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COVER STORY PAGE 30

"If it wasn't for the FIA needing to create an even field, we'd be kicking the living shit out of everybody!"

RACE TECH INTERNATIONAL
Motorsport Engineering

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EXIT OR REMAIN, THAT IS THE QUESTION

AS WE go to press with this issue, the UK news is full of stories about whether the country will vote to leave or remain in the European Union in a referendum on 23 June. Many of the stories put forward by both sides of the argument are highly emotive and sometimes misleading.

For example, those arguing for Brexit – Britain Exiting the EU – have put forward pretty mischievous claims that where Adolf Hitler and Napoleon failed unification, the EU was "an attempt to do this by different methods". According to Boris Johnson, the former colourful Mayor of London who issued this statement, the EU was a "peaceful organisation" but that it was "fundamentally undemocratic" and said it was operating "by stealth" and taking away the "powers and prerogatives of the people of this country". Powerful stuff that strikes a chord with some people, but it did also cause offence to a lot of people as did his peculiar remark about President Obama's Kenyan heritage.

Then there is the totally spurious argument that the EU is now preventing bananas being sold in bunches of more than three, again courtesy of Johnson but which cleverly plays on the underlying distrust of them bureaucrats in Brussels.

When it comes to Britain's motorsport industry, it is quite difficult to ascertain just what the effect will be but when pretty well all leading industrialists and businessmen in the country come out in favour of remaining in the EU for various reasons, including the general economic wellbeing, then it is also reasonable to say that such arguments should also resonate with the motorsport industry.

Although difficult to verify, it is said that there are around 4,300 businesses accounting for over 40,000 jobs in the UK that owe their existence to motorsport and which between them generate around £10 billion to the economy. Apart from the value, the industry is a honeypot for people from around the world who recognise that if they want a decent career in the industry, then the UK has to be at the top of the list, or as near as dammit. For those who were born in one of the 28 EU countries, getting a job is not an issue as one of the principles close to the heart of the whole setup is the freedom of movement and work. No hassle about getting work permits and visas because you are treated in just the same way as anyone else applying for a job from the home country.

So if the UK decides to leave the EU, this could possibly have an effect on employment. It would not happen instantly, because the process of leaving the EU would take years, but ultimately it would lead to visas and work permits becoming necessary for anyone born out of the UK.

While this might seem a bit farfetched, one of the basic arguments for leaving the EU, apart from getting away from meddling bureaucrats in Brussels, is to take control of the country's borders and put a stop to net immigration, which are very emotive and powerful arguments. Only today, for example, the newspapers are alive with the story that EU nationals working in the UK have reached a record high. Over the past year to March, the number has risen by 224,000, a figure that appears to account for more than half of all the new jobs created in that time although this has been countered by the British government saying that nine in 10 people in work are British. However, the Brexit campaigners immediately latch onto this by saying that it is the low paid jobs and unemployed who are paying the price as they are being outpriced by cheap labour from abroad.

Then there is all the red tape when it comes to importing and exporting, which is bound to get worse no matter what agreement is reached by the UK and the EU. I still remember the time coming back from Le Mans around 20 years ago and pre EU free movement of goods with four boxes of magazines that were going to be dropped off at a shipping agent. Having run out of time to do so on my way to Le Mans, they were still in the car on my return journey when I got stopped by Customs officers at the Calais autoroute toll booth. I was detained for almost two hours by two over-excited Customs officers who wanted to charge me for 'exporting' the magazines, the same ones I had brought into the country a few days beforehand, but they couldn't decide on the fee. In the end I became so exasperated that I told them they could keep the blooming things and drove off.

Although a one-off personal anecdote, the thought of going back to things like that appals me.

Whichever way the vote goes, though, by the time the next issue comes out, we will know whether the UK is still part of the EU or has decided to go it alone. Exciting times.

William Kimberley
EDITOR

Stewart and Stevens pay in NASCAR nuts case

Andrew Charman

DAYTONA BEACH, FL: Multiple NASCAR Sprint Cup champion Tony Stewart earned a $35,000 fine for criticising NASCAR's stance on lug nuts – and then almost immediately saw the governing body change the rules.

Prior to the 2015 season NASCAR insisted that all five nuts on each wheel be tightened during a pit stop. If any missing nuts were spotted by pitlane officials the team concerned were penalised, and made to return to the pits to fix the issue. With the advent of the video-based pitlane monitoring system, however, and the reduction of officials actually on pitlane, NASCAR rescinded the rule, stating that it was up to teams to decide whether all nuts needed to be tight.

This has resulted in a growing trend amongst teams, particularly in the later stages of races, to risk leaving one or even two nuts off to speed up the pit stop time and gain track position, and perhaps not surprisingly, incidents of loose wheels have grown in number as a result.

Just before returning to racing at Richmond on 24 April, having recovered from a back injury, speaking at a quick lube and tyre shop to promote sponsor Mobil 1's involvement in NASCAR's Race to Green initiative, Stewart argued that the lack of rulings over lug nuts was taking the sport down a dangerous path. He said that NASCAR had made a bad decision.

"I guarantee you that envelope is going to keep getting pushed until somebody gets hurt. You will not have heard a rant that's going to be as bad as what's going to come out of my mouth if a driver gets hurt because of a loose wheel."

Stewart's words earned him the $35,000 fine for contravening section 12 of the NASCAR rule book, disparaging the sport or its leadership. However, the penalty angered the rest of pitlane, the Sprint Cup Drivers Council issuing a statement supporting Stewart's stance and the nine driver members offering to contribute equally to paying the fine. "While we do not condone drivers lashing out freely at NASCAR, we do feel Tony was in his rights to state his opinion," the Council stated.

NASCAR insisted that Stewart pay the fine himself, but also agreed to look again at the issue. "Since the drivers are now questioning it, it's time for us re-evaluate our position and work with the community on looking at possibly different ways to enforce the pit-road rules," said senior vice president of competition Scott Miller.

Days later a rule book revision was issued mandating that all five nuts must be installed on each wheel at all times during a race and specifying significant penalties for non compliance. If nuts are found missing before a race, the competitor will be made to start from the rear of the field. Missing nuts found after a race will earn the crew chief concerned a one-race suspension and $20,000 fine in the Sprint Cup, the fine reduced to $10,000 for second-division Xfinity Series crew chiefs.

NASCAR will also at any time reserve the right to bring a car to pitlane to check all of its lug nuts in place, a move clearly intended to ensure teams do not try to circumvent the rules in the middle of the race. If such moves result in an incident such as a lost wheel, the crew chief, tyre changer and tyre carrier could all suffer minimum four-race suspensions.

The new rules saw Joe Gibbs Racing crew chief Adam Stevens suspended following Kyle Busch's win at Kansas on 7 May, the crew chief caught out by social media. Following the win NASCAR officials noted all five nuts in place on each wheel of Busch's Toyota, but pictures of his celebrations posted on social media clearly showed a right-side wheel with only four, and having study additional video evidence penalised the team.

Stevens was suspended for one week and fined $20,000, the tyre changer Jos Leslie also suspended. JGR accepted while present at the chequered flag, not all the nuts were tight and decided not to appeal the penalty. RT


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Although some will do so under the cloak of confidentiality, nearly half the 2016 Le Mans field is reliant on DSSV dampers and Multimatic is looking to repeat last year's outstanding successes.
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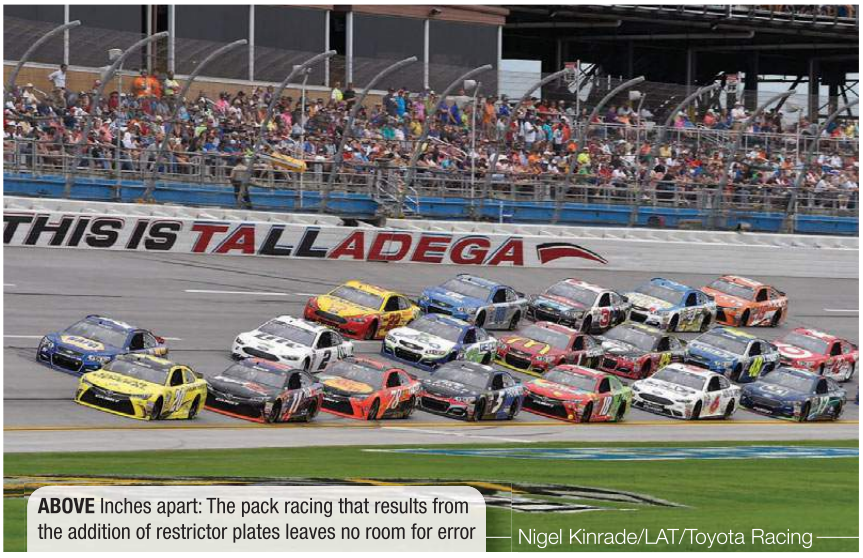
Wild Talladega produces '$10 million' damage bill

TALLADEGA, AL: NASCAR is counting the cost of its Sprint Cup race at Talladega superspeedway on 1 May, which saw multiple accidents, three cars airborne and 35 of the 40-car field involved in at least one incident. An informal survey taken after the race on the 2.6-mile restrictor-plate track speculated that the total cost to teams in damaged racing cars was close to $10 million.



ABOVE Inches apart: The pack racing that results from the addition of restrictor plates leaves no room for error — Nigel Kinrade/LAT/Toyota Racing

Talladega is renowned for producing at least one major accident, 'the big one', per race, due to the equalisation in performance produced by the mandatory inlet restrictor plates fitted to slow the cars' top speed, and the 200 mph pack racing that results. However, analysts pointed to particular reasons for the several crashes that marked out the 1 May event.

In particular, a consistent threat of rain resulted in drivers racing more aggressively earlier in the event, knowing that if rain had fallen after the halfway point and the race was unable to be restarted, it would have been declared official. In fact the circuit escaped the rain and the race ran to its full 500-mile length.

The carnage has revived calls to find a way of making restrictor-plate racing less damaging, principally by reducing the packs. NASCAR intends to study the circumstances of the Talladega race and in particular what caused three cars to take off. RT

Testing time for WRC Citroën

ALGARVE, Portugal: Three weeks after its first outing, Citroën Racing has continued development of its 2017 World Rally Car in the south of Portugal. Faced with varied weather conditions, Kris Meeke and Stéphane Lefebvre racked up the miles during four days of testing.

"We were actually quite pleased to have such variable conditions because they meant we could test different setups and assess how the bodywork stood up to being loaded with mud," said Laurent Fregosi, Citroën Racing's technical director. "Seeing our World Rally Car complete two long test sessions on demanding surfaces without encountering any major problems is very satisfying and just rewards for those who have been working on this project for over a year."

Built in less than a month, the assembly of the first prototype involved the efforts of various teams. "It was a critical moment because some components took a long time to manufacture. In the workshops, the technicians adopted a just-in-time approach, so that we would be ready on schedule. Although we have already completed two test sessions, we've only just begun the journey. Analysing the data and driver feedback helps us to develop the technical definition whilst selecting the most efficient solutions. As the same time, we are also preparing a second car, which will be shortly used for testing on tarmac. This iterative way of working – which affects all areas, from the chassis to the engine, including the transmission and the aerodynamics – will continue until we need to obtain homologation of the car for the 2017 Monte Carlo Rally. That point seems so far away, and yet it'll be here before we know it!" RT

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ABOVE No place to go: Safety concerns saw all four Subarus withdrawn after qualifying for the Thruxton meeting

JakobEbrey/BTCC

Fear of fire leaves Subarus in pits

Andrew Charman

THRUXTON, UK: Development of the Subaru Levorg as a British Touring Car Championship contender suffered a major setback at Thruxton on 8 May when all four cars were withdrawn from the meeting before the first race. Team BMR took the decision not to race over fears of a repeat of the fuel fire that had severely damaged the Levorg of James Cole during the previous meeting at Donington Park.

A statement issued by the team revealed that the problem with Cole's car had been identified as a failure of the high-pressure fuel rail, and this had been redesigned and remanufactured for all four cars prior to the Thruxton event.

The statement added; "Following a review of the new design post qualifying, the new part has shown signs of fatigue that could lead to a similar failure.

"We have investigated all avenues available to us overnight and this morning, however the engineering team has taken the decision to withdraw the cars as none of the solutions available are able to be durability tested prior to competing on circuit."

Team BMR added that to race would have put an unacceptable risk on its drivers, other competitors and circuit officials. The withdrawal added to what has so far been a difficult development programme for the Subaru Levorg, which as well as being a new car to the series has a very different engine, the flat-four 'Boxer' unit which due to its compact size is able to be located very low and far back in the engine bay.

PSP Images

LEFT Fire down below: James Cole's Levorg erupted into flame without warning during the Donington Park meeting

However, speaking at Thruxton, BMR driver Jason Plato sounded a note of optimism, predicting an upturn of fortunes for the team in the next rounds at Oulton Park on 5 June. "We have a stronger, better fix for the fuel rail, and a development engine for Oulton," he said, while the team will also be hoping for some assistance from BTCC organiser TOCA's review of throttle body sizes, restrictors, rpm limits and crucially turbo boost pressure.

Under the series regulations these reviews take place after rounds 9 and 18 of the series and *Race Tech* will report any mandated changes in the next issue. RT

Andrew Charman

LEFT How many hands? Team BMR's enforced withdrawal from the British Touring Car Championship rounds at Thruxton meant that its mechanics could come to the aid of sister team Triple Eight Racing, which had only around 90 minutes to rebuild the severely damaged MG6 of Josh Cook after the first race on 8 May. At least 11 team members can be counted working on the car – their efforts got Cook onto the second race grid and he finished 12th.

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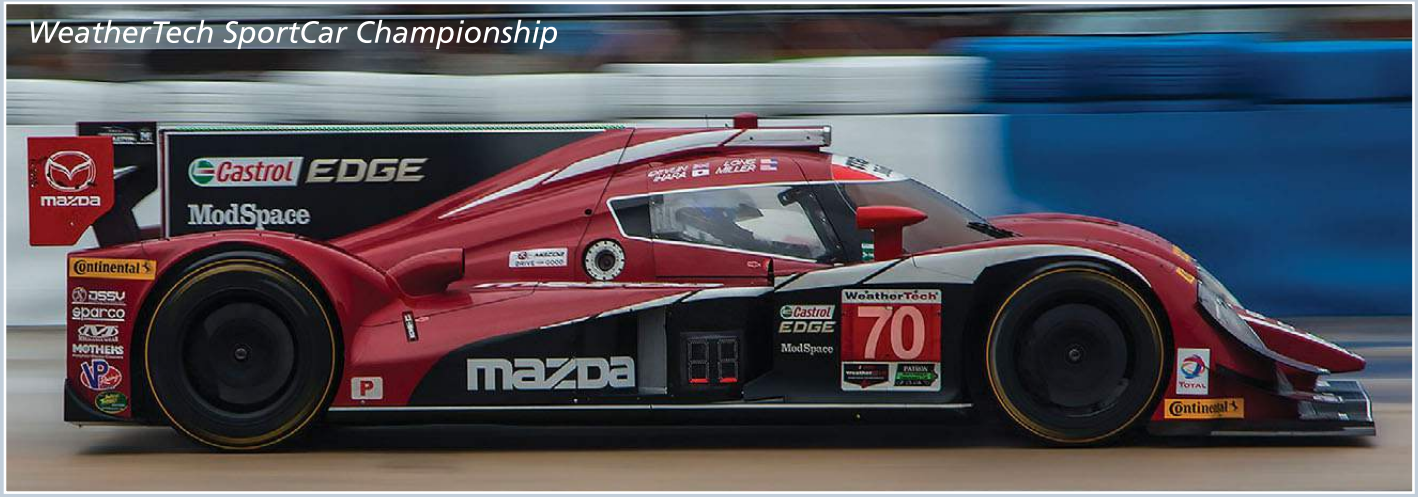

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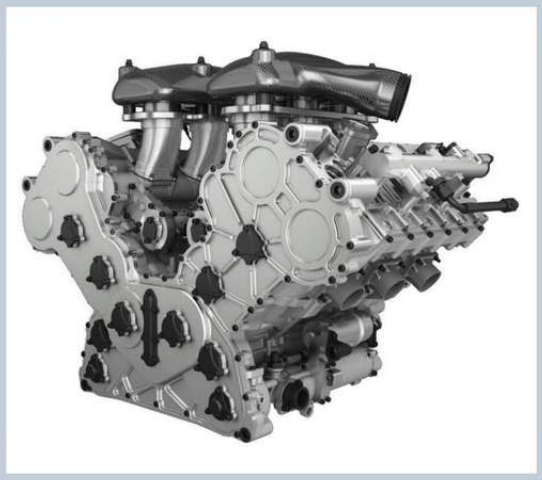

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BELOW Up for the Cup: The appearance of two 308 Cup specification Peugeots in the Spa races has stoked speculation of a forthcoming TCR programme from the French manufacturer

TCR Series

New cars, new series for growing TCR

GROSS ENZERSDORF, Austria: The growth of the TCR touring car formula is continuing apace with new cars and new series being announced. Kia has now revealed full details of its first-ever customer racing programme based around a TCR specification version of the Cee'd hatch. This will be run by Austrian team STARD (Stohl Advanced Research And Development), long associated with the South Korean brand and responsible for a successful China Touring Car Championship programme with the K3S, a close relative to the Cee'd. The Cee'd TCR is currently in development, and not expected to appear until late in 2016.

Meanwhile at the TCR International rounds in Spa-Francorchamps over the first weekend of May, two Peugeot 308s to the manufacturer's Cup racing specification competed, run by WTCC squad Sebastian Loeb Racing.

The cars, powered by a 1.6-litre turbo engine compared to the normal 2.0-litre TCR unit, were both testing for future Cup competition and evaluating the TCR concept, leading to speculation that Peugeot may join the TCR ranks before long.

The latest championship announced is TCR Las Americas, organised by the promoters of the TCR International Series and to be run between October 2016 and March 2017. Rounds will be held in seven countries in the Central America-Caribbean area, with organisers hopeful of attracting a 16-car initial grid and the inaugural event being part of the Mexican Formula 1 GP meeting on 30 October – the TCR International Series already stages two rounds alongside F1 events this year in Shanghai and Bahrain.

According to TCR founder Marcello Lottia, a Latin America series has been planned for some time. "This region is an important market for car manufacturers and has a longstanding tradition for Touring Car competitions," he said. "The fact that the series will be run in what we consider the 'off season' in Europe may encourage some of the European teams to take part," Lotti added.

Meanwhile the Swedish Touring Car Championship is expected to become the first major existing national series to effectively switch to TCR regulations, from its current silhouette-based formula known as Solution F.

TCR regulations form the FIA's TCN2 formula, the lower cost of the world governing body's two national series Touring Car specifications, the other being NGTC as used by the British Touring Car Championship.

The Swedish series is planning to adopt TCN2, due to a declining entry list – just 10 cars competed in the opening round at Skövde on 1 May – and the growing number of cars becoming available to TCR specification.

A decision is expected in June but has not found support with the STCC's strongest team, Volvo. The Swedish manufacturer has so far firmly rejected any idea of building a car to TCR specification and suggested it would leave the series unless the decision is delayed or a balance of performance formula created between TCR and Solution F cars.

Volvo quits V8 Supercars series

AS VOLVO considers its future in its home Swedish championship, the brand has announced that its three-year programme in Australia's V8 Supercars series will end with the conclusion of the 2016 season.

According to Niels Möller, CEO of Volvo's now fully factory-owned Polestar performance division, the brand's strategy and business objectives require it to focus attention "to other technologies and championships in the near future".

No indication was given as to whether Volvo is considering entering a new series – the brand has begun a World Touring Car Championship programme this year.

Garry Rogers Motorsport, which has run Volvo's programme in the V8 Series, responded by insisting that it would continue with the Swedish cars in 2017, despite the brand insisting it would reclaim ownership of both the S60 cars and engines at the end of the 2016 season.

* Ahead of the adoption of its new Gen2 regulations in 2017, the V8 Supercars series has dropped the 'V8' part of its title. The new regulations will permit teams to race coupes with four cylinder or V6 engines, but organisers insist V8s will continue to be a central part of Supercars.

The series has also announced a new five-year sponsor, becoming the Virgin Australia Supercars Championship.

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Future F1 power unit plans

Sebastian Scott

PARIS, France: The controversial power unit token system used in Formula 1 will be dropped at the end of this year to allow manufacturers behind to catch up. However, each driver will be allocated only four power units for the year regardless of the number of races. This will then be reduced to three in 2018.

