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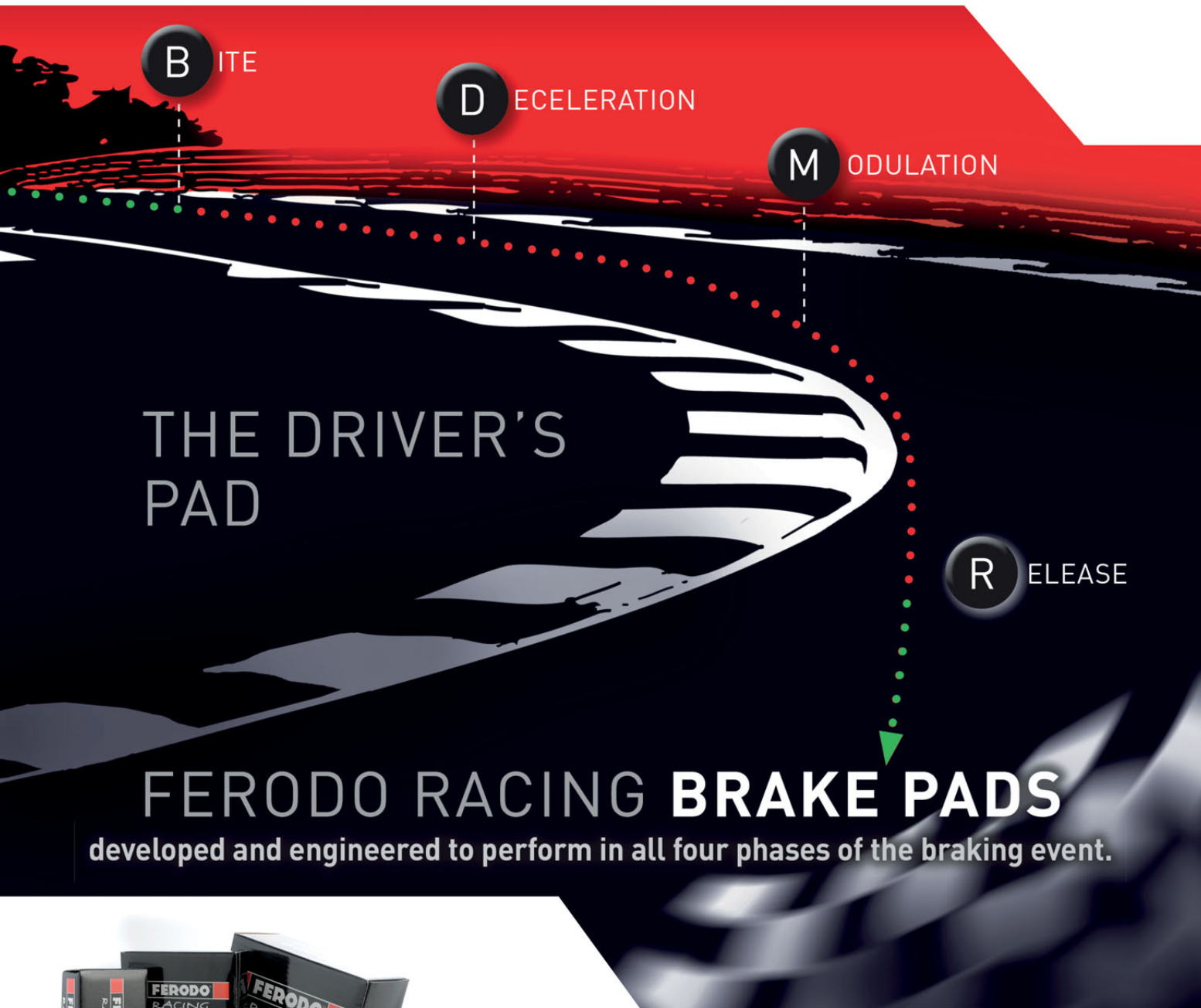


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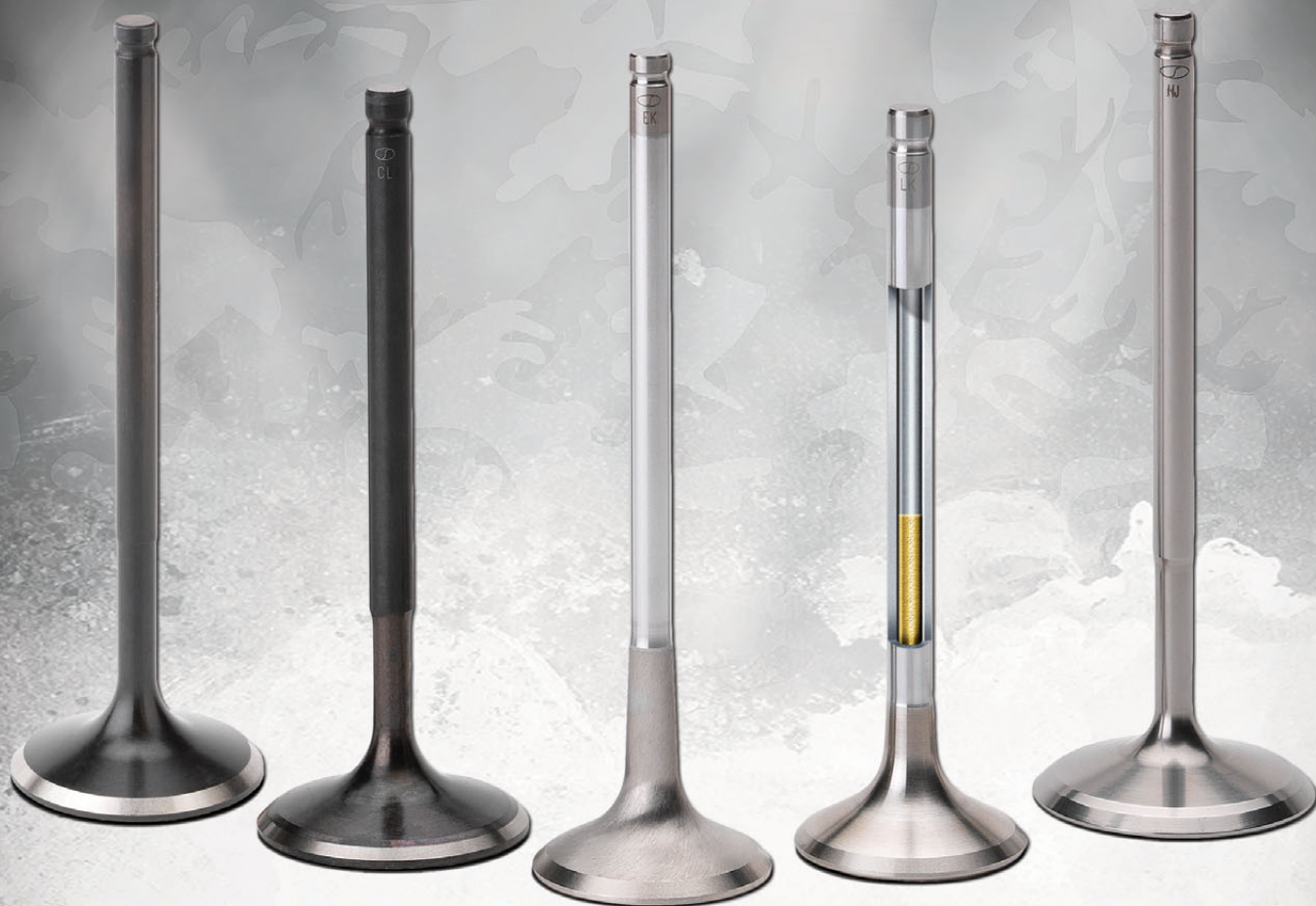
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EDITOR

William Kimberley

CONSULTANT EDITOR

Mark Skewis

ASSISTANT EDITOR

Alan Stoddart

HEAD OF DIGITAL CONTENT

Sara Kimberley

PHOTOGRAPHY

LAT

ART EDITOR

Paul Bullock

ACCOUNTS MANAGER

Vikki Amour

ADVERTISING

Mike Norman

COMMERCIAL DIRECTOR

Maryam Lamond

MANAGING DIRECTOR

Adrian Goodsell

PUBLISHING DIRECTOR

Soheila Kimberley



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

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GOING BACK TO ITS ROOTS

The Le Mans 24 Hour race always generates a lot of stories and this year it was no different. The race itself may have been something of a foregone conclusion, although having said that, very many congratulations to the Toyota Motorsport team for its success. If any team knows it's them after the last lap heartache two years ago which showed that there's no such thing as a sure win at the French circuit. However, the talk in the paddock centred on the proposed new regulations that are coming endurance racing's way from 2020.

Endurance racing has always had to weather peaks and troughs in its fortunes over the decades, and they are usually associated with manufacturer involvement in the main category. Principally thanks to Audi along with Peugeot, Porsche and Toyota, it has been on a particular high for quite some time. However, now that they have all gone away, with the single exception of the Japanese manufacturer, the landscape has massively changed and the FIA and the Automobile Club de l'Ouest had to respond. That they have done so in such a positive way is a tribute to them.

As will be read in Gary Watkins' article within these pages, what is being proposed is quite revolutionary. What the FIA/ACO want are cars in what will replace the current LMP1 category that are clearly distinguishable by brand so that the man in the street can identify with them. This will be achieved as the quest for downforce will be strictly limited while there will be a minimum drag number. The idea is that the aerodynamicists will no longer rule the roost as to how the cars will look although they are still bound to be pretty influential.


Another element is that the cars must have a hybrid powertrain with the engine configuration itself being completely open. I understand that it has caught one or two manufacturers out, so there's a scramble to find tech-ready partners that might be able to apply solutions quickly. At the same time, the prospect of hybrid-powered hypercars going for outright wins at Le Mans is pretty mouthwatering and goes back to the roots of what Le Mans used to be all about, which is about development and pushing

boundaries, gaining knowledge that can be fed back to the manufacturers.

I suppose the one grey area is the budget cap, set at something like a quarter of what the factory teams were spending in the last few years. It depends whose figures you go by, but it would seem that it would mean a cost cap of somewhere around €30-€40 million. However, for Scott Atherton, IMSA president, it's still far too high for his LMP2 and DPI teams. There is also the question of how it's going to be policed.

What the cost cap may do, though, is to encourage those manufacturers that are developing hybrid hypercars to consider coming to Le Mans when such a thought might never have come onto their radar. I already know of one that has absolutely no Le Mans or even racing heritage that is now actively considering developing a car if it can organise the finance and find a team to run it.

One manufacturer that has already committed to the new-look future is Toyota which has said that it will be developing its Gazoo Racing Super Sports Concept, which is basically a road-going version of the TS050 race car that's just taken the Japanese carmaker to Le Mans success. It's in line with its long-term commitment to hybrid technology.

Another element of the new regulations that is intriguing is the creation of a category for hydrogen fuel cell-powered cars in 2024. A working group is already in place and includes various parties with an interest in the subject. Seven automotive multinationals, a mixture of major manufacturers and parts makers, actively developing this technology are involved in setting down the conditions required for the creation of this class, and in demonstrating the relevance and efficiency of this new engine technology. The jury is still out on this power source as being the sustainable future of zero-emission mobility, and as one who lived through its coming 20 years ago, there is still some degree of scepticism about it. However, I really do hope that it kick starts some research and that we do see some cars compete in the class in six years' time. 

William Kimberley
EDITOR



WEC details its 'hypercar' plans for 2020

Alan Stoddart and William Kimberley

LE MANS, France: The World Endurance Championship has shared more details on its upcoming 'hypercar' class which is set to take over from LMP1 as the top tier in the sportscar category from 2020.

The new hypercar-based regulations were first confirmed by the World Motor Sport Council in early June, before being fleshed out by the championship in the run up to the 24 Hours of Le Mans. Although this new top-tier category is yet to be named, the FIA has said that the regulations are set to focus on the 'appearance, style and lines' of the cars, and emphasised that 'aerodynamics cannot take precedence over aesthetics'. The cars are to be based on 'hypercars, supercars, prestigious GTs and concept cars' and will offer more 'marque cachet' – a move the body hopes will help attract more

works entries to the category.

All of the cars in this new class will be hybrid, using a single hybrid KERS system on the front axle to put 200 kW to the front wheels, while having a free choice of combustion engine, which is to be offered at a fixed, predetermined cost. The FIA hopes that this openness will lead to a variance of competitive options, which can be either naturally aspirated or turbocharged, with a mooted maximum power of 700 hp. These changes mean that the cars will be slower than the works cars that have defined the LMP1 era, with a targeted lap time of 3m 20s at the Circuit de la Sarthe, compared to a pole time of 3m 15.377s set by Kazuki Nakajima in the Toyota TS050 during qualifying for this year's Le Mans 24.

Another of the main thrusts of the changes

was to reduce the cost of competing at the top level of the WEC, with the body asserting that the new prototypes will require around a quarter of the budget of a current entry.

"Costly developments will be kept in check by a new homologation procedure and technical rules that will naturally reduce budgets," said FIA technical director Gilles Simon at the press announcement who also said that highly expensive aero programmes will become a thing of the past. "We believe that if we can control the aero performance of the car, we will allow enough freedom for each manufacturer to use a base design that is already existing on the road.

"The downforce we have with the current LMP1 cars today is exceptional. If we want to have more flexibility in the design of the car, if we want more styling in the cars and cars looking more like hypercars, then we need to lower this number.

BELOW The recently announced Aston Martin DBS Superleggera or its AMR Pro models are precisely the types of cars that the FIA and ACO hope to see competing at Le Mans for overall honours in the future as long as they are powered by hybrid powertrains



"The new regulations for the FIA World Endurance Championship, which come into effect for the 2020/21 season, are the result of hard work between members of the FIA, ACO, manufacturers and teams," said FIA president Jean Todt. "This will provide endurance racing with a long term, stable platform, while continuing to offer a cost-effective stage to showcase future technologies."

Pierre Fillon, president of the Automobile Club de l'Ouest, added that crafting the new regulations had been "particularly satisfying". "A new era will dawn in 2020 for endurance racing. On paper it has enormous potential. Le Mans 2018, 2019 and 2020 will each be outstanding editions, but now I can't wait for the start of the 2021 24 Hours of Le Mans," he enthused.

Zak Brown, who was present as the owner of LMP2 team United Autosport was

excited by what he heard at the press conference. "I like the regulations and the direction they're going and think that they'll be exciting for the fans as they will identify with the cars competing at Le Mans and in the championship as a whole. This must make it exciting for more manufacturer participation.

"I think the smaller budgets are required because the payback just isn't there for the hundreds of millions being spent. However, I haven't thought about the implications for LMP2 which I think is currently the most competitive class and with which the FIA/ACO has done extremely well, so I think it shouldn't be touched for a while. United Autosport has been a great team with great results and any time you can get involved with a manufacturer, it elevates the team, but I must make it clear that I keep United Autosport and McLaren very separated."

As the former chairman of Aston Martin as well as chairman of Prodrive, the motorsport company that prepares cars for Aston Martin Racing as well as for private teams, David Richards was able to give an overview from both points of view.

"I think it's the style of car. A race car will inevitably be quite different and to take a standard street car to racing is no longer possible, and we have to be realistic about that. However, in LMP1 at the moment, they all look the same and you don't see them on the streets.

"We must have a car that resembles the standard street car, so people in the grandstand will be able to recognise it as an Aston Martin, a Ferrari, a Porsche, a Corvette and so on, and that's what we need to achieve. I'm pretty sure we'll be in there with them.

"At the end of the day the GTE class will become the AM class, which I think will naturally happen. I don't know how it will work out in the long term, but I would expect to see Aston Martin in both categories." **RT**

Aston Martin CEO endorses new-look regs

Dr Andy Palmer is among the industry figures that are positive about the new hypercar regulations, stating that he would "dearly love to race a Valkyrie against a P1 or a Senna versus a 918 versus a LaFerrari – that, I think would be amazing."

Speaking to *Race Tech* at the global unveiling of the new DBS Superleggera, the Aston Martin chief executive explained his enthusiasm. "The current anonymous prototypes are great but they are anonymous - it is hard to get excited about them after a while. But, if it is a car that you could ultimately aspire to, that's something to get really excited about.

"So, I hope the regs come out in the way that we think they are going to. I hope that we are able to get the cars as close as possible to the road versions. Whether that is in LMP1 or whatever, it's going to be called in the future, or in GTE, we'd like to be there and competing."

However, Palmer cautioned that despite his keenness to see an Aston Martin racing in a new hypercar class at Le Mans, there were still practical considerations to be addressed. "I hope that it comes to fruition," he said, "but that also of course means that the costs need to be capped to make it possible for smaller companies like us to come and compete." **RT**

Toyota GR Super Sport with 1,000hp headed for production

Alan Stoddart

LE MANS, France: Toyota Gazoo Racing unveiled the GR Super Sport Concept in the run up to the 24 hour race at Le Mans. The next-generation hypercar uses hybrid electric engine technology that has been honed through the Japanese marque's participation in the World Endurance Championship.

Toyota has confirmed that it has already started development on the road car, directly bringing its Le Mans powertrain technology to public streets. This move comes ahead of changes in the Le Mans regulations which will see 'hypercar' style cars that are homologated on a manufacturer's road-going offering competing in the top tier of the World Endurance Championship, as was the case in the GT1 era in the 90s which gave rise to monsters like the Mercedes CLK GTR and the last Toyota hypercar – the road-going GT One.

The GR Super Sport Concept is powered by a twin-turbocharged V6 engine and the Toyota Hybrid System – Racing (THS-R).

Like the Toyota TS050 LMP1 race car, this powertrain delivers 1,000 hp.

"Competing in the World Endurance Championship – one of the most demanding motorsport series – and racing at Le Mans helps us to advance the development of our world-leading hybrid electric technology and enables us to transfer the knowledge we gain to our production cars," said Shigeki Tomoyama, Toyota Gazoo Racing's president.

"As the automotive industry is

approaching an era of big changes, we will continue our passion for making cars that are truly exciting. No matter how electronics and digital technology will continue to transform vehicles, we will make sure that our cars will not become just another commodity," he continued.

"We started this project because we believe that creating a super sports car that delivers the same appeal as the TS050 Hybrid greatly adds to Toyota's involvement in the WEC. At some point in the near future, customers will have a chance to get behind the wheel of this incredible machine and experience its astonishing power and driving performance." **RT**



ABOVE Toyota could well continue its Le Mans legacy with the GR Super Sport Concept it unveiled in the run up to the 24 hour race

Race ready Tesla unveiled in Barcelona

William Kimberley

BARCELONA, Spain: Electric GT Holdings and SPV Racing have unveiled the race-ready version of the EPCS V2.3 Tesla P100DL in Barcelona, ahead of the first season of the Electric Production Car Series (EPCS), its headline category. SPV's car was the first to be delivered to a team before the series debut in November.

Finished in SPV's racing livery, the P100DL completed a shakedown at the Circuit de Barcelona-Catalunya with SPV development drivers Emma Kimiläinen and Alvaro Fontes behind the wheel.

"This is a very significant day for the championship as we deliver the first race-ready EPCS car to SPV Racing," said Mark Gemmell, CEO of Electric GT Holdings. "Years of planning and hard work have

gone into delivering this championship and today I'm proud to be presenting a real, thoroughbred, race-ready car that will challenge all comers and thrill fans around the world. This is exactly the calibre of race car that will allow us to showcase and to fully engage the potential of the electric future."

In the inaugural season, all EPCS drivers in the series will compete in an identical specification race-prepared EPCS V2.3 Tesla P100DL, which puts out a healthy 778 bhp and 995 Nm of torque. The racer will be capable of achieving 0-100 kph in 2.1s, and will be capable of hitting speeds as high as 250 kph.

The Electric Production Car Series was introduced to celebrate the growing prevalence of all-electric transportation, to help push the capabilities of electric road cars and to drive forward a new age of electric innovation. Electric GT Holdings hopes that each event on the EPCS calendar will become a weekend-long festival of technology and innovation for sustainability, featuring racing at the centre. The trio of race categories will also include the Electric GT eKarting Series and the Electric GT eSports Series, offering a gateway from virtual racing to the circuit. **RT**



LEFT The Electric Production Car Series is getting closer with race-ready Teslas starting to make an appearance



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Volkswagen's I.D. R smashes Pikes Peak record

Hal Ridge

PIKES PEAK, CO: Volkswagen Motorsport smashed the Pikes Peak International Hill Climb record with its I.D. R Pikes Peak prototype, driven by Romain Dumas, setting a time of 7m 57.148s on the 19.99 kilometre, 156-corner Colorado course.

VW's bespoke I.D. R Pikes Peak (featured in RT212) was created as a partnership of Volkswagen engineers in Wolfsburg and at Volkswagen Motorsport's base in Hanover. Integral e-Drive, the electric drives division of UK company Integral Powertrain, was also an important technology partner in the project.

The twin-motor, four-wheel drive 500 kW (680 horsepower with 650 Nm of torque) machine has its lithium-ion batteries located next to and behind the centrally-seated driver and weighs less than 1,100 kg, including driver, but it is aerodynamically heavy, with as much development going into the aerodynamic efficiency of the machine at the differing air densities on the Pikes Peak course as has gone into the car's fully-electric powertrain.

The I.D. R Pikes Peak is the first car of any

propulsion to climb the hill in under eight minutes, bettering the previous record set by Peugeot and Sebastien Loeb in 2013 by 16 seconds.

"This is a fantastic day for Volkswagen and one which we are very proud," said Volkswagen Motorsport director Sven Smeets. "The I.D. R Pikes Peak is the most innovative and complex car ever developed by Volkswagen Motorsport. Every employee involved in the Pikes Peak project has constantly had to push their boundaries and show extreme commitment and dedication. Without this, it would not have been possible to repeatedly overcome new challenges and come up with new solutions."

From the announcement of the project in October 2017, VW had played down its hopes of challenging for the overall record, instead stating its focus was on beating the electric record of 8:57.118 minutes, set in 2016 by Rhys Millen driving a e0 PP100.

However, having set the fastest time in pre-event qualifying, the electric machine beat the outright record in its only run up the world's most famous hill climb.

