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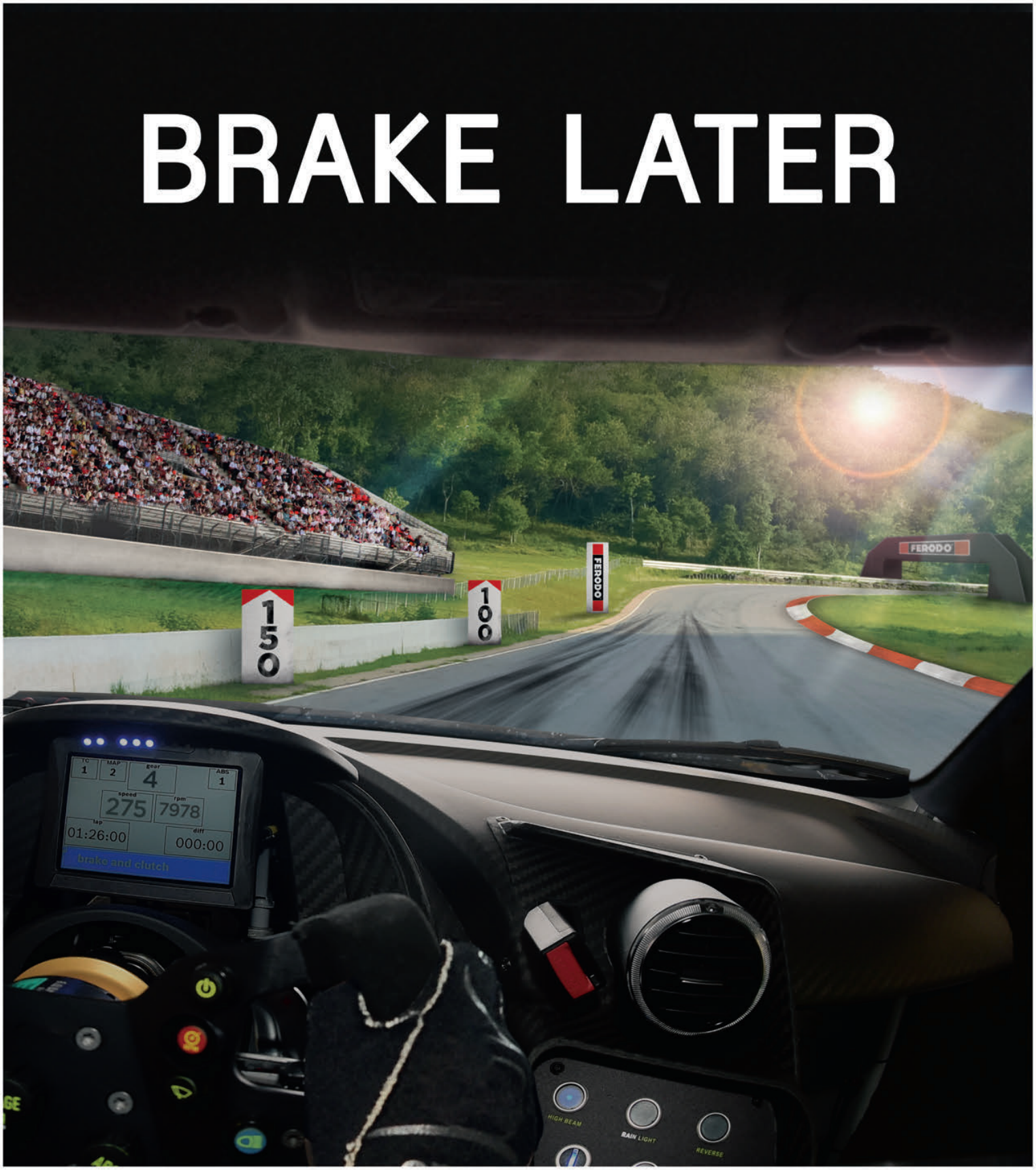

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Why McLaren is offering world's best gamer a role on its F1 sim team

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PREPARE FOR REVOLUTION

IMMEDIATELY after the Le Mans 24-hour race finished then it was in the car and on the road on a 500-mile trip to Stuttgart to attend the Engine and Testing Expo there the following week. It's not normally a show I visit, but with the wearing of my new Automotive Engineer hat, it was necessary to catch up with what is happening in the automotive industry and it was really quite illuminating.

The largest of the various halls was the one devoted to testing. There were many names I didn't know, but quite a number I did, such as Cruden, Cosworth, RML and Alcon amongst others. What came through loud and clear is that the automotive industry is undergoing a revolution and with no-one clear about just what the future was, there was a real sense of a lack of direction.

What was on the tip of evetryone's tongue, and was the focus of so much attention there, was autonomous driving or ADAS (Advanced Driver Assistance Systems) and electric vehicles. There was a sense of emergency. Even while visiting the show, the Mayor of London issued a draft proposal that included a pay-per-mile suggestion, extending bus lanes at the expense of other vehicles, reducing car journeys by three million a day and 80 per cent of journeys to be made by public transport and 70 per cent of Londoners to live within 400 metres of a cycle route.

Additionally from next year, all new double-deck buses will be hybrid, electric or hydrogen and in central London all double-deck buses will be hybrid by 2019. All single-deck buses will emit zero exhaust emissions by 2020.

None of this, of course, seemingly has anything to do with motorsport, but what I found most interesting is that because of the onslaught against the internal combustion engine, and because of the absolute urgency to develop alternatively powered transport, a number of companies are turning to motorsport ones to help them. What they are finding, and I am talking very generally here, is that the 'can do' attitude is a real bonus at this time of heightend development.

Most mainstream automotive companies are just as clever but they are used to a develeopment process that takes months if not years and not weeks. I have no doubt, though, that once the specialist companies' brains have been picked, they will be spat out, but I would guesstimate that there is a five-year window for motorsport companies to capitalise on this situation.

What is happening in London will more than likely be taken up by other cities around the world so this anti-car culture is something we had better get used to, so how motorsport as a sport and an industry responds in the immediate future will be vital if it is to survive. One thing is certain, though, it has to be prepared for what it coming, embrace it where it can and ride the rollercoaster.

While at the show I was told by someone of a photograph of a busy New York street taken in 1901. The street was filled with horses and, as a speck in the background, a single car. A picture taken from exactly the same place in 1911 showed streets full of cars and not a horse in sight. A revolution has taken place and I believe we are on the verge of one now.

Motorsport, like horse racing, will always be there but it could become even more of a specialist sport in the future than it already is if we are not careful.

William Kimberley
EDITOR

Photo: Porsche

ABOVE As from 2020 the LMP1-H cars will be able to rapid recharge while refuelling and then be compelled to leave the pits and cover the next kilometre solely under electric power

2020 LMP1-H regulations announced

William Kimberley

LE MANS, France: Adapting technologies to production vehicles, cost capping and safety form the basis of the Automobile Club de l'Ouest and the FIA's proposed new regulations that come into force for LMP1 Hybrids in 2020. Perhaps the most eye-catching detail in these regulations is the requirement for an LMP1-H car to run in full electric mode for the first kilometre after a fuel stop as well as crossing the finishing line in full electric mode.

The two energy recovery systems remain same size as the current ones and still limited to 8 MJ while an effort is being made to increase the integration of biofuel and more evolved fuels. At the same time, the ACO and FIA want research work to continue on new energies such as hydrogen with the intention of introducing them some time into the future. With an eye on production cars, plug-in hybrids will be able to a rapid recharge at the same time as being refuelled.

In the hope of containing costs, the regulations outline 10 points that it expects will limit expense. They include a limitation on the number of bodywork sets with a single bodywork set being homologated per year and there will be strict limits on the number of test days.

Wind tunnel testing will be reduced to an annual 600 hours compared to current 800 while a system will be put in place to prevent manufacturers from being able to build a new car every year. The regulations will define the features such as the chassis, engine, hybrid system and the bodywork that the manufacturer will be able to develop between two seasons so choices will have to be made.

Development possibilities for the car's underbody will be severely restricted and perimeters will be defined to reduce development opportunities in the areas that currently have a major impact on performance. Free zones will be allowed to enable manufacturers to innovate but with a big reduction in budgets devoted to these areas. The regulations on brake cooling will be tightened as the ACO believes that too much resource is being put into this area and there will be a limitation on the number of components in the power unit per year. Gearboxes will be limited to two units.

Finally there will be a reduction on the number of team members that can be taken to every race, down from the current 65 to 50, but there will be no limitations on the number that can be taken to the Le Mans 24 Hours.

For their part, the ACO and FIA have given an undertaking to keep the regulations stable for four years.

With reference to safety, there will be an Imposition of a free volume around the drivers' helmet and more room in the cockpit. Legroom space will be slightly increased to facilitate driver change and there will be a protective foam for the driver's legs. There will be stiffer front and rear crash tests of the monocoque and the crushable structures and Improved cockpit ergonomics to enhance driver visibility.

On announcing the regulations at the annual FIA/ACO press conference the day before the racing started, Lindsay Owen-Jones, president of the FIA's Endurance Commission said that the regulations need to remain attractive to car makers as well as reducing costs. "These regulations must be relevant, should provide charismatic and powerful cars for the spectators but recognising that curbing emissions is important, with more and more cities closing zones and districts to traditional road traffic in preference to electric modes of transport. In future these zones and distances will be bigger and we want to make sure our regulations reflect the need for development." RT

See Le Mans Rules page 38

Toyota and Global Institute collaborate on multi-year safety research programme

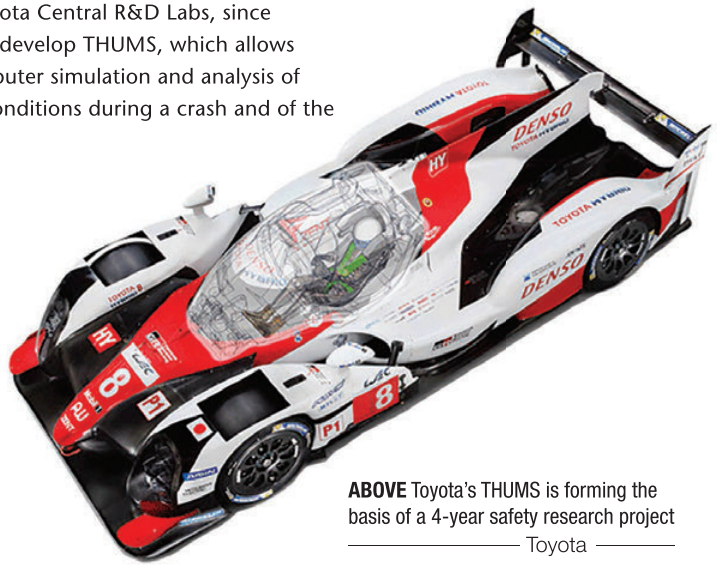
William Kimberley

TOKYO, Japan: Toyota and the Global Institute for Motor Sport Safety have launched a four-year research project using Toyota's Total Human Model for Safety (THUMS) with the aim of enhancing safety in motorsport.

The joint research project covers research on collisions involving not only closed-circuit race cars, but also rally cars, and possibly will include review of seat structures and seatbelt positioning. Based on the results, the Global Institute plans to consider measures that could lead to updating motorsport regulations and other actions to enhance the safety of motorsports vehicles.

Although crash dummies are commonly used in vehicle collision tests, they do not allow for easy and detailed analysis of how collisions impact the brain, internal organs and certain other parts of the body. As a result, Toyota has been working with Toyota Central R&D Labs, since 2000 to develop THUMS, which allows for computer simulation and analysis of actual conditions during a crash and of the mechanisms of injury occurrence, including that of injuries to internal organs and other parts of the body.

Since 2007, Toyota has been using THUMS not only for general automobiles, but also to analyse injuries due to crashes in motorsport. In response to a request from the FIA and NASCAR, it has also been using THUMS to identify deceleration G forces and the powerful forces imposed during a collision on the spine and internal organs, due to the seating conditions unique to race cars, and to investigate methods of mitigating those forces. RT



ABOVE Toyota's THUMS is forming the basis of a 4-year safety research project
Toyota

Academy opens for disabled racing drivers

Hal Ridge

BLOIS, France: Frédéric Sausset, the first quadruple amputee driver to compete at and complete the Le Mans 24 hours (featured in RT189), has launched an academy aimed at enabling disabled driver line-ups to compete in the famous endurance race, with the first entry expected to be in 2020.

The first driver to be confirmed as part of Sausset's plans is rising British star Billy Monger, who lost both legs in an F4 accident at Donnington Park earlier this year. He will return to competition by racing in a VdeV Endurance series round at Estoril in November, where he will share a Ligier JS 53 CN with Sausset, the same car that the Frenchman shared with Christophe Tinseau in 2015, in preparation for his Le Mans debut as a 'Garage 56' entry for innovative design.

The academy will select 15 candidates annually from across the globe, before narrowing the selection to three winners who will undertake a three-year training programme with Sausset's new Blois-based team, concluding in racing at Le Mans. The project is expected to begin in January.

ABOVE Billy Monger has joined the academy for disabled driver line-ups to compete at Le Mans that has been launched by Frédéric Sausset

"I've been working on this relentlessly since April last year," said Sausset. "I really needed to undertake another significant challenge after racing at La Sarthe in 2016. I also wanted to change the general perception of disabled people. I believe that taking the chequered flag at Le Mans has given me the legitimacy to do so."

The project is being backed by the FIA, ACO and FFSA, with Richard Mille involved in helping to fund the programme. "Of course, we need to make sure that all our candidates are individually qualified to undertake such a programme. We also need to make sure that their disabilities are complementary and compatible with our cars," concluded Sausset.

Monger joined Sausset for the academy's launch at Le Mans last month. "I am recovering well from my injuries and I am looking forward to joining Frédéric in this academy," he said. RT

IndyCar hands body to Dallara

Andrew Charman

VERANO DE' MELEGARI, Italy: Italian race car manufacturer Dallara will supply the new universal bodywork that will be introduced to the Verizon IndyCar Series in 2018. The winner of the tender was announced by IndyCar on 6 June and met with little surprise – Dallara is a long-time partner of the series and supplies the DW12 race car chassis used by all teams.

The single kit will replace the bespoke versions developed by engine suppliers Chevrolet and Honda and used in the series since 2015. These were intended to be introduced with the DW12 in 2012, but delayed with teams blaming costs.

Since their introduction the kits have proven difficult to equalise, while their costs have added to budgets for competing teams, sending the series back down the route of a single kit.

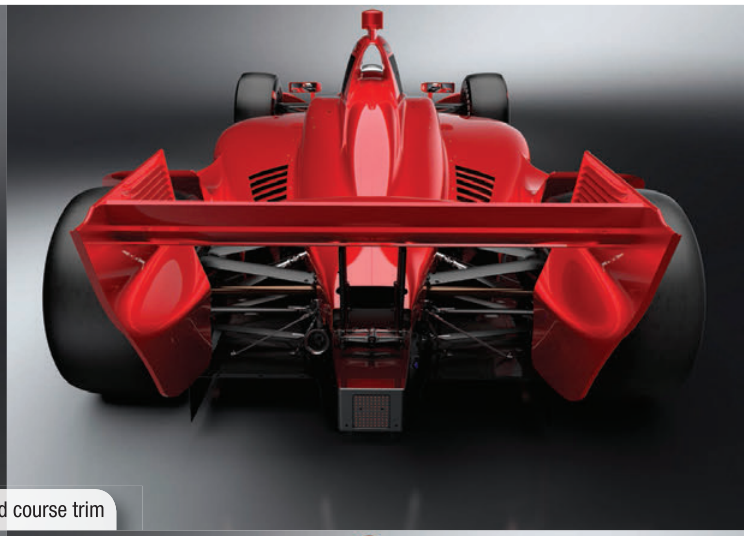
Dallara CEO and general manager Andrea Pontremoli has welcomed the decision, describing the continuation of the firm's partnership with IndyCar as "a great honour". The 2017 season marks the 20th anniversary of Dallara's presence in the series. "Our main goal for the new aero kit was to work on the style, trying to maintain the American essence of the car and the series keeping a good level of performance and safety."

IndyCar will begin track testing the new kits in the superspeedway format at Indianapolis Motor Speedway on 25-26 July. Further tests will take place on the Mid-Ohio road course on 1 August, Iowa Speedway on 10 August and the Sebring road course on 26 September.

Teams will carry out the test programmes, most likely one each representing Chevrolet and Honda, and IndyCar president Jay Frye has emphasised that the tests will be aimed at "signing off" the kits rather than improving performance. The selected teams will each provide a chassis to Dallara and these will be based in a bespoke facility at the constructor, with any work on the cars only carried out with a Dallara representative present.

Indycar is believed to be planning to update its car electronics at the same time as it introduces new bodywork in 2018. The series has used ECUs from McLaren Applied Technologies since 2012 when the current 2.2-litre formula was introduced, and rumours suggest Bosch and Cosworth are vying with McLaren to supply a new unit. Cosworth's current electronic dash could also make way for a new unit, with paddock speculation suggesting that teams could face an electronics upgrade cost of around $40,000 per car.

All pics from IndyCar



ABOVE road course trim

ABOVE superspeedway trim

New Proton Iriz R5 reveal

Hal Ridge

MILFORD, UK: British firm MEM, the outfit responsible for the successful Proton Satria Super2000 programme, has constructed a new Iriz R5, set to be homologated on 1 January, 2018.

The Chris Mellors owned squad revealed the new car to the public for the first time at the Goodwood Festival of Speed. The Iriz's Super2000 predecessor, the Satria Neo, achieved success in the Asia-Pacific Rally Championship, the Intercontinental Rally Challenge and the WRC's Super2000 sub-category with drivers like Alister McRae, Guy Wilks and PG Andersson.

"When the Satria production stopped we were looking for something else and now the new Iriz is launched, it's an ideal platform," said Mellors. "We had some cars sent over here and did some evaluations and decided that we could make a very, very good R5 car out of it. It's shorter than the Satria, but the wheel base is longer."

Although the project is a private effort run from MEM's Derbyshire workshops, it does receive support from Proton, largely in data sharing. Unlike the Super2000 car, the Iriz has being fully designed using CAD.

"The Super2000 was the first car we designed literally from scratch. It was very successful, but we did have some hurdles to overcome along the way. With this car, we're older and wiser and have managed to steer around the pitfalls. It's been totally designed in CAD this time, that's been a big help. We have a good relationship with Proton and we're linked into their main computer so we can get all the CAD files we require from the base cars and any technical support from that side, but as usual in motorsport, the competition car tends to be divorced from the road car. They're very keen and help us wherever they can."

The car's engine is based on the 4B11 unit more commonly found in a Mitsubishi Evo X. "We haven't had to make any compromises and I think we've got all the right components. The engine is a very good strong base and we've gone for what we consider to be the finest gearbox – Xtrac. We've used Cosworth electronics, Reiger suspension and Brembo brakes, hopefully it couldn't get much better. We're already in the homologation process and the test programme will start basically straight after Goodwood. It's very exciting." RT

LEFT Rallycross Supercar driver James Grint and the Spencer Sport team debuted the new Mitsubishi Mirage RX feature in RT199 at the third round of the MSA British Rallycross Championship in South Wales on 25 June and finished fourth. Having been forced out of the second round of the series due to pre-event engine issues, the squad undertook a two-day test at Dreux in France before heading to Pembrey.

RIGHT Holden has released concept drawings of the next-generation Commodore planned for the Virgin Australia Supercars series. Works team Triple Eight Race Engineering will build and race the car from the 2018 season, initially with the current V8 engine and from 2019 with a new twin-turbo V6 unit built by GM in the US as Supercars transitions to its Gen-2 regulations. The new Commodore is a global platform design, launching in Europe as the Insignia. Its homologation with the existing V8 engine is likely to encourage other teams running the Commodore in Supercars to upgrade to the new model earlier.

Holden

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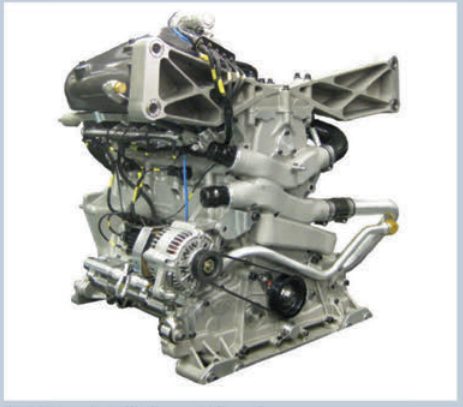
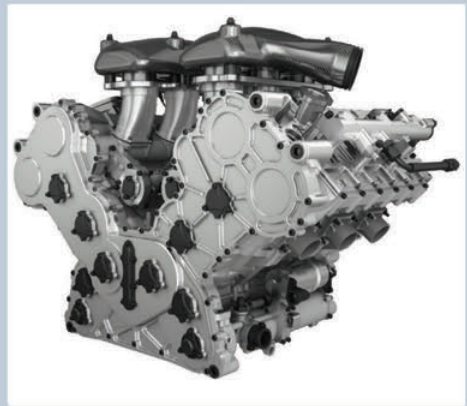


P63 Indy Lights Mazda



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WTCC plays its joker on the streets

Andrew Charman

VILA REAL, Portugal: The FIA World Touring Car Championship introduced its controversial 'Joker Lap' procedure at the round held on the Vila Real street circuit in Portugal on 25 June. Borrowing a technique established in World Rallycross competition, the Joker Lap was intended to improve action on the tight street circuit where even an FIA press release admitted "overtaking isn't always possible."

In rallycross, the 'Joker' consists of a separate and longer section of circuit which all competitors must negotiate once in each race. The FIA version at Vila Real was based on the final roundabout leading onto the start-finish straight. A fast right-left-right flick on a normal lap, the Joker was marked by blue lines and took cars on a much tighter left-right combination around the other side of the roundabout before re-joining the straight.

Every car was required to take the Joker route once at any time after lap 3 of each race, and organisers calculated that it added two seconds to a lap, giving teams an opportunity to practice different strategies.

Drivers were able to try out the Joker section during the two free practice sessions, and after this expressed concerns at the siting of the exit, fearing that cars were re-joining the racing line at too slow a speed. Organisers duly added 15 metres to the exit line ensuring that cars on the Joker and normal lines came together later and at more equal speeds.

The Joker was employed in both WTCC races with no problems, after which WTCC organisers declared it a success. Main race winner Norbert Michelisz said that planning when to take the Joker was difficult; "The first message from my engineer was to do the Joker lap early. I disagreed, but we managed to find a good solution and I was able to stay in front."

Honda works driver Tiago Monteiro retook the WTCC points lead with a pair of podium finishes and praised the introduction of the Joker, while perhaps alluding to a wider problem with the choice of venues for the championship. "Two podiums on a track where it's hard to overtake wouldn't have been possible without the Joker lap. It was a good success and congratulations to the organisers, Eurosport Events and François Ribeiro," he said.

Safety standards on the Vila Real track were put in the spotlight in the opening free practice session after an accident put Tom Coronel's Chevrolet Cruze out of the rest of the meeting. He lost control at Turn 22 and headed up an escape road. The Chevrolet launched over a flower bed, which detached its wheel, and made heavy impact with the side of a rescue vehicle.

ABOVE Changing lanes: The much tighter route of the Joker Lap, edged in blue, is clear from this aerial view

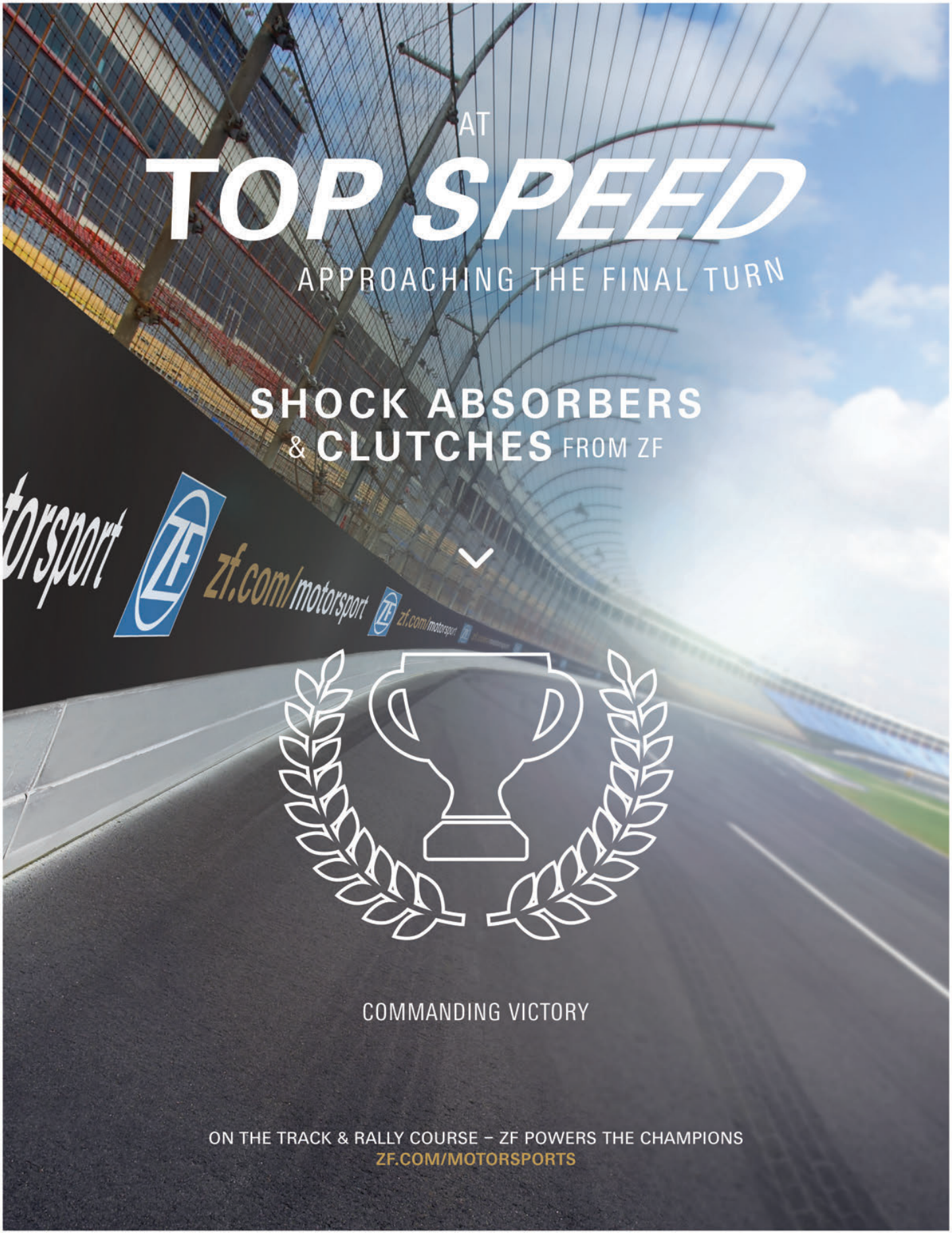
Citroën C3 WRC upgrades

Hal Ridge

PARIS, France: Ahead of the eighth round of the FIA World Rally Championship in Poland's Mikolajki region, Citroën Racing submitted two upgrades to its C3 WRC to the FIA, following a four-day pre-event test where Andreas Mikkelsen, Craig Breen and Stéphane Lefebvre all drove. Britain's Kris Meeke didn't drive however, having been sidelined for the Polish round by the team following a spate of difficult events for its lead driver.

The French marque's two upgrades included 'homologation of a new rear differential rail and a mechanical 'joker' in order to modify the torque split between the axles.' However, a delay in parts supply means that only 2016-event winner Mikkelsen's car would be fitted with the new components.

Having taken a year out of full-time WRC competition in 2016 to develop its C3 WRC, the Citroën squad has struggled so far in 2017, despite winning with Meeke in Mexico. "We needed to take a step back to note that some of the risks we had taken during development of the C3 WRC were not paying off. Our car is unquestionably fast, but the window in which it works efficiently was proving too narrow," said team principal Yves Matton. "We have therefore begun making some major changes to our organisation, our methods and our principles. The first of these was the arrival of Andreas Mikkelsen, who encouraged us to explore some new ideas. After his first proper test session in the C3 WRC, we have introduced some upgrades that supplement the work done over the last few months. With a more versatile car, our drivers will be able to aim for the kind of results that match Citroën's high expectations."