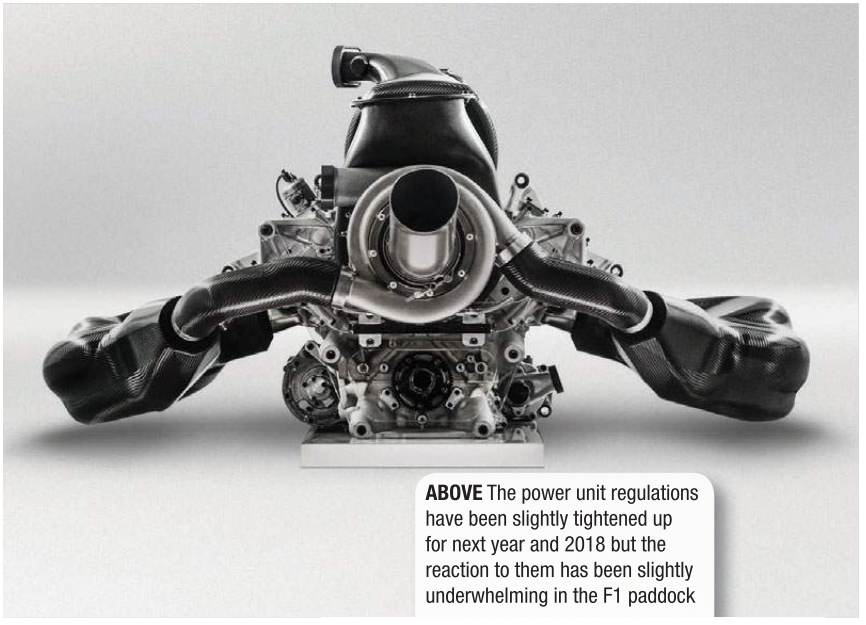
While the 1.6-litre V6 turbo hybrid power unit will remain, turbo boost temperature will be limited to reduce cooling development along with the packaging of the energy store and control electronics which will be limited to just two per car from 2018. There will also be tougher dimensional constraints on key engine components, including limits on the crankshaft dimensions and the weight of some parts in an effort to place a limit on their development.

The restrictions are an attempt to reduce costs dramatically and ensure the playing field is levelled for teams, according to Fabrice Lom, the FIA head of powertrain who explained the changes in Spain ahead of the Spanish Grand Prix.

"To reduce the cost, firstly in 2017 we will go down to four power units per car per season, instead of the five today, whatever the number of grands prix," he said. "In 2018 we will go down to three ICEs, plus turbo, plus MGU-H and only two energy stores, control electronics and MGU-K. So it's nearly 50% less parts, so it should reduce the cost by a nice amount."

Despite major issues being addressed and major revisions made, Formula 1 team bosses don't seem to be impressed and slightly underwhelmed with the FIA's latest announcement.

"I think we'll reserve our position," is all Force India F1 team principal Robert Fernley had to say on the subject, with Red Bull Racing team principal Christian Horner adding: "I think what Bob was trying to say is that it is a little underwhelming. It's a very soft agreement between the manufacturers and the FIA. It tickles the price, deals a little bit with convergence, but the obligation to supply doesn't really apply, so it's a very weak agreement. It's a shame more couldn't be done, but I suppose if you look on the bright side it's better than nothing."



ABOVE The power unit regulations have been slightly tightened up for next year and 2018 but the reaction to them has been slightly underwhelming in the F1 paddock

Obligation to Supply

Sebastian Scott

PARIS, France: From 2017 the power unit manufacturers will be obliged to supply teams that have not signed up to one. If a team finds itself without a power unit it can formally request the FIA to be allocated one through a ballot system if necessary.

Speaking at the Circuit de Catalunya ahead of the Spanish Grand Prix, FIA head of powertrain, Fabrice Lom said that in the event of a team not having a power unit supplier for 2017 then the FIA would ensure that it will get one. The first choice will be to demand that any power unit manufacturer that is supplying only one team will have to provide its power units to the team that does not have one. In the case of two power unit manufacturers supplying the same number of teams, there will be a ballot between them to decide which one will supply at a price that does not exceed 12 million from 2018.

By the 15 May, power unit suppliers will have informed the FIA about which teams have contracts in place with them. From there the FIA will contact power unit manufacturers concerning teams that are yet to have a contract in place and attempt to sort them out with a supplier. Should one not have an engine supply contract by 1 June they will be placed in the ballot process.

F1 fuel limit increase

THE maximum fuel limit for 2017 Formula 1 cars will increase by 5 kg in order to compensate for the increase in downforce and weight of the cars. "This is actually not part of the package but effectively it will go up by five kilos just in relationship with the new aero or chassis regulations," said Fabrice Lom, FIA head of powertrain. "Because we have cars that will be going much faster with much more full load, so naturally the consumption will go up, but it is not at all linked to the package." When further quizzed about the increase in the maximum fuel capacity permitted, Lom revealed that the limit will be 105 kg and that it had already been decided and voted in for the 2017 regulations.

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Porsche 911 RSR successor revealed

STUTTGART, Germany: The most successful GT race car of the 2015 season will be replaced by a completely new race car in 2017. The successor to the 911 RSR has already completed a successful rollout on the test track in Weissach. The test phase on selected racetracks around the world is now underway.

The first outing of the RSR successor is planned for January 2017 at the 24-hour race at Daytona. "The race debut of a completely new vehicle at a 24-hour race is a big challenge, but we are right on schedule," saidDr Frank-Steffen Walliser, the head of Porsche Motorsport. RT

Become a motorsport manager

William Kimberley

GUILDFORD, UK: One of the greatest strategy games that grows in terms of users worldwide every year is SEGA's Football Manager. It has now turned its attention to Motorsport Manager.

Originally developed as a motorsport management simulator for mobiles by Christian West, founder of Playsport Games, it came to the notice of SEGA Europe after more than 1.4 million apps had been sold. A partnership was formed between the two in October last year since when more resources have been pumped into developing an expanded and highly detailed game for Windows, Mac and Linux.

The player can start with the feeder series – GP2, but not named as such – or else take control of one of the teams in the main single-seater series – not Formula 1, but while all the drivers and teams are fictitious with made-up sponsors, it does not take a rocket scientist to see who the teams relate to in real life.

On entering the game, the player assumes the role of team principal, chief technology officer, team manager and race engineer all in one. The first part of the game is to decide on how you want to spend your resources – wind tunnel, developing new technologies, logistics and much more – the bigger the team, the more the resources, but everything needs to be spent wisely.

Then there are the drivers. Do you go for two hotshots, a more experienced one who will make more demands over a young up and coming one. Part of the remit is also to recruit engineers and these come in several shapes and sizes as well.

Then there is the development of the car. Unlike Formula 1 and the power unit token system you may decide to put all your resources into developing more power, but then it will be at the expense of all other parts of your car that can be developed such as the front and rear wings, or the suspension or gearbox.

Come the race weekend, there is practice, then qualifying and then the race. The track conditions vary considerably as more rubber gets laid onto the track, the track temperature fluctuates, the weather changes and the drivers and engineers have to cope with this. The data received from practice is invaluable when it comes to qualifying and the race itself.

The circuits are highly detailed and really stand out as the real thing. The player watches the race from a helicopter point of view and can toggle back and forth between the two drivers. The danger is that one driver can be neglected, but then he will soon be on the radio complaining about something.

As the race unfolds, the engine power can be regulated, but turn up too much boost and you might not have sufficient fuel to finish the race, although pit stops for refuelling are allowed, but then you will lose valuable time coming in, as are the change of tyres which vary from soft, medium, hard and wet.

As the race unfolds the player is literally bombarded with information which is difficult to assimilate in one go, but that of course is part of the fun. The race itself usually lasts about 15 minutes as you watch the cars speed round the track but you rarely have time just to sit and watch because there is always something happening. Perhaps a bit unrealistic when a driver starts to lose gears and needs to pit to have that rectified, but in the interests of playability, you turn a blind eye to that, but brakes, fuel, tyres and the engine itself all have to be watched. It is possible for your car to crash out but the developers ensure that it doesn't happen to both your cars, again in the interest of playability.

While all this is going on you are accountable to the powers-that-be that own your team. Fail to meet their targets, and you could well find yourself out of a job.

Whether this game will ever become as big as Football Manager remains to be seen but it has all the ingredients there to show what really goes on behind the scenes of a racing team. The game will be launched in September. RT

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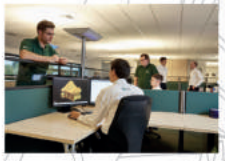

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Endurance racing returns to the UK

LONDON, UK: Endurance racing has returned to the UK this year with the creation of the Britcar-run Dunlop Endurance Championship. Eligible cars include the Porsche 911 RSR, Ginetta G55 GT4, Aston Martin Vantage GT4, Ferrari 458 Challenge and Audi R8 among others. After the first two rounds a Ginetta G55 GT4 is in the lead followed by an Audi R8, Porsche 911 RSR and Honda Civic Type R.

The cars have been categorised in one of five classes, a new classification system providing a more complete vehicle performance indicator according to lap times rather than engine power. For a two hour race there will be one mandatory pit stop of 90 seconds but for all races over two hours there will be two mandatory pit stops.

To make closer racing 'success penalties' are added on to the pit stop times at the following race so a class win results in 15 seconds being added, 10 seconds for a second in class and five seconds for third. However, they are not accumulative, but just based on the mandatory pit stop plus the results from the last round.

This season the championship comprises eight weekends of eight races but with only seven counting in the final points tally. Race lengths will range from two to four hours at some of the UK's best circuits plus a non-championship four hour race at Spa Francorchamps.

Dunlop is continuing its long-term relationship with Britcar and its tyres will be mandatory for all races and while Sunoco will be attending all events to help avoid the issues with fuel transportation, it is not mandatory to use its fuel.

All rounds will be covered by Sky and Motors TV. RT

IndyCar to go to one aero kit?

Andrew Charman

INDIANAPOLIS, IN: The IndyCar Series could be heading back to a single aerodynamic body kit in 2017, following the controversy that has accompanied perceived performance disparities between the kits produced by engine suppliers Chevrolet and Honda for the 2016 season. According to series CEO Mark Miles adopting a single kit is one option under consideration for 2017, but not the only one.

Honda team owners have led criticism of the current kits, arguing that they have put them at a disadvantage to Chevrolet's runners, Andretti Autosport's Michael Andretti being particularly vocal. Owners also argue that the $30 million cost of developing the kits could have been much better spent on promoting the series, while the organisers' hopes that blue-chip specialist companies would be drawn into the series as kit designers have not been realised.

Calls for a return to a single aero specification have been heightened by continuing controversy over the domed skids added to the undersides of cars in superspeedway configuration, introduced in a bid to prevent the airborne accidents resulting from cars spinning during the 2015 season.

Following a test at Texas Speedway on 3 May, Honda drivers remained convinced that the increase in ride heights required to fit the skids had made their cars both more dangerous to drive and less competitive compared to the Chevrolet runners.

The Indianapolis 500 on 29 May is expected to be the major test of the skid concept. Teams have been allowed to lower the underwing sidewalls, which are an optional part of the aero kits, by 9 mm to help downforce, but Honda runners are still insisting that a poor race could result from the use of skids, with Chevrolet dominating. RT

Magneti Marelli motors into Formula E 2016/17 Season

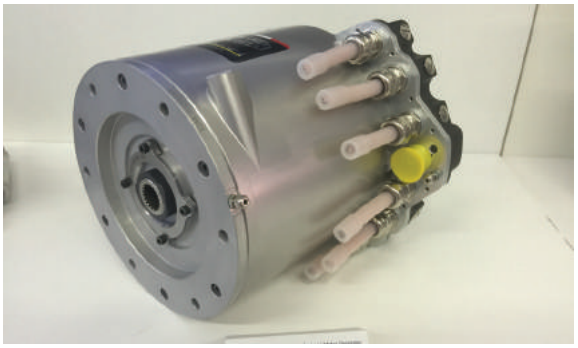
Sebastian Scott

CORBETTA, Italy: The 2016-17 season of the all-electric Formula E racing series will see Italian electronics specialist Magneti Marelli enter as a powertrain partner to Mahindra Racing, powering the M3 Electro. Dilbagh Gill, Mahindra Racing team principal, said he was looking forward to working with the Italian company, which currently supplies the telemetry system for the Formula E Championship.

"Mahindra Racing has developed a very strong relationship with Magneti Marelli over the past few months while developing our powertrain for the next season. We are proud to display its branding on our car for the last five races of this season and into season three."

Already a hands-on partner of several Formula 1 teams, supporting them with its electrical and electronic hardware, the idea of entering Formula E has been on the cards for Magneti Marelli for some time. A six phase Formula E motor developed in house, claimed to produce 300 kW, displayed at the Italian Grand Prix in 2015 was an indicator there was interest from the Italian manufacturer.

"Magneti Marelli has brought innovative technologies to multiple racing categories," said the company's motorsport director, Roberto Dalla. "Formula E allows us to exploit our knowledge in strategic components for hybrid and electric propulsion." RT



LEFT Magneti Marelli has beomce more involved in Formula E as the powertrain partner to Mahindra Racing

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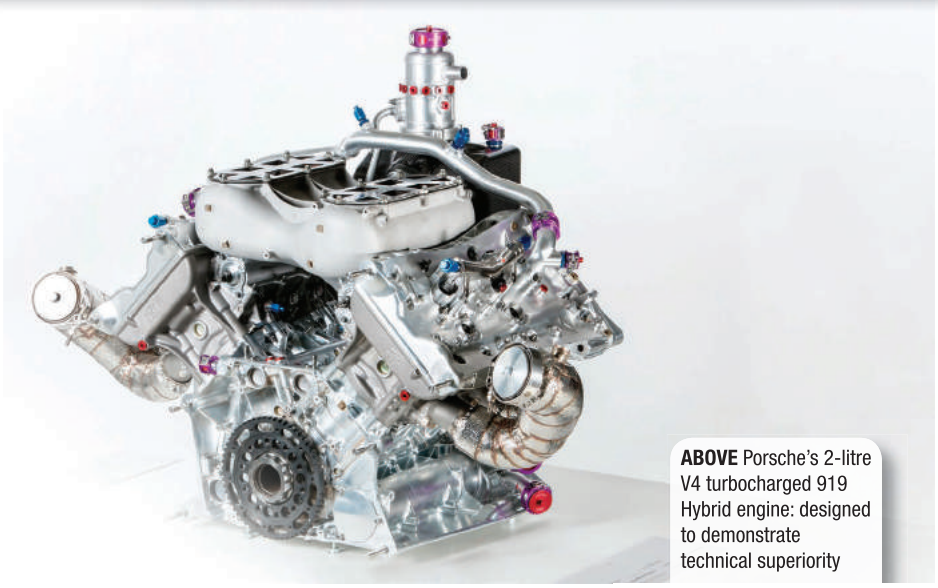

ABOVE Porsche's 2-litre V4 turbocharged 919 Hybrid engine: designed to demonstrate technical superiority

WE'VE LOST THE PLOT!

Motorsport is a labyrinth of regulations but **Chris Ellis** argues that a vital one is missing

ACCORDING to Wikipedia, 'auto racing' will be 150 next year. The first race was on a public road in England, and it broke the 4 mph speed limit imposed (by the horse-riding aristocracy?) in the 1865 'Red Flag' Act, so-called because a red flag had to be carried at least 60 yards in front of the vehicle.

The original 1861 Locomotive Act had simply set a 10 mph speed limit, with no need for a red flag. So even then, we had vehicle regulators behaving sensibly at first, and then losing the plot.

The 4 mph limit wasn't lifted until 1896.

Given our growing ability to engineer almost anything, including levels of artificial intelligence way beyond those we have achieved so far, all engineers need to keep in mind the old mantra 'just because we can, doesn't mean we should', and we will need regulations and limits more than ever. But the necessary limits must be appropriate and sensible or they will just become targets to be broken, see 1867.

Enough of the long-range systems engineering! Last month, I promised to set out in more detail the key characteristics of the engines that should be powering the top class of cars in the World Endurance Championship. Characteristics, not precise regulations – those can come later.

First, let's dispel the myth that motorsport still *innovates* anything of significance. The last important engine innovation driven by motor racing was probably Peugeot's introduction of four valves and twin overhead cams in 1912, provoked by a new 7.6-litre capacity limit. V12s appeared in boats years before they were installed in cars. Yes, motorsport historically helped *development*; for example, disc brakes were originally produced for aircraft and then evolved in racing towards suitability for road cars.

But racing no longer develops anything relevant. Prompted by the absurd focus now in F1 on specific fuel consumption, Mercedes appears to have utilised HCCI (aka 'DiesOtto'), which it has been working on for more than 10 years. Similarly, Mahle then offered Ferrari its Jet Ignition technology as an alternative. But the main development thrust in both cases was, and will continue to be, towards road engines. It has to be, because although road and F1 engines are fundamentally similar, their operating characteristics are so different that results for one are usually irrelevant to the other. Contrast full power 70% of the time at around 12,000 rpm versus less than 40% power at less than 2,000 rpm most of the time. Running spikes versus kitten heels; yes, they're both shoes, but…

Remember, if you want *real* straight-line performance today, you stuff in a Rolls-Royce EJ200 from a Eurofighter, plus a Nammo rocket engine fitted with a 5.0-litre V8 just to drive its fuel pump. This reminds me that it is now some 70 years since 160,000(!) Merlin V12s dominated the skies over Europe. The leading edge has moved on, a long way.

My relevant point is that V8s and V12s are playthings now, and their fuel consumption, once so important, has become irrelevant. On the road, it's little three-cylinder engines which are now critical to overall fuel consumption, in combination with hybridisation.

The major manufacturers enter Le Mans and WEC to market their premium brands. That's it. Nothing to do with innovation or road car development, it's about demonstrating technical superiority. When Porsche's top road car is powered by a 2-litre V4, like its LMP1-H, I'll believe I'm wrong. The FIA's obsession with fuel consumption in WEC is going to make the LMPs even more irrelevant and out of touch with real needs. Which means the manufacturers will gradually lose interest, followed by the fans.

Remedy: aspirational engines. Engines which the drivers, engineers and fans hope will be in their next road cars, and which some of them will want to buy to put in their pet projects. Fortunately, the ACO took a big step in the right direction when it removed all the dimensional prescriptions for LMP1-H engines; most importantly, it ditched the capacity limits. Of course, this was probably done to hide the previous nonsense where diesels could be 85%(!) larger than petrol engines. Whatever, we are left with only one silly rule, the fuel flow limit, and one missing regulation, the key to just about everything, an *engine power limit*. So the result will be that manufacturers will be able to demonstrate any engine they like, provided they don't exceed the power limit.

Assuming we Brexit, I will lobby Parliament (where, years ago, I helped install and run its first computer system) to set a UK road car power limit of 600 bhp, which might prompt the FIA to follow suit for F1 and WEC. On the other hand, if we don't leave the EU, I'll be off to Brussels, to ask for a 450 kW limit. IF that happens, then the FIA is certain to follow orders. Note that 'Brexit or not' will make no practical difference; critical is whether the FIA is smart enough to do the right thing.

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IGNITION TRICKS THAT SPARKED AN ARMS RACE

Craig Scarborough investigates the ingenious combustion technology behind F1's incredible gains in engine horsepower and efficiency

IT'S been a challenge for the technical fan to uncover just how F1 Power Unit manufacturers have been able to reduce fuel consumption by over 33% and improve thermal efficiency to up to 40% during the space of a few years. Over this time there's been a media cycle of rumour, denial and counter-rumour, with few facts emerging from the teams. It transpires the answer, for Ferrari at least, was hidden in plain sight all along.