"We exceeded even our own high

expectations with that result," said driver Dumas. "Since this week's tests, we have known that it was possible to break the all-time record. For it to come off, everything had to come together perfectly – from the technology to the driver – and the weather had to play ball too. That everything ran so smoothly is an incredible feeling, and the new record on Pikes Peak is the icing on the cake. I still cannot believe that Volkswagen and my name are behind this incredible time. The I.D. R Pikes Peak is the most impressive car I have ever driven in competition."

By the regulations, the PPIH record setting car had to be rechargeable within 20 minutes, should the race be suspended. In a bid to evolve charging technology, Volkswagen fuelled generators with glycerol, a by-product of the manufacture of biodiesel which it says combusts with virtually no harmful exhaust fumes or residues.

The brand used the project to spearhead its I.D. range. The German marque is also understood to be one of the leading manufacturers looking to sign up for the Electric World Rallycross Championship, which is set to switch to fully electric cars from 2020.

"Today, we saw what this technology is capable of," said Dr Frank Welsch, member of the Board of Management of Volkswagen Passenger Cars. "The Volkswagen I.D. R Pikes Peak has now set the fastest time in the history of this hill climb, which spans more than 100 years – that speaks volumes for electric mobility." **RT**

BELOW Volkswagen smashed the fastest time up the celebrated Pikes Peak Hill Climb with its sensational all-electric I.D. R





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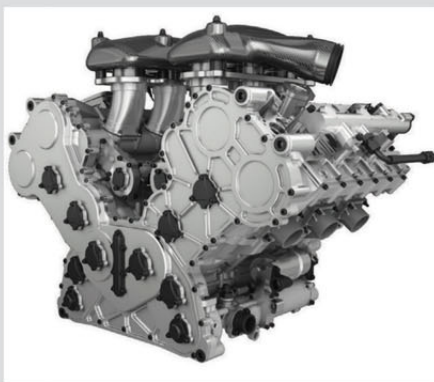


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ABOVE End of the line for such rallycross cars following the FIA World Motor Sport Council's vote to switch to electric cars in the top class from 2020

Electric World Rallycross gets WMSC approval for 2020

Hal Ridge

MANILA, Philippines: The FIA World Motor Sport Council has approved plans for the World Rallycross Championship to switch to electric cars from 2020 at its latest meeting held in the Philippines on 7 June.

Invitations to tender for a common chassis and battery pack were issued in February, covered in-depth in RT210. The single-make carbon monocoque chassis kit will be developed and supplied by French company ORECA, which already produces the FIA-sanctioned R4 rally kit, while Williams Advanced Engineering has been announced as the common battery pack supplier. The two firms will work together to integrate the components, while manufacturers and privateers will install their own four-wheel drive powertrain with a motor at each axle, producing a total of 500 kW.

The motors will be "derived from those applicable for Formula E cars, with some restrictions aimed at controlling costs and development," said the WMSC's statement.

The WMSC announcement also revealed that alongside manufacturer entrants, private companies will be able to

homologate their own cars for the series, using the same single-make chassis kit and battery pack as the manufacturers, and their own powertrains. However, while manufacturers will homologate existing road car 'silhouette-type' bodies, which will sit on top of the spec-chassis, privateers will "design their bodywork from a generic car model required by the FIA" to homologate their own cars.

The format of events will remain the same as currently used in World RX, with free practice and four qualifying sessions ahead of semi-finals and final. A calendar of 12 to 14 rounds will be maintained, while entries will be reserved for two-car teams.

It's expected that manufacturers would run multiple cars, possibly split into two-car teams under different banners, similar to a DTM-type format. Two World Championship titles will continue to be contested, for Drivers and Manufacturers, the latter changing from the current Teams Championship.

However, while only two nominated drivers score Teams points currently, from 2020 the "four best results among cars from each manufacturer per event will count towards the Manufacturers' Championship

classification," said the WMSC. A Team Trophy will be created for private teams taking part in the championship.

The next critical stage for the 2020 switch is the deadline for manufacturers to sign up for the electric series, on 30 July. Peugeot, Audi and Volkswagen, the three marques backing existing programmes in World RX, are three of the nine manufacturers that have been involved in the FIA Technical Working Group meetings for the last 18 months and the most likely to sign up first.

Four manufacturers are required to get the electric move to be confirmed. "We are very excited about the future. The next stage of the process is 30 July, that's the deadline for when the manufacturers have to make their decision to enter," said World Rallycross managing director Paul Bellamy. "The FIA has said there needs to be four manufacturers to make it happen in 2020. If there are three, there will be discussions had between the three manufacturers that have committed, and the other interested manufacturers. Then a decision will be taken as to how to move forward."

STARD, the Manfred Stohl-owned firm responsible for the first four-wheel drive electric rallycross prototype, called HIPER, featured in RT193 (December 2016), is working on plans to either work with a manufacturer for EWRX, or to enter with a privateer programme. **RT**



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Red Bull confirms engine for 2019

Alan Stoddart

MILTON KEYNES, UK: Red Bull has officially confirmed that from next year, the F1 team will drop the Renault engines that it has relied on for the last 12 years in favour of the Honda engines that are currently powering its junior team, Scuderia Toro Rosso.

The move will effectively result in Red Bull becoming a works outfit for the first time, leaving Renault supplying only its own works entry and McLaren. The switch to Honda power was announced on 19 June, well ahead of the Austrian Grand Prix which is when the outfit was originally expected to make its decision public.

"After careful consideration and evaluation, we are certain this partnership with Honda is the right direction for the team," said Red Bull team principal Christian Horner.

"We have been impressed by Honda's commitment to F1, by the rapid steps it has made in recent times with our sister team Scuderia Toro Rosso, and by the scope of its ambition, which matches our own."

The move means that from next year, the Japanese firm will supply both Red Bull and Toro Rosso with identical engines, and marks the first time Honda will supply more than

one team following its return to F1 with McLaren in 2015.

"Having two teams means we can access twice as much data as previously," added Takahiro Hachigo, president & representative director of Honda Motor. "We believe that working with both Toro Rosso and Red Bull Racing will allow us to get closer to our goal of winning races and championships, building two strong partnerships."

Renault meanwhile explained that Red Bull's move away from its engines was a 'natural evolution' given the French company's increasingly competitive works team and Renault and Red Bull's 'respective aspirations'. **IT**



LEFT After 12 years, Red Bull Racing is switching from Renault to Honda as it tries to add to the four World Championships it achieved with the French manufacturer

Aston's new Vantage GT3 makes race debut at Le Mans



ABOVE Aston Martin has introduced the new Vantage GT3 and Vantage GT4 customer cars that are derived from the new Aston Martin GTE

Alan Stoddart

LE MANS, France: Aston Martin revealed both its new Vantage GT3 and Vantage GT4 customer racing cars to the public at June's 24 Hours of Le Mans, while the Vantage GT3 made its racing debut in the Michelin Aston Martin Racing Le Mans Festival, which was held on the Saturday morning before the World Endurance Series' most prestigious round.

The new Vantage GT3 and GT4 are derived

from the new Aston Martin Vantage GTE; two of which were entered into the GTE Pro category of the weekend's showpiece endurance event. All three modern Vantage race cars are based on the critically acclaimed Aston Martin Vantage road car and powered by the same 4.0-litre turbocharged V8 engine, optimised by Aston Martin Racing.

Weighing in dry at 1245 kg, the Vantage GT3 produces a boost-variable 535 bhp and 700 Nm of torque. It is built from a lightweight aluminium chassis, again based

on the road car and features a steel roll-cage, an Xtrac 6-speed sequential gearbox, an Alcon motorsport multi-plate clutch, Öhlins four-way adjustable dampers and Alcon brakes and Bosch Motorsport ABS.

The Vantage GT3 remains in development until homologated on 1 March, 2019 and replaces Aston Martin's most successful customer car, the V12 Vantage GT3, which is still winning races seven years after it was first introduced to the market – most recently in the Blancpain GT Series Endurance Cup and British GT series. One of the key reasons for the popularity of the Vantage GT3's predecessor was the ease at which it allowed inexperienced racers to drive quickly while maintaining an optimum performance window for professional drivers to be competitive in.

"Driveability and a wide operating window remain key targets for us as we develop the new Vantage GT3 and GT4 racing cars," said Aston Martin Racing managing director John Gaw. "The fact that our customers can still purchase the V12 Vantage GT3 and be competitive seven years after it was introduced is a fantastic legacy to build on, and the new cars will take this concept on in leaps and bounds." **IT**

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DTM and Super GT present joint technical regulations

Alan Stoddart

NUREMBURG, Germany: The new 'Class 1' regulations for DTM and the Japanese Super GT series have been completed following several years of discussions between the two series.

The new joint regulations will be implemented from next year in DTM, and a year later in Super GT, and seek to meet three key goals: safety, cost reduction and equal opportunities. The most important factor in meeting these goals is the common part concept, which will see components of many different areas of the car standardised and produced and distributed in both Europe in Japan. For these common components, the manufacturers are saved from having to invest in expensive design and development programmes, while the DTM's carbon fibre monocoque with an integrated safety cell will be retained.

Another area of divergence from the previous set of DTM regulations is under the bonnet. The V8s currently in use by the series will be replaced by a state-of-the-art 2-litre 4-cylinder turbo engine, which will produce some 620 bhp – 100 bhp more than the unit it is replacing. This extra power means that the cars will need more braking power, so the cars' front aero design will be adapted to gather more air for



improved cooling of both the engine and the brakes. Furthermore the front and rear diffuser and the rear wing will be modified as the current Super GT specifications will be incorporated.

Although Super GT is set to adopt the Class 1 regulations a year after DTM in 2020, DTM and Super GT's organisers, ITR and GTA respectively, plan to hold two joint race meetings, one in Europe and one in Asia as early as 2019. The format will resemble the sporting regulations of DTM, with two sprint races without a driver swap or refuelling,

but including an obligatory pitstop for the change of all the four tyres. For these race meetings, a one-off Balance of Performance will be created to equalise the different vehicles of their respective series.

"I'm really happy about the fact that DTM and Super GT made a crucial step on the way to our goal: to jointly hold races. By the creation of these regulations we kept on pursuing our previous course consequently," said ITR's chairman Gerhard Berger. "Furthermore, we set the course for the future of DTM that will fully adopt the new regulations from 2019, thus remaining an attractive platform for the car manufacturers.

"I strongly believe that the joint events will bring new excitement for motorsport fans around the world and both Super GT and DTM will continuously develop together." **IT**

ABOVE & BELOW Cars in the Japanese Super GT series will soon be competing against DTM cars



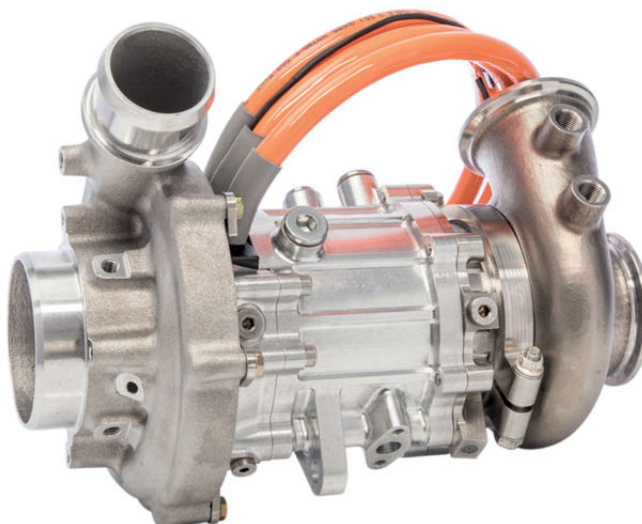
PERSONNEL

SUSIE Wolff has been appointed team principal of the Venturi Formula E Team and is also now a shareholder of the Monegasque team. Her new role marks her first formal step into team management and ownership. She will work at Venturi's Monaco headquarters, collaborating closely with all of the departments working on the group's Formula E activities, with the clear goal of building on the strong foundations of the team and leading the team forward for Season 5 of the championship. **IT**

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A portent for the future?

IN June we saw what could well be classified as a game changer. While not widely reported in the mainstream media, it nonetheless was a momentous result – Volkswagen's all-electric car, the I.D R smashing not just the all-electric car record at Pikes Peak, but the outright record as well by as much as 16 seconds.

There will be those who say that this isn't a racing car, but a prototype that's been specifically developed for this event, and they would be right, but does it herald the future? Can we expect more spectacular cars like this take to the race track and compete against each other.

There is a sense that the tide is turning. Formula E is going from strength to strength, the FIA has confirmed that the main class in rallycross will be all electric while the new Tesla one-make series is gathering momentum as well. It is easy to take things out of

proportion, but just what should we expect in the future?

The World Motorsport Symposium has developed a reputation for been an influential Think Tank where important issues like these are openly discussed by the most senior engineers and executives in the industry. Formula E, for example, was first discussed at the Symposium when it was no more than a twinkle in the eye of one or two visionaries.

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JOHN MANCHESTER, Operations Director, Gibson Technology Ltd





ESCAPING A MIDFIELD MAELSTROM

What is the key to emerging on top in the midfield pack's ferocious scrap for points? **Craig Scarborough** asks three of the tech chiefs involved

FORMULA 1 2018 has proven to be super-competitive, with Red Bull now firmly in contention with Mercedes and Ferrari. But beyond the big three teams, recent seasons have brought the remaining seven entrants into even closer competition. Where once there was a clear separation between midfield and tail-enders, now there is just one pack fighting ferociously for the remaining points.

Race Tech caught up with three of these midfield teams, all with very different backstories, to find out how they can escape the maelstrom of the midfield over the remaining races.

NO MORE TAIL-ENDERS

Formula 1 has perennially featured a battle of haves and the have-nots, resulting in a few leading teams and some distinct tail-enders. These groups sandwich the 'not-quite-haves': the midfield. In 2010 F1 introduced new entries for three low budget teams, but by 2017 all three had dissolved, having propped up the back of the grid for the intervening seasons. Now, teams are finding no middle ground, there's just the leading squads and everyone else, but no tail-enders.

Paddy Lowe, now chief technical officer at Williams, hits the nail on the head. "Midfield

is not the right term any more, is it?" he ponders. "We lost the stragglers off the back. The last car off the back was the Sauber, but they've done a great job over the winter and are really performing well this year."

Toro Rosso's technical director, James Key, simply describes this pack as "really tight". This midfield battle is also in a constant state of flux, as different teams outperform each other at different tracks. "It's the little subtleties like circuit sensitivity and how your drivers like the track that make the difference," he says. "All drivers have their favourites. It's also about how the tyres are working for you that weekend – lots of ▶

“What would it take to bridge the gap to the front? A couple of hundred million a year and 600 people!”



ABOVE Tiny nuances change the composition of the midfield pack from race to race

little subtleties that shift things around. It means everything is open and possible. Your development rate and making the most of every weekend is pretty fundamental."

MIND THE GAP

What's more, the closeness of the midfield only serves to highlight the gap to the top three teams ahead. It's a fact pointed out by Lowe: "I think what's particularly marked this year is that the gap remaining to the front hasn't been breached by anyone. If anything, it seems a bit bigger. The pack behind is generally within quite a close distance of each other. We're too often towards the back of it, but it isn't actually too big a step to be at the front of it."

Key, meanwhile, affirms that this gap is testament to the work of the top teams. "It shows the brilliant job they've done, I guess," he reflects.

This gap can be put down to the difference in budget and resources of these three teams, according to Force India technical director Andrew Green. His blunt assessment of what

BELOW While rivals redesigned their monocoques to pursue the raised sidepod inlet route, Force India had little choice but to integrate the Halo with existing side impact structures



it would take to bridge the gap is "a couple of hundred million a year and 600 people!"

"Those big teams are 800-1000+ people," he points out. "We're 400. They are in the hundreds of millions of dollars a year; we are a hundred million. That's what it takes..."

2018 STRATEGY

Sponsors and investors aren't going to deliver that sort of finance to the seven midfield teams any time soon, and FIA budget capping regulations are still some way off. Therefore, the strategy these teams take

towards the 2018 season and preparations for next year's changes, exploiting their budget to the full, is critical to their chances of topping that midfield group by the final race of the year.

Of course, your approach is all down to how you fared last season and what's changed for you this year. Taking Toro Rosso first, its 2017 campaign wasn't a strong one and the switch to Honda from Renault power units for 2018 also affected the planning. "We've always accepted we'll treat this year as a little bit of a building year," acknowledges Key. "For us the chassis was ▶



ABOVE & BELOW Force India repeatedly punches above its weight with its in-season technical developments



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a bit underdeveloped. We have had to take new directions to solve some of the issues from the end of last year and they all take time to mature."

Part of the approach is to understand where Toro Rosso wants to end up. "We want to finish the season in a more competitive state than we started in. So, you spread the budget accordingly: it's too easy to front-load the spend and you'll spend it very quickly if you're not careful," Key cautions. "So, we've been fairly targeted in our developments and looking to take a step at a time to get the maximum bang for our buck." He adds: "We've already brought one update to the car and that was at Bahrain, but after that it will begin to change to much more regular steps."

The other part of Toro Rosso's strategy concerned the cooperation with Honda.

BELOW Toro Rosso discovered as early as the second race, when it celebrated fourth place, that the relationship with Honda wasn't the poisoned chalice some had suggested



Photos: Craig Scarborough

ABOVE & BELOW The Williams FW41 pursues some of the more aggressive solutions seen on the grid



Power unit to car integration work is shared and having been an engine customer throughout its time in F1, being a works-supported team is a new experience for the Faenza group. It is a nice situation to be in, according to Key: "Honda is a far bigger project for us. There's a lot of dyno testing, which is great for us from an engineering perspective. There are gearboxes and all sorts of other things that need to be accounted for, that we didn't do before."

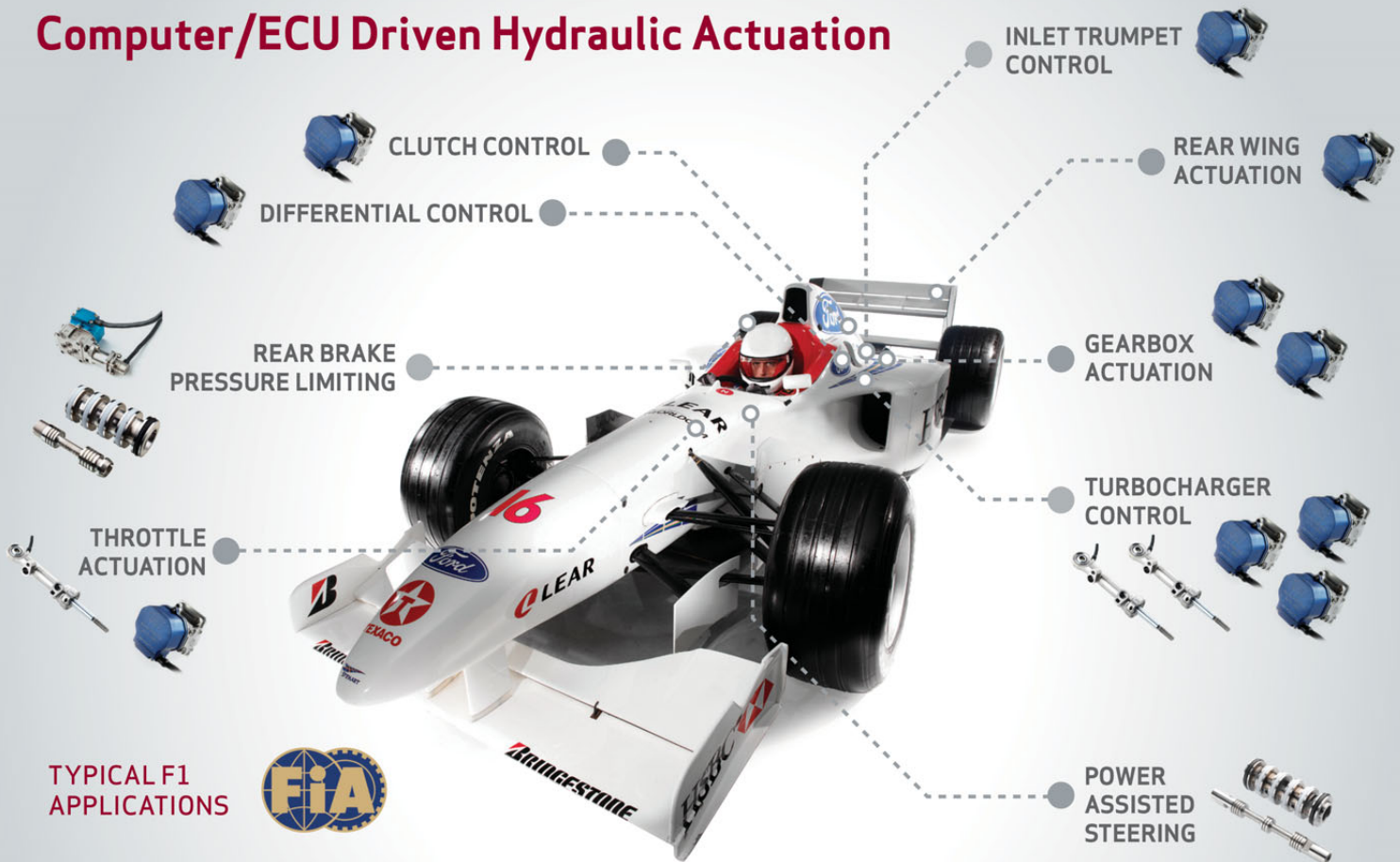
Toro Rosso has to commit a certain budget to activities direct with Honda but the remainder can be used on its own car development. With few rules changes for this year, there was little to disrupt the team's planning. Key even admits that integrating the Halo frontal cockpit protection wasn't a huge budgetary burden. "Things like the Halo you kind of soak up," he says. "You're doing a new chassis anyway. There's a bit of cost attached to it, but not much. You do your R&D etc and make the best of it."

Another perennial midfielder, albeit one with wins in its history, is the Silverstone-based team that has morphed from Jordan, Midland and Spyker into Force India. In its latest incarnation the team has done a great job of maintaining competitiveness in spite of limited resources. Last season it finished the Constructors' championship in fourth behind Red Bull.