MOTION AND MOBILITY

TCR new cars make their debut

Andrew Charman


Hyundai Motorsport

ABOVE Testing times: Gabriele Tarquini has been putting miles on the TCR Hyundai i30


TCR

ABOVE New shape: The Kia cee'd driven by Ferenc Fieza made a promising debut in Hungary while adding to the variety of cars in TCR

HUNGARORING, Hungary: The variety of cars contesting the TCR category is continuing to grow, with Hyundai and Kia models appearing in recent weeks. Former British Touring Car champion and WTCC driver Gabriele Tarquini has been continuing testing of Hyundai's new i30 N TCR in Spain and Italy, and the car was set to make its competition debut in the 24 Hours of Misano in Italy on 8-9 July.

The Hyundai Motorsport programme is the Korean make's first-ever exercise in circuit racing and personnel emphasise that with the aim being to build a customer production run, reliability of the car is the first essential. The Misano race will be treated as a test session with the aim being to analyse the car under longer runs. No decision has yet been announced as to when the i30 will first compete in TCR.

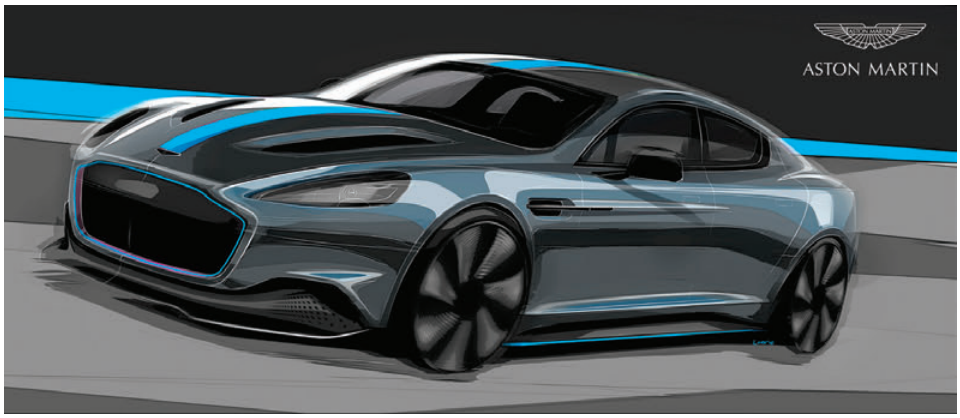
The Hungaroring races on 18 June saw the debut of the Kia brand in TCR International, with two of the STARD-built Kia cee'ds entered. Ferenc Fieza's Zengö Motorsport entry suffered from typical new car problems in practice, the team having only taken delivery of the car hours before the first session began on Saturday. It then stopped on the first lap of that session with a broken throttle cable, resulting in Feng shaking the car down in the qualifying session.

Starting both races from the back of the grid, he drove the car to a best finish of 14th in race two, a points-scoring position had the car not been competing under a temporary homologation form. The Hungarian-based Botka Rally Team cee'd of Istvan Bernula did not start race one but finished 16th in race two.

Meanwhile a TCR spec Volkswagen Golf GTI entered in the 24 Hours of Nurburgring by Mathilda Racing not only won the TCR class but finished 29th overall, significantly the best Touring Car result.

Brands with full-blown TCR models now include Honda, SEAT, Volkswagen, Audi, Alfa Romeo, Opel, Ford, Subaru, Kia and Hyundai. RT

IN BRIEF



Williams Advanced Engineering has been commissioned by Aston Martin to develop the carmaker's all-electric RapidE that will enter production in 2019. Based upon the forthcoming Rapide AMR concept, RapidE will deliver four-door sports car looks and dynamics of the Rapide S powered by an all-electric powertrain replacing the six-litre V12 engine. More information will be revealed about the RapidE's all-electric powertrain in due course.

Following F1 driver Fernando Alonso's impressive performance in the Indianapolis 500, in which he led a number of laps until forced to retire with engine failure, McLaren executive director Zak Brown has stated that he would like to see the team in the race on a regular basis and a decision would be taken "in the next couple of months." However, a suggested full-time entry in the Verizon IndyCar Series is unlikely for "a few years".

NASCAR has threatened to deprive teams of some of their race tyre allocation if cars continue to consistently fail scrutineering. NASCAR senior vice president of competition Scott Miller made the suggestion during a radio interview – several teams have missed qualifying sessions this season due to their cars having to make multiple passes through the inspection process before being declared race legal. Eight teams were penalised practice time at the Dover race weekend after inspection issues the previous weekend at Charlotte. RT

TCR

ABOVE Unfair advantage? The ComtoYou Audi team is among those complaining loudly over perceived Balance of Performance disadvantages

BoP in TCR stokes controversy

Andrew Charman

SALZBURGRING, Austria: Competitors in the TCR International Series are growing increasingly critical of the category's Balance of Performance process, with the view that TCR technical personnel are making incorrect rulings from one race to the next.

The TCR BoP formula, now in its third year, is based on an initial setting made at the start of the season, followed by adjustments on a race-by-race basis during the championship. However, teams have highlighted the example of Honda being able to win a race on an aerodynamics dominated circuit despite carrying full success ballast, while an Audi team is threatening to quit the series, claiming it has been given BoP penalties on tracks where its car was already less competitive.

TCR technical director Andreas Bellu explained to *Race Tech* that the BoP uses simulation programs and reverse engineering to separate the performance of the car from the team and driver. Vehicle parameters supplied by the manufacturer, such as corner weights, engine power and aerodynamics, form a starting point.

Each different brand of car then attends a pre-season BoP test where they are analysed in the wind tunnel, on an engine dyno and on track by a single driver nominated by the TCR series, and not one of its entrants.

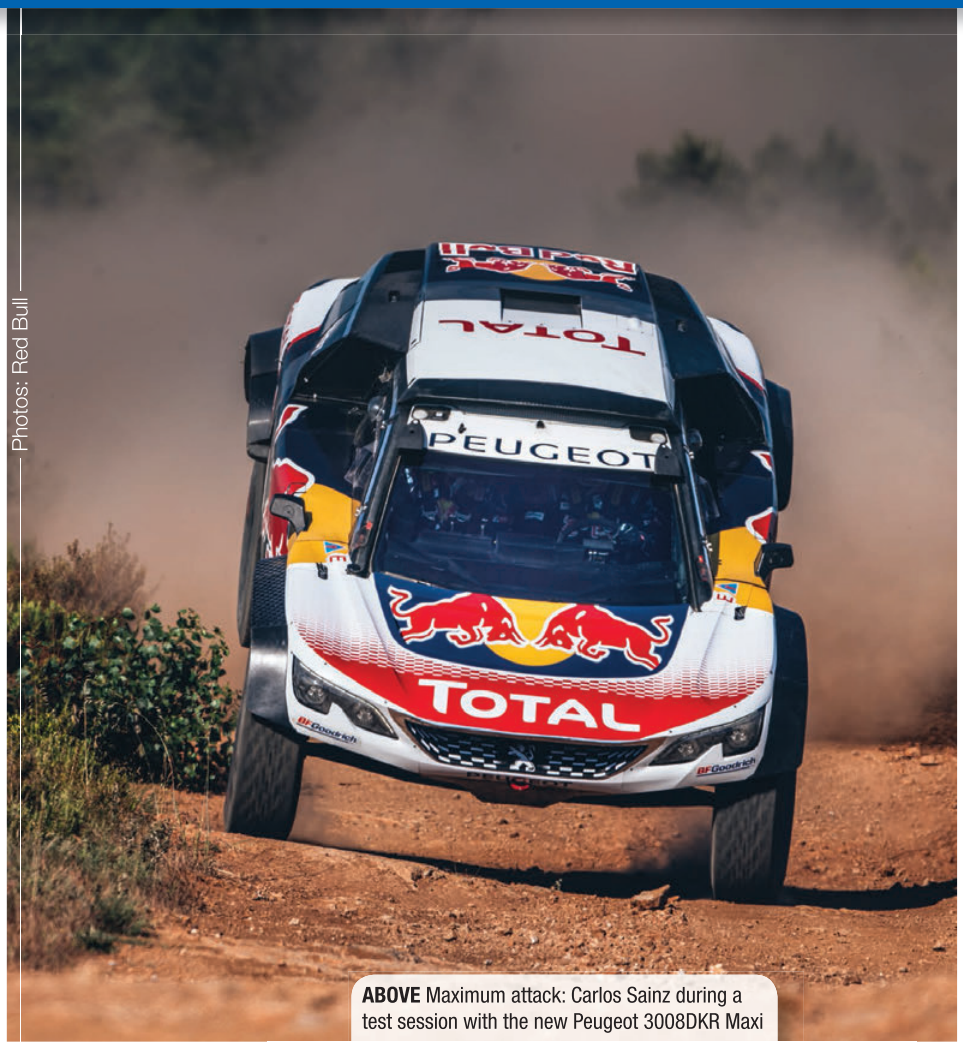
TCR uses a generic model of a TCR car, calculating each car's reference to it and then the specific parameters of each circuit, adjusting each car in an attempt to average out performance of each model across the season. If after an event the performance of a model has differed significantly from the expected performance distribution its BoP is adjusted, mainly through weight, ride height and engine power.

While BoP has always been a contentious issue across all race series in which it is applied, the controversy grew in TCR after the Salzburgring round on 11 June. James Nixon, team principal of Swedish team WestCoast Racing which runs Volkswagen Golf GTIs in the series, suggested that the BoP formula needed modification, after Honda driver Roberto Colciago was able to win on the aerodynamics dominated track, despite carrying a full 30 kg of success ballast and not benefiting from any slipstreaming tows from team mates.

Before the next TCR round at the Hungaroring BoP changes added 10 kg to the base weight of the Honda Civic Type Rs, while removing the same amount from the Volkswagen and SEAT entries. However, rivals to the Honda claimed the changes were not sufficient, with Frédéric Vervisch of the Comtoyou Audi team claiming that the formula appeared to be calculated on driver rather than car performance.

Following the Hungaroring races, Comtoyou, which includes TCR International's two-time and currently only champion Stefano Comini in its team, threatened to quit the series over the BoP regulations. The team claimed that the weight breaks given to the Volkswagen and SEAT entries further penalised the Audi at a circuit where it was known to be disadvantaged anyway. Team principal Jean-Michel Baert told Belgian media Speedweek that the BoP was being changed without any sporting reason.

"Nunzia Corvino, sporting & series director told me 'Well, the BoP was modified following the results.' So it's a BoS, a 'Balance of Success' and not a BoP", said Baert. "I do not want to have an advantage, I just want to go back to a BoP that worked relatively well before Budapest. I'm okay to see my team lose, provided we have had the same chances as our opponents." RT



Photos: Red Bull

ABOVE Maximum attack: Carlos Sainz during a test session with the new Peugeot 3008DKR Maxi

DESERT STORM ON THE WAY?

Anthony Peacock considers why Peugeot's new 'Maxi' rally raid contender could be its last

THE winds of change are sweeping through the desert.

Quite literally, as it happens, because sandstorms are a common feature of the Dakar Rally, reducing visibility to centimetres and stripping the enamel off teeth. But there's a wider wind of change blowing through the whole cross country scene, with even more potential for abrasion than any Bolivian sandstorm can whip up.

First, here's what's new on the technical front for next year. The Peugeot 3008 DKR that dominated Dakar to the extent that it occupied the top three places in January (having also won in 2016) gets a small but significant enhancement. Meanwhile the manufacturer's 'dream team' of Cyril Despres, Sebastien Loeb, Stephane Peterhansel and Carlos Sainz is retained for another season.

Peugeot is at pains to point out that its definitive 2018 Dakar spec is yet to be finalised, but there's one obvious evolution on the latest car, as the new name – Peugeot 3008 DKR Maxi – suggests. It's bigger.

Or rather, wider. The track has been increased by 10 centimetres on each side, a measure that has called for new upper and lower wishbones, as well as front and rear track rod ends and driveshafts. The result is a considerably more stable car than its predecessor, which was undeniably effective but pitched around like an aeroplane simulator despite the two adjustable dampers per wheel.

"With the new track, you can be more aggressive with the car, slide it more," points out Loeb, who came within five minutes – a blink of an eye – of winning his first Dakar in January. "It's obviously been a good car, but never particularly easy to drive: it had a tendency to go on its door handles. Now you can attack more."

Other modifications to engine and suspension are likely to follow, but they're almost not needed, such has been the superiority of the Peugeot.

> *"The stronger should be prepared to give up something, especially if he is so dominant"*

So, here's the bombshell: next year might be the last one. Because if Peugeot doesn't like a new raft of technical rules that are proposed for the future – and motorsport history shows that those who dominate are normally opposed to technical revolution – then the French team is out.

A number of proposals are on the table, including handicapping the two-wheel drive 'buggy' formula that has been so successful in the hands of Peugeot. MINI boss Sven Quandt (whose car is four-wheel drive) points out: "The stronger should be prepared to give up something, especially if he is so dominant."

Like the (ageing) MINI ALL4 Racing, the 3008 relies on a 3.0-litre V6 turbodiesel. Road car sales suggest though that diesel has had its day; as prominent capital cities turn their backs on it. With Audi having pulled out of the World Endurance Championship last year, cross country is the only show left in global motorsport that puts diesel on a pedestal.

Peugeot explains that it's turbo technology rather than diesel per se it is promoting, but the black smoke that all the diesel-powered cars on the Dakar emit is hard to ignore, now that it's caught the attention of the health and safety mafia.

The other big player, Toyota, has gone down a different route, with a normally aspirated 5.0-litre V8 powering its Hilux: arguably an even more politically incorrect powerplant than a 'dirty diesel'.

So, the obvious solution would be a smaller capacity turbocharged petrol, as seen in Formula 1, the World Rally Championship and even World Touring Cars. But there's a problem. The history of the Dakar is littered with fiery accidents, which have resulted in

ABOVE Peugeot's 3008DKR Maxi takes shape at the PSA factory in Versailles

ABOVE The suspension track has been increased each side by 10 centimetres

heavy loss of life, as the cars set off with 400 litres of fuel aboard, normally in roastingly hot conditions. That quantity of petrol anywhere near a glowing turbo could spell disaster, whereas diesel is a lot less flammable.

On top of that, the shape of the championship itself is changing. The FIA Cross-Country Rally World Cup doesn't actually take in the discipline's best-known event, the Dakar Rally, nor another epic rally that's even longer and forms an additional centrepiece to Peugeot's campaign: the Silk Way Rally, which goes from Russia to China. That's the event on which the new Peugeot 3008 Maxi gets its debut this summer. But, of course, it wasn't that long ago that there was no Le Mans in the World Endurance Championship...

So, everything is changing. On Peugeot's wish list after 2018 is no handicapping, technical freedom, and a true FIA endurance championship for cross country rally cars: maybe five long rallies per year, taking in all five continents. There would be no stronger message to promote the go-anywhere ability of the latest range of SUVs.

But Peugeot is the only 'full' manufacturer entrant in the field, which continually improves its car year on year. The privateers who make up the bulk of the entries don't necessarily have the time nor the budget to entertain such a notion; particularly with the specialised technology that would no doubt be needed.

But you've got to admit it sounds great, doesn't it? RT

WHERE THE REAL WORLD MEETS THE VIRTUAL WORLD...

McLaren is offering the world's fastest gamer a year-long test role in its simulator. **Gary Watkins** finds, to his surprise, that 'the greatest job in esports' really might be more than just a gimmick

THE idea of plucking someone from the world of esports and plugging them into a Formula 1 team's simulator programme might sound preposterous. But then so did taking a computer gamer and turning them into an international racing driver, and Nissan's GT Academy has proved the validity of that idea. So why shouldn't a scheme dubbed 'World's Fastest Gamer' produce a valued member of McLaren's simulator team?

The GT Academy has put six drivers on the grid for the Le Mans 24 Hours since it was launched in 2007 and, more pertinently, turned three of its multiple winners into true professional racing drivers with factory contracts. The architect of that scheme, former Nissan global motorsport boss Darren Cox, has now come up with the plan to find an F1 simulator driver from the world of online gaming. It was, perhaps, the obvious next step for a man who describes gaming as "bigger than Hollywood".

"The way online gamers talk about their set-ups would shame some drivers in the junior formulae," says Cox, now the self-styled chief maverick officer of the IDEAS+CARS consultancy he established following his departure from Nissan in the wake of the unsuccessful LMP1 programme with the front-engined GT-R NISMO LM in 2015. "It is obvious that gaming is getting closer to real simulation.

"It wasn't long ago that F1 teams were using rFactor

ABOVE Nice work if you can get it: the winner of the World's Fastest Gamer initiative will land a role on McLaren's sim team

McLaren

as the basis of their simulators and now it is freely available for a high-end PC costing a couple of grand. It is not a very big jump to think that someone who is good at gaming could be a help to McLaren in their simulator programme."

McLaren was an obvious fit for Cox's latest idea. Among its sponsors are Logitech G, a manufacturer of gaming equipment, and racewear specialist Sparco, which has recently moved into the gaming market. Both have signed up to the World's Fastest Gamer concept, along with the givemesport internet news portal.

New McLaren Technology Group chief executive Zak Brown clearly likes the idea. "The business we are in lends itself towards esports," he says. "Simulation has been very important to McLaren's success and esports has a very young and exciting audience, who we will get to talk to through this competition.

"Gaming is becoming increasingly real. The only thing you can't do when playing a computer game is hurt yourself. Short of that gaming and simulation does everything else."

HOW IT WILL WORK

Cox is describing World's Fastest Gamer as a "champion of champions" that will bring together 10 top esports competitors from various platforms, such as rFactor and iRacing, for the finals in September at the McLaren Technology Centre in Woking.

"Six of the 10 will be chosen from existing platforms by a panel and a further four from events that we will be organising through the summer," he explains. "We will look at the result of the Vegas eRace organised by Formula E, and those who are competing in iRacing championships, Forza Motorsport and Project CARS. Those people are going to choose themselves, because we want the top drivers across all gaming platforms."

> *"A gamer should be better at optimising set-up in a simulator than a racing driver"*
>
> ***Gary Anderson,** former Jordan and Stewart F1 designer*

Two of those events have already been announced, the first for Silverstone, in August and early September around the rFactor 2 platform, and the second in the USA for the Xbox One. It is also intended that there will be a qualifying event based around a mobile phone game.

Cox says that there are agreements in place for World's Fastest Gamer to run for multiple years. "It's not a short-term thing," he insists, explaining that in future years the selection process would become more structured, with the winners of chosen championships proceeding directly to the finals.

"We want it to become more democratic, with the winners of various championships going through to the finals," he explains. "Someone who has never been involved in motorsport or gaming could start practising now and ▶

McLaren

ABOVE The inspiring surroundings of the McLaren Technology Centre will provide the backdrop for the competition's final, held later this year

potentially be in the final next year."

The finals, says Cox, "won't be so much a run-off as a job interview". The lucky 10 will be put through their paces on the McLaren F1 simulator in the same way as racing drivers trying out for a place on the F1 team's programme.

Alice Rowlands, a vehicle dynamics and driver development engineer at McLaren, explains the process. "The first test is just, are you quick enough? You need to be driving close to the limit to be able to really feel what is going on with the car," she says. "Then we encourage them to find consistency and measure things like their lap time consistency and then their braking consistency.

"Then the final test, which we really find useful and asks a lot of them, is about feedback. We start off doing something where we know what the change does, something that almost anyone with any experience of driving a real car should be able to pick up. Then we move closer and closer to the almost ridiculously fine detail that we expect from our very experienced drivers to see how far they can go."

WHY IT CAN SUCCEED

World's Fastest Gamer is based on the same premise as the GT Academy. And that's sheer weight of numbers. If you push enough people into the system – and entries for the PlayStation-based Nissan scheme have topped one million – then the winner will be a bit special.

"The premise on which the GT Academy works is by having a huge funnel into which you pour up to a million people playing Gran Turismo on their PlayStations around the world," explains Laurence Wiltshire, project director of GT Academy. "It's a good enough game that it acts as a filter to give you winners who have good raw skills and persistence, the kind of attributes you want in a racing driver.

"A fraction of the number of people taking up gaming each year begin real motorsport whether in karting or cars. In the non-virtual world, the filter isn't only skill of the driver. It's financial because it is not only the drivers with talent who move towards the pinnacle. The real world involves a much smaller sample and an unfair system."

The winner of the inaugural World's Fastest Gamer finals won't be the finished article, of course. No one is saying that. They might be quick, perhaps quicker than regular McLaren F1 drivers Fernando Alonso and Stoffel Vandoorne. Witness that when Formula E held its big-money sim race in Las Vegas early this year, it wasn't one of the drivers from the FIA's electric-vehicle championship that came out on top. Bono Huis scooped the $200,000 first prize – not to mention $25,000 for pole position – on the way to a victory over Mahindra FE driver Felix Rosenqvist.

The winner of the McLaren scheme will need to be turned into a simulator driver in the same way as the competition winners in GT Academy have had to be educated, trained and prepared for their prize drive aboard a GT car in the Dubai 24 Hours. ▶

Nissan

ABOVE GT Academy winners like Lucas Ordonez, seen here driving to his first SuperGT victory in Japan, have already proved the validity of the gaming route into motorsport

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That involves everything from doing the necessary national-level racing to upgrade to an international licence, to experiencing the uncomfortable reality of signing on at 7am at a damp and miserable Castle Combe or wherever.

"There's no doubt that you could find someone from the gaming world who could do a good job at driving the simulator," says Aston Martin Racing GT driver Darren Turner, who leads Base Performance Simulators in Banbury. "But they are only going to be of any use to McLaren if they can give the feedback the engineers require. When they are gaming, they set up the car themselves, but in the F1 simulator programmes that's the engineer's job.

"There will have to be a process of education to enable them to learn more about set-up and to understand how an F1 simulator programme operates, so that they can give the engineering staff valuable feedback. But you could potentially find someone who is the perfect simulator driver because there is such a big pond of people to dip into."

Mark Temple, Alonso's race engineer at McLaren, believes that the skills acquired in the virtual world of gaming are "very transferable" to a modern F1 simulator. But, he says, "the key will be relating the feelings of the real car from the simulator".

"A gamer might not be able to relate what's happening on the simulator to the racing car, but you don't necessarily need to have a background of driving a real car to do that," he explains. "We see some racing drivers get into the simulator who are very insensitive to how it feels, but can drive a racing car very quickly. There will be an education process, but I believe it is actually more about the person and the skills someone has, rather than where they learned."

How McLaren hones the skills of the competition winner has yet to be determined. Rowlands suggests that it is likely that driving a real racing car – though probably not an F1 – will be part of that process. ▶

ABOVE & BELOW Far from the usual competition winner who everyone wants to stay out of the way, the WFG victor will be at the heart of McLaren's simulator team

Photos: McLaren

> *"I see gaming as a route into racing. Some countries have few karting circuits, but everyone has a mobile phone"*

ABOVE Simulation has played an increasingly pivotal role in the setup of the real car for the racetrack

Tee/LAT/McLaren

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ABOVE Cox believes high-end gaming will eclipse the junior racing formulae in feeding young talent into motorsport

"I believe it would be valuable to give the winner some time in a real car to learn some simple things like how the car rattles you around and what a tyre feels like when it is sliding," she says. "I'd be looking for an opportunity to get them some time in a real car on-track, even if it were much lower performance than a F1 car."

REAL CAR EXPERIENCE

Whether real car experience is necessary is an interesting question. Talk to some drivers and they will tell you that driving on the sim is a totally different discipline to driving a race car.

Porsche LMP1 driver Nick Tandy, winner at Le Mans in 2015, has interesting views on this. "When you are driving on the track, the g-forces are the all-important inputs that you drive by," he says. "On the sim, the inputs come from vision and sound, because you can't accurately simulate sustained g-forces.

"Driving a simulator is so different to driving a racing car that the only way you can become good at it is, like most things in life, by practising. If I've been away from the Porsche simulator for a month, I have to practise hard for couple of days on the set-up that I've got at home to make sure I'm ready and dialled-in for it."

Gary Anderson, the former Jordan and Stewart F1 designer, goes even further.

"A gamer should be better at optimising set-up in a simulator than a racing driver," he says. "That's because you drive a racing car through the seat of your pants, but you don't do that in a simulator. You have totally different inputs."

It is different, as Tandy says, because the forces to which a driver in the simulator is subjected are nothing more than a representation of those that he would encounter in the car out on the racetrack.

"We're not trying to give the sim driver the sensation of 5g under braking, because that is not actually that important," says Rowlands. "You could swing the driver around like a pendulum to represent the forces involved in driving an F1 car, but the drivers already know about that. What we are trying to do is to give them as much information as possible about the minute details, the high frequency things."


FIA/Formula E

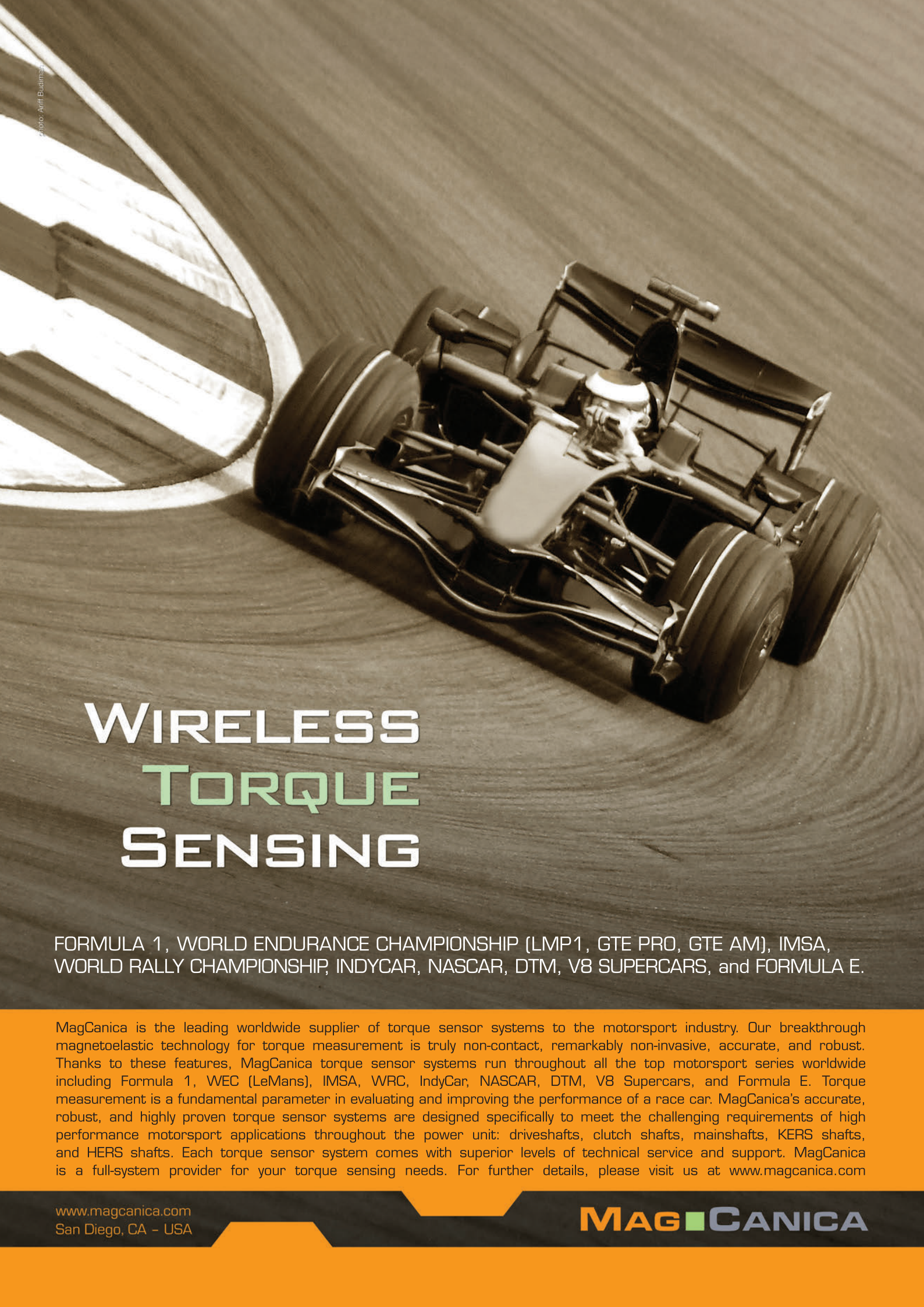
BELOW When Formula E staged its big-money sim race in Las Vegas, it wasn't one of the championship's real racing drivers who came out on top

WHY GAMING IS VALUABLE

Alonso made a comment late last season suggesting that hours spent on his PlayStation had served him well as he attempted to make up places from lowly grid positions – he gained a total of 29 positions in five end-of-season races in 2016. How serious he was being isn't clear, though Temple reckons that "there is often an element of truth to his jokes".