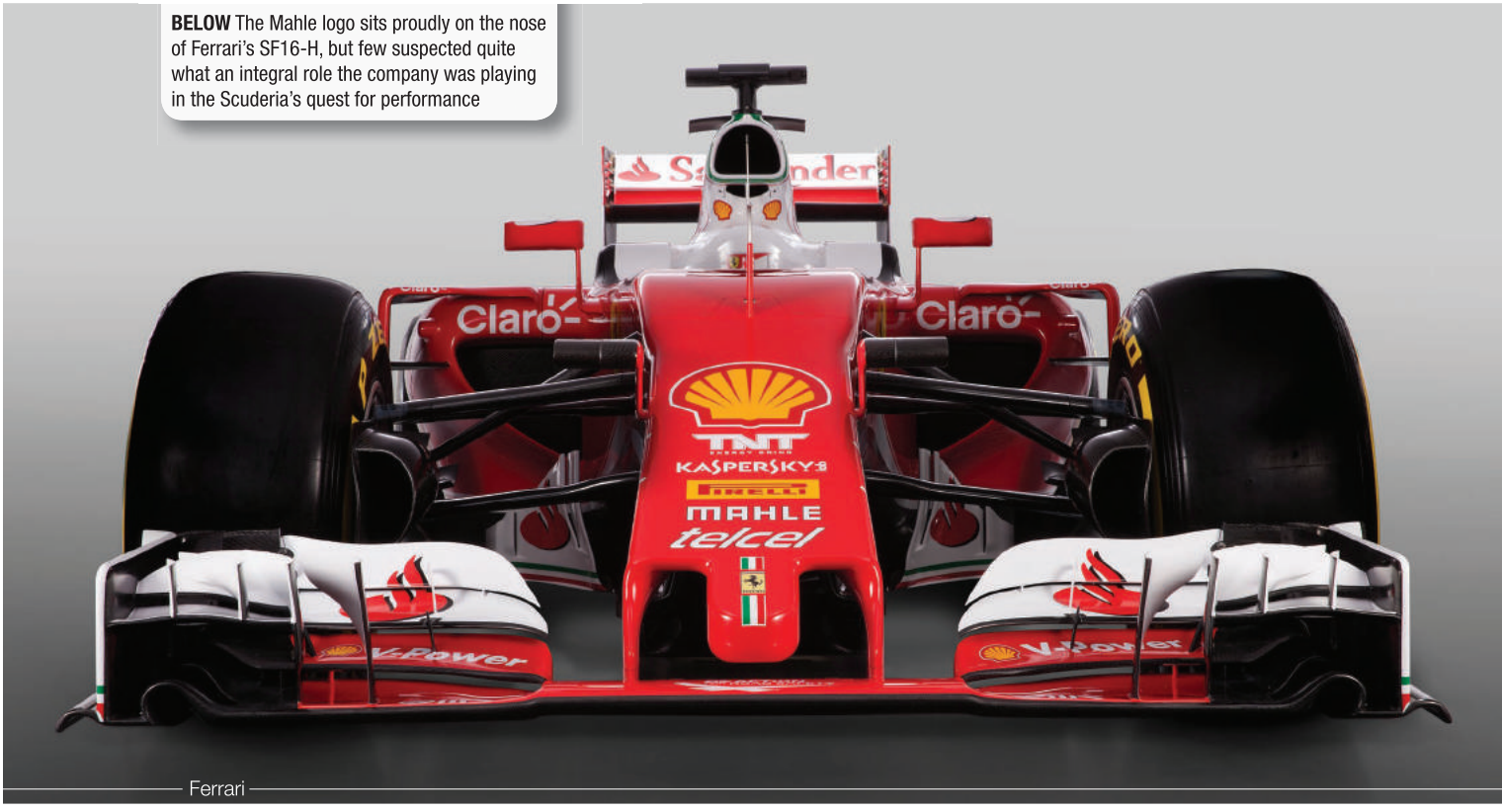
It lay in a press release from Mahle announcing its Turbulent Jet Ignition technology back at the start of the season. Ironically, the answers to the challenge of meeting the new technical regulations, which demanded lean burn technology, ended up being found in the issues confronting diesel engines!

COMBUSTION ISSUES

Formula 1 positioned itself as a high-efficiency category with its choice of power units in 2014, discarding the high-revving normally aspirated 2.4-litre V8 engines for hybrid power units based around a turbocharged 1.6-litre V6 Internal Combustion Engine (ICE). With this change came restrictions on the fuel flow, somewhat offset by the allowance of direct Injection for the first time. Now instantaneous fuel flow is restricted and monitored at 100 kg/hr, while fuel pressure was increased to a maximum of 500 bar (see sidebar).

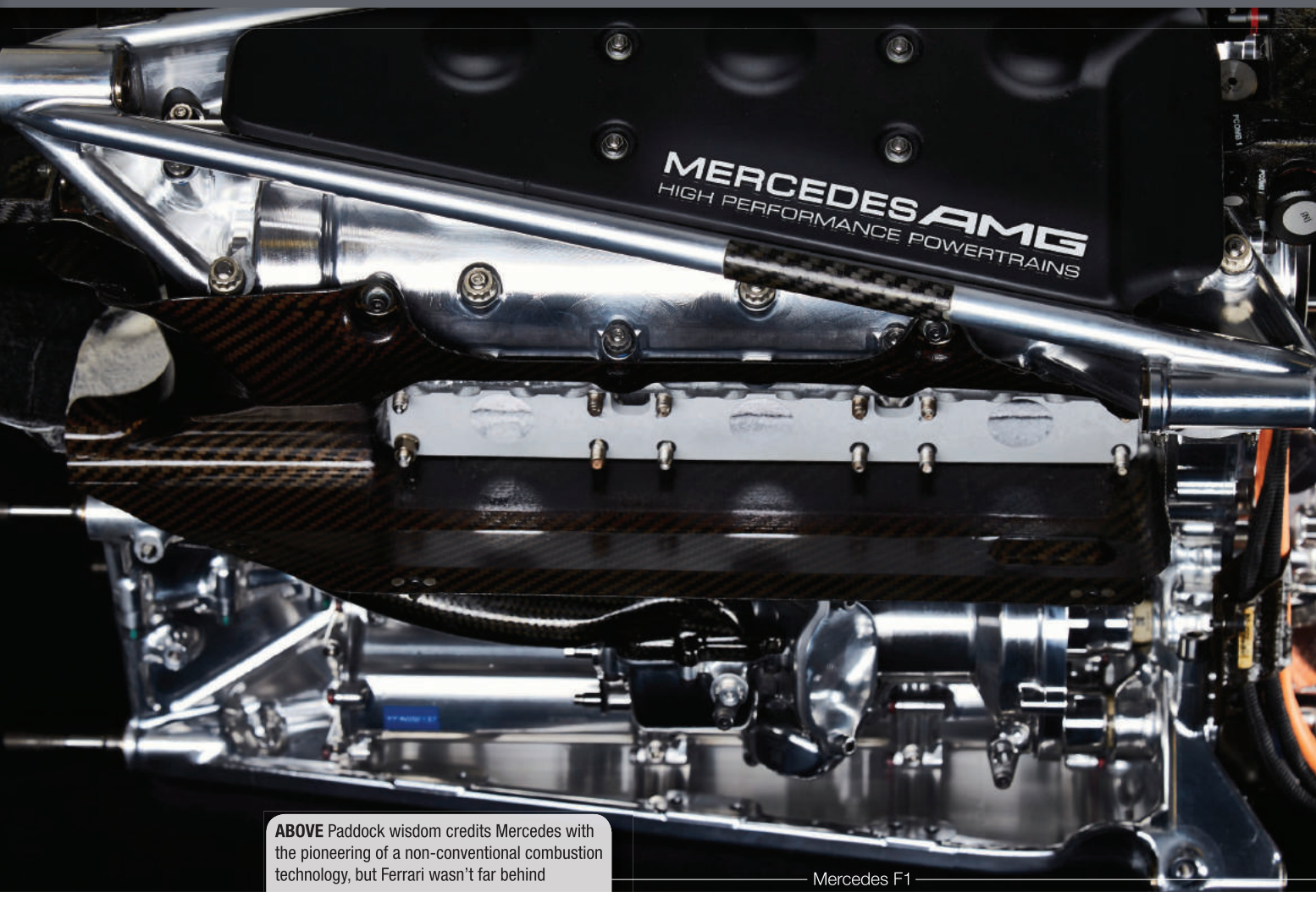
One noted F1 engine designer puts the fuel problem into context for us, saying: "Today's F1 engines are running air flow of the same order of magnitude as 12-litre heavy duty diesel engines!" Even though the unit is a mere 1600 cc, with high RPM and boost pressure from the turbo, this can be understood. However, he goes on to say, "To push this air into the chamber is (relatively) easy; then you have to mix it with the fuel and this is not obvious. If you would reach a perfect air/fuel mixture, then combustion should be okay, but this is not the case."

Any good engine designer would go for a means to add more fuel with higher



BELOW The Mahle logo sits proudly on the nose of Ferrari's SF16-H, but few suspected quite what an integral role the company was playing in the Scuderia's quest for performance

Ferrari



ABOVE Paddock wisdom credits Mercedes with the pioneering of a non-conventional combustion technology, but Ferrari wasn't far behind

Mercedes F1

pressure or flow rate, but the regulations prevent this, "even with 500 bar fuel injectors!" as our expert concedes. "Ideally we would want to have at least 800 bars to reach a good mixture preparation," he explains. "So we have combustion issues!"

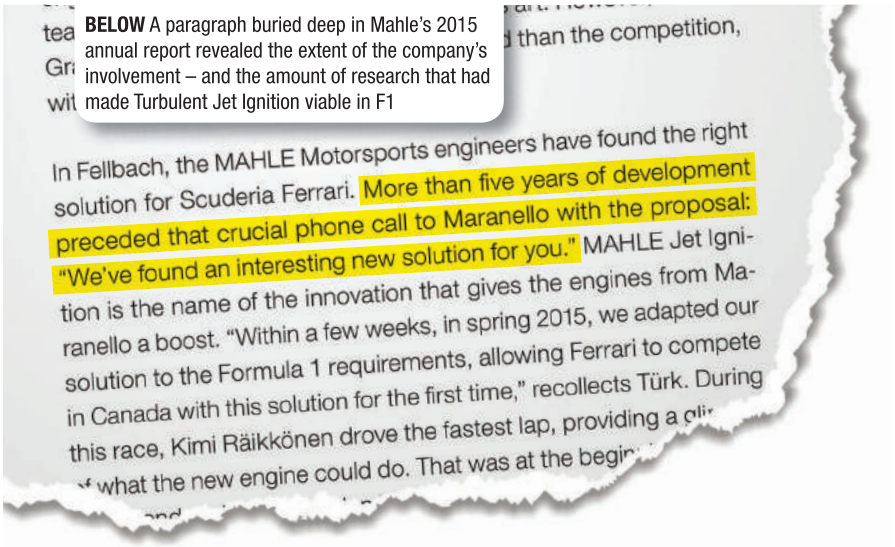
With this in mind, the extraction of power from the turbocharged engine could not follow the usual methods, as the engine was so starved of fuel and running on the limit of knock. In the first year of the new regulations, combustion development was believed to be focused on fuel development. It was also initially understood that the combustion process was traditional with a combustion chamber formed between piston and cylinder head fired by a spark plug. It became apparent that to make a larger step in power output, a different combustion process was required.

GAME-CHANGER

In the first year of the formula the three manufacturers, Mercedes, Ferrari and Renault – Honda had yet to rejoin the series – had vastly differing results as the balance of performance was split between the ability to create power from the ICE and recover energy from the ERS. Clearly Mercedes got the balance right, while rivals struggled with different aspects of both ICE and ERS performance.

Ferrari and Renault had largely resolved their ERS issues as they headed into the second year of the new category in 2015. Once more the focus reverted towards the traditional aim of extracting more power from the engine. Honda, meanwhile, had made its debut but encountered a plethora of issues with both its ICE and ERS.

As the 2015 season progressed, rumours spread about a different combustion process. Some of them suggested that no spark plugs were required; others talked of incredibly high cylinder pressures being achieved. External analysis proved fruitless as the engines are barely visible even with the bodywork off, but images of engine telemetry showed multiple fuel rails and elevated fuel temperatures within them. ▶


than the competition,

In Fellbach, the MAHLE Motorsports engineers have found the right solution for Scuderia Ferrari. More than five years of development preceded that crucial phone call to Maranello with the proposal: "We've found an interesting new solution for you." MAHLE Jet Ignition is the name of the innovation that gives the engines from Maranello a boost. "Within a few weeks, in spring 2015, we adapted our solution to the Formula 1 requirements, allowing Ferrari to compete in Canada with this solution for the first time," recollects Türk. During this race, Kimi Räikkönen drove the fastest lap, providing a gli
what the new engine could do. That was at the begi

BELOW A paragraph buried deep in Mahle's 2015 annual report revealed the extent of the company's involvement – and the amount of research that had made Turbulent Jet Ignition viable in F1

A couple of development directions came under scrutiny, but of course the manufacturers were unwilling to reveal their technology. One lean burn combustion technology was HCCI, which uses a spark-assisted compression-ignition format. This seemed to tie in with the fuel development, fuel temperature and rumours of high cylinder pressures. This was a feasible method, albeit facing ignition control issues caused by the regulations not allowing variability in cylinder pressures, variable valve timing or multiple injectors.

The FIA even accepted that secondary compression ignition was legal, as long as ignition was started by the single spark plug. Of course teams denied this and, more importantly, industry insiders felt that full HCCI or any form of semi-compression ignition was unlikely to be in use in F1.

It now transpires that as we moved into the third season of these engines, the secret had been let out, for Ferrari at least. By now it was accepted that Mercedes had made some form of step change in combustion technology with its Monza upgrade in 2015. This much-publicised upgrade was not supported by any facts; all that was known was that fuel supplier Petronas was a key partner is its development.

Ferrari

Craig Scarborough

ABOVE & BELOW Kimi Räikkönen left last year's Montreal race with fastest lap but only insiders at Ferrari and Mahle knew about the new technology being trialled in the car's power unit


Bloxham/LAT

BELOW Lewis Hamilton leads the field at Monza in 2015, where Mercedes made a step change in combustion technology with its upgrade

Petronas's own lean burn technology, "spray-guided direct injection", was developed in an award-winning research programme with Ricardo and may well have played a part in either the engine's initial development or this Monza upgrade. Its closer control of the fuel spray allowed for effective combustion with the fuel vapour sitting centrally in the combustion chamber, near the spark plug and keeping the charge away from the cylinder walls. But again, this has never been officially admitted.

When Ferrari made a clear step in horsepower over the winter going into 2016, it was rumoured to have followed whatever direction Mercedes had taken. But, an innocuous press release at the start of the 2016 season, confirming Ferrari's continued partnership with piston supplier Mahle, ultimately gave the game away. Crucially, the document also mentioned the sharing of Mahle's own 'Turbulent Jet Ignition' technology with the Scuderia.

Subsequent closer inspection of Mahle's involvement showed that it had in fact ▶

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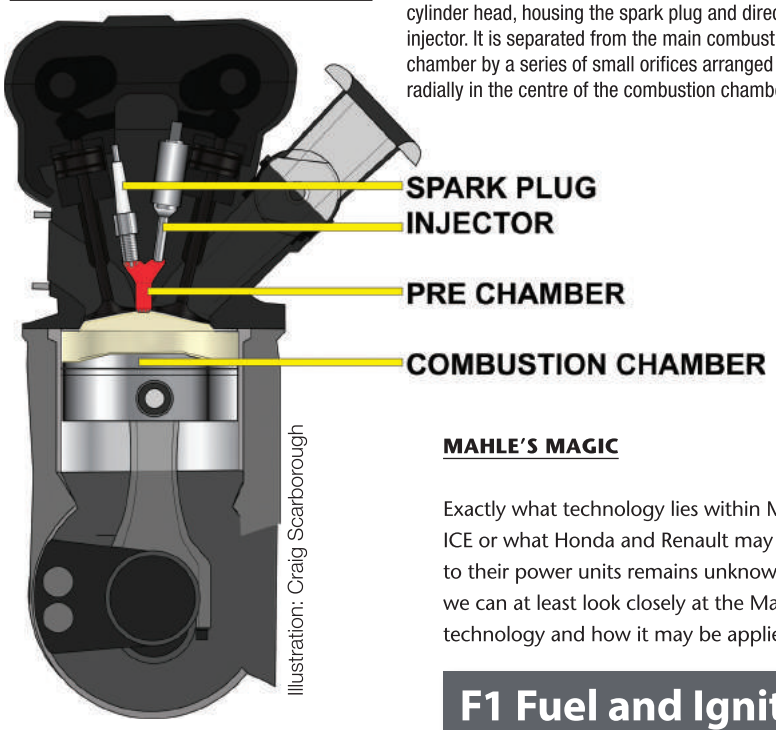
MAHLE'S TURBULENT JET IGNITION



The pre-chamber is a small volume inside the cylinder head, housing the spark plug and direct injector. It is separated from the main combustion chamber by a series of small orifices arranged radially in the centre of the combustion chamber roof

Illustration: Craig Scarborough

MAHLE'S MAGIC

Exactly what technology lies within Mercedes' ICE or what Honda and Renault may bring to their power units remains unknown, but we can at least look closely at the Mahle technology and how it may be applied to Ferrari's F1 ICE. With a pre-chamber setup, such as Mahle's branded Turbulent JET Ignition (TJI), the combustion process is broken down into two locations: the pre-chamber and the main combustion chamber.

This pre-chamber is a small volume inside the cylinder head, housing the spark plug and direct injector and separated from the main combustion chamber by a series of small orifices arranged radially in the centre of the combustion chamber roof. The ratio of pre-chamber to combustion chamber is of around 1:20.

During the induction stroke the combustion chamber is filled with a lean charge of hot fuel and the compressed charge air, while the pre-chamber is treated to a homogenous charge at or near stoichiometric. Upon ignition the spark plug combusts the pre-chamber charge and the hot gasses expand a fire through the orifices into the combustion chamber; ▶ shared this technology with Ferrari in 2015 and that the setup raced for the first time at the Canadian Grand Prix, just round seven of the 19-race season. This was well before Mercedes' alleged introduction of a new combustion technology at Monza, some five races later.

Clearly the secrecy of the teams and manufacturers means that the true chronology of the new combustion technology – or, indeed, the detail of the technology itself – is far from clear. It remains paddock wisdom (a far from reliable barometer) that Mercedes probably pioneered a non-conventional combustion technology first and Ferrari has since followed.

However, since the Ferrari/Mahle link has become known, Mercedes has still been unwilling to comment on its combustion technology, only stating that it isn't with Mahle and that it uses a "conventional spark ignition". So there may be more than one lean burn technology in use, despite yet more rumours suggesting they are all using Turbulent Jet Ignition.

The two remaining manufacturers, Renault and Honda, are not believed to have yet adopted anything other than conventional GDI with their ICE. However, updates expected to race by mid-season may well incorporate these.

F1 Fuel and Ignition Technical Regulations

5.10 FUEL SYSTEMS:

5.10.1 The pressure of the fuel supplied to the injectors may not exceed 500 bar. Only approved parts may be used and the list of parts approved by the FIA, and the approval procedure, may be found in the Appendix to the Technical Regulations.

5.10.2 There may only be one direct injector per cylinder and no injectors are permitted upstream of the intake valves or downstream of the exhaust valves. Only approved parts may be used and the list of parts approved by the FIA, and the approval procedure, may be found in the Appendix to the Technical Regulations.

5.10.3 All cars must be fitted with a single fuel flow sensor, wholly within the fuel tank, which has been manufactured by the FIA designated supplier to a specification determined by the FIA. This sensor may only be used as specified by the FIA.

5.10.4 Homologated sensors which directly measure the pressure and temperature of the fuel supplied to the injectors must also be fitted, these signals must be supplied to the FIA data logger.

5.10.5 Any device, system or procedure the purpose and/or effect of which is to increase the flow rate after the measurement point is prohibited.

5.11 IGNITION SYSTEMS:

5.11.1 Ignition is only permitted by means of a single ignition coil and single spark plug per cylinder. No more than five sparks per cylinder per engine cycle are permitted.
The use of plasma, laser or other high frequency ignition techniques is forbidden.
Only approved ignition coils may be used and the list of parts approved by the FIA, and the approval procedure, may be found in the Appendix to the Technical Regulations.

5.11.2 Only conventional spark plugs that function by high tension electrical discharge across an exposed gap are permitted.
Spark plugs are not subject to the materials restrictions described in Articles 5.16 and 5.17.

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MAHLE'S TURBULENT JET IGNITION

The combustion gasses effectively act as multiple spark plugs. While ignition normally takes place in the centre of the cylinder, with Jet Ignition it essentially takes place from the outside toward the inside. This allows significantly better combustion of the fuel

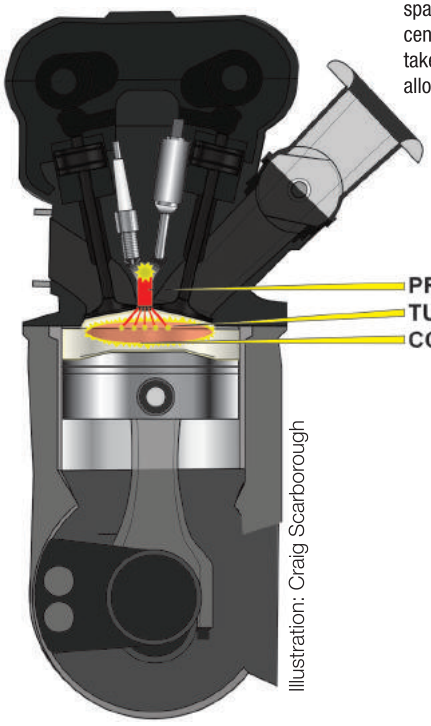


Illustration: Craig Scarborough

with multiple orifices, the lean combustion chamber charge is ignited. With this charge being quickly and efficiently ignited, the resulting power stroke provides more horsepower. Effectively the fuel is divided into two, where the rich mix can be easily burnt and the combustion gasses effectively act as multiple spark plugs (of course specifically banned in F1) to burn the otherwise incombustible mix in the combustion chamber.

