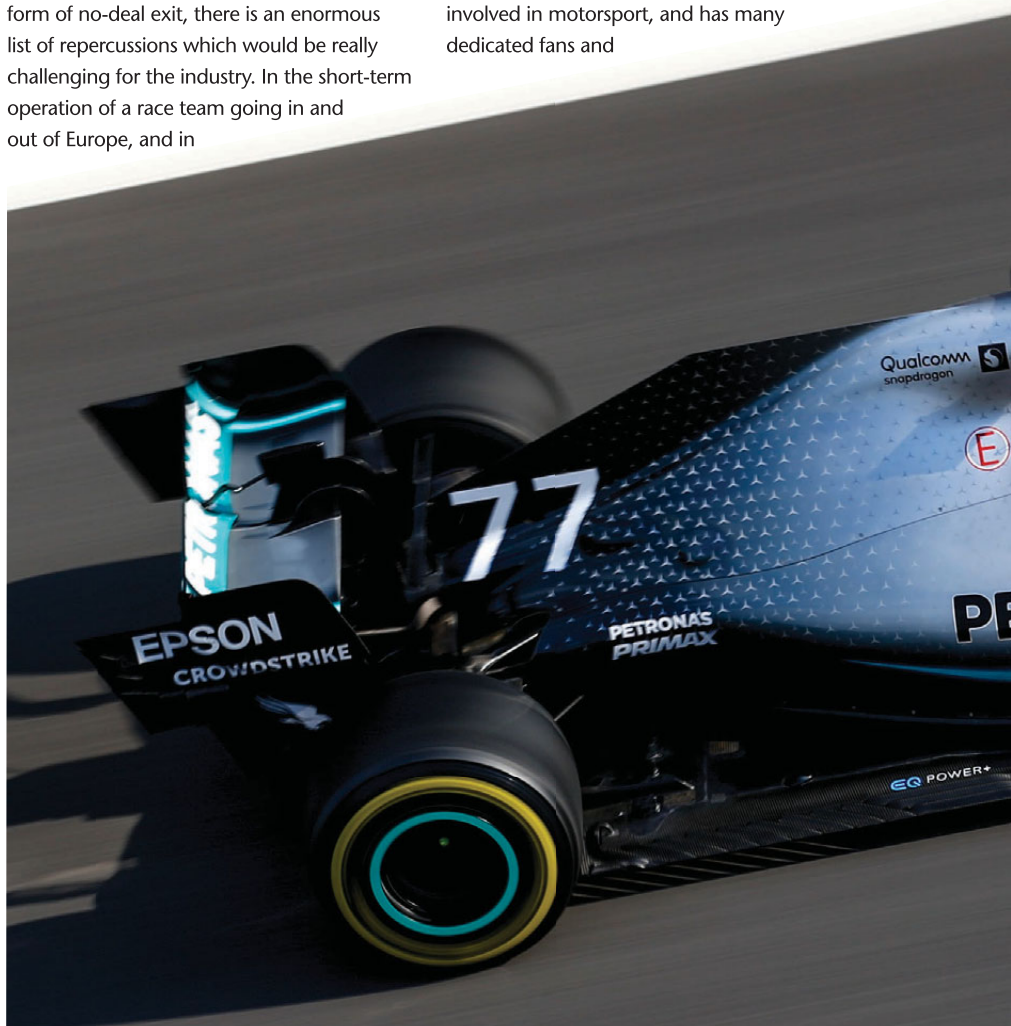
“There are so many scenarios to consider,”

explains David Richards, chairman of both Prodrive and Motorsport UK. “In a managed process where we are in the single market there would be little impact on us, I suspect. There might be some issues about employment of foreign nationals in race teams, but in the transfer of componentry, the sales of parts and the operating of a team, I wouldn't imagine it will be too much of a headache.

“However, in the event of it going completely wrong and us having some form of no-deal exit, there is an enormous list of repercussions which would be really challenging for the industry. In the short-term operation of a race team going in and out of Europe, and in

the longer term in a lot of logistical issues. It would inevitably put pressure on UK teams and their competitiveness.”

The issues would not be limited to the practical running of teams either, adds Richards, who warns that the UK's departure from the EU is also likely to affect its ability to exert the same influence on global motorsport as it does presently. He compares this lack of influence to America, which although is the largest market for many of the companies involved in motorsport, and has many dedicated fans and



grassroots competitors across the country, has very limited sway over the governance of global motorsport.

These are issues that will play out over the longer-term, but that isn't to say there aren't pressures that, just weeks away from the departure date, aren't already being felt. Motorsport teams are relatively short-term in their thinking, with their priorities being the first test ahead of the season, or the next race, and how to win the ongoing championship. The uncertainty surrounding the UK's future relationship with Europe means that teams and organisations are having to balance whether it is worth investing time and effort into creating contingency plans, which depending on the form the departure takes, may never come to bear, or, continue to instead focus on the business of winning races and risk potential upset when March 29th finally comes around.

Richards advises that this contingency planning "shouldn't be a priority for a team today". ▶



ABOVE & BELOW Mercedes is just one of many F1 heavy-hitters with bases in the UK as well as the EU. Toto Wolff, the team's boss, echoes Richards' opinion that Brexit could diminish the appeal of such a set up



“Second-guessing what’s going to happen shouldn’t be a priority for a team”

ABOVE The smooth progress of the vast convoys of trucks currently transporting teams’ freight between EU countries could be threatened

“There are so many unknowns out there, why waste your time second-guessing what’s going to happen?” Although, he emphasises that this doesn’t mean completely ignoring near-term issues. “I think that teams that are travelling to Europe, and certainly our own Aston Martin team, and various other teams that travel to European championships are going to have to start thinking about the necessity of carnets, and their transport arrangements in and out of Europe and the potential transport problems. It won’t be the smooth flow across the English Channel that it has been in the past.”

This would obviously be catastrophic for a team competing at Spa or Catalunya, for example, that urgently needed something to be transported from a UK base, with a delay crossing the channel potentially making the difference between starting a race or not.

These types of difficulties could in future lead to the establishment of satellite operations on the Continent where teams can base themselves between events, and could also lead to the migration of skills and infrastructure into Europe. Nevertheless, Richards is keen to caution that, given the present uncertainty, these are currently very much speculative solutions to as-yet potential problems.

Another of the difficulties in making plans for after the UK leaves the EU is not only the sheer volume of potential regulatory issues that could arise following the split, but, given the decades of progressive alignment, there is the chance that seemingly insignificant pieces of legislation, which may have been hitherto overlooked, might reveal themselves

to be crucial to the smooth operation of an international motorsports outfit. “Minor things will become major issues,” Richards explains.

These potential issues could affect all levels of British motorsport. The mission statement of Motorsport UK is: ‘To inspire and enable more people to participate in our sport in a safe, fair, fun, inclusive and progressive environment. To use our reach and influence to create a sustainable future for our sport.’ For the organisation to be successful in this mission, it considers developing grassroots motorsport in the UK its priority. Richards warns that even this relatively localised aspect of the motorsport industry could be in jeopardy following the UK’s break from Europe.

NATIONAL RAMIFICATIONS

“At Motorsport UK, we see our priority as working for our members in the UK, for British nationals or people residing in the UK and participating in motorsport,” he says. “We have long been held as a beacon of motorsport governance, of organisation and of events here in the UK, and I do worry that if it is more difficult for overseas participants to come to the UK to compete, we will have both less influence, and also less participation in the longer term.”


Perhaps these concerns are balanced by opportunities. After all, in the run up to the referendum in 2016, there were many Eurosceptic campaigners who promised upsides to all manner of British businesses and organisations, including many which also operate on the Continent. Richards, however,

is sceptical, and when asked about any potential positives that may come from the break with Europe, he replies simply: “I have yet to find any.”

As such, Motorsport UK is itself helping its members that compete in Europe prepare themselves for a no-deal divorce. The organisation is building a contingency plan for them, as well as sending out some advisory notices, to tell teams and competitors what they should be doing to avoid as many potential problems as possible.

Ultimately though, it remains to be seen what the true impact of the UK’s EU exit will be. Whether, as is hoped, the split can be properly managed with the minimum of disruption to both the motorsport industry and the wider community, or whether the severest warnings of Richards and others will be realised and the UK’s place as a centre of excellence for motorsport engineering will be cast in doubt.

What Richards is adamant about, however, is that for the effects of the break to be mitigated, the current uncertainty needs to end as soon as possible. “These decisions should have been made a long time ago. Politicians need to make a decision now and just get on with it,” he concludes. “Making decisions about what form our relationship with Europe is going to take less than one month before its implementation date would, in most business circles, be regarded as devastatingly incompetent.”

“So, we are only just seeing the magnitude of the complexity of what we are letting ourselves in for.” 

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PEOPLE LAUGHED, BUT HANS WENT ON TO SAVE COUNTLESS LIVES

William Kimberley marks the passing of a man who was behind the greatest safety innovation since the seatbelt

It is with great sadness that we heard of the recent death of Robert (Bob) Hubbard, a retired professor from Michigan State University, a long-time crash researcher for GM and an expert in the field of spinal biomechanics. Along with brother-in-law multiple IMSA champion Jim Downing, he was the person behind the HANS (head and neck restraint) device.

Together they went on to form a company initially known as Hubbard-Downing Inc, but which is now known simply as HANS Performance Products.

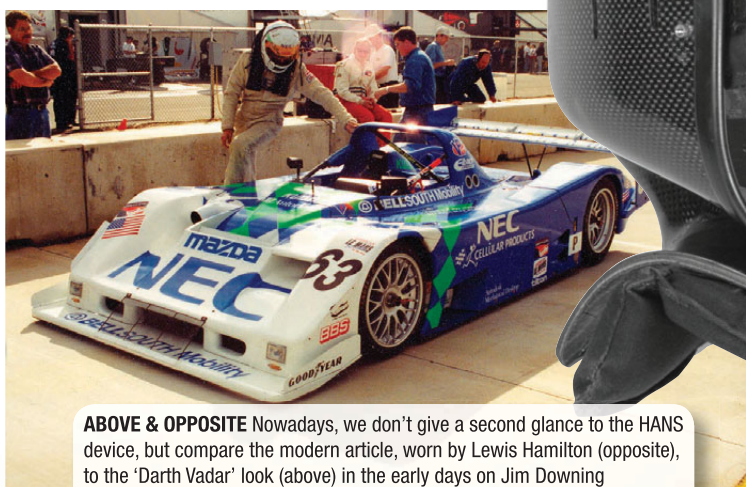
It was a source of pride to Hubbard that the HANS device would go on to become as much a part of drivers' kit as the ubiquitous fireproof overalls, gloves and helmets. However, when seen publicly worn by Downing for the first time it was not readily accepted. In fact, strange as it might seem now, the device even attracted ridicule.

"Yeah, people used to point and smile and wonder what I was wearing," Downing recalls. "I guess I looked like a fool walking around in it, but that's how we did our early publicity. I'd thought it was going to be the greatest thing since sliced bread but that wasn't the reception it got – in those early years between 1986-91 we got almost no-one to wear it."



ABOVE Belatedly, Hubbard received due recognition for his role in creating HANS





ABOVE & OPPOSITE Nowadays, we don't give a second glance to the HANS device, but compare the modern article, worn by Lewis Hamilton (opposite), to the 'Darth Vader' look (above) in the early days on Jim Downing

Years later, both men and device were recognised by the prestigious MSEC (Motorsport Safety & Engineering Committee), which is affiliated to the SAE, winning the SAE John Melvin Motorsports Safety Award. The late Dr John Melvin was a pioneer in the field of driver safety, especially in driver restraint systems, and was also a key developer of 'black box' data recording. Hubbard later told MSEC member Thomas Gideon that receiving the award, with Jim Downing and Hubert Gramling in 2016, was one of his proudest moments.

EARNHARDT FACTOR

Though the innovation changed the course of motorsport history, sales were slow to take off. By 1997 fewer than 300 HANS devices had been sold. Tragedy proved the biggest catalyst for acceptance, though. Tellingly, over 250 were ordered in the week following the death of NASCAR legend Dale Earnhardt at Daytona in 2001.

Ayrton Senna's death at Imola in 1994 sparked similar soul-searching in Formula 1, where for the first time there was an acceptance that the science of safety needed to be studied. It was after Mika Hakkinen's enormous accident in Adelaide in 1995, in which he fractured his skull, that the FIA instigated research to establish the best way of protecting drivers' heads in major impacts. Airbags and 'active' safety systems were briefly considered, before the focus shifted to development of a HANS system suitable for grand prix racing. It was mandated by Formula 1 in 2003.

Many thousands of HANS are now sold worldwide and many sanctioning bodies demand that their drivers must wear them. A HANS device has been mandated by

NASCAR since October 2001.

HANS itself continues to evolve. The device did shrink considerably over the years, with input from, among others, GM and Mercedes, who, on different sides of the Atlantic, had big stakes in motorsport. The smaller device became suitable for single-seaters but that shrinkage also made it more acceptable to closed-cockpit racers.

The range expanded too. Advances in technology enabled the ability to offer products to fit most sizes of driver but, perhaps more crucially, all types of seat – from the near-horizontal position of open-wheel racing, through to the more conventional sports seats in rally cars.

In the modern era its developments are frequently more to do with ease-of-use, packaging and comfort. In recent times HANS Performance Products partnered with companies like harness manufacturers Schroth and racewear company Stand 21 to develop products that integrated better.

More recently, a HANS II device was

created specifically for club racers. Moulded with DuPont Zytel RS polyamide, it is 30 per cent lighter than the previous model while retaining the stiffness, elongation, loading, deflection and impact strength.

As is the case at the top level, racing any car, even in historic events, without a HANS device is now unthinkable. The lives saved number in the thousands. Everyone involved in motor racing owes a debt of gratitude to Dr Bob Hubbard and Jim Downing. **RT**



ABOVE Tragedies fuelled the acceptance of the HANS device. More than 250 were ordered in the week following the death of NASCAR legend Dale Earnhardt at Daytona in 2001

CAN THE BEAST OF THE WRC BE TAMED?

World rallying's biggest news is Citroën's coup of uniting the driver at the top of the table with the car at the very bottom. **Hal Ridge** reports

ONCE imperious on the stages, Citroën has had to adjust to life at the bottom of rallying's new world order. Until now.

Having experienced a title drought since winning a ninth World Rally Championship drivers' crown with Sébastien Loeb in 2012, the introduction of new technical regulations for 2017 brought a reinvigorated effort from Citroën Racing. The new C3 was devised to take the French marque back to the summit of rallying.

But, even the withdrawal of the dominant Volkswagen outfit, which left a more even playing field between the remaining four marques, couldn't help Citroën return to the top step of the podium on a regular basis.

The C3 WRC was clearly fast, and lead driver Kris Meeke won on just the car's third event, in Mexico, but his season was marred by accidents. Many of those offs were believed to be in part down to inconsistency in the C3's handling characteristics, especially when grip was at its most changeable.

With the car at its best on Tarmac, Meeke won Spain's mixed surface event towards the end of the year, but Citroën ended the campaign fourth, and last, in the manufacturers' table.

The 2018 season started little better, although Craig Breen and Meeke managed podiums in the second and third rounds and the returning Loeb led in Mexico. New rear suspension geometry was introduced in Argentina but following a huge accident at the next event in Portugal, Meeke was sacked and the French squad looked even more in disarray and further from its glory years than ever.

Just two rounds later in Finland, however, thanks to revisions to the C3's front axle geometry, adding to those at the rear, Mads Ostberg challenged for victory. The squad's upward trajectory was confirmed when Loeb returned for his third and final outing of the campaign and won in Spain.

Showing its intent to fight for the drivers' crown, Citroën prised former driver Sébastien Ogier, now a six-time champion, from the clutches of private squad M-Sport to lead its assault in 2019 and the Frenchman duly won on his debut in the C3 WRC on the Monte Carlo rally. Remarkably though, the car's success on the opening round of the 2019 season wasn't due to a raft of technical revisions over the winter. Instead, it was down largely to refinements to the setup that built on the changes made in the latter part of the previous season.

"Compared to Monte Carlo last year we had some huge improvements, especially on the suspension, but compared with the end of the year, we didn't have anything else than a specific setup which has been defined with our new drivers. We didn't pass any joker for this beginning of the year," explained team principal Pierre Budar following the marque's Monte Carlo win, Citroën's 100th WRC victory.

The surprise that Citroën didn't introduce any homologation jokers (which it can play at intervals through the year) over the winter is compounded by the fact that the Versailles-based squad doesn't plan to implement any until later in the campaign. "We are working on several items. Of course we need quite some time to finalise all the improvements and validation. I think probably not before the middle of the year [before implementing them]," says Budar, a long-time PSA Group employee who took the helm of the works rally programme at the start of 2018 when predecessor Yves Matton moved to become the FIA's rally director.

Budar says that Ogier has been an intrinsic part of refining the C3 for 2019. The reigning champion's talent is beyond question, but he also brings unprecedented experience of the new generation of WRC ►



“The main aim was to get the drivers confident, even when the grip is changing during the stage”

ABOVE Sébastien Ogier's Monte Carlo victory suggested a reward for drastic revisions, but the C3 was largely unchanged from its predecessor



ABOVE Lappi's drive in Sweden, where he claimed the team's second successive podium, underlined the squad's forward momentum

machinery. Not only had he extensively tested the stillborn 2017 Polo WRC, but he also tried Toyota's Yaris before signing to drive M-Sport's Fiesta to the last two titles.

"His experience is very positive for us," admits Budar. "It's quite interesting because he has a clear view where to go. When we do some tests and we talk about some work to be done, every time he keeps in mind the complete picture. Of course we are going into details but, he doesn't go into specific detail which maybe would focus a lot of time and a lot of work. With Sébastien we have the complete picture of the behaviour of the car and the setup.

"So we are not working only to solve specific details, we are working every time for a setup completely focused on the next race. That's very interesting, just to have somebody who reminds us to keep in mind the complete picture, not only to be very, very accurate and very, very performant on very specific details."

It was a shrewd, if expensive, move to insert the second most successful driver in WRC history just as the greatest rally driver

of all-time left the Citroën programme for 2019. (Loeb's departure was largely due to Peugeot's withdrawal from World Rallycross.) Nevertheless, Citroën has been working on step-by-step developments to tame its beast for some time, in a raft of areas, including the active centre differential.

"For sure the body parts are the same [as they were in 2017], but we had a lot of new developments made since the beginning of the first season. On the chassis side and engine side mainly of course, and the differential also. Most of the work has been done on the chassis, especially on gravel," explains Budar, who openly admits that consistency from the car had been lacking before the changes.