This continuous presence has enabled the team to become sharp at the practice of making the most of its budget, something of a core philosophy adopted at Force India. "There's lots of philosophies we apply, from how we employ people, who we employ ►

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BELOW Williams is trying to sort its existing car's problems without hurting the gameplan for next season

and how we treat them when they're with us," explains Green. "Even to how we spend the money we do have, how we go about spending it through the season and spending within our means."

The lack of budget is compensated for by having to work harder, Green admits: "It's not easy. It's very hard to keep all those plates spinning. There are lots of very difficult decisions to be made on a daily basis. Obviously, we can't do everything that the big teams can do. They can take all their ideas, then get them all to a level of maturity and decide which ones they want to pick up. We can't do that, but we do have people generating ideas, trying to manage them and their expectations in what can or can't be done, then try to keep everyone motivated. It's a very fine line to try and walk."

The Halo frontal cockpit protection becoming mandatory this year is just one example of the enforced limited approach Force India has to take. While other teams were redesigning the monocoques to house lower side impact protection in order to raise the sidepod inlet to a Ferrari-style design, Force India was resigned to simply integrating the Halo and keeping the existing side impact structures in place. In doing so,

it knew it was giving away a small potential performance advantage to rivals such as Williams or Haas which have been more aggressive in this area.

QUEST FOR FRESH GLORY DAYS

Compared to Toro Rosso and Force India, Williams was in a very different position as it approached the 2018 season. The team has slipped into the midfield, having led this pack in 2014. Subsequent years have seen its performance decline and new top-level management are in place to turn things around.

Ex-McLaren and Mercedes technical director Paddy Lowe has returned to the team to head the technical side. But having slipped to fifth position in the Constructors' series in 2017, was there a brief set out for Lowe from the team? "I don't think it needed to be set," he says. "The brief was to get back to winning ways. We're in our 41st year of existence, although Frank has some different numbers. The first 20 years were a lot more successful than the last 20 years. Along with Claire [Williams] and Mike [O'Driscoll] we set our goal to try to get to a period of prolonged success, win races

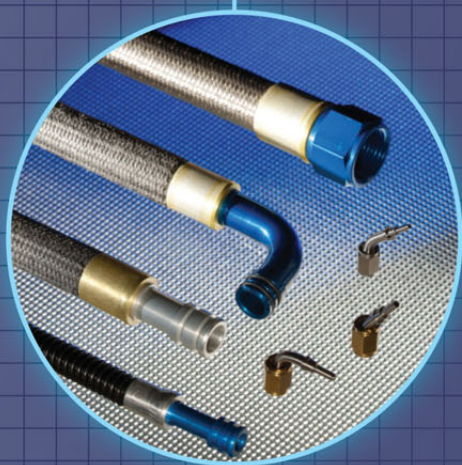
and championships. That's not going to happen in a hurry. We don't need to write that down!"

Thus, Williams finds itself at the start of a long game, getting the resources and structure to reach its goal. Lowe bases his optimism on the engineering strength of the Williams organisation, both the Applied Engineering division and the experience of the F1 team members. "Some of those guys have been doing this job for 20 years," he says. "They've seen everything and done everything. They are real specialists. It's a great opportunity to harness that experience and turn it in the right direction."

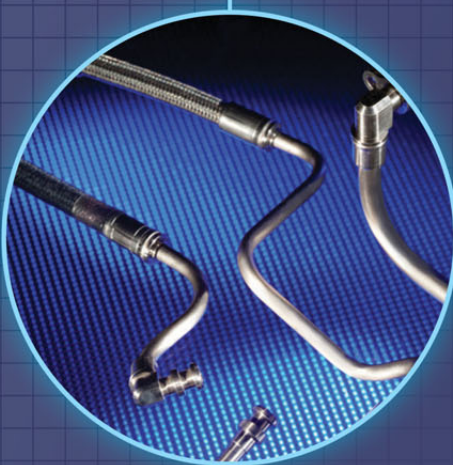
Last year's FW40 was a development of a series of cars going back to 2014. Lowe wanted to make a step change with the new car for 2018. "We wanted to really push the envelope much harder in a number of areas we thought were important and we did so. When you look at the car, it has some of the more aggressive solutions on the grid," he stresses. This is true: the sidepod, bargeboard and even the chassis top treatment are a significant step for Williams, exploring new areas as yet undeveloped by other teams.

However, the FW41 has struggled with ►

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ABOVE & BELOW Toro Rosso has been wary of front-loading the development spend on its STR13 in the chase for points



performance due to a stalling underfloor. Lowe admits the problems but doesn't relate them to the intentional concept changes adopted this year. "Where we've lost our way is in a number of other areas. They were valid steps, but we haven't translated that into the right performance," he says. "We understand that now and we will correct them." With the underlying problems solved, Lowe is optimistic of the step-change approach: "Then we will start to see some of that work come to fruition."

R&D DECISIONS

Part of the planning process for a team is deciding how to divide up the R&D budget. Obviously the new car and some in-season development is a must, but so too is a longer R&D programme that looks ahead to larger projects or future directions not able to fit into the current

car development programme.

"It's a challenge to manage those things but we have an underlying plan," explains Lowe. "A good example, there are things I wanted to do last year, but felt were beyond the capabilities of the team in one annual cycle. Things which we will now be doing for 2019. The R&D for those things is still in the background; we need to maintain that to make an even bigger step for next year. In the meantime, we need to sort out this car and we really need to put all of our effort into doing that without raiding the resources that should be working on the longer-term picture. I think we're still on track to do what we set out to do for next year."

IN-SEASON DEVELOPMENT

Once the new car is built and out on track, then comes the next tranche of spending, which is the in-season development, to keep pace with improvements in the competition. This apportioning of the budget through the year is a fundamental part of the technical director role, according to Key. "That of course always changes a bit and is dynamic depending on what you're finding from your competitors," he admits.

This R&D spend is a mix of fixed and variable costs. "A lot of R&D costs are fixed," says Key. "You run your CFD cluster, your wind tunnel, your bench tests and R&D staff and so on. They will be running everyday anyway. You've got to make the most of ►



ABOVE Variable costs, such as complicated aero developments like the front wing, have to be factored in alongside fixed outgoings

Photos: Craig Scarborough

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that fixed cost." Then variable costs are, he says, the expense of the actual parts. "If you take an aero development, for example the front wing, they are incredibly complicated. A huge amount of tooling is involved, and you want to compress the amount of time you take to manufacture these parts. That's where some of the bigger costs come in. The

it's a primary issue, there's no point in developing wherever we're going now until we fix this problem, because anything we bring to the car is likely not to work until we fix that problem."

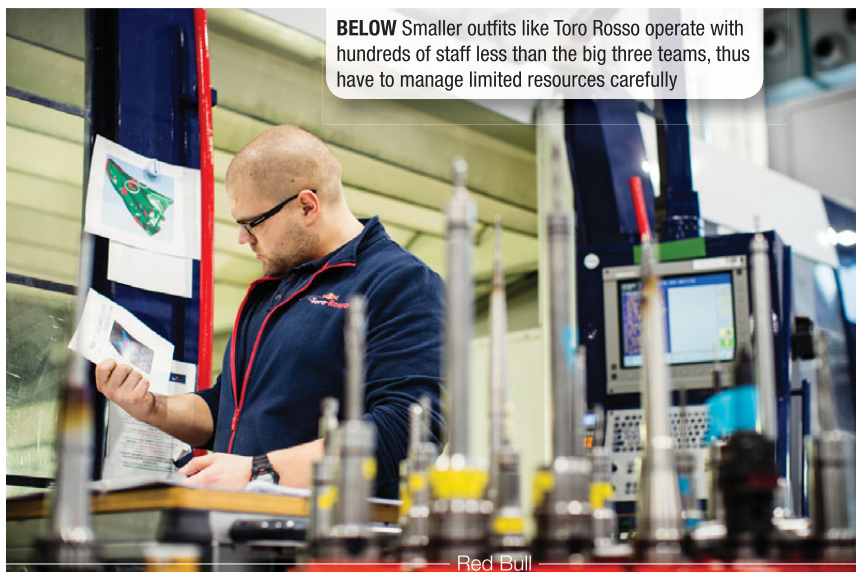
It is, says Green, another balancing act: "How much resource do I allocate to keep on developing the car, versus how much I

pull off that to fix the problem. You can't just stop everything."

Then there's the usual looking up and down the pitlane at competitors' cars, poring over the high resolution 'spy' photography. How much do teams *actually* look at their competitors and react? For Key at Toro Rosso, this is part of the development process.

"Absolutely, we keep a very close eye on the competition, on what they're doing, looking at our strengths and weaknesses," he concedes. "So, if your rival is really struggling in slow speed corners, there's little point in developing low-speed corner stuff if you've got a gap in the high-speed stuff. There's a lot of attention being paid to what we need to do to match them, and we need to make up in each area. Every couple of weeks, we go through that."

This contrasts sharply with Force India's approach, Green insists: "We tend not to think about our rivals too much as there's not too much we can do about that. We tend to focus on what we can do. We have plenty of discussions on where we should go over the winter, based on what we learnt last season."



BELOW Smaller outfits like Toro Rosso operate with hundreds of staff less than the big three teams, thus have to manage limited resources carefully

budget we reserve is to actually make the bits to get on the car."

As soon as the cars are running in testing and the first races, then the true picture of a team's competitiveness becomes clear. Is the car working as it should? Do rivals have something better? Does the pre-planned spending forecast change or do you stick with it?

For Force India the car wasn't working as the simulations predicted. So with a limited in-season spend, how does a team react to initial design problems? Green says the situation demonstrated that Force India is highly adaptable in this regard: "It does affect the planning, so the initial ideas of where we thought we were going to be and what we thought we were going to be developing this year, but we keep it flexible. Until we start running the car we don't get the data, we don't have this idealist world where the car perfectly mimics the CFD and we can carry on developing, that's never happened. There's always something on the car that doesn't quite match where it should be and we have to go back fixing that."

The impact of this depends of the severity of the problem. "Maybe it's one of those where you think, 'We can fix that and not affect any other of our developments' – a secondary fix," says Green. "Or if



ABOVE Force India's plans were hampered by its new car not working initially as simulations had suggested

Pirelli



ABOVE In spite of the ferocity of the midfield struggle, no-one has bridged the gap to the big three teams at the front

2019 APPROACHING

As we now reach the midway part of the season, the focus naturally switches towards next year. Teams have to balance in-season development with planning for the new car. Up until the first GP of the season, there were no intentions to change the rules for 2019 as there were larger rule changes, to aid overtaking and reducing costs, planned for 2021. But a lack of overtaking at the first races acted as a catalyst to push some of the new rules into the 2019 regulations to improve the situation.

These were detailed to the teams over the Spanish GP weekend and a package of simplified aero has now been scheduled for 2019. At a stroke the teams' initial plans for their new cars were scrapped and the demand for the major reworking of the car's aero package had to be budgeted and scheduled instead.

Toro Rosso's approach is typical for the midfield, as Key outlines. "The 2019 stuff is what it is. It's done. We need to go and make the best of it," he says. "It does have an impact. The original theory was if we could have a strong development this year, it's great to finish the season strongly, because

“Agile decision making: not even a formal meeting, just a scrum”

your baseline for the following year is that much higher. All that knowledge and IP being developed can be transferred directly into the new car for next year. So, you're not running two programmes in parallel."

Now, however, dual programmes are required as the new regs are such a fundamental change that there are a huge amount of new ideas to develop. "That's where by being a bit bigger you have an advantage," he notes, "although small teams have the flexibility and communication. There will be costs involved. That's mainly on the aerodynamics. We've got no baseline, no history for that, so we have to build that up from scratch. There's quite a big workload involved."

By contrast, Lowe sees the upheaval as a good thing for Williams. "It's almost an opportunity for us, playing to our advantages," he reckons. "We see this as a good direction for the spectacle."

Then there is the question of when do you switch focus from this year to next year? Force India has taken the changes on board with its

usual agile approach. "We've already had that discussion," says Green. "This is broadly what the regulations are going to look like, what sort of resources do we think are going to be moved across and in what stages? When is it all going to start? The answer is, 'We should have started months ago!' They are the sort of the decisions we are good at making very quickly and efficiently because of the small nature of the team. We just stand around a desk, not even a formal meeting, just a scrum: 'Right, what are we going to do?' Then everyone goes off and carries on working."

As the season reaches the summer break, teams are already planning the upgrades to the cars to see out the campaign, as well as working towards the 2019 cars. Meanwhile the 21 races of the current year continue, and the pattern between who races and qualifies well varies with each differing track. Such is the fine balance of results and failures through the course of the year, picking the eventual winner from this maelstrom is akin to finding the winning lottery numbers. **TI**

“AESTHETICS OVER AERODYNAMICS”

That's the mantra behind revolutionary regulations fashioned to lure a spectacular new breed of prototypes to the Le Mans 24 Hours. **Gary Watkins** investigates

A McLaren Senna and a LaFerrari racing each other at the Le Mans 24 Hours and in the World Endurance Championship isn't going to happen. But a McLaren that looks like Senna and a Ferrari resembling the Italian marque's most recent super sports car could be on the grid when the 2020/21 WEC winter season kicks off in a little over two years' time.

The rule makers, the FIA and the Automobile Club de l'Ouest, made it clear that this was their intent when they unveiled the broad framework of their new "hypercar concept" regulations for the top class of the WEC at the traditional press conference on the Friday ahead of the Le

Mans blue riband WEC round in June. The idea is that the cars, which will have a five-season lifespan, will look like "hypercars, supercars, luxury GTs or concept cars", according to Richard Mille, president of the FIA's Endurance Commission.

Underneath, however, they will be pure-bred prototypes. Each will be built by an OEM car maker or a constructor on its own chassis. These rules have little in common with those that allow the Daytona Prototype international manufacturers competing in the IMSA SportsCar Championship to take an off-the-shelf LMP2 chassis, imbue it with some token styling cues, fit their own engine and give it a new name.

The LMP1 replacement class in the WEC puts "aesthetics over aerodynamics" – a kind of tag line being used by the FIA and the ACO – and has been conceived to encourage more manufacturers to compete at the highest level of sportscar racing. They will be encouraged, reason the rule makers and the brands that have joined around the table in formulating the ideas, because they will be able to go racing with a car that resembles something they sell for the road.

But they will also be encouraged because the cost of competing will be massively reduced over levels in the current twin-►

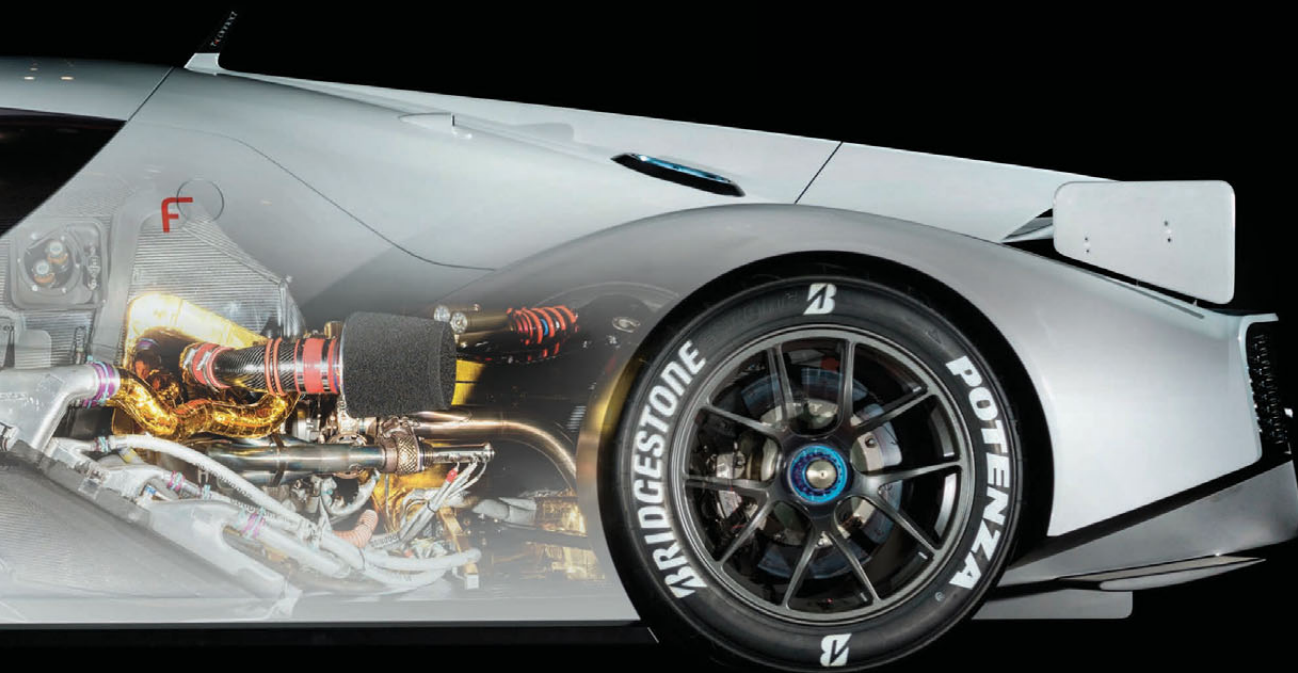
“A maximum downforce figure, along with a minimum drag number, will be mandated”





ABOVE & BELOW Shape of the future: Toyota's GR Super Sport next-generation hypercar could be a template for the new rules. It incorporates hybrid electric technology honed through Toyota's WEC programme with the TS050

Photos: Toyota Gazoo Racing



hybrid LMP1 class. And this is the beauty of the rules. The means by which a diverse range of shapes will be allowed will also reduce the cost of competing for one of the biggest prizes in motorsport at Le Mans.

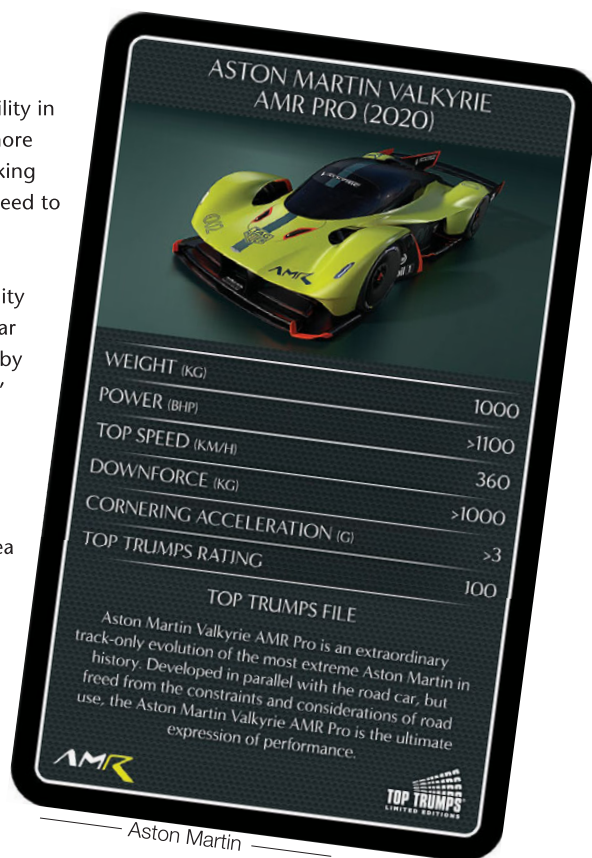
The look of the cars will not be defined by the windtunnel or the computational fluid dynamics (CFD) program because a maximum downforce figure, along with a minimum drag number, will be mandated in the rules. What have been described as "achievable" targets significantly lower than today's levels in LMP1 will allow a diversity of styling at the same time as slashing aero development costs. Highly-expensive aero programmes will become a thing of the past.

"We believe that if we can control the aero performance of the car, we will allow enough freedom for each manufacturer to use a base design that is already existing on the road," says FIA technical director Gilles Simon. "The downforce we have with the current LMP1 cars today is exceptional.

If we want to have more flexibility in design of the car, if we want more styling in the cars and cars looking more like hypercars, then we need to lower this number."

"The key point is that the manufacturer will have the ability to determine the shape of its car because it will not be dictated by the need to create downforce," explains Vincent Beaumesnil, sporting director at the ACO, both the organiser of the 24 Hours at Le Mans and the promoter of the WEC. "The idea is that if you define the values then there is no reason to spend money on windtunnel development because you will get no reward.

"This will be a new process in which we will measure the cars in the windtunnel and make full bodyscans of them.



ABOVE The regulations seek to encourage the 'Top Trumps' dreams sparked by hypercars like Aston Martin's Valkyrie AMR Pro

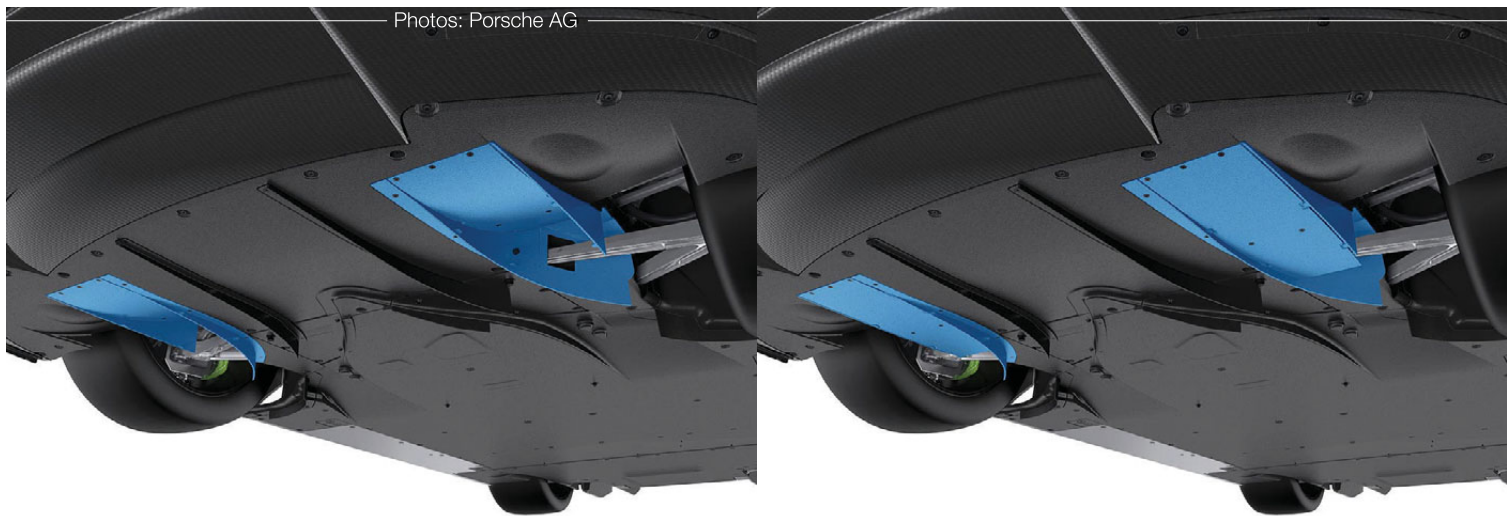
This way we can make sure that the cars can go up to the point we lay down, but not go over it."