On paper this seems a simple process and well-suited to the needs of F1. However, all the embodiments of the Mahle Jet setup use two injectors, one for the pre-chamber and a second for the combustion chamber. This isn't possible with F1's restriction to a single direct injector. Moreover, the presence of an injector in the pre-chamber may contravene the accepted definition of a direct injector. So it remains a mystery how the system provides both the late combustion chamber injection phase and the even later pre-chamber injection with a single injector.

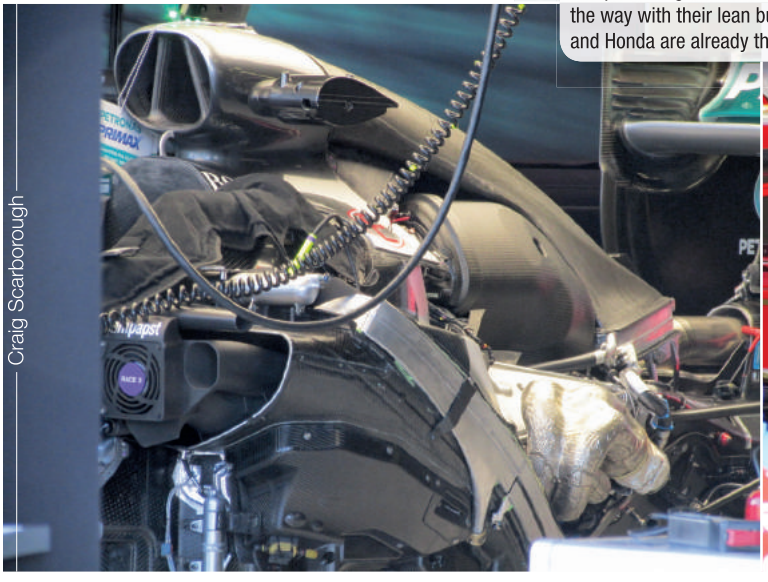
It's possible that either a single injector spans the two chambers, with its nozzles split between them, or that a pre-chamber injector delivers the combustion chamber fuel through the orifices on the induction stroke. Neither seem practical methods, but clearly there is a solution at Ferrari that meets the FIA's interpretation of the rules and has allowed the parts to be homologated.

It seems that all of the potential lean burn technology is already out there and just needing an application and development. With the power of the competition in F1, the four manufacturers are pushing the boundaries of lean burn technology, taking ideas from the road vehicle industry and rapidly developing them. There's a good message to be spread about F1's move to such efficient race engines; there's also a good opportunity for the economic fuel burning technology to migrate back to the more humble road driver.

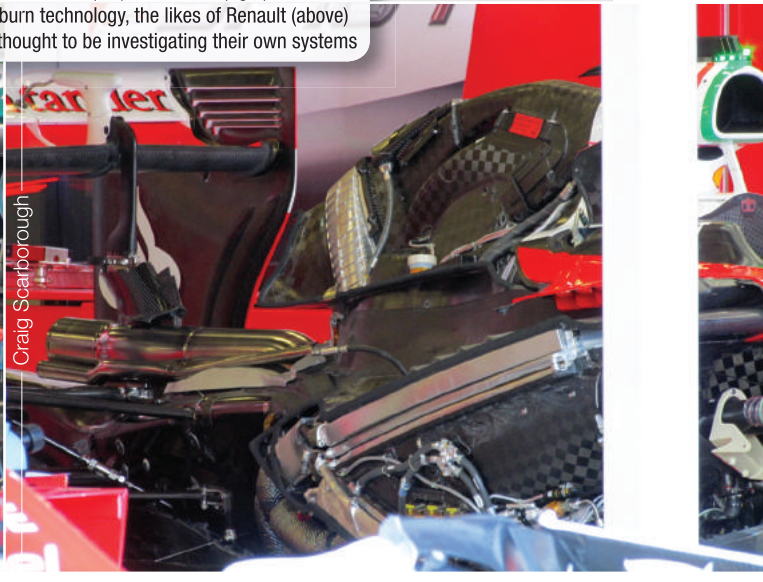
Quite which technologies are in use, over and above Mahle's solution detailed here, will no doubt remain a secret. But is F1 *missing* a trick by hiding its tricks? RT

RenaultSport

LEFT, RIGHT & ABOVE The quest is on for diesel-like fuel efficiency in a petrol engine. While Mercedes (left) and Ferrari (right) have led the way with their lean burn technology, the likes of Renault (above) and Honda are already thought to be investigating their own systems



Craig Scarborough



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A transatlantic Ford operation, a link with Lola and the deep involvement of an ex-Aston Martin man: **William Kimberley** explains why, 50 years on from the Ford GT40's watershed win at Le Mans, the wheel has turned…

FULL CIRCLE

MULTIMATIC'S vice president of engineering Larry Holt is not your typical executive. Extrovert, unconventional, maybe even brash to some eyes, he is someone who might have his knuckles rapped for getting caught on YouTube for doing a burn-out up the high street in his home town of Uxbridge, Ontario, Canada because he felt like it. But in this case it's not a question of judging a book by its cover, because he is a driven, probably ruthless, man.

At the circuit, he may call himself a Fairlaner – a slightly derogatory description that dates back to the time when the Ford GT40 was racing and the 'suits' from Ford's HQ

in Dearborn came to oversee things, Fair Lane being Henry Ford's private estate near Dearborn – but he is being much too modest. He is very much a hands-on guy.

"I was involved in the project from almost day one and the story about 12 Ford guys in the basement sworn to secrecy is all true," he says. "The design and styling of the vehicle were born in that basement in Dearborn. The whole thing was actually conceived by senior Ford exec Raj Nair, a very progressive and creative guy who believed that two things were needed. One was to celebrate the 50th anniversary of Ford's win at Le Mans in 1966, not paying lip service to it but celebrating it with more substance, and the other was the need to have another halo car.

"General Motors had the Corvette and Fiat Chrysler the Viper, but Ford didn't have an equivalent supercar to offer. An early idea was to develop a very high-performance competition-oriented Mustang, but the idea was dropped."

The reason that Holt and Multimatic were drawn into the secret gang of 12 was because of their engineering expertise in special projects like the GT. Multimatic is one of those companies that tend to fly under the radar as a supplier, not just of specialist engineering services, but also of high-volume components (see sidebar).

Yet it has around 3,400 employees worldwide, mainly in Canada, but spread as far afield as China and Europe.

It also has a large contingent in the UK of around 600 staff spread over more than half a dozen sites, and here's the Lola connection: Multimatic acquired the brand right to Lola from Martin Birrane, which also includes two warehouses full of Lola inventory including all the Formula 1 items from 1997.

"Multimatic was also a natural choice because of our long-term relationship with the company," says Nair, whose official title since the start of December is executive vice president, product development and ▶

"If it wasn't for the FIA needing to create an even field, we'd be kicking the living shit out of everybody!"

ABOVE A legend reborn: The Ford GT runs wheel-to-wheel with the car that inspired it

ABOVE Lights-camera-action: The GT has starred on both sides of the Atlantic

chief technology officer. "It's not only a production supplier to us but also a long-time race partner, and we've long admired Larry Holt and his team's capabilities. When we talked about putting this race and road car programme together and you look at Multimatic's capabilities, and particularly with some of the technologies that we knew were going to be part of this programme, it was the natural choice."

"We do a lot of business with Ford," confirms Holt. "For example, we supply engineering and the production of all the suspension parts on the Ford 150 pickup truck, the highest volume vehicle in the world with 850,000 units being produced a year, and high-level technology on the road car side. We've also run race teams for it for years and so have a unique relationship which is how we came to be partners on the project, focusing on the chassis and suspension development.

"It was also decided very early on that it would be a carbon fibre tub and having had experience building the 177 for Aston Martin, it ticked another box. Ford is actually very focused on proliferating the technology and bringing carbon fibre into mainstream, high-volume automotive and has a relationship with DowAksa on the material side, so this whole carbon tub programme is a technology leader for that purpose. We have that expertise and so got brought in as a very serious partner."

While the GT was originally conceived as a road car, it very quickly became apparent that – with the 50th anniversary of Ford's win at Le Mans coming up – the car would also be developed for the racetrack. That was quite a leap of faith and a big test for all concerned.

RUMOUR IS WRONG

"There is this rumour that the project started with a race car that got developed into a road car, but that's just not true," says Holt. "It's not even possible. You can't develop a race car and then try and homologate it for crash, but while it was originally signed off as a road car, it was almost immediately decided that it would be taken racing and so the two were developed in parallel, which is unique in this day and age."

Developing the two in tandem may seem the obvious thing to do but it brought with it quite a number of challenges, one being the timetable. "It was essential that we had to get the road car homologated by January 1 but sometimes there would be delays as there wasn't that sense of extreme urgency on the road car side," he notes. "It meant that we sometimes had to push for decisions being made so that we could carry on developing the race car."

Another challenge was meeting both the global road regulations as well as the different racing rulebooks. "When developing a new road car there are so many requirements to take into consideration," says Holt. "There are the European regulations, the Federal Motor Vehicle regulations, Chinese and Gulf States ones and so on, but then it's a whole new ball game when you also take the sporting rulebooks into account: the FIA one for the World Endurance Championship and IMSA's for the WeatherTech SportsCar Championship.

"Back in the day 50 years or so ago you could drive a race-prepared Ferrari 250LM on the street, but you can't do such things nowadays. We chose to do some things in the road car to give some race car advantage but which then made it harder than normal for us to homologate it. It was a unique approach and while the aim wasn't to create the ultimate race car, it nevertheless brought with it advantages over other cars racing in GT that were originally developed for reasons other than racing." ▶

The Ford GT40 legend

THE face of sportscar racing changed on June 19, 1966. That was the day when three GT40 Mark II-As, raced by Bruce McLaren and Chris Amon, Ken Miles and Denny Hulme, and Ronnie Bucknum and Dick Hutcherson, crossed the finish line, respectively – one-two-three – to win the Le Mans 24 Hours.

It was the first-ever overall win for an American carmaker and the first of four consecutive victories in the world's most prestigious race. In 1967 a Mark IV J-6, driven by Dan Gurney and AJ Foyt, took the win and, in 1968 and 1969 Pedro Rodriguez and Lucian Bianchi and Jackie Ickx and Jackie Oliver, respectively, made it three and four in a row. For the first time, America and Ford had dominated international road racing.

Ford's GT40 Mark IIs and Mark IV were designed, engineered and developed under Roy Lunn's direction at Ford's Skunk Works, Kar-Kraft, but lacking the expertise to develop such a high-performance mid-engine car, Lunn looked to England for help. Initially Colin Chapman was considered as he was already involved with Ford in an IndyCar project but his demands were too great. Instead Lunn turned to Eric Broadley of Lola Cars, which had been running a Ford V8 in its mid-engined Mk6, which was also known as a Lola GT. It was regarded as the most advanced racing car of the time, even though it did not finish in the '63 Le Mans race due to low gearing and slow revving out on the Mulsanne Straight.

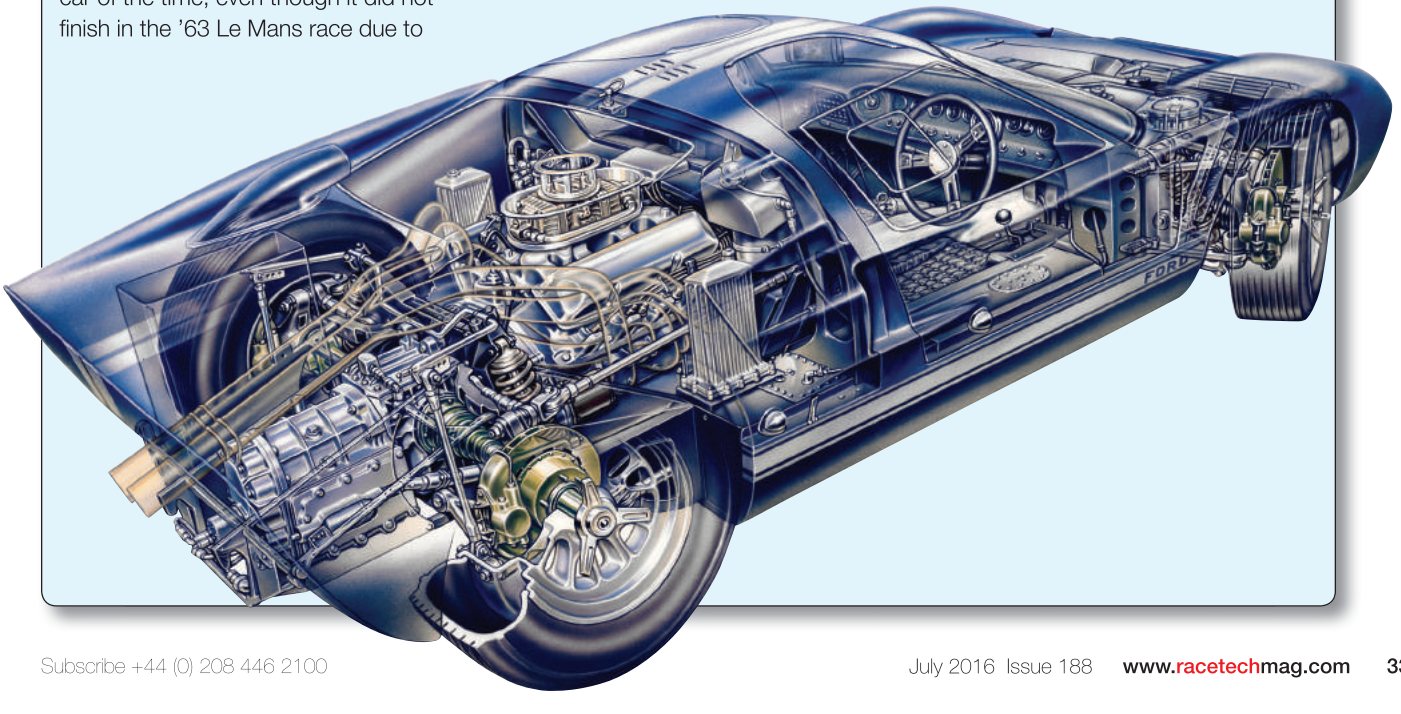
ABOVE & BELOW By the time of the famous Le Mans victory in 1966 (above), the GT40 MkII (below) had been made reliable

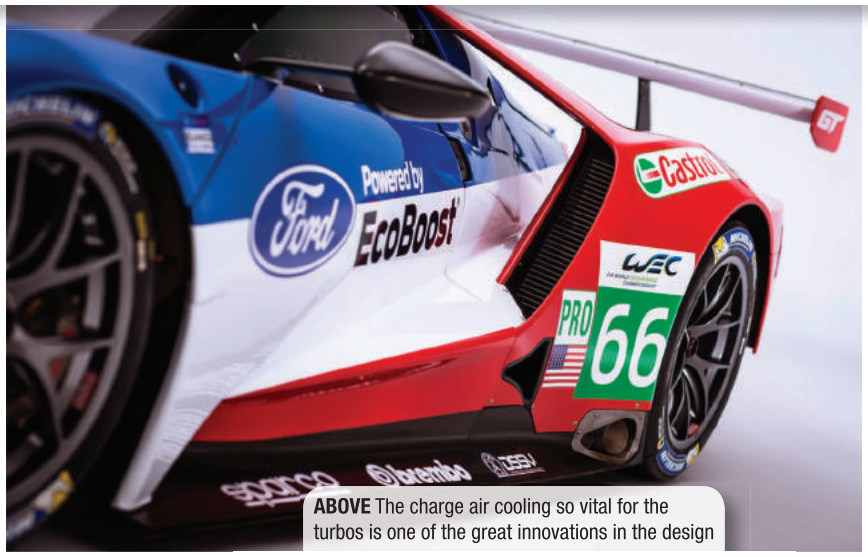
A one-year agreement was struck personally with Broadley and the two Lola Mk 6 chassis were sold to Ford. To form the development team, Ford also hired former Aston Martin team manager John Wyer.

Overseen by Harley Copp, the team of Broadley, Lunn and Wyer began working on the new car at the Lola factory in Bromley in the UK. At the end of 1963 the team moved to Slough under the banner of Ford Advanced Vehicles, a new subsidiary under the direction of Wyer, to manage the project. The first chassis built by Abbey Panels of Coventry was delivered on March 16, 1963, with fibre glass mouldings produced by Fibre Glass Engineering.

The first "Ford GT", the GT/101, was unveiled in England on April 1 with the purchase price of the completed car for competition use being £5,200. It was powered by the 4.2-litre Fairlane engine with a Colotti transaxle, the same powerplant used by the Lola GT and the single-seater Lotus 29 that came second in that year's Indy 500.

The car made its debut at the Nürburgring in May 1964 followed by Le Mans, but failed to finish both races, nor did the team have success the following year. However, there was enough potential for Ford not to lose heart and continue racing – and the rest is history. RT





ABOVE The charge air cooling so vital for the turbos is one of the great innovations in the design

What did not help, though, was that the FIA and IMSA regulations were quite different. While the car is fundamentally the same for both series, it is the myriad detail differences that need addressing that added stress and time to the project.

"The cars for the two series are almost identical until you come to the things that need to be done to meet the regulations," says George Howard-Chappell, the Ford GT programme manager working for Multimatic, "and that's quite a long list. In the old days when you had an FIA car and an ACO car, for want of a better word, the changes were pretty minor. Then when we had the American Le Mans Series that was pretty much aligned to the ACO so that European and US cars were nearly the same, whereas now quite a few things are different. It means that we have to convert the IMSA cars to comply with the FIA regs when we bring them to Le Mans. However, the WEC team will be helping the American cousins to make sure they can get their cars ready for the race without any dramas."

"Would it have been easier if the regulations governing the two race series were the same? The answer has to be yes," confirms Nair, "but we knew from the very beginning that we would be racing in both and knew what the regulation changes would be."

Another minor variation between the IMSA and WEC cars is the tyres. While both are running on Michelin, there is a slight difference in the compound. "Both teams have had the chance to test and evaluate all the tyres available," says Howard-Chappell, "and while they're not the same at the moment, they will be soon, so it's not an issue."