"We had to reconsider even some geometry approach to get the car more consistent, whatever the grip level. That was the main item: to get the drivers confident even when the grip is changing during the stage. The car was quite competitive on gravel, but a bit sharp, especially when the grip was moving and changing a lot. We had to find a way to

give better confidence to the drivers."

The team also worked hard on damper development. Falling in line with the trend for each WRC manufacturer to select a different damper supplier for its MacPherson strut suspension, Citroën started using Öhlins towards the end of 2017 on gravel as well as Tarmac. It was a link carried over between the PSA Group's then rallycross programme and Formula E.

However, the squad was also spotted testing different damper suppliers ahead of this season's Monte Carlo WRC opener, and could swap brands during the year. For 2019, rival M-Sport has switched full-time from Reiger to ZF. "So far we are still using Öhlins. We are working also on different options but it's not settled yet," hints Budar.

LOEB LESSONS

As part of the latest generation of regulations introduced in 2017, which brought more aggressive aerodynamics, better safety and increased power, active centre differentials were permitted to join the mechanical ►




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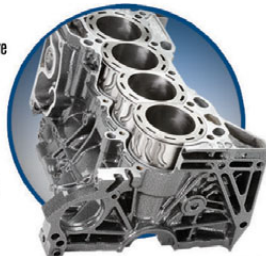
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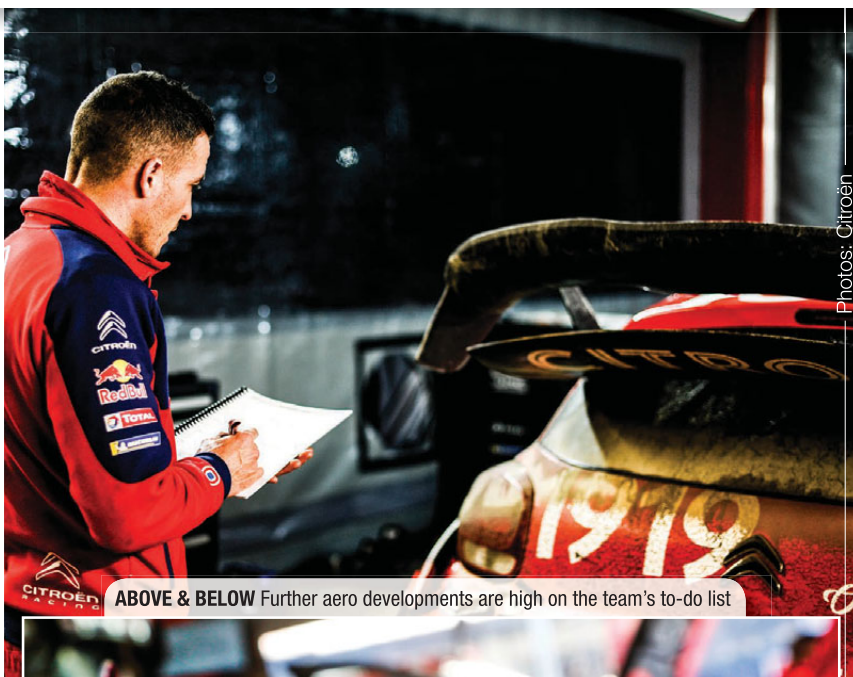


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front and rear units in the four-wheel drive machines. In the relatively recent past, Citroën ran an active differential on its championship-winning C4. While constant refinement is made to the active diff and Citroën can draw on that knowledge from a car used a decade ago, Budar says that drivers with experience of competing in that period are just as useful for making development strides. As such, having now Hyundai driver Loeb test the C3 last year helped the team move forward.

"We never stopped doing some refinements on the mapping of the centre differential. For the mechanical ones, it's a bit more complicated to do some changes. It's maybe easier to work with some drivers who had the same experience and if you consider, let's say, old drivers such as Sebastien Loeb who was used to these differentials, we got from him more interesting feedback compared to young drivers who never experienced this before in a race.

"The old experienced drivers were quite good for that. He [Loeb] had a more focused approach on this kind of active differential. It was quite interesting to get his feedback. We had no surprises with him, but a lot of confirmation on the proper way to go to get the car easier to drive." ►



ABOVE & BELOW Further aero developments are high on the team's to-do list



ABOVE The mechanics work against the clock to turn the C3 WRC around at a service halt

Photos: Citroën



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ABOVE Team principal Pierre Budar clutches the trophy in Monte Carlo, Citroën's 100th WRC victory

drivers and engineers moving across from different teams have an indication as to where any individual car really is compared to its competition.

With aerodynamics, however – especially in the current rule set that has allowed for wider, more aero-heavy cars with rear diffusers and huge rear wings – visual comparisons are more easily made. Since its inception, the C3 has appeared to be the most conservative of the four current WRC machines aesthetically. Budar argues that just because the C3 isn't as wild-looking as its rivals, doesn't mean that it's not efficient.

"If it's a question of looks, our car is nice for sure," he insists. "Aerodynamics are quite complicated to judge only on the look of the car. You cannot know or see what the proper solution is: even if one is looking very, very good aerodynamically-speaking, we cannot be sure that it's the case."

He does concede nevertheless that aerodynamics is one of the areas for improvement this season: "We have to consider what can be done because we have some freedom around this better than on previous cars. The question is how to do the good move on that point because it's quite difficult to make sure you have the proper improvements on the aerodynamic side. Downforce when the car is moving a lot as ►

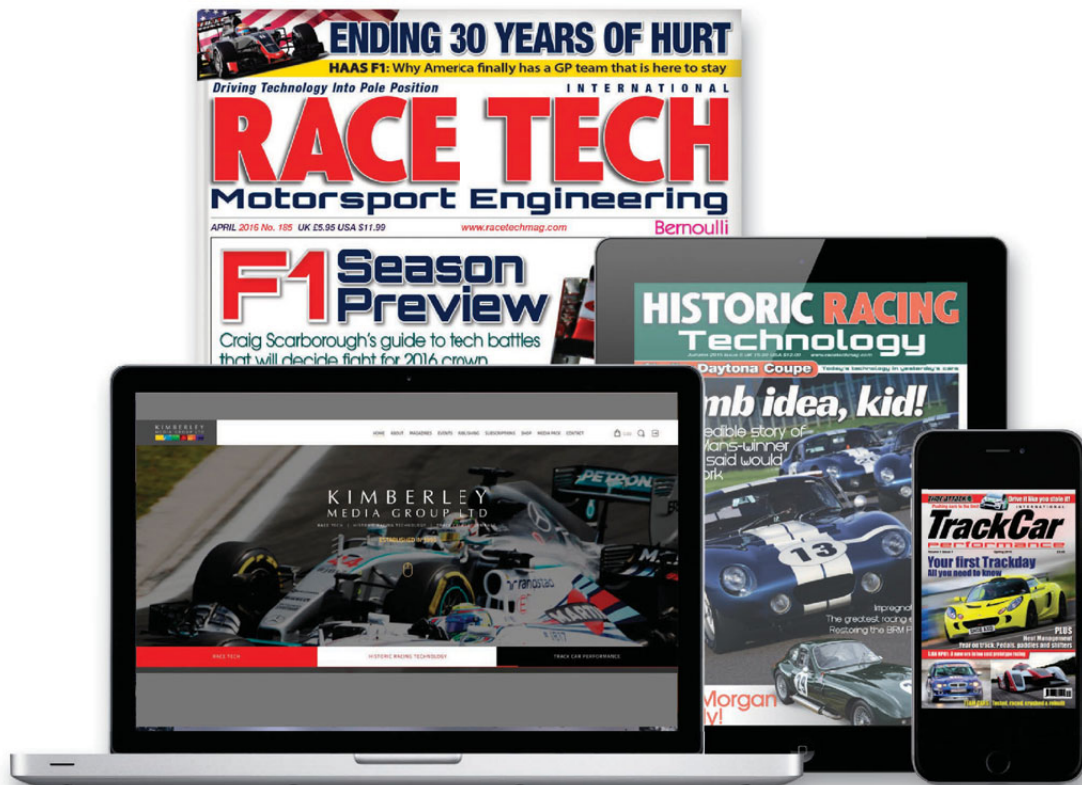
Increased traction, especially on very rough gravel, is an area where Citroën feels its WRC challenger can be improved. By contrast, from the very beginning of the project the in-house developed 1600 cc, four-cylinder, turbocharged engine has been acknowledged as a key strength of the package. Featuring a bore of 84 mm and stroke of 72 mm, the unit produces over 50 horsepower more than its predecessor [up to 380 horsepower at 6,000 PRM] thanks to a 20% increased airflow.

When, at the end of last season, Esapekka Lappi switched to Citroën from Toyota – itself acknowledged to have an impressive power unit – some of the Finn's initial public comments from testing complimented the strength of his new team's engine. But, while Ogier claimed victory on the Monte, albeit with a sticking throttle issue on the final day, Lappi retired with an engine failure. Budar is quick to reiterate that maintaining reliability is as important as chasing performance.

In the modern WRC era engine figures are kept under wraps and bonnets are closed at all times. Consequently, only



ABOVE The C3's engine, kept hidden from view, is believed to be an inherently strong part of the package



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Are hybrids coming to the stages?

ALTHOUGH the current WRC regulations have been heralded a success in providing exciting machines and close competition, sizeable issues dominate discussion over the next rule change, set to come into place at the end of the current homologation cycle for 2022.

Both the FIA and the current competing manufacturers have publicly made noise about the need to embrace new, alternative energy technologies into the future.

"We have confirmed we will be there in 2019 and 2020. We will see, according to the new regulations to come in, if we want to stay here longer or not," says Citroën boss Pierre Budar. "If you want manufacturers to stay involved in motorsport, you have to be able to give them the motorsport support which is in line with their expectations in terms of marketing.

"We can remain with the current cars, but you will lose the manufacturers because marketing-wise, they need to focus on the new technology because of the new CO2 regulations coming in, especially in Europe. You know how tough it is going to be for the manufacturers to reach the CO2 level requested, so they need to promote the new technology to make sure customers will be interested in it and to show our skill in this technology."

How those new regulations may look is still up for debate, although having fully electric cars with the current event structure is unlikely in the timescale, due to the length of stages and liaison sections. It's widely accepted though that a solid solution could be to embrace hybrid technology in rallying, using the conventional internal combustion engines for the stages, and electric motors for the liaisons. "Probably hybrid is one of the good options we could work on," says Budar. "The target at the end of the day, if you want to get manufacturers involved, is to be able to promote new technology saving CO2. If it's hybrid, it's okay. Let's show what we can do with hybrid in motorsport. Why not? It can be nice also to have a proper rally car as we know it today in the stages with a complete show, and very quiet cars when you go through villages and towns and no CO2 emissions during the road section. It could be one way to show how modern the rally car can be." 

BELOW Citroën's DS performance brand is already involved in Formula E through DS TECHEETAH. Can the WRC afford to ignore new technologies with the next iteration of its rules package?



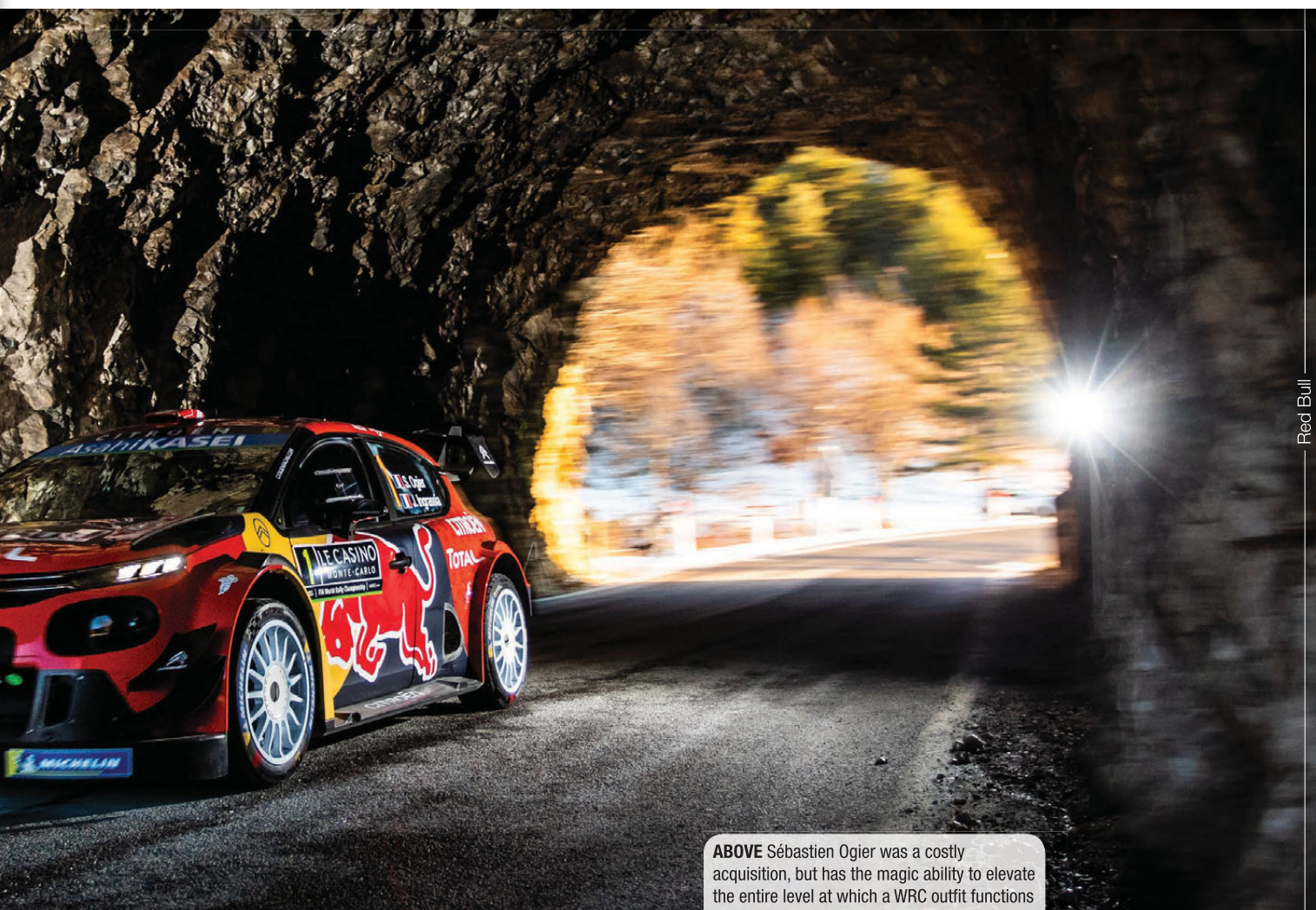
LAT Images/FIA/Formula E



a rally car is much more difficult than on a track car, which is much more stable. The effort you need to spend for development on aerodynamics – time, money, parts and so on – you cannot afford to make a mistake because it's too expensive, it's too long and it costs you too many jokeros."

CORRELATION

While many leading competition car producers increasingly lean on Computational Fluid Dynamics (CFD) to develop aerodynamic concepts, in France Citroën still relies heavily on wind tunnel and field tests to evaluate aerodynamic changes. "CFD of course can help, but it can also be not so easy to trust 100%," cautions Budar. "According to the tests we have done previously, we have made some CFD, some tests on track and also wind tunnel and it's quite difficult to have a correlation between the results, especially because of what we were talking about, with the whole attitude of the car to take into consideration. We still need to have some correlation tests to see if the CFD results can be trusted; our experience has shown it's not enough to just use CFD."



ABOVE Sébastien Ogier was a costly acquisition, but has the magic ability to elevate the entire level at which a WRC outfit functions

Red Bull

Strict homologation rules mean that cars must largely remain the same for all surfaces, notwithstanding the large changes in ride height and the amount of pitch and yaw encountered from rally to rally. That's along with the prospect of entering any given corner sideways, and potentially in the air.

"It's easy to have some downforce on the car; we know how to do it, but if you lose the downforce, it's a worse situation


for the drivers because they'll lose their confidence in the car," says Budar. "It's a compromise, not to get the highest downforce we can, but to be consistent, whatever the position of the car."

Evaluating developments means returning to similar terrains time and time again to assess differences, while also testing updates on all surfaces for the campaign ahead.

Before the 2019 season-opener, the C3 test

car was seen with an elevated rear wing and additional winglets on the front wings ahead of possible changes to the car this year. "It [aero] will be one of the items we are working on and probably if we are ready you will be able to see something [different] during the season, but for the time being it's too soon to be sure when we will be able to introduce these new parts," he says.

Citroën is currently only committed to the WRC until the end of next season, which is seemingly also when Ogier's terms are agreed until. But, as Budar has enthused, the development window of the C3, arguably the most difficult of the current WRC generation to tame, is being pushed hard. In its 100th year, Citroën, having all but abandoned the manufacturers' title by only running two cars instead of the permitted three, is all-in to try and ensure the C3 follows in the footsteps of the Xsara, C4 and DS3 by carrying its crew to the drivers' crown this season.

"This is our target for sure," says the team boss. "When you have the six-time champion in your team, you cannot focus on any other target. It will be difficult, we are very aware of this, but we will fight." 



ABOVE Damper technology is currently a hot area of development in the WRC

Citroën

THE FAST – AND THE FURIOUS

With the last rule upheaval dedicated to speed, but to the detriment of overtaking, F1 has fast-tracked some alterations originally intended for 2021. **Craig Scarborough** evaluates the design trends that mark the latest crop of new F1 machinery

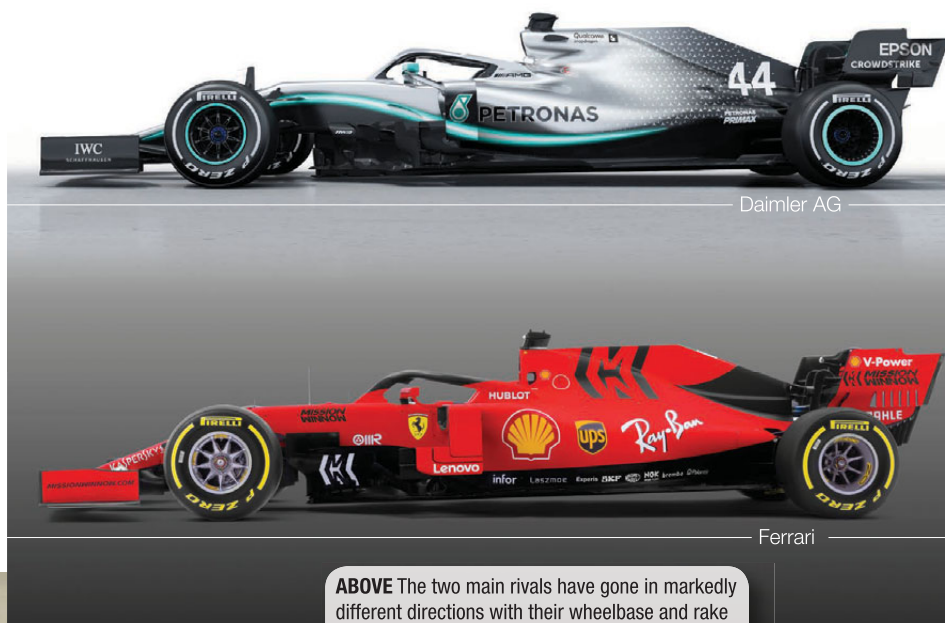


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ABOVE Mercedes-AMG continues to plough its own furrow with the design philosophy behind its new W10

F1 rarely sits still for very long: 2019 sees the introduction of a raft of new rules primarily aimed at improving overtaking. Meanwhile, the inexorable development race for those parts unchanged by regulation continues at the usual breakneck pace.