It is fact, however, that many of the latest wave of drivers to reach F1 are or have been active gamers. There's little doubt that a generation of drivers who have been prevented from testing to the same level as their predecessors, before and after they get to the pinnacle of our sport, have gained from the hours spent competing online.

European Formula 3 Championship frontrunner Lando Norris, a member of McLaren's young driver programme, still competes for the Team Redline online squad ▶



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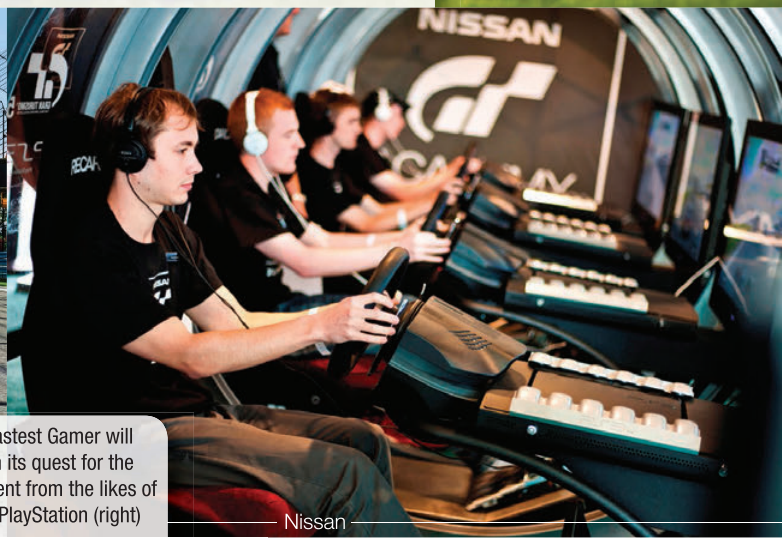
ABOVE The likes of Verstappen and Ocon lead a new generation starved of track testing but brought up with gaming and simulation

iRacing



Nissan

ABOVE World's Fastest Gamer will cross platforms in its quest for the best, sourcing talent from the likes of iRacing (left) and PlayStation (right)

on iRacing. He says driving in the virtual world is of most value when it comes to learning a new circuit or car, but reckons that gaming is good for trouble-shooting.

"If I want to work on a certain area of my driving, I go on the sim at home," he says. "I can compare a lap with someone who is good in that particular area. That can be quite valuable."

Rowlands believes that gaming is probably most useful for the young up-and-comer in "helping to train the brain in different racing scenarios".

"Where high-level gaming really helps a young driver is that it allows them to, if you like, practise racing and in particular wheel-to-wheel racing, because there is only limited opportunity to do that on track," she says. "Gaming teaches you how to think strategically. You have to line up your opponent, work out your strategy through a race. That's something you don't really do in karting or the junior single-seater categories. But you can build up hours and hours of that virtually."

ALTERNATIVE TO KARTING

It could be argued that the best of the 21 GT Academy winners so far have already proved that gaming is an alternative to years spent charging around kart circuits as a teenager or before. Lucas Ordonez and Jann Mardenborough are now fully-fledged professional racing drivers with Nissan factory contracts, while Wolfgang Reip gave the scheme additional credence when he was picked up by Bentley's GT3 programme in 2016, admittedly on a one-year deal.

"Participation rates are rising as new simulator centres start up," says Wiltshire. "Many of them don't just do birthday parties and corporate events, they put on proper race meetings. These are the new karting circuits."

Cox believes that high-end gaming will become most significant in feeding drivers into the motorsport ladder in the emerging motorsport markets.

"Some countries have no culture of motorsport and relatively few karting circuits, but everyone has got a mobile phone," he says. "That's where gaming and simulation can be used to get people interested in competing, to get them started. I see gaming as a route into motor racing in place of, or at least in parallel to, karting."

Brown isn't ruling out the competition winner getting a chance to drive for the McLaren F1 team. That probably is PR speak, but Brown's insistence that the World's Fastest Gamer competition is no gimmick is eminently believable.

"It is a marketing exercise, but the idea is that it will contribute speed to our F1 team," says the McLaren boss. "We are taking it very seriously because we are going to learn new things this new driver is going to teach us.

"This is unlike other promotions where you might get the chance to be part of the pit crew for the day, but your real job is to keep out of the way of the pit crew. The competition winner is going to get a job as a professional F1 simulator driver. This is real." RT

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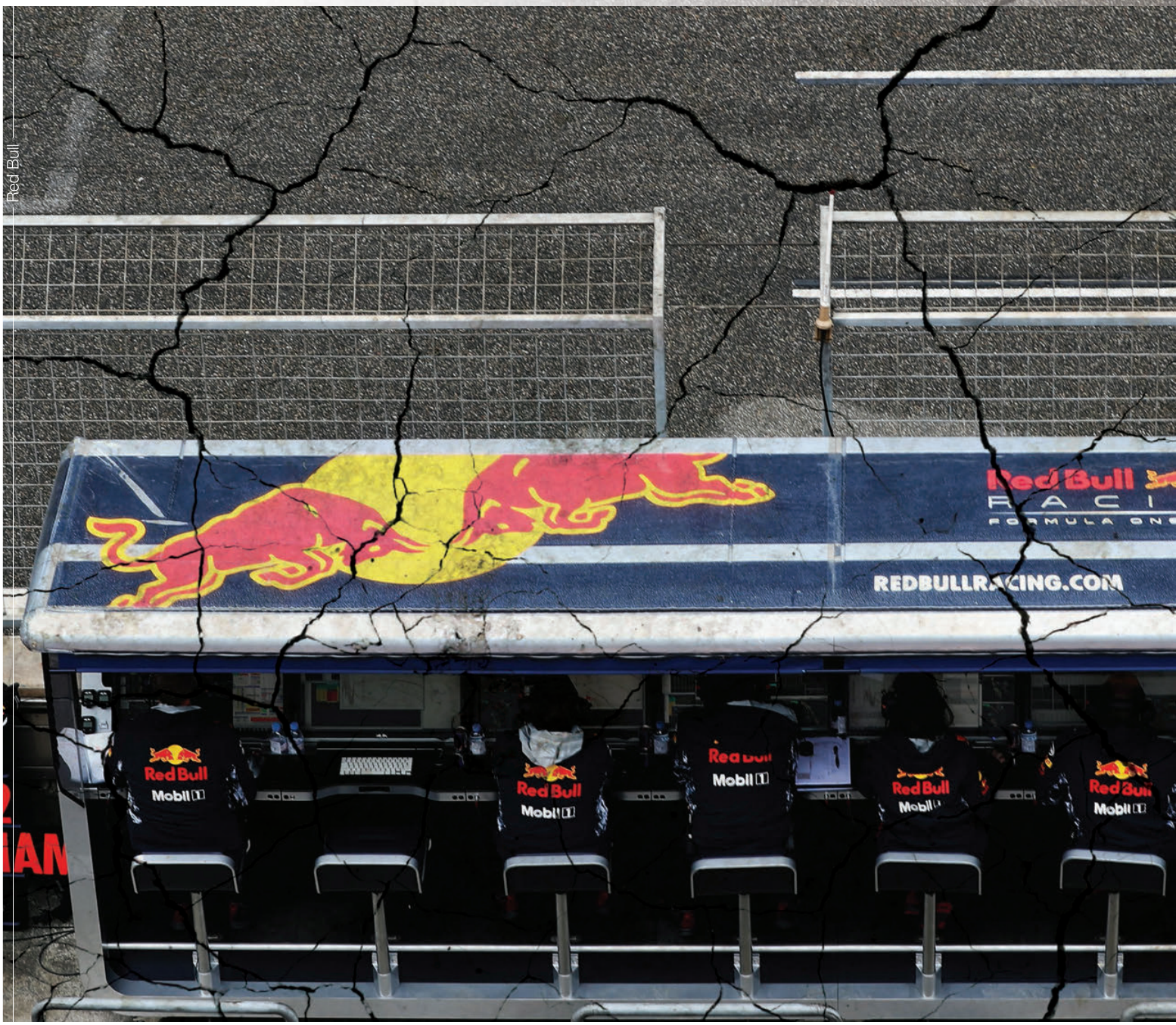
CRACKS IN THE WALL!

Are the pit wall timing stands relics of a bygone age, or a crucial part of the F1 show? **Dominic Harlow** investigates



ABOVE Almost oblivious to the cars streaking past just inches away, the Red Bull squad stay focused on their data screens

COMING towards the end of a long test, with a few hours of track time to cram in the inevitable last-minute items and those that have somehow slipped down the test list, you can always rely on one thing. A Senior Logistics Technologist, aka chief truckie, will ask, "Can the prat perch be packed down yet, as you're not using it, are you?" He then ambles off to start that long engine warm-up that modern diesel trucks somehow still seem to need.

At least this used to be the case. In recent times, it seems to have happened with an increasing frequency that, despite protestations from some quarters, the whole thing – possibly a rather special relic of old test team equipment – never makes it out of the truck to start with or even never gets loaded! At races though, when everything a team does is constantly on show to the world, the absence of the pit wall setup is still unthinkable. Or, it seems, *was* unthinkable.

Until now the pitwall stand has remained a mainstay of the trackside setup of pretty much any serious motorsport operation, from karting through to Formula 1. But how long will that continue?

Former Williams tech boss Pat Symonds believes that Formula 1 could simply scrap the presence of teams' command centres on the pit wall. Team managers and race engineers traditionally use the vantage point to direct a race and devise strategies based on extensive data fed to their computer screens. But Symonds contends that this is now an outdated concept, which exists perhaps more for the benefit of the TV audience than teams' executives.

> *"The pitwall is the football dugout of motorsport"*

"I would say that the command centres on the pit wall are meant more for viewers than the teams themselves," he says. "The team can operate fine from the garage. There is the same data and information inside. That would be no challenge."

Now a consultant for Sky Sports F1, Symonds suggests that the pitwall stand is a relic from a bygone era: "The command centre on the pit wall dates from the time you really had to sit on the pit wall to see some of the action on the track. Now you look only at computer screens. You can turn around only to see the pit stops."

Unlike the cars themselves, talk is cheap in the Formula 1 paddock. But when someone of Pat's ilk – with probably more than 10 thousand hours of pit stand experience behind him – ponders the issue, it is worth further investigation.

BLAZING THE TRAIL

So where did the idea of standing by the side of the track, monitoring the action that was unfolding and acting on that information, come from? It is probably most fairly attributed to the Mercedes-Benz GP team's Alfred Neubauer, the original and self-styled *Rennleiter* (or race team manager). His 'antics', as they were described by one Race Steward in 1926, of timing, lap charting and relaying information to his drivers, encapsulated the key functions of the pitwall. These are essentially the same today: observing, monitoring, timing and communicating, of course now with radio as well as with pit boards.

Moving on 50 years, as technology evolved and professionalism increased, evocative images from the trackside of electronic timing systems come to mind. (It probably made sense for this equipment ▶

to be located directly alongside the track, since it avoided the need for networking and the triggering system was elementary).

One can picture clusters of those fantastic-looking Olivetti-style 'green screen' monitors, covered by sun umbrellas. They were probably bedecked in tobacco logos and surrounded by team members sporting large collared shirts and equally huge sunglasses in a style made famous a few years later in *Top Gun*. Perhaps this period was the genesis of some of the aesthetic appeal and the entertainment factor of the latter-day pitwall.

It looks like all this glamour became too attractive at some point, hence the presence of team personnel in the pit wall signalling area became a subject to be dealt with by the regulations for reasons of safety. Article 22.13, as it has become, of the current Formula 1 sporting regulations, permits up to six team members per car to be present at any time during practice and the race, except at the start when the number is reduced to a total of two. This and similar restrictions have made each seat on the pit stand both a privileged and exclusive place to be, maintaining the interest of media and sponsors alike.

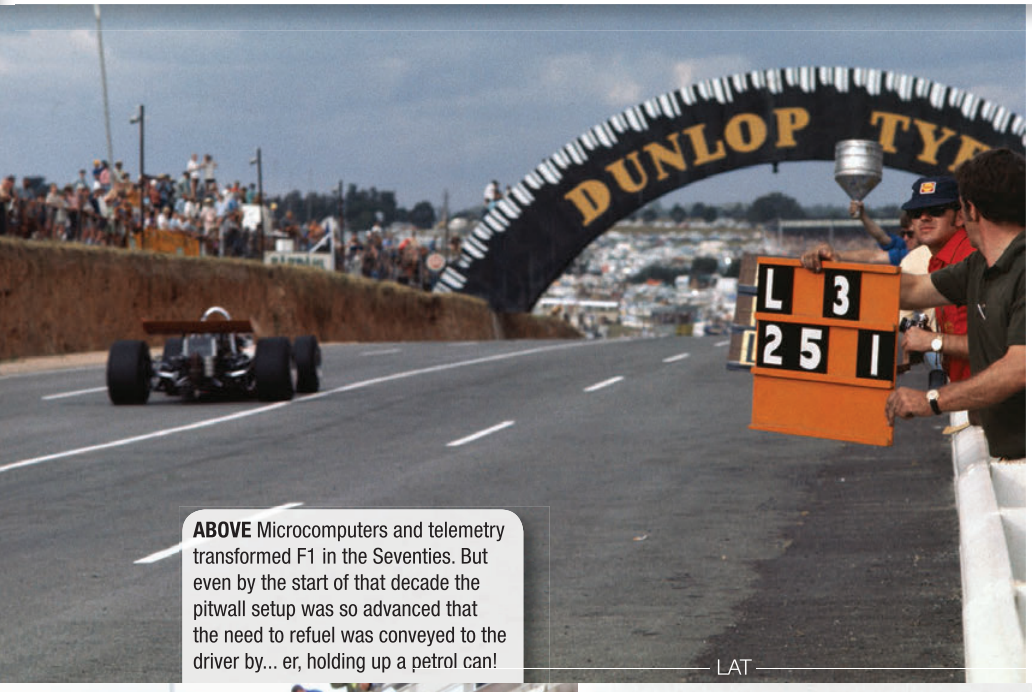
The safety measures are necessary, though. Those on the pitwall are amongst the very few in the active pitlane not wearing PPE (Personal Protective Equipment) of any form, but are exposed to increased risk from trackside debris or pitlane incident.

STATE OF THE ART

We take the Formula 1 pitwall setup for granted, but what do they actually consist of? They range from spartan sentry boxes, with room for little more than a laptop or clipboard, to eight-seater palatial constructions that are larger than your average bar or restaurant in Roppongi, downtown Tokyo. In the F1 pitlane at least, they are also altogether better equipped than the Christopher C Kraft Jr control room in Houston, wanting only for a water cooler and a coffee machine.

A typical pitwall timing stand, 'prat perch' or whatever you want to call it, accommodates eight personnel and two

ABOVE Best seat in the house? The gantry affords a strategic view of pit lane action

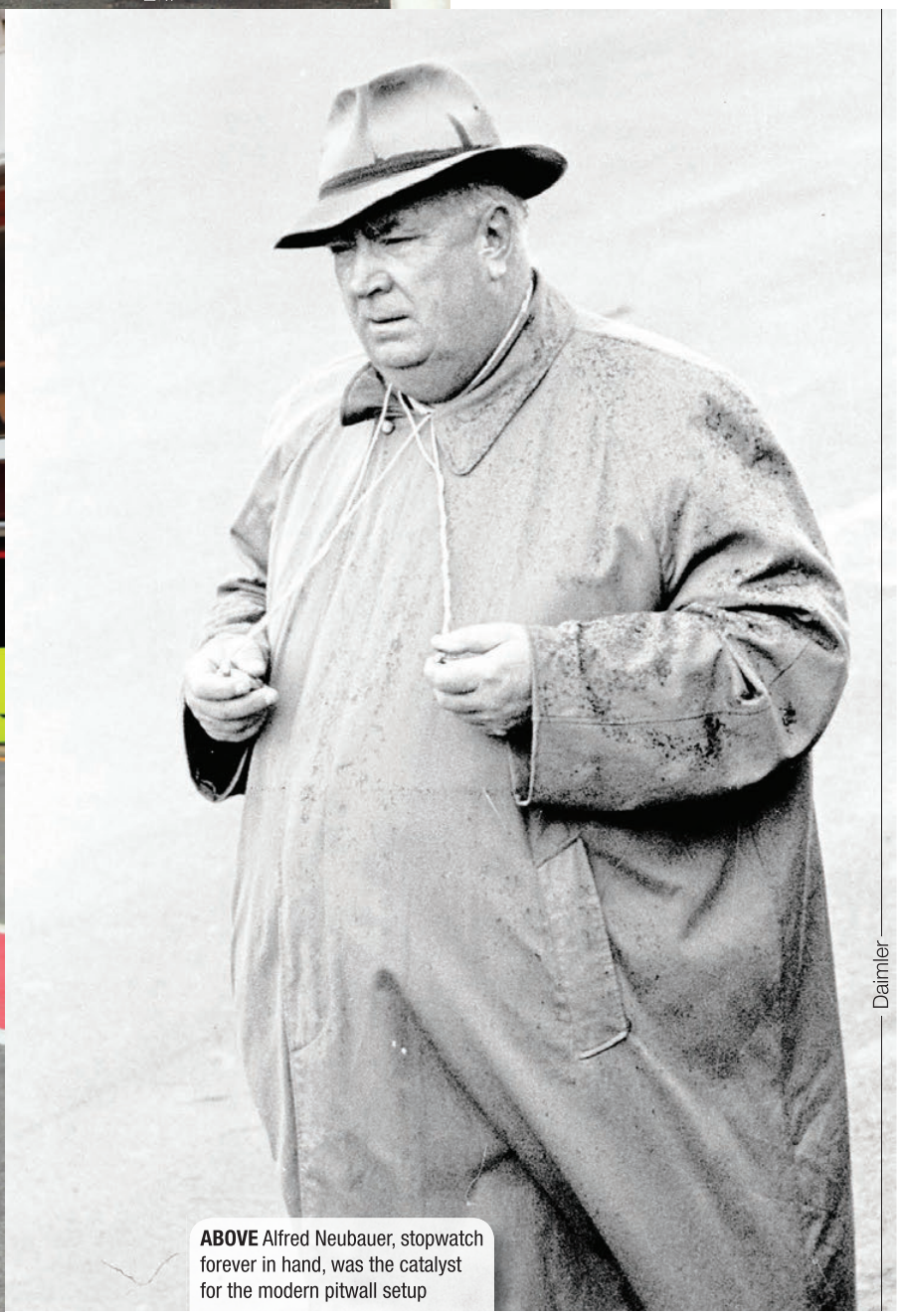


ABOVE Microcomputers and telemetry transformed F1 in the Seventies. But even by the start of that decade the pitwall setup was so advanced that the need to refuel was conveyed to the driver by... er, holding up a petrol can!

LAT

pit signalers. Usually there are the two race engineers, the chief engineer, technical director, team manager, strategist, team principal and owner. Every team in F1 operates this way because of the location of the common intercom connection to Race Control. But variations do exist, some choosing not to locate race engineers on the pitwall at all in favour of senior management, while others place two race engineers per car together on the stand.

It is normal to co-ordinate the seating plan by function, so that there is line of sight between the engineers and their car and driver and the pitstop position. If all else fails, hand signals or signs still form a part of the communication protocol to the pit crew ▶



ABOVE Alfred Neubauer, stopwatch forever in hand, was the catalyst for the modern pitwall setup

Daimler

in some circumstances, and they are close to their working counterparts. This might mean a split between a kind of technical and management area, for example.

Clearly these different layouts place a varying emphasis on the actual operational role of the pitwall. The more there are engineers, the more decisions will be enacted from it and the more outgoing and incoming communications traffic there will be to the other 'mission critical' areas within the team.

Although intercom and radio is ubiquitous in all these scenarios, what is commonly agreed on is that it is important to get the engineers together in one place. The reason for this is clearly in the sense of a group with a shared mission and that, as Albert Mehrabian's studies at the University of California in the 1970s remind us, 93% of communication between two people is non-verbal! That's a critical point to be giving up by scattering the team too much. It might go a long way to explaining one of the reasons why more trackside engineering can't be outsourced to the better-equipped and far less exposed nerve centres in teams' mission control rooms back at the factory.

As with early sun umbrellas, the pitwall stands have become an extension of a team's branding. They are therefore almost exclusively designed by specialists who do not work on parts of the car but specifically pit equipment and its ilk. They will weigh as much as a small car yet pack down to a fraction of their volume and be equipped with multiple intercom panels, screens and computing resource (for example a small 12U server rack located close by with UPS and back-up generator) and a communications node housing radios and intercom switches. Each seat can then access the full suite of timing, car, image, weather and peripheral data that would be available to anyone in the team. Most circuits now have rat tunnels beneath the pitlane that allow cabled networking to support this infrastructure. Where that is not available then remote connections, which were a necessity in the past, are used.

> *"Cameras can focus on tell-tale body language that betrays otherwise deadpan expressions"*

One irony of this amazing information-rich environment is that often the screens and panels completely blank any view of the track that was afforded by the location alongside the pit straight! A few teams have got around this by cutting viewing slots but, in reality, the additional situational awareness of the location is usually limited. It does afford a slightly broader view of the pitlane (and thus strategic information on the activities in other garages and pitstop positions, for example), combined with a slightly better feeling for the weather. I have never really understood, though, why it is necessary to hold one's hand outstretched whilst looking quizzically at the sky to determine the rain intensity with the greatest degree of accuracy.

It might look a glamorous life from the outside, but I have experienced working on some stands that somehow focused the sun's rays with incredible efficiency. They ensured that whoever was working underneath the roof was at risk of heat-stroke, or being slowly cooked. Yes, there were tiny fans, but they merely circulated the warm air enough to ensure it was an even job.

Other pit gantries have been tightly sealed from the elements in winter and heated with enough fan heaters to cause the generator to cut-out. For the engineer it felt as if the track had been transported to Malaysia or Bahrain. ▶

ABOVE For all the modern technology, hand signals remain part of the communication protocol: Damon Hill wishes Michael Schumacher 'good luck' from the pit wall at Silverstone testing! Tee/LAT

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BACK TO THE DRAWING BOARD

How Mature Technologies are Making a Comeback

Everything is changing but in a sense it's the same as it ever was, to quote Talking Heads.

Over the last few years we have peered into the far horizon and considered the increased electrification of the powertrain, autonomous racing, racing and many other future technologies almost overlooking the fact that the combustion engine is still here and is still being developed, as are other parts of the car.

So it's time we took that into consideration.

There is a vast amount of work going into making the combustion engine even cleaner and more fuel efficient than ever. It is still likely to be a vehicle's primary motive power for years to come, and this will be reflected in motorsport, not just in terms of competition but in terms of continued development. Cool burning, variable valve timing and lift, pre combustion chambers, and synthetic fuels — the possible disrupter of the disrupters — are just some of the areas of current intensive research.

While going back to the drawing board we will be going into aerodynamics, vehicle dynamics and lightweighting but not forgetting modern issues like connectivity, autonomy and increased hybridisation in the quest to engage a wider audience.

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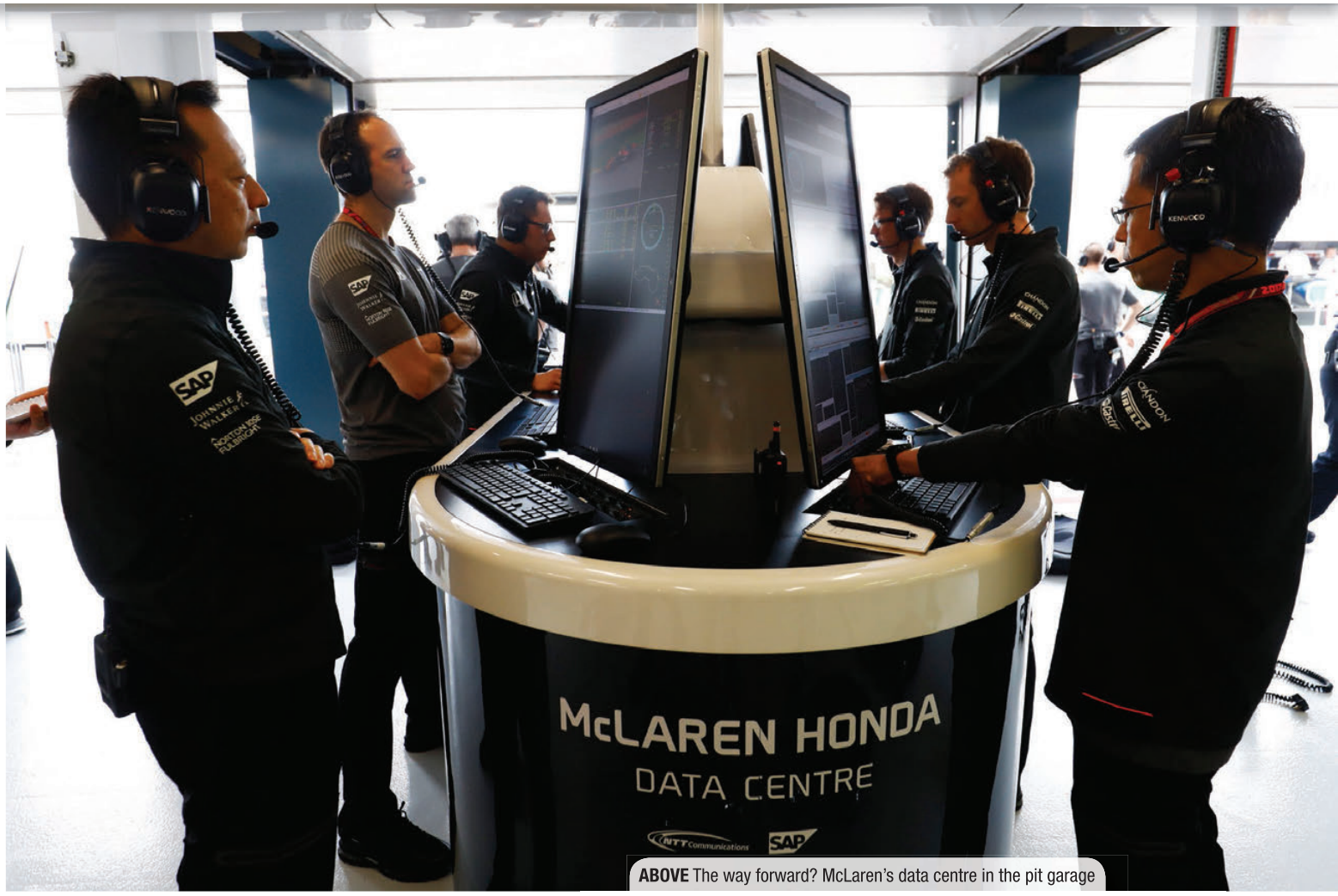

ABOVE The way forward? McLaren's data centre in the pit garage

COMPLAINTS COUNTER

To return to Pat's point, however, why not do away with all this seemingly unnecessary operational bravura and work in the garages or even the circuit office buildings? Well ahead of its time and still un-replicated, but set to be a feature of grands prix again soon, is the layout at Paul Ricard. This places the team offices at the back of the garages, directly linked and with panoramic windows overlooking the garage. It's an excellent concept.

It is increasingly common to move all engineering functions to a garage base. This idea of an 'island' or 'Complaints Counter', to use the jargon, was probably pioneered by McLaren. Perhaps Ricard was part of the inspiration? There are some benefits in that briefings and debriefings can also be carried out before and after sessions without having to change location (not possible when the pitwall is needed by another series). Also, the centralized IT infrastructure should provide greater reliability.

On the flipside, the garages are noisy and often quite cramped. In the case of circuits like Montreal, that is unlikely to change for some time. Certainly this kind of thing would not have been possible in the days of the 'T-car'. With the larger cars of 2017 and all their life-support systems, some might already have noticed a bit more of a squeeze.