The mid-engine design was decided from the very beginning, as was the choice to use the twin turbocharged 3.5-litre V6 EcoBoost engine as it endorsed Ford's global message with this family of engines. "We are also showing the world that there's a more efficient way to do cars like the GT," says Nair. "This car has one of the best power-to-weight ratios of any production car out there. The EcoBoost technology is allowing us to do ▶

BELOW The GT uses a development of the twin-turbo 3.5-litre EcoBoost V6 powerplant that was trialled in the Daytona Prototype programme

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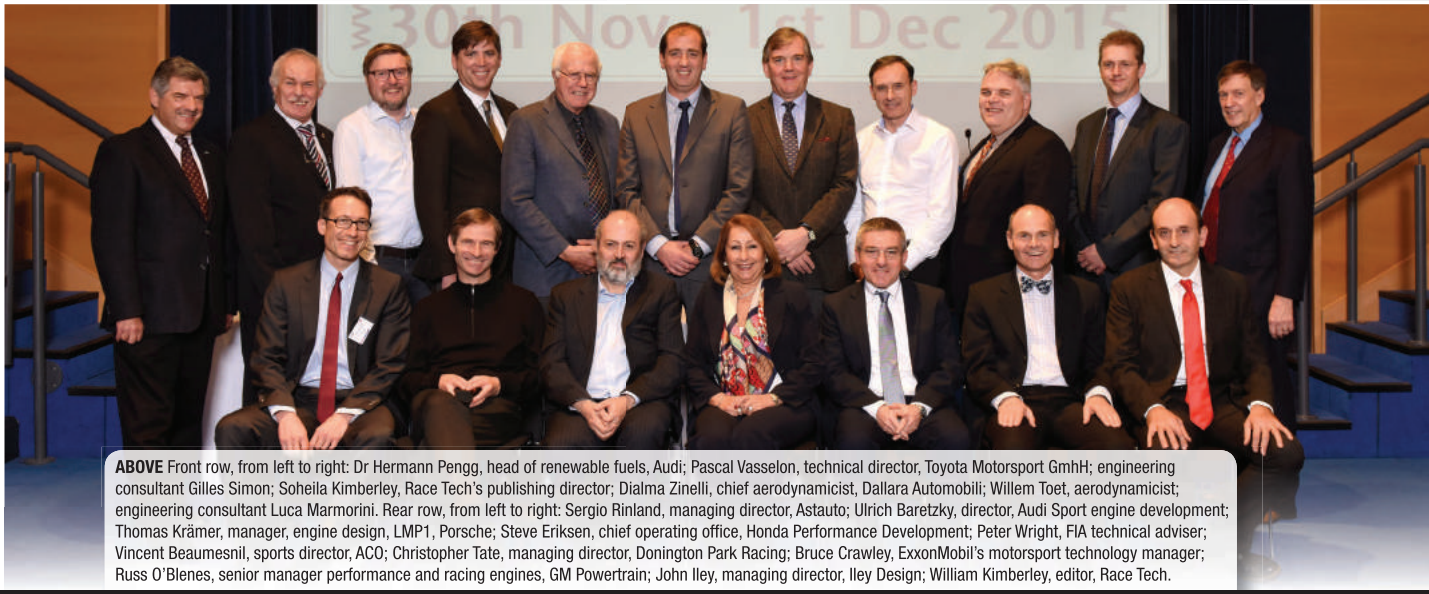
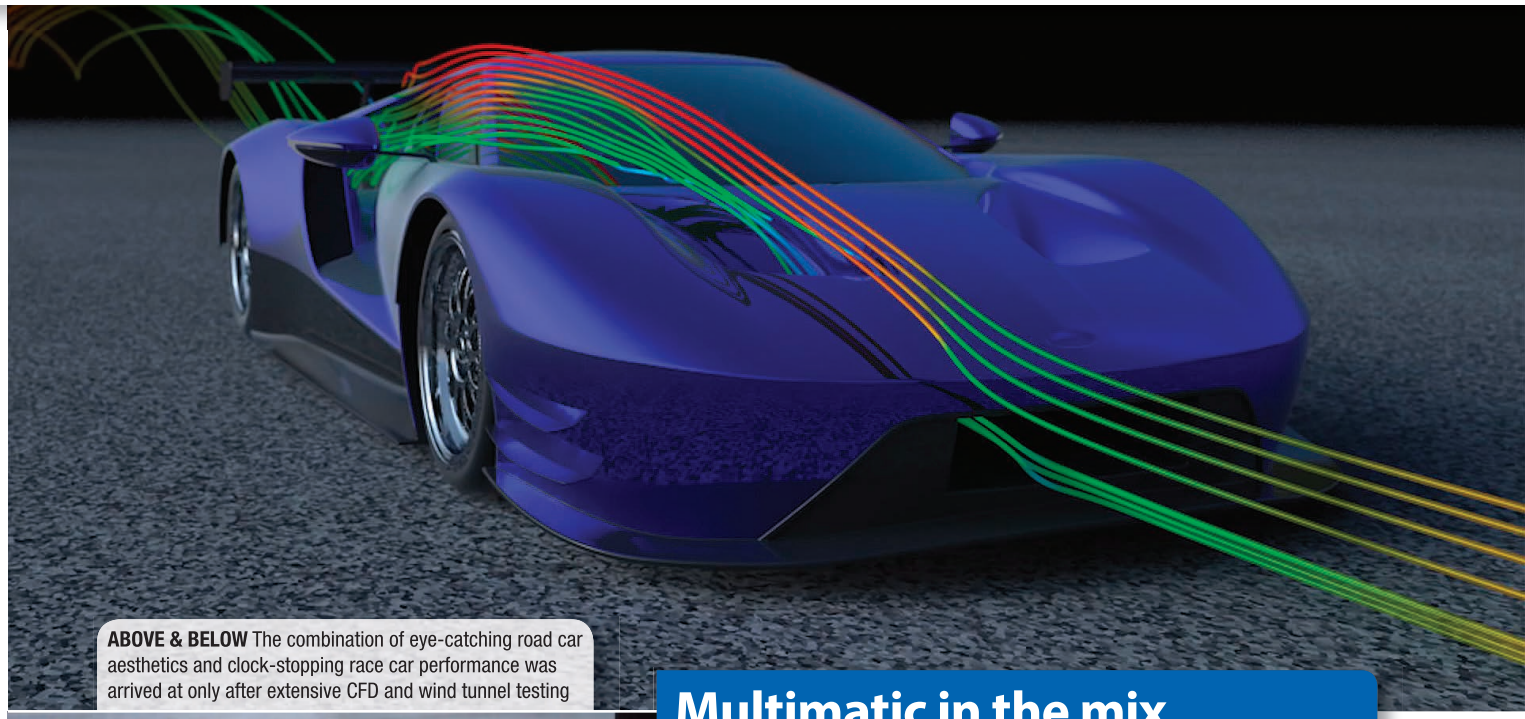
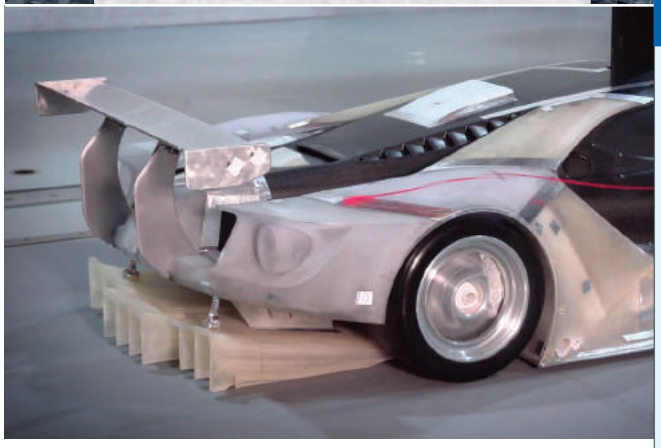


ABOVE Front row, from left to right: Dr Hermann Pengg, head of renewable fuels, Audi; Pascal Vasselon, technical director, Toyota Motorsport GmbH; engineering consultant Gilles Simon; Soheila Kimberley, Race Tech's publishing director; Dialma Zinelli, chief aerodynamicist, Dallara Automobili; Willem Toet, aerodynamicist; engineering consultant Luca Marmorini. Rear row, from left to right: Sergio Rinland, managing director, Astauto; Ulrich Baretzky, director, Audi Sport engine development; Thomas Krämer, manager, engine design, LMP1, Porsche; Steve Eriksen, chief operating office, Honda Performance Development; Peter Wright, FIA technical adviser; Vincent Beaumesnil, sports director, ACO; Christopher Tate, managing director, Donington Park Racing; Bruce Crawley, ExxonMobil's motorsport technology manager; Russ O'Blenes, senior manager performance and racing engines, GM Powertrain; John Iley, managing director, Iley Design; William Kimberley, editor, Race Tech.



ABOVE & BELOW The combination of eye-catching road car aesthetics and clock-stopping race car performance was arrived at only after extensive CFD and wind tunnel testing



that – and a V6 engine putting out more than 600 hp: who would've thought that possible?"

"Having a mid-engined layout didn't help with the front weight bias and that was one of our challenges," says Holt, "but it helped with things like thermal issues and heat dissipation and allowed us to do some unique things with the front aero underparts. From an aerodynamic perspective if you were to ask what was the biggest challenge with a GT racing car, it would be getting front downforce.

"The regulations allow a wing on the back but not on the front, so if the car has a reasonably good centre of pressure (CoP) and is driveable and you put a big wing on the back, the CoP gets shifted to the rear, leading to understeer. This means you have to find ways of generating front downforce. If you've got a big engine at the front with the wheel house and the tyres there's not much you can do with that but if the engine's in the middle of the car, it means you can be creative at the front."

The aero development was a joint programme led by Multimatic's Mark Handford and Ford Performance's Bernie Marcus, but Peter Gibbons, who has worked at Multimatic for the last half a dozen years since leaving Michael Andretti's team, also played a massively important role to ensure that the car remained good-looking while having some theme of the original Ford GT in it. "I think the guys in the studio did a ▶

Multimatic in the mix

IF the term Multimatic means anything to most people it is because of its DSSV dampers that are widely used in racing, including F1, DTM and IndyCar.

While not a giant in the automotive industry, without its manufacturing capabilities the Ford F150 pickup truck, of which 850,000 are made every year, would be running around without any suspension parts, which it was commissioned by Ford to engineer. It has a similar arrangement with General Motors. It also makes things like Tesla's automatic front opening door and the Model S rear aero and it does a lot of work for Aston Martin.

"We were purely a mechanical operation until about six years ago when we made a very conscious move to enter the world of mechatronics, mixing power systems with mechanisms," says Larry Holt, Multimatic's vice president of engineering. "We also made a conscious decision that, while we weren't going to make our own electronics, we would do all our own software because in my mind that's where the IP rests. So the idea is to come up with clever mechanical solutions driven by power, produce a custom electronics board with a Pektron with which we've partnered and then develop the software that makes it work, which is the IP. We therefore formed a software group that is growing daily.

"Pektron is the ideal partner for us. With a £120 million turnover, it's not a little company but nor is it a 30,000 lb gorilla. It supplies things like the dashboards and window regulator controllers for the McLaren road cars, all the controls on the original 12-volt Tesla S and Triumph Motorcycles and so it's a comfortable fit for us. We do active aero controls with them and they are involved in an active version of the DSSV damper, the Ford GT being the first car to be produced with an adaptive version." RT

ABOVE Larry Holt: driven man

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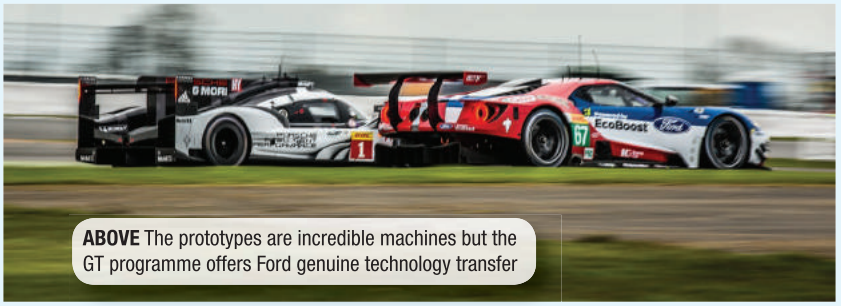
Ford Performance and technology transfer

FORD Performance is the result of the merger of SVT, which used to develop Ford's performance cars, Ford Racing that raced them, Team RS in Europe and the performance parts and accessories. It is headed up by Dave Pericak, previously chief engineer for the 2015 Ford Mustang. As chief technology officer, it has been Raj Nair who has been responsible for bringing the Ford GT to life, both as a road car and in racing.

"For this programme, we've assembled the best team we know with the best technology that we know and the best drivers we could line up, but we understand that it's a huge challenge for us," he says. "It follows our belief that our race cars have to be something that our customers can relate to and not just a technical and engineering exercise. The P1s are incredible machines and as an engineer I really appreciate what they're doing, but if you look at the series we participate in and the cars we race with, it's something that hopefully the customers can relate to."

There is also the technology transfer aspect which Nair says is extremely important to Ford. "The 3.5-litre V6 EcoBoost started as a production engine but we realised that it had a lot of potential and so developed it for our Daytona Prototype racing programme where it proved to be a winner. We had, for example, several model year 17 parts running in that race engine that will now be going into the production engine. The learnings from that of how to get 600+ horsepower, we put into the production 3.5-litre that's going into the GT road car.

"Interestingly, the work we've now done on the production engine is being fed back into the racing one. So this is an example of technology transfer that's going both ways." RT



ABOVE The prototypes are incredible machines but the GT programme offers Ford genuine technology transfer

fabulous job of making something that works aerodynamically, is beautiful and you can see the old car in it," says Howard-Chappell. "At the same time, everything that was done on this car – every curve, every shape, every circle – has been done with the intent of reducing drag and improving downforce."

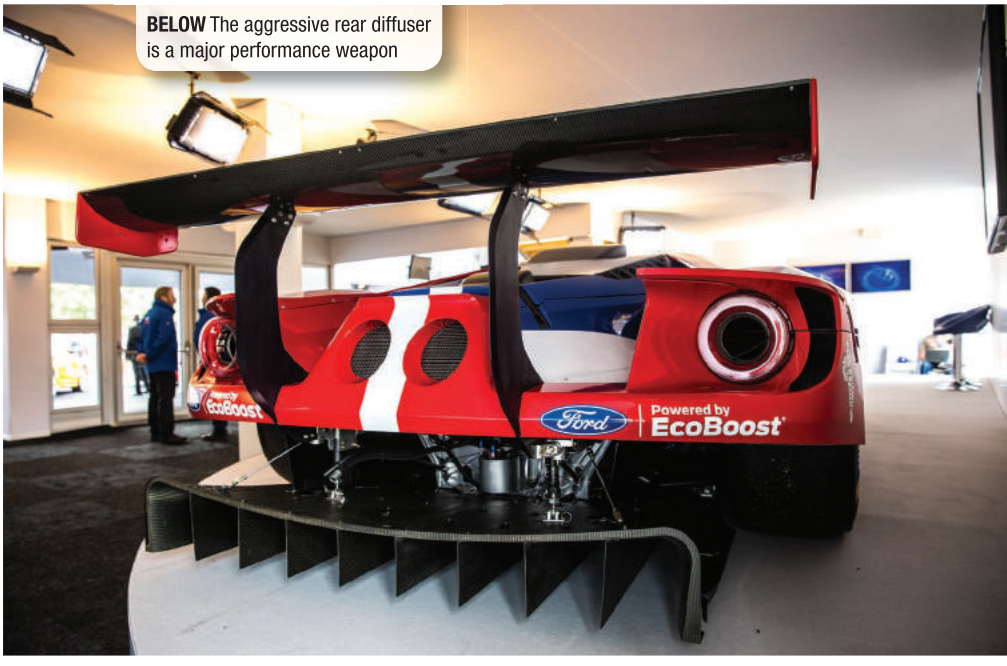
HUGE AMOUNT OF CFD

The 40 per cent modelling was done at ARC in Indianapolis led by Marcus, while Handford and his team did a huge amount of CFD work, the two sides working hand-in-hand to finesse the shape and lines. The next stages were full-scale wind tunnel tests at the Ganassi Laurel Hill underground tunnel in Pennsylvania, and also at Windshear in North Carolina, followed by a lot of on track testing. Then there was a massive programme to examine how all of that correlated, which in some ways it did, and on others it didn't, according to Holt.

"What this gave us was a very good handle on how it behaves aerodynamically," he says. "Where the road car differs from the race car is that it has active aerodynamics, which isn't allowed in racing, but it uses the base capabilities. All we do with the active aero is change the Cd, which is very low when the active aero is not deployed but causes massive downforce when it is. The chord length doesn't change, but the shape of the wing morphs into an aerodynamic wing section. When the front wing is down on the active aero car, it defeats some of the natural downforce that the car has as otherwise the CoP would be way too far ahead. When the wing goes up, then a device at the front basically turns itself off and lets the car do what it naturally does."

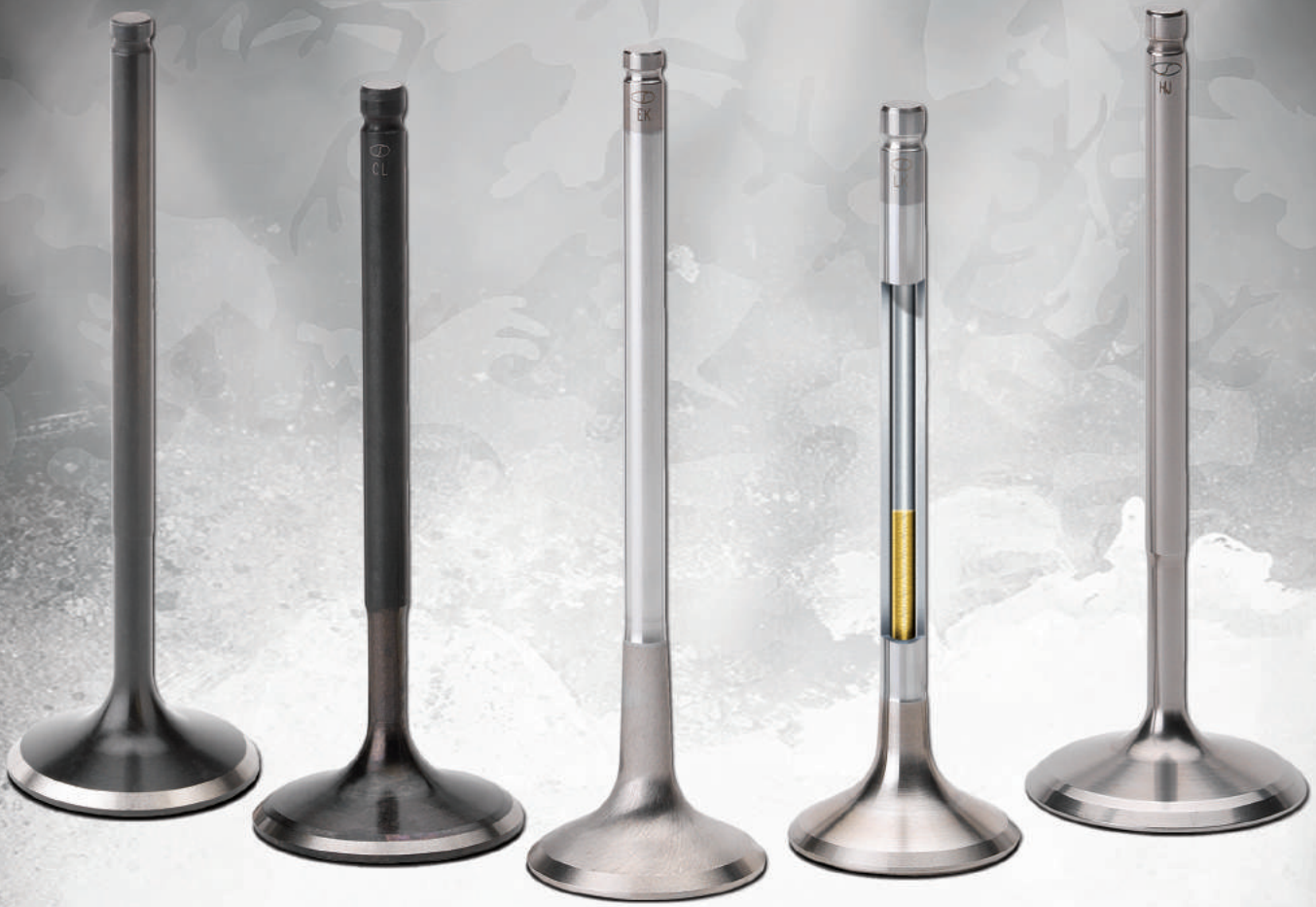
Holt says that the aerodynamic lessons learnt from the car will be proliferated across the production car range as aerodynamic efficiency is a Ford theme. "It's all about fuel saving and emissions, and the production guys are under huge pressure to come up with answers," he says. "Louvered shutters on radiators, active wheel spats, cleaning up the underside of a car are all areas where there is intensive work going on and lessons can be learnt from the race car."