With simpler front wings and bigger rear wings foisted upon them, teams have started to find clever ways to recreate the beneficial outwash effect they had before, that usefully improves their car's performance to the detriment of the car following it. But the underlying technical battle is between Mercedes, standing apart from the fold with its own design



Daimler AG

Ferrari

ABOVE The two main rivals have gone in markedly different directions with their wheelbase and rake

philosophy, and the rest of the grid that is increasingly converging on a series of identical aero designs.

TURBULENT TIMES

The rule revisions, largely aimed at improving overtaking, were somewhat ironically forced onto the agenda by the poor racing resulting from the outcome of previous changes. The 2017 revamp had been overly focused on adding speed to the cars, without fully considering the ramifications for overtaking. As a result, cars that were already shedding turbulent wakes into the path of the following car, now formed even larger wakes, leading to the inability of the pursuing car to get close enough to pass, even with the DRS (Drag Reduction System).

It's been apparent within the sport, for some time, what the mechanisms are that restrict overtaking. With Liberty's new ownership of F1, Ross Brawn was recruited to head a research and development team tasked with several objectives, one being the overtaking conundrum. Armed with a squad of ex-F1 engineers and data from the current teams, a new set of rules is being devised for 2021. However, F1 couldn't wait two years, during which time the situation was likely to deteriorate further, so part of this research was accelerated and forms the basis of the 2019 rules.

In terms of aiding overtaking, the outwash effect of the wide front wing and the lack of DRS effect from the rear wing formed

the targets. While not a complete solution, they have shaped the key aero changes for the 2019 campaign.

Thus, the near-limitless complexity of the front wing within its regulatory volume has gone. Instead, a five-element wing, bereft of the aero add-ons from the past 10 years, has been enforced. The endplates are also simplified, straightened and the entire wing assembly widened to the full width of the car (2,000 mm). This should reduce the outwash and vortices created by the wing to push the front tyre wake away from the rear of the car. This airflow outboard of the car's width was the key contributor to it being hard to follow for another car. In theory, now the car should ingest

“ Mercedes has pursued its own path, aerodynamically, mechanically and with the power unit”

some of the front tyre wake through the coke bottle section of sidepods and produce a narrower wake downstream.

Additionally, the top rear wing has been widened and deepened, then the entire assembly lifted higher. Allied to a larger opening between the mainplane and flap when DRS is opened on the straights, it's thought the draggier rear wing should have a larger DRS delta, leading to the following car getting a greater speed boost on the straight. ►





ABOVE Ferrari, which pioneered the high-top sidepod route, looks in a strong position from testing with its SF90

FOLLOWING THE HERD

In the light of the 2017 rules cars have started to converge on a key set of major design concepts. This is leading to a near cookie cutter format for the car's basic layout. The majority of the grid's new cars can be broken down into a series of key design traits, with only Mercedes bucking this trend and going wholly its own way in design.

From front to rear, the contemporary F1 car design starts with the thumb tip nosecone: this is a reaction to the 2014

rules that mandated lower nose tips of fixed cross-sections, to reduce flip-over accidents after nose-to-wheel contact. Teams choose to run a wider nose cross-section, with the thumb-like protuberance to meet the rule's geometric demands. The wider nose also provides a wider-spaced front wing mounting pylon, that has become twisted and slotted to work with the rest of the turning vanes and bargeboards downstream.

Inside the nose an S-duct is common, there being inlets under the nose to scrape off any turbulence and boundary layer. This

is routed through S-shaped ducts inside the nose, to exit into the low-pressure area where the nose meets the monocoque.

Front suspension layout is a key variable, with two schools of thought commonplace: the double wishbone and track rod geometry isn't primarily focused on tyre contact patch management, but aerodynamics. The default position is a high mounting, the lower wishbone outboard pivot in-line with the front axle height, the top wishbone being mounted as high up inside the 13" wheel rim as space allows.

Mounting the wishbones to the chassis is the team's own variable, with higher or lower inboard pivots and anti-dive geometry. In this setup, the wishbones are raised to clear the front wing efflux and low enough to divert airflow towards the sidepod's undercut: a neat compromise.

The increasingly popular geometry is a very high wishbone mounting, given the small diameter wheel is the restriction of top wishbone height, and thus the lower wishbone height. So, the upper outboard mount is moved outside the wheel with a swan neck camber plate extending upwards and inwards through the wheel rim/brake duct. This raises the wishbones by tens of millimetres. The result is greater space for the front wing airflow, with perhaps a compromised sidepod downwash effect.

“Design teams beat the intended effect of the rule changes even before the first race has taken place”

Rear suspension, in contrast, follows a near common pattern. As with the front wishbones, the lower wishbone is raised to align with the driveshaft and the upper wishbone mounted very high and pivoting outboard with swan-neck camber plate extending out through the wheel.

Oddly, the monocoque's side impact protection spars are an area of differentiation, albeit the spars themselves are designed to a common standard. There are two pairs of spars, upper and lower. The lower pair sits at floor level, while the upper pair has a wider height window to fit within. A rules mismatch between this ►

Photos: Ferrari



ABOVE Ferrari has adopted the veined rear wing approach introduced first by McLaren

height and the maximum bodywork height allowed for the sidepods, creates a gap between the maximum spar height and the top of the sidepod.

Ferrari realised in 2017 that a slightly lower upper spar mounting could place the inlet over the top of it and one that reached the maximum height of the sidepod bodywork. In this layout the aerodynamically powerful undercut under the inlet can be larger, used to force higher pressure over the diffuser. Termed a high-top sidepod, Red Bull, Williams and Haas followed this design in 2018. For 2019, everyone bar Mercedes has gone this route.

MERC GOES ITS OWN WAY

Mercedes has been the dominant team in the sport since the big 2014 rule changes that brought in the V6-turbo/double hybrid power units. Even the aero changes of 2017 did little to diminish its supremacy.

Despite this domination of the championships, it has pursued its own



Mercedes-Benz

path, aerodynamically, mechanically and with the power unit. Given the champions' position, it's surprising no other team has tried to follow the Anglo-German squad's design direction.

Starting by simply looking at the W10, it's clear it's different: the wheelbase is huge at over 3.7 metres. When adding the mandatory overhangs, the car is longer than the manufacturer's long-wheelbase

E-Class! This length is required because the car doesn't run the raked setup of its rivals. Where Red Bull may be nearing some 150 mm of rear ride height and less than 30 mm at the front, the Mercedes is far flatter. This long wheelbase provides a longer floor to produce the downforce, rather than it being generated by the greater airflow expansion of a raked setup.

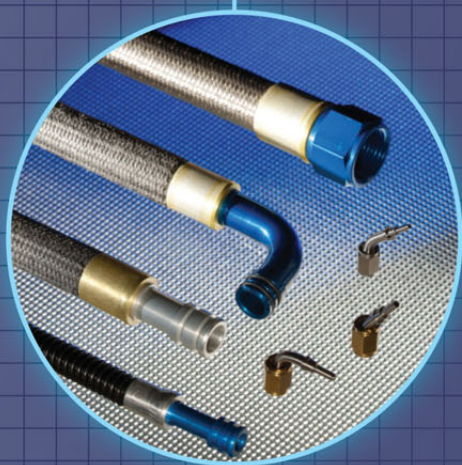
What Mercedes gains is a lower centre ►

ABOVE & BELOW The high front suspension geometry, seen here on the Mercedes-AMG W10, is currently a popular option

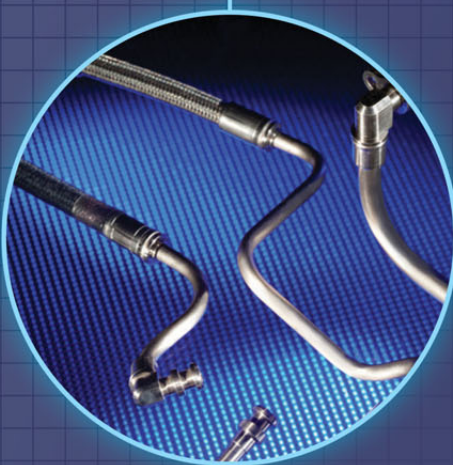


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BELOW The bargeboard of Red Bull's RB15 features a tall inner vane



Red Bull

of gravity height, through the lack of rear ride height, but it does have a long and potentially more pitch-sensitive floor to manage. Fortunately, the team has been a leader in suspension compliance for many years. Even with the more complicated passive hydraulic systems banned, Mercedes uses hydraulic heave elements to finely control the car's pitch attitude, overcoming the LWB layout's greatest handicap.

Contrasting to the cookie cutter F1 designs, the Mercedes W10 differs front to rear in many ways. Firstly, the nose tip's mandatory cross-sections merge into a slim rounded tip. This leads underneath not to turning vanes but to what Mercedes terms a 'cape', flow control devices that form

vortices at the edges that then pass through the bargeboards; similar in effect to the more common front turning vanes, just a different surface.

For its sidepods, Mercedes chose not to follow the Ferrari high-top concept in 2018, although a mid-season update introduced vane-work similar in shape to that of Ferrari's, but without the repackaging of the side impact spars underneath. This year its W10 still eschews the high-top concept; instead, the inlet is below a high-mounted spar, with the inlet being deep yet narrow, forming a narrower front to the sidepod. So, airflow is encouraged around the entire sidepod, rather than through a deep undercut formed below the inlet.

2019 SOLUTIONS

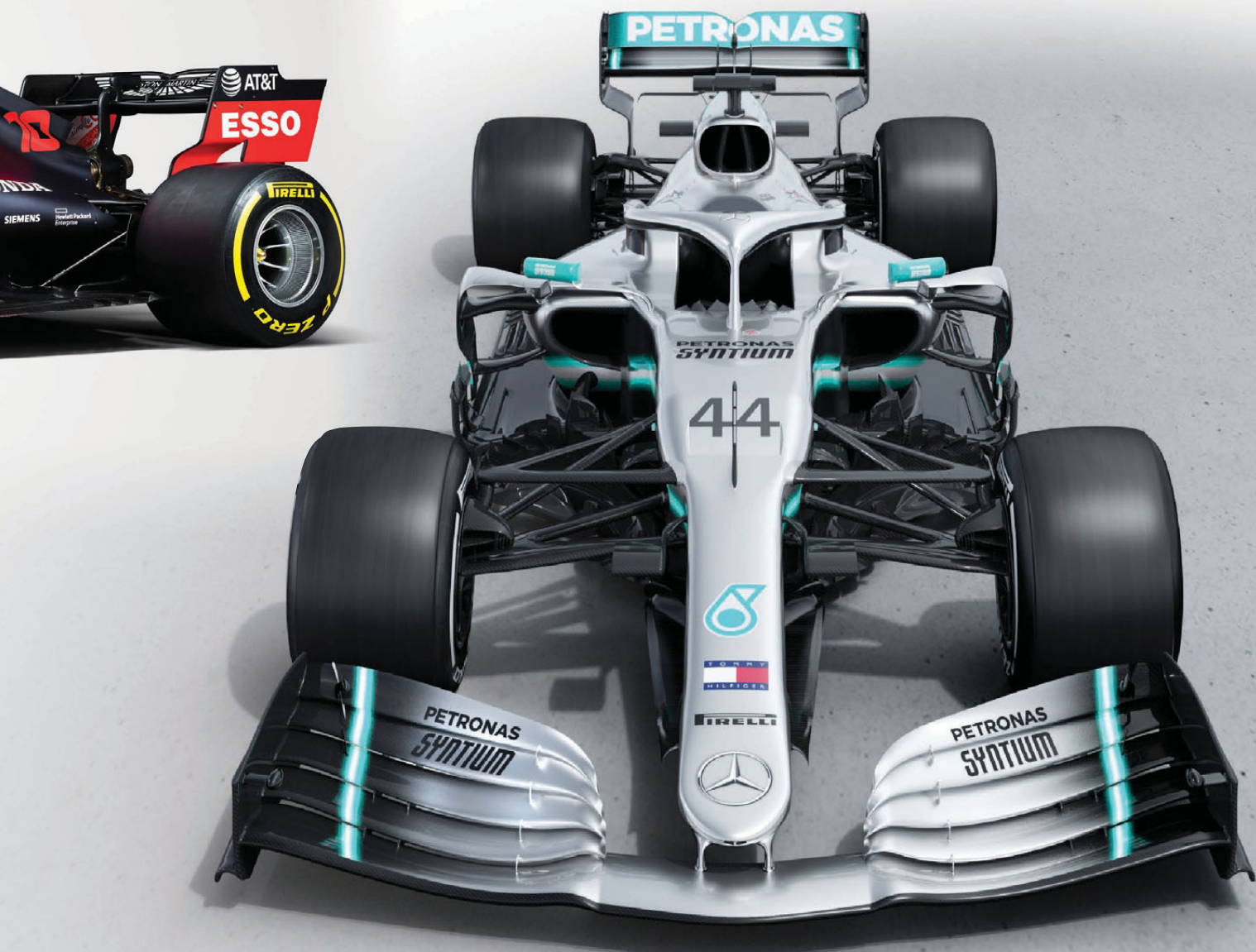
With the rule changes being quite targeted in their application, even if much of the car's design is year-on-year development, a number of new tricks appeared on the cars



ABOVE Haas, like some others, stops the rolled footplate short of the end of the endplate



ABOVE The Alfa Romeo C38's front wing, with its flattened out angle of attack near the endplates, is typical of the solutions a number of teams are experimenting with



ABOVE Mercedes found a slightly different outwash solution with the trailing edge of its endplate

as they began to test.

2019's simpler front wings are refreshingly clean-looking, although the increase in span, height and chord does make them look huge. Teams will split the wing's duties into three: downforce, outwash and Y250. As with any race car, end of straight speed is set by the rear wing, thus the front wing is only there to achieve an aero balance. Given the two-metre span, achieving this load target is easy, even with just five elements. Thus the middle of each wing's span is given over to downforce creation: this area sports the steepest angle-of-attack (AOA) and is adjustable.

Outwash is now limited to what curvature the rules allow the endplate, what teams do with the outboard tip and how they join the endplate. Most launch-specification wings run moderately steep profiles at the endplates, which creates outwash, but the tip vortices that are formed are relatively

high and would ideally be lower to suit the airflow spilling outboard off the tyre.

Several teams have found alternative solutions here, with Ferrari, Alfa Romeo and Toro Rosso harnessing a similar concept. The wing's AOA is flattened off the endplate, to the extent that there is little or no connection of the wing tips and endplate. This exposes the outwardly curved endplate to do the job of creating outwash without being obstructed by the wing. It certainly looks counter-intuitive for an F1 car to run so little wing, but the three-part function of the wing is still achieved with this format, despite appearances that it won't produce the downforce required.

Mercedes found a slightly different outwash solution with its endplate. The trailing upper corner of the endplate is leant inwards. This reverses the flow structure formed on the top edge of the endplate, to that of a typical outswept endplate. The top edge vortex

will roll off the inner edge towards the outer face of the endplate, putting it in different rotation and position relative to the tyre, offsetting some of the wake formed on the lower outer edge of the tyre.

Haas likewise rearranged its endplate to shorten the rolled footplate short of the end of the endplate. Again, this repositions the vortex formed by the lower edges and directs them to offset the tyre wake.

One part of the rule changes not for performance limitation, but for marketing reasons, is the height of the bargeboards. This lower height was to allow for large sponsor logos on the side of the chassis. All teams have lowered the inner vanes of their bargeboards, but also the outer vanes mounted outboard of the sidepod inlet. Thus, teams are finding neat ways to exploit this remaining area. McLaren has formed an almost stylised vane around the front of the bargeboard package, fitting right up to the ►

edges permitted in the rules.

Red Bull has pushed all of its bargeboards and boomerang wing elements down into the allowed volume but found a loophole in this area. The maximum height volume does not quite reach the side of the chassis, leaving a few centimetres to fit in higher bodywork right next to the tub. Thus its bargeboard has a tall inner vane, sitting outside of the exclusion zone.

The mirror mounting, not typically an exciting area for development, has also been exploited under rules that were intended to simplify the area, now limited to two mountings on the inner and bottom face of the mirror pod. Allied to this, the mirrors can be mounted further from the cockpit to afford a better rear view, through the newly raised rear wing. Immediately every team has used the now wide inner mounting as a vane to direct airflow down over the sidepods, while the lower mount is used in a similar directional function.

The rear wing is also subject to a marketing-led rule change, closing off the drag-reducing louvres moulded into the front upper corner of the endplate, as the



McLaren

holes broke up the sponsor logos. With a larger rear wing and no drag-reducing louvres, teams have sought to find other ways to make the rear wing more efficient. The new trick here is a recent McLaren idea: the endplate must be creased to widen from between the rear wheels to the top rear wing; this creased area is opened up and vanes hang inside the gap. This helps expand the airflow through the rear wing, lowering the pressure and increasing downforce for a given wing level.

POWER STRUGGLE

Aside from 5 kg extra race fuel allowance, there are no major Power Unit changes

for 2019, so the turbo hybrid engine development will continue unabated. Last year Mercedes and Ferrari were neck and neck as the best PUs, while Renault was in a battle with Honda, both somewhat down on power and reliability compared to the leaders.

For 2019 Mercedes claims to have an all-new PU, while Ferrari has clearly repackaged its version, especially around the inlet plenum and charge air cooling package. Renault, having recommitted to F1 with its own factory race team, looks to now be leading the midfield on the evidence of testing.