JIGGLING FOOT

There is no critical reason why a pitwall stand is needed. But nor is there an overriding benefit of doing away with it. In some senses, it provides more 'real-estate' for a team to operate in at the track, and it has the commercial element that is also highlighted. It provides the cameras with a slightly better opportunity to focus on the perspiring brow, jiggling foot, or whatever 'tell-tale' body language betrays the otherwise deadpan expressions.

Similarly, the celebrations are there too. The pitwall is the football dug out of motorsport. (To extend that analogy, ▶

Red Bull

ABOVE Each seat can access the full suite of timing, car, image, weather and peripheral data. Mind you, you can't see the track any more!

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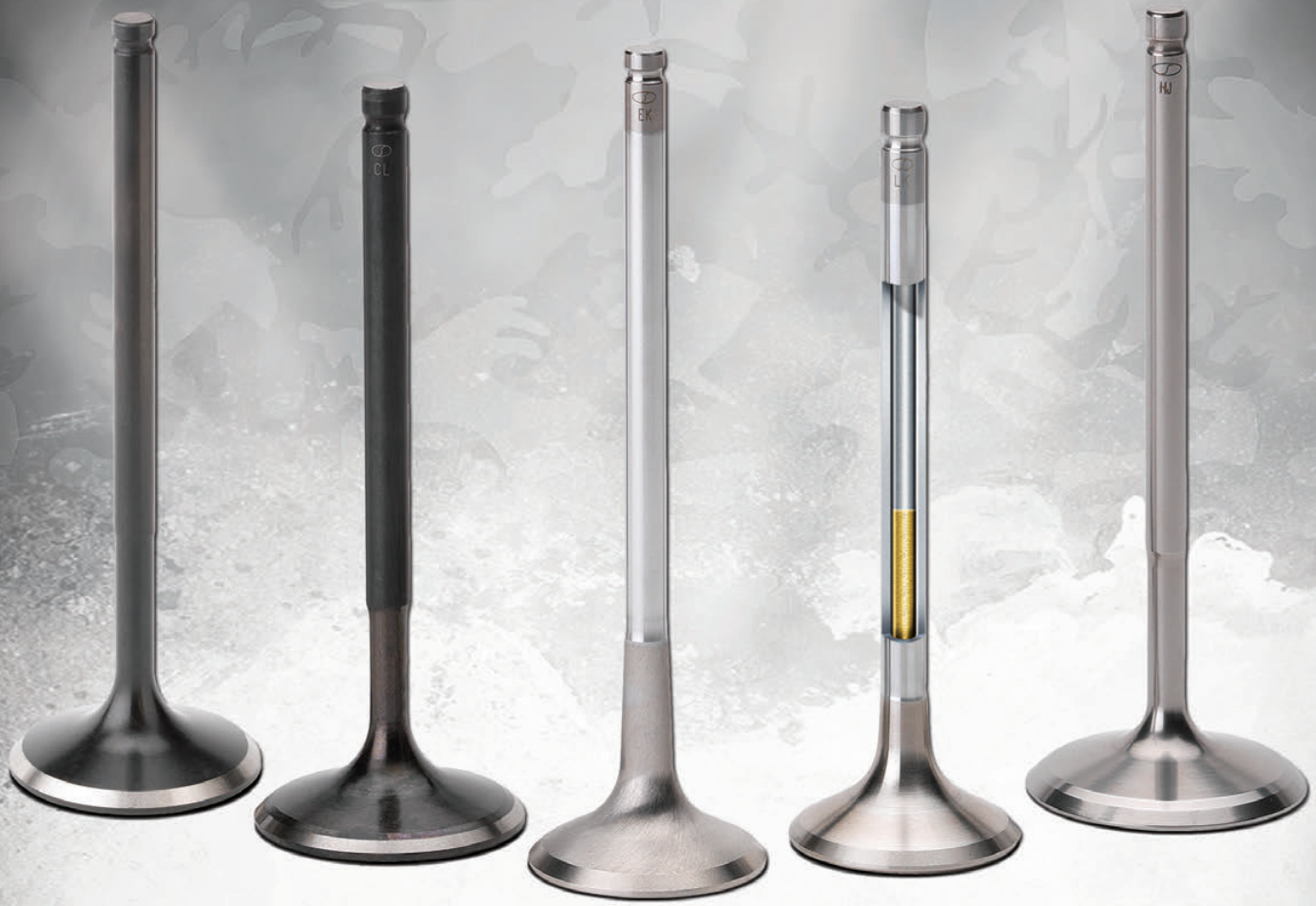

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BELOW The Monaco pitlane presents challenges like no other

there is no touchline ban in racing but maybe there should be!) Again, the loss of this aspect of the show is something that could be overcome: the cameras can roam and it would be interesting to have them following the reaction of the Mission Control rooms and those working behind the scenes back at the factories, at the data racks or wherever, who are no less committed with their efforts.

People sometimes ask if the cameras intrude when you are on the pitwall. Often, you don't even notice them in the heat of the moment. One recent trend is for permanent Go-Pro-type cameras to be attached to the stands, so the TV director can just cut to the footage whenever it's wanted. That means you don't even know when you are being observed.

Generally things on the pitwall are pretty absorbing and you get a kind of blinkered concentration (which you should guard against to an extent). The first time you

Monte Carlo and the fireman's pole

WHEN Pat Symonds talked of teams' ability to function without the pit wall gantries, his experience of the Monaco Grand Prix could well have been uppermost in his mind.

People always talk about the F1 paddock at Monaco whenever the event comes around: how cramped, how difficult to work in it is, but how atmospheric and eccentric and somehow special.

This year was no exception. Coming from the contrast of modern purpose-built venues like Sochi or traditional circuits like Barcelona, the principality is always a shock to the senses.

Since the renovations and circuit changes in 2004, Monaco has been even more unique in that it is physically impossible to place pitwall stands alongside the start/finish straight of the track. This unusual layout is because the pit wall from Antony Noghes to Sainte Devote runs along a row of trees that are almost part of the pit buildings that somehow stand around and amongst them.

This has necessitated a rather bizarre situation where the pit gantries are set on the first floor of the garage buildings, usually facing into a blank wall and with a limited view of the track from the swimming pool exit to Rascasse, and of the pitlane below through a rather precarious opening in the wall. The bird's eye view of the pit stops is novel and so far, it seems no one has been unfortunate enough to have fallen out.

To add to the general disorientation of those on the first floor pitwall, in order to get to the cars they must walk out through another upstairs room and descend a staircase in the far corner. They can then dodge around the spare engines and rear ends to access the working horseshoe around the car. It has long been discussed that a fireman's pole would be a useful garage modification for some of the less fit team members. RT

ABOVE & BELOW The driver currently deals with more than 50 functions on his steering wheel. Does he really need a lap count on a pit board too?

Darren Heath

ABOVE McLaren was one of the first teams to introduce a 'mission control' room back at the factory, better equipped and less exposed than the pit wall nerve centre

notice a camera is when you see the image on the monitor in front of you and it quickly dawns what's happening. A split-second later the producer realises his subject is no longer being observed 'in the wild' and cuts away!

The original function of Neubauer's invention also involved passing information to the cars, in other words pit signalling. Invariably the pitwall will provide for those using the pit boards, emerging every lap through a slot in the safety fence to carry information on the race gaps and number of laps completed or remaining.

> *"Intercom and radio is ubiquitous but 93% of communication between two people is non-verbal"*

It was interesting in Monaco to hear a recently retired F1 driver explaining how important he had considered the pit board to be. On the other hand, if the pitwall stand is an anachronism, then surely the pit board is pre-historic and using it little more than a discipline to be learned in the lower formulas and kept sharp as a matter of maintaining the highest standards?

It has almost become a tradition, rather like an airline pilot still knowing the meaning of coloured light signals from a control tower or a carrier captain using semaphore to relay a message to a nuclear submarine. The general point is clear: technology is fundamental to motorsport as a whole, and to Formula 1 in particular, so it seems slightly ridiculous that there are not more efficient means of communication.

With more than 50 functions on the steering wheel and large display and multiple aspects of the car to manage, the driver cannot be expected to reliably perceive and process pitboard information on every occasion anyway. Certain circuits, for example Interlagos, and poor weather make it on occasion even less feasible.

It seems that like control towers at major airports, whilst the reasons for the pitwall are eroded it is still a fundamentally sound principle and will continue to stand the test of time for a long while to come. So where's that truckie? The generator's out of fuel again and someone's lost the remote for the pitwall TVs… RT

WEC TARGETS SHIFT FROM ZERO TO HERO

With zero-emissions, plug-in hybrids and moveable aerodynamics on its agenda, the World Endurance Championship has plotted a route to 2020. **Gary Watkins** investigates

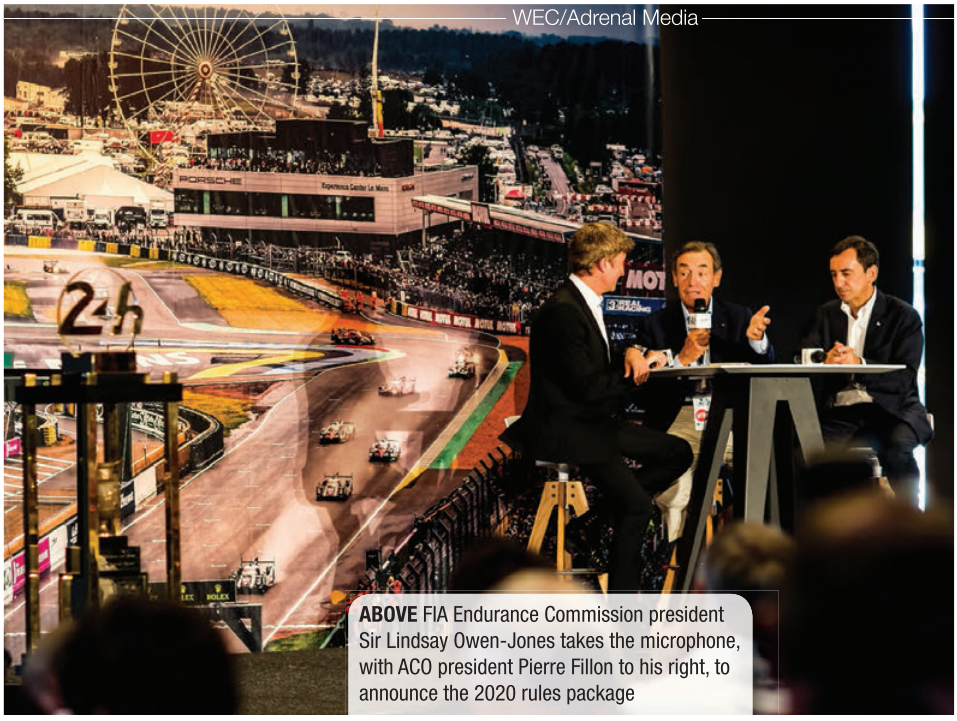
TECHNICAL innovation will still be at the core of the LMP1 Hybrid category when new rules come into force for the World Endurance Championship in 2020. The next generation of factory P1 car will be required to race in all-electric or zero-emissions mode, though admittedly for short periods only. And they will run active aerodynamics, too.

The increase in the scope of hybrid technology with the introduction of zero-emissions running, for one kilometre after every fuel stop, comes at the same time as a raft of cost-cutting measures aimed at encouraging new manufacturers into the P1 division. Active or moveable aero is actually one of those measures conceived in the name of budget reduction.

Everyone involved in drawing up the broad outline of the 2020 rules was insistent that there must be no step backwards in terms of technology. The manufacturers – existing LMP1 competitors Porsche and Toyota and potential returnee Peugeot – need a message to tell, and the rule makers, the FIA and WEC promoter the Automobile Club de l'Ouest, agree.

"Everyone wants to save costs, but not at the expense at emptying the technological tank," says Toyota Motorsport GmbH technical director Pascal Vasselon. "Manufacturers such as Toyota have come into the WEC because it is an opportunity to showcase high-level technology that is relevant to road car development. We want to showcase a high level of electric performance."

Vasselon suggests that it is important that LMP1 doesn't become something like the Daytona Prototype international category, the LMP2-based class for manufacturers competing in the IMSA SportsCar Championship in North America: "We don't want a super-DPi, because then we would stop."



ABOVE FIA Endurance Commission president Sir Lindsay Owen-Jones takes the microphone, with ACO president Pierre Fillon to his right, to announce the 2020 rules package

> *"Everyone wants to save costs, but not at the expense of emptying the technological tank"*

WEC/Adrenal Media

ABOVE The new rules juggle the need to restrict manufacturers' spending while at the same time offering them a technical narrative to woo the automotive industry

MARKET RELEVANCE

The cost-cutting drive began when the rules freeze for LMP1 hybrids covering the 2017-19 seasons was implemented at the end of last year, in the wake of Audi's withdrawal from the prototype arena after 18 seasons. That decision put on ice a ramping up of hybrid technology for the 2018 season. The maximum amount of energy that would have been able to be deployed over a lap of Le Mans was due to go from eight to 10 megajoules, and a third energy-retrieval system would have been allowed to enable the manufacturers to reach the new limit.

The rule makers and the manufacturers believe that what has emerged in its place is much more road-relevant and, just as crucially, gives the manufacturers a new technological narrative to tell. Zero-emissions running will go hand in hand with the introduction of plug-in rapid charging technology to be utilised at the same time as a car is refuelled.

"By increasing the energy to 10 MJ, what would we show?" says FIA technical director Bernard Niclot. "The technology already exists on these cars, so where is the value? Plug-in hybrids are much more interesting for the manufacturers; just read the newspapers. Sure, there will be a cost of developing the technology, but the manufacturers will have something to show for it."

The introduction of plug-in charging and zero-emissions running reflects developments in the automotive industry, argues FIA Endurance Commission president Sir Lindsay Owen-Jones.

"It is the conviction of the manufacturers that plug-in hybrids are what they will be selling in five years' time," he says. "More and more cities are closing their roads to cars that are not zero emissions, so this rule gives a new dimension to our ▶

WEC/Adrenal Media

ABOVE Cars will have to cover the first kilometre after each refuelling stop in full electric mode

regulations. This has not been done on a whim. We are reflecting movements in the automotive industry."

The FIA and the ACO are hoping to keep a cap on the development costs of the new technology. The idea, at least for the moment, is for a spec charging system to be developed that would be used by all the manufacturers.

The one-kilometre distance that the cars must complete on their electric motors has been driven by the current 8 MJ energy limit. The rule makers believe that this amount of electrical charge will allow the next breed of LMP1 to race at or near full speed with their internal combustion engines switched off.

"We did not come up with this figure of one kilometre randomly," explains Niclot. "Our simulations suggest that to be at full performance for one kilometre – and that is what we want – you need 8 MJ."

ACO sporting director Vincent Beaumesnil is insistent that there will be "no sacrifices when it comes to performance" over the zero-emissions kilometre. "We want to keep the racing exciting and are doing everything possible to maintain normal performance, even in electric mode," he continues. "That is the target we have."

There will be a second element of the zero-emissions rule requiring the cars to take the chequered flag in electric mode. How much of the final lap of the race the cars will have to complete running without burning fossil fuels has yet to be set.

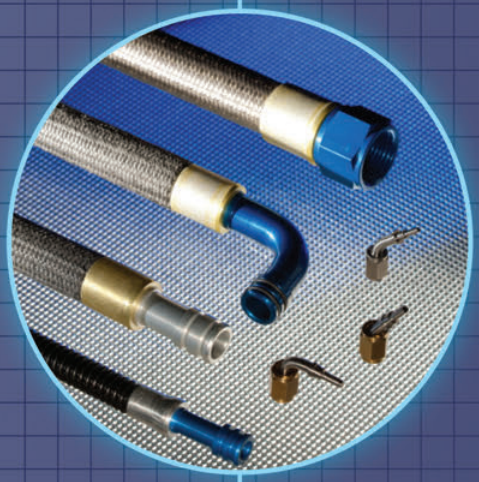
The introduction of the one-kilometre rule will effectively remove the possibility of a manufacturer competing in any other of the four hybrid sub-classes other than the highest 8 MJ division. That's interesting because Peugeot had publicly stated that the level of technology in LMP1 was the primary reason why it remained out of reach financially. It had been supposed that the French manufacturer was lobbying to be able to run competitively with a smaller hybrid system, though it denied that this was a precondition of its re-entry.

Niclot suggests that a likely byproduct of the one-kilometre rule could be the disappearance of the system of hybrid sub-classes that have been part of the rulebook since the energy-based formula came on stream for 2014. With that will go appendix B, the chart that provides the fuel flow and energy values for the two, four, six and eight megajoule classes. ▶

ABOVE The zero-emissions rule will require the flag to be taken in electric mode

WEC/Adrenal Media

INTELLIGENCE CONNECTED



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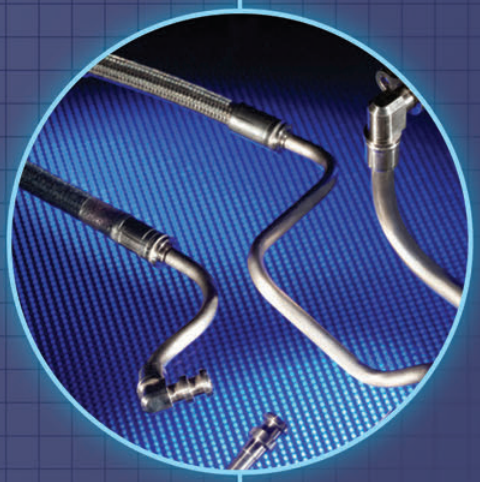

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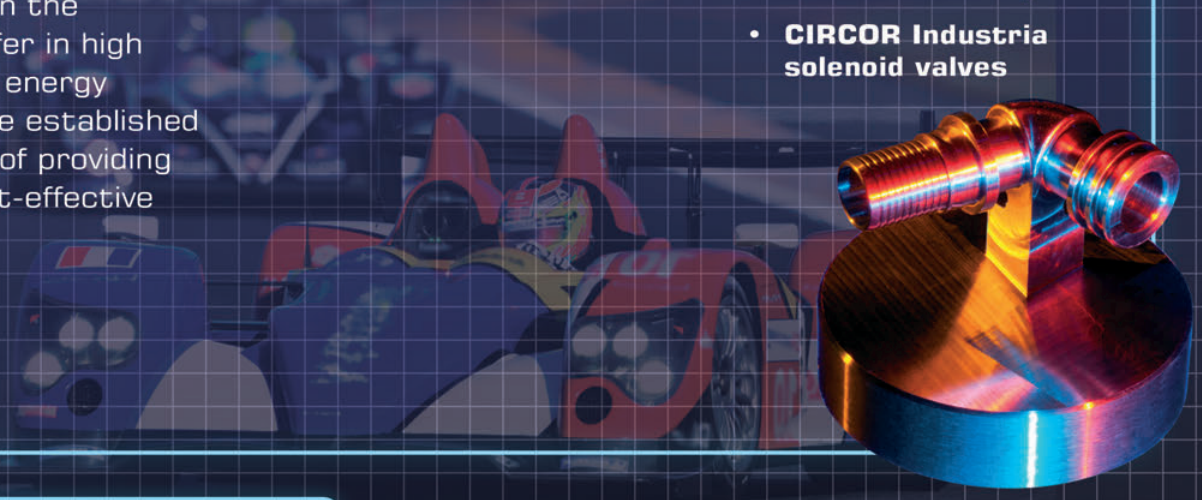

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MOVEABLE AERO

The introduction of active or moveable aerodynamics is part of the cost-cutting drive of the new rules. Its raison d'etre is a further reduction in the number of bodywork configurations allowed each season. In 2020, just one kit will be allowed, down from the first limit of three introduced in 2016 and this year's two. The idea is that moveable aerodynamic elements at the front and rear will allow the manufacturers to optimise their cars for the different demands of a range of tracks that includes the 8.47-mile Circuit de la Sarthe at Le Mans.

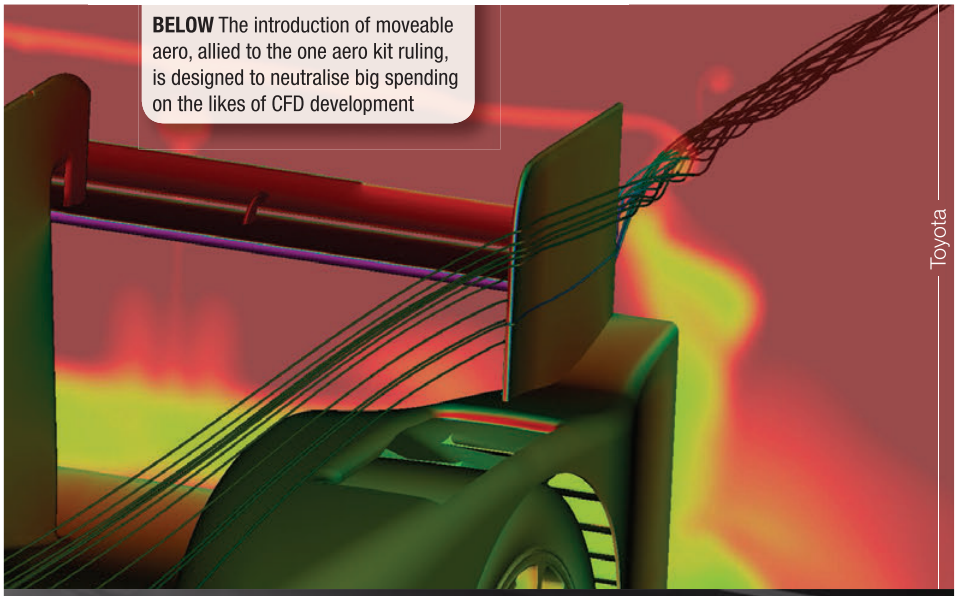
"To manage the compromise between top speed and downforce you have to come up with very complicated solutions with passive aerodynamics that cost a huge amount to develop," explains Niclot. "With our solution, we believe you can achieve a high level of performance with lower development costs. If someone wants to spend more in CFD [Computational Fluid Dynamics] we cannot prevent them from doing it. The idea is that if they do, they don't take a huge advantage from it."

The rule that will allow active aero is still in the formulation stage and how it works will be hammered out over the coming months. What is clear is that the regulation will encompass both the rear wing and the front flaps under the nose, which were allowed for the first time in 2014. This is important, says Niclot, in order for an "aerodynamic balance to be preserved".

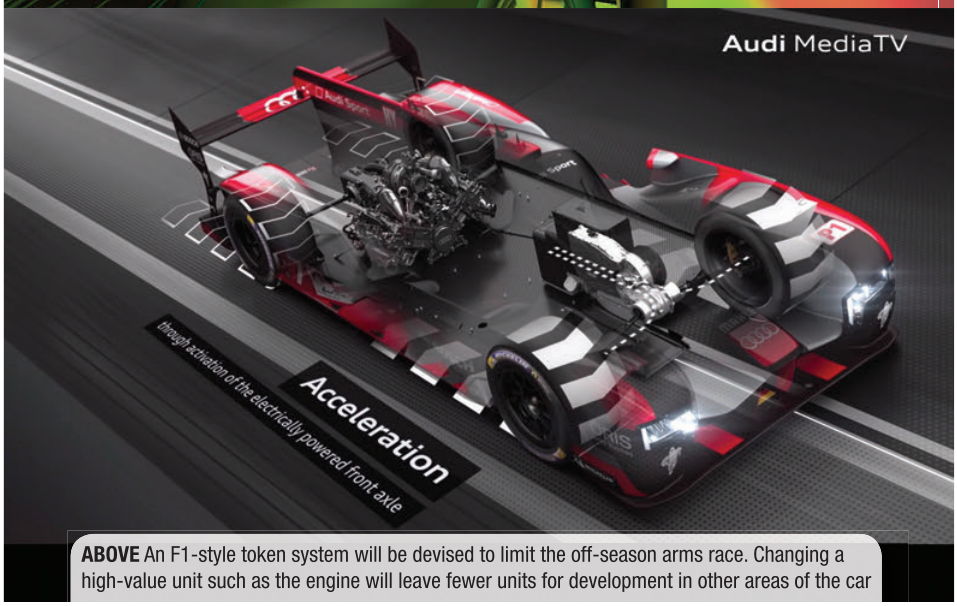
The idea at the moment is that each manufacturer would be allowed a limited number of positions for the moveable front and rear flaps that can be used over the course of the season. "We do not want to have 30 positions; that is not what we have in mind," says Niclot. "Perhaps we will have four positions, perhaps we will have two. It is also possible that in some zones on a particular track we will limit the use to the high or low-downforce positions.

"The devil will be in the detail. But safety, of course, will be our priority. You can have failure in such systems, so the default mode must be the safe one with high downforce."

There will be a new lower limit of days each manufacturer can spend in the windtunnel developing its aero over the course of a calendar year. The 1200-hour limit introduced for 2016, already reduced to 800 hours for this year, will be cut to 600 for 2020.



BELOW The introduction of moveable aero, allied to the one aero kit ruling, is designed to neutralise big spending on the likes of CFD development



ABOVE An F1-style token system will be devised to limit the off-season arms race. Changing a high-value unit such as the engine will leave fewer units for development in other areas of the car

DEVELOPMENT LIMITATIONS

A reduction in windtunnel hours will not be the only means by which development is limited from 2020. The aim is to stop the manufacturers building what are to all intents and purposes new cars around their existing monocoque designs each year. There will be strict limits on all elements of a new LMP1 over the four-year life-cycle of the next rulebook.

The principles on which the rules will be based are not dissimilar to the token system employed in F1 on the introduction of the current 1.6 V6 turbo formula in 2014 and then abandoned after 2016. "What we are saying is that you will not be able to develop and make changes to the full car between seasons," explains Beaumesnil. "This will have a huge impact on the cost.

"We will define a weighting for each parameter of the car, give different values to different parts. Every part will have a number of units and you will have a total number of units to use over the winter. If you change a high-value unit such as the engine, for example, you will have fewer units for development in other areas of the car."

There will also be ever stricter regulations limiting development of the underbodies of LMP1 cars. It is also envisaged that the rules will restrict developments in the area of brake cooling, which the FIA and ACO believes offers little in the way of technology transfer to road cars.

Beaumesnil revealed that the incentives for a new manufacturer joining LMP1 would likely be retained even at the start of the new rules cycle. Extra testing days and windtunnel hours for newcomers were introduced for this year. ▶

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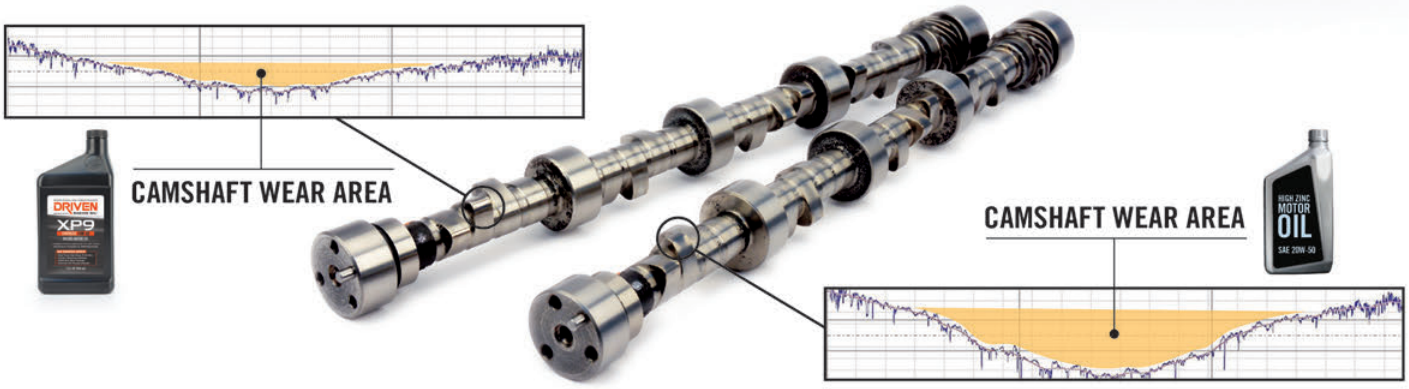
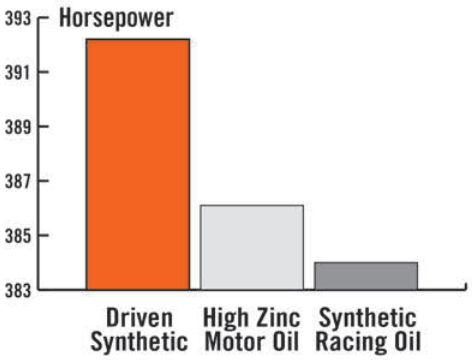
CAMSHAFT WEAR REDUCTION

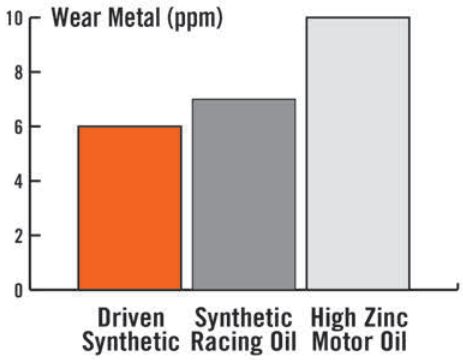
Camshaft wear is measured in microns, and the human eye can only see down to 40 microns. As a result, two camshafts can "look good" but differ in wear by as much as 62%. Because the total amount of wear is less than 20 microns, the difference can not be discerned visually.