He agrees that it's a shame that the active aero and other electronics items have to be removed from the car to go racing. "We ▶



BELOW The aggressive rear diffuser is a major performance weapon

SUPERTECH



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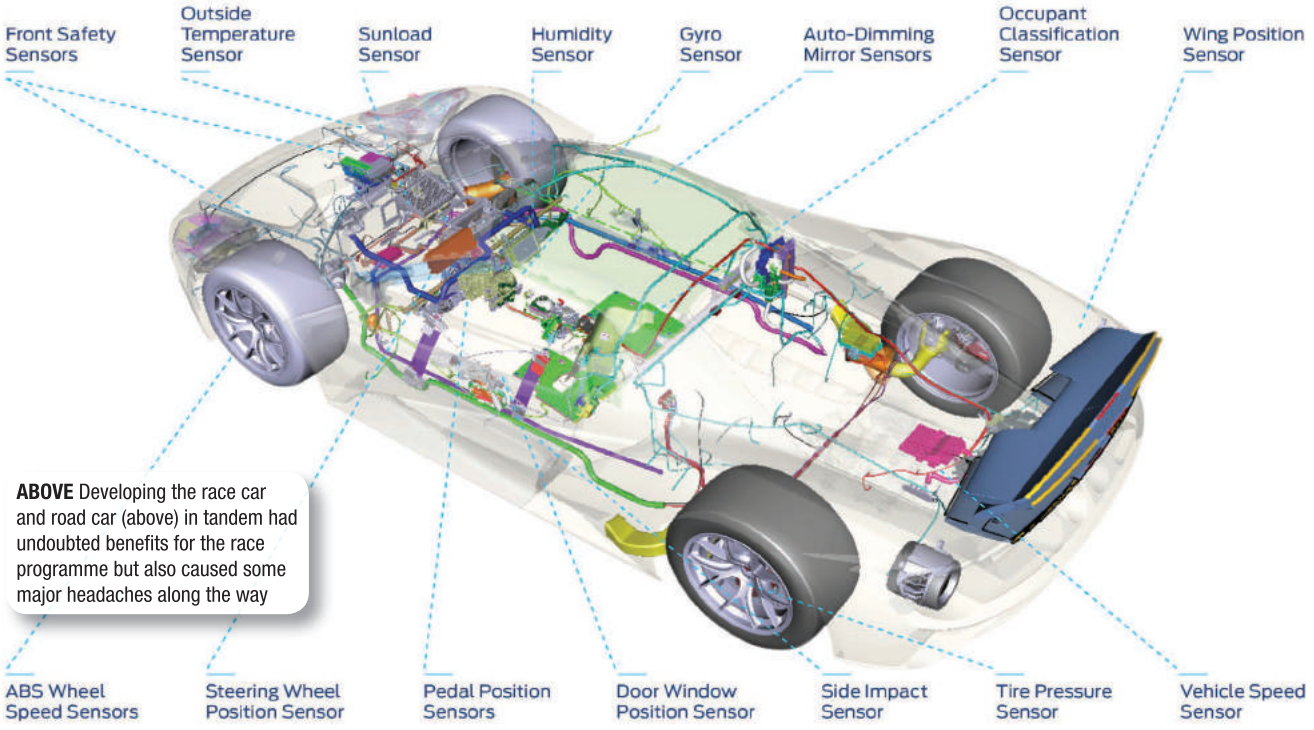

ABOVE Developing the race car and road car (above) in tandem had undoubted benefits for the race programme but also caused some major headaches along the way

have some amazing electronic stability programmes and also ABS and while traction control is allowed, it's not to the same level of sophistication that's being used in a road car. We are also making around 100 horsepower less in the race car, so it doesn't tell the story as we have in excess of 600 hp on the road car, and this is from a V6 3.5-litre engine. The torque is also spectacular, but in racing it's limited. We can make the car lighter but we have to put ballast in it to comply with the regulations, which I do understand as the FIA needs to create as much of an even field as possible. However, if it wasn't the case, we'd be kicking the living shit out of everybody!"

GREAT INNOVATIONS

The wheels are in a separate pod so it looks like an LMP car while one of the great innovations in the car, according to Holt, is to do with the charge air cooling that is so important for the turbocharger. "One of the major challenges of charge air coolers is getting free air through them. If located inside the bodywork of the car with scoops and stuff, there's very low freestream air percentage, perhaps as low as six to eight per cent. However, on the GT we've located the charge air cooler into the opening in the pod where the wheel is that gets us 35 per cent freestream air.

"Then the challenge becomes how to feed the air to the engine. So what we have done is designed a duct into the buttress that goes from the centre of the car to the pod, so it's not just some aesthetic thing, but a fully functioning device."

BBS wheels are fitted to both the road and race version of the GT. "I've always put BBS wheels on my race cars," says Holt. "It really developed out of a relationship with John Slagle, the then-president of BBS North America. I was always late and I would take our race cars to Sebring with no wheels, one hundred per cent relying on a truck delivering my wheels to me – and it always did. He's now moved on to a forging company in California and all the control and suspension arms for the production Ford GT are supplied by his company because of that relationship as well as the high quality parts they produce on time and on budget."

Another longstanding relationship is that with Diego Minen of VI-grade, the company that specialises in simulation solutions and processes. "Diego and I go back 20 years and it was he who convinced me to purchase our first platform (we actually now have two) while Ford also has one in North Carolina. In the end, a platform is a platform, it's what you can do with it which is where VI-grade comes into it."

Naturally the car is equipped with Multimatic's DSSV dampers while Brembo is the brake supplier – carbon for the road car and cast-iron for the race version – and Bosch is used for all the stability controls, including ABS on the road cars. The road car features a seven-speed dual-clutch transmission from Getrag weighing in at around 125 kg, whereas the race car's six-speed Ricardo gearbox weighs just 75 kg.

Another unique feature, according to Holt, is the fixed seat on both the road car and race car. "We have a fixed H-point; there's no ▶

"Magic recipe"

VI-grade's simulation technologies were harnessed to help develop the Ford GT road and race car.

"Multimatic and VI-grade have been able to create a unique technological partnership in which engineering, computer science and motorsport passion are mixed in a magic recipe," reveals VI-grade's Diego Minen. "Both companies have achieved terrific results in these years thanks to that, and we have learned how important it is to complement each other.

"I have personally learned from Larry [Holt] and his crew what it means to dream, engineer and drive a race car. This has helped VI-grade to develop an outstanding new generation of driving simulator systems, adding new functionalities to the virtual environment for engineers and drivers for an absolutely realistic driver feeling." RT

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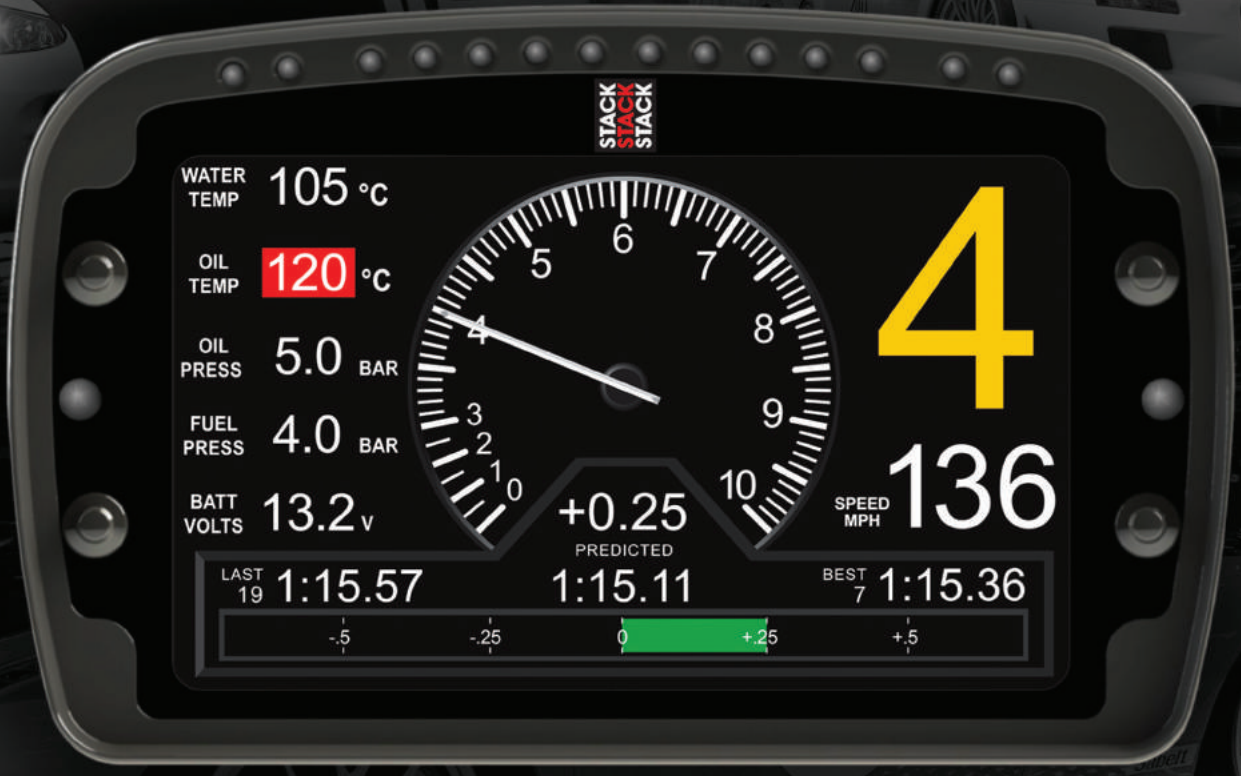

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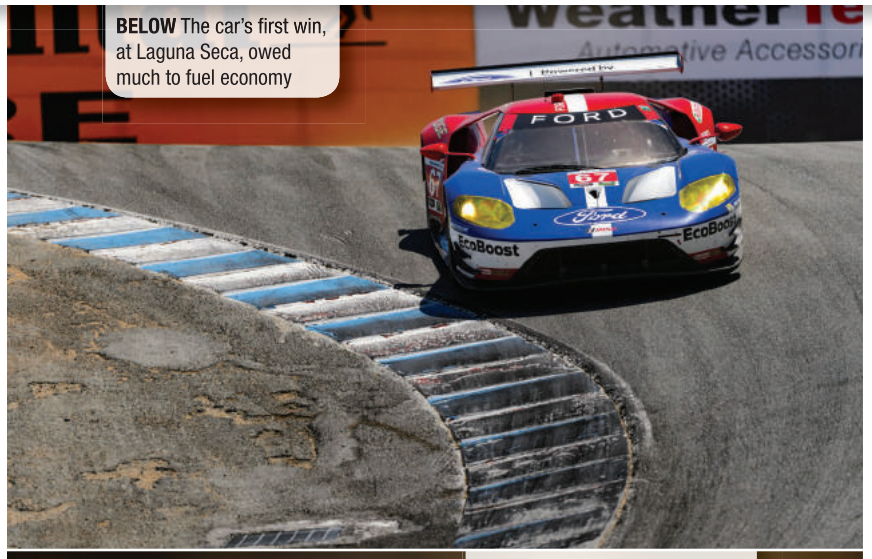

BELOW The car's first win, at Laguna Seca, owed much to fuel economy

BELOW George Howard-Chappell: a modern John Wyer

> *"There is a rumour that the project started with a race car that got developed into a road car, but that's just not true"*

seat track and while the LaFerrari also has a fixed seat, ours has a moving back. This is something we conceived at Multimatic but then got specialist seat company Sparco to produce it. The entire pedal assembly, including the dead pedal and brake booster, move backwards and forwards, so the driver sits in the car and brings everything, including the steering wheel, to him."

Multimatic is responsible for producing both the road and race versions of the cars at one of its plants in Ontario, Canada. "There isn't a Ford facility that is suited to building just 250 cars a year and from October, we will be building a car a day in a new purpose-built facility in Toronto," says Holt.

Other important partners in the Ford GT equation are Roush Industries and RoushYates and Chip Ganassi Racing. Given the historic relationship with the Charlotte, North Carolina-based RoushYates organisation across very many forms of racing in the US, including NASCAR Cup, it would have been strange had the decision been taken to go elsewhere or take the project in-house. What was much more of a surprise, though, was the appointment of Chip Ganassi Racing in 2014 to handle all the track activities.

This team has a long and successful track record in all the top echelons of North American motorsport, but it is all with General Motors, so for Ford to select this team to run its car in both the WeatherTech and WEC series was a real shock. "We knew Chip from just being at the racetrack and although he was with a different manufacturer we were very pleased to have him join us and run the Ford GT programme at the track," says Nair. It was an inspiring choice because in the first year, the Ford Chip Ganassi Racing team scored five wins, including the 12 Hours of Sebring, with the 3.5-litre EcoBoost-powered Riley. It added the 24 Hours of Daytona to the roll of honour the following year. All the while, the three entities of Ford, RoushYates and Chip Ganassi Racing were learning how to work together.

This year is different, though, because for all its massive experience in North American racing, the Chip Ganassi Racing team has very little when it comes to racing internationally – and this is where Multimatic comes in. A splinter Multimatic group has been established in the UK to handle the WEC side of things, but still under the Ford Chip Ganassi banner.

KEY ELEMENT

A key element in this is Howard-Chappell, the John Wyer of today. At the time it was a shock to virtually everyone when he left Prodrive in October 2011 after 13 years, during which time he had masterminded the company's success with Aston Martin and Ferrari, to join Multimatic, a company that few knew about. Rumours flew with the belief that after a quarter-century of race engineering he wanted a quieter life. Well everyone got that bit wrong because he became intimately involved with the Ford GT programme from the get-go.

He gives an interesting insight into how the Ford operation differs from that of Aston Martin. While being careful not to disparage the Prodrive operation, he comments that having the full weight of a manufacturer behind the racing activities, as it is with Ford, has brought the whole thing to a new level.

"Chip Ganassi's team is very well established in North America but it would have had to start from scratch in Europe, so it made sense to use some of our guys in Europe as we were already set up there, especially in the UK," he notes. "So outwardly it is one team – the Ford Chip Ganassi Racing team – but the WEC guys are predominantly from Multimatic and it's mainly Chip Ganassi Racing guys on the other side of the Atlantic, but it's all one effort. When we are deciding the direction of the programme and talking about development and dealing with issues on the car, then it's everybody together, there's no division."

In the GT's first competitive outing in the Daytona 24 Hours, there was disappointment all round, a series of niggling problems handicapping both cars. While this could be expected as bedding-in issues, Howard-

Chappell says that what made it all the more annoying was that they made the classic mistake: something that had been proven in pre-season testing, when the cars ran like clockwork, was changed for something that had not been thoroughly tested.

Things were much better in the 12 Hours of Sebring, where one of the cars battled all day on the lead lap, led a portion of the race, and was in contention for a podium finish in the final 10 minutes of the race before getting knocked off track. It finished fifth in GTLM while its sister car was never in contention due to an early accident that hamstrung its efforts, although it did finish.

The first two races for the WEC cars, at Silverstone and Spa, were mixed bags. The Fords were outpaced by the AF Corse Ferrari 488s in both, but finished fourth and fifth in class in the UK, and second in Belgium. The joy of landing the first WEC podium was initially overshadowed by Stefan Mücke's big accident in the #66 car coming out of Eau Rouge, which saw him hospitalised. Fortunately, the German escaped with only heavy bruising.

However, it was at the third round of the WeatherTech series at Laguna Seca on May 1 that history was made, Ryan Briscoe and Richard Westbrook giving the GT its first competitive win through a combination of pace and fuel economy. The #67 Ford GT was able to cruise to the victory on the back of only one pit stop, while the rest of the competitors took two or three. The team later revealed the feat had been made possible by the drivers' experiments with fuel consumption at Daytona after encountering gearbox problems.

"It was a fuel-saving race from the start, because we wanted to do it on one stop, but when Richard got in, we were definitely out of the window," Briscoe said of the Laguna win. "The numbers he was making were just unbelievable. I never thought we'd be able to do it and I think that actually helped look after the tyres. The pace was just as good as anyone's at the end. It's a phenomenal result."

"We've been waiting for this win for a long time," said Pericak. "I think it's great that it came as a fuel economy win. It's great for Ford EcoBoost, because that's what it's all about, but this is really a boost for the team going into Le Mans. We've been working up to this point to showcase the car's durability and I think this is what the team needed to go to Le Mans."

ABOVE The Ford GT, seen here at Spa, was initially codenamed 'Project Phoenix' and has risen from a secret basement at Ford

THE AERO CURSE

The focus of the 2016 Audi R18 e-tron quattro is on the radical aerodynamics and new hybrid system. But, as **William Kimberley** reports, there is more to the car than meets the eye

THE first two rounds of the World Endurance Championship have proved to be tumultuous for Audi. A totally new car for this year, but still with the same nomenclature, the Audi R18 e-tron quattro of Marcel Fässler, André Lotterer and Benoît Tréluyer took the chequered flag at Silverstone for the first round of the championship to give the marque its first win since the second round at Spa last year. A few hours later, though, the champagne turned to vinegar with the news that the car had been disqualified due to an infringement of the regulations, namely for wear beyond the permitted 5 mm on the front skid block. It was heartbreak for all concerned.

At Spa, it was a different story. As one team insider said, Audi might have won the race but such were the mistakes made by the team that they did not deserve to. A question of Lady Luck's swings and roundabouts, this time to the advantage of the car wearing the four rings. Whatever it was, Audi was back to its winning ways after a lengthy spell, much to the joy and relief of all concerned.

ABANDONED FLYWHEEL

In order to try to redress some of the disadvantages it felt it was suffering at the hands of Porsche last year, Audi went up from the 4-megajoule class to the 6-megajoule category, which equates to the 8-megajoule band for the gasoline-powered cars. This switch necessitated a fundamental change in the hybrid system.

Where the then-new GKN Gyrodrive flywheel hybrid energy storage system enabled Audi to compete in the 4-megajoule of hybrid energy category last year, the next step to the 6-megajoule level was one too far. It was consequently replaced by an electrochemical storage system, in the form of a lithium-ion accumulator, which is more suitable for high levels of energy storage and recovery as it can recover 50% more energy than last year's car.

While the 120-degree V6 TDI engine can

> *"The pursuit of aero nirvana can have a detrimental effect on the car's other systems"*

BELOW The R18s in the thick of the action at Spa

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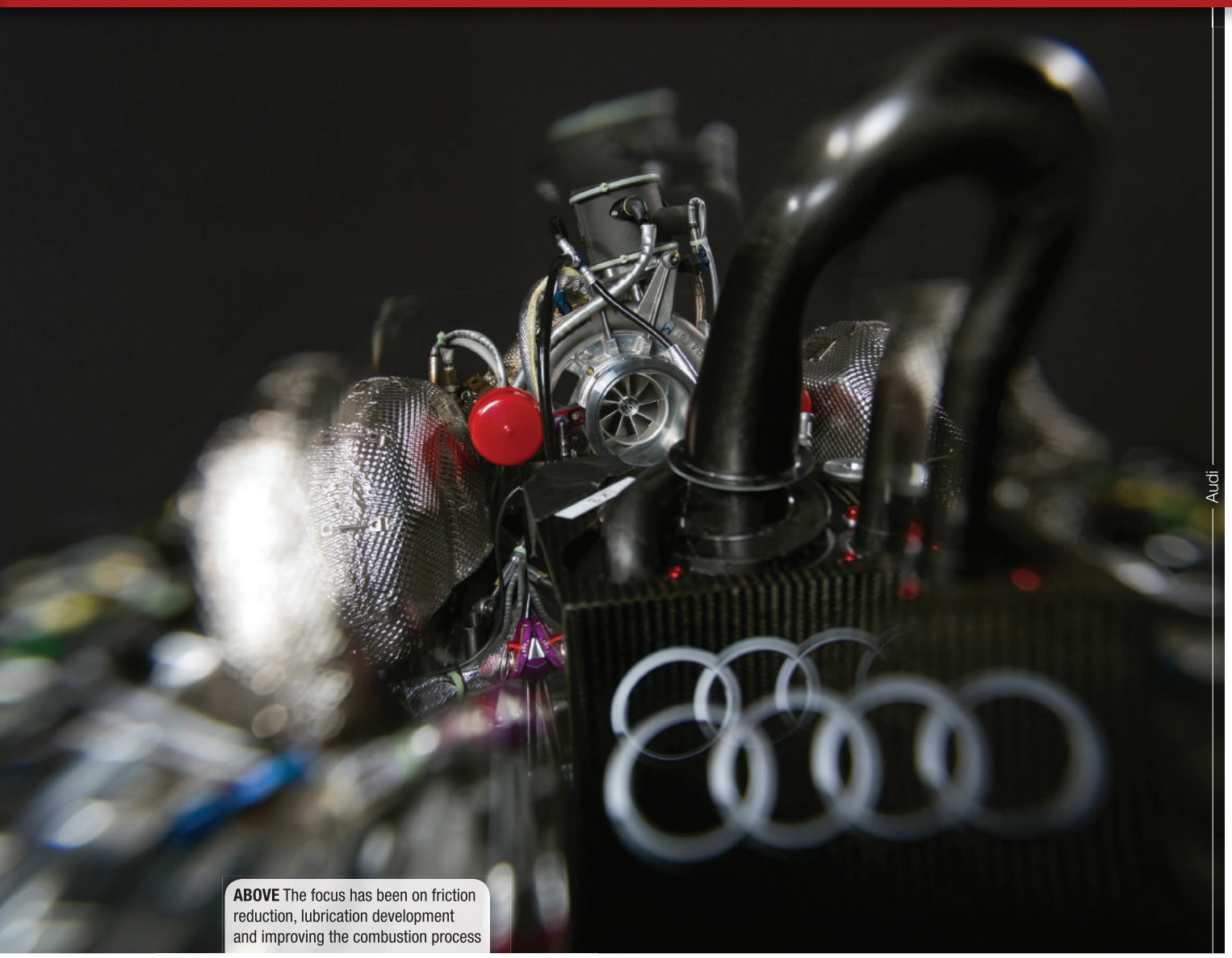

Audi

ABOVE The focus has been on friction reduction, lubrication development and improving the combustion process

trace its roots back to the original 2011 unit, over the years it has been massively developed, often to meet the prevailing regulations. For example, in 2013 there was a 0.7 mm reduction in the diameter of the air restrictor that limited the output to around 360 kW (490 hp), although the torque could be maintained at around 850 Nm.