It is, says Toyota Motorsport GmbH technical director Pascal Vasselon, an "interesting innovation".

"Instead of micro managing the regulations by banning this winglet or that one, where the regulatory body is always behind the engineers, here the actual aerodynamic performance is set," explains the Frenchman, who was one of the key players in the formulation of the new rules package. "The target is to set the aero efficiency at an achievable level, not at a level that requires 30 people over three ►

ABOVE & BELOW Manufacturers could be enticed by the inclusion of active aerodynamics. Porsche, for instance, has for years trumpeted the moveable aero showcased on cars like the 918 Spyder, on which adjustable air flaps in the underfloor open and close to create ground effect benefits

Photos: Porsche AG



LE MANS WINNERS



In the 2018 Le Mans 24 Hours, LMP2 was the only class that featured competition between tyre manufacturers.

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years. It should be achievable by a team with a few good CFD engineers. That is the best way to manage things."

The new regulations will offer one class for all. There will be no sub-division or separate rule book for privateers.

"There is no constraint to have a hypercar to participate," says Beaumesnil. "All kinds of ideas are possible. Maybe a privateer could link up with a company like Koenigsegg."

The constraints on aero development are one of a number of limitations that will be placed on the designers of the new breed of prototype. Engine performance will also be capped at just over 700 bhp (520 kW is the figure given) and the fuel flow principle enshrined in the LMP1 regulations since 2014 will remain in place. The architecture and capacity of the conventional powerplants will be free, however.

There will also be strict guidelines governing the weight and centre of gravity of the engines and a ban on what were nebulously described as "expensive materials", all in the name of cost reduction.

MOVEABLE AERO

Active aerodynamics are also a key tenet of the philosophy of the new rules. FIA technical director Gilles Simon has revealed that moveable aerodynamic parts will allow for "greater efficiency at lower cost".

It will also do away with the need to develop different aero configurations for the unique demands of the Circuit de la Sarthe at Le Mans and the regular WEC six-hour races held on Formula 1 circuits. Just one aero spec will be allowed under the rules, another key cost saving.

Simon added that it was the "right time" to allow active aero on prototypes in the WEC because it is becoming increasingly common on high-performance road cars. The idea of active aero isn't new, however. It was first raised as a means of increasing the performance of privateer machinery back in 2016 and was part of the stillborn rules package, which included the electric kilometre, announced 12 months ago prior to Porsche's decision to leave LMP1.

What will be permitted in terms of active aero has yet to be fully defined. Vasselon explained that it might not necessarily be just Drag Reduction Systems (DRS) and could involve some kind of "aero management device".

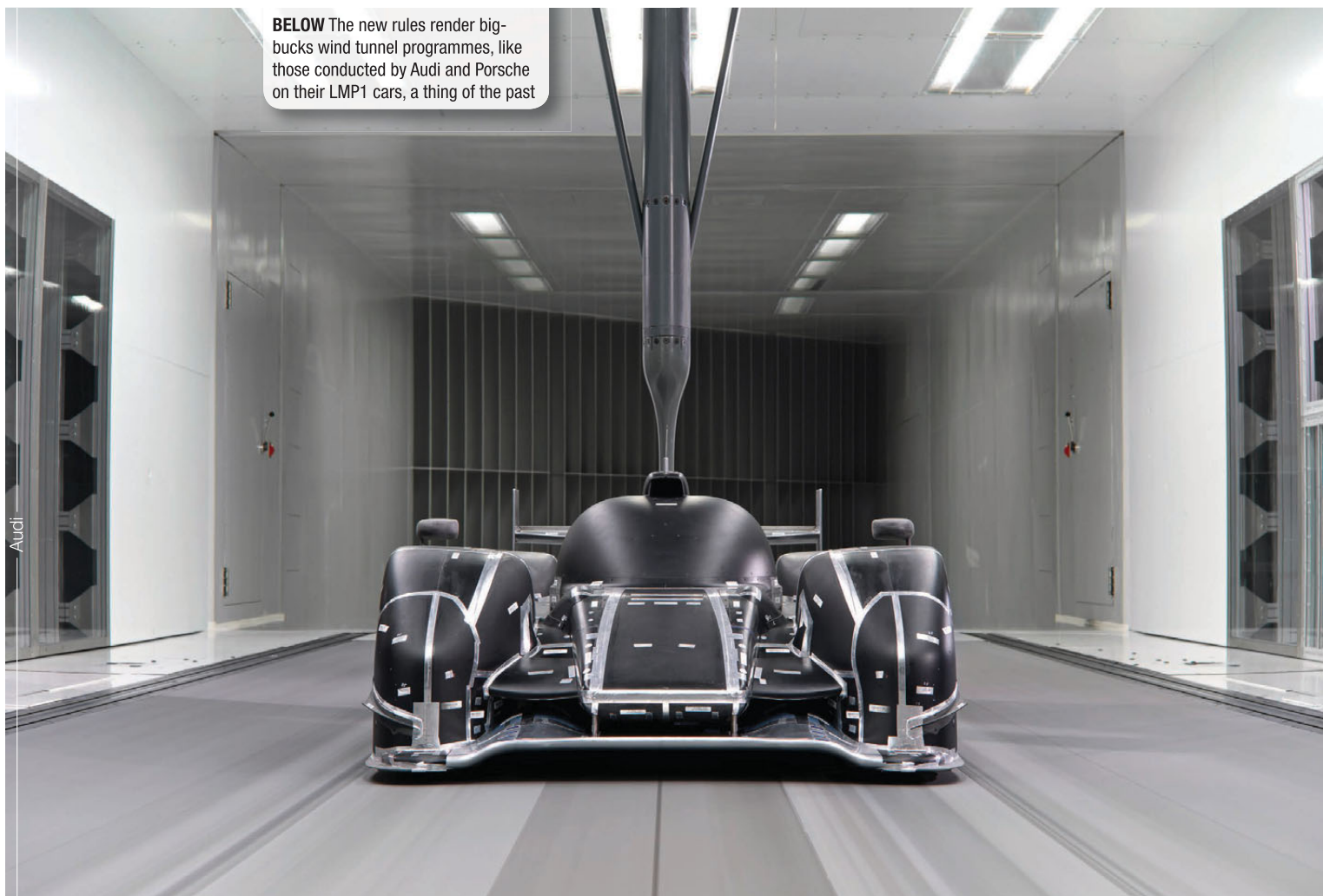
The use of common aerodynamic components had been explored, but this was thrown out because it would have been counter to the principle of "aesthetics over aerodynamics".

"We discussed having a spec floor," says Vasselon, "but the floor dominates the aero structure, so all the cars might end up looking similar or the same. That is not what was wanted."

HYBRIDS

The new cars will be hybrids, though the level of technology will be significantly downscaled from where it is now. Just a single front axle kinetic energy-retrieval system will be allowed, rather than the current two systems, and the maximum ►

BELOW The new rules render big-bucks wind tunnel programmes, like those conducted by Audi and Porsche on their LMP1 cars, a thing of the past





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McLaren

power output will be reduced from 300 kW (just over 400 bhp) to 200 kW (approximately 270 bhp).

Cost will be further limited by mandating common control electronics for the hybrid systems. The use of a spec hybrid system to be used by manufacturers or privateers not wanting to develop their own was explored. It was abandoned in favour of an idea borrowed from Formula E and being exploited to some effect in season four of the FIA electric vehicle series by the championship-leading Techeetah team.

Manufacturers developing energy-retrieval technology will have to make their system – battery and all – available on a lease to other participants at a price that has yet to be determined. The low cost of a lease of an FE powertrain is a means by which the series is trying to avoid a technology explosion.

BIGGER CARS

The “aesthetics over aerodynamics” drive means that the new-rules cars will be true two-seaters with larger greenhouse areas. This will allow the FIA and the ACO to mandate the new safety rules that at one point had been due to come on stream as early as 2018 before the technology freeze that was agreed after Audi’s withdrawal from the WEC at the end of 2016.

“We will be able to review several areas of safety inside the car,” says Beaumesnil. “It will be a continuation of our previous plans. We have this new shape and increased volume inside the cockpit, so it is a good time to do it.”

A more upright seating position, as well as more room around the driver’s head and legs, are expected to be part of the safety upgrade.

The cars will be heavier than at present. A minimum weight of 980 kg, as opposed to the current 878 kg, is envisaged. The larger cockpit areas and the drive to reduce costs offer an explanation.

TARGET LAP TIMES

An increase in roughly 200 horsepower over present levels from the new cars’ conventional engines explains why they will only be a little slower than a 2018/19 LMP1, despite lower aero figures, less hybrid boost and more weight. The target lap time around the eight and a half miles of the Circuit de la Sarthe – always the reference in ACO/FIA prototype rules – is 3m 20s in qualifying, which is only five seconds slower than Toyota’s pole position mark for this year’s race.

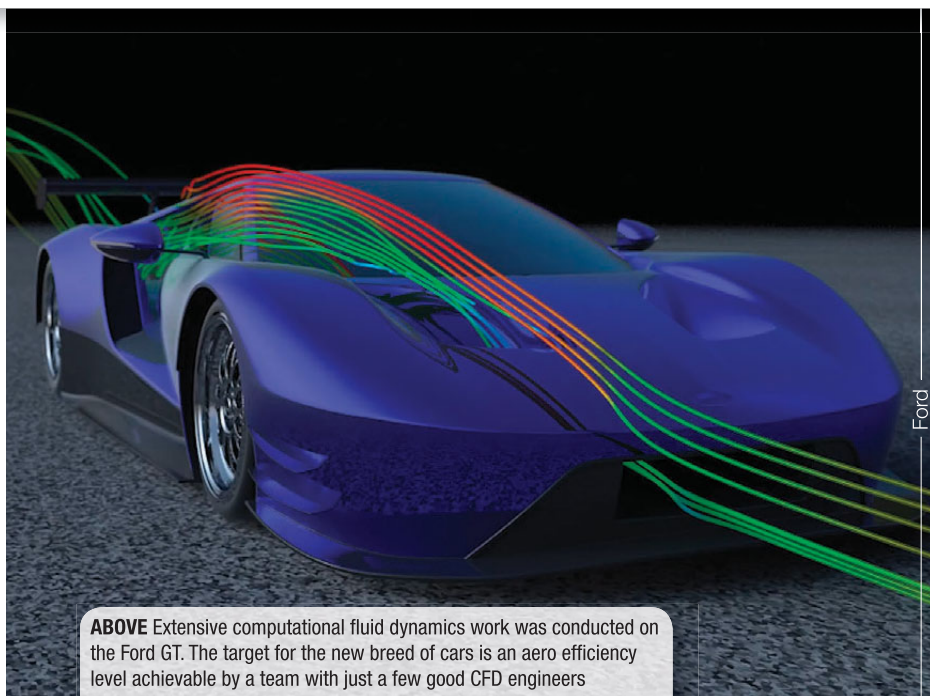
Simon insists this is achievable: “We have ►



ABOVE & BELOW A McLaren resembling the Senna GTR could be on the Le Mans grid with a LaFerrari-based rival for 2020/21



Ferrari



ABOVE Extensive computational fluid dynamics work was conducted on the Ford GT. The target for the new breed of cars is an aero efficiency level achievable by a team with just a few good CFD engineers

Ford

year). IMSA acknowledges the benefits of a common platform across the WEC and its series. In fact, it is in favour of the idea of the cars that race for outright honours at Le Mans also being able to do so in its marquee enduros at Daytona and Sebring.

STICKING POINT

But there remains a sticking point if the 2020/21 regulations are to be adopted in a second championship. And it's one of cost. IMSA reckons the €25-30 million figure for a season is too high even for the manufacturers running Daytona Prototype international machinery to sustain.

"In many areas we are completely aligned, but I would say the one category that continues to be a point of separation is budget," says IMSA boss Scott Atherton. "Even with the significant reductions announced it still represents a big increase from where we are with the DPi [Daytona Prototype international] and LMP2 formula that is working well."

Atherton suggests that the largest DPi budgets right now are still some way south of the ACO/FIA target. Suggest to him that

done the simulations and the numbers we have say it is possible."

The new rules are intended to reduce budgets to approximately 25 percent of current levels. The ACO mentions a figure of €25-30 million per season, but appears not to want to be tied down by it.

Beaumesnil admits the ACO arrived at that figure by using Toyota's estimated budget as

the benchmark. The Japanese manufacturer is generally reckoned to be spending in the region of €100 million a season. Porsche and Audi were believed to have spent more.

That reduction appears not to be enough if the new rules are to be adopted by IMSA in North America after its current rules cycle ends at the end of the 2021 season (it was extended by one season earlier this

— IMSA/LAT USA —



ABOVE Alignment between the WEC and IMSA would be attractive. As yet, though, the proposed budgets are still higher than those of the US series' flagship DPi category

the likes of Acura, which is teamed with Penske Racing, may be nudging \$20 million, and he responds that the figure is “a little too aggressive”.

“What we do not want to do is to embrace a set of regulations that abandon the core elements of what has made our current platform successful,” he explains. “We have spoken to several manufacturers who share our opinion that even with what has been achieved in terms of cost reduction it is not yet to a level that would enable them to participate.

“Our mission right now is to do everything we can to have common regulations. We will be working aggressively in that direction over the next four or five months before the rules need to be ratified at the end of the year. Let’s take a hard look at each category in the rules and see what are the opportunities for further efficiencies.”

He reveals that Simon Hodgson, IMSA’s vice-president of competition, is due to travel straight from the Watkins Glen 6 Hours round of the North American championship at the beginning of July to join the first of the technical working groups that will draft the rules from the broad definitions announced in June.

WHAT THE MANUFACTURERS SAY

The five manufacturers that have been around the table since last year coming up with the principles of the new rules – Toyota, McLaren, Aston Martin, Ferrari and Ford – are all saying positive things about the rules as you might expect. Each has pointed out, however, that the regulations have yet to be finalised in detail.

Porsche, which was an observer rather than a participant in discussions, says similar things.

“There are many positive elements, but so far it is only a set of targets,” says Frank-Steffen Walliser, head of GT motorsports and for production sportscars at Porsche. “We cannot comment further until we see the final regulations.”

Toyota has given a clear indication of its enthusiasm for the new rules. It unveiled the GR Super Sport Concept at the Tokyo Auto Salon in January as a demonstrator for its hybrid technology – it uses a TS050 HYBRID – and to help launch the GR sub-brand taken from the Gazoo Racing tagline under which Toyota undertakes its major international motorsport


Hydrogen for the future

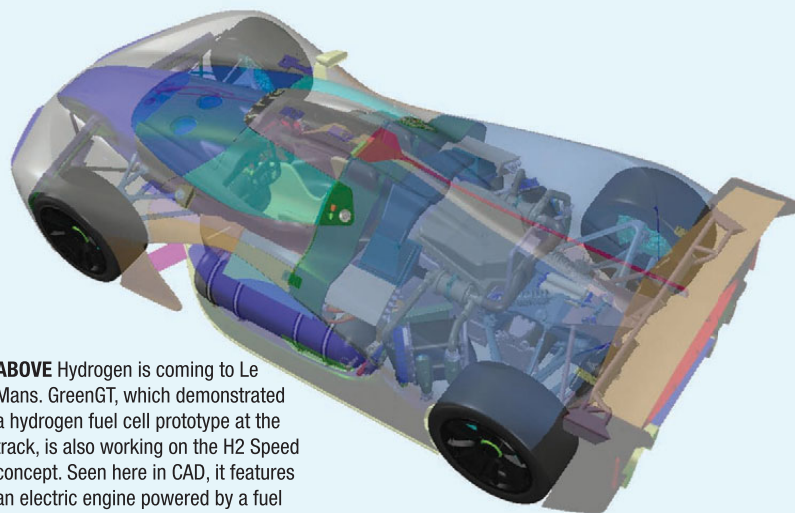
AUTOMOBILE Club de l’Ouest president Pierre Fillon appears to have made it his personal mission to have zero-emission racing at the Le Mans 24 Hours. And he wants it by 2024. This is the year that he has targeted for the first hydrogen fuel cell car to be racing in the French enduro.

“Le Mans should remain a technological laboratory and we strongly believe in hydrogen fuel cells,” he says. “For 2024 we want a hydrogen category, and it is not a dream. It is our long-term vision.”

The ACO has said that seven OEMs actively developing fuel-cell technology for the road are involved in working out how to get hydrogen-powered machinery onto the Le Mans grid.

ACO sporting director Vincent Beaumesnil says that the plans are some way from being finalised. “We have a strong and high quality group coming from great companies working with us,” he notes. “We know the target is 2024, but how it will race we don’t know.”

He couldn’t confirm if a fuel cell car could join the top class of the World Endurance Championship, race in its own category or be a Garage 56 entry for an experimental technology. “We need to take some time before giving more details,” he says. 



ABOVE Hydrogen is coming to Le Mans. GreenGT, which demonstrated a hydrogen fuel cell prototype at the track, is also working on the H2 Speed concept. Seen here in CAD, it features an electric engine powered by a fuel cell fed by three hydrogen tanks

programmes in the WEC and the World Rally Championship.


The GR Super Sport was present at Le Mans and TMG boss Hisatake Murata asked Shigeki Tomoyama, Toyota’s executive vice president whose remit includes motorsport, at a press event if the car could be raced. The answer, in a clearly choreographed exchange, was in the affirmative.

Ford has said that it agrees with “some but not all” of the principles of the new rules. Mark Rushbrook, global director of Ford Performance Motorsports, underlines the need for a common platform across the WEC and IMSA if it is to step up to the prototype ranks.

“We want the same model that we have been able to use with the Ford GT in that

we want to be able to race a car in both IMSA and the WEC,” he says. “The FIA and the ACO know that and so do IMSA.”

There’s a lot of work to go before the rules are finalised. Meat needs to be put on the bones by the various technical working groups before the regulations can go first to the FIA Endurance Commission and then for final ratification to the World Motor Sport Council. The governing body’s stability rules means this needs to happen before January 1, 2019, which means a sign-off at the December meeting of the WMSC.

There is also another task for the FIA and the ACO, one which they say will involve consulting the fans of sportscar racing. They need to come up with a name for the new class. 

ALL SYSTEMS GO

It was a Le Mans with a difference, not so much due to the racing but for all the buzz and excitement emanating from the paddock over different issues, as **William Kimberley** reports

If there's one thing that the supply chain in motorsport loves most, it's new regulations. If there's one thing that manufacturers and teams *hate* most, it's new regulations. It means money being spent.

It was the new World Endurance Championship regulations, announced by the FIA and ACO at a press conference the day before the race got underway, that was the talking point in the paddock. Of course, everyone knew they were coming, but in what shape and capacity?

As will be read in Gary Watkins' article in this issue, they are extensive, bold and will change the shape and look of endurance racing. Because of this, it is also transforming

comes to their production cars but lack the knowledge for the requirements of a motorsport system, and the clock is counting down very fast indeed.

One such company that has now geared itself up to work with constructors to produce systems is Bosch Motorsport. One of the pioneers in the automotive industry all those years ago, it is now offering total solutions rather than individual products.

As Klaus Boettcher, managing director of Bosch Motorsport, explained: "In a two-pronged strategy, we have put a lot of thought into looking at what the racing car might be in 10 years' time and worked back from that while at the same time taking into consideration what is needed now and next year moving forward.

"We have been

“Transforming the way suppliers approach their business model”

the way some suppliers approach their business model.

In fact, it's reminiscent of what happened to the automotive industry some 20 years ago. The 1000-plus tier-one suppliers to the carmakers were whittled down to 20 or so tier-one suppliers that were in the business to supply 'systems'. In other words, the manufacturers dispensed with the need to talk to loads of individual suppliers, but instead delegated that responsibility to massive companies like Delphi and Visteon to do that for them. As such, the route to market for the now second and third tier suppliers was very different and far more complicated for them.

The word 'systems' was very much in evidence in the Le Mans paddock following the FIA/ACO announcement. With hybrid powertrains becoming compulsory in the category that will replace what is now called LMP1, it has wrong-footed a few manufacturers. They might have hybrid technology when it

offering a new suite of products since the early part of the year. For example, if you add the power stages for electric drive, it's necessary to have some kind of brake balance. We have therefore started the development of a new, intelligent brake system based on our ABS, not only for one axle, but to think about two axles, which happily coincides with the new four-wheel drive WEC regulations for 2020.

"Then we thought about power steering because in the future you won't have a hydraulic power system in the car. We also thought about the cooling pump as a different cooling system is required, not just for the motor but for the battery. A different vehicle control unit is also needed because a standard ECU only makes sense with a hybrid car as you don't need the power stages for ignition and an injection unit on an electric car and you need something different for data logging and connectivity. So we sorted out a lot of different products and started the development.



"So not only can we offer an entire system, we can also help teams and constructors when it comes to the layout in a car. It may not just be the powertrain but the entire car. We can also provide lap simulations and offer our advice on the optimum layout for thermal efficiency. It also takes advantage of our knowledge of the strategy functionality inside the control unit.

"In the more immediate future, for those customers going into Formula E or e-Rallycross, we are also in a position to offer new products for these types of category whereas just one year ago we weren't in a position to offer any products for electric rallycross or the forthcoming



Toyota Gazoo Racing

BELOW & INSET Well before Toyota's brace of TS050s had finally ended the manufacturer's 24-hour jinx, paddock attention had switched to the challenge of the 2020 rules – embodied in the presence of Toyota's GT Super Sport (inset)

hybrid Le Mans category. Naturally we are keeping the old technology as the Formula 1 powertrain direct injection is necessary for us. We will also keep all the systems for the internal combustion engine, although we have parked those for a diesel system as we don't know if it will be necessary for the future."