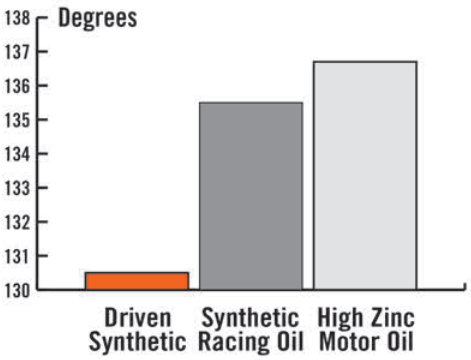
HORSEPOWER INCREASE



USED OIL ANALYSIS



OIL TEMPERATURE



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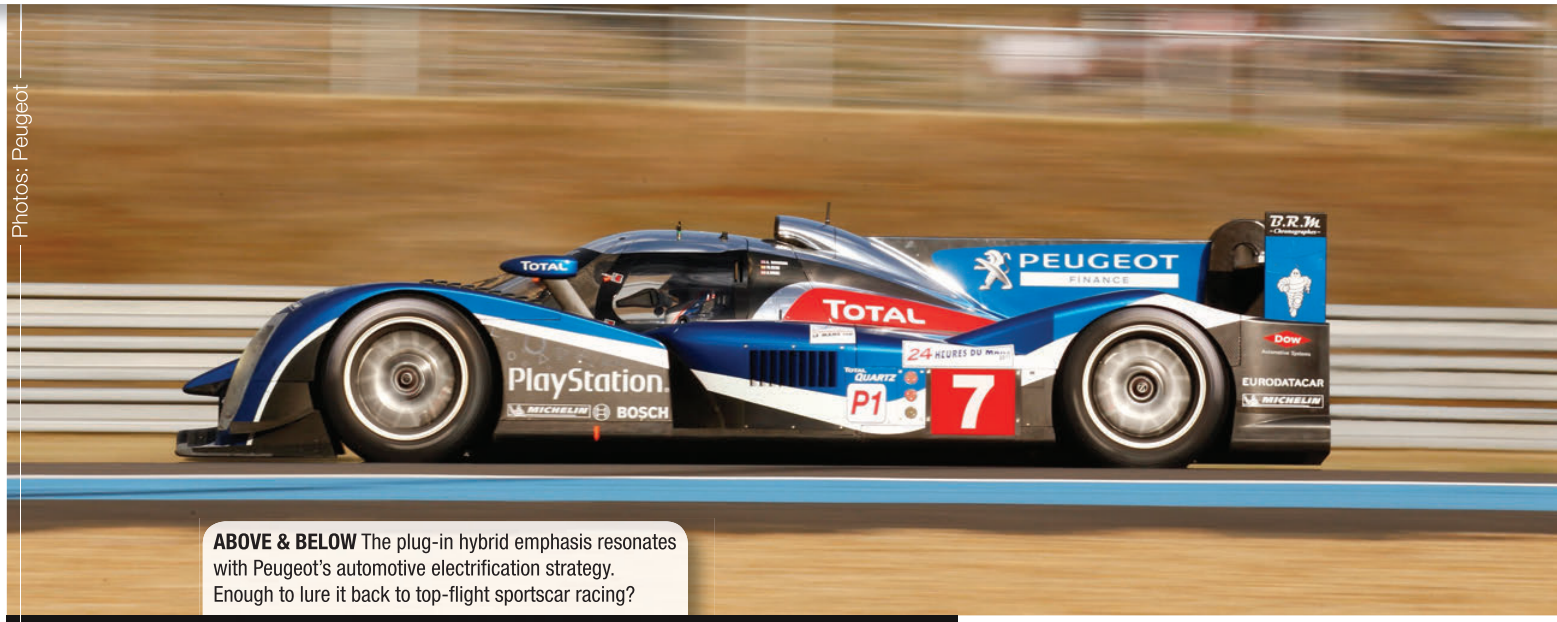
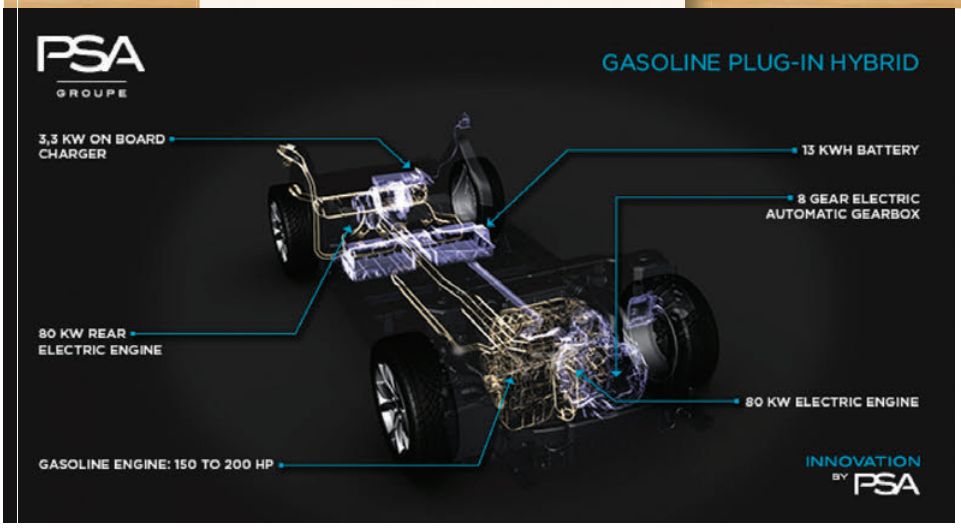


Photos: Peugeot

ABOVE & BELOW The plug-in hybrid emphasis resonates with Peugeot's automotive electrification strategy. Enough to lure it back to top-flight sportscar racing?



"We will keep this because we need an incentive for new manufacturers to come," continued Beaumesnil. "The level that Porsche and Toyota have reached is very high and they concede that help needs to be given to new manufacturers joining LMP1. The current incentives remain in force until 2019 and the incentives for 2020 will be defined by the technical working group."

TESTING LIMITS

The total number of car days allowed to each P1 manufacturer will be nibbled downwards in time for 2020. The plan is that the current figure of 40 days per year will be reduced to 30, but more significant in terms of cost saving will be the introduction of collective tests.

There has been no requirement for this in the past, though the official WEC pre-season test, the Le Mans Test Day prior to the 24 Hours, and the end-of-season rookie test have counted as part of each manufacturer's allocation. The FIA and the ACO believe that there are significant savings to be made for the teams by organising the tests itself.

"We have a target of 30 days with some collective tests where the costs of the track and the logistics are shared," says Beaumesnil.

LMP1 is following the lead of F1 here, though Beaumesnil says that we shouldn't expect such draconian restrictions as those that limit grand prix teams to 12 days of testing this year, eight before the season and four during its course.

"I don't think we will ever go as low as F1, because our manufacturers have to validate the reliability of their cars for a 24-hour race," he says.

Beaumesnil suggests that the new testing restrictions could be in place before 2020: "It is something we are working on now and maybe we will try to do it for next season."

There are a series of other cost-cutting measures due to be put in place for 2020. The number of personnel that each factory team is allowed to take to WEC events will be cut from 65 to 50. Four rather than five engines will be allowed to each car over the course of the season and only two gearboxes will be able to be used.

HOW MUCH WILL IT SAVE?

The rule makers, understandably, aren't putting a figure on that. And nor are Porsche or Toyota saying how much they expect to save should they continue in LMP1 into the next rules phase.

"We know the new electric concept will require some budget for development," says Beaumesnil. "But we have been very aggressive on areas of development and we know what the impact is line by line because we have been running now for three years a working group looking at ideas on how to cut costs."

WEC boss Gerard Neveu is more gung-ho. "Budgets will absolutely be reduced," he says. "It will be less than €100 million and you will still have the ability to compete for wins. That was always the plan."

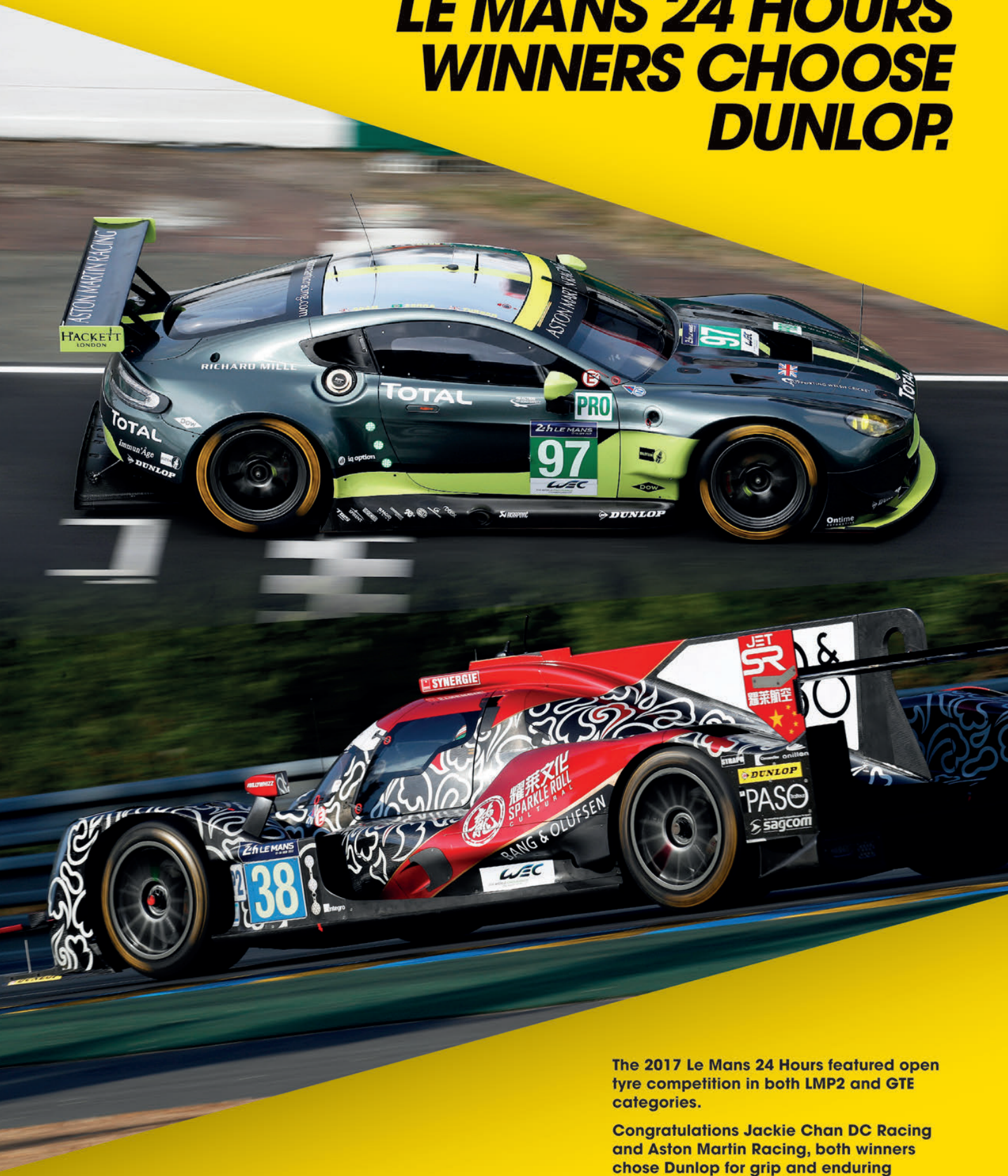
To put that in perspective, Porsche is reckoned to be spending somewhere north of that figure. It could be as high as €130 million, though nowhere near the €200 million it was reputed to spend in the initial phase of its return to the sportscar racing big time in 2014.

SAFETY RULES

The new survival cell rules that had been due to come into force in 2018 prior to the rules freeze will be incorporated into the new rulebook at the start of the next decade. These are, like the 2020 rules themselves, wide ranging.

The most significant change is an increase in the volume of the cockpit. "We have slowly increased the protection for the driver, but there can be a moment in an accident where what we have done with the safety measures become something ▶

LE MANS 24 HOURS WINNERS CHOOSE DUNLOP.



The 2017 Le Mans 24 Hours featured open tyre competition in both LMP2 and GTE categories.

Congratulations Jackie Chan DC Racing and Aston Martin Racing, both winners chose Dunlop for grip and enduring performance.

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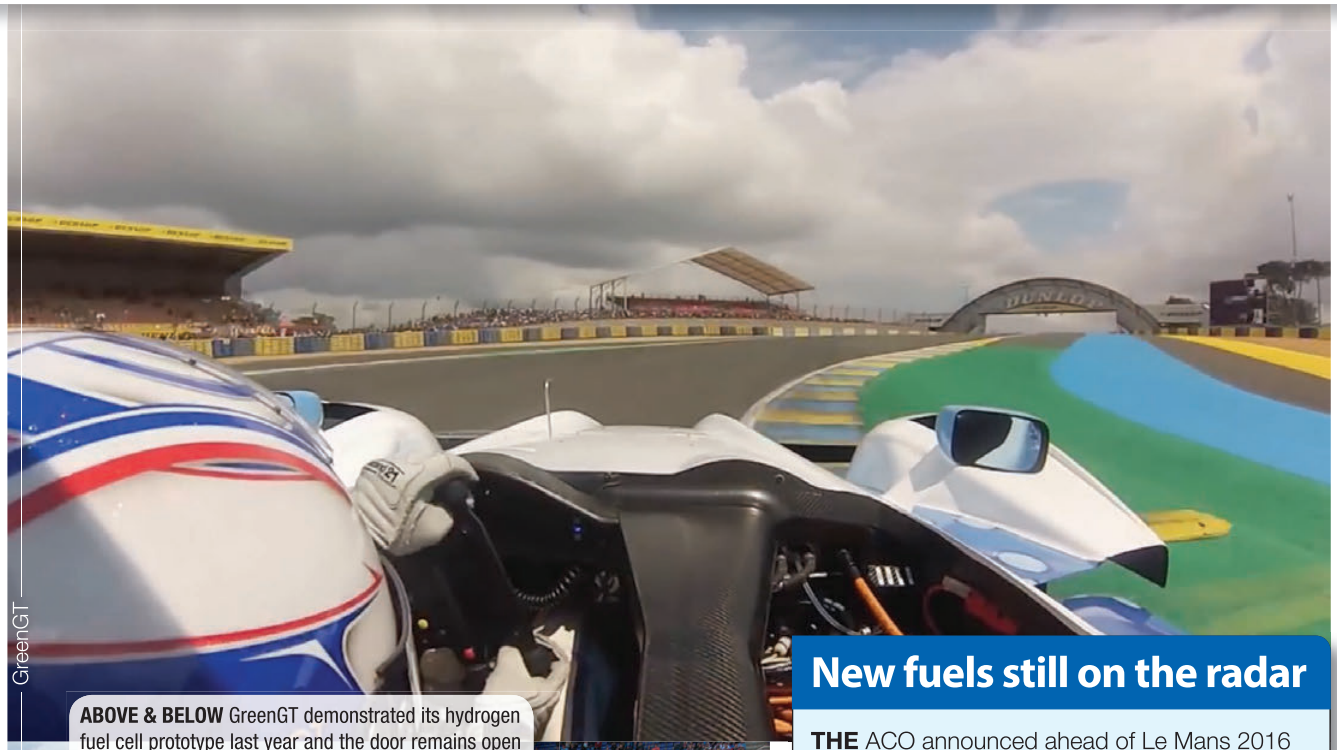

ABOVE & BELOW GreenGT demonstrated its hydrogen fuel cell prototype last year and the door remains open for experimental entries in the Garage 56 class

aggressive for the driver," says Niclot. "We are aiming to make the cockpit more friendly for the driver.

"At one point I said to the safety people that you are asking for too much volume and they have shown to us and manufacturers some studies into the movement of the driver in a big shunt. We took this onboard and said, 'Okay'."

The driver will also sit in a more upright position and new visibility templates for their field of vision mandated. Side impact protection for both the driver and fuel tanks will be improved with new rules on the Zylon panels employed since 2014.

That's what is planned for 2020. There's still a lot of work to be done, but it is the intention of the FIA and the ACO to have detail regulations by the start of next year. Who will take the challenge of the new rules remains to be seen.

"There have been three manufacturers around the table discussing the rules," says Vasselon. "We have no crystal ball, but we still believe in the future of this championship." RT

Sergio Rinland's take on the 2020 rules: see page 80


82 LAST LAP with Sergio Rinland

THE WEC'S PARALLEL UNIVERSE

Sergio Rinland evaluates a new rules package for the World Endurance Championship that trumpets a move towards plug-in hybrid technology

The one-kilometre rule

New fuels still on the radar

THE ACO announced ahead of Le Mans 2016 that it was working together with the FIA on allowing hydrogen-powered cars into LMP1. Other priorities have delayed working out how to incorporate fuel-cells into the regulations, but the rule makers remain committed to hydrogen and other new fuels.

"We are committed to hydrogen, but we think it needs more time," says Beaumesnil. "It is clear it is a challenge to bring it to the level of performance we have in LMP1. We believe we will have a hydrogen-powered car at Le Mans one day."

Asked if a hydrogen power car could fill the 'Garage 56' grid spot for a car utilising innovative technology, Beaumesnil replies: "I would love to have a hydrogen car in 'Garage 56'. We are happy to discuss any intermediary step with GreenGT [which last year demonstrated its fuel-cell car during Le Mans week] or anyone else."

There was no 'Garage 56' entry at Le Mans this year, but the ACO is confident that it will return in 2018.

"We strongly believe in the concept and, knowing the projects that are out there, we believe it has a strong future," explains Beaumesnil. "There are some very interesting projects with strong companies that have Le Mans and endurance experience. We want projects that showcase new technologies or are a way of testing a new direction for the rules."

The Green4U Panoz Racing GT-EV, which was unveiled in mock-up form at Le Mans in June, is one of the projects in the running for the 'Garage 56' slot. But Beaumesnil says that there has been no contact with the GreenGT organisation, which had been set to race at Le Mans in 2013 with its fuel-cell car, about filling the innovative entry spot in 2018. RT

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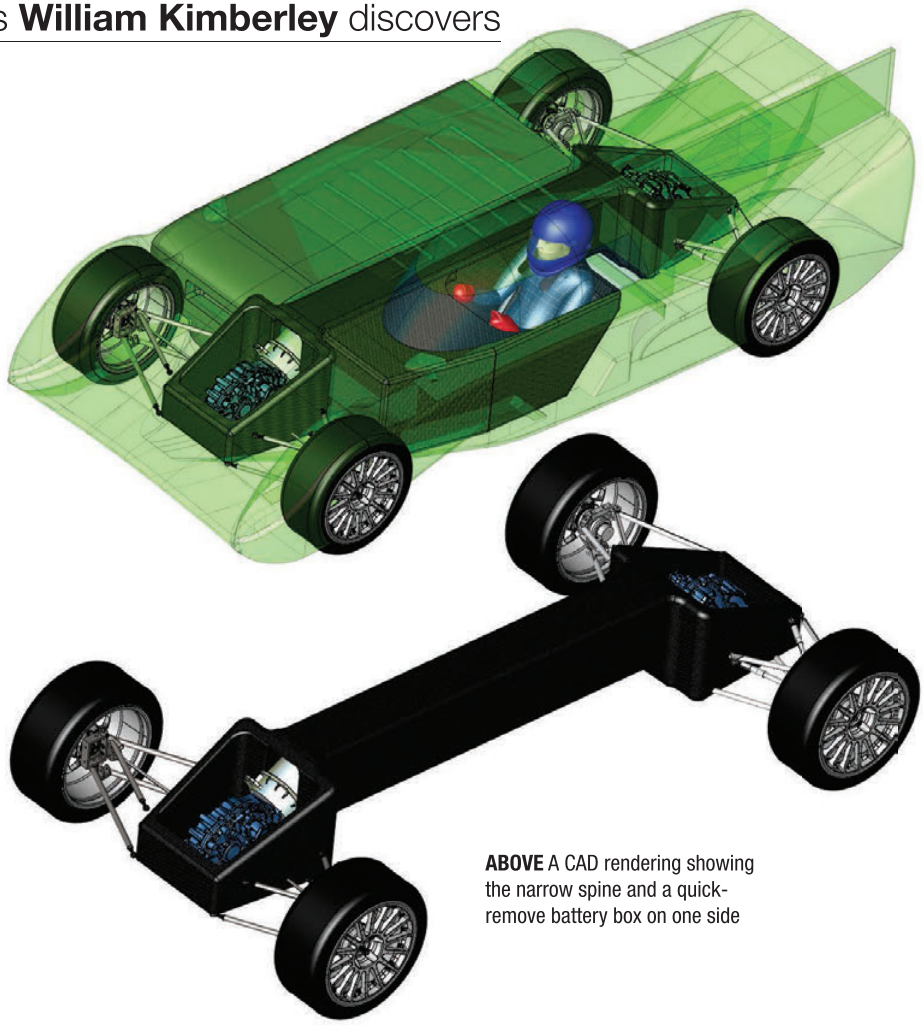
‘COMPLETELY NUTS – COUNT ME IN!’

Le Mans, pushing boundaries and passion are all synonymous with the Panoz name, and he’s at it again, coming up with a race car that ticks all those boxes, as **William Kimberley** discovers



ABOVE A CAD rendering showing the narrow spine and a quick-remove battery box on one side

WITH the 24-hour race as a background, and using his long affiliation with the Automobile Club de l’Oeust, US entrepreneur Don Panoz announced that his engineering team in Braselton, Georgia was developing an all-electric racing car.

It is being built by Green4U Technologies, a company that was formed in September last year as a result of Panoz and automotive supplier entrepreneur Jack Perkowski coming together to create the new entity with assets valued at over $200 million. Earlier this year, this new company acquired Panoz’s DeltaWing Technology Group (DWTG), Panoz LLC and Panoz Racing, along with more than 600,000 square feet of existing manufacturing space near DWTG’s manufacturing facilities in Braselton.

“We are not about incrementally adding technology to a vehicle platform that dates back to the 19th century,” says Panoz. “We aim to disrupt current thinking about what a passenger vehicle should be, using additive technology, form, architecture, lightweight motors and powertrains, advanced battery and charge monitoring technologies.”

While the focus of this new company is to meet the growing demand for electric vehicles from taxi fleets, municipalities, military units, logistics companies and individual consumers, with Panoz’s passion for racing, a team has been set up to develop an all-electric racing car. The goal is to deliver a performance and range similar to internal combustion engine and hybrid powertrain race cars and be able to compete in long-distance endurance racing.

“We’re debuting it here at Le Mans because of this iconic race’s history where the brightest and most ambitious and tenacious competitors always push the motorsports and automotive boundaries,” says Panoz. “We pushed the boundaries when we brought Sparky (the 1998 Panoz Q9 GTR-1 Hybrid) and the DeltaWing to Le Mans, and we’ll do the same with the all-electric GT-EV.”

“Our goal is to run our car in a race, perhaps even applying for a future Garage 56 slot, and apply what we learn to our Green4U EV vehicle designs,” says Perkowski, Green4U Technologies’ CEO and co-founder. “The development of an all-electric race car that can compete with the best internal combustion engine race cars places Green4U at the forefront of electric vehicle technology.”

The man tasked with delivering the project is Brian Willis, who was appointed vice president of engineering and design at DWTG in March 2015. His 29-year career includes stints as senior designer for Williams Motorsports, director of engineering for Élan Technologies’ motorsports division, and chief engineer for Panoz Motorsports. He was also technical director for the 2004 Le Mans-winning Audi Sport Japan with the Team Goh Audi

ABOVE Don Panoz considers the Green4U Panoz Racing GT-EV, an all-electric racecar designed to compete with ICE rivals, to be the 'Holy Grail' of racing

ABOVE The driver is offset to accommodate the battery pack

R8 and, most recently, director of technical services for Multimatic in Canada where he was involved in the Ford GT project.

"Our team is focused on achieving the speed and range of current road racing sports cars," he says. "Key is the ability to go as far as petrol and hybrid race cars on the power contained in a single battery pack, then exchange the battery in about the time that it takes them to refill their tanks.

"My starting point was to look at an existing Le Mans GT car, something like a Ferrari 458 or a Ford GT, as I had a great deal of knowledge and understanding of the characteristics of those cars. So if I took a GT car and turned it into an electric one, what would its performance be like and how long could it run?

"I approached it from two different ways. The simplest way was to say that a GT car uses up 90 litres of fuel in one stint, roughly 55 minutes to an hour. I know the thermal/combustion efficiency of an IC engine along with the driveline efficiency, so I know what the propulsive effort applied to the tyres would be for an IC engine at Le Mans. Using this information, I could then define the size and mass of an equivalent battery pack, which in this case would weigh roughly 2500 lb. In other words, as much as the entire car, which immediately tells you that it's not feasible, so throw that out.

> *"We aim to disrupt current thinking"*

"Also, just to make sure I didn't do anything wrong, I looked at rpm versus distance versus time for a lap of Le Mans. I have curves of power and torque versus rpm, so now I have a curve of power versus distance. The area under the curve is where I get my energy and doing it that way I come to 2100 lb for the battery weight.

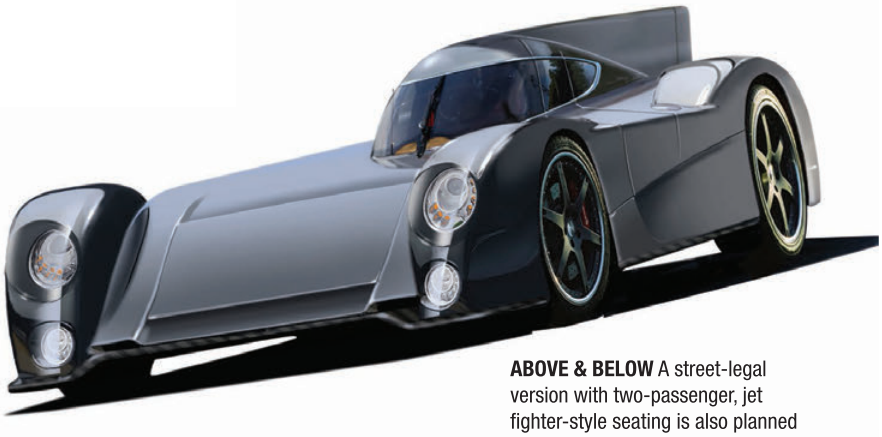
"I felt pretty confident in my analyses, rough as they were, that they were accurate. Unfortunately what it also told me was that it didn't work. So I went back to my engineering roots and looked at the equations for power consumption for a car, which is a function of the mass of the car, inertial forces because you've got to accelerate and decelerate while also going around corners: F = MA. The lower the mass for a particular acceleration, the lower the force and the less energy is needed."