The following year Audi produced what it called an "all-new" engine as it saw an increase in its cubic capacity from 3.7 litres to four. However, the fundamental architecture remained the same. To comply with the 2015 regulations, the engine now developing 410 kW (550 hp) had to use 2.5 per cent less diesel fuel per lap than in 2014, leading to further optimisation.

The story continues into 2016, but along with the switch in the hybrid system, there have been some changes to the engine as well. This time they have been driven by the demands of the aerodynamicists – the bane of the powertrain engineers. While the principal concern of an aerodynamicist is to make the car go through the air more efficiently, what they sometimes overlook is that their single-minded pursuit of aero nirvana can have a detrimental effect on the car's other systems by starving them of the precious cooling air.

DISRUPTIVE ELEMENTS

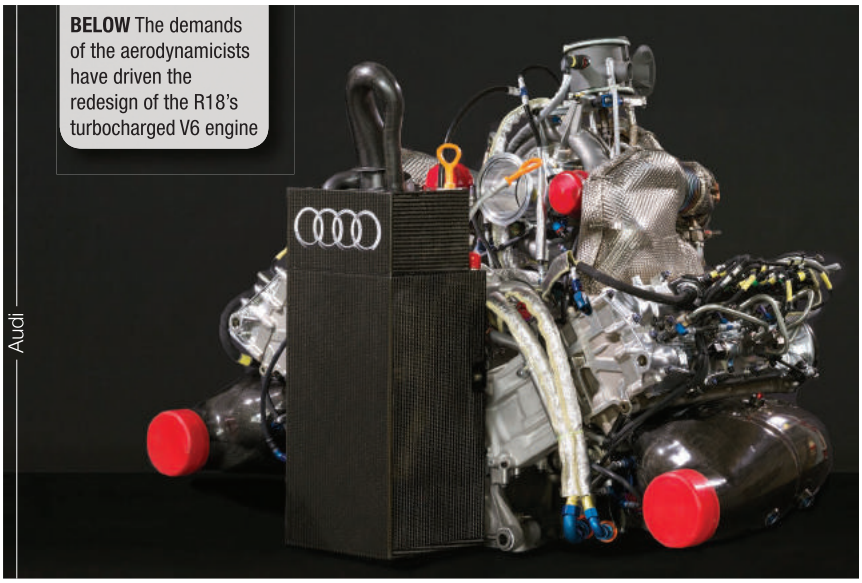
There is no question that the 2016 Audi R18 e-tron quattro looks hugely different from its predecessor with its raised nose and various air scoops, but one of the more disruptive elements in its new configuration is the airflow underneath the car and the space required for a new rear diffuser. "The new proportions influence weight distribution and aerodynamics," explains Jörg Zander, head of engineering at Audi Sport, "and our most important objective was to improve airflow."

At the front end, airflow has to be directed across the top of the race car and between the wheel wells, enter the cooling ducts through the bodyshell and optimally approach the underfloor. At the rear, the air exits through the diffuser, resulting in a major portion of the downforce being produced under the car, which is beneficial in cornering. "In this process, vortices must be avoided, as this costs energy," says Zander, explaining that undesirable vortices and turbulent flow reduce the energy in the airflow and increase resistance. The smaller the space the monocoque occupies in this area, the larger the clearances for low-loss airflow.

The direct effect of this has meant that the high-pressure injection pump has had to be relocated from where it was beneath the engine. In turn, this led to half of the engine being modified. This includes the castings, although the main dimensions remain unchanged. However once everything is taken into account, the engine is slightly down on power, producing 378 kW (507 hp) although the maximum torque at 850 Nm remains the same. Allied to the new ▶

hybrid system, though, the overall power rating has increased to over 1,000 hp.

At the same time work has not stopped on taking weight out of the car wherever possible, and thanks to the torque of the engine, it has meant that a gear could safely be removed from the 7-speed Xtrac gearbox without any detrimental effect on driveability. Friction reduction, lubrication development and an improvement in the combustion process were also all put under the microscope.


Audi

BELOW The demands of the aerodynamicists have driven the redesign of the R18's turbocharged V6 engine

LOW-HANGING FRUIT

One of the problems that the Audi powertrain engineers face is that because the engine has been around for so many years, it is so much harder to find any major gains in performance and power; for both Porsche and Toyota, especially in the latter's case, there is still an amount of low-hanging fruit within their grasp as their engines are so much newer.

As things stand, this could all be about to change. It is understood that the new regulations for 2018 will be announced at Le Mans. The suggestion is that they will see the introduction of a third hybrid system and an increase to 10 megajoules.

> *"It can recover 50% more energy than last year's car"*

According to a senior engineer from a car manufacturer which is considering entering the World Endurance Championship at this time, this is a worrying development: he says it is not relevant to production cars, while it will also drive up costs substantially. It is believed that behind the scenes there is quite a bit of negotiation taking place, so this has yet to be decided.

The spotlight here and now, though, is on Le Mans. There is all to play for with Audi focused on resuming its winning ways there, Porsche wanting to show that last year's win was not a fluke and Toyota desperate to score it first win there. Once Brad Pitt drops the starter's flag, the gloves are off. RT

Ebrey/LAT

ABOVE Victory at Spa didn't mask the fact that Audi has much work to do for Le Mans

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LITE RELIEF?

If there's to be a giant-killing feat at Le Mans, it could come from the LMP1 'Lite' ranks powered by AER's P60 engine. **Chris Pickering** reports on its development

SOME 93 years after the event was first run, an outright win at Le Mans is still one of the most prized achievements in motorsport. Today, the top-level LMP1 category may be dominated by manufacturers, but that's not quite the full story. Snapping at their heels are the privateer teams of the LMP1 'Lite' (LMP1-L) class. And each of them at this year's event uses the same AER P60 engine.

AER – otherwise known as Advanced Engine Research – has a long history in the privateer ranks at Le Mans. In 2006 it became the first engine manufacturer to take the LMP2 victory with a turbocharged inline four. The same year, AER-powered cars took every single pole *and* every single win in the European Le Mans Series' LMP2 category, followed inevitably by the championship itself.

Of course, unless a disaster of biblical proportions were to befall the Audi, Toyota and Porsche works outfits, it's rather unlikely that either of the LMP1-L teams will take overall victory. That's an accepted fact among the privateer ranks, but it doesn't lessen the engineering challenge of taking on the top category of the world's greatest race (an overall third and fourth place for Rebellion at the Silverstone and Spa WEC races recently proves 'the unlikely' can still happen though).

There are differences to the LMP1-H regulations under which the manufacturers compete. Most notably, energy recovery systems are not allowed in any form under the LMP1-L rules. There's also a token 5,500 cc capacity limit (while the hybrid engines are unlimited) and a somewhat more generous fuel flow allocation for the privateer teams, but essentially the major constraints are the same. That means the engine regulations are still about as open as it's possible to get in international motorsport: there is no boost limit as such for turbocharged engines, no intake restrictor and no cap on engine speed. Providing it's a four-stroke reciprocating engine that adheres to the fuel flow requirements and uses no more than four valves per cylinder, the engineers are more or less free to do as they please.

This degree of freedom must have been a tantalising prospect for the engineers at AER, but it also raised a very significant dilemma: what to do?

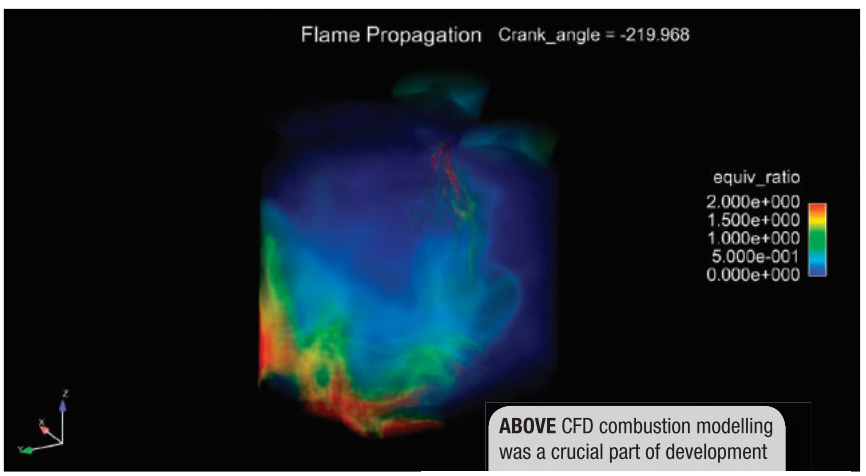
"When the fuel flow regulations were first mooted it became obvious that LMP1 – and perhaps other categories – would move over to that system. We took the decision to analyse various types of engine to see how they worked at different power levels and fuel flows," explains Mike Lancaster, managing director of AER.

The idea was to evaluate all the potential options using a mixture of dyno testing, computer simulation and existing data. AER began with its substantial back catalogue, which included the 4-litre naturally aspirated P32 V8 – both with and without turbocharging – plus the P90 inline four and several V6 configurations. A whole range of other theoretical options were considered, including – somewhat tantalisingly – a diesel.

Much of the work was carried out with simulation, using the 1D code GT Power integrated with a full CFD combustion model run in Converge.

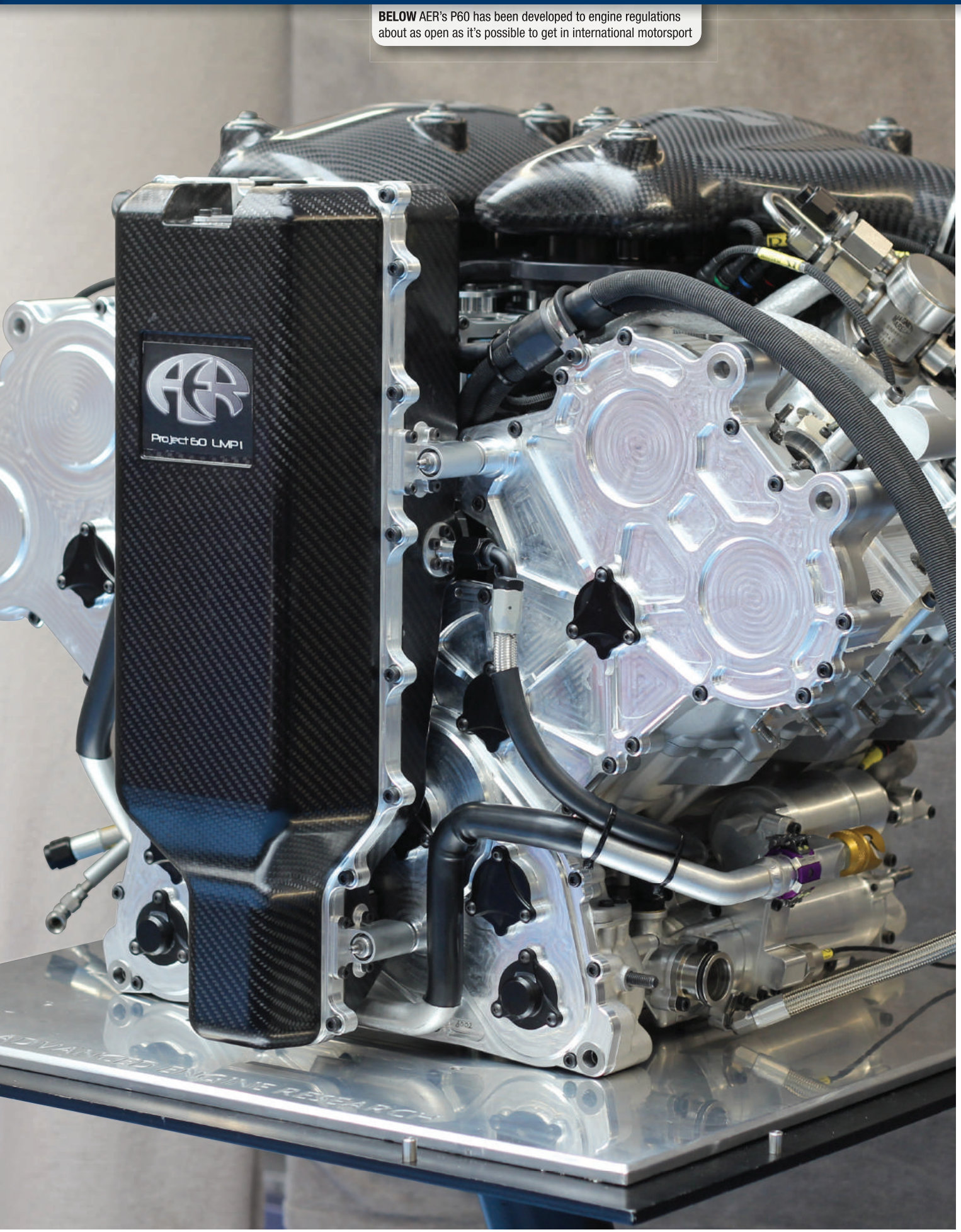
"Linking a CFD combustion model with a 1D simulation gave us a very strong overall package for a relatively manageable ▶

> *"Linking a CFD combustion model with a 1D simulation gave us a very strong overall package for a relatively manageable budget"*



ABOVE CFD combustion modelling was a crucial part of development

BELOW AER's P60 has been developed to engine regulations about as open as it's possible to get in international motorsport



budget," comments Lancaster. "There's the potential to get lost in the complexity of simulation and testing if you're not careful. We wanted to evaluate various options as efficiently as possible."

The Holy Grail as far as AER was concerned was brake specific fuel consumption (BSFC). Focusing on this measure of power output per unit of fuel consumed gave Lancaster and his colleagues a universal measurement with which to compare engines of different types. It also gave them a direct indication of where each engine would sit within the LMP1 fuel flow limits.

"By and large the results were fairly predictable," recalls Lancaster. "We were aiming for a very low BSFC, so the engine – by definition – had to be happy running at very lean lambda values. Taking the fuel flow allocation gives you an idea of what the mass air flow would need to be, which gives you an indication of what you could achieve with the various different engine configurations.

"That leads to the question of how much power you can expect to get from that amount of fuel, while maximising BSFC. What we're trying to achieve in all of this is combustion efficiency. A combination of empirical knowledge and simulation analysis pushes you towards a certain displacement and a certain number of cylinders. From that, you get a good idea of the optimum valve size, tumble ratios, bore and stroke."

After the initial study, it rapidly became clear to the AER engineers that turbocharging was the way to go. Working back from the fuel allocation given by the FIA they then identified what they believed to be the ideal capacity and configuration. Curiously, the size remains a secret, although *Autosport* originally reported it as 2.4 litres, as do several Wikipedia pages. Whatever the case, AER's desired cylinder capacity pointed the way towards a six-cylinder engine, which made a V6 the default choice. Furthermore, the engine was to be a fully stressed member of the chassis and the vee configuration would provide a wider base for mounting.

There's plenty of ingenuity at work, but the design process itself follows a fundamentally logical path. Armed with the dimensions, you can start to fill in the gaps, Lancaster explains. For instance, once a V6 began to look like the favoured configuration, significant analysis work proves that a 90-degree vee angle would result in a smaller crankshaft, which means smaller bearing sizes and hence lower friction than a 60-degree vee. It also results in a lower centre of gravity and a lower overall height.

> *"The Holy Grail as far as AER was concerned was brake specific fuel consumption"*

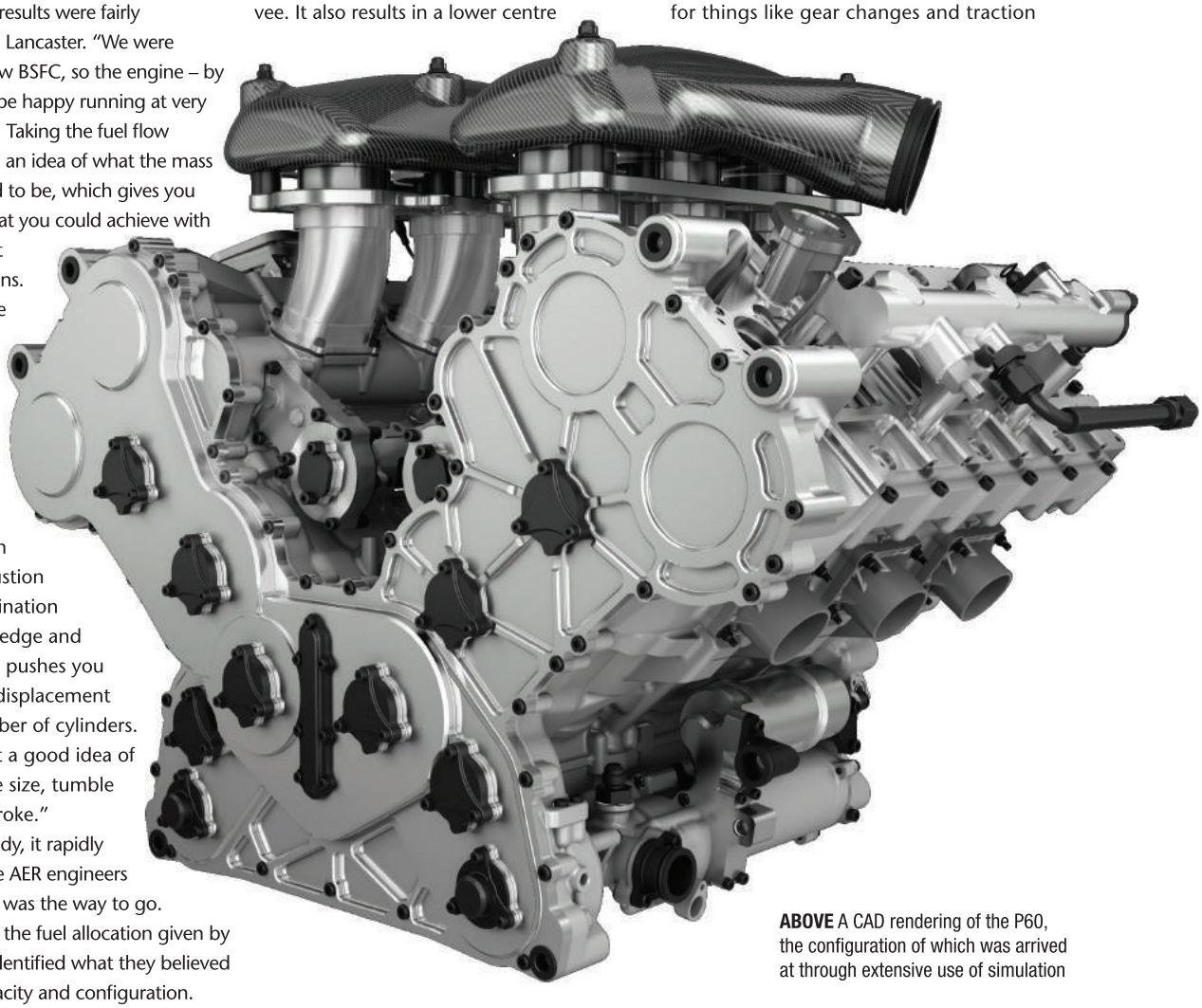
The caveat to all of this is 'what do you do if the specifications change?' and sure enough they did. "When we began looking at LMP1, the fuel allocation was less than 100 kg/hr and now it's nominally 110 kg/hr with a maximum 'lap energy' of 98.2 MJ. You have to be able to accommodate those changes, which does complicate the development," comments Lancaster.

THE DIRECT APPROACH

One thing that the AER engineers knew from the start was that they wanted to use a direct injection (DI) system.

"DI is simply a no-brainer these days," says Lancaster. "It's so much better than port injection in so many different ways – particularly in the fine control of the engine for things like gear changes and traction control. It requires more sophisticated electronics, better fuel injection hardware and more calibration work to do it right, but the rewards are massive. You get power benefits and a huge improvement in fuel consumption right across the board. We wouldn't use port injection for anything other than cost control reasons anymore."