There is nowhere to hide for Honda, which is now supplying Red Bull in addition to Toro Rosso. It faces a major challenge to match

ABOVE & BELOW McLaren has formed an almost stylised vane around the front of the bargeboard package



Andre/LAT



Renault Sport F1

ABOVE & BELOW Renault's early test pace appeared to vindicate its claim of progress with its PU (above), while Honda must perform now it is a works team with Red Bull




Red Bull

the speed of the Red Bull chassis.

Both Renault and Honda are boasting that over the winter they have made major gains. They will need them: the bar is now set at 1,000 hp, and just three PUs are permitted for the season ahead.

BEATING THE RULES

These new rules were conceived to improve overtaking, but their effect will be limited, both by the restricted scope of the changes and the teams' hard work to overcome them. The revisions seek to achieve a plateau in the cars' ability to create downforce or overtake, but design teams beat the intended effect of the rule changes even before the first race has taken place. Haas team principal Gunther Steiner suggests that the development curve won't plateau, but simply keep on rising.

Teams will have already found any lost downforce and will slowly shed the added drag of the new rules. Early predictions of over two seconds per lap lost are already cut by half a second. The reality is that we will probably have to wait until 2021 for a fully developed rules package that will improve overtaking in F1. 

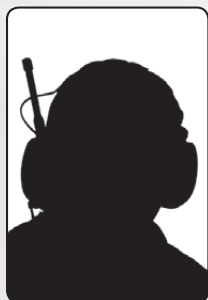


Mercedes

ABOVE Bargeboards have been lowered this year to show the side of the chassis



Amid growing fears over the increasing number of 'B-team' alliances being forged in F1, our **Expert Witness** – an insider who must retain anonymity – asks whether this is a case of:



DOUBLE OR QUILTS?





ABOVE No amount of camouflage can disguise the similarities between Red Bull's RB15 (left) and Toro Rosso's STR14 (top)

In general industry the expression "economy of scale" is applied to most products. If you want to make something unique in small quantities to your own design, that is possible, but requires specialist skills, manufacturing and is expensive. If you want large quantities of something that already exists, production-made, off the shelf, that is much cheaper and readily available.

Motorsport has historically been good at providing this whole spectrum, something for everybody, but what about at the pinnacle of the sport, F1?

A foundation cornerstone of grand prix racing has always been that all entrants are manufacturers, designing and building their own unique prototype to compete against each other; may the best team and driver combination win. When the financial pinch comes, it means there is a high turnover of smaller teams, unable to sustain competing. We're familiar with that. That's why we don't need pre-qualifying any more. But when even the large teams are struggling to attract sponsorship revenues and fund hybrid engine development programmes, there is definitively a cost problem that needs to be solved.

So, what do you do, if you want to enter the sport, but see no way through the glass ceiling, or should that be *class* ceiling? How can you compete, on a budget? The truth at the moment is you can't: the current rules and governance of this game mean you're either destined to fail or can only participate for a while at great expense. This is an integral part of Liberty Media's huge challenge.

less units, or not for sale under any circumstances, depending on who you are. They are not all making their own.

Which brings me onto "listed parts", the areas of an F1 car you don't have to manufacture, a list that is becoming increasingly longer, gearbox cassette internals now joining for 2021. This system has been most recently exploited best by the Haas F1 Team. A technical partnership with Ferrari provided very significant support to their fledgling programme, so much so that the initial competitiveness of the team was far superior to anything in recent times. How much of Ferrari's input had they inherited? After investigation, nothing was found to be beyond the line, which suddenly makes this model extremely attractive to both parties and a dangerous precedent.

BIG BROTHER'S R&D SUBSIDISED

In this scenario the larger team's R&D is subsidised by becoming a supplier, plus benefits from more technical feedback on its power units, while having a strong controlling interest over its 'wing man'. We are not going to hurt each other, are we?

The most obvious example of this approach is Red Bull and Toro Rosso, now sharing the Honda and a good deal of expertise besides. Why argue unsuccessfully for three-car teams, when by another mechanism you can have four? The unfortunate casualty in this increasingly familiar circumstance is James Key, Toro Rosso's former technical director, allegedly moving on to McLaren because too much of the new car was being

“What is the future of F1, this Noah's Ark of teams weathering the current storm two-by-two?”

Engine, now powertrain, supply is at the very heart of this dilemma. Since the update five years ago to the existing highly complex and car-integrated rules, which rather suited some of the best strategic brains of the time, manufacturers and customers have wrestled with the eye-watering costs of both development and supply respectively. There are currently four options, increasingly converging in performance, provided to the teams, either at a hefty price for increasingly

inherited from big brother.

Let's not also forget that we are talking about a Red Bull Aston Martin, using a Honda powertrain, where the AM road cars have recently upgraded to AMG Mercedes turbo engines, a clear and obvious mis-alignment of partners.

Sauber, another one of the last true independents, has also been absorbed, becoming Alfa Romeo, another romantic and beguiling brand which has actually graced F1 previously with success. However, ►

let's not kid ourselves: the only genuine contribution now is budget and the badge, although in this latter case, like Haas, the Italian team links are far, far stronger.

To exist then, perhaps you must now join one of the big three? Mercedes GP, as multiple reigning champions, is the most obvious choice given the opportunity of technical partnership. Who wouldn't want to benefit from that recent dominant capability?

Williams, apparently. As a longstanding and committed member of the independent manufacturing DNA of F1, it went against all they believe in at Grove to follow this customer path, so they refused. At what cost to the team?

Racing Point, under another new



Dunbar/LAT

ABOVE Williams is adamant that it should remain a constructor in its own right, rather than double up with an existing heavy-hitter, but at what cost? Its new FW42 arrived late to Barcelona testing



Hone/LAT

ABOVE Alfa Romeo has a rich motor racing heritage but, realistically, the new Alfa Romeo Racing C38 isn't part of it

name and financial management – also, coincidentally, inherited from Grove – but already a Mercedes power unit client and partially in Brackley, were much more inclined to agree. Traditionally punching well above their weight, this will nicely support them as they build up the infrastructure required for the future of F1 with their newly-found proper budget.

What is the future of F1? This Noah's Ark of the teams weathering the current storm two-by-two to emerge from the other side can only be a stopgap, can't it? Or are we inexorably sliding towards GP1: yes, underneath they are all the same, but look, some of the pretty concept shapes are done by stylists, they are different colours, big brands, more races, and powertrains still come from different places. Anyway, the fans don't really care and can't tell the

difference. How else were we going to control the costs unless we made it more and more of a spec series?

At a time where rapid innovation and development is so desperately needed in both the automotive and motorsport industry, it would be a missed opportunity to over-regulate this out of the premium flagship category. A far more open technology race, with budget control, would see both the best and most cost-effective engineering solutions flourish and then be usefully applied elsewhere.

Maybe this is not F1's mandate any more? Is it just about putting on more successful shows, to more people, more often, to generate more revenue? For sure the DNA has to change, but in which direction to best survive and then thrive? **RT**



Andre/LAT/LAT

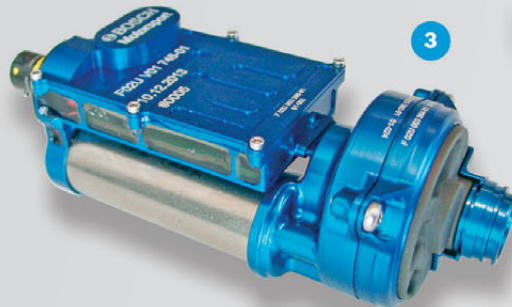
ABOVE The black and gold livery may be part of the sport's rich history, but will the 'Listed Parts' approach exploited by Haas be remembered so fondly?

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THE FOUR 'F'S!

First, Fix the Fuels - Fast! **Chris Ellis** examines how recent technical developments – including gasoline made from carbon sucked from the air – may have changed the landscape ahead of F1's 2021 reset

LAST August, I highlighted a discovery at the largest US Department of Energy laboratory that offers F1 the chance to lead the way in the development of road-relevant technology. (See Race Tech 213, 'Fuelling Formula 1'.)

Since then, quite a lot has changed: technical developments that make it all the more imperative that F1 should take the lead.

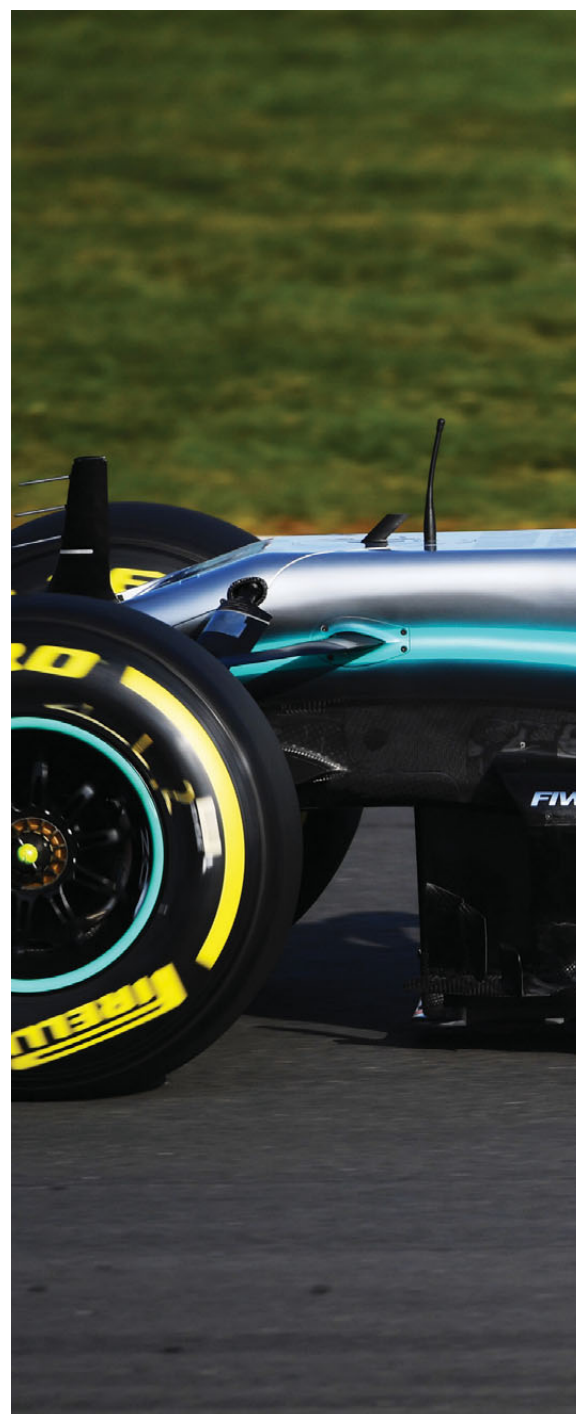
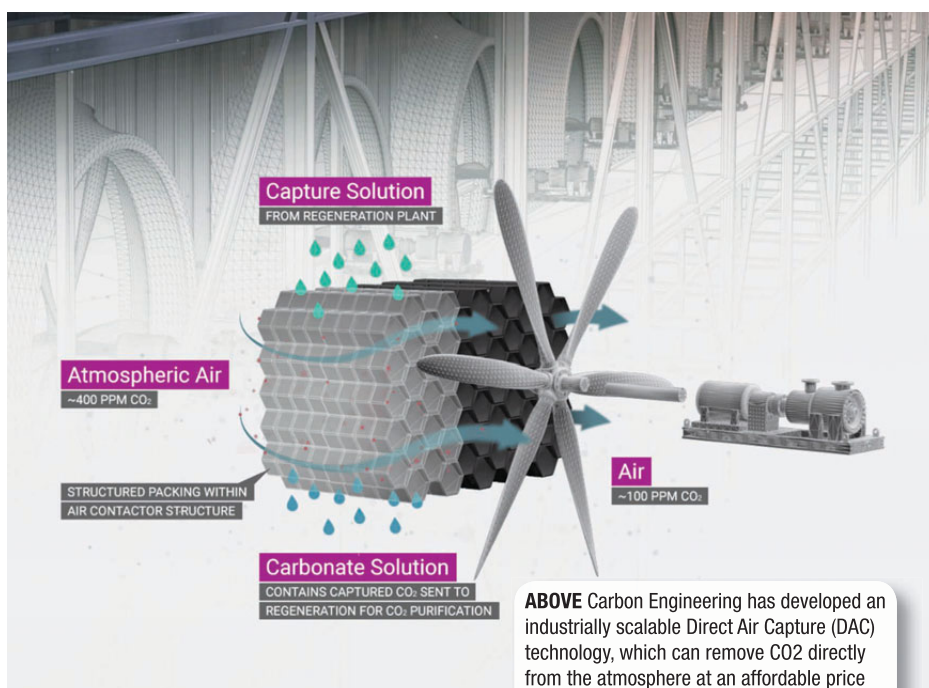
National Geographic has since published an article with the title 'This Gasoline Is Made of Carbon Sucked From the Air'. This explained that a small Canadian company, Carbon Engineering, had developed a process capable of extracting carbon dioxide from the air for less than \$100 per ton. A second development is the ability to produce 'artificial petrol' and jet fuel from little more

than CO₂, water and plenty of low-cost electricity from renewables. At a practical level, two major oil companies, Chevron and Occidental, have already become shareholders, and a pilot plant producing 200 barrels a day is under construction, and should be operational next year.

SPLASH HEADLINES

Consequently I need to upgrade my suggestion that Formula 1 should be running on E25 in 2021. I still believe this is optimal, assuming the ethanol in the E25 is not produced from fossil fuels but from the process the Oak Ridge National Laboratory discovered in 2016, which, again, requires little more than CO₂, water and cheap

“On carbon-neutral fuel, F1 would cause less total impact on the environment than Formula E”



electricity from solar, wind, etc. The upgrade is to use 'petrol' from Carbon Engineering to replace the 75% of E25 that is currently derived from crude oil.

While 200 barrels a day is not even a drop in the global bucket of conventional daily petrol production, only four days' worth (some 35,000 US gallons) should be enough to fuel all 24 cars for practice, qualifying and the race at every location throughout the 2021 season. It hardly needs saying that this could provide Formula 1 and Liberty Media with sensational headlines, so it won't surprise

you I alerted them to this opportunity weeks before you are reading this!

F1 would then cause less total impact on the environment than Formula E, because its batteries are much smaller than those of FE, even though they are allowed to be replaced every race...

The French government seems to have followed the FIA's now obsolete position, with its proclamation: "There is only one answer - Stick a battery in everything by 2040!" But fortunately, the Chinese and US governments haven't believed the

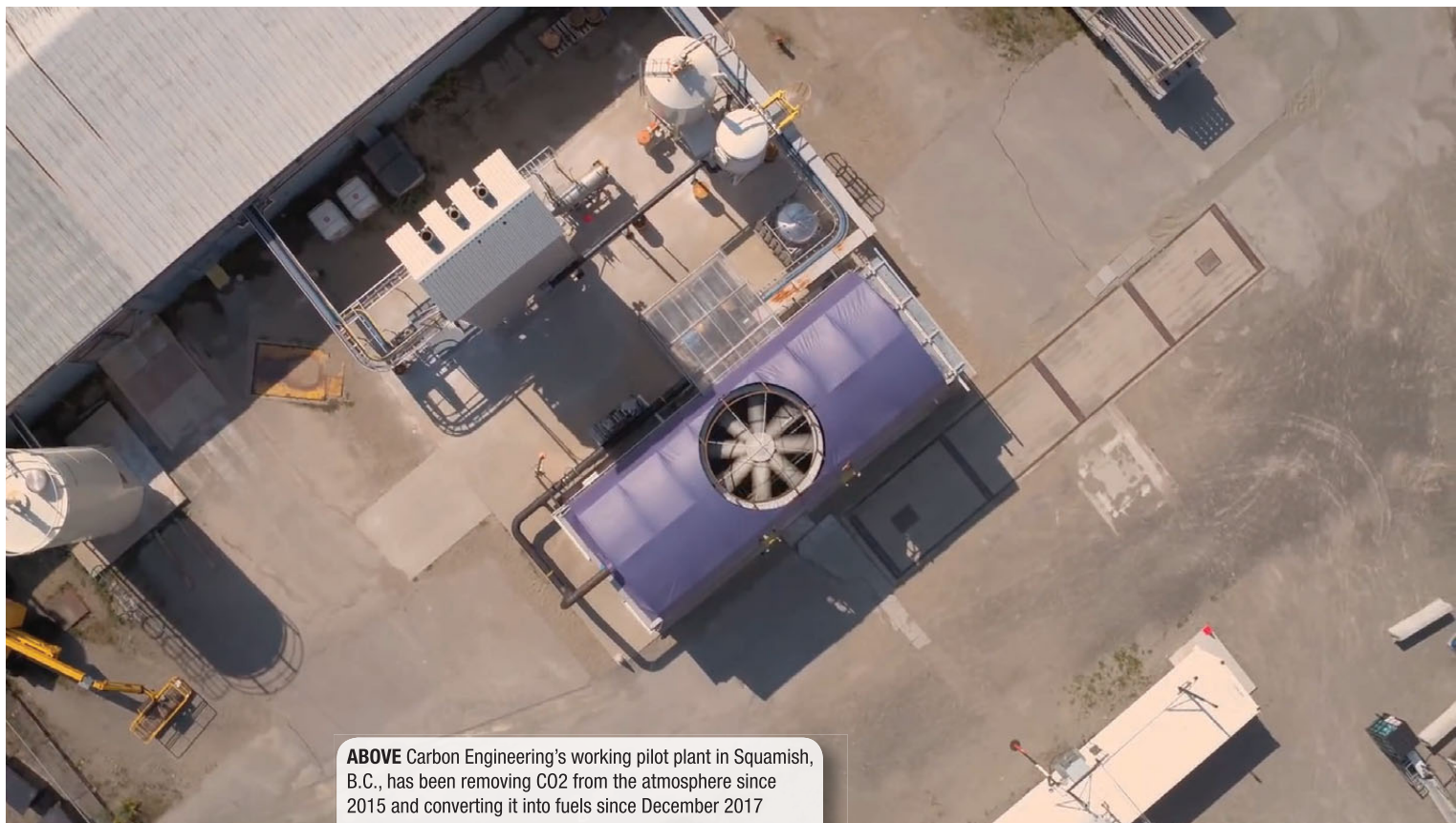
propaganda from the BEV cult.