Apart from deciding just what energy storage system was required, other issues he and his team had to confront were the ▶

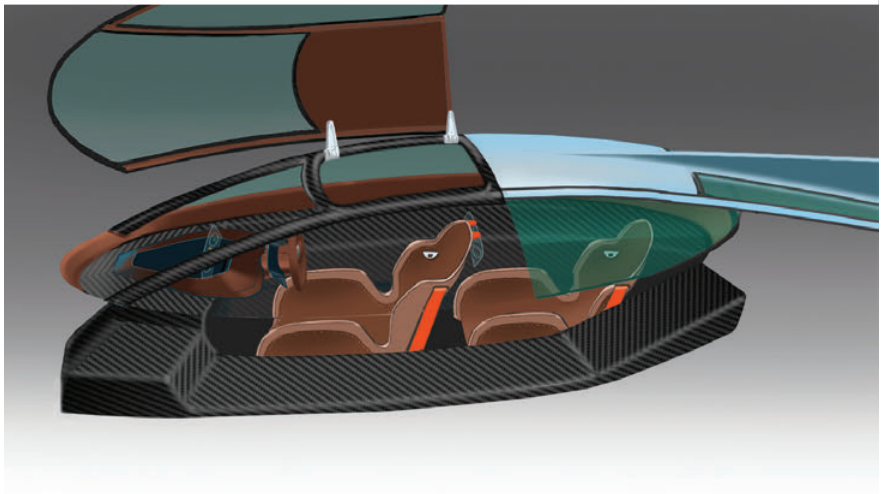
ABOVE The potential 'Garage 56' project revolves around the ability to exchange the battery pack in the same time as rivals take to refuel

thermal ones. They may not be in the same way as an IC engine and while EV traction motors are very efficient, they still need to be cooled, as does the battery pack.

"What makes it in more ways somewhat more difficult are the differing optimal temperatures of the battery pack and the motor," says Willis. "However, the problem you run into on any thermal dynamic system like this is that the key driver in the system's performance is the difference between the inlet cooling temperature versus the outward temperature of the thermal mass you are trying to cool. Even though the temperatures may be lower, not a lot is saved on core size. It means you have to work very hard with respect to that to make these things work. You save some but it's not like there aren't any radiators on the car because they're needed to cool things."



ABOVE & BELOW A street-legal version with two-passenger, jet fighter-style seating is also planned



THINKING OUTSIDE THE BOX

Aerodynamics play a key part in the car's performance, Willis thinking outside the box to arrive at some answers, even to the extent of basing the cockpit design on the F16 jet fighter. "I literally went on the internet and found a jpeg of one and scaled ▶

it to the size I needed," he says.

"The coefficient of drag needs to be lowered as much as possible, and the way to do that at Le Mans is active aerodynamics, so we are looking at wings that go up and down, the Formula 1 Drag Reduction System, a deployable front splitter and even things as crazy as diveplanes that extend out from the sides of the car.

"I have even gone so far as to look at things like tyre size – the smaller the diameter of the tyre, the lower the fender line, so what I wanted were 13" tyres from an F1 car. The problem is that no-one makes 13" tyres for Le Mans. We've been talking to different tyre manufacturers, and still are about doing a smaller tyre, but the problem with the 13" tyre is that there isn't enough brake area for the mass of the car. However, 18" is just way too big, so we're looking at something in the 16" tyre diameter. As a back up I'm having to look at 18" in case I can't find the right size. We are also looking for a forged magnesium wheel, not a 3-piece 16" wheel."

Peter Stevens, the renowned stylist, is

responsible for the shape of the production car, an old friend of Willis, the two having collaborated on different projects before. The road race car will be very similar but not identical, for example, not having a door compared to the single door on the production version.

As Willis says, he is not constrained by any set of rules: "It's a clean sheet of paper so it's not a question of looking at what an LMP car looks like, because that's not what I need, nor is it a GT car. I need a car that's very unique. I also need a quick-remove battery box so that's where the concept came up with a battery box on one side, the driver offset the other side and a very small central spine, the idea coming from a Lotus Elan.

"Conceptually it's a very simple car. That allows us the put the time and effort into the EV drive system and its components, making sure we put the money where it's really important and not take too many risks on doing something too crazy in terms of the overall package of the car."

Willis says that a number of suppliers have already been selected, including talking to a number while at Le Mans and, prior to the race, some in the UK. "We can't provide details yet but we've talked to the obvious companies who understand EV cars and EV racing," he notes.

"It's interesting because the reactions from people we've talked to are either there's no way on earth they can supply what we want, that it's too aggressive and the project isn't of interest as it scares them. Or, the other response is that it's such a crazy idea that they're interested. That's what Peter Stevens said. He looked at the concept and wrote to me to say that we're completely nuts but that he's in." RT

ABOVE & BELOW Panoz is no stranger to pushing the boundaries at Le Mans. It performed pioneering work on the DeltaWing (below), as it had on 'Sparky' the Q9 GTR-1 hybrid in 1998 (above)

CARTEK MOTORSPORT ELECTRONICS

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Red Bull

ABOVE From 54th position to first: no wonder Porsche celebrated

THE LE MANS MYTH IS ALIVE!

The Le Mans 24 Hours serves up a different storyline every year, tales of heartbreak and heroism, hard-fought duels and hard-hitting encounters. **William Kimberley** says this year's race was another classic

THIS was the year for Toyota. After fate dealt a truly horrendous hand to the team 12 months ago, this had to be its moment.

Pretty well all neutrals just willed it to come good this year, but it was not to be. However, while Porsche's 919 Hybrid did take the victory, it was not a foregone conclusion. The eventual winner, car #2, lost an hour and five minutes in the pits to change the electric engine that drives the front axle. When it rejoined the race, at 7:35 pm, it was placed 54th, 19 laps down on the leader.

When its sister car retired and the Toyotas hit problems, it looked for a while as if a Gibson-powered ORECA LMP2 car was going to perform a giantkilling act. But it was hunted down by the delayed Porsche as the race entered its final phase. The Porsche took the lead with just 20 laps remaining.

"A fightback from P54 to P1 – who could have ever believed that this was possible?" asked Oliver Blume, chairman of Porsche AG's executive board. "The Le Mans myth is alive, exactly because of such unbelievable stories."

GTE THRILLER

The Balance of Performance may not be popular with purists, but it did set in motion a thrilling finale in the GTE class. Aston Martin ran in Corvette's wheeltracks as the clock ticked down, finally getting ahead on the penultimate lap when its rival locked up and fatally flat-spotted a tyre. A Ford GT further demoted the Corvette as it limped to the flag.

One of those enthralled by the Aston/Corvette battle was Florian Haegemann, head of divison aftermarket marketing at Bilstein, a technology partner of Aston Martin Racing. Unless there's suspension damage during the race, he is just an interested observer willing his team on.

"Our job takes place well before the race," he said. "As we have been working with Aston Martin since 2014, we have a pretty good idea of what they want, but it is a case of continual development for our dampers; we don't stand still. Once the race starts, though, my job is pretty well done, or it should be anyway. We know the tracks, we know how to set the car up for them when it comes to the dampers, so when we came here to Le Mans, we didn't have to change the settings."

For Dom Lester, the thrilling encounter was his introduction to Le Mans. As the person who has succeeded the indomitable Russ O'Blenes to head up General Motors' racing and performance division, he has big shoes to fill. However, as winner of the Boss Kettering prize in 2010, GM's highest technical award, and with several years as an engine designer at GM, it was something he could take in his stride.

"Being here at Le Mans is just the finale of what has been a huge team effort with a lot of labour and intense work of a dedicated group of people," he said.

Lester has been with GM for nearly 10 years, starting as an advanced cylinder head design engineer when he introduced integrated exhaust manifold technology into other GM product teams. At the same time he is the owner and president of L&L Racing Engines that produces bespoke dragster engines. Needless to say his time there is extremely limited, especially with his new responsibilities.

One of the elements he is encountering is Balance of Performance, but he is unfazed by it, saying that engineering is the art of balance and constraint. "There are boundary conditions and multiple variables and you just need to work through them the best way you can. I personally find it a challenge whether it's a new balance of performance or coming up with a new design and a patent for General Motors. If you come out on top then it really adds icing to the cake and a sense of pride in the same way as if you've solved a complicated puzzle."

Lester follows the company line about the racing experience being directly transferable to the production cars. "Coming from a production background, I can name many times when we've worked with the race and advanced teams to bring forward different designs and technologies into the production cars," he said. "It's something that General Motors has been successful in achieving in many arenas.

ABOVE Disbelief turns to despair as the TV monitors show the leading Toyota's retirement and the shutters come down on another failed shot at Le Mans glory

ABOVE A fantastic battle for GTE honours saw the duel between the #97 Aston Martin and #63 Corvette go down to the wire

Red Bull

LAT

ABOVE A late puncture denied Corvette

"There's a lot of advanced technology in how to improve the internal combustion engine, especially when talking about the fuel economy as some of the technologies we have really driven into the racing world as well. It's all about integration and synergies to bring it to market – if it wasn't for that, we wouldn't be here."

100% A WINNER

No matter what the outcome of the race was in every class, Aero Tec Laboratories (ATL) was going to be a winner – and that was because every car in the field had one or more of its items, whether it be the fuel cell, an ATL fuel tower, refuelling bowser or volume displacement balls. This includes the jet pump that was introduced by ATL towards the end of 2015.

"Once we get to Le Mans we want to make sure everydody is happy and that if they need any help or advice, we are on hand to give it," said James Gornall, ATL's sales manager. "Apart from the factory outfits, there are also a lot of customer teams, so while we supply ORECA or Onroak directly,

Breda Racing

ONCE again, thanks to the collaboration with Caseliner, some of the newest range of Breda Racing equipment was to be seen in the technical support area at Le Mans.

It was, for example, possible to see the newest Air Jack series and a Set Up Wheel and Pad with load cells, plus ride height and toe bars and customised front and rear zimmers.

"We are very pleased that several teams competing in this important event have been Breda Racing customers for a long time," said Teresa Cobos, business development and brand identity leader at Breda Racing. "We saw a lot of our air jacks, a best-seller for us, but the acute eyes of the technicians would surely have glimpsed the refuelling equipment and the engine/gearbox trolleys and other equipment which are less visible or hidden inside the garages."

Breda Racing is celebrating 30 years of activity in 2018. "That means 30 years and more of experience, in-depth knowledge of the motorsport world and a continuous committment to excellence in all areas, including parts and equipment and also service and relationships with the customers," said Cobos. "Keeping these principles and a passion for motorsport that led to the company's foundation has been our driving force for all these years." RT

ABOVE The Breda Racing air jack was much in evidence and this shot captures part of the set up equipment (zimmer) specially manufactured for the Dallara LMP2 2017 car

we do still like to talk to the teams to make sure we give them the knowledge that they actually require.

"The jet pump, for example, is being used by a number of teams here at Le Mans this year. Customers will often have a good idea of what they want, some having been designing these systems for many years themselves, and we aren't trying to reinvent the wheel. However, we always give our help, advice and explain any new technology. If they want to adopt it, wonderful, but if not then a slightly more conservative approach will be taken and the jet pump is a good example. It's a good way to improve reliability and reduce weight, it doesn't draw any current and it doesn't fail, so for us it's win-win-win."

Working with a manufacturer team is a different proposition, said Gornall, and depends on the project. "Sometimes we have such close relationships and they know we will produce the best product that is the lightest, picks up more fuel and will last longer and be more reliable. Some customers will simply send us a shape and tell us to get on with it and design a system.

"The other end of the scale is where a customer really knows what they want. We would still give our advice and make recommendations, which aren't always taken, but we accept that they may well have the best solution. In that situation we can take a mature design and put it into something we can make as our manufacturing methods mean that we have to productionise the design. It's still a fair amount of work, even if we are given a final product to work on."

Gornall said that a lead time for a motorsport product from the moment an order is confirmed to the time they receive the final item is on average eight weeks. "That will probably include a full refuelling system as well," he said. "As with all motorsport business, the lead time can get a little bit longer in the winter, but that's the challenge we all face. However, we are always recruiting people to try and solve that problem."

NEW HAT

Sven Behrens is a regular attendee at Le Mans, but this year was different for him. Instead of coming as part of the Bosch Motorsport team, as he has done for many years, he was at the race in his new

Around the world – 3½ times!

LAT

ABOVE It couldn't happen, could it? Jackie Chan DC Racing won LMP2 but also came close to pulling off a giantkilling feat

A WINNER in every sense of the word at Le Mans was Gibson Technology. This time last year it was announced as the sole engine supplier to the new-look LMP2 class. Remarkably, LMP2 cars finished second through to seventh this season.

To put all that was achieved into perspective, 21 of the 25 LMP2 cars finished the race, and the four that did not reach the end dropped out for reasons other than engine issues. Together, the LMP2 cars completed 143,400 km in a combined total of 719 hours and 27 minutes, which is something like circumnavigating the globe three and a half times. Furthermore, oil consumption was kept to a minimum, most teams adding just half or a whole litre of oil to the engine during the 24 hours.

As John Manchester, operations director at Gibson Technology, said: "The result exceeded all expectations, especially getting two cars on the podium." Asked if he was disappointed that one of his engines did not win the race, he gave the surpsiring answer that he was pleased that an LMP1 car did win as it was good for Le Mans, but it did not take away his pride at what the Gibson Technology engineers at Repton in England had achieved.

The brief from the FIA was that the 4.2-litre engine – the first such configuration that Gibson Technology, or Zytek Engineering as it used to be called, had ever designed and built – had to develop 600 bhp. That figure had to be sustained throughout the race, and part of the deal was that engine rebuilds were only allowed after 50-60 hours. It was a tough assignment, but Gibson Technology came through with flying colours.

"When we first won the contract, we thought a worst-case scenario would be building engines for 10 cars, 15 for average and a best-case scenario supplying 20 cars," revealed Manchester. "By the time the season started, we had 33 cars and so had to double engine production. It was a nice problem to have but it did have its challenges, especially on the logistics side, but everyone worked so well, we got through."

Another challenge was that while the company is well versed in providing engines for one-make series, starting with Formula 3000 in 1996, A1GP and the Formula Renault 3.5 Series, it was always for a single chassis. The LMP2 programme, though, meant working with four different chassis constructors.

"It threw up interesting challenges, especially dealing with heat rejection, but we had a very good working relationship with them," said Manchester. "We worked with them all through the development process and the fact that there wasn't a single engine issue in the 24-hour race shows just how well it all came together. It highlights just how good LMP2 is and what great value for money." RT

role as director of motorsports at ZF Race Engineering. Its clutches and dampers could be found in all the LMP1 cars and 90 per cent of the GT field.

"On the one hand it's a surprise coming here to Le Mans not being with Bosch, but on the other it isn't," he replied to the question of wearing a different hat. "For example, a lot of customers used to ask me about power steering but as part of ZF Race Engineering I'm now able to help because of the recent merger with TRW Conekt, which means we now have steering systems as part of our product portfolio."

While clutches and dampers are the main products, Behrens said that he is also looking at gearboxes for the motorsport portfolio: "As an engine man, for me it was the law that you had to use a sequential gearbox in a race car, but those developed for production cars are so good. They are heavier, of course, but they can be developed so I would think that we can see some more applications in the future, especially in GT4, which is more budget-conscious. It's also easier for the gentleman driver to adapt to so that they can spend more time racing on the track rather than learning how to drive with a sequential box."

Last year we featured the clutch that ZF Race Engineering has specially developed for quadruple amputee Frédéric Sausset. It has now been further refined and is the basis of an as yet unnamed project that is in the pipeline. "We are very happy about this," said Michael Istschenko, development engineer at ZF Race Engineering, "because we are able to further develop the technology with particular reference for the privateers."

Istschenko also talked about clutches used in Formula 1 this season, ZF Race Engineering currently supplying two teams. Not widely known is the fact that the launch in F1 has changed this year, the driver only having one paddle. This means that the transfer that comes in between throttle position and torque has to be set and the driver has to reach exactly the right spot. Previously there were two paddles with a dead spot and as long as the driver was roughly in the right spot, the computer would take over.

"In the past the clutch deployment was mainly software-driven, whereas now the drivers have much more input," said Istschenko. "It's better for us as the clutch is now much more important because the drivers have to operate it as in the past. It also makes it a bit more difficult to have reliable clutches as more energy goes through them and so we have to think how to make them more driveable and more resistant. This was our goal and we obviously did a good job as we now have two teams using them."

F1 CHALLENGE

The clutch operation in Formula 1 is also of great interest to Sami Bitar, the founder and CEO of MagCanica, who was making his annual trip to Le Mans. The Californian company designs, develops and manufactures wireless torque sensors and rate-of-change-of-torque (ROC) sensors for high-performance applications such as automotive racing powertrains, turboshaft engines and associated rotorcraft transmissions.

"When F1 cars now launch, it's controlled by the computer closing a loop around our sensors," said Bitar. "If the driver asks for 60 per cent, our sensor will be measuring it until it gets to 60 because it's a closed loop. This has raised the stakes for us because our sensors are no longer being used just to look out for traction control.

"At the start of the process we were quite amazed that some teams hadn't measured torque before, while others had used different systems to ours. One of our aims was not to end up in the news, as happened with the fuel flow sensors when they were first introduced by another company.

"It does actually make the launch faster to do it this way because you are controlling around the actual torque and not what you think it's going to be. It's really hard to predict during a launch. It's very inconsistent as the components don't behave in the same way every time. The whole idea behnd the regulation is to make the launch more exciting and to stop the teams from spending crazy amounts of money developing their clutches."

ABOVE Few believed the race would ultimately rest on the LMP1 cars chasing down their LMP2 quarry

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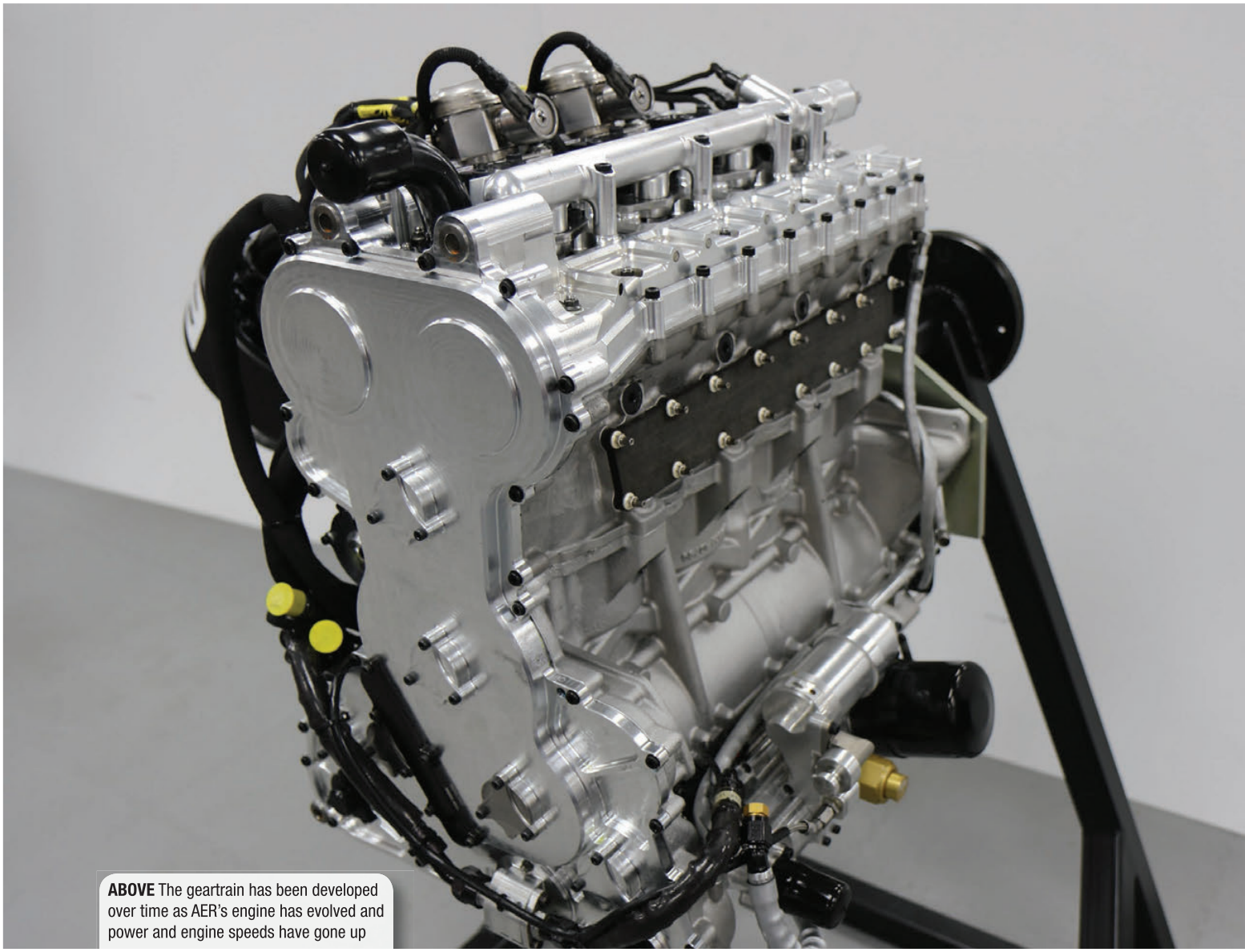
DEALING WITH A DPi CURVEBALL

A bespoke boost curve, rather than intake air restrictors, regulates IMSA's turbocharged Daytona Prototype international engines. **Chris Pickering** examines the creation of Mazda's MZ-2.0T

ONE of the great appeals of sportscar racing has always been the variety of machinery it attracts. Nowhere is this truer than in the Prototype category of the IMSA WeatherTech SportsCar Championship. Here LMP2 cars go wheel-to-wheel with the new generation of Daytona Prototypes, with an equally diverse pool of engines.

One end of the spectrum is marked by the turbocharged Mazda MZ-2.0T, which squeezes around 600 bhp from four cylinders and just two litres. Operating in a performance-balanced category, it competes head-to-head against engines ranging up to 6.2 litres, including both naturally aspirated and turbocharged units.

The MZ-2.0T made its debut at the start of this year, but it has a bloodline that stretches back more than a decade. Back in 2006, Mazda approached Advanced Engine Research (AER) with the aim of co-developing a four-cylinder turbocharged engine to replace its rotary powerplant in the American Le Mans Series (ALMS). The engine that resulted from that partnership was a 2-litre turbocharged LMP2 engine, known internally as the P41. Its origins actually stretch back even further, though: the four-cylinder P41 was based on the architecture of AER's P32T twin turbocharged V8, which had been developed for LMP1.



ABOVE The geartrain has been developed over time as AER's engine has evolved and power and engine speeds have gone up

Halving a V8 is relatively common practice. It means the areas of the engine that typically take the longest to develop and test – the cylinder head, combustion chamber geometry and valvetrain – can be carried over with relatively little modification. Similarly, while the detail design may change, maintaining the same basic philosophy sets a clear blueprint for the engine as a whole. The P41, for instance, could inherit the V8's gear-driven valvetrain concept.

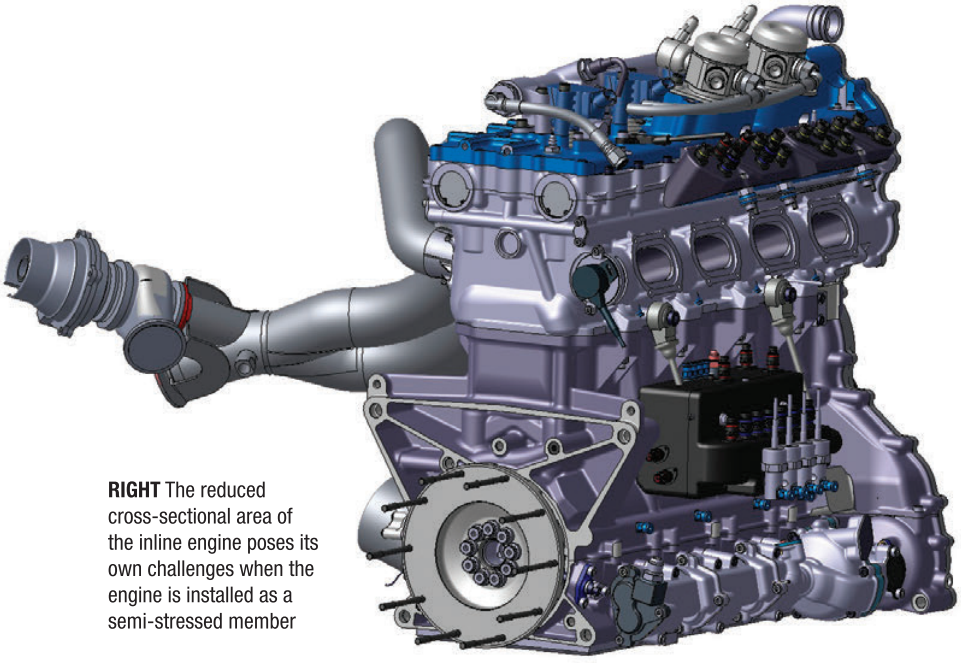
The P41 raced successfully in the ALMS for three seasons from 2007 to 2009. Mazda moved to LMP1 in 2010, with an uprated version of the same 2-litre engine, known in AER circles as the P70. This featured a strengthened block and cylinder head to accommodate the increased power demands.

It was the smallest engine in LMP1, producing more power per cylinder than a contemporary Formula 1 unit, and it proved to be a winning recipe. In 2011, Dyson Racing swept the championship table in the ALMS LMP1 class with the manufacturer, driver and team championships. The same year, the engine (now known as the P80) was revised again. This brought an uprated timing drive, designed to provide more cushioning for high rpm operation, plus a new crankshaft that featured heavy duty flywheel fixings to cope with the increased torque and higher engine speeds.

Perhaps the most significant evolutionary step occurred in 2013. This was around the time that Formula 1 had been flirting with the idea of four-cylinder turbo engines. AER had developed a direct injection (DI) cylinder head and fuel system as part of a design study for an F1 engine manufacturer. This concept was then applied to the LMP1 engine to create a new design known as the P90.

"It was very much an integrated design approach," explains Dr Mark Ellis, technical director of AER. "We were able to apply the principles from the F1 DI system, including the revised combustion chamber, piston and airflow concepts to the P90."

The main benefit of switching to DI is more accurate control of the fuel delivery per cycle, he points out. A lot of the challenges involved in calibrating the ECU to handle transients are easier to optimise under these conditions, particularly those that require a very fast response like traction control intervention.



RIGHT The reduced cross-sectional area of the inline engine poses its own challenges when the engine is installed as a semi-stressed member

> *"Slashing the boost target acts as both a restrictor and a rev limit"*

"With a port-injected turbocharged engine the drivability is generally at a disadvantage to a naturally aspirated engine, because there are times when it's unwise to simply cut the spark," comments AER's engineering manager Andrew Saunders. "If you introduce DI that issue goes away. There's an immediate benefit to every single strategy that may involve turning a cylinder off."

While the theory is quite straightforward, putting it into practice – particularly at that time – was somewhat harder, he recalls: "Initially when you're developing a DI engine the packaging is quite tricky. Valve area is critical in most racing formulae, so there's not usually a great deal of space in there. You also need to ensure that the system is reliable and safe – you're talking about connecting up fuel at several hundred bar and then rattling it around Sebring for 12 hours."

The devil is in the detail, he says: "The P90 was one of the first purpose-built competition engines to use DI outside of Formula 1, so we found the choice of equipment was quite limited at that stage and the prices were very high. Even among the major manufacturers it was a steep learning curve. Once Formula 1 got involved, things became a lot easier. The knowledge out there has improved exponentially and the cost has come down significantly."

A NEW ERA

The P90 raced successfully in what had now become the United SportsCar Championship until the end of last year, but 2017 was to mark another significant change, with the introduction of the P91. Again there were detail changes to the block and the reciprocating assembly to accommodate higher engine speeds and more power. However, the biggest changes were to stem from a seemingly innocuous change in the technical regulations.

With the start of the 2017 season, championship organisers IMSA brought in a heavily revised BoP system to ensure the 'manufacturer' engines would have parity against the new ACO-specification Gibson LMP2 unit. The idea was to bring not just the outright power, but also the torque curve and drivability of all the engines closer. To achieve this, the previous system, based on intake air restrictors, was scrapped for the turbocharged engines. In its place, each engine would be given a bespoke boost curve, designed – in essence – to mimic the characteristics of the naturally aspirated engines.

Under this system, the air mass is still controlled indirectly by the boost pressure. Instead of a restrictor orifice choking and refusing to admit any more air into the engine, the boost ratio target reduces to one (i.e. the same as a naturally aspirated engine) ▶

IMSA/LAT USA

ABOVE Mazda's RT24-P secured its first podium in Detroit

once it reaches the top of the table at 8,900 rpm. Actually, strictly speaking, it plummets. The boost ratio – as published in the latest IMSA technical bulletin – follows a slightly tortuous pattern, flitting up and down, but it stays in the range of 2.671 to 2.463 all the way from 2,000 rpm to 8,300 rpm. Even at 8,800 rpm it's still 2.226, but at the final point it crashes down to 1.000.