FULL SYSTEMS SUPPLIER

The same line of thought was also offered by Sven Behrens, motorsport director at ZF Race Engineering. "We are now a full systems supplier for our customers, but it's one that has extended beyond just motorsport."

While parent company ZF is well known for its transmissions, it is a massive tier-one company in the automotive market, providing a wide range of products, and it is some of these that ZF Race Engineering is offering in its portfolio. This was further extended when the group acquired the TRW group, a primary developer and producer of active and passive safety systems, in May 2015.

The catalyst for this change has been Formula E, ZF being extensively involved in this championship with the Venturi team. "If you look at Formula E, the centre of gravity for the project is more on the efficiency and weight that both stand out for the

production engineers, because efficiency means mileage. It has been interesting to see a lot of production engineers from ZF joining the Formula E programme as part of their career progression so that they learn how to think on their feet, be agile and flexible. It therefore isn't just a pure technology transfer, but the whole package. If you understand the whole system rather than just a part, it's much better."

Another significant factor for ZF Race Engineering, and one of which Behrens is extremely proud, is that not only did his company win a contract from Porsche to supply dampers to its GT race programme, but also to become a supplier on the ►

production side as well.

"We have been working on Porsche's motorsport programme for years. This year it even went a stage further as we won the series production contract to supply the 992 GT3/GT3RS with our CDC dampers and our new lift system," he reported. "It is a big step for us and part of our plan of taking all our motorsport experience and making it available for series production models. Truly a success 'from the track to the road'.

"For us it's a perfect mixture between motorsport and series production, starting at one piece for the special series production items to anything from 200 to 5000 units. With the consistency and safety of the process guaranteed by the ZF series production standards and the agile motorsport-based engineering team, we are able to answer the demand of the niche vehicle and super sports car industry."

"When a motorsport customer talks to us about one of our products, we now ask about their street cars and whether it would be a good idea to combine the two. This

ABOVE Bosch Motorsport is looking ahead, offering solutions for Formula E (like this electric coolant pump) and e-Rallycross

is in line with our policy of now offering motorsport, special series and engineering services. For example, a discussion might start on motorsport clutches with a customer but end up with power steering for some special cars. In my career, it's not something I have seen before."

Behrens confirmed that ZF Race Engineering is also going ahead with its automatic transmission products in motorsport. "I know that for some racers, that's an issue but we are close to a new project that – after the very successful BMW automatic transmission project – is on the horizon. That's a signal for the market to understand that it's possible. It's always

a compromise revolving around cost, reliability, power and weight that requires a solution, so it needs a clear definition at the start on the objectives."

CHANGING DEMANDS

Another German company making inroads at Le Mans was Bilstein which is hard at work developing versions of a 379 modular damper system and while it wasn't ready for Le Mans, it will be very suitable for the new-look Le Mans coming in 2020. "We are already talking with our customers and potential customers about this," said Martin Flick, Bilstein's motorsport manager, "Many ►



ABOVE Even the best laid plans go astray: 24 hours to go and your car is involved in a first corner clash...

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OEMs are doing much more customer sports and the request for robust and solid parts is growing.

"Interestingly, questions about damper weight are not so common now. One customer has already told us that it doesn't care about the weight as it has to be robust, and that's a change. Five years ago, friction and weight were the main topics but it's now much more about being user-friendly and driveability."

HYPERCAR LURE

Performance parts and 2020 were also the focus of Pankl at Le Mans, as commented upon by both Oliver Wolkner, managing director, sales & technology, Engine Systems, Pankl Systems Austria and Hans-Jurgen Januschkowetz, managing director, sales & technology, Drivetrain Systems, Pankl Systems Austria.

"On the engine components side we've already made the transition from being a pure racing company into one that does racing as well as high-performance road cars. So at the moment on the connecting rods side we are producing around 600,000 a year for road car projects, along



ABOVE Racetech seats developed an integrated solution for Porsche

with 200,000 pistons a year for road car projects," said Wolkner. "The new 2020 regulations continue along the same path as far as we are concerned. The proposed hybrid hypercars are exactly the projects we want to be involved in with our expertise.

"That development to a certain extent will be standardised, which will be positive for the race class, as it should not end in a 'development war' which would be the death of endurance racing. From our perspective there will be new development anyway, whether there's a cost cap or not."

"This development will be for sure

extended to the drivetrain side including the hybrid systems as well, which definitely opens business opportunities for Pankl," said Januschkowetz. "With our competence in designing, validating and testing drivetrain and suspension systems we take this change positively, but obviously we still need to wait till the regulations are finalised."

INTEGRATED APPROACH

While not quite such a comprehensive systems supplier as Bosch Motorsport or ZF Race Engineering, it's possible to buy more ▶

Special celebration

FIFTY-ONE wins out of 52 is a pretty good score by any standards, but that feat has been achieved by Dunlop with the number of its LMP2 triumphs. That tally also includes the win at Le Mans this year, whether it is the G-Drive Racing team – which was excluded after winning the category, but is appealing at the time of writing – or the Signatech Alpine ORECA, which inherited the victory. Whichever team prevails, it makes for Dunlop's eighth consecutive Le Mans victory in the year it is celebrating its 130th anniversary as a tyre marker.

"The reason we like this class and focus there specifically is to do with the level of competition," says Ben Crawley, motorsport director at Goodyear Dunlop Tyres. "It allows tyres to make a difference, while the duel with Michelin continually pushes us on to develop new technology that ultimately allows us to hopefully win."

While Le Mans is generally regarded

as a 24-hour race, for those that are a part of it, it's almost a two-week journey from the start of the test weekend through to the end of the race on the Sunday. "We have around 50 members and colleagues helping us here at Le Mans, with just under half that number being fitters, plus the track service engineers, one dedicated to each one of the 15 teams using our tyres, and the rest of the group being made up of various managers," said Crawley, who was enjoying his first Le Mans experience.

Over this period more than 1200 tyres are fitted. "Because we don't know what the weather is going to be like, we don't necessarily know the race strategy beforehand as it's evolving all the time," he explained. "So we have around 3000 tyres on site across the dry, intermediate, wet specifications that we have. It's clearly a complex operation that needs to cater for all the possible eventualities." **RT**



TOP LMP2 rivals Signatech Alpine Matmut and G-Drive Racing head under the Dunlop Bridge

ABOVE Dunlop made a huge effort this year, replacing all its 2017 specifications in the face of fierce competition

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than just off-the-shelf seats from Racetech Seats, as managing director David Black explained. "While other teams including Aston Martin use our standard seats in GT racing, it's much more comprehensive with Porsche," he noted. "They wanted something quite specific, so we developed the seats for them, working with them to develop brackets to make them fit the car properly and which can be integrated in the way that they need to."

"We are also working with another car manufacturer in the UK at the moment that has got us involved very early in the process. That works well because we can help them design the bracketry to go on the car."

FULL CIRCLE

One company that always thrives at Le Mans is Xtrac. Accounting for 70% of the grid, including the entire LMP1 field as well as all the ORECA and Dallaras in LMP2, it would be hard to fail.

"It was a race where I'm pleased to say

that we had no real issues at all with any of the cars using our gearbox, so it was a very good race for us," said Adrian Moore, Xtrac's managing director.

It was a risk, though, because the new privateer LMP1 teams were all using Xtrac's 6- or 7-speed P1159 transverse gearbox that was originally designed for the 2014 LMP1 regulations. It was itself based on the successful series of P529 and P1059 gearboxes that can trace its origins back to the Le Mans-winning BMW of 1999 and Bentley of 2003. In 2015 a 6-speed version was launched for LMP2, retaining many of the LMP1 features packaged to suit the needs of LMP2 and DPi, so in effect it has almost gone full circle.

"The installation is pretty common," said Moore, "but there's more freedom in LMP1 on differentials and gearchange systems because of the regulations and so from that perspective it's a little bit different. They also all have to run a torque sensing input shaft. We work with MagCanica, the US supplier, to ensure it really is an optimised

installation that gives the data needed by regulations, but it's also a performance aid for the teams as well. It's a single line in the regulations but more than the work of five minutes to implement."

Xtrac transmissions could also be found in many GTE cars, including the new Aston Martin Vantage. "It's a different gearbox in the new car," says Moore, "that's bespoke for Aston's installation, which being a front-engined car is a bit different to others."

Moore is very bullish about the future and the 2020 WEC regulations. "We're heavily involved in electric racing and also high-performance electric road vehicles so the regulations requiring cars have a 200 kW front electric system is exactly where we are at," he said. "We have a conceptual offering that meets the regulations, taking into account the individual packaging requirements along with those of the motors and their input speeds as well."

Xtrac's immediate competitor at Le Mans is Ricardo. It also welcomes the new regulations as it sees the same crossover ►

BELOW The new privateer LMP1 teams were all using Xtrac's P1159 transverse gearbox



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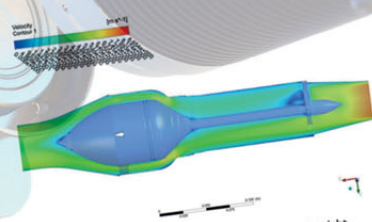


Abbildung: Strömungsgeschwindigkeit Detailsansicht



ABOVE Fernando Alonso's completion of the second leg of his 'triple crown' captured the headlines. Behind the scenes, many suppliers were congratulating themselves on a job well done

from high-end road car to motorsport and vice versa.

"There's a lot of development, some of which is applicable to motorsport, while the market is changing significantly with the introduction of electric vehicles or electric-supported vehicles in which we are heavily involved," said James Sundler, head of sales, Performance Products, the motorsport arm of Ricardo. "However, it's a very different set of requirements to those required at Le Mans, but no less relevant. For example, one is the speed of prototyping as the automotive market tends to move far more slowly than the motorsport one for valid reasons. However, that's not to say that the automotive market can't at times benefit from very quickly available prototype units for validation, tests and design iterations."

BALANCING ACT

ExxonMobil had a busy Le Mans working with three factory teams – Toyota Motorsport, Porsche and Corvette – fulfilling relationships that have been in place for a good many years. However, as it did not have the fuel rights to the race, ExxonMobil's role was that of lubricants supplier in all cases. "Our concentration is on the engine oils, transmissions gear lubes and greases,"

said David Tsurusaki, ExxonMobil's global motorsports technology manager.


"My group, which is research, is all about innovation and product technologies and finding new processes, chemicals and whatever it is that makes our products better. Motorsport is also an area where you give some young engineers an opportunity to get involved in an exciting part of the business. They can develop and test products, bring them to racing, watch and be part of it which doesn't really happen with consumer products.

"Rather than working to a defined standard, in motorsport they are working with one team and they design and develop for that team, test with it, not worrying about industry standards. And if they like it and it works, or if there are some small tweaks needed to improve it, it's done with that team and then you go racing. There's no time for delay and it teaches young engineers new skills and allows them to think differently and react differently."

The relationship with Toyota Motorsport in Germany is one that sees ExxonMobil also supply lubricants to its rally team. "Uniquely we are working with Toyota's World Rally Championship (WRC) team in Cologne, so we are going back and forth on some of that," he said. "As it's a similar technology

to the lubricants used by the LMP1 team, there's a good crossover between the two.

"Right now, a lot of technology has been moving towards continuing the work with WRC as the WEC has not dramatically changed as it's a mature programme although we are still working on new developments for future engines and any likely future WEC race entry. The focus in the current WEC has been on durability and maintaining performance rather than finding a way to increase it. In endurance racing it's as important that the engine is at optimum performance in hour 24 as it is in hour 1. You don't want to sacrifice wear for some short-term performance as you've got to finish the race. Durability has always been critical.

"While we still work on optimal performance improvements, we have to weigh up that any performance gains might well be negated with a revised Balance of Performance adjustment, which doesn't make sense. Where it does, though, is if that performance benefit leads to something else that can be done on the car, such as a beefier component where the limits are being reached. It means that there's still a reason to work on it but it's not necessarily for the obvious reasons. When you have a Balance of Performance series, you have to look at it a little bit differently." 

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INDEPENDENTS' DAY – AND NIGHT!

LAT



ABOVE & BELOW Gibson's GL458, a 4.5-litre V8, powered Rebellion to third and fourth overall

William Kimberley catches up with the LMP1 engine makers

LAST year Gibson Technology had a fabulous Le Mans, and while it might be said that of course it would have been the sole supplier to the LMP2 class, not one of its engines failed in the race. Between them they clocked up enough mileage to circumnavigate the globe three and a half times while also coming within a hair's breadth of winning the race outright.

This year, though, it was a different matter. Every LMP2 team had a Gibson Technology engine, but the company was also supplying the Rebellion Racing team which had moved back into LMP1 along with DragonSpeed.

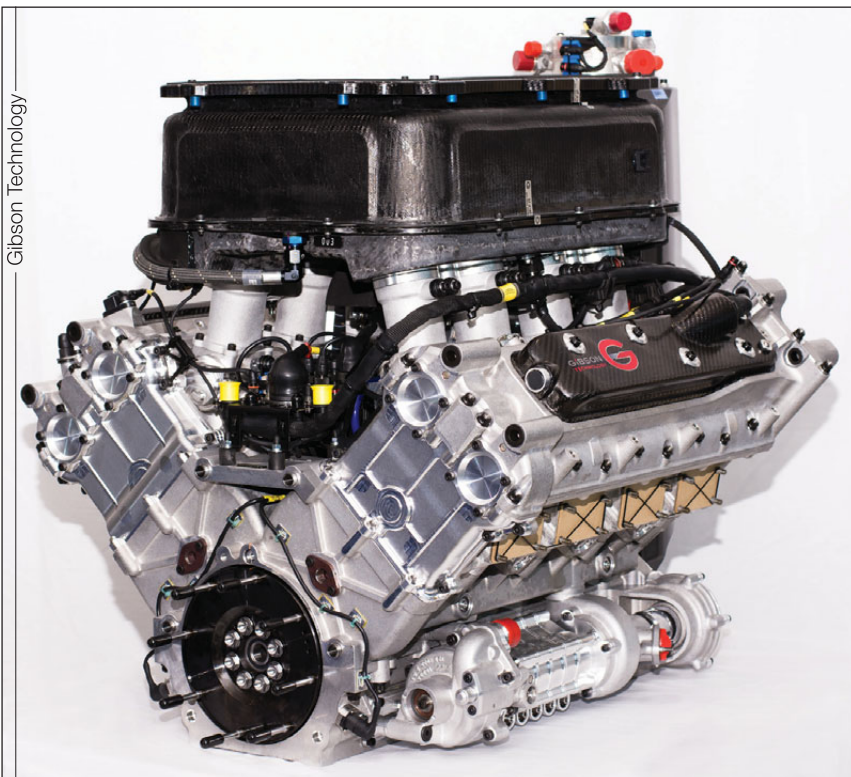
"The LMP1 engine programme came very late and the short timeframe was one of the biggest challenges. To get everything completed in terms of durability and performance was difficult," said John Manchester, Gibson Technology's operations director. "We were speaking to ORECA at the time, but that wasn't quite finalised so we did the initial deal with DragonSpeed. However, there were a few installation issues because its car, the Dallara-built BR1 Engineering chassis, had been designed for another type of engine, so of course we couldn't fit our engine directly in without a large amount of engineering work for them. The deal with ORECA wasn't

finalised until December/January."

Manchester said that some preliminary work had been carried out on an engine, looking at fuel flow analysis to obtain an understanding of how it would behave and whether it would meet those limits. "There were a lot of things we had to introduce, such as mechanical changes, new software and new code changes to be able to achieve that," he explained. "So there was a big learning curve for us in terms

of calibration, but it went extremely well, and we started to make some huge strides."

In the first development phase it was a 4.5-litre, which used the same block as the P2 engine but with a different bore size and different stroke, and it was the same with the heads. "So about 40 per cent of the parts within the engine are a new design, but a lot are obviously the same," said Manchester. "Phase two was performance evaluation and



Gibson Technology

validation of some of the production parts. We then finalised the design and commenced with the manufacturing, after which we went to phase three, which was undertaking durability and validation work on all of those parts. Phase four was mainly calibration in the car.

"As Total fuel is used across the board in WEC, we had a delivery of the fuel sent to our engineering facility in Repton. We performed final calibration runs on that and ensured that all of the performance targets were met."

While the DragonSpeed entry was involved in a crash that put it out of the running, the two Rebellion cars came home third and fourth behind the winning Toyotas.

AER'S P1 RETURN

AER returned to Le Mans this year when the SMP Racing team turned to the British company to power its Dallara-built BR1 Engineering chassis.

A successor to AER's P60 twin-turbo V6 LMP1-L engine, which powered Rebellion Racing to the Endurance Trophy for privateer LMP1 teams in the 2015 and 2016 seasons, the P60B incorporated improvements that made it a step up from the P60 in terms of both performance and reliability.

"Our LMP1 engine has been in a state of constant development since its inception in 2013," said AER technical director Mark Ellis. "However, the specific, integrated package of upgrades we've been working on since March

last year represents a sufficient step forward that warrants the change in nomenclature.

"It was really a two-pronged approach. Wanting to develop further the performance, we undertook a component optimisation where we built a development engine that was run with the two banks of the vee independently. We evaluated different combustion chamber geometry, compression ratios, ports and the turbo exhaust and were able to do that quite efficiently through dyno testing and simulation."

The other element of the approach to the P60B was to address any outstanding reliability issues. "Quite a bit had been developed and worked on already through the P60 running with existing teams and customers but we had the opportunity last year to evaluate all the aspects thoroughly of the engine and put forward some development of components to address any known reliability issues," reported Ellis. "Those two elements form what we now call the P60B engine."

The P60's engine architecture and calibration was originally designed for the fuel flow formula. "What we have done is to be able to conduct more transient endurance testing and further develop the strategy to improve driveability and torque response," said Ellis.

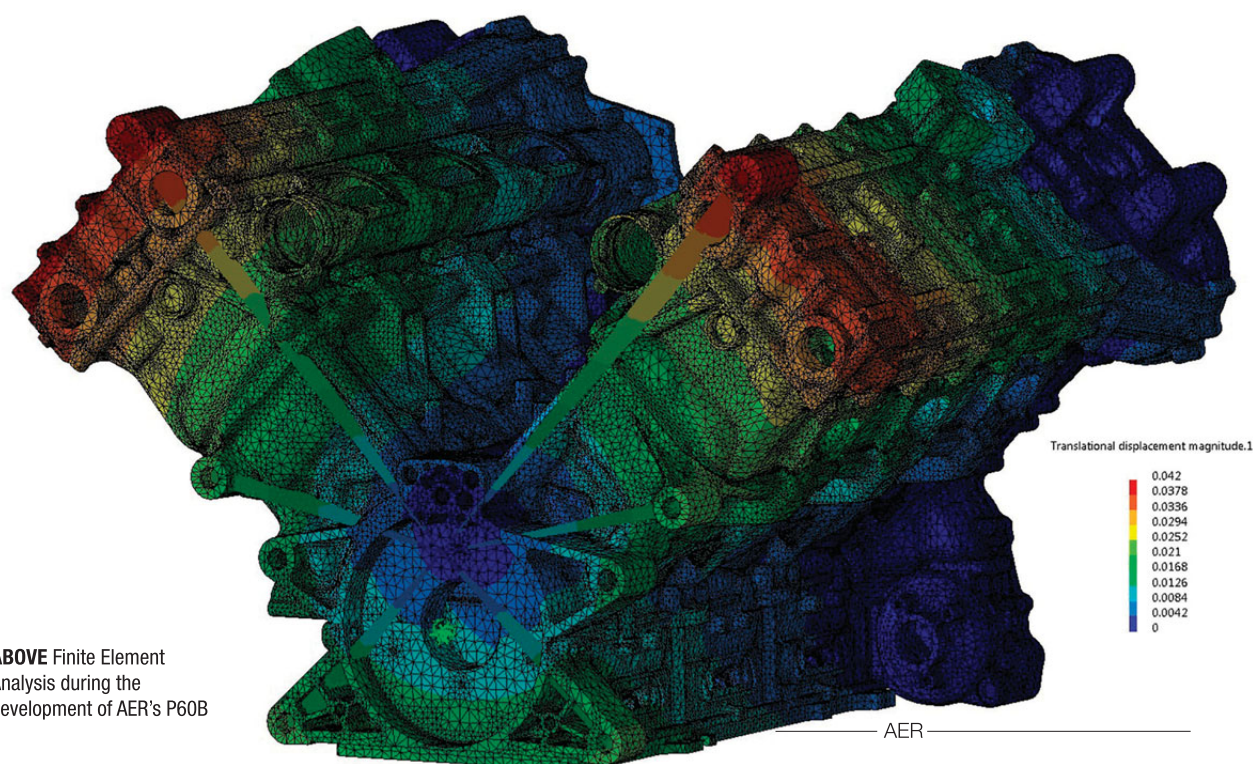
"At the same time that we were developing the P60B, we were closely engaged with Dallara through installation meetings, both face to face and in weekly conference calls, exchanging CAD and optimising

the installation. The engine manufacturer needs to supply information to the chassis manufacturer over and above just physical CAD, taking into account heat rejection and performance data. So we therefore worked very closely with Dallara to optimise the installation in that chassis.

"Obviously we have operating parameters, and limits for the engine. Early on, while the rules were still being developed, AER attended the Technical Working Group meetings with the FIA, so we had a good idea where the fuel flow rate was likely to end up, and all our development was centred around similar numbers to those we see here at Le Mans."

The development work involved three or four months of intense activity on the dyno and in simulation. "We also, in parallel, started to build the first team engines," he said. "They were shipped to Dallara at the beginning of October, but the mock-up engine was sent before that to help with their chassis installation. In excess of a Le Mans distance was completed throughout winter testing.