In August last year, China announced its new plan for a mandatory minimum of 10% bio-ethanol in 'petrol' by the end of 2020, which should become a reality across all of China during 2021. It already is, in several provinces. And the plan includes other provisions which suggest a target, soon, of ubiquitous E25. When? I couldn't possibly say, except to remind you that President Xi's first degree is in chemical engineering...

I don't know whether the Chinese government's announcement this January of ▶



ABOVE The F1 fuel and oil partners make a vital contribution to teams' individual performance, such as with Merc's new W10, but it is current developments away from the racetrack that have the potential to show the sport as a whole in a good light



ABOVE Carbon Engineering's working pilot plant in Squamish, B.C., has been removing CO₂ from the atmosphere since 2015 and converting it into fuels since December 2017

its new complementary plan for solar energy was, at least in part, stimulated by the *National Geographic* article, but that doesn't really matter. In my mind, 'if it looks like a plan, and acts like a plan – it's a plan!'

The bottom line for F1 will be that the new fuel ('R25'?) will be 'net-zero' with respect to CO₂, because the CO₂ will be recycled. However, it will require a lot more fuel to clean up all the big support trucks that come to most races. But here's an idea. What if the FIA, Liberty Media and the circuit owners insist that, by 2022, no trucks running on any sort of diesel fuel will be allowed near the grandstands, to limit air pollution? BMW, JLR and Mercedes will, by then, be capable of supplying flex-fuel 3.0-litre straight-sixes of over 450 hp which will be an easy fit in the spaces previously occupied by big straight-six diesel engines. Now think how valuable the large advertising spaces on the sides of the massive trailers will be when towed by 'near-perfect' tractors to the F1 circuits. 'R25 - Beyond Petroleum!' or 'Solarpec-powered', for example. (Solarpec might become Sinopec's new all-ethanol subsidiary and global brand – by 2021?)

The transition from fossil fuels to 'sunshine fuels' is going to cost trillions. But think how this could stimulate industry in

general, globally. Plus pull most of the countries under the 'Global Sunbelt' out of poverty faster than their peoples have dreamed possible. And, in the long-term, if we don't stop Global Warming, the cost won't be measured in dollars, but in hundreds of flooded cities and millions of lives. And all of these efforts could be led by Formula 1! Who knew?

TRUE LEADERSHIP

So who is going to tell the FIA we want our V12s back? Jay Leno might; see the CNN interview in his garage full of over 100 collectable cars, in which he laments the loss of screaming engines, etc.

As I explained in my August article, F1 choosing E25 rather than E85 for 2021 could be projected as the FIA showing true leadership. Three road cars running on E25 should cause slightly less pollution than one SUV on E85 'hogging' the available ethanol, which will be in short supply for at least the first five years.

Most people reading this are probably not directly involved in motorsport, just keen fans like me, and many won't even be employed in the automotive industry. Some might work in the nuclear industry,

for example, and they will know already how valuable low-cost bulk storage of its output could be. Well, it's arrived, in the form of Oak Ridge's breakthrough discovery. The surplus energy produced by reactors and turbines potentially running at optimal power throughout every night is inherently already as cheap as it needs to be to make 'ORNL ethanol' an immediate commercial success. So EDF could become a fuel supplier... Does Total know?

In parallel, I hope other readers will be thinking thoughts like: "I wonder how easy it could be to convert our smelting process from natural gas to ethanol?"

As my 'Fuelling Formula 1' article made clear, I believe there are at least three main 'solutions' to the problem of powering road transport with minimal impact on the environment.

First, to relieve the very obvious congestion in most major cities worldwide, governments will legislate (and tax) to encourage the adoption of zero-emission fuel-cell-powered taxis, soon to be known as 'autos' when driverless. Their fuel cells will probably be running on a similar mix of ethanol and water to the one pioneered by Nissan in Brazil, and hopefully still on track for production in 2020.

“The battery manufacturers may have won the ‘F1 KERS battle’, but they have already lost the war – they just don’t know it yet”

The fuel cell stack will be supported by a Surge Power Unit (SPU, aka KERS) which will need less than one kilowatt-hour of capacity, but will be able to provide some 80 kW of acceleration, and absorb kinetic energy at a similar rate during braking. Porsche (and Audi at Le Mans) has proved repeatedly that using flywheels can do this better than batteries, on the track. Now watch several Chinese companies prove it on the road, this year...

Max Mosley (barrister, *physicist* and former President of the FIA) has made it clear “it was a great frustration” he didn’t manage to persuade the F1 teams back in 2009 to introduce flywheel-based KERS, not just batteries. So now most F1 teams take advantage of the loophole left in the regulations that allows them to replace the batteries *every* race... To them, what’s a mere 24 times \$50,000(?) when the ‘power unit’ (sic) for each car costs at least \$10 million per season? But, even for Bernie Ecclestone, that would be a little excessive in a road car!

WILL BATTERIES FADE AWAY?

However, it really doesn’t matter any more what type of KERS F1 chooses for 2021. The battery manufacturers may have won the ‘F1 KERS battle’, but they have already lost the ‘SPU war’ – they just don’t know it yet. So I believe we will see the market for large capacity batteries gradually fade away, as it becomes obvious that fuel-only hybrids (with SI engines or fuel cells) have much lower lifetime costs for energy storage on autos and heavy duty vehicles typically exceeding 100,000 km per year, and which don’t need more than a few kWhs of SPU capacity. Also, batteries are now irrelevant for bulk storage of sunshine. Remember, the winds ultimately get their energy from sunshine, and solar power is essentially fusion power.

My key point is that ethanol has become the ideal way to ‘store sunshine’ in bulk, now that it can be produced really cheaply, with bulk electricity from solar soon below 2 US cents per kWh. Storage of renewable and nuclear energy is the key remaining technical hurdle, both on and off vehicles.

And now it looks as if it has been leapt over, with apparent ease. Congratulations, Carbon Engineering and Oak Ridge!

For the next 20 years, most cars, vans and trucks in the total vehicle fleet will probably still have internal combustion engines, but could be running mainly on ‘net zero’ fuels by 2030. However, development of advanced spark ignition engines was cut back, years ago, by most vehicle manufacturers in Europe when governments tried to reduce CO2 output by putting significantly more tax on petrol than on diesel. The motive was good but the action was typically misguided, and governments were deliberately misled by some of the manufacturers, see ‘Dieselgate’. So then the cutbacks cut further, to release resources to focus on BOVs, in the mistaken

belief that the only remedy was to stick a battery in everything!

But now we know we have the ability, working together, to ‘First, Fix the Fuels – Fast!’. So we can expect some of the great work on ‘petrol engines’ which was shelved half a decade or more ago to come out into the open again, this year. Homogeneous Charge Compression Ignition (HCCI) and flex-fuel ‘done right’ are amongst the obvious candidates, but there are several others.

Now let’s see how long it takes all of us, globally, to educate our governments... In China, it will be so easy – just send Carbon Engineering’s *Joule* articles to President Xi and ask him what they mean. And The lady in Downing Street with a geography degree May get the basic idea almost as quickly. Just put the *National Geographic* article into her Red Box! Who else? Ratan Tata, Bill Gates and Arnold Schwarzenegger (see regions20.org) obviously. And Jay Leno! And who else do you think? So tell them, please: ‘FFFF – First, Fix the Fuels – fast!’ **RT**

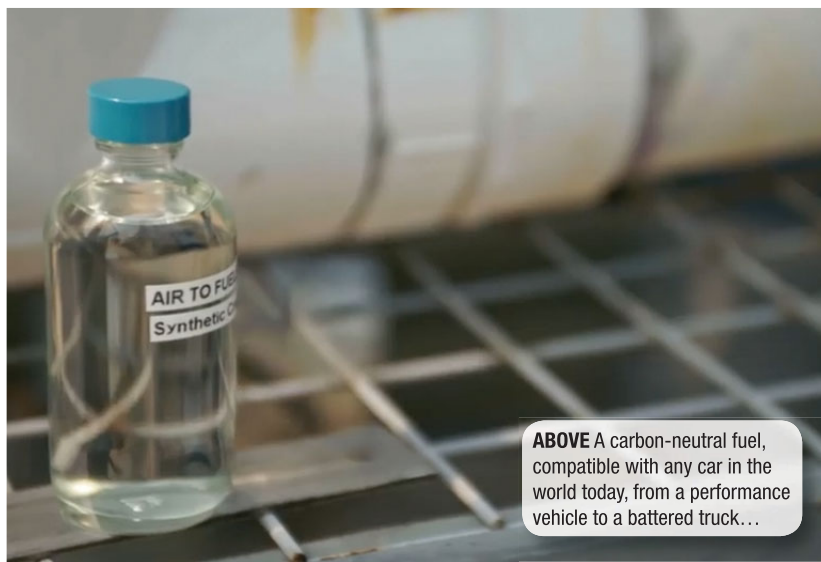
Carbon capture: eight years of hard work pay off

CARBON Engineering has not claimed a breakthrough, just modestly announced the details, in *Joule* magazine, of eight years of hard work. But the net result certainly seems like a breakthrough.

The first major achievement was to cut the cost of extracting CO2 from the air from around \$600 per ton to less than \$100/ton.

The second key step is the development of an efficient, low-cost process combining hydrogen from water with carbon dioxide to produce ‘petrol’, jet fuel, etc. The recent dramatic fall in the bulk price of solar power to less than two pence per kWh promises non-fossil fuels at competitive prices in Europe soon, if governments can be persuaded to take appropriate action on fuel taxes.

For full details:- <http://carbonengineering.com/> **HRT**



ABOVE A carbon-neutral fuel, compatible with any car in the world today, from a performance vehicle to a battered truck...

THE BEST NEVER REST

As Mercedes looks ahead to life after the DTM, **Chris Pickering** finds out some of the lessons the German manufacturer discovered from its time at the top of the world's fastest touring car series

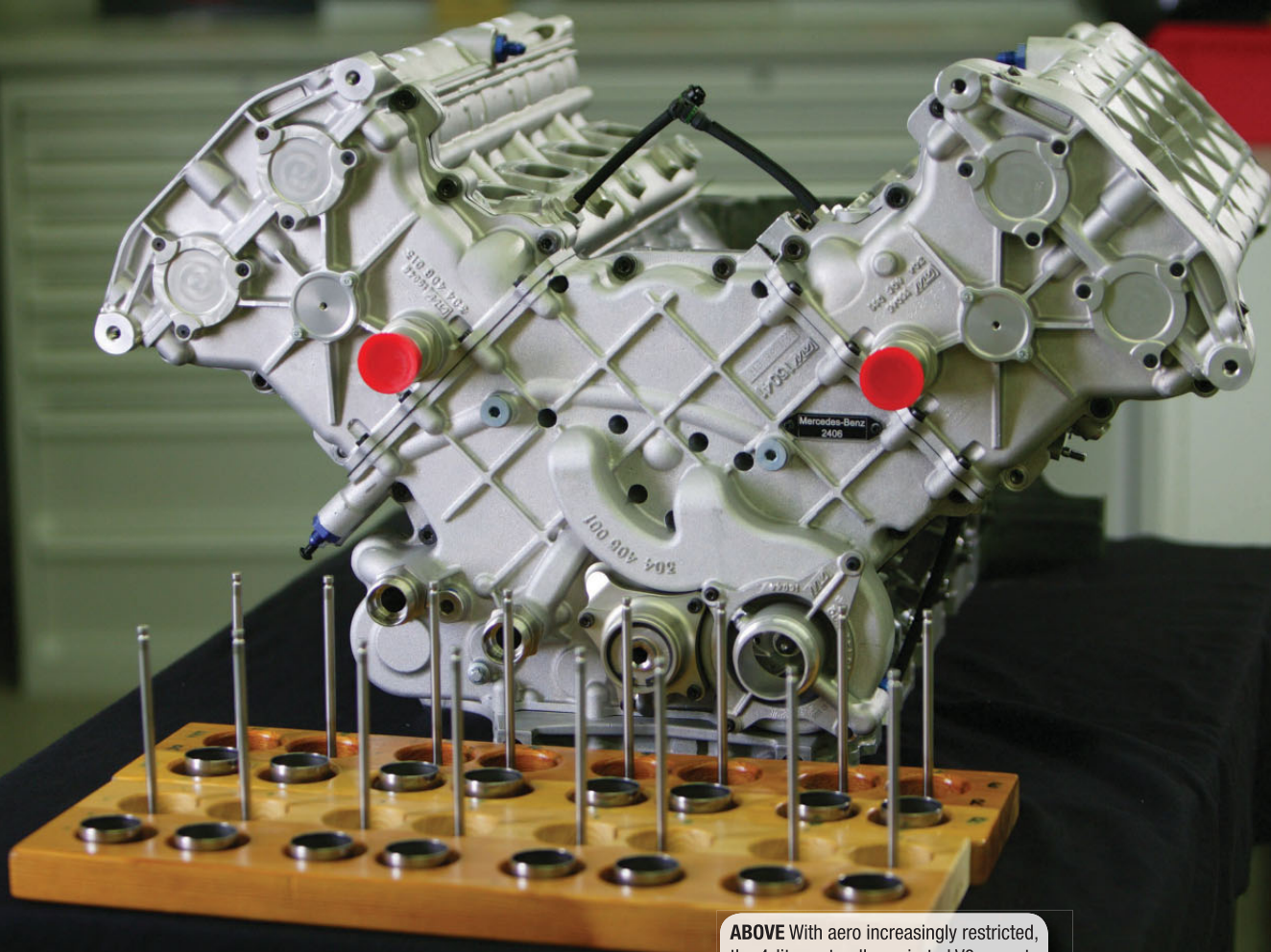
ALL good things must come to an end. And so it was that Mercedes withdrew from DTM at the end of last season, bringing the curtain down on its most recent 18-year stint in the world's most dramatic touring car series.

Throughout this time there was a longstanding technical battle being fought between the two

stalwarts of the series, Audi and Mercedes, with BMW and Opel also putting up strong opposition at varying times. Some might downplay the engineering challenge of the DTM, where the cars share a number of spec components, but it can still be the difference between winning and losing. In recent years, in particular, that deciding factor could be the engine. And the powertrain design is



ABOVE The three-pointed star bowed out on a high, with the Mercedes-AMG C63 DTM carrying Gary Paffett to the Drivers' title, in addition to scooping the Teams' and Manufacturers' honours



ABOVE With aero increasingly restricted, the 4-litre naturally aspirated V8 was at the heart of Merc's success

Photos: Daimler AG/HWA

something that the engineers at Mercedes' technical partner HWA AG are particularly proud of when they look back.

"I think it's obvious that we had a pretty strong engine, particularly in 2018," comments Hubert Hügler, development director at HWA AG. "DTM was heavily aero-dominated for many years, but when the standardised aero kit came in, the emphasis shifted to mechanical grip and the engine performance. Reliability was a big part of that. We occasionally had small issues like leaking cylinder head gaskets, but we didn't have a single blown engine in 18 years."

Mercedes went out on a high, winning both the teams' and drivers' championship in its final season in the DTM. Indeed, the start of the programme had gone much the same way, with Mercedes winning the constructors' title in eight out of the first 10 seasons of the V8 era. Behind the scenes, however, there were some teething troubles.

"At the start of the V8 era – between 2000 and 2002 – the engine was not the strongest

in the field," admits Hügler. "The mileage limitations were very tough with just one engine per year, so we were quite reluctant to take any risks and I think we played it a bit too safe initially. Later on in the programme we reached the stage where the engines were more or less dead by the time they crossed the finish line of the final race."

Internally, HWA set a durability target of

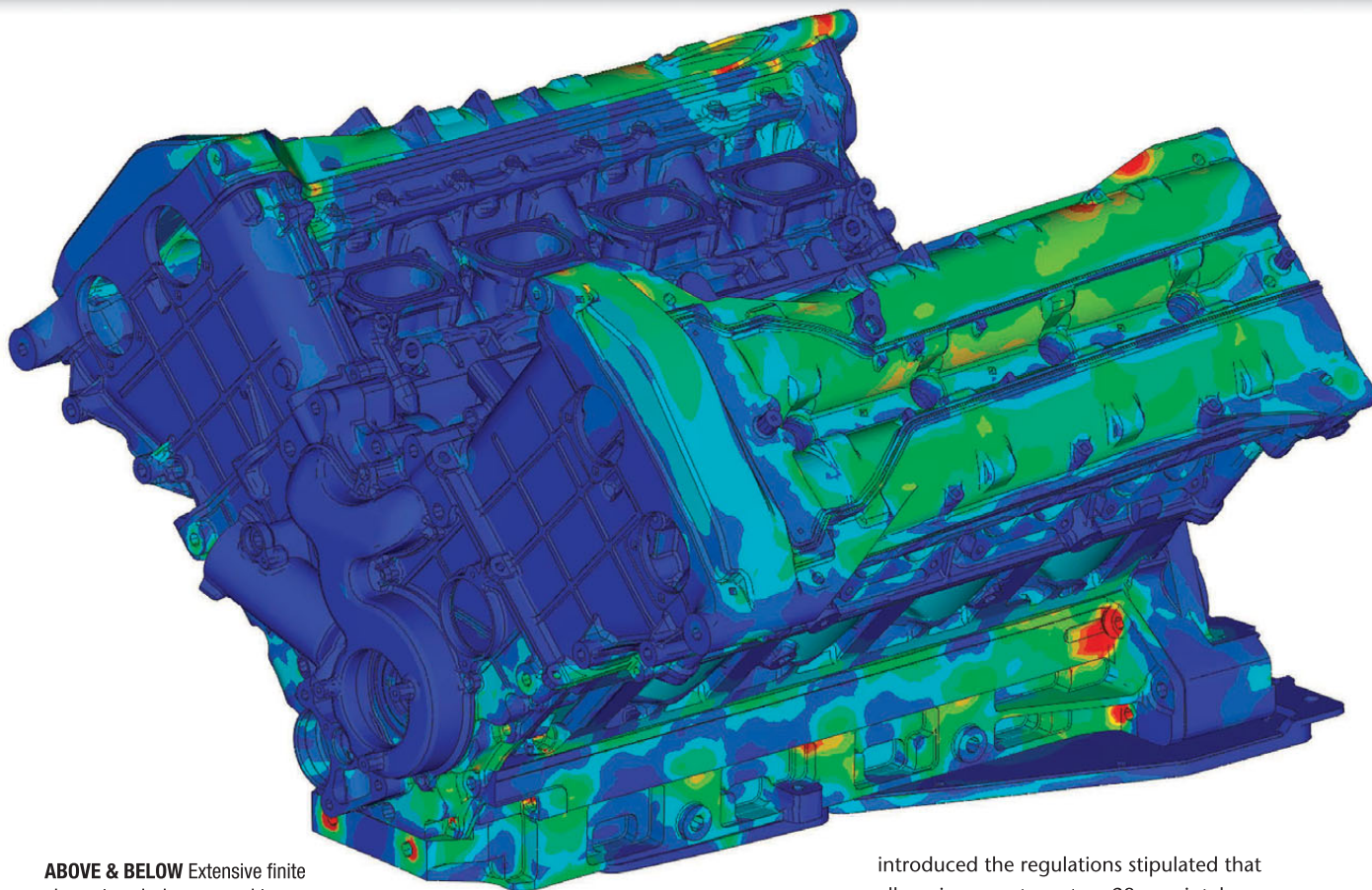
A full season of DTM race weekends, for comparison, covered around 5,400 km. During that time, the teams were allowed to adjust the valve clearance twice and change the oil, but no further maintenance was permitted. Ordinarily, the engines were sealed, with engineers only allowed to strip them down for inspection twice per season – and only then if there was a scrutineer present.