On an engine designed with the sole purpose of running at high boost pressures that's like switching off the lights. It could be a struggle just to get the car back to the pits in the event of a turbo failure, Saunders notes, and slashing the boost target has much the same effect; it acts as both a restrictor and a rev limit. The challenge, however, is that it doesn't take effect immediately.

"There are significant penalties for going beyond the targets laid out in the boost curves," explains Saunders. "Engine speed on a four-cylinder can be quite volatile, and the moment it registers a revolution above 8,900 rpm you find yourself in an illegal condition. If you take somewhere like Detroit, which is quite bumpy, that can be a real challenge.

"The wastegate can control the boost pretty accurately, but once it's fully open there's nothing more you can do. If you're at 8,899 rpm and the boost target drops to one that's going to be unachievable. Short of jamming a screwdriver into the turbine you can't shed that much boost."

> *"AER has applied F1 methodology"*

Under most conditions the turbo control alone is sufficient, but very precise regulation of the engine speed is vital to prevent the boost pressure spiking over bumps and during gearshifts. This is achieved by cutting the fuel and the spark, but it has to be done in a way that doesn't destabilise the car or the engine. That's hard enough to achieve on a V8, but on a four-cylinder engine (with half as many firings per revolution) it becomes even trickier.

Interestingly, the technical bulletins also specify a minimum lambda value for each engine. This is done to prevent the engine builders disguising their true performance with a rich lambda target, which could then be leaned off to liberate additional power at the track.

As part of the pre-season homologation process, the engines are stripped, weighed, photographed and dyno tested. Wind tunnel tests are carried out in parallel, later followed by track testing, with the aim of balancing the complete package.

"There are lots of things the governing body can do to slow a car down, but it tends to fall to the powertrain if they want to speed it up. That means the burden of the responsibility falls on the engine supplier to ensure there's potential for future adjustments, even if the car is at the head of the field," comments Saunders.

With the new BoP system looming, AER carried out an extensive programme of simulation at the start of the P91 project. Using GT Power for 1D modelling, coupled with Converge for 3D in-cylinder CFD, the engineering team was able to study the effects before moving on to physical testing.

One of the upsides to running in a performance-balanced class is that there are relatively few constraints in the engine regulations. There are some basic restrictions on things like material properties, but Ellis says none of these proved restrictive enough to impact the development of the engine. ▶

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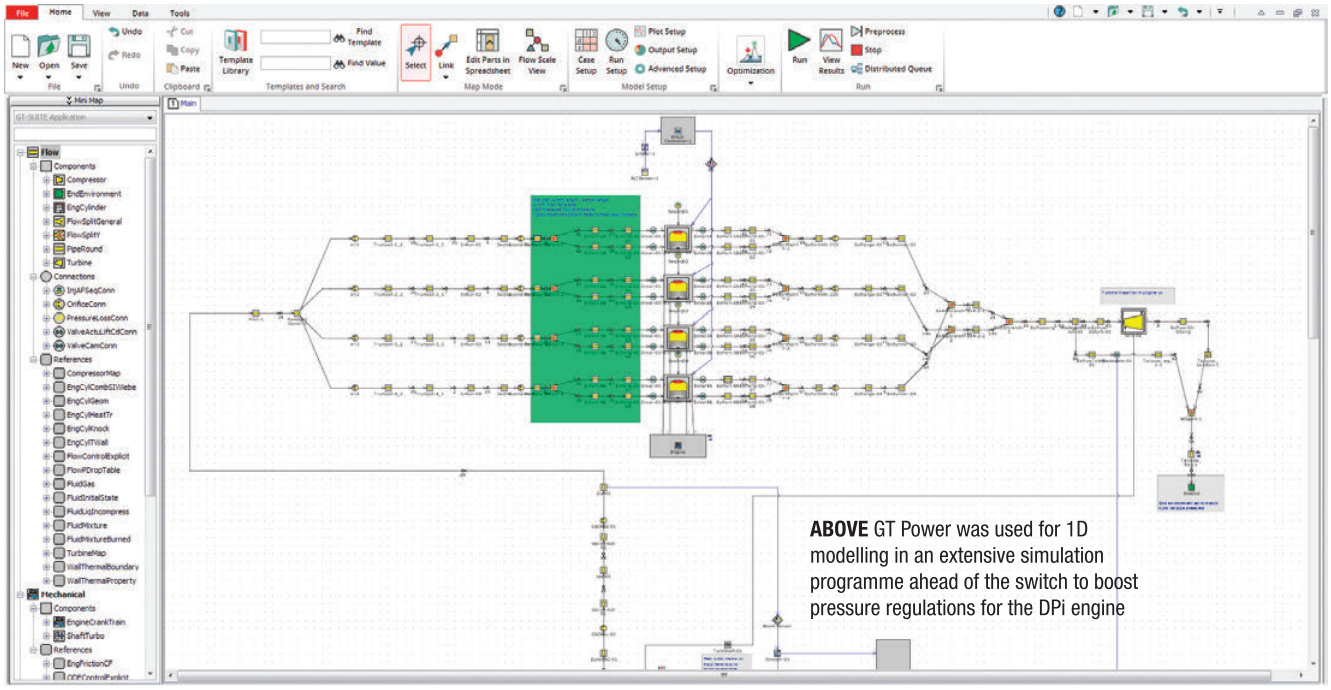


ABOVE GT Power was used for 1D modelling in an extensive simulation programme ahead of the switch to boost pressure regulations for the DPi engine

SMALL PACKAGES

Each of the 'manufacturer' engines in the Daytona Prototype International class have links to their road-going cousins. The 3.8-litre NISMO engine used in the Onroak DPi is actually a development of the Nissan GT-R road car unit, while the ECR-developed 6.2-litre V8 in the Cadillac is loosely based on that of the brand's CTS-V super saloon. Mazda, meanwhile, was one of the first companies – particularly in the American market – to switch exclusively to small four-cylinders, so the company was keen to follow a similar philosophy for its race engines.

From an engineering perspective, an inline four offers a number of attractive qualities. Even with the turbocharger and associated hardware in place it's thought to be the lightest engine on the grid by some margin. The inline layout makes it compact too, freeing up additional space for both the chassis designers and aerodynamicists to exploit.

A small capacity and a low cylinder count help to reduce fuel consumption. They also minimise the heat rejection to the water and oil systems, Ellis explains: "Reducing the cylinder count minimises the surface-to-volume ratio for the combustion chamber, as well as the parasitic losses. As a result, the overall cooling requirements are similar – if not a little lower – to those of the equivalent naturally aspirated engine. For a big vee engine in this sort of application you'd typically need two water radiators; here we have one radiator and one intercooler. So there's an aero benefit there too."

This philosophy isn't without its drawbacks, however. There's the added complication of developing and packaging the intercooler installation. Plus, the reduced cross-sectional area of an inline engine means the cylinder block will tend to have a lower torsional rigidity. That's no great issue from a powertrain perspective, but it means additional bracing can be required when the engine is installed as a stressed member.

> *"Very precise regulation of engine speed is vital to prevent boost pressure spiking over bumps and during gearshifts"*

The designers also needed to consider the durability implications of squeezing a comparable amount of power from an engine that's barely more than half the size of the next smallest competitor. This is something that AER is well-versed at, though, and despite producing something in the region of 300 bhp/litre, the MZ-2.0T has an enviable reliability record. So far, there have been no engine-related retirements whatsoever in the P91 era.

There's a lot to be said for starting off with a purpose-built race engine, Saunders points out: "Everything has its own challenges. If you take a large capacity road car engine, the chances are that the production blocks aren't cast to the same standards as a race engine. Similarly, if you take a production engine and start to rev it way beyond its original design criteria that introduces other challenges."

Getting the design right is only part of the puzzle. Quality control and servicing can be every bit as critical. Recently, AER has been applying F1 methodology, with an increasing use of mileage-tracking for lifed components. All the critical parts are laser-etched with a machine-readable code. This is common practice in series like F1 and NASCAR, but it's much harder to implement on a sports car budget.

"Key items have always been tracked, but we've increased the scope of our database quite significantly," comments Saunders. "Batch traceability is also very important. If you notice a small problem with an item in build it's very useful if you can interrogate the database and locate all the others from that batch."

At each event, a trackside support team of three to five people is on hand to carry out minor maintenance. They also have access to AER's sister company Life Racing, ▶

which provides the engine control unit. This handles all the powertrain and transmission control functions onboard, including gear selection, anti-lag and traction control.

"There are benefits to having an ECU supplier in-house," Saunders notes. "In racing – particularly in a performance-balanced class – you're always trying to get the most out of the package on that day at that circuit. There are times when it's beneficial to modify certain strategies, and we can call the person who writes the code and get them to send a revised version across for the next event, the next day or potentially even the next session."

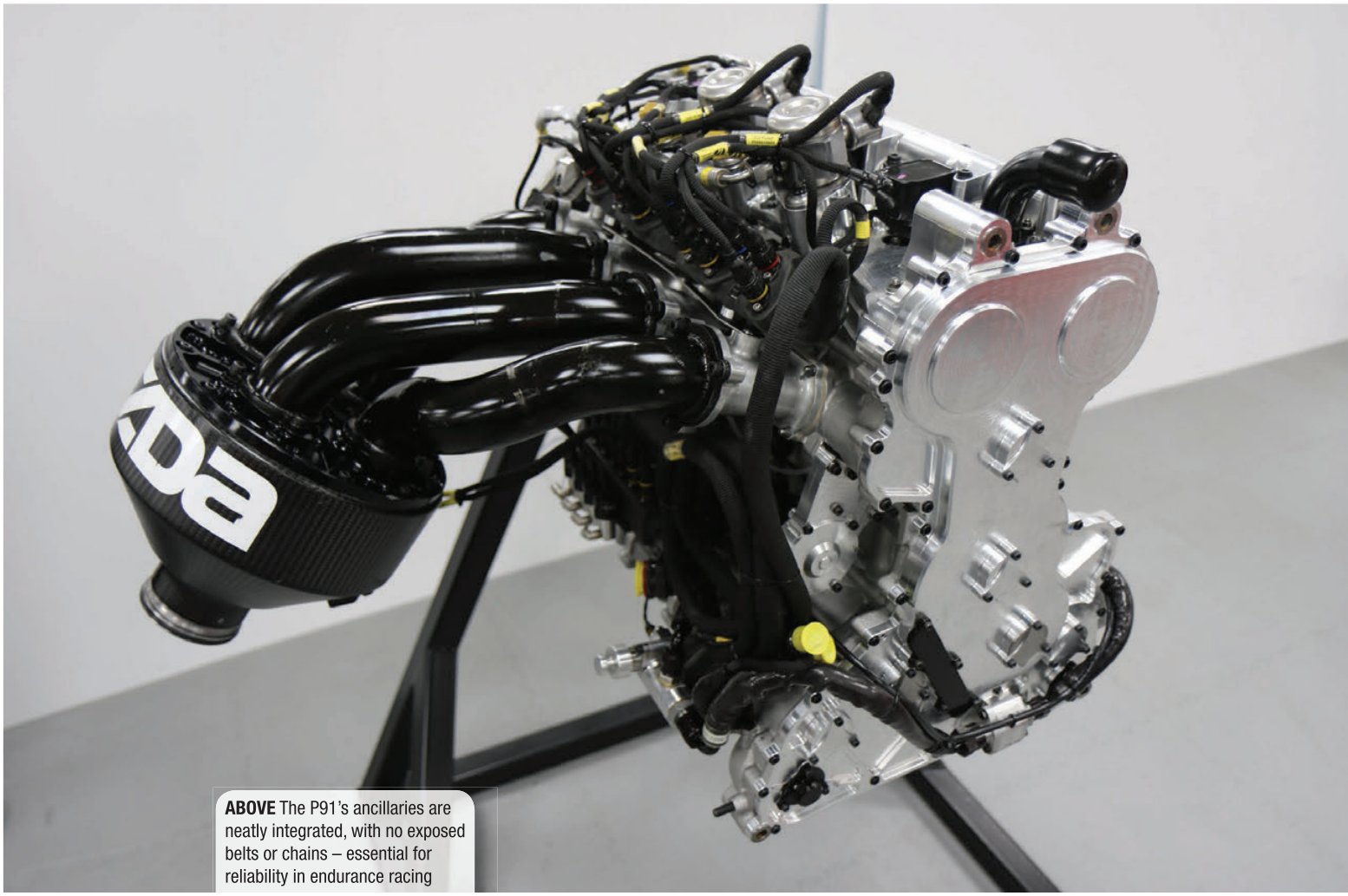
When the engines reach the end of their mileage limit – roughly 4,500 km – they are sent back to AER's facility in Basildon for a full rebuild. There are no official targets for rebuild life in the IMSA Prototype class, and Saunders believes it's the right way to go. "Personally, I've come to the opinion that pushing engines for higher and higher mileages can be counterproductive," he says. "Rebuilding engines isn't especially expensive, but re-developing them to run for much-extended mileages can cost millions."

After a somewhat cautious start, the MZ-2.0T-powered Riley Mk30s of Mazda Motorsports are starting to show encouraging form. The team took its first podium of the year in June at the Chevrolet Sportscar Classic on the streets of Detroit.

For Mazda and AER, this is just the latest product of an on-going partnership, which stretches back many years. With the downsizing trend very much in evidence in motorsport, and the compact architecture ideal for hybrid installations, it's likely that there will be more to come from this four-cylinder family. RT

Mazda MZ-2.0T Spec List

Capacity	1,998 cc
Layout	Inline four-cylinder, double overhead cam, single turbo
Fuel capacity	78 litres
Fuel	VP Racing IMSA E20 (mandated by series)
Power	Approximately 600 bhp
Maximum revs	8,900 rpm
Fuel pumps and injectors	Bosch Motorsport
Fuel rail	AER
Castings	Grainger & Worrall
Geartrain components	Precision Technologies
Turbocharger	Single Garrett custom turbo
Valvetrain components	Xceldyne
Coatings	Oerlikon Balzers



ABOVE The P91's ancillaries are neatly integrated, with no exposed belts or chains – essential for reliability in endurance racing

‘BAD-ASS’ INDYCAR TO RECREATE GLORY DAYS

The 2018 aero kit catapults IndyCar into a bold new era – by harking back to a golden one. **Simon Marshall** quizzes Tino Belli, IndyCar’s Director of Aerodynamic Development

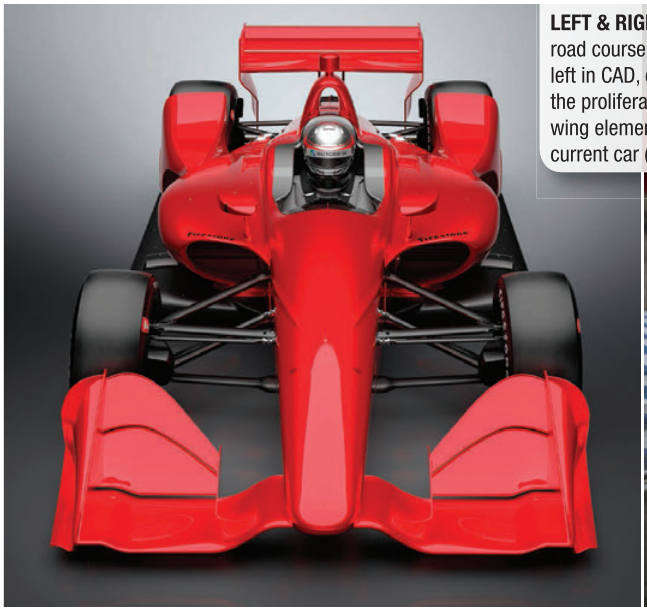
All photos: IndyCar

INDYCAR has found a sweet spot with close, competitive, exciting racing. Does the move to a new look for 2018 risk upsetting those hard-fought gains, or can the introduction of a universal aero kit make the Dallara DW12 even more entertaining?

Out go the Honda vs Chevy aero kits (and all the performance balancing and policing that go along with them). In comes a new single kit of parts designed on a clean sheet of paper, over the existing mechanicals and chassis. “We will replace all the components that were part of the Honda and Chevy aero kit – and a few extra,” says Tino Belli, IndyCar’s director of aerodynamic development. “The aero kit will have less options to make the parts easier and less expensive to make and maintain.”

IndyCar set the design and performance guidelines early on, in March 2016 at the Barber race, and distributed them to various manufacturers for consideration. It opted to go with its tried and trusted partner, Dallara, and involved itself in the design process by facilitating changes to the guidelines and aims as new ideas and information came to light through the evolution.

“Dallara has been a great partner, and



LEFT & RIGHT The road course spec, seen left in CAD, cleans up the proliferation of wing elements on the current car (right)

ABOVE & INSET The next-gen Indy car, seen here in speedway spec, takes over from the existing Honda and Chevrolet kits (inset) in 2018

we couldn't be more enthused with the look, the safety enhancements and the performance objectives of the 2018 car," stresses Jay Frye, IndyCar president of competition and operations.

It's easy to see the effect of 'free areas' on the current 2016/2017 design: as many elements are jammed in as possible to raise the performance at the expense of cost and practicality. The introduction of the universal aero kit will make the governing body's aero performance targets far easier to hit simply.

The targets are the current aero performances, with at least the same stability at all angles, but without some of the elements that were added to fix the previous instability problems (domed skid and big tail fin) and perceived racing risks (rear wheel guards).

SETTING THE BAR

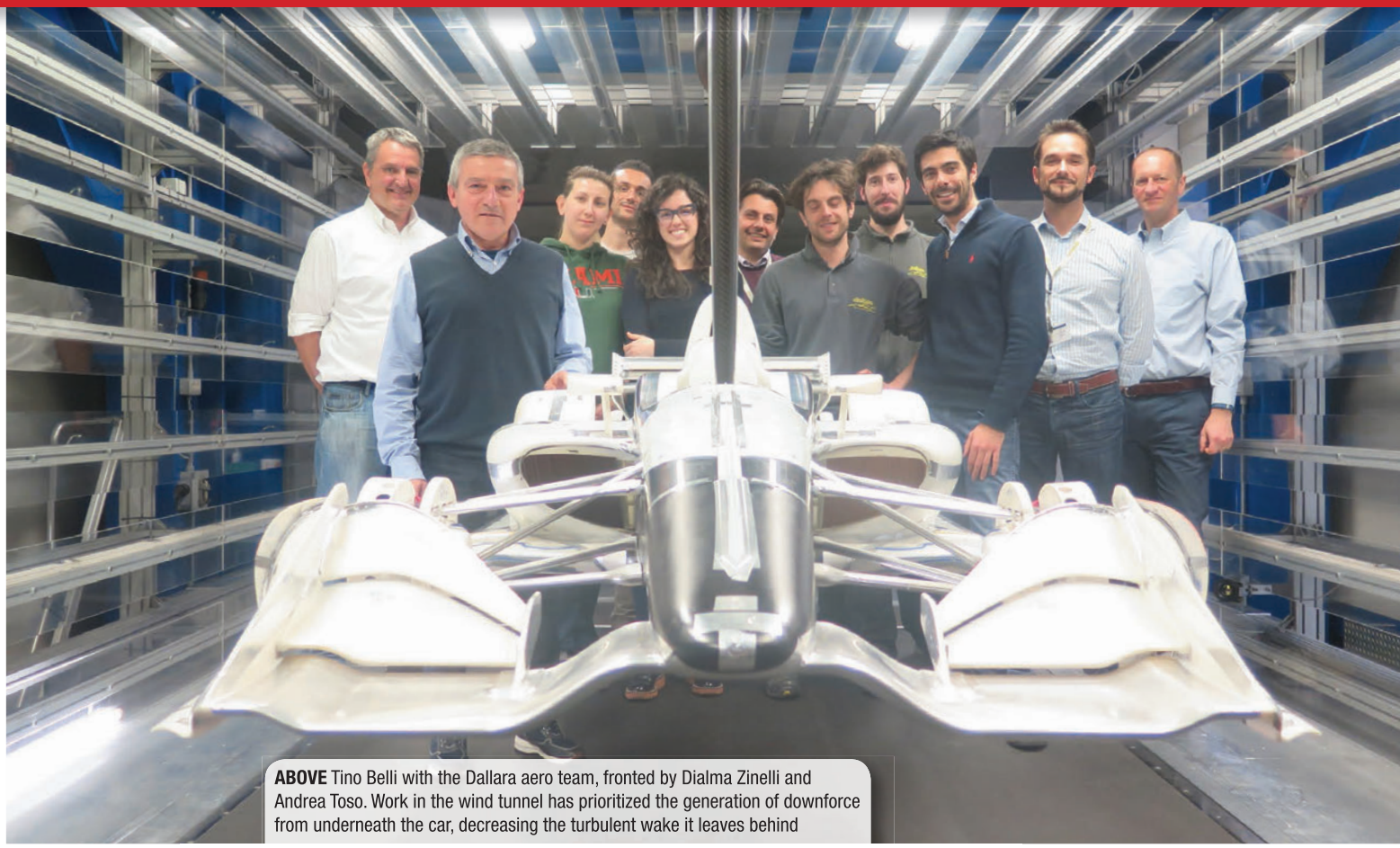
The racing has been very close and entertaining throughout 2016 and '17. While a new look was sought, a crucial goal was to maintain or improve the quality of the show.

IndyCar has a mass of track data supplied by the teams, together with Honda and Chevrolet development data and its own studies. It even quantifies the quality of the racing, based on certain factors: number of passes, lead changes, spread of the field, yellow flags etc.

Since 2012 the data has been collected, manipulated and weighed against the track type and measured against audience surveys after every race. The 2017 Indy 500 ranked as the most entertaining event so far in this study. The raw numbers agreed with the audience (and internet) surveys.

The performance targets for 2018 have been set based on the mix of empirical and scientific data:

- Road Course/Short Oval max downforce to match Chevrolet 2015 levels
- Road Course/Short Oval min downforce to be less than minimum Chevrolet 2015 & 2016 level (based on Iowa 7/8-mile short oval qualifying)
- Indy 500 & Superspeedway races downforce range to be as 2016 (2650 lb downforce at 200 mph average) but with only one rear wing mainplane, without the current outer winglet additions ▶



ABOVE Tino Belli with the Dallara aero team, fronted by Dialma Zinelli and Andrea Toso. Work in the wind tunnel has prioritized the generation of downforce from underneath the car, decreasing the turbulent wake it leaves behind

- Indy 500 qualifying speed average to be close to 230 mph

In 2017 the turbo boost was set at 140 KPa (ie 40 KPa, 400 mbar above atmospheric) for short oval events and Indy Qualifying, down to 130 KPa for Superspeedway events and the Indy 500 race, and up to 150 KPa for road track events. Given the 2018 Indy Qualifying speed targets, the turbo boost, according to Belli, needs to be "about 145 KPa" (about 5 psi gauge boost).

SAFETY AND AERO STABILITY

The continual drive for safety improvements has dictated that the Indy 500 aero stability benchmarks for the new aero kit surpass the 2017 levels at the 5° nose up, 90° yaw, 135° yaw, 180° yaw conditions. The new car reflects the fact that Dallara and IndyCar now have six years of research and learning to help understand where the limits of control are with the DW12 and the art of taming the beast when the line is crossed.

The domed skid (under the car) is being done away with, as this has caused its own logistical problems. If the clean sheet design can achieve the stability targets without the domed skid, Belli says, "We can save the weight and cost and wear policing" associated with it.

> *"We transferred downforce from the wings to the underfloor and the following distance in the wake was halved"*

The 10 mm higher ride height that the domed skid demanded was also a negative for drivers and engineers alike. More wing angle had to be run to achieve the downforce required, but the wings were more easily disturbed in traffic than the underbody. The lower this type of underbody is run, the more efficient aerodynamic performance can be extracted, and this plays a pivotal role in the new dawn for 2018.

"We're working on creating more of the downforce from the underwing," explains Belli. "We transferred the downforce from the wings to the underfloor and the following distance in the wake was halved."

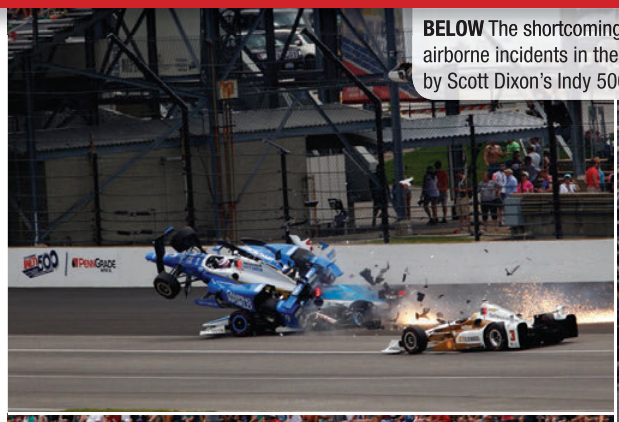
Confirmation that IndyCar was heading in the right direction was provided by a test conducted at Phoenix International Raceway at the end of 2016 with the current bodywork configuration. By removing the rear wheel guards, closing up the forward underbody 'hole' and adding fences in the rear of the underbody, front wing angle was reduced, followed by lower rear wing angle. This resulted in a quantifiable (by data logging and photography) change in the ability of the following car to keep up in the corners.

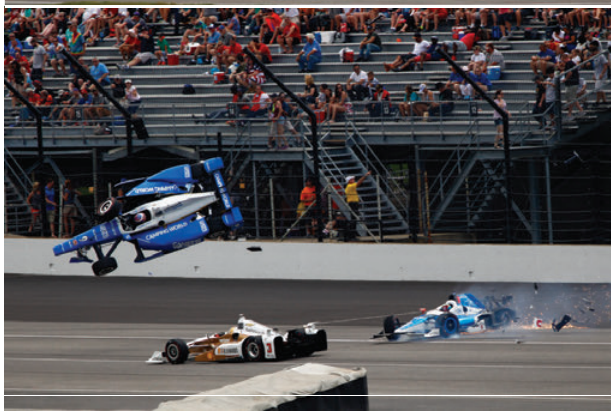
It was thus decided that the existing underbody could be modified to work harder, which could prove beneficial at all tracks. Interestingly, the proposed modifications to enhance the existing underbody can't simply be applied to this years' car, as the current aero kit contract between IndyCar and the manufacturers assures a development freeze. Opening up underbody development would enrage the accountants at this stage.

RETRO LOOK

The 2018 cars are characterized by a look reminiscent of the low-line turbo Indy cars of the early '90s. This aesthetic was a collaboration between IndyCar and Dallara with the style design support of Chris Beatty, a concept design and 3D animation consultant based in the United Kingdom.

The new look proved a hit with the drivers back in January 2017 when IndyCar released ▶





BELOW The shortcomings of the boxy rear wheel fairings, intended to reduce airborne incidents in the event of wheel-to-wheel contact, were highlighted by Scott Dixon's Indy 500 crash. They are removed from the new car

Abbott/LAT USA

its first sketches at the Detroit Auto Show. "It looks like a real race car, for sure, which is awesome," said former Indy 500 winner Alexander Rossi.

"It takes us back to kind of the glory days, I think," agreed Team Penske's Josef Newgarden. "It's not like a production car. I mean, it's kind of like a fantasy, almost, which is what makes Indy cars so cool. The sexy element, making them bad-ass-looking, is really, really critical."

The drivers have a point. Racing organizations have been through a slump of trying to outsmart innovation, cut costs and limit possible performance, whilst forgetting about the look and emotion of the car. That is, let's face it, why we're watching… or we could just have the drivers try a running race.

The most visual impact comes from the low engine cover. Together with the 200 mm lower road track rear wing endplates, the car has a long, lean look. Significantly, the aero gadget proliferation that accompanied the move to open aero kits has been cleaned up. There are two- or three-element options for the front and rear wing and wider, lower rear road course wings.

Gone too are the rear wheel guards. The boxy rear wheel fairings were introduced to prevent the car behind climbing up when tyre-to-tyre contact was made. They were actually good for drag reduction at Indy, but generally made the car look bulky. They added weight and cost, and were responsible for a lot of crash debris!

> *"Racing organisations tried to outsmart innovation and cut costs, forgetting about the look and emotion of the car"*

Since 2012 the rear wheel guard never really worked to prevent wheel-to-wheel take-off as the parts would be knocked off too easily. That much was demonstrated under the glare of the media spotlight at this year's Indy 500, when Scott Dixon flew so spectacularly after front wheel to rear wheel guard contact.