"There's still a time difference to Toyota, but that's somewhat inbuilt into the regulations. The current pace of the Rebellion Gibson is good and it's clearly a well developed package, but we are pretty pleased with the performance of the P60B, and the Dallara ART GP car, and think there's significant scope for improvement in the near term. So we are pretty optimistic for the pace of the car and for future results." **RT**



ABOVE Finite Element Analysis during the development of AER's P60B

AER



CHRIS BEATTY
design-direction-animation



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AND THE AWARD GOES TO... *WHO?*

William Kimberley talks to Louis Schwitzer Award winner Chris Beatty about his role in developing the 2018 IndyCar universal aero kit

It was Chris Beatty's passion for motorsport that by a fortuitous route led him into the inner design group that was responsible for the new IndyCar universal aero kit and who were duly celebrated for their work by winning the prestigious Louis Schwitzer award at Indianapolis in the run up to the 500. However, had it not been for a concept drawing on his website and a subsequent write-up on another website, it could well not have happened.

Although he works in multimedia and 3D animation, Beatty by trade and discipline is a product designer, albeit not in motorsport despite being a passionate fan. He was at Brands Hatch when Henry Surtees lost his life and in a cruel twist of fate, at Pocono when Justin Wilson died in an accident. These two incidents got his mind working and led him

to bring his design talents to devise a better cockpit protection solution.

"I created a concept car about two-and-a-half years ago called the Velocity at about the same time that the FIA was just talking about the Halo," says Beatty. "However, I was opposed to its design concept as it just didn't look right on a racing car and so came up with what I thought was a potentially more thought-through solution to cockpit protection."

Calling it Velocity, he uploaded it onto social media where it immediately attracted the eye of a number of people. One such was IndyCar driver Alex Lloyd, who wrote an article on Yahoo.com in January 2016 stating that in his view IndyCar was broken. In offering an explanation of how to save it, he leant on Beatty's design concept.

"Following that I contacted Justin Wilson's brother, Stefan, via Twitter to get his take on the concept I'd developed," explains Beatty. "He told me he liked the idea of a canopy rather than the Halo and that the following day he had a meeting with Jeff Horton, IndyCar's director of engineering and safety, and that he would show him my ideas. This led to Jeff commissioning me to work with him and Dr Terry Trammell on the initial concept and shape studies for the IndyCar windscreen."

SCREEN TEST

A number of factors had to be considered such as how far the screen could be laid back in terms of the shallowest angle that could be got away with before it



scuppered the driver's view too much, finding out what was acceptable to the first responders in the case of an accident, the height of the headrest and so on. Then there were things like looking at different profile shapes such as whether it should have a flat front or be fully curved.

"We probably did around 15 different concepts before Jeff could go to PPG with a viable design," he recalls. "It was really just getting their feedback, so from then on my involvement came to a halt because it moved on to more of an engineering process between PPG and Dallara as to how it was going to be mounted. However, the screen we see today is not too far from where some of those concepts were."

According to Beatty, the aeroscreen wasn't originally going to have side pieces on it and was going to be a straight cut-off due to the requests from the first responders and medics. "That's also what PPG wanted to manufacture, a piece that just cut straight off at the back. However, after some tests in the simulator, it was found that the visual distortion in the peripheral vision was causing issues, so they then decided to wrap it around a little bit further. It's now been tested on track with the feedback from the

drivers being generally pretty positive."

By this time, Beatty's involvement in the project was coming to an end but it had given him a real taste for becoming more involved in the overall car design, leading him to approach Tino Belli, IndyCar's director of aero development.

"The windscreen project was great but the chance to get on to designing the actual car was actually what my goal was from the outset, so I wrote to Tino," he says. "I received back a very pleasant reply, but it ►

“I thought, ‘I’ve had a good shot at it,’ and left it at that. A month later, an email arrived”

ABOVE & BELOW Beatty's 'Velocity' concept car, developed prior to Red Bull's Aeroscreen, was a hit on social media and the catalyst for a remarkable story



BELOW Beatty unexpectedly rose to prominence as one of the team involved in the conception of IndyCar's universal aero kit for 2018

Abbott/LAT



was very much a 'this is an aero engineering project and we're not sure where we are going with it yet, but we'll be in contact if anything comes up'. So I thought to myself, 'Okay, I've had a good shot at it, I've done all I can,' and kind of left it at that."

A month or so later, an email arrived in Beatty's inbox showing the initial concepts that Dallara had done for IndyCar. "At that point IndyCar hadn't published who they were going to go with, so it was really just what did I think of it from an aesthetic point of view? As a fan, although it was an improvement over the car at that time, I was left a bit underwhelmed. I thought they had an opportunity and they weren't making the most of it. So I took the renders, because at that stage they were just 3D renders of the car as this was prior to any of the sketches being released, and went to work on them over the course of a weekend and just made a load of suggestions.

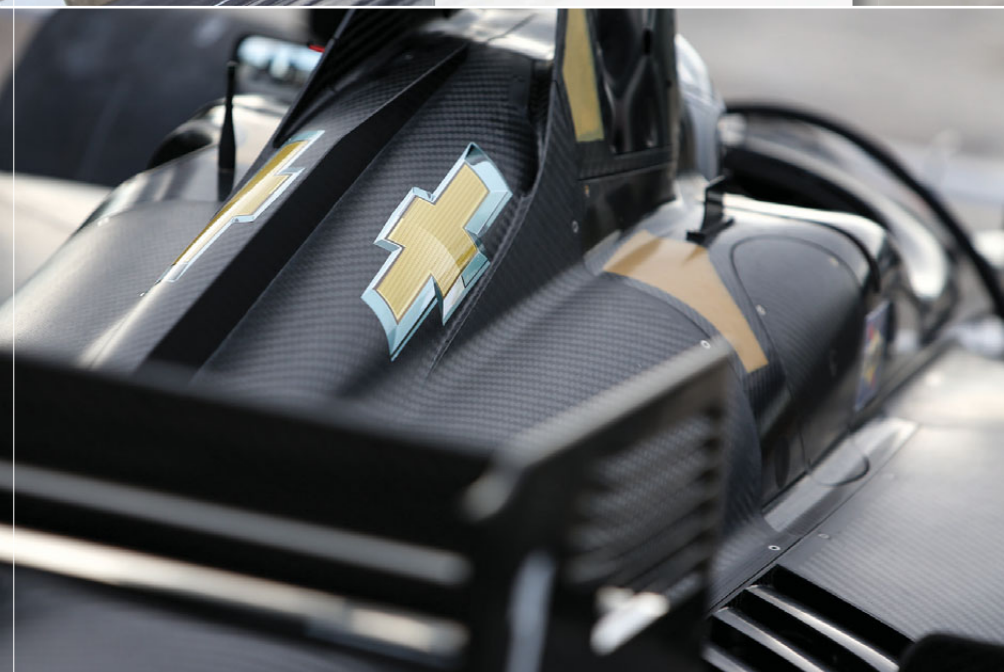
"It was really a case of taking a fairly standard-looking concept racing car and making it look quick. There was no real aggression in there and it just didn't hang together properly. At this stage, the engine cover and the rear pods had already been removed and lowered. My first input was getting the roll hoop leaning forwards and wings swept back. The sidepods were halfway there, but the front was just a straight cut-off. I also wanted to bring the leading edge as far forward as we could to increase driver protection. This in turn led IndyCar and Dallara to develop the new crash structures.

"Then there were things like the wings on the Superspeedway car with the front wing ►



Photos: IndyCar

ABOVE & BELOW Initial testing of the kit. The intention was for it to look fast, even standing still



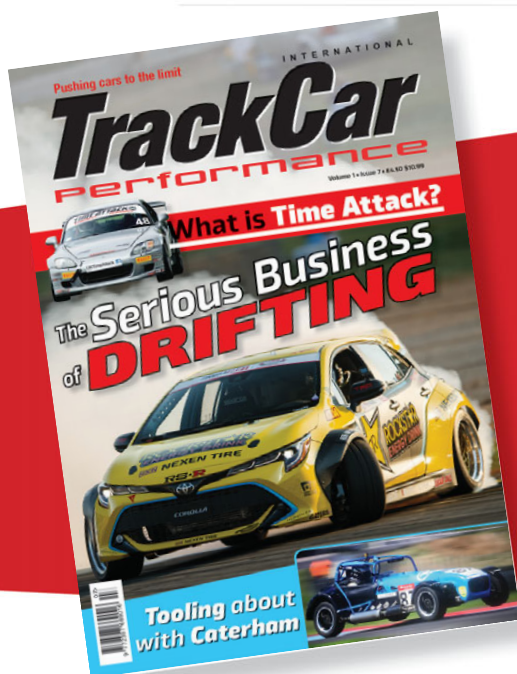
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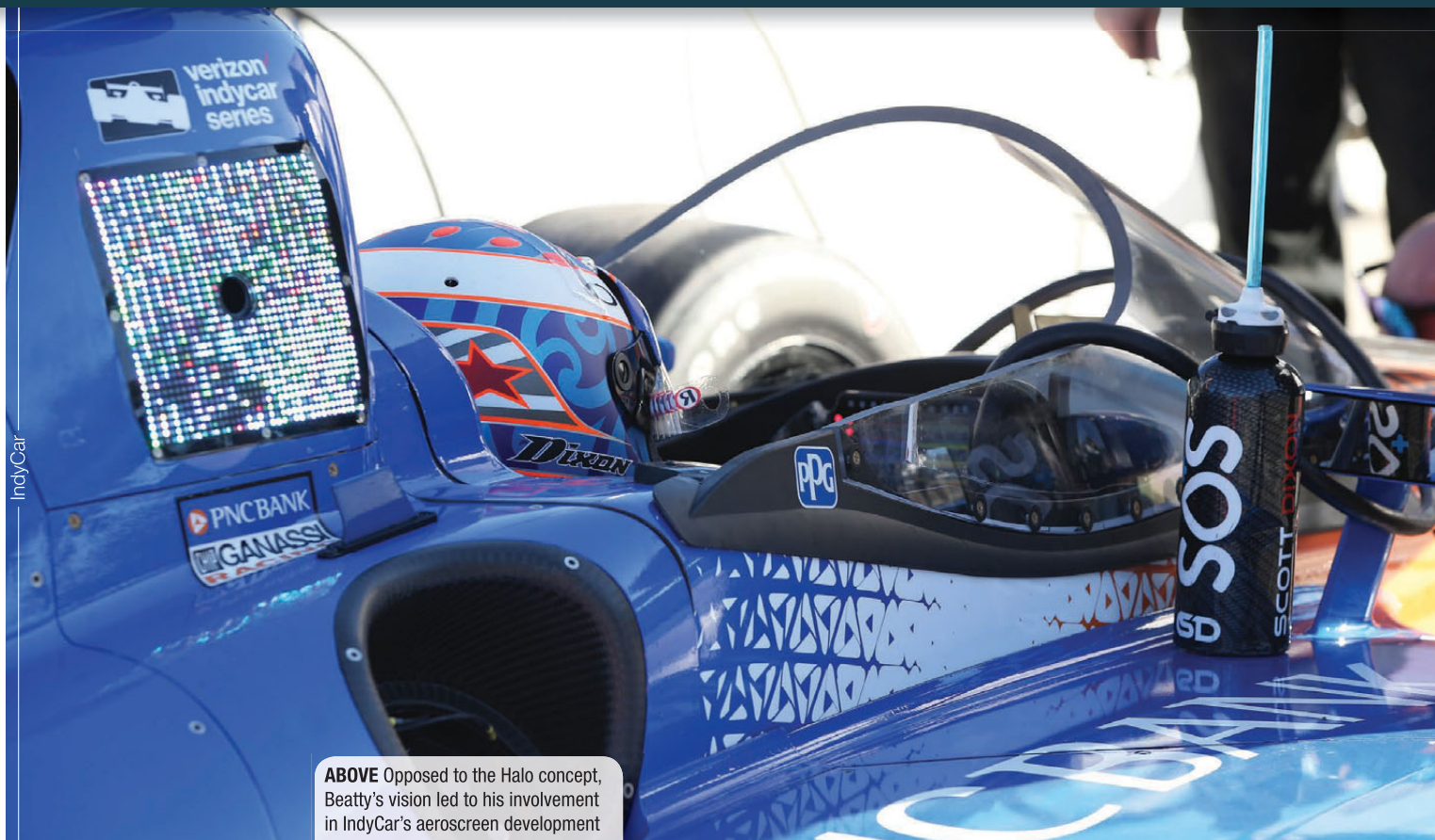
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ABOVE Opposed to the Halo concept, Beatty's vision led to his involvement in IndyCar's aeroscreen development

sweeping back, really just restyling the car. Obviously there were also time and budget constraints, so there are things we would have liked to have done but couldn't, or they wouldn't have worked aerodynamically, or that sort of thing. At the end of the day the car will be doing 230 mph, so it's got to be safe and it's got to work, so the aesthetics work in partnership with the engineering and aero instead of being the overriding factor. I was just trying to get it to the point where the car looked like it was doing 230 mph, even when it was up on the jacks. That was really what my main role was on the project.

"My involvement in the car has now been signed-off. I think with the Superspeedway kit they are looking at modifying the front wing, and I believe there are some add-ons that are coming as a result of driver feedback from the Indy 500 and other recent races to further improve the car's handling and overall raceability, specifically when running in a larger group. My hope is that the car will bring the fans close, exciting and intelligent racing without the lottery of all-out pack racing and the inherent dangers of open-wheel cars running in very close formation.

"IndyCar and Dallara will never stand still, the car will continue to be developed and fine-tuned over its lifetime until the racing product is optimised." **RT**

The Louis Schwitzer Award

PRESENTED by engineers to engineers, the Louis Schwitzer Award recognises individuals for innovation and engineering excellence in racing technology associated with the annual Indianapolis 500 and honours those with the courage and motivation to identify new concepts in racing technology. Judges look for advancements that increase performance, safety or energy efficiency and emphasise the competitive potential in racing with additional applications in off-track vehicles.

Recent past innovations to win the Louis Schwitzer Award include the PFC carbon disc brake system from PFC Brakes in 2017 and the rear beam wing flap from Dallara in 2016.

This year the award was given to Tino Belli from IndyCar, Andrea Toso and Antonio Montanari from Dallara, and Chris Beatty from Chris Beatty Design Limited for the IndyCar Universal Aero Kit. **RT**



ABOVE IndyCar's Tino Belli and Dallara's Andrea Toso are introduced at the Louis Schwitzer award ceremony at Indianapolis. One of their winning colleagues came as a surprise to some, though!



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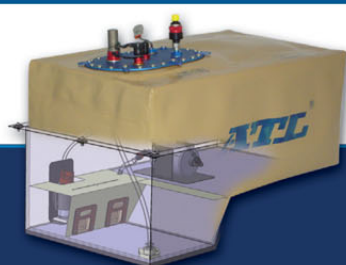
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KOREA GUIDANCE

Hal Ridge talks to the team principal who has steered Hyundai to the brink of World Rally Championship glory

HYUNDAI might stand tantalisingly close to capturing an elusive first WRC crown, but its assault on the summit of world rallying has taught it to take nothing for granted.

Its first foray into rallying's highest level left it licking its wounds. The Accent WRC, built and operated by British outfit Motor Sports Development (MSD), won stages and led rallies on occasion,

but in a four-year campaign that ended prematurely in the 2003 season due to budgetary issues, the best the car could achieve was a brace of fourth place finishes.

Hyundai vowed to return, but the marque wouldn't officially be seen on the WRC's stages again for over a decade. The return in 2014 heralded a new era, now running the operation in-house as Hyundai Motorsport from Alzenau in Germany. The team scored an incredible one-two finish on Rallye Deutschland in its first assault with the i20 WRC and won further rallies with a

revised four-door version of the car in 2016.

The latest era of regulations, introduced for the 2017 season, forced a fundamental redesign for the manufacturers in the series, giving Hyundai the opportunity to grow from rally winner to genuine title challenger.

The i20 Coupe WRC was arguably the fastest of the new breed when it left the starting blocks and scored four wins last season, but ultimately driver error and reliability issues denied Hyundai the title it yearned. Although by its own admission the Korean-German firm has perhaps lost its pace-setting edge this year, the first seven rounds of the season have yielded three victories and eight podiums, the points amassed putting Hyundai to the top of the drivers and manufacturers standings.

RALLY AERO GETS SERIOUS

Team Principal Michel Nandan says that while the regulations instigated for 2017, that brought an increase in safety and performance, carried continuity in some areas, a more open approach to aerodynamics and chassis design has been key to helping Hyundai reach the front.

"As far as the engine was concerned, on the



hardware side it's the same [regulations], the increase of performance [by 80 horsepower to 380] is due mainly to the restrictor size [increased from 33 mm to 36 mm]. The turbo type was changed because we wanted to increase the power and of course the engine has been redesigned in order to supply the performance requested, but there was no big change in regulation," explains Nandan. "The biggest change was concerning the chassis. First with the [active centre] differential, which was something that had been used in the past anyway, but I would say the biggest change was concerning the bodywork and aerodynamics. That was a difference in the approach, because aerodynamics [previously] were limited and more focused on the cooling. For the first time an aerodynamic

"The sport has changed. Today you have more power, less investment"

study could be done, even if on this type of car it's not so big because the speed you reach is not so high, but it was possible to do something and you can see from the outside the car is a bit more fancy for the fans, and for aerodynamic balance. There is also more freedom in suspension pick-up points, which allows you to really do more adapted suspension, especially for gravel because before the base car was still a big influence on the position of the dampers, front top mounts or the front wishbone pickup points, things like that."

While Hyundai's second tenure at the WRC's top level has been led by its own motorsport division, when it returned to the stages for 2014 the engine was produced by French firm Pipo. But, for the latest incarnation of the i20, the engine too has been developed in-house.

"Since the start of the 2017 car, the engine has been done totally in-house, from engineering to testing and dyno," says Nandan. "We have two dynos here and a dedicated team for it."

As with the majority of this car, the ►



ABOVE Hyundai's i20 Coupe WRC has emerged as arguably the best of the spectacular new generation of WRC machines

design, development and construction is done internally, but parts production is outsourced. "We are not equipped to do production, so nearly all of the parts are outsourced to suppliers: engine blocks, cylinder heads, connecting rods, everything," he says. "After that everything is assembled and kept in-house. Some prototype parts can be done because we have some CNC machines and things like that, but it's really just to do prototypes."

The four-cylinder 1600 cc DI turbo engine has an 83.0 mm bore and 73.9 mm stroke, producing 380 horsepower at 6,500 rpm [maximum permitted is 8,500 rpm, with 2.5 bar of boost]. Its peak torque of 450 Nm is achieved at 5,500 rpm, controlled by a Magneti Marelli SRG ECU.

Mated to the transversally-mounted engine, via a twin-plate cerametallic clutch, is a hydraulically-operated paddle shift six-speed sequential gearbox. While fully active WRC cars were banned in 2005, paddle shift transmissions were also outlawed between 2011 and 2014, but in

the current regulations have returned. A hydraulically-operated centre diff is also allowed, controlled using data gathered from front and rear slip, speed, throttle and brake position with additional map variants available to the driver to adjust the lock between the front and rear axles. Passive (mechanical) diffs continue to be used front and rear.

VERTICAL DAMPERS

Since 2016, the i20's MacPherson dampers have been supplied by Italian firm Xtreme Racing Shox, attached to the chassis at the lowermost point by a lower A-arm. Unlike M-Sport's Fiesta, the front dampers on the Hyundai are relatively vertical, but in a bid to increase strength and torsional stiffness in the chassis, suspension points can be attached to the car's roll cage.

At each corner, the suspension is joined by four-pot air-cooled Brembo callipers and vented discs. A 370 mm diameter front disc is mandated on asphalt, with 320 mm used

on the i20 on gravel. Brembo advises that lighter discs are run on rallies that require less heavy braking, with softer compound ceramic pads.

Arguably the i20's biggest Achilles heel in 2017 was its susceptibility to suspension damage, notably in Germany and Spain where broken suspension forced lead driver Thierry Neuville out of the running. "Our weakness last year was really with some reliability issues. The car was really fast, that was shown from the beginning of the season, so we concentrated much more to improve the car on the durability side," says Nandan. "This year it's a little bit different because we can see that some competitors have improved a lot.

"We don't have the fastest car anymore," he suggests. "Well, according to me. We're a bit away from that. But we have improved the durability and so far we've had no really big issues. Now we need to work more on the performance side, especially on Tarmac, because some of our competitors have improved a lot. Even if we have improved, it's ►

BELOW Running a three-car factory team is a huge logistical challenge, but the FIA's regulations have been devised to avoid an arms race between manufacturers






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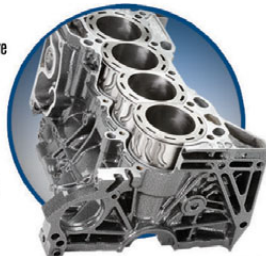
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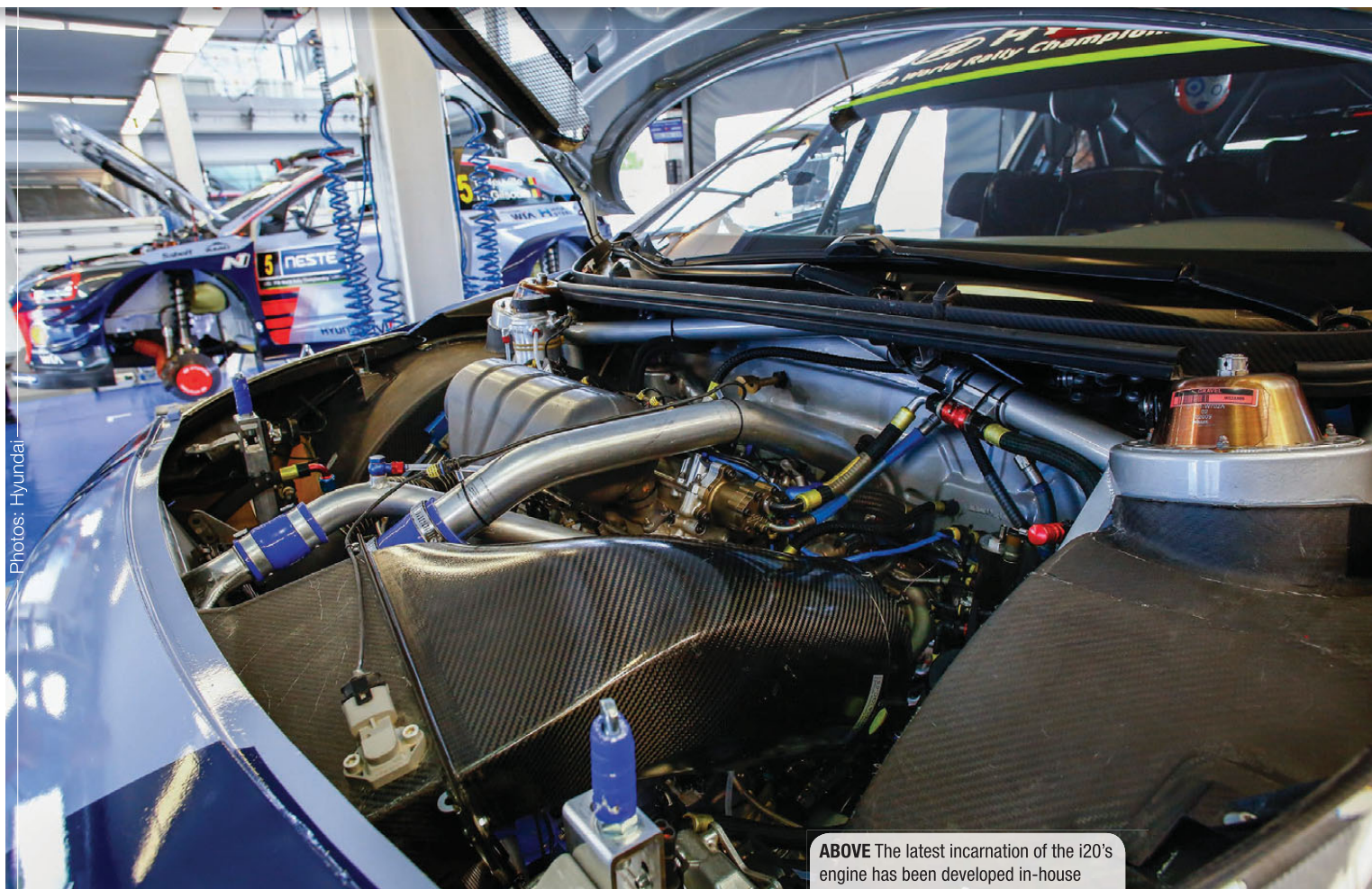


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Photos: Hyundai

ABOVE The latest incarnation of the i20's engine has been developed in-house

not enough, and on the other surfaces, it's really depending on which rally it is. We need to perform more on the loose conditions, but there are evolutions coming."