“We reached the stage where the engines were more or less dead by the time they crossed the finish line of the final race”

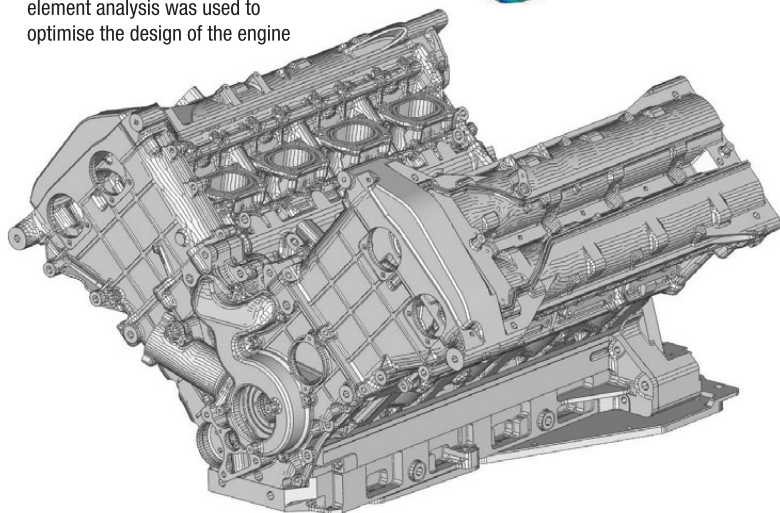
6,000 km on each engine, which was used as a benchmark for dyno testing. The company has a fully-transient dyno facility with track profiles for every single circuit on the DTM calendar, so the development engines could effectively be subjected to an entire season of racing, including pit speeds and standing starts, all from the comfort of a test cell.

BACK TO THE START

The Mercedes engine was a completely clean sheet design when it debuted in 2000. As per the series regulations, it was a 4-litre naturally aspirated V8 with a 90-degree bank angle, double overhead cams on each bank and four valves per cylinder. Other notable ►



ABOVE & BELOW Extensive finite element analysis was used to optimise the design of the engine



constraints included minimum weight limits for numerous components, as well as a total weight limit for the complete engine. There were, however, areas where the manufacturers were free to innovate.

"One of the biggest areas of freedom that we had within the engine was the use of coatings," comments Hügler. "We spent a lot of time looking at friction reduction with coatings on the pistons and the bores. The valvetrain was another area where we used this technology, along with the bearings."

On the chassis and driveline side, the DTM cars used a number of spec components, including Hewland 6-speed sequential gearbox, a ZF 3-plate CFRP clutch, AP

Racing discs and callipers, plus ATS forged aluminium wheels. When it came to the powertrain, however, the only standard part on the base engine was a Bosch Motronic MS 5.1 ECU. A mandatory catalytic converter also had to be fitted to comply with the series' regulations, but this competition-spec part was relatively easy to integrate, Hügler explains: "The only issue there was making sure we didn't generate too much heat around the monocoque."

In terms of the fundamentals, one of the most important aspects was the engine's breathing, with a lot of the initial development work focused on the intake system. When the V8 formula was first

introduced the regulations stipulated that all engines must run two 28 mm intake restrictors (one for each bank). More recently, in 2017, the restrictor size was increased to 29 mm, but it has remained one of the principal restrictions on the engines' performance.

"The main challenge on a DTM engine is getting the best possible air intake design," explains Hügler. "The length and design of the trumpets is crucial, as is the throttle system and the design of the air filter. When the body shape changed (first from the CLK to the W204-shape C-Class and then to the newer W205) it also prompted a corresponding change in air box design."

Cooling also tends to be an issue in air restricted engines, Hügler points out. The long, varied season of the DTM can see ambient temperatures range from 10 deg C at the opening round in Hockenheim, through to nearly 40 deg C at the height of summer.

ENGINE vs AERO 'DISCUSSION'!

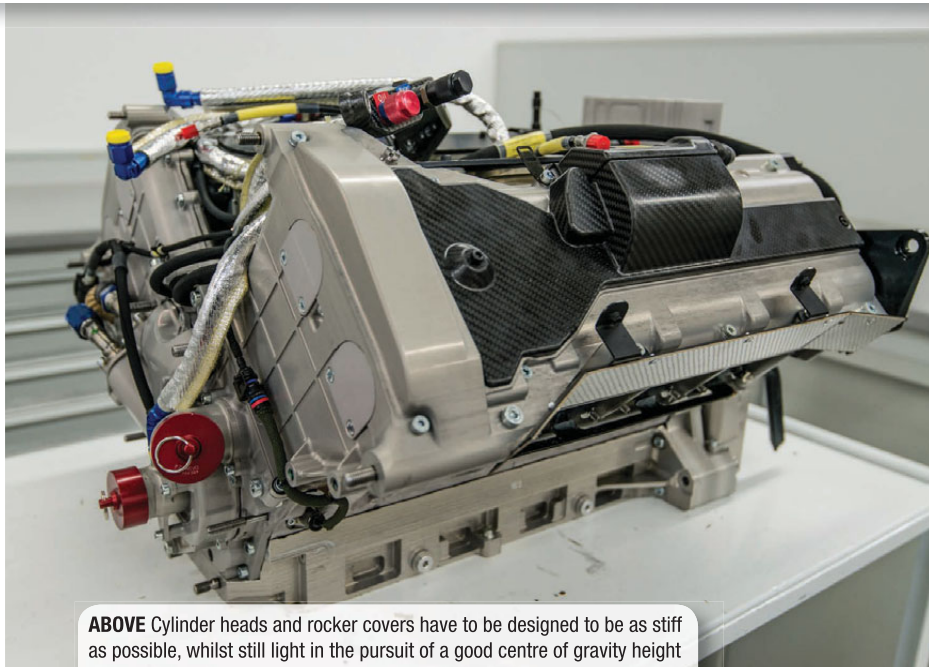
"Cooling always leads to a lot of discussion between the engine guys and the aerodynamicists," he comments. "The final specification car used a water-to-oil heat exchanger to get the engine oil up to temperature as soon as possible and maintain a steady level for the whole race. On the water side, we try to blank as much ►

“When you have a minimum weight limit there’s no point removing material from everywhere, but you have to think very carefully about where you leave it”

as possible to reduce drag.”

Block heaters were employed for both the engine and the gearbox during the start-up routine. The engine would be heated up to around 60 deg C before it was started. Below that sort of temperature, Hügler notes, the bearings would be very tight, resulting in excessive wear if the engine was run from cold.

Another key goal was to keep the centre of gravity height as low as possible. This is always one of the main targets, but it becomes particularly relevant when there is a minimum weight limit for the engine. “When you have a minimum weight limit there’s no point removing material



ABOVE Cylinder heads and rocker covers have to be designed to be as stiff as possible, whilst still light in the pursuit of a good centre of gravity height

from everywhere, but you have to think very carefully about where you leave it. Naturally we wanted it as low down as possible,” notes Hügler.

Somewhat unusually for a front-engined design, the DTM machines also used a semi-stressed engine, with the front suspension hung off a subframe that bolts directly onto the crankcase. As a result, the cylinder block and heads not only needed

to contend with the engine’s own internal forces, but with loads coming from the front suspension and indeed those fed in from elsewhere on the vehicle.

“You can see the effects of running a stressed engine in the upper parts of the design,” explains Hügler. “The cylinder heads and the rocker covers have to be designed to be as stiff as possible, but of course, you still want them to be as light as possible to ►



ABOVE Talented drivers like Gary Paffett and Paul di Resta became household names for their exploits for Mercedes-Benz

BELOW The team notched up its first title success in 1991, its fourth works DTM campaign, securing the Teams' and Constructors' championships with the Mercedes-Benz 190 E 2.5-16 Evolution and Evolution II



reduce the centre of gravity height. When it comes to the lower part of the engine and the dry sump system this is fairly easy, because there is enough material present due to the minimum weight regulations, but for the upper part of the engine it's quite a complex challenge."

Extensive finite element analysis was used to optimise this area of the design, Hügler

explains, looking at both the engine and the subframe. These loading characteristics were also influenced by the design of the rest of the chassis, which evolved considerably over time. While the carbon fibre monocoque was a spec part, the upper roll cage structure that contributed significantly to the strength and rigidity of the car was carefully honed over time. It started off as a tubular steel

spaceframe, which weighed around 160 kg when the formula began, but dropped to just 86 kg during the final season before the carbon fibre monocoque was introduced. This process of evolution meant that the structural loads on the engine had to be continually re-evaluated.

The other challenges were sometimes less obvious. Right from its inception, the DTM has been the fastest touring car series in the world, although some might argue it's stretching the term a little bit far. With their carbon fibre chassis, single-seater style pushrod suspension and very high levels of downforce, they have more in common with Le Mans Prototypes or even a Formula 1 car than a traditional tin-top.

AERO-LED

Aerodynamic development was so important in the early days of the V8 era that it started to have a significant impact on the development of the engine. The only significant redesign in its entire 18-year career came in 2005, when the powertrain engineers were under pressure to reduce the width of the engine – and in particular, the sump – as far as possible to free up space for the aerodynamicists to exploit. At ►



ABOVE The DTM's successful drive to strip out costs was perhaps best illustrated by the manufacturers' cooperation to produce a standard safety cell

the nose of the engine, where it met the front diffuser, they were given an area just 180 mm wide – less than the width of this magazine – to accommodate the sump.

"I said to one of our designers, 'We need this shape for the dry sump, can you do it?' and three or four months later we had the new design. We ran like that for the rest of the programme and it's something we're pretty proud of," comments Hügler.

TIGHT SQUEEZE

A number of other features were revised to allow the V8 to squeeze into such a tight space. The servo pump was relocated to the front of the engine, so it was driven directly off the crankshaft. Meanwhile, the gear drive was relocated to the back of the engine, freeing up further space. It clearly worked, with Mercedes remaining one of the dominant forces within the championship

for the next 13 years.

When the brand did finally withdraw, at the end of the 2018 season, it dealt a considerable blow to the DTM. That's not to say that things have gone quiet at the HWA workshops, however. The company still supports AMG's GT3 and GT4 programmes and it is involved with a number of hypercar projects, including the GT1-inspired Apollo IE. Notably, Vynamic GmbH, HWA Group's new joint venture with AF Racing, will underpin the Aston Martin brand's new DTM entry.

By far the biggest talking point, however,

is Formula E. Here, HWA currently acts as a customer team to Monaco-based constructor Venturi, but planning is already well underway for a full works programme with Mercedes for the 2019-2020 season. To some that might seem like the antithesis of the outgoing DTM category, with its ear-splitting naturally aspirated V8s, but it's undoubtedly the next big thing. And you can be sure that the skills and resources that stood Hügler and his colleagues in good stead over two decades of DTM racing will be put to good use there too. **LT**



ABOVE & BELOW Where aerodynamics used to be king in the DTM, freedom in this area has been severely reined in over recent seasons. Even between 2017 (above) and '18 (below), downforce was reduced by a third



BREAKING NEWS

Alan Stoddart was present to see Mazda eclipse the 26-year-old lap record in qualifying for the Daytona 24. The feat underscored the manufacturer's ambitions for the future, as well as saluting the heroes of the past

AS 2019 began, there was very little thought given to the Daytona 24's lap record, and why should there have been? It was old news. In fact it was 26-year-old news, with the time of 1:33.875, set by P.J. Jones, having stood since the All American Racers team, headed by Dan Gurney, dominated the GTP class with its Toyota-powered Eagle MkIII in the 1993 running of the event.

The 1993 season was legendary, with the Eagle so far ahead of the rest of the grid it won every single round of the championship that it entered. The car was so thoroughly insurmountable that it was ultimately blamed for the collapse of the series in which it raced.

Among those that had given this record very little thought was John Doonan,

Mazda's director of motorsports in North America. He had too much on his plate, trying to evaluate Mazda Team Joest's 2018 season in IMSA's DPi class, and working during the "so-called off-season" on developments, and improvements to help the team reach that elusive top step of the podium. After all this effort had been spent, the team showed up to the Roar Before the 24 pre-season test, and set about seeing what the car was capable of.

As it turned out the car was capable of a great deal: a lap of 1:33.423, in fact. Taking place during a practice session, this time was unofficial, but the fact that the 26-year-old record could be potentially overturned created a buzz of excitement going into the Rolex 24 itself.

And then it happened. During a qualifying session which saw fans crowding the fences of Daytona's 'Roval' course, the time flashed up on the timing screens and murmurs of 'they've done it' spread through the spectators and the paddock alike. The record that had stood since before Emerson Fittipaldi took his second Indy 500 win, when Nigel Mansell was the Formula 1 World Champion and Lancia and Audi were going head-to-head in world rallying, had finally been broken with an official pole time of 1:33.685.

The historical significance isn't lost on Doonan, who "as a student of the game", says that thinking about the record gives him "chills".

"You develop heroes over time, and we dream of being heroes ourselves, or we dream of being in the record books, and then you finally have the opportunity.

"Going into the 2019 season I had no idea who held the record, and I didn't go in with any thoughts about trying to break the record, but when those things come up it is cause for pause to think about who blazed the trail before us. For us now to be part of that history is a really big deal."

INSPIRATION

For Doonan, the significance of breaking the lap record at the Daytona 24 is also magnified because of who previously held the benchmark. After all, he says, who better to emulate than Dan Gurney, especially given the "remarkable" accomplishments of the All American Racers. He also thinks this aspiration is particularly apt for Mazda Team Joest given similarities he sees in their situations.

"The facility they operated out of for years, and what they accomplished out of that facility, representing a major manufacturer like Toyota, is similar to how we operate," he explains. "We obviously are a major manufacturer, but we want to achieve what they did, and in the same way as they did, and my hope is that we can accomplish half of what they accomplished, because then we would certainly be in a championship situation.

"But, if you recall, when they first started that project they didn't have a 100 per cent success rate with the powerplant or with reliability, so it is an inspiration and something to use as a benchmark."

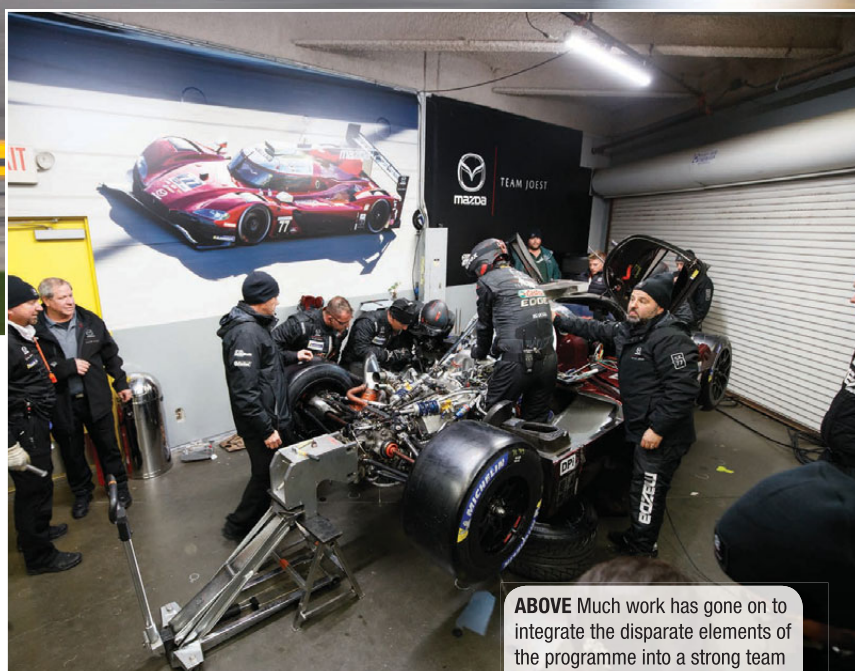
The last of these parallels will be particularly



ABOVE Though buoyed by its pole success (here John Doonan celebrates with Oliver Jarvis), the team had hoped for so much more from the overall race weekend



Photos: Mazda



ABOVE Could it? Would it? Much intrigue surrounded the team's efforts to break the longstanding lap record

ABOVE Much work has gone on to integrate the disparate elements of the programme into a strong team

comforting to the Mazda team, after the elation the crew enjoyed following Thursday's qualifying, turned to dismay during the race when both of the cars were struck by "purely bad and unexpected luck" within 15 minutes of one another. First, Oliver Pla piloting the #55 car heard an explosion, and after recycling the car's electronics was able to head to the garage where a fuel leak was diagnosed, a repair made, and the car sent out to rejoin the race three laps down. The

record-breaking #77 Mazda, meanwhile, wasn't so lucky, and burst into flames with what turned out to be terminal damage.

If there is an upside to be taken from the incidents, it is that human error, and not a fundamental mechanical problem was the cause of the issues, which Doonan says were different on each car. In fact, optimistically, he contends that the problems, and the steps that the team has taken to ensure they never happen again, mean that Mazda

actually has an "edge" going into the next round at Sebring in March.

This perceived advantage stems from the meticulous dissection of January's race. Looking back, Doonan is "really proud of the preparation on the cars by the guys in the shop. I'm proud of the mechanics and the engineers and how the race itself operated from a strategy standpoint, and I'm also really proud of the drivers and the stints that they put in."

"But," he continues, "We have identified engine challenges and I think in working with Multimatic and AER, our top technical partner and our engine partner, we've been able to put some processes in place to make sure that we don't have any quality issues going forward... this means we can spend our time preparing for Sebring with 100 per cent focus."