The rear beam wing (between the rear wheel pods) has also been removed. We investigated the success of the beam flap in Race Tech 199 and the device won awards for counteracting the propensity for lift-off when the car was travelling backwards. One of the culprits for that backwards instability was the beam wing itself, which the safety flap happened to be attached to!

We've come full circle now, with a clean sheet approach to the bodywork, and the root causes of instability can be designed out. On the 2018 Speedway setup, the flap device will sit on the top surface of the trailing edge of the underwing.

Modern racing cars use honeycomb or ▶

ABOVE The removal of the rear wheel guards makes for an aggressive, well-proportioned look

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Canopy collaboration with F1

BELOW IndyCar is investigating a version of the aeroscreen, trialled by Red Bull in F1

INTERESTINGLY, the cockpit aeroscreen that has been talked about vigorously in IndyCar has not necessarily been included in the 2018 requirements.

"We are looking at a windscreen or a halo-type application," confirmed Jay Frye, IndyCar president of competition and operations, at the Detroit Auto Show earlier this year. "Will that be on the car in '2018? I'm not sure, but we're full speed ahead designing and developing as soon as possible."

Jeff Horton, director, engineering & safety at IndyCar, adds: "When we design safety parts for the cars we make no promises on delivery dates. We deliver when they are ready. We hope to have a working prototype later this summer with the intention of running it during our 2018 body kit validation testing."

IndyCar has been developing a screen, incorporating a carbon frame, with PPG Aerospace 'Opticor' abraision-resistant polycarbonate-like material, used on fighter jet canopies. In fact, the first test item was actually created from an F16 canopy.

The impact criteria ranges from wing endplates to nosecones and wheels, and of course stationary objects (speedway catchfencing poles etc) that might be the toughest challenge.

Horton and Dr Terry Trammell, safety consultant to IndyCar, are part of the GIMSS (Global Institute of Motorsport Safety) committee which is where the F1 windscreen specifications may one day be defined. IndyCar and PPG have agreed to share their findings with the FIA and F1.

F1 has recently moved away from the 'halo' concept and towards testing the windshield approach (the prototype for which was made by Isoclima in Italy) as modelled on the Red Bull car in a 2016 test.

A 'pre-prototype' was tried on the Dallara driver simulator in Speedway, Indiana, in 2016, to gauge the distortion of vision the drivers are fearing. However, they were pleasantly surprised by the optics, even at an early development stage.

The first fully formed prototype is expected to be tried in the Dallara Indianapolis simulator later this summer.

rigid foam core between thin composite skins, with reinforced fixing inserts. Contact damage usually results in parts flying off the car, which can be dangerous to drivers and fans, while sharp pieces can also be responsible for cut tyres.

FIA-sanctioned events are likely to be held at venues where the spectators are kept well away from the track, but with a lot of IndyCar races being on oval tracks or street courses, where the spectators are a lot closer to the action, special attention was given to dealing with this problem. The result of that work is that the 2018 car will use carbon/Dyneema hybrid outer plies on structures that are likely to be impacted.

ENGINE INSTALLATION

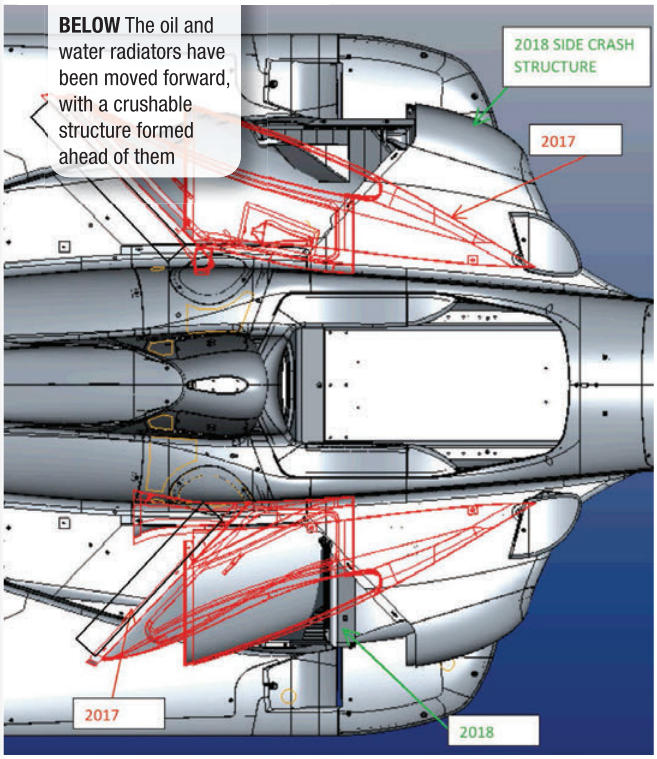
The current 2.2-litre V6 engines supplied by Chevrolet and Honda are retained for 2018. "To save cost we have kept as much of the current engine architecture as possible, including turbo position and the turbo to plenum pipe," says Belli.

"Currently the air inlet is through the crash hoop and there is a duct down to the air filter which is above the plenum. The air went down the side of the engine to the turbo and back up to the plenum. It was a pretty inelegant, tortuous solution, but for the manufacturers the positive pressure above the drivers' head made it worth it.

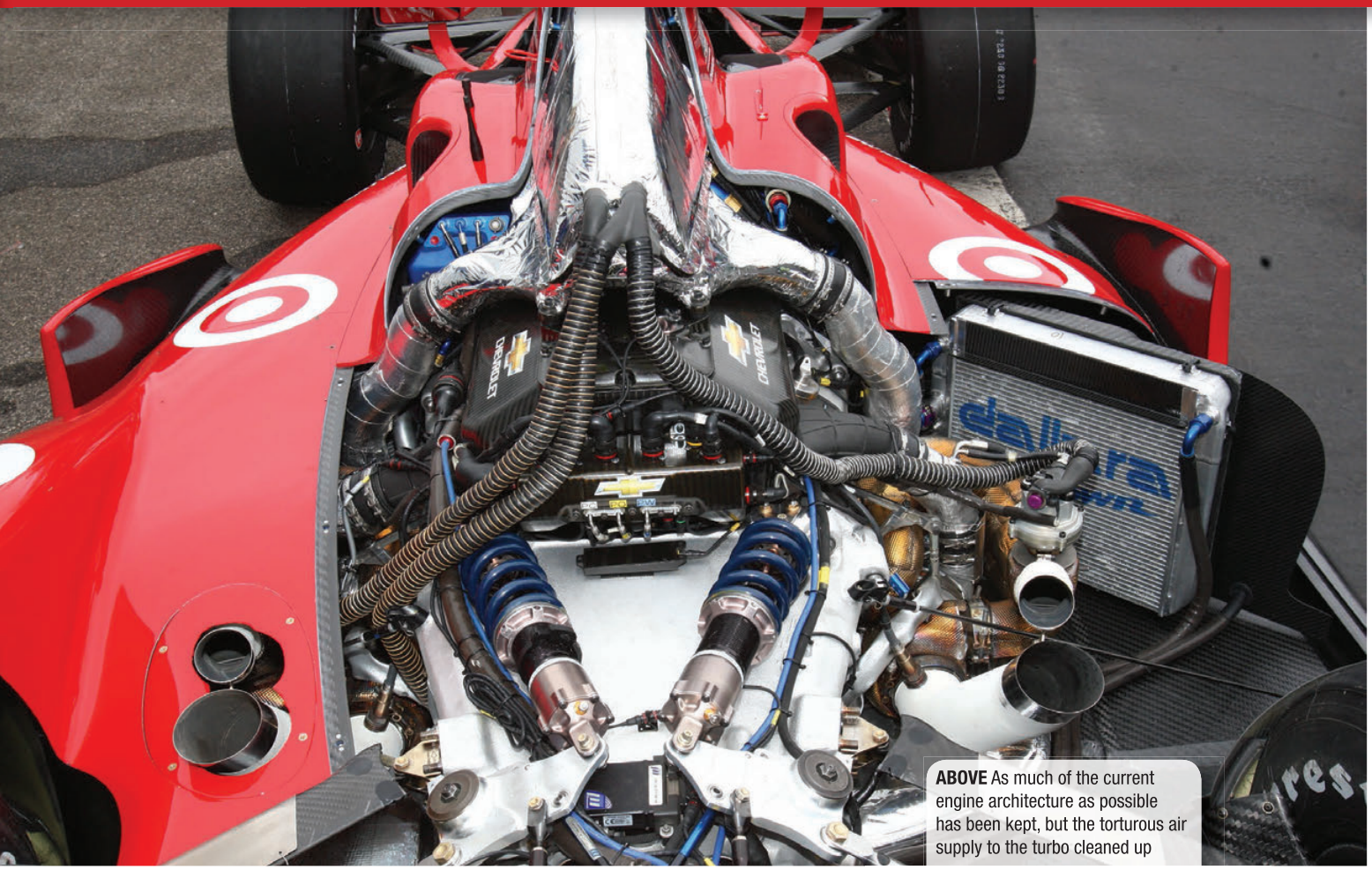
"Next year the air will come in through the sidepods (between the radiators and the monocoque), have a short run to the turbo (via a filter) and up to the plenum."

With the driver's safety in mind, the oil and water radiators have been moved forwards, into wider forward sidepod areas. This gives some added cushioning to the driver's side. The sidepod leading edge and inlet duct are joined with bulkheads to make a proper crushable structure ahead of the radiator.

The cooling package is re-organised, but actually uses the same parts as 2017: PWR air/oil cooler and PWR aluminium or Mezzo stainless steel water coolers. The Mezzo radiators, on paper, are



BELOW The oil and water radiators have been moved forward, with a crushable structure formed ahead of them



ABOVE As much of the current engine architecture as possible has been kept, but the torturous air supply to the turbo cleaned up

heavier and more expensive, but they are much more durable than a typical aluminium finned radiator, and teams appreciate the net gain over the whole season.

The Indy car doesn't use a turbo intercooler as the ethanol fuel goes in at such a rate (similar to the old ChampCar running methanol) with one third lower calorific value than gasoline, and a beneficial higher cooling effect on the charge.

WHAT NEXT?

The testing plan is:

- Indy 500 track test, July 25-26 2017. Superspeedway stability, reliability and drag.
- Mid-Ohio, Aug 1, Road Course test.
- Iowa, August 10, chosen for its specific demands as a 7/8-mile short oval with roadtrack-like downforce.
- Sebring, Sept 21, brakes and cooling 'stress test'.

The intention is to deliver 21 kits to teams by November 27th 2017 (one per full season entry), with a further 21 kits to follow by the end of January 2018.

The logistics of what, and when, are a year-long exercise in engineering, production, financial planning and risk management. The parts have to be delivered to the teams in a fair manner, allowing plenty of time for all outfits to become experts in running the cars again.

There will always be unexpected issues when dealing with design and production on a short timescale. But, as Winston Churchill said: "Plans are of little importance, but planning is essential."

Back in March 2017, deep in the re-invention process, Belli suggested that "IndyCar has achieved 97 per cent of its goals". It appeared a bold statement to some but, as the car comes to fruition, he's pushing the 99 per cent threshold. Well, no-one's perfect!

ABOVE & BELOW IndyCar based its new car on a form of reverse-engineering: it worked on aesthetics first, then created a performance package around it. This is the Road/Street and Short Oval kit seen in CAD (above) and the Superspeedway trim (below)

BELOW Jonathan Hughes, a lead research scientist at Toray CMA, was involved in developing its new product

INNOVATION BY CHEMISTRY

William Kimberley reveals that a big player in other industries is launching a product offensive in motorsport

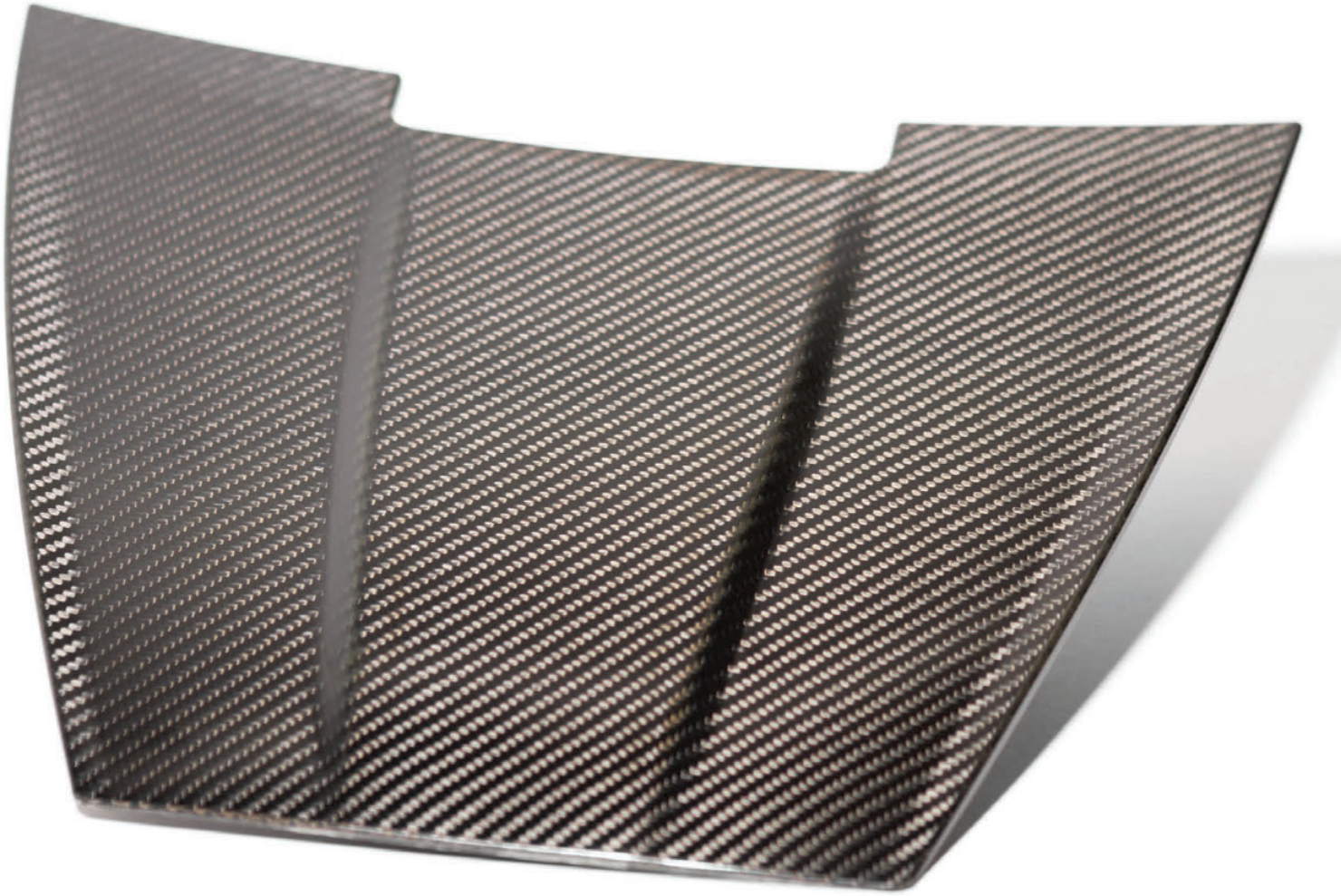
TORAY Industries has been in the materials business since its formation in Japan in 1926. Originally specialising in rayon, which uses pulp as a raw material and is mankind's first chemical fibre, it then became involved in nylon in the early pioneering days.

Over the decades it has expanded its business overseas so that it has a worldwide footprint, including the US. It has always kept its eye on opportunities so that when it saw that the aerospace industry was beginning to turn to non-ferrous materials in the 1960s, it was there to meet the need.

By 1990, Toray prepreg was certified for the first time as a primary structural material in tail assemblies for the Boeing 777 and it was this that led to the formation of Toray Composites (America), Inc (TCA) in Tacoma, Washington State, adjacent to Boeing's Composite Manufacturing Center. First used on the Boeing 777, Toray's carbon fibre prepreg materials are now incorporated into the 777 and 787 primary structure and will be used on the new 777X wing.

A recent expansion of around 110,000 square feet at its Tacoma facility, along with the investment in a new 400-acre site in South Carolina, means that the company finally has capacity to diversify, with one of the industries it is looking to break into being motorsport. While in

ABOVE Expansion of the group's Tacoma facility has enabled CMA to diversify



> *"We're going to see some new product coming that will make big waves"*

2015 the group acquired Italian company Composite Materials (Italy) S.r.l., (CIT) and purchased the majority share of Delta Tech S.p.A, which already had well established business in motor racing, particularly Formula 1, it specifically wants to exploit TCA's expertise in prepreg.

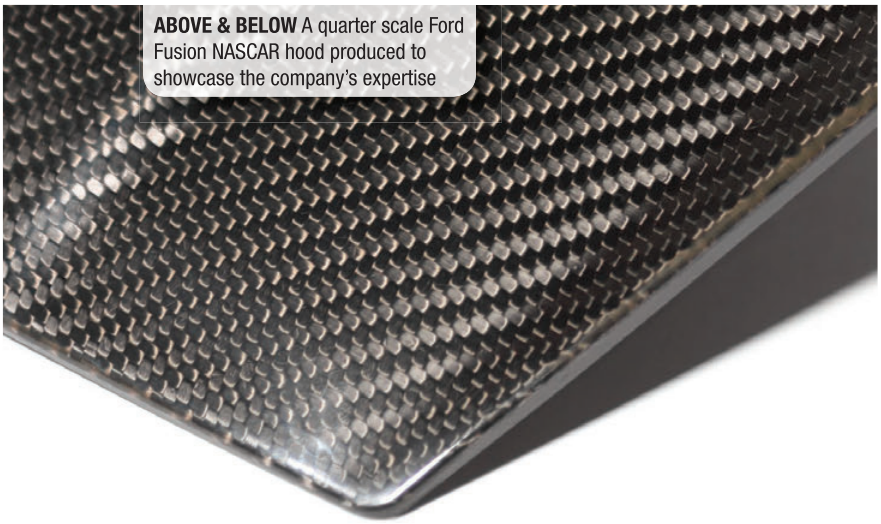
The man tasked with leading the team to look at just such opportunities is product development manager Jason Nelson. A motor racing enthusiast and the proud owner of a Formula 2 Renault, he cut his teeth in the sport as co-captain of Western Washington University's FSAE car when it competed with Viking 30, the fabled V8-powered car, in 2001.

"Toray has hundreds of chemists, chemical engineers and material scientists," he says. "Some of them are being directed onto non-aerospace products and I'm pretty certain we're going to see some new product coming that will make big waves in other industries.

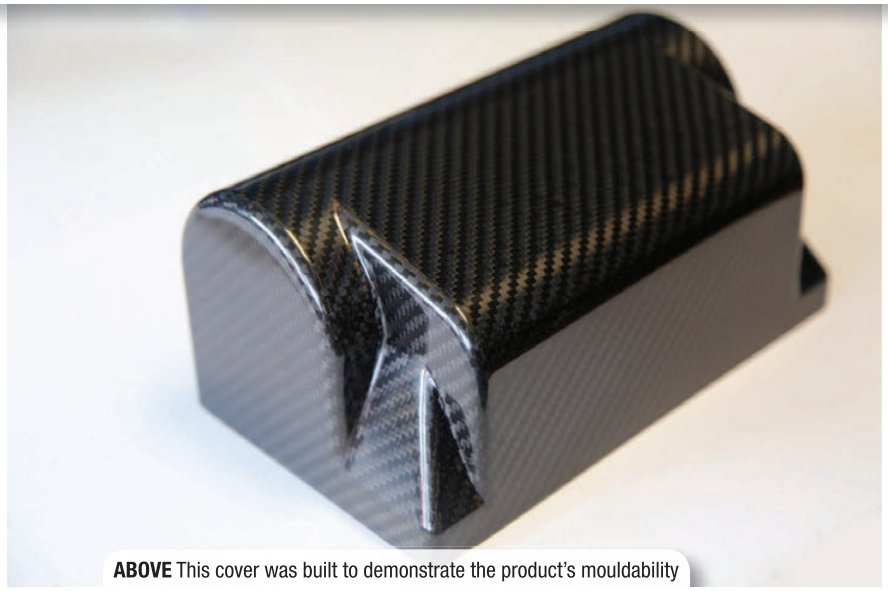
"So one of the things I think Toray, which has the tag line 'Innovation by Chemistry', is going to be able to lend Delta Tech and CIT is continued formulations or advancements on the resin side. Composites comprise two parts – the fibre and the matrix, with resin chemistry and the sizing on the fibre, which is that interface. Most people design around elevated temperature/wet – ETW OHC (open hole compression) – a resin-dominated property."

Nelson's job, though, is to promote his side of the business. In early April, TCA was consolidated with Toray's Alabama facility Carbon Fibers America, Inc into a single business entity to become Toray Composite Materials America (CMA). This allows the new entity to better integrate, innovate and meet the demands of its customers.

"Aerospace material requires a very high level of consistency and quality," he says. "Customers want to get the same thing over and over. When you buy some 6061 T6 aluminium, for example, you don't ▶



ABOVE & BELOW A quarter scale Ford Fusion NASCAR hood produced to showcase the company's expertise



ABOVE This cover was built to demonstrate the product's mouldability

care where it comes from because it's all the same, but composites haven't reached that level of maturity yet. However, our 25 years of serving the aerospace industry has drilled into us consistency and quality requirements, so we've already built those into our systems."

TORAY'S 'UNFAIR ADVANTAGE'

Apart from the consistency of its products and the quality assurance, Nelson points out that while every race team comprises mechanical engineers, few if any have a scientist or chemist. It's here that he believes that Toray CMA has a great deal to offer.

"As we met with the race teams, we quickly realised that none had chemists, but everything occurs at the molecular level. One of the things we can offer customers and potential customers is that we have dozens of chemists here on site at Tacoma who can help them better understand what's happening with the resin during cure or what's happening during cross-linking, how the resin bonds to the fibre or the sizing available to them."

While composites and carbon fibre tend to be associated with high end motorsport, Nelson believes that the use of composite panels will start to trickle down to the lower level series where cost is even more important. However, opportunities will still remain in the higher levels of the sport as he believes that composites will play a greater role in structural parts such as wishbones and uprights.

While still relatively new to the industry, success has already been notched up with a fire-resistant product it is selling into NASCAR. "It's not a traditional flame retardant resin because we don't use halogenated components that can decrease the performance of the matrix and are toxic," he says, noting that this is just the start of a product offensive.

"We understand that the use of carbon fibre and prepreg is already well established in motorsport, but with our DNA being in the demanding aerospace sector, with the resources in terms of brainpower we have at our disposal, our fresh approach will quickly bring us market share. All we have to do now is prove ourselves." RT

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ABOVE While NASCAR is currently the primary focus, Toray is also targeting the Indy, sports car and NHRA drag racing sectors

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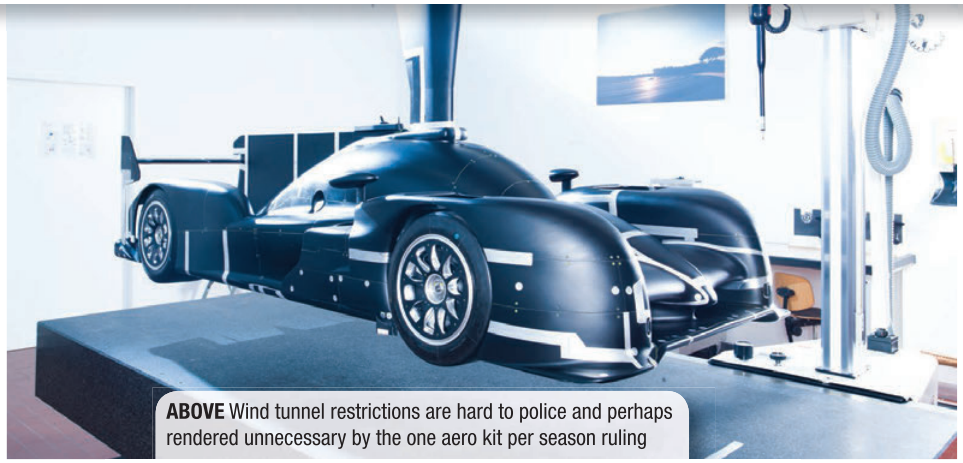

ABOVE Wind tunnel restrictions are hard to police and perhaps rendered unnecessary by the one aero kit per season ruling

THE WEC'S PARALLEL UNIVERSE

Sergio Rinland evaluates a new rules package for the World Endurance Championship that trumpets a move towards plug-in hybrid technology

WE have just witnessed one of the most dramatic Le Mans 24 Hours in history, comparable to when Ford beat Porsche by a whisker in 1969, but we nearly had the embarrassment of an LMP2 car winning overall and that should sound an alarm bell for the Automobile Club de l'Ouest and FIA. There were only five competitive LMP1 cars this year; the absence of Audi was felt. Consequently, it only takes a few problems to eliminate the whole field, which is what nearly happened.

So, in response to this potential situation, the ACO and FIA have announced the new rules for 2020. They target five main objectives: adapting the technologies to road-going vehicles; cost capping; technological diversity; a level playing field in terms of performance; and retaining the appeal of endurance racing.

The measures announced to cut costs are good. They are in line with what has been suggested for some time, limiting in-season development, mainly aerodynamics by allowing only one set of bodywork to be homologated at the start of the year. There will also be new limits on track testing, the amount of powertrains and gearboxes to be used in one season, and on the number of personnel at the races. All good and logical measures which will not hinder the technological advances, rather encourage them.

Limiting hours of wind tunnel time? I am not too sure about that. Not because I think it should be free, but looking at the F1 experience in limiting wind tunnel and CFD, we can see that it is not working as desired, so what makes them think it will work in WEC? It is a very difficult rule to implement; they should leave it alone. The homologation and one-per-season bodywork will take care of the aero development costs.

Movable aerodynamic devices? I am all for it: we are not in the 1970s anymore, and the advances in technology make them viable and safe. I would also encourage them to develop electronically deformable body panels, and the use of intelligent materials, all relevant to the automotive industry. This is aimed not only to save costs but also energy. The proposed safety rules are also a step in the right direction. Motorsport can never be 'safe enough'.

Where I am not in total agreement is in the proposed rules promoting a particular technology that is clearly understood by the automotive industry to be a stepping stone towards full electric propulsion, ie Plug-in Parallel Hybrids. Tesla has shown the traditional automotive industry the direction it should take, and legislation around the world is going in the same direction. What needs to be understood is not what is selling now or in five years' time (that technology is already sorted), but what will be sold in 10 to 15 years' time. That is where motorsport developments can help.

Parallel Hybrid – as currently showcased in Formula 1 and the WEC – is a good way to reduce emissions and/or enhance performance, but it is a by-product of more than 120 years of investment and development of Internal Combustion Engine (ICE) vehicles. It is adding electric power to a current platform design – an acceptable stepping stone before going fully electric or to hydrogen fuel cell hybrids.

What should the rules be to develop powertrains in the EV direction? The obvious answer is Series Hybrid, which would develop EV technologies with the help of inboard electric generation and storage. The step from an ICE Series Hybrid to a Hydrogen Fuel Cell EV is much shorter than from a Parallel Hybrid technology.

I am not advocating a fully electric vehicle for a 24-hour race, since it will be many decades before batteries and fast-charging can be a viable solution for long-distance racing. Changing batteries in a pit stop is not a very good idea: a multi-million dollar company (Better Place) promoting that concept went bust a few years ago because with the current battery technology getting to 500 to 600 km range, switching is no longer as necessary as initially thought. So, here is where I think the ACO and FIA need to have a re-think. They have a bit of time for that.

I sympathise with Porsche and Toyota, who have spent an enormous amount of money developing the current crop of LMP1 Parallel Hybrids. But there are more OEMs wanting to get into LMP1 who are not necessarily interested in developing a technology that does not suit their products and that will eventually be obsolete.

The one-kilometre rule

ONE of the headline announcements of the new rules package is that, from 2020, cars will be required to cover the first kilometre after each refuelling stop in full electric mode at racing speed.

But why one kilometre? It's a statement, I guess, but I would make it a lap! That would be a *real* statement and would push constructors to develop batteries relevant to road cars. One kilometre is nothing.

Mind you, if you were to offer me the choice as a designer who wanted to create a car to win races, I would do 1 km and have a small battery! Rules...

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