For the most part, in the strictly controlled world of FIA homologation, evolutions and updates can only be introduced by using a homologation 'joker'. In the first year of the new regulations, manufacturers were permitted five chassis jokers (including bodywork, suspension and transmission) and three for engine homologation. Hyundai used

them all at various stages of the campaign, including the introduction of a new exhaust manifold, but for 2018 only three chassis and three engine jokers are allowed.

"So far we have used one joker for the engine because we changed the complete timing drive for the camshaft. On the chassis we haven't done anything but one chassis joker will come in July and for sure some more later," says Nandan, understandably coy about specifically what changes his squad will make to its chassis in the

immediate future.

The juggling act for all WRC manufacturers is when and how to use their jokers, which also have to be implemented in allotted FIA homologation phases. But, if a problem is discovered when all the jokers have been used up, you're stuck with it. That said, some components can be adapted outside of the joker process, and it's that avenue Hyundai went down to overcome its suspension troubles in 2017, as Nandan explains.

"Some components are regulated by jokers, others are regulated by variant options, which means that you can homologate it every three months, where you don't pay for it with a joker," he says. "All the evolutions we did concerning the durability of the front suspension were more on the variant options. That was a big help."

WINDS OF CHANGE

Although Monaco-born Nandan has only worked with Hyundai in the WRC's latest era, he has rich experience of the sport's past, having achieved success with Toyota and Peugeot, and also worked with Suzuki.

The experienced engineer says it's not only the technical regulations that have changed the sport in recent years, but also the way ►



ABOVE Nandan (left) has been instrumental in steering the manufacturer to the top of both the drivers' and constructors' championships

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the cars are conceived from the outset, from an engineering and financial perspective.

"When I was at Peugeot, the regulations had much more freedom, even if the engine was based on a stock block and a stock cylinder head [as opposed to the bespoke units used today]," he opines. "There was much more freedom because you could have all three differentials active, active suspension, ABS, whatever. That meant a lot of development costs. Nowadays, it's easier for a manufacturer to do a car which is quite on the pace, because the current regulations have some freedom but some constraints [too], which gives you more reliability. For example with the engine, you have minimum weight for parts which are aimed at not spending too much money. The cars today are much more competitive with more power and less investment [required] than 15 years ago. This is the biggest change in the WRC and for sure, it's positive."

TECH DEVELOPMENTS

Part of the reason that budgets have been able to be trimmed, aside from in the structure of the regulations, is by the technology available with which to undertake development. Not having to build prototypes or scale models has vastly reduced both lead times and costs.

"It's easier and for sure faster now," he says. "With CFD [computational fluid dynamics] you can do a lot of things on aerodynamics,

but also on the cooling side and engine side. You can do a lot of simulation, which allows us to be more reactive and spend less time testing and in wind tunnel tests, for example, so in the end it's less expensive."

One of the biggest changes aesthetically to the 2017-spec WRC cars was the aerodynamics. The revamp was designed not only to offer improved performance but to increase fan appeal, giving a nod to the revered Group B era of the 1980s.

Current cars feature a width increase of 55 mm, an additional 60 mm of overhang at the front and 30 mm at the rear. A rear diffuser can extrude beyond the rear bumper, the rear wing can be more

elaborate and aerodynamic devices are permitted both in front and behind the front and rear wheels.

Compared to Toyota's garish styling on its Yaris, Hyundai's i20 is slightly less radical in its aesthetics, but is still a big step up from its predecessor.

Ducts at the top of the rear quarters – outwardly a smaller version of a rear cooling duct on a rallycross Supercar – provide cooling for the rear brakes with the intention of having a minimal effect on airflow and drag. Like all of the current WRC machines, the i20 has louvres in the rear bumper, behind the rear wheel to direct the warm air departing the car. Changes to the rear arches ▶



BELOW Susceptibility to suspension damage was the i20's Achilles heel last season but has now been addressed

Hyundai



ABOVE Aerodynamics play a more prominent role on the current cars than at any point in the sport's history

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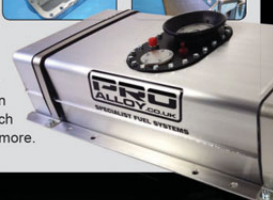


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ABOVE Hyundai has racked up three wins this season. Here Neuville leads the way in Portugal

in late 2017 also included a small winglet at the furthestmost rear, to increase downforce, with air forced over the top of the arches by changes to the front of the panel.

Initially using two diveplanes at each side of the front bumper, the i20 was subsequently changed in late 2017 and continued into this year to use a single diveplane per side. The implementation of CFD means that more than ever before, the undulations of a rally stage can be simulated, rather than using a flat wind tunnel throughout the design phase.

"The main aerodynamics study was done on CFD, and the final step was at the wind tunnel. That's more to really see a real number for the wind tunnel and to maybe fine tune, but most of the development is done in CFD," notes Nandan. Prior to the 2017-spec WRC challengers entering competition, there was significant speculation as to whether the aero devices would be durable enough to survive the harsh environments of the world's stages, especially on gravel.

OVER-ENGINEERED

Nandan says that his team accounted for such concerns and even over-engineered its package. "When we did the car last year, some of the aerodynamic devices were quite strong, I have to say," he reveals. "The front splitter, for example, was done probably a bit too strong. Most of the cars didn't lose too many parts, so the aero was a bit stronger than we were expecting. For this year we took that into consideration to get some weight off some components; so far it's working quite well. OK, you can damage some parts, but not really in a

drastic way. You must take into account that stages are a bit less rough than in the past, even six or seven years ago. Rallies are a bit, let's say, nicer."

As Nandan acknowledges, the nature of rallying has changed since the epic endurance events of 20 years ago. But bigger changes still would appear to lie ahead, with manufacturers' increasing desire to push alternative technologies for the road, seen by the resurgence of high-profile entries into Formula E and the World Rallycross Championship's impending switch to electrically-powered Supercars from 2020. Rallying may well have to move away from the traditional ICE (internal combustion engine) in the not too distant future too.

While creating an electric car to compete in a six-lap rallycross race or a Formula E encounter next to a well-supported paddock is one thing, doing so for the long and often remote tests of rallying is quite another. Nevertheless, World Champions M-Sport, Austrian firm STARD and MPart AB (creators of the Mitsubishi Mirage R5) have all either developed or are developing their own electric rally cars.

"It's true that all the other disciplines are becoming electrified, or hybrid or something. For sure I think the WRC will probably have to go this way too because manufacturers, for their road cars, are more and more involved in electrifying components," accepts Nandan. "It could be e-turbo, even without talking about hybrids. It is something that will come, but it's a bit less easy on a rally car to do things like that, compared to a racing car, because we are on open roads and safety is also to be considered. It depends on which type

of technology is chosen. At the moment, nobody knows because we are just talking about that."

From a personal point of view, Nandan would like for costs to remain controlled as a priority: "Like they are now, the regulations are really well done because you can have a competitive car which is not costing too much and is still a good racing car. When you introduce new technology, like batteries or electric motors or whatever, the change of regulations should be really well done, in a way to keep this cost level.

"It's really quick with new technology to increase the cost, but this is something the FIA is quite aware of and are taking care of. That's why it's not so easy to decide, 'OK,



the new generation of WRC should be that, that and that'. For sure, something should be done because technology is moving, but with the costs contained like they are now, if we want to have the manufacturers competing in this championship."

The Hyundai boss is also content with the format of the sport in its current guise but feels the challenging spirit of the discipline needs to be retained. "Now we are on a quite good level, because you have an

average of a few kilometre stages, up to 40 or 50 km. I really don't think we should have stages more than 50 km because it's more difficult for safety and also not really more interesting for the people," he says. "The layout we have at the moment is not too bad, but you still need to have the spirit of rally. If you want to have really proper sprints, then change disciplines; you do rallycross or something else."

Marcus Gronholm, who won two WRC

driver titles with Nandan at Peugeot, has bought a pair of 2016-spec i20 WRCs to adapt for World RX this season. Asked if there is a desire to have a works presence in rallycross, Nandan replies: "At the moment it's not a decision for Hyundai to look to rallycross. It's a good show, for sure, and there is starting to be manufacturers involved with it, so it could be also an option for the future. But, at the moment it's full WRC concentration for Hyundai."

It needs to be, for the stakes are high: the Korean-German effort is fighting for its first world title. Given the hugely competitive nature of the current era at rallying's highest level, a championship trophy would be both hard earned and well deserved. **RT**

“All the other disciplines are becoming electrified or hybrid. The WRC will probably have to go this way too”



ABOVE Rally Italia Sardegna highlighted the intensity of the championship battle. Thierry Neuville's Hyundai triumphed by just seven tenths of a second in the WRC's third closest finish ever

FUELLING FORMULA 1

A discovery at the largest US Department of Energy laboratory offers F1 the chance to lead the way in the development of road-relevant technology. **Chris Ellis** explains

THE fuel clause in the current Formula 1 regulations should be completely replaced for 2021. By then, it will be obvious that petrol will soon become as obsolete as diesel.

It will be replaced by a fuel which will be more effective, both economically and environmentally, than the electric vehicles that some governments are proclaiming the ultimate solution to ground transport. At the beginning of the last century, petrol became very cheap, and proved more cost-effective than batteries or ethanol. Now, two developments will combine to make ethanol more effective overall at storing energy than batteries or petrol. And the internal combustion engine will live on...

By 2021, ethanol produced from renewables will already be available in sufficient quantities to be appearing on forecourts in most major markets. Years ago, IndyCar adopted E85, but this will become almost ideal only when the ethanol is produced renewably.

The Greens, and others, don't like E85 because its ethanol is produced mainly on land that could be growing food. But Oak Ridge's recent discovery of a process which requires only CO₂, water and electricity means no arable land and little labour will be required. Now combine this with the latest major contract in Saudi Arabia for solar-powered electricity, agreed at a bulk price of only 2.36 US cents per kilowatt-hour, much earlier than forecast. This means that 'renewable ethanol' costing less than two dollars a gallon is probably going to be available to the customer-facing parts of BP, Exxon, Shell, Sinopec, Total, etc, by 2021. Which probably alarms their upstream businesses... But not their shareholders, who

will now worry less about the threat from electric vehicles.

Recently, Oak Ridge has realised that the ideal location for the ORNL process will be next to an existing bio-ethanol plant, to take full advantage of the concentrated, clean, volumes of CO₂ it produces, plus the existing infrastructure for distributing the ethanol. For the latest details on the progress in commercialising the process, see: www.ethanolproducer.com/articles/15004/next-level-nanoscience.

It is worth remembering that almost all the energy we have ever used came originally from fusion in the sun, even if most of what we currently use has been stored underground for millions of years. So fuels are a good way of storing energy from fusion,



ABOVE F1's multiple fuel suppliers currently work hard behind the scenes to offer their teams a competitive edge



ABOVE Formula 1 can play a role in educating the global motoring public about the 'true pathway' for future road cars

— Mauger/LAT —

long- or short-term. But coal is the major source of air pollution, and oil and gas are running out, so we are going to have to become increasingly dependent on direct solar power, until 'artificial fusion' becomes economic. Whenever that might be.

So the simple summary of the key automotive problem becomes – how will we get electricity from solar panels *least expensively* to the road wheels of each particular type of vehicle? Consequently, there is a major battle developing between the new 'electric' offerings and the established ICE-based solution, now enhanced by a much better fuel. Essentially, the *least expensive* offering will come to dominate each major sector, the same reason batteries and ethanol lost out to petrol a century ago. But note that this is a battle already confined to the ground. In the air and at sea, renewables will continue the domination of liquid fuels until small fusion reactors arrive.

On land, my current medium-term forecast is that depot-based, long-distance vehicles (i.e. big trucks and buses) will be powered by hydrogen fuel cells, while city runabouts will run directly on inducted electricity (think Scalextric scaled up). The vast middle ground

will be shared between fuel cell vehicles running on a mix of water and renewable ethanol, and reciprocating engines running mainly on renewable ethanol.

Now try a 'panel-to-wheel' assessment of each of these alternatives versus the 'batteries-only' option. The adverse environmental impact of battery manufacture makes battery-only cars (BOVs) look bad even when faced by ICEs on E85, leave alone the other alternatives. Only France, of any of the major countries, can make a good case for BOVs in the short/medium term, courtesy of its massive investment in nuclear power

investing in solar power to see the way the wind is blowing...

The second reason for replacing the fuel clause in the F1 regs is the current rules allow *multiple* fuel suppliers, who are then encouraged to waste money developing special variants of 'petrol' to give their sponsored teams a covert advantage on the track. We have now had several years of a single tyre supplier, which has successfully cut overall costs, so I am advocating the same approach in the new fuel clause. As with the tyre regs change, there will be squawks from the vested interests, but

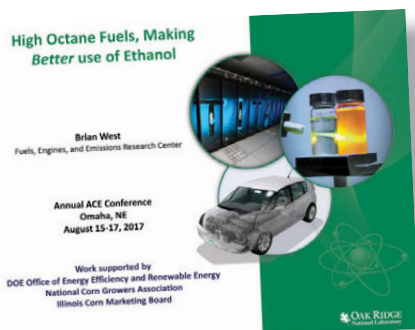
“A major battle is developing between the new 'electric' offerings and the established ICE-based solution, now enhanced by a much better fuel”

plants. But even in France, nuclear's share of electricity production is being deliberately cut back, to allow renewables to thrive.

Note that the production of renewable ethanol may also be provided by wind, hydro and, eventually, fusion reactors, although solar is expected to dominate. Just take a look at how enthusiastically the Saudis are

the fans will be comfortable with it, if not exactly excited about it! The clever minds being wasted on optimising 'petrol' for F1 should be re-directed to develop HCCI for road cars. Please...

If Formula 1 is to remain credible in claiming to lead in developing road-relevant technology, the choice of fuel for 2021 and ►



ABOVE ORNL research highlights the environmental value of even relatively low levels of ethanol in road car engines

beyond is a key decision. The ideal solution will be renewable ethanol dissolved in petrol at a ratio of one to three.

But why such a low proportion of renewable ethanol, when there are over 20 million Flex Fuel vehicles in the US alone already capable of running on R85? Simply because it will take at least a decade to build up ethanol production from all sources to a level needed to go significantly higher than E25 in the majority of cars and countries worldwide. A

recent excellent presentation by Brian West of Oak Ridge shows the results of extensive testing, proving the environmental value of relatively low levels of ethanol in road car engines. The slides are available at: www.eesi.org/files/Brian_West_111317.pdf.

Back in 2013, the consultancy Element Energy produced a report which explained why reciprocating engines will probably continue to dominate the car market until at least 2030. This was well before Oak Ridge's discovery, which further strengthens this opinion. The report's key findings were:

- High level of biofuels blending can be achieved within supply constraints and achieves significant emission savings (up to 4Mt/year in medium pathway). Advanced biofuels technologies allow this high level of blending, and reduce lifecycle GHG emissions from the biofuels mix.
- At vehicle level, blending biofuels in fuels is a cheaper way to reduce emissions

than using BEVs in the timeframe to 2030: biofuels translate into an average £13 annual cost increase for consumers compared to £195 annualised cost for BEVs. This translates into costs of £95/tCO₂ versus £170/tCO₂.

- Achieving savings through high plug-in vehicles uptake results in an additional cost to the UK of £1,230m against a fuel premium of £336m in biofuel pathways in 2030.
- Biofuel pathways are complementary to HEVs and PHEVs, which are expected to dominate low carbon powertrains during the 2020s. This means that there is a low risk of technology lock-in to pursuing increased use of biofuels alongside continued efforts to electrify road transport.
- Advanced biofuels address emissions of both new and existing vehicles, thus reducing emissions earlier than new powertrains and abating the risk of relying solely on longer term deployment of new technology.

No transportation without taxation!

More important than the FIA's choice of fuel for F1 is what each major European government chooses to do with fuel taxes

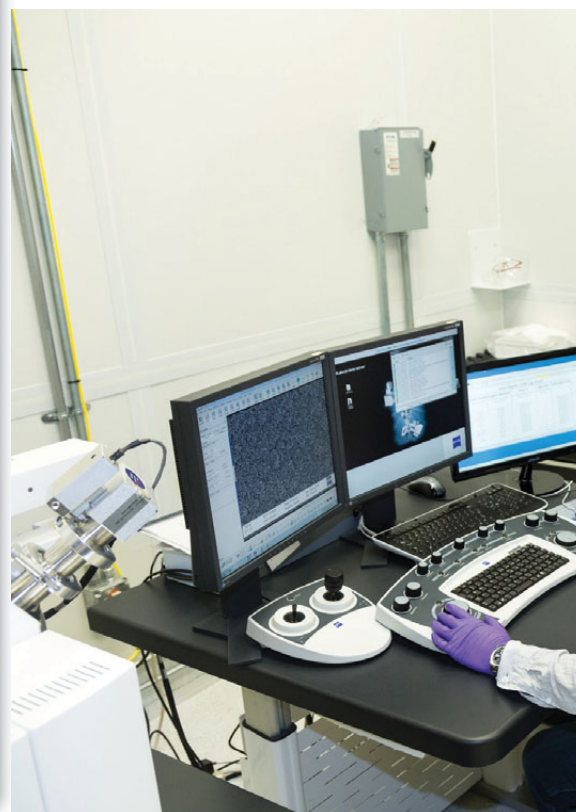
THE British government should renew the extra tax imposed on diesel fuel several years ago. This would provide enough revenue to cover the cost of the other moves recommended below. However, other European governments will only need to introduce tax parity between diesel and petrol to more than pay for what now needs to be done.

The first move should be to lower the tax on any fuel containing at least 25% ethanol of any type. Because almost 70% of the price of petrol is tax across Europe, governments have the opportunity to put strong incentives in place. The cost to governments will be low initially, even though the incentive can be very obvious at the pumps if E25 is priced at, say, 75% of petrol and 65% of diesel.

The second move is surely to encourage the downstream businesses of the major oil companies to put in place more pumps delivering E25, and to offer *renewable* ethanol enthusiastically. This might be done simply by the government paying the oil companies an annual subsidy based on the total volume of renewable ethanol sold in fuels which customers will still see simply as E25 and E85.

Now imagine the massive drop in tax revenues when, say, 30% of the cars on the road pay no fuel tax. The equitable solution is to phase in Road Usage Pricing (RUP) for electric vehicles *only*, initially, to begin to level the playing field. How will a fuel cell car running on untaxed ethanol or hydrogen compare with a battery-only car running on untaxed electricity if they are both paying the same per mile to use the same roads? And what if the electricity comes from solar panels on the roof of your garage, and the surplus is fed to an 'ORNL reactor' in your local filling station? To run your 1968 E-Type with a 'proper' engine? Or will some governments (re-)introduce Prohibition? You may laugh, but RUP is a serious consideration in the more enlightened finance ministries across Europe. **RT**

This study has shown the UK has the opportunity to significantly reduce the fleet emissions by 2030, ahead of the market maturity of zero tailpipe emission vehicles. Increasing the role of advanced biofuels in road transport has a low risk



of technology lock-in since the majority of vehicles, including PHEVs, benefit from biofuel blending.

To capture the benefits of advanced biofuels, the UK must however put in place policy signals for the advanced biofuel supply chain to develop and provide a major contribution to emission reductions in the 2020s.

Note the key point that the use of increased levels of ethanol will help lower the emissions of the massive installed base of *existing* vehicles, not just new ones. You would be surprised at how many new cars are already capable of running on E25, with no fanfares.

POLICY SIGNALS

The main policy signals and incentives will come from the clever use of fuel and vehicle-usage taxes to guide vehicle buyers and manufacturers along the multiple 'true paths'. One reason European governments should respond enthusiastically to this approach is it will require almost no investment – by governments! Note the deliberate use of the plural, paths, because in 2035 I believe there will still be at least three types of powertrain: electric-only, fuel cells running on either hydrogen or ethanol plus water, and good old reciprocating engines running on the appropriate mix of petrol and ethanol for the vintage of the vehicle, and almost all with

some form of regenerative braking.