The development and refinements to the programme are also simply a result of ►

familiarity and experience with the car and the team, which has also seen some changes over the last few months. In 2018, the team unveiled what was essentially a new car, having withdrawn from the preceding season early to go back to the drawing board with the RT-24P and bring its performance up to a more competitive level. In addition, this was also the first year that Mazda's WeatherTech SportsCar effort was managed by Joest, after the German team best known for its numerous Le Mans wins with Audi was brought in to help take Mazda to the front.

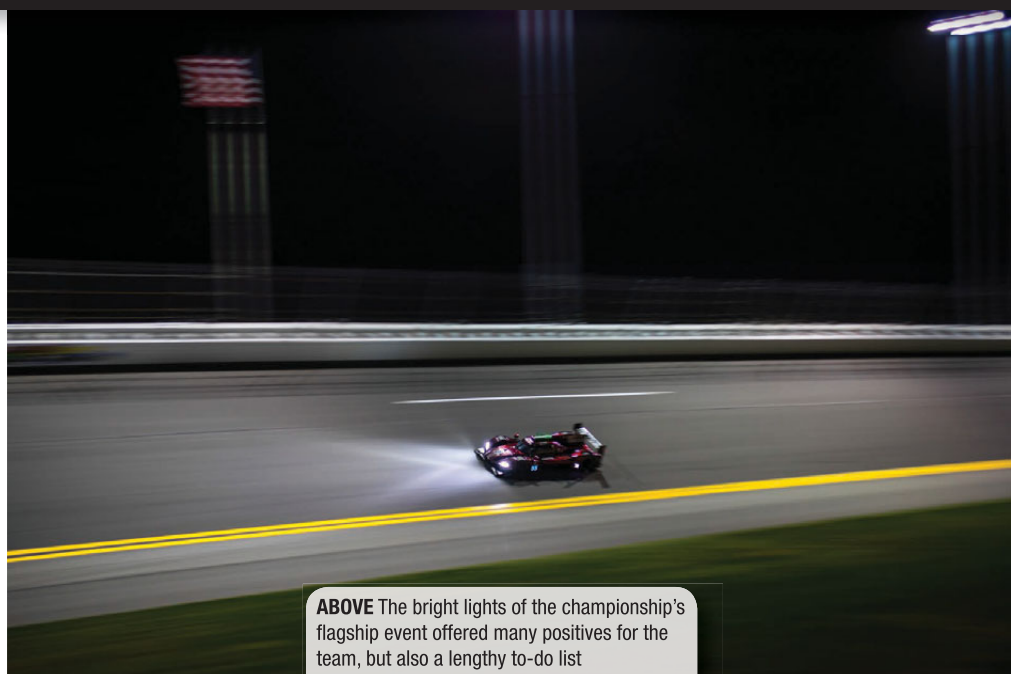
The 2018 season however turned out to be something of a damp squib, with the new car and the new team failing to secure wins despite having several opportunities to do so. Again, says Doonan, a period of introspection was necessary.

"We looked at ways to refine our programme. Some new personnel were added, and there were some adjustments made in terms of roles and responsibility. Chris Mower joined us as team coordinator and he has operated the US shop on a day to day basis, while Jan Lange, a long-time

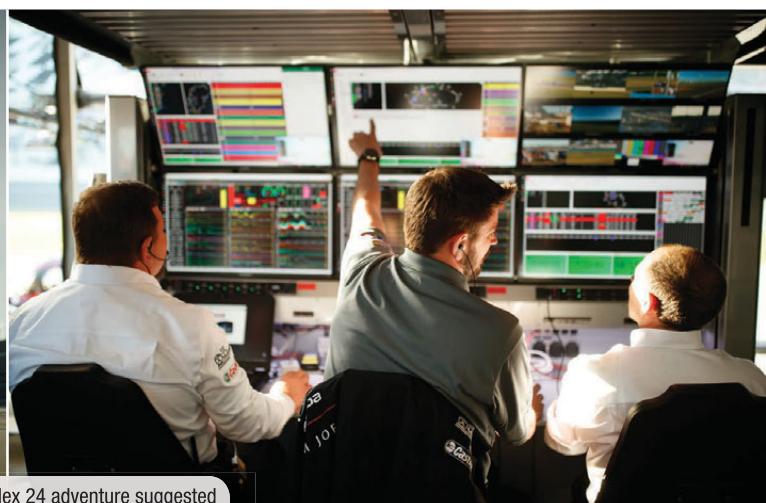
Joest employee who previously served as a great liaison between Audi and the team, took on more of a leadership role with us in the place of Ralf Jüttner.

"I think of this as like trying to set a fast lap. Initially you know there are big chunks of pace that you can find, and now we are looking for those extra tenths."

Getting those 'tenths' requires everyone to be singing from the same hymn sheet, which isn't necessarily as simple a task as it may sound, given the involvement of different partners with responsibility for different aspects of the car. It is an effort worth going to however, with close communication between different partners facilitating the ►



ABOVE The bright lights of the championship's flagship event offered many positives for the team, but also a lengthy to-do list



ABOVE & BELOW The Rolex 24 adventure suggested the close-season revamp is paying dividends



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ABOVE The four-cylinder architecture of the team's AER engine deliberately mirrors that of every single Mazda on sale

important incremental changes that can return big dividends come raceday. Before the start of the 2019 season for example, the open dialogue and synergy of vision between Multimatic and AER enabled the RT-24P's engine bay to be cleaned up and streamlined, and a new, improved airbox to be implemented.

This even extends beyond those that are

immediately part of the team or its partners, however. With Mazda keen to ensure that the DPi car challenging for wins at the WeatherTech rounds shared the same DNA as the cars that were used daily by fans of the brand on the road, and enjoyed by enthusiasts at a grassroots level, the company actually enlisted the team at its research and design facility in Irvine, California, to

pen its DPi racer. Giving the design team this challenge was rather like "giving a little boy or a little girl a blank sheet of paper and asking them to design a rocket ship," reminisces Doonan, but their enthusiasm meant that not only was the final design inextricably tied to the marque's design language, but it also used an approach to aerodynamics that is unique. "In fact," he adds, "when people first saw our car they looked at it and said 'that can't be aero efficient' based on what we've all learned about prototype sports cars in the last decade or two... but it is."

This individual approach is something that guides Mazda, and one of the reasons it doesn't always do things the simplest way. The team's engine choice is representative of this philosophy. Although an AER engine, and not a derivative of one of Mazda's roadgoing engines, it is important to the team that it at least uses the same small-displacement four-cylinder architecture as appears in every single Mazda on sale today. Choosing this architecture was not the easiest option, given that it would have to compete with V8s and twin-turbocharged V6 engines, but it was the one which Mazda believed



ABOVE Mazda's speed at Daytona signalled its intent to claw its way to the top of the DPi summit

was right when priorities away from the racetrack were also considered.

"As you may know, Mazda's headquarters are in Hiroshima. Hiroshima has been through a great deal in its history and the people of Hiroshima always had the same spirit of never giving up, and that carries over to our engineers," Doonan explains.

"Whether that sounds clichéd or not, it's the truth. When the rotary engine became a possibility, they made sure they saw it through and didn't give up on the technology, and it is the same kind of philosophy with what we call SkyActiv [the moniker given to Mazda's engine technology].

ICE EFFICIENCIES

"Across the globe there is nothing but four-cylinder engines in Mazda's line up, and it is Mazda's belief that the four-cylinder engine, or the internal combustion engine, still has opportunities to find efficiencies, and that's what you see in our overall philosophy. That's why we work on things like our SkyActiv-X [homogenous charge

“The people of Hiroshima always had the same spirit of never giving up; that carries over to our engineers”

compression ignition] technology which enables a petrol engine to act like a diesel in terms of efficiency.”

There is also the hope that by using technology reminiscent of Mazda's street cars, the DPi programme could be used as a development platform for many different aspects of future road car technologies, whether that is on the aerodynamics side, the engine side, or in more unusual and unexpected ways such as interior design. For example, Mazda's road team suggested that the none-homologated aspects of the cockpit could provide an excellent opportunity to study things like seating positions, ergonomics and sight lines.

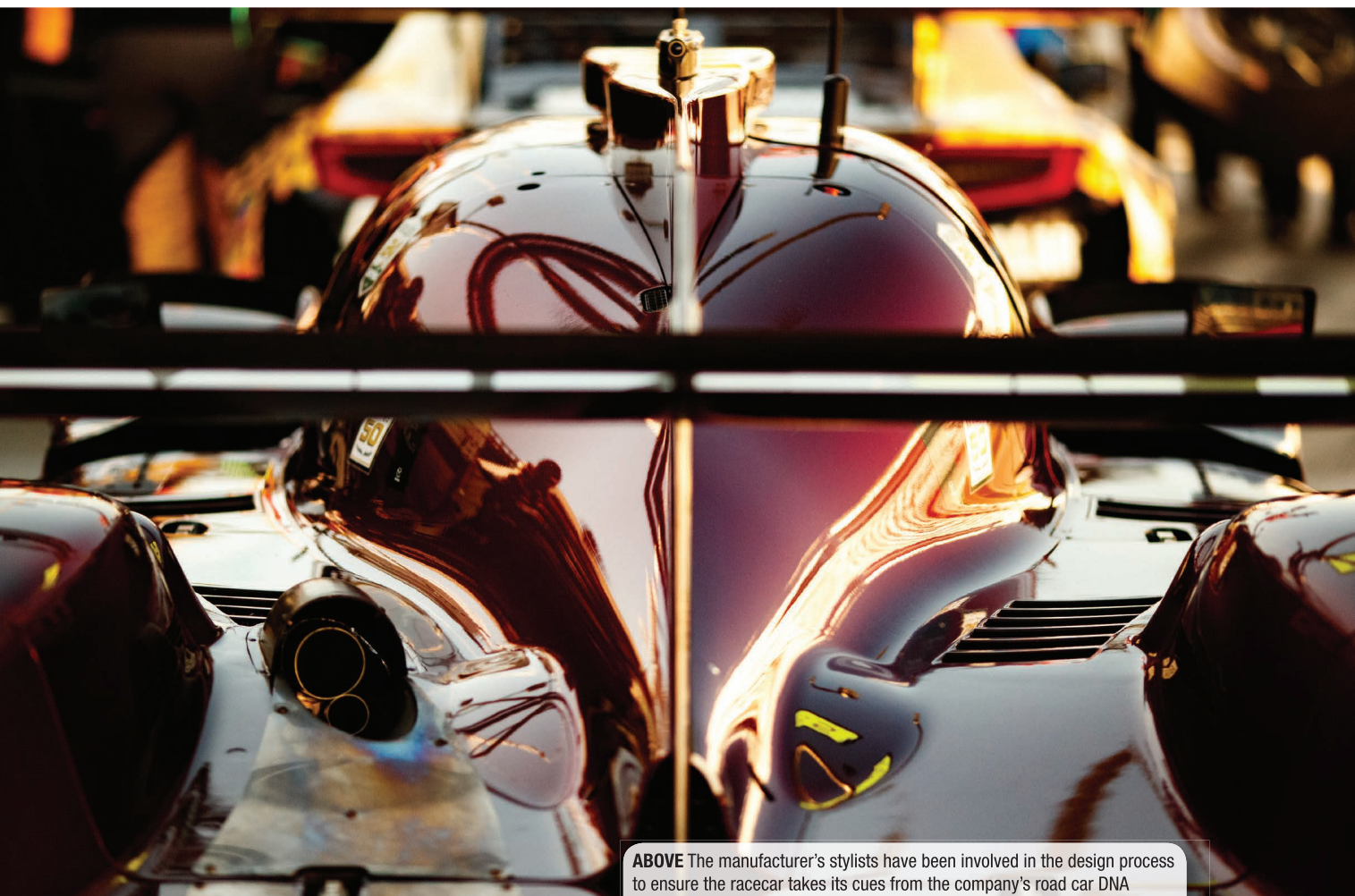
These considerations don't change the primary reason Mazda is racing in the WeatherTech SportsCar Championship though. Mazda is involved to win races; something it hasn't achieved since

September 2013 when its diesel-powered Mazda 6 took the top step in the Grand-Am series' GX class.

"The results haven't been put on the board yet for the DPi project. But we've sustained this programme through rotary engines, small petrol engines and the SkyActiv diesel road car engine, and now we are here in the DPi, but without a doubt we are here to win races," stresses Doonan.

"We have been a partner of IMSA for almost all of their 50 years of existence and we are not going anywhere... There is a renewed commitment from all the partners that we are going to win races whatever it takes, and everyone has knuckled down and said we are going to make it happen.

"We want to win races for the Mazda faithful, and I, for one, am looking forward to hopefully hoisting a trophy soon in honour of all those people." **RT**



ABOVE The manufacturer's stylists have been involved in the design process to ensure the racecar takes its cues from the company's road car DNA



ABOVE One of the 13,000 tyres Michelin brought to the Rolex 24

INTENT TO SUPPLY

The Rolex 24 at Daytona saw some incredible action from the 47 entrants battling it out on track, but, as **Alan Stoddart** discovers, what goes on behind the scenes is just as impressive

ONE of the companies with the most responsibility this year was **Michelin**, which took over from Continental as IMSA's title sponsor for 2019. This has meant that instead of supplying nine cars in the GTLM category as it did last year, being the only category in the IMSA endurance series that was open in terms of tyre choice, Michelin had to provide tyres to every single racer, including the additional 49 competing in the Michelin Pilot Challenge series, which ran the day before the Rolex 24.

Meeting this huge new demand was not

easy, explains Michelin North America's motorsports technical director Ken Payne. As well as "increasing everything" to be able to supply the 13,000 tyres required over the week, Michelin had to also make sure that it brought the right tyres to the race.

"We had to identify what the approximate entries were going to look like so we could identify rough tyre volumes," he says. "Then we could start drilling down into what cars in different classes would need as well as looking at the schedule and the circuits to decide which of our products would be best

suited to the cars in that event."

For some classes, this meant identifying the best single specification tyre. The DPis all run the same sized tyre, and at Daytona run what is called the IMSA Medium compound, which is a specially tailored version of the LMP2 tyre Michelin uses in the World Endurance Championship. In other classes, such as the GTDs for example, products from Michelin's commercial tyre range are utilised. For Daytona, following pre-season testing with MSA teams, Michelin selected the medium, or S8 designation tyres from the commercial range for GTD.

Making the right choice, however, is crucial. Payne says there are lots of factors taken into account when this decision is made. "The first order of compound selection is looking at the typical ambient conditions for the event weekend. Here, air temperature and track temperature ranges guide us. Then we look at the track itself.

"Daytona is a unique animal with its roval, and that is key given our focus on the overall durability of the tyre. While the track is not terribly hard on a tyre from a wear standpoint, it can be brutal because of the banking and the range of temperatures you experience throughout a 24-hour race."

This durability isn't just a property of the ►

tyres themselves though, it is helped by the expertise of Michelin's engineers, who are embedded within teams to ensure that they are able to make the right choices in terms of setup at the track. This expertise means that teams are able to get the best out of the tyres, and concentrate on the business of winning races.

With everything on a racecar being so interdependent, the change to Michelin tyres has also had a knock-on effect for other companies that supply the teams in the IMSA series. One of these is **Pagid**, which was supplying brake pads and discs to a wide variety of cars in both the WeatherTech and Pilot Challenge series at Daytona.

"At first we thought we would have higher pad wear with the Michelin tyres because they have more grip, and usually with more grip on the tyres, the pad wear goes up," explains Pagid Racing's motorsport consultant in the USA, Andreas Boehm.

"But," he continues, "with the ABS cars it is a little different because when there

is more grip on the tyres there is less ABS activation, so that reduces the wear a little bit. So, I think having theMichelins is definitely an advantage compared to the Continentals last year."

Every little advantage is helpful at Daytona, a track that can be unkind to brakes thanks to the very long, fast section ahead of turn one, giving them time to cool. This means that when the brakes are slammed on to turn into the infield section, the discs undergo a dramatic heat shock. Managing this rapid temperature change is crucial, but it also involves some compromise.

"You have to keep the brakes hot, but the hot brakes also increase the pad wear so there is a trade off with set up. But, it is better to have higher pad wear than a cracked or exploding disc, which of course is the other risk."

The added wear on pads also isn't necessarily as detrimental to races as it might be in other series. In the World Endurance Championship for example, work cannot be carried out on the car during refuelling, but

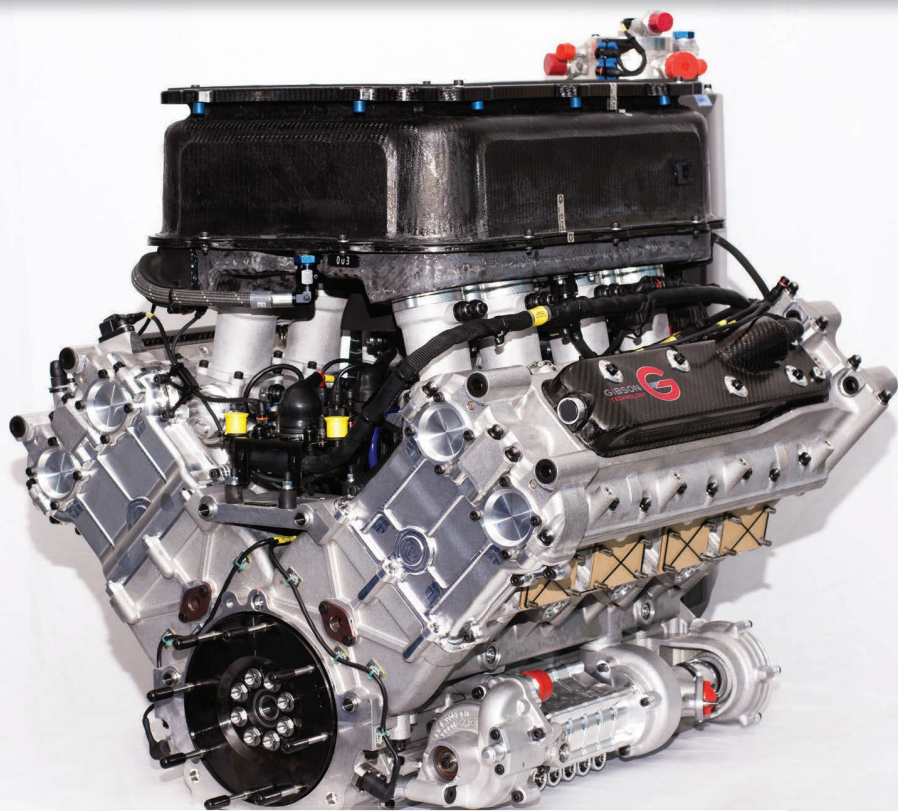
this is allowed in the WeatherTech SportsCar Championship. This, along with very well-trained mechanics and quick connectors allowing the calliper, pads and disc to be changed all at once means that the time penalty for changing brakes is minimal. Some teams even take this one step further, and instead of using Pagid's RSL1 endurance compound, which usually requires just one change at the front in the entire 24-hour race, opt for a stronger sprint race material and just change the pads a few more times.