Remember that most cars built in 2020 will still be running in 2030... Eventually (and soon in France?), city runabouts will need only tiny energy storage units because they will use inductance charging, both when parked and on the move, to power their motors directly. Direct inductance will deliver, by 2025, roughly the same efficiency as charging and discharging batteries, so batteries will gradually price themselves out of the market. Deflection shooting, ladies and gentlemen! Don't aim at where the requirements are now, target where they will be when it really counts.

This is particularly true of infrastructure, because of the time it takes to change it. So I already believe the focus in our major cities should be on inductance charging. By 2030, we won't need parking meters – Wi-Fi and ubiquitous cameras will see to that. It will be a real shame if the ugly things are still around, just to provide recharging sockets. Imagine silent, all-night, autonomous taxis using mobile inductance and a fuel cell stack of less than 20 kW, plus flywheel energy storage for acceleration, regenerative braking and 'fuel cell smoothing'.

I have focused briefly on road cars for an important reason – if Formula 1 is helping to educate the global motoring public about the 'true pathway' for future road cars, then it will be seen as useful by the 'powers-that-be', rather than as a threat to the environment. So, from 2021, Formula 1 should take the lead in the motoring world by using and promoting the 'correct' fuel, particularly if it will cost the organisers and the teams almost nothing to do so. And it should give the team owners something righteous to shout about...

Please compare the complexity of the

current clause, below, governing the specification of the fuel with my suggested replacement (in *italics*) that follows it, based on the current tyre regulation:

19.4.5 Hydrocarbons (as defined in 19.2, but not including di-olefins) and oxygenates (lying outside the 19.4.3 definition) or mixtures thereof, which have been produced from biomass, may be included in Formula 1 fuel as part of the 5.75% bio-components quota, provided that a suitable analytical procedure is available for their quantification and to verify their biological origin. Their use in F1 fuel will be dependent on evidence indicating that the supplier is genuinely developing these compounds for use in commercial fuels.

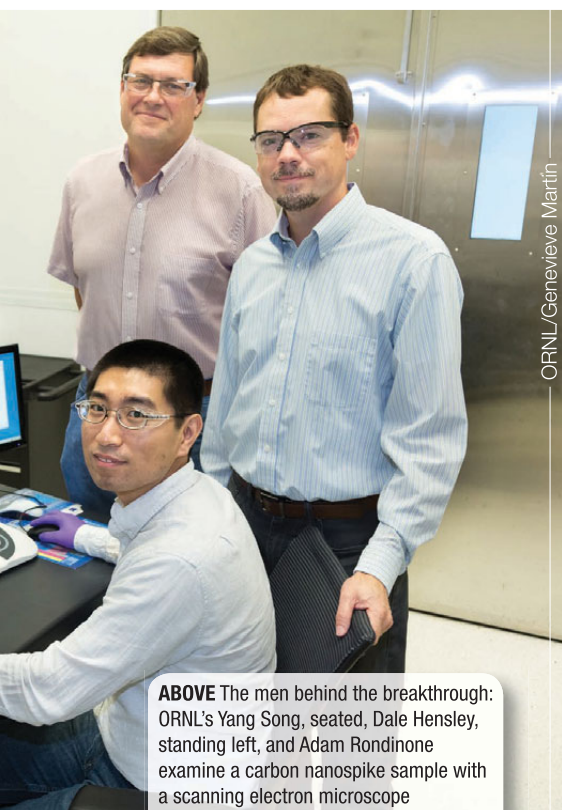
19.4.5 Fuel specifications will be determined by the fuel supplier, in agreement with the FIA, no later than 1 September of the previous season. Once determined in this way, the specification of the fuel will not be changed without the agreement of at least 70% of the competing teams.

The main reason for choosing E25 rather than E85 for Formula 1's next generation of fuels is because the limited total supply of ethanol from all sources will be the critical factor for the next decade at least, and three road cars running optimally on E25 will be more beneficial to the environment than one on E85. But Formula 1 can go a step further, and flaunt the fact that its E25 actually uses ethanol that is entirely produced from renewables – the direction in which we should all be heading.

Bottom line: the internal combustion engine is far from dead... **RT**



ABOVE IndyCar led the way with a switch to E85



ABOVE The men behind the breakthrough: ORNL's Yang Song, seated, Dale Hensley, standing left, and Adam Rondinone examine a carbon nanospike sample with a scanning electron microscope

CHARGING TO VICTORY

Potentially dangerous and traditionally very heavy, batteries have been ripe for improvement. Fortunately, as **Alan Stoddart** finds out, some companies are continually refining their offerings

THERE are areas in motorsport engineering which are the perpetual focus of companies and suppliers, areas to which new innovations are constantly sought and improvements eked out. Two of these, lightweighting and safety, are particularly pertinent to the batteries used

on race cars, since they are both relatively heavy and potentially volatile thanks to the chemicals they depend on. However, several companies are working hard to ensure that the batteries they produce meet the demands of teams and race car builders.

This is the case at DMS Technologies,

owner of the Varley Red Top brand. Varley Red Top batteries have been used across many levels of motorsport thanks to them being compact, relatively lightweight and built using an absorbed glass matt (AGM) construction. This allows them to be fitted anywhere to suit a racing car's packaging requirements, whether that necessitates them being behind seats or in sidepods and installed either upright or on their side.

However, with the increased prevalence of lithium ion cells in mobile phones and laptops, and the higher power densities available from those cells, it wasn't long before motorsport engineers turned those technologies to their advantage. Up until the lithium battery was widely available, a race team could spend thousands and thousands of pounds just to save a kilogram. Now the same savings can be had for just a couple of hundred.

The team at DMS spent a lot of time researching the different cell type possibilities, whilst also keeping a watchful eye on changes in legislation concerning the use and transportation of the potentially volatile battery chemistry. In the end, the company decided to aim for the smaller capacity end of the market and subsequently created and tested three different variants.

The smallest of the range, the 12V 2.4Ah Li-3, was successfully tested on 600 cc motorcycles, with one of the British Army riders winning his class in the national motorcycle combination (sidecar) championship.

A 5.5Ah 12V battery meanwhile was tested in FF1600 by Cliff Dempsey Racing and soon proved popular in that series, in which entrants run a total loss system instead of using an alternator. It is also the battery of choice for a leading supplier into British Hillclimb, and even performed well in the Race of Remembrance endurance race at Anglesey in the cold, wet and dark!

The largest of the batteries in the range, a 12V 16.1Ah variant, has been proven in both modern and historic touring cars, as well as in historic Formula 1. The battery has the same cranking capability as a Varley Red Top 30, but weighs only 3.2 kg instead of 10.1 kg, and is the size of a Varley Red Top 15 – a massive gain in terms of both weight and ability to be optimally placed.

THE FULL PACKAGE

Similarly, Dutch motorsport battery specialist Super B has also been honing its lithium batteries for 10 years, after it was inspired ►



ABOVE The compact size of Varley batteries means that they can be tucked away where they will best meet a racer's packaging requirements

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ABOVE Super B developed a new production method to make sure its battery was safe enough for the extreme conditions in motorsport

by the challenge of creating a new type of battery that could outperform the traditional options in all areas. That led to the creation of its first lithium battery in 2007, which met its brief of being lightweight, high-performance, safe and reliable, and suitable for use in extreme environments.

One of the things that carried through from then to now is Super B's use of lithium iron phosphate technology (LiFePO₄) – the safest chemistry available today. Super B

says that this technology has two important advantages over the lithium ion alternatives: thermal and chemical stability, both of which improve battery safety.

Safety and reliability are obviously qualities a motorsport battery must possess, with the thermal stability of these cells perhaps the most important of several parameters that determine their overall safety. However, as energy levels increase, designing safe battery packs and cells becomes more difficult. To meet this challenge, Super B used a new and innovative production method, at its own production facilities in the Netherlands.

One of the goals for the Super B battery was to ensure that it had high passive safety, which means that even without electronics the battery should be safe. To this end, the company takes great care in its choice of materials, and in the construction of the batteries. Every batch produced by Super B is copiously checked and thoroughly inspected, and then optimised to provide maximum safety and performance. The casings are especially designed for the type of extreme environments and abuse they will be subjected to in motorsport, and are so strong

that even in the extremely unlikely event of a cell failure there will be no visible damage, only a top cover lifted by 2 mm to relieve the internal pressure.

All these considerations have resulted in a motorsport battery that offers consistently high performance, while being safe and long lasting. The batteries offer high energy density, and crucially for racing, are very lightweight, weighing 80 per cent less than conventional batteries, while taking up less space and charging quickly.

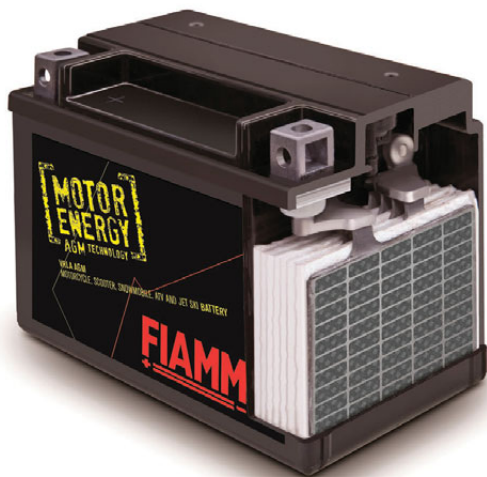
PROPER TESTING

One of the ways another battery manufacturer, FIAMM Energy Technology, is putting its motorsport batteries to the test is through a tie-up as technical partner to the brand new G1 Series. The championship is a single-make series for Griip single-seaters powered by 201 bhp, Aprilia V4 motorbike engines. The cars weigh in at less than 400 kg including fuel and have high downforce bodies, meaning that the G1 is a pretty serious racer.

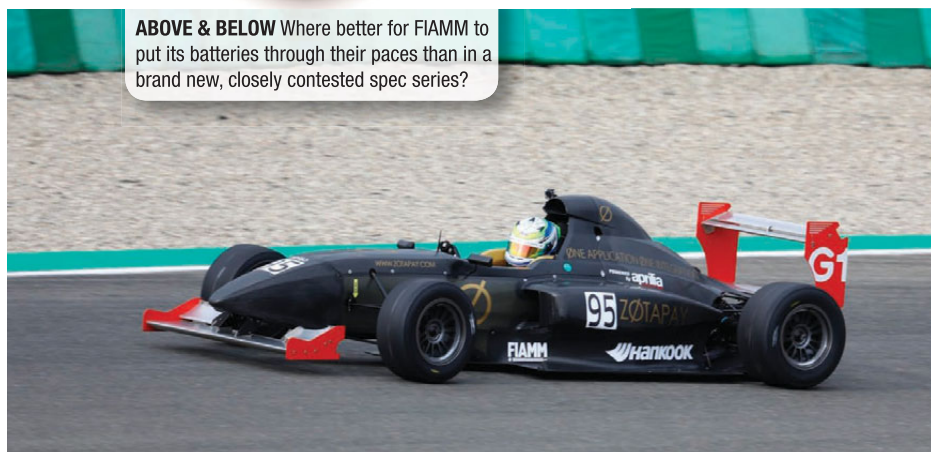
For this demanding application, FIAMM used its FT12A-BS battery, from its MotorEnergy range, which features AGM technology to guarantee maximum power at start up, no maintenance and high resistance to vibration – crucial in a taut single-seater. The AGM gas-recombination technology employed by the battery stops the dissociation of water into hydrogen and oxygen, and their subsequent release through the caps as happens in traditional batteries. This means that when the battery is recharged, the level of electrolyte gradually decreases.

In FIAMM's batteries, this is prevented with the use of a very fine separator, the absorbent glass matt, which is steeped in a controlled amount of electrolyte. This means that during charging, the oxygen released from the positive plate due to the dissociation of water can migrate to the negative plate where it is fixed, and can recombine with hydrogen to form water again. As such, in principle at least, a closed electrochemical cycle is created which avoids gas emissions and the consumption of water.

FIAMM says it is a simple system in theory, but in practice it requires high constructive accuracy and the very careful selection of components to ensure that it can reliably work without issue – exactly what is needed when beating another G1 to an apex on the last lap of a tightly fought race. **RT**



ABOVE & BELOW Where better for FIAMM to put its batteries through their paces than in a brand new, closely contested spec series?





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CARTEK are pleased to announce the new Power Distribution Panel is now available. This product is a full redesign of their successful but bespoke, Power Control Panels, with the main aim of allowing the user to customise and configure it themselves

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ABOVE Extensive research underpins the design and development of the new Hurricane

LIKE A HURRICANE

In a world where a good pitstop can win a race, mechanics need a wheelgun that gets the job done quickly and reliably.

As **Alan Stoddart** finds out, this has been the myopic focus of Paoli in making its new Hurricane impact wrench

IN the very highest classes of motorsport, races and even championships can be won and lost in the pits.

In Formula 1, the difference between a seamless two second pitstop and a fumbled three and a half second wheel change is the difference between returning to the track in the lead and having a run through clear air to the top step of the podium, and coming out in the wash of a rival and spending Sunday afternoon managing overheating tyres 1.5 seconds away from the front.

To be able to repeatedly deliver those blistering stops, crews need powerful and reliable tools that can screw and unscrew the wheel nut in a heartbeat, which is exactly what Paoli's new Hurricane impact wrench was designed to do. The Hurricane was originally developed for the Ferrari F1 team, which had an exclusive contract on the gun for two years. Those two years are up but the seasons of hard use by the Scuderia have helped Paoli optimise the

Hurricane for the general market.

As well as different techniques being used in its manufacture, such as lost wax casting instead of the rapid prototyping technology employed on the Ferrari-specific gun, additional features were also included, such as an adjustable oiler, which is the only one of its kind.

The design of the impact wrench was honed through a CFD study to optimise its engine performance, while it also has new airflow channels to make it the most powerful gun Paoli has ever made. "It's more powerful than the most powerful wrench we had until last year, which was the DP6000," says Dr Federico Galloni, Dino Paoli's commercial director. "This is superior."

"Everything has been redesigned and remanufactured apart from the hammer mechanism, which is very similar to the DP6000. What has changed is the complete motor, and also importantly the air channels have been redesigned. Also all the parts

comprising the handle and the motor, have been totally redesigned."

As well as the mechanics of the gun being improved, it has also been tweaked to ensure that it is optimised for all-around performance based on what teams require. Galloni says that this is what led to an increase in the gap between tightening and loosening. "They ask us to keep the tightening force as it is and then to increase the loosening force as much as possible," he explains. "We call this the gap."

Paoli has experience supplying all levels of competition, and recently won the contract to supply all the teams in NASCAR's Xfinity and Monster series with guns, regulators, hoses, sockets and other things. The Hurricane is also available to teams of any category, and is already in use by some major Formula 1 outfits, as well as some that compete in endurance series such as United Autosport, and Loris Kessel Racing.

"It's also built to survive in Indy," adds Galloni, emphasising that the Hurricane has been designed from the ground up to be dependable and stand up to the rigours of being used day in and day out in the heat of battle, as well as literally being thrown about by pit crews, as is customary in the IndyCar series. Although, at least he is able to see the silver lining.

"Luckily," he muses, "they are only throwing one gun." **TT**

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START YOUR ENGINES

Alan Stoddart reports on a range of starter motors conceived for motorsport

In motorsport, the aim of every engineer and racing car builder is to achieve higher power and greater performance whilst using lighter weight components. This is one of the goals that Powerlite set itself with its range of Slimline starter motors.

These compact units are far lighter than the equivalent conventional high torque motors, while still delivering enough power to quickly start any engine, regardless of its temperature or compression ratio. These starter motors have been pushed to the limit across a range of disciplines. This highlights the importance of motorsport to Powerlite, which works closely with its partners in everything from touring cars to single-seaters, and from sports cars to rally teams, on both a national and international basis.

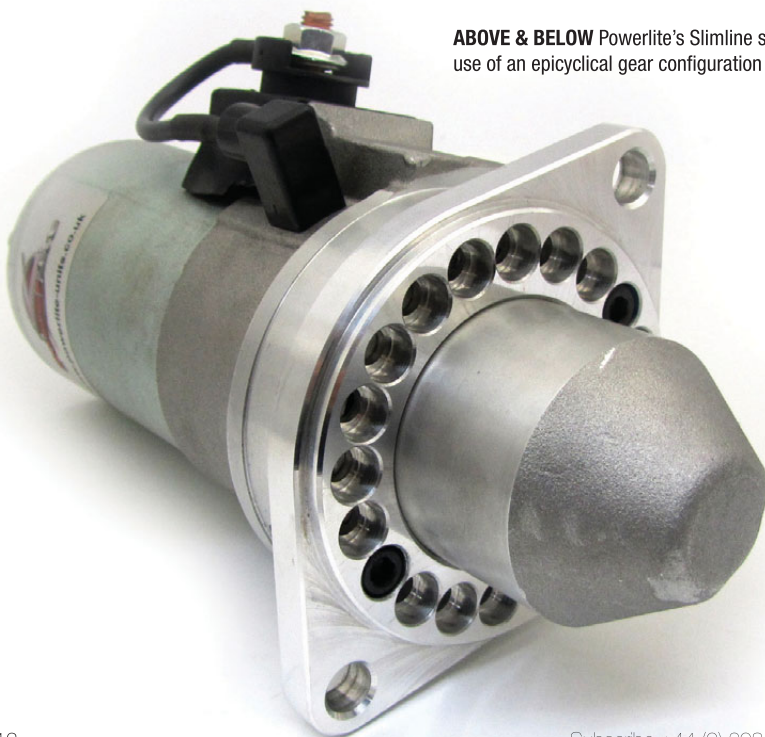
One of the added benefits of the units, which is especially advantageous to a race car's chassis builder or engine designer, is that their small size means they can be packaged far more efficiently around the engine and the gearbox, and resultantly take up far less space than the conventional alternatives. This compact size is achieved in part by the gear reduction technology employed by the Powerlite units. The majority of starters use an 'in line' set of gears from the pinion shaft outwards. Powerlite's Slimline starters on the other hand make use of an epicyclical gear configuration which enables a reduction in the frontal area of the motors by around 50 percent. In addition, this epicyclical arrangement helps contribute to the unit's increased power output as well as its reduction in battery draw during the startup process.

Packaging is also a crucial part of motorsport design, with the placement of parts affecting everything from a car's centre of gravity to the management of the heat and airflow in its engine bay. This is one of

the reasons Powerlite offers up its capability of designing and machining the correct face plate profile and pinion specification to fit almost any required installation, helping engineers to make the perfect starter solution for whatever race car they happen to be working on.

In addition to the company's ability to design and manufacture bespoke face plate profiles, Powerlite can also add in additional features to its Slimline units, in the same manner as it does for the rest of its range. These add-in features are things that help the starters stand up to the harsh environments they will be subject to in the engine bays of potent racing cars, like anti-vibration and heat management technologies. These additions stem from

“A reduction in the frontal area of the motors by around 50 percent”



Powerlite's close ties to other manufacturers in the UK and abroad.

While a starter motor might not be the most glamorous part of a racing car, it is still a component that can bring significant improvements, especially when it is as carefully designed as Powerlite's Slimline starters. The improvements to weight, performance and packaging all contribute to a significant advantage. **IT**

ABOVE & BELOW Powerlite's Slimline starters use of an epicyclical gear configuration

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ABOVE & BOTTOM Could a new breed of hypercar-based racers (above) enable privateers to compete against the factories like McLaren's F1 GTR did in the '90s (bottom)



Sergio Rinland relishes the creation of a new top class for Le Mans in 2020 that is designed to be both innovative and affordable

Why 2020 vision offers Le Mans fans hope for a bright future

THE ACO and FIA have announced the concept of the new regulations for their top class of endurance racing. It looks good.

We spoke before in this column about the quest for the identity of motorsport and its main classes. I believe the ACO and FIA are on the right track with this new blueprint for the top tier of competition at Le Mans.

Last month we were critical of the timid change F1 is proposing for next year and hoping that by the time 2021 is with us it could find its identity and regulate a formula to inspire the young generation and take F1 forward. If the same FIA which just announced this WEC plan works on the new F1 with FOM, then we have hope.

The first step to find that identity for endurance racing is to go to what sports cars are all about and the second and very impressive step is to have asked the public to find the appropriate name for these new cars. This is a novel concept: ask your customer what they want to see!

The cars will still be prototypes but, in the quest to attract sports car manufacturers, the racing machines will have to incorporate cues of the cars and manufacturers they represent, not just a mere logo. This is not the first time we have gone down this route. Throughout the history of Le Mans there were many periods when the cars that competed were production sports cars prepared specially for endurance racing. The last time we had this was in the late 1990s when manufacturers

fielded cars either developed from production (McLaren F1) or as prototypes with cues from their production cars (Porsche and Mercedes).

The next generation WEC sounds like it will be a similar concept, which will align and identify the top class at Le Mans with supercars and high range sports cars. Gordon Murray suggested this same idea about 15 years ago – it was time to make it reality!

There are not currently many details on the regulations, but the following aspects have been hinted at:

- ICEs free with a limited fuel consumption and cost
- Hybrid systems derived from production cars or precursors of future production systems
- Aerodynamics cannot take precedence over aesthetics

The free ICE will pave the way for the manufacturers to try their solutions to see who would be the most efficient and the cost cap can ensure privateers can actually

afford to buy those cars.

If hybrid systems have to be derived from production, it opens the door to develop Series Hybrid, a concept seen in the Ariel Supercar and pre-empting the future hydrogen fuel cell concepts to substitute the ICEs.

The third and final point, regarding aerodynamics, is not clear. If the rules mandate that the cars have to resemble their production cousins, then unless they regulate the amount of downforce they generate (as we proposed some time ago), I cannot see how the FIA and ACO can guarantee that some cars will not be disadvantaged just because their production model was not designed with racing in mind. The only way Balance of Performance will work is if they regulate the outcome (downforce); any other way will be a muddy business. Trying to repeat what the FIA does with GT cars, which feels too artificial, would be a mistake.

We want to see these new cars as soon as possible. The proposed category has all the ingredients to become a solution to the manufacturers/privateers conundrum, as it was in the late '90s when private outfits could compete with the works teams. Let's hope this time they get it right. **LT**



LAT



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