There is no getting away from the fact that the Daytona 24 Hours is still an endurance race though, and that necessitates reliability. One company that appreciates this more than most is **Gibson Technology**, which supplies all three LMP2 teams with their engines. Since its engines are leased by the teams instead of being bought outright, Gibson is also responsible for making sure they are in perfect condition, and can be relied on for the full 24 hours.

"The teams benefit from our technical ►

BELOW Turner Motorsports' BMW M6 GT3 is just one of the cars benefitting from Pagid's know-how





ABOVE Gibson's GL458 engine boasts remarkable reliability. Crucial in a 24-hour race

support," explains senior project manager Bob Baker. "So, we check the engine parameters every time a car goes out in a session. When it returns we download the engine data logger and analyse the various engine parameters to ensure that everything is where it should be and doing what it should do."

This analytical approach involves looking at things like whether the correct oil and coolant temperatures were maintained, which can often be affected by the choices the teams make in setting up the car, such as blanking radiators or changing the aero configuration.

However, Gibson also carries out a more in-depth analysis, which assesses various parameters such as how the engine is performing, checking that factors like the air/fuel ratio is correct, the ignition values are on target and the electronic throttles are operating correctly. The company is also on hand to advise if the teams have any problems.

"They might come to us and say that the driver felt there was some sort of misfire maybe, or that the engine had a bit of a hesitation coming out of a certain turn or in a particular place on track, and then we can home in on that and see if it is something on the engine side."

Often however, the fault can be traced back to something in the car, notes Baker. "On a complex car like the current LMP2, the engine can be affected by lots of

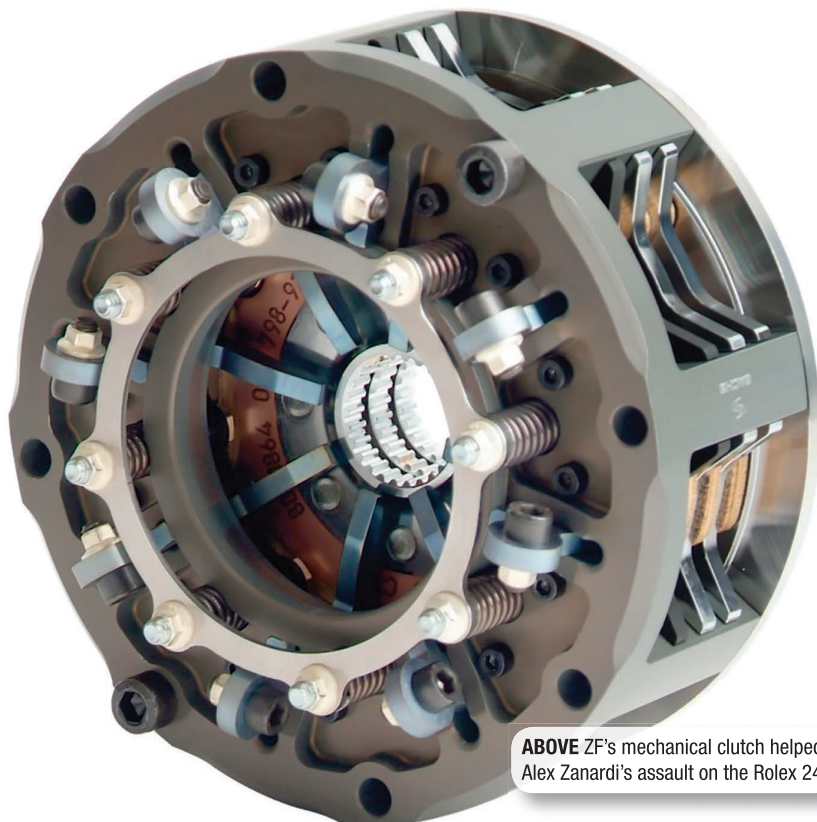
different things, so it is the first thing the driver will report back. They'll say 'the engine had a misfire' or 'I felt a hesitation when going on throttle out of the corner', but you look into it and realise that it's the fuel pump that's broken, or a faulty wheel speed sensor has caused the traction control to come in."

Dealing with the power of a racing car's engine is another matter however, particularly if you happen to be a double amputee. Alongside supplying clutches and dampers to an enormous range of cars, this was one of the challenges that **ZF** was able to assist with.

To help BMW and Alex Zanardi with the multiple Paralympic gold medallist's Daytona debut, ZF turned to a technology it had developed several years ago.

Zanardi's BMW M8 GTE is equipped with a special clutch that doesn't require any input from the driver. Instead it is a purely mechanical centrifugal clutch which engages and disengages based on the engine's speed, which Zanardi controls with a steering wheel-mounted throttle. When the engine speed rises above a particular threshold that has been pre-set by the team's engineers, the clutch engages and the car can pull away. Similarly, when the engine speed drops below that threshold, when the car stops in the pits for example, the clutch automatically disengages. This functionality hints at the centrifugal clutch's original application as an anti-stall device, with its engagement based on revs making it impossible to stall.

Despite lasting for a full 24 hours, ZF says the Daytona 24 is not actually that hard on ▶



ABOVE ZF's mechanical clutch helped Alex Zanardi's assault on the Rolex 24

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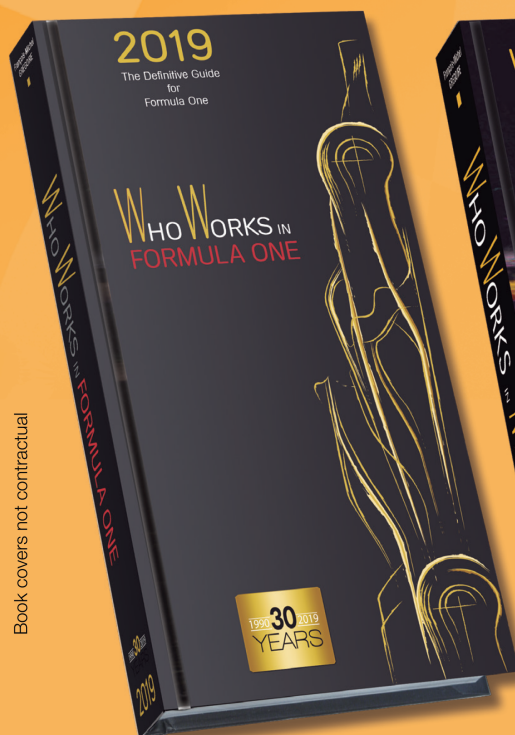
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clutches because it doesn't have a standing start. That, however, doesn't mean that there aren't areas where the clutch can make a big difference.

"It does have an effect at the pit stops, for example," says Patrick Orth, manager of ZF Race Engineering in North America. "You want to have a proper launch and not stall the car and lose time. So, basically you want a clutch that is giving constant driver feel, then aside from that it is just about keeping the wear rate in a range that it doesn't fail over the 24 hours."

McLaren Applied Technologies also supplies a variety of high-performance products, including alternators and ECUs, to many of the teams competing in the IMSA WeatherTech SportsCar Championship. For Richard Hull, the company's motorsport business development manager, this is really exciting.

"NASCAR and IndyCar use our ECU as a standard application, so having it in a competitive environment where we aren't guaranteed to cross the finish line first because not every car is running our ECU, definitely makes for an interesting change of pace," explains Hull.

On the other hand, with it not being a standardised part it does mean that customers can be more sensitive when it comes to sharing information about their cars. Yet crucially, one of the advantages of the McLaren Applied Technologies ECU is that it allows teams to be relatively autonomous and avoid sharing data with anyone external.

"The teams can buy the hardware and necessary software, and then write all the necessary applications themselves so they don't have to rely on us," adds Hull. "We are there when they need us, but it allows them to stay quite independent."

Another advantage McLaren Applied Technologies offers its customers, is its consultative approach to its relationships with clients. For example, one of its alternator customers at Daytona wanted to mount the component in the gearbox bellhousing. Although it isn't a location McLaren Applied Technologies would necessarily recommend, it was able to advise on how best to install the part there to ensure it operated as designed.

Fortunately for the team in question, Daytona is a track that is kind to alternators. It isn't particularly harsh in terms of

vibration, and being a high-speed, high-revving track, the alternator is sufficiently cooled and isn't overworked.

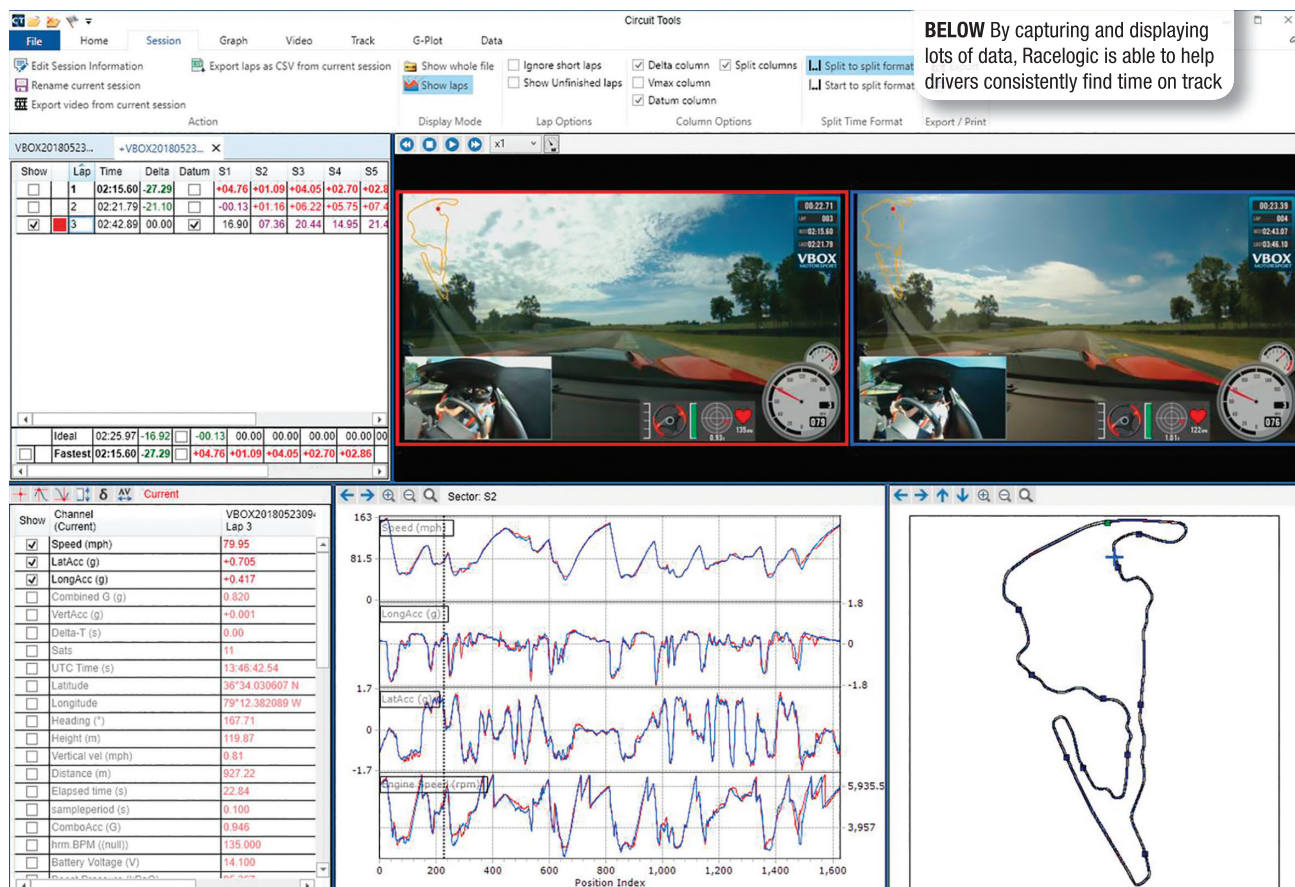
For success in the Rolex 24 however, it isn't just the cars that have to be worked on, the drivers themselves often need some help.

This is one of the tasks that **Racelogic** is charged with. As well as providing technical support for the teams, ensuring that they have no connectivity issues and are able to download all the necessary data off the cars, Racelogic also helps analyse this information afterwards.

"We provide video with data overlay that can be paired with multiple other lap videos, and synched by track position, that way we can analyse and compare side by side each lap and give the drivers pointers to tell them how they can go faster on the track," explains Racelogic's motorsport manager in the US, Paul Ferreira. "Although the drivers are pros, there is always time to be found, and with our systems they can find that time. What's more, they can actually find consistency on their times without overusing or abusing their equipment. That is really important, especially on endurance races."

This is helped by the sheer volume of ▶

BELOW By capturing and displaying lots of data, Racelogic is able to help drivers consistently find time on track





Galstad/LAT

ABOVE With so many cars running at Daytona, suppliers have their work cut out

data that Racelogic's VBox systems are able to gather. "We get everything from G-forces, where they apply brakes, where they apply the throttle, corner speed at the entry, mid-corner and exit, and car placement. So even if they are missing just 20 centimetres in a corner entry, that could mean two or three miles an hour throughout the corner, which could be five or six by the end of the straightaway.

"And that, will eventually be enough to pass a car," concludes Ferreira.

While Racelogic focuses on improving drivers, **Sabelt** is concerned with protecting them. To this end it has partnered with the JDC Motorsports team which is running Cadillac's ferocious DPi car.

Sabelt America's Erik Krammer says that this partnership sees the company supply all the safety gear for the drivers and the crews, including all the suits, boots, gloves, underwear and fireproof clothing, as well as the seatbelts in the cars. All of this safety gear is custom-made for the teams, with each of its members fitted and measured to make sure that it fits properly, which is crucial to ensure that it performs as required. However, all of this custom work means that the Rolex 24,

and particularly the Roar Before the 24's proximity to Christmas can make things more difficult.

"Timing is always a challenge with the Roar and the Rolex," Krammer says. "You know we have got the holidays and three days later is the Roar and then three weeks after that is the Rolex."

Timing is also a concern for drivers during changes, who need to be able to get in and out of the car as quickly as possible. This

is why many teams choose to use Sabelt's Endurance cam lock, which has guides on it to make it easier to insert the belts into the lock, a feature that Krammer reckons saves about seven seconds a driver change.

These sorts of benefits can be what makes the difference between winning races like the Rolex 24 at Daytona, and merely taking part. They are also the sort of advantages that using the right suppliers can help achieve. **IT**



BELOW It isn't just drivers that are kept safe by Sabelt, the whole JDC Miller pit crew also benefits

Levitt/LAT

BLUE PLANET MEETS DAKAR!



ABOVE The ambition is to showcase what is effectively an ordinary breed of cars in extraordinary environments



Sergio Rinland looks at Extreme E, a new series promising to combine science, innovation and exploration

THE revelation of plans for the new Extreme E racing series, to be started in January 2021, captured a lot of headlines. Understandably so. The concept is great: very 'today'.

SUVs are the best-selling vehicles on the planet over the last 20 years: Porsche has become the most profitable OEM thanks to their Cayman and Macan; JLR lives on mainly thanks to the fantastic popularity of the best SUVs of all, the Range Rover line, which is huge and to every taste; we now have SUVs from Lamborghini, Alfa Romeo, Bentley, Rolls Royce, Aston Martin and, soon, even Ferrari! Every manufacturer in the world has an SUV in their range or at least a Cross Over, the smaller siblings, and they usually happen to be their best-selling vehicles.

We've already experienced them racing in rally raids for some time. The Dakar Rally attracted VW's Toureg years ago. More recently the Mini Cross Over has won outright before Peugeot's tour de force with its 3008 DKR mid-range SUV. And now we have the Jaguar i-Pace SUV series, together with Formula E.

So it comes as not such a big surprise that the ever-creative mind of Alejandro Agag, the visionary behind Formula E, has come up with the concept of racing electric SUVs at the most extreme locations on the planet. It's a concept that may leave the rigours of the Dakar looking like a child's game by comparison.

The concept follows very much in Formula E's footsteps. Sensibly, it starts

“The Dakar is looking like a child's game by comparison”

with private teams fielding control vehicles and plans to attract OEMs as the series gains momentum.

The message is clear: to raise awareness of the huge environmental challenge facing our planet. The concept is a mix of Formula E, David Attenborough's Planet Earth series, Jacques Cousteau's Calypso, Amazon Grand Tour and the Dakar Rally all rolled into one: fantastic!

The races will not be broadcast live. The plan is to feed them as documentaries.

What a great idea to raise awareness of the challenges our planet is enduring at the present time and accelerate the human race into more and faster action to address the crisis.

There are no details of the cars yet, but if they choose to use existing machinery, there will be no shortage of options. If they want to build purpose-designed vehicles for those extreme conditions, resembling existing SUVs, I cannot see the OEMs waiting too long to get involved. It is a no-brainer marketing exercise.


MUMS' GRAND PRIX

Do we like SUVs? Some car lovers, purists like Jeremy Clarkson, loathe them. My neighbours don't like them very much when they have to drive out of their house, down our narrow street, with SUVs parked both sides, for at 9.00 am and 3.30 pm they fill our neighbourhood with the 'Mums' Grand Prix' school runs. From what I can see, though, SUVs are here to stay for the foreseeable future.

The biggest criticism of them is that these vehicles burn huge amounts of petrol or diesel, polluting our cities and roads. As a result, most of the OEMs making these monsters are designing Hybrid and EV versions of them. What better way than Extreme E to advertise them? It would be like 'Montezuma's Revenge' for those manufacturers! And it will keep the dollars rolling in.

From the technical point of view, Extreme E represents a huge challenge, but what a fantastic one! Batteries and electric motors will have to endure from -30°C in the Arctic or Antarctic, to +40°C in deserts and jungles, through rain, snow, sand, mud – you name it, they will have to face it!

The concept is that they will live in a travelling workshop, the St Helena ship, so I don't think they will be able to build special vehicles. Chassis and structures that have to survive in those environments, with very few opportunities for repairs, will inevitably require great engineering compromises.

The bottom line is that Agag looks to have finally found motorsport's identity for the 21st century that we have all been waiting for. As I have said before, hats off to Alejandro! 



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