Some engines use supplementary port injection to help with the fuel delivery ▶



ABOVE A CAD rendering of the P60, the configuration of which was arrived at through extensive use of simulation

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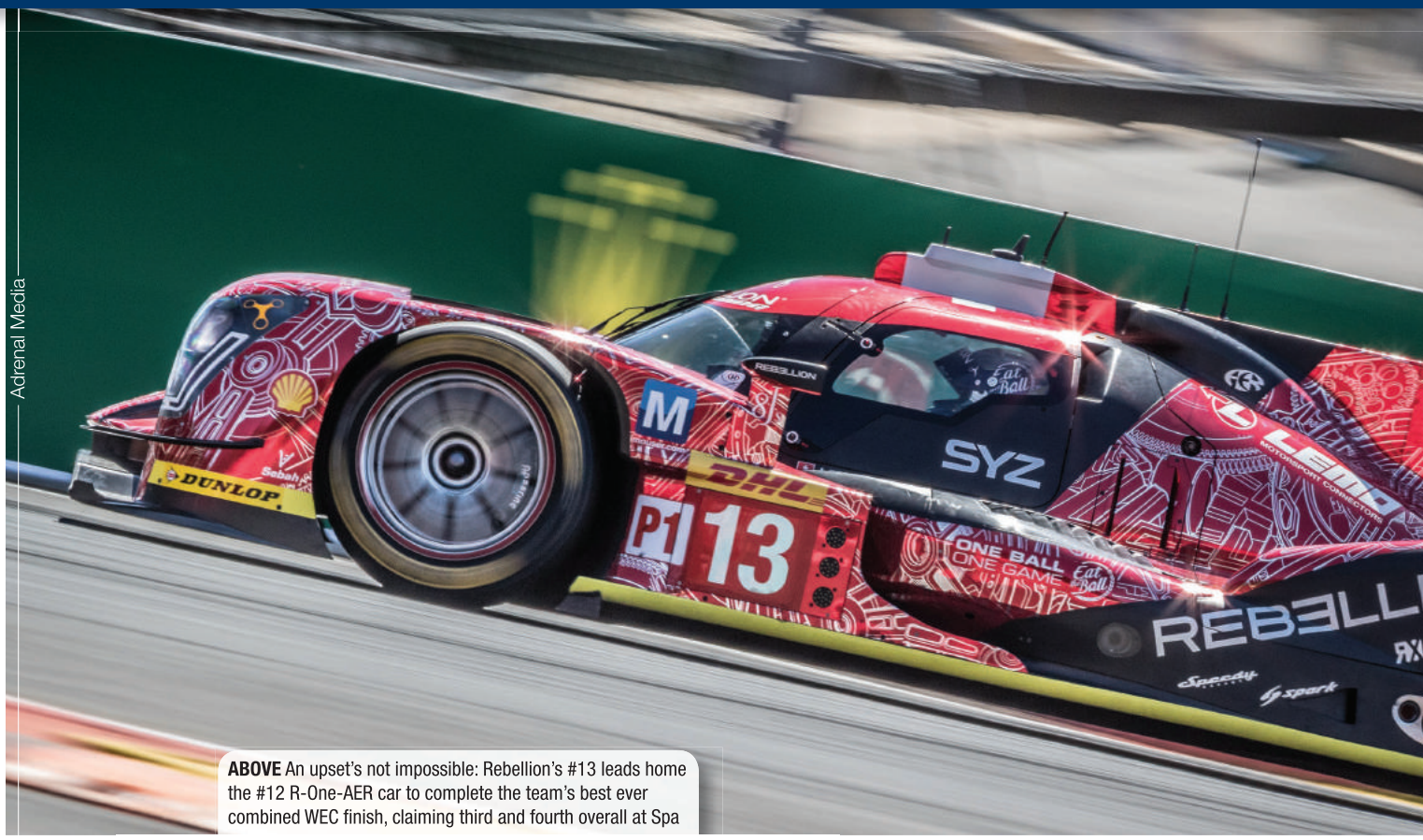

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ABOVE An upset's not impossible: Rebellion's #13 leads home the #12 R-One-AER car to complete the team's best ever combined WEC finish, claiming third and fourth overall at Spa

at very high revs, but the P60 is a pure DI setup. Even at the higher end of the potential speed range, Lancaster says one set of injectors was enough: "The rev range is tailored towards the best BSFC, but we have run various engines with similar architecture at higher speeds. For instance, we did a Formula 1 test programme for a four-cylinder concept before the regulations were changed to V6. That revved to around 12,000 rpm with pure DI – ultimately limited by mean piston speed."

OLD AND NEW

Piece by piece, everything began to take shape. It's often said in engine design that you don't unlearn what you've done before and this project is no exception; there are certainly similarities to a number of AER's other engines in the P60, but it's fundamentally a clean sheet design. The block is an all-new aluminium alloy unit, developed in-house and cast by Grainger and Worrall in the Midlands. Likewise, the cylinder heads, sump and covers are all bespoke to the LMP1 engine. The crankshaft comes from Arrow Precision, as do the connecting rods, while the pistons are from Capricorn.

Elsewhere, AER has cherry-picked inspiration from across its range, Lancaster explains: "The design itself is new, but the P60's cylinder head construction is quite close to the P90 four-cylinder – the enormous pressures involved with a GDI turbo engine mean they're quite similar across the entire range. It's quite a useful feature to have when you're manufacturing the parts."

In some cases these similarities arise purely out of performance considerations. In others, cost reduction plays a part, but he's keen to point out that AER never carries over ideas simply to make life easy: "We didn't want to constrain ourselves – for instance targeting the same bore spacing as the other engines – in order to save costs. Everything has been chosen for strength, durability and power first and foremost.

"It would have been incredibly easy for us to adapt the P90 four-cylinder engine – maybe enlarge it slightly or something like that – and there would have been a commercial case for doing that, but it simply wouldn't have been as good. It's the same as trying to take a current Formula 1 engine and turn it into an LMP engine or something like that."

You might expect a comparatively small capacity turbocharged inline four to be highly stressed, but that's not the main reason that the four-cylinder route was discounted, Lancaster explains: "We've made four-cylinder engines that make more power than the P60 with a smaller displacement and less cylinders. The issue is combustion efficiency. Inevitably, if you want to extract more power out of a smaller capacity, the engine speeds will be higher. That increases friction and windage, but it also means you get different combustion characteristics: some good, some not so good."

ANCILLARIES

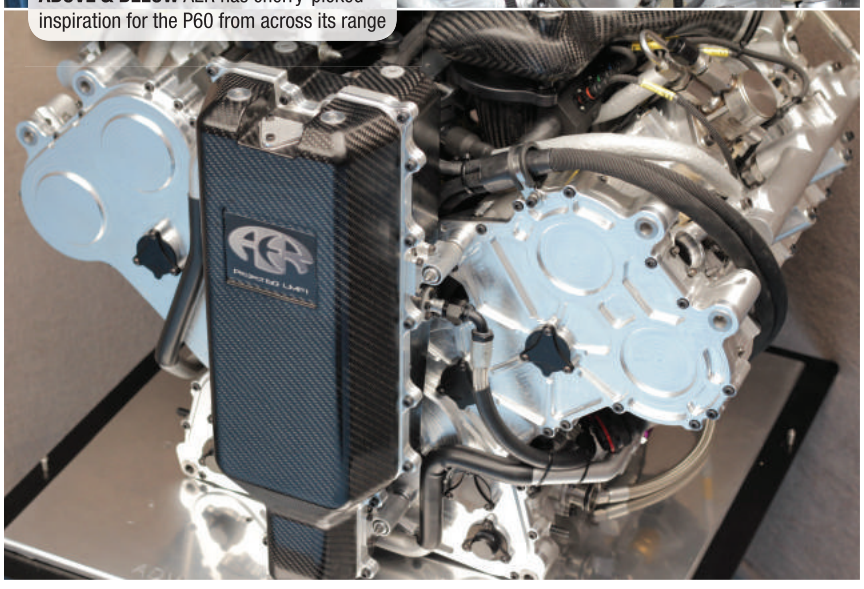
In an effort to maximise reliability, the engine has no external belt drives. The camshafts, twin water pumps and oil pumps are driven by fully enclosed gears. This also reduces weight and improves timing accuracy. Torsional vibrations can sometimes be an issue in gear-driven systems, but careful analysis and design of the valvetrain components means the AER P60 engine is generally not affected. For certain engine speed ranges, however, the company has developed a torsional vibration damper that eliminates any unwanted harmonics.

The oil system is self-contained within the engine, eliminating the need for external plumbing of chassis-mounted oil radiators. Instead, the oil is cooled by an integrated oil/water heat exchanger, located in the vee of the block, fed directly by the oil pressure pump.

In contrast to the current trend for 'hot vee' engines, the exhaust ports are on the outside of the P60 with the twin Garrett ▶

turbochargers, mounted low down on either side. The boost is regulated by electronically-controlled wastegates, developed in-house by AER. On the intake side, the P60 uses twin barrel throttle bodies, controlled by fly-by-wire motors, designed to optimise pedal response.

The FIA-inspected F90 family of ECUs from AER's sister company Life Racing is specified for the P60 V6 engine. This ECU works with the transmission and chassis systems to provide full control of the engine, gearbox, and clutch (where necessary).



ABOVE & BELOW AER has cherry-picked inspiration for the P60 from across its range

"The ECU has to be capable of regulating the engine to a very high degree of precision for a DI engine and Life Racing has been working with these requirements for a long time," says Lancaster. "On top of that, you need to be able to provide enough data to the FIA for them to monitor the fuel flow properly. It means the engine design and the electronics become quite heavily entangled."

Under the LMP1 rules, a lengthy list of parameters have to be streamed to the logger, including lambda values, pressure histories and ignition timing for each individual cylinder, plus torque sensor readings.

FUTURE PERFECT

Thanks to its lightweight design, the base engine tips the scales at a very trim 108 kg. It's also said to have a notably low centre of gravity and an excellent polar moment of inertia. AER is remaining tight-lipped as to how much power it produces, although Lancaster confirms that it's substantially more than the internal combustion portion of the works hybrid engines. Given that Audi has released a figure of 375 kW (510 hp) for the diesel R18, while the Porsche 919 is said to be 'in excess of 500 hp', we'd expect that to be over 600 hp.

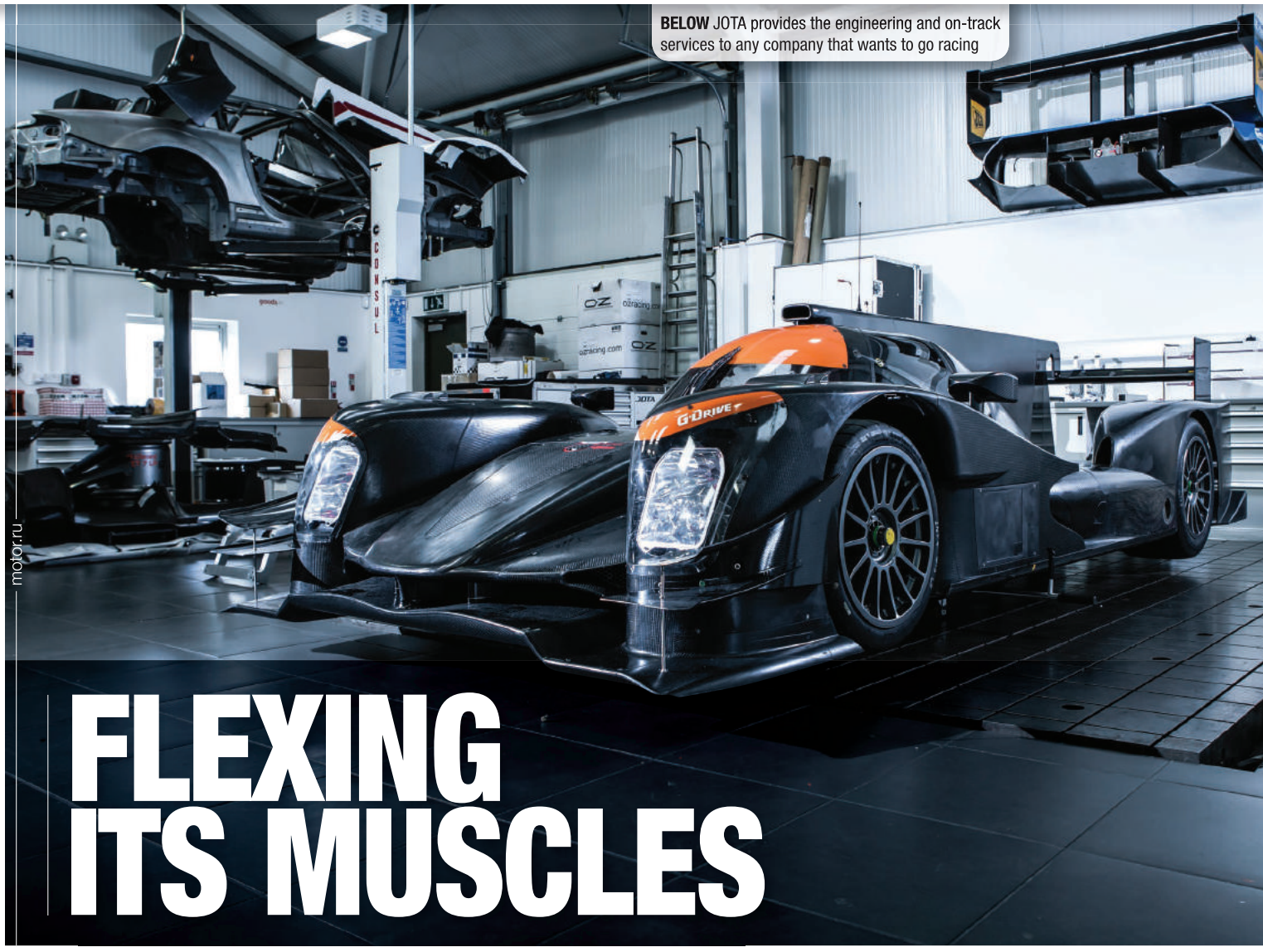
Assuming all goes well for the teams, victory in the unofficial 'LMP1 privateer' class should be a mathematical certainty for AER this year. Hollow as that may sound with only three cars in the field, Lancaster is genuinely upbeat about the prospects for independent teams in LMP1.

"There is a lot of interest in the LMP1-L category at the moment, particularly as LMP2 moves towards more of a spec series," he says. "I think there's a real desire from some of the teams to compete in a higher category with a lot more performance, but it is a slightly more expensive proposition and the FIA is mindful to make sure it doesn't get too technically sophisticated and we are all for that control."

There is a lot of discussion on the future of the series at the moment. Lancaster says he's had enquiries from teams looking to join the category and he believes that other engine manufacturers are working on LMP1-L powerplants. There's a suspicion, however, that people are waiting on the next set of regulations to confirm their decision. Despite a somewhat difficult gestation, there is now a general acceptance in the LMP paddock that fuel flow metering with its massive fuel efficiency improvements remains the way to go and that reverting to other forms of power limiting is stepping back into the 'dark ages' somewhat.

The general consensus also seems to be that the energy recovery systems should remain confined to the factory teams. Lancaster agrees: "The LMP-H category is there for manufacturers developing new technology. It's a very important part of LMP1, but I don't think privateers have the budgets or the desire to do that. We looked into the possibility of fitting an exhaust energy recovery system before the rules solidified. We know from our model based analysis that it will work extremely well, but the cost and complexity of the hardware and attendant electronics spiral as soon as you do so and getting the system to work reliably in a high temperature environment will all come at an uncomfortably high cost for most privateers."

Whatever the future holds, 2016 should be another great race at Le Mans. Inevitably, the headlines will tend to focus on the three main factory teams, but keep an eye out for the AER-powered cars fighting for the privateer honours. You never know, there might just be a surprise in store.



BELOW JOTA provides the engineering and on-track services to any company that wants to go racing

motor.ru

FLEXING ITS MUSCLES

The prototypes steal the limelight as they compete for the overall win, and GTE cars grab the glamour. But LMP2 is far from being a poor relation, as **William Kimberley** discovers when he visits JOTA Sport

WHAT is JOTA Sport? The name seems to imply that it might be Japanese, but on the other hand it ran the Muscle Milk LMP1 effort a few years ago, so perhaps it's American? There again, it's been a stalwart in European racing and with Jota being the Spanish for the letter j, maybe it's Spanish? However, it is now running under the G-Drive Racing and Gazprom banner, so perhaps it's Russian? In fact, none of these is correct: it is a very British operation.

It all started with a dream of racing at Le Mans. Having graduated in materials engineering from Imperial College in London, Sam Hignett's first aspirations were to be a racing driver. Initially it was in Formula Vauxhall Junior with John Village Automotive and Marino Franchitti as team-mate in 1999, but coming to the realisation that he did not have the funding to continue in single-seaters, he switched his focus to tin-top racing. An introduction to John Stack, an estate agent who also wanted to go motor racing, led to the creation of Team JOTA, the first car being a Honda Integra built specifically for endurance racing. That year the team competed at the Nürburgring 24 Hours and the Spa 24 Hours, followed by participation in the Renault Clio V6 Trophy in 2001.

"We were sponsored by the Mezzanine Flooring Company which was big into motorsport sponsorship at the time and was in no small part responsible for Tom Kristensen's career," says Hignett, "and we were working out of a corner of its factory in Tonbridge with our goal always being Le Mans. At the time the junior sportscar formula in the FIA Sportscar Championship was the SR2 class for cars with production-based engines limited to a maximum of six cylinders and a maximum capacity of 3000 cc, so in 2002 we bought a Nissan-powered Pilbeam MP84 and finished second in the series and third in 2003."

The following year was the start of a relationship that continues to this day with ▶

> *"Our plan is to be the very best LMP2 team so that if an OEM wants to come in, we are on the receiving end of a call"*

Zytek, Hignett and Stack buying the 04S, Zytek's very first car, to compete in LMP1. With sponsorship from QinetiQ and joined by Italian driver Gianni Collini, the team competed in the new European Le Mans Series and finished sixth overall. Joined by Japanese driver Haruki Kurosawa the following year, it participated again in ELMS, achieving another sixth overall result, but it was this year that both Hignett and Stack achieved their long-held ambition to race at Le Mans. Unfortunately, they didn't finish due to an accident on track, but held fifth place up until the 22nd hour.

"Having raced at Le Mans in 2005, both John and myself had achieved what we set out to do in racing," says Hignett. "John then didn't want to race at that level any more; nor did I, so we looked at what we could do with the business. In 2006 we became more of a facilitating company whereby we provide the engineering and on-track services to any company that wants to go racing."

During that year, Team JOTA ran the Zytek factory team in the newly-named Le Mans Series in which it finished fifth in class and 24th overall at Le Mans. It ended the year competing in the final two rounds of the American Le Mans Series, which included a second place overall for drivers Stefan Johansson and Johnny Mowlem at Petit Le Mans and seventh overall at Laguna Seca.

The following season led to a tie-up with Antonin Charouz. The Czech's original intention was to race in A1GP with the support of DAMS, with which Hignett had a working relationship, but a half-joking suggestion that the Czech team should really seriously consider sportscar racing led to a change of heart. "Before we knew it he had ordered a Lola B07/10 and a Judd engine," recalls Hignett. "Racing as a facilitator under the Charouz Racing Systems banner, 2007 turned out to be a fantastic year for us. It was very well funded with good drivers and we could arguably have been the most competitive private LMP1 team up against the works teams."

Photo©AdrenalMedia.com

ABOVE & BELOW JOTA is in the unique position of running both an ORECA (above) and a Gibson (below) this season

At the end of the year, Charouz joined the Aston Martin ranks but JOTA picked up a deal for 2008 with Team Cytosport, the US Muscle Milk team led by Greg Pickett, that was temporarily leaving ALMS specifically to compete at Le Mans. Despite a driver line-up that included Jan Lammers, a blown engine on lap 146 put paid to its chances.

"It was during this period that Sam Hancock, one of our old drivers, turned up," says Hignett. "He'd been doing some driver coaching with Simon Dolan who wanted to do some racing himself and wanted to get involved in the team financially." It led to the creation of JOTA Sport, which is now part of the JOTA 'Group' that also includes a design and engineering division, an historic and private client division and even a private airline.

CHANGE OF FOCUS

During this period, the team's focus changed away from international endurance racing to compete in the British Porsche Carrera Cup, reflecting Dolan's desire to bring himself up to speed with the aim of racing at Le Mans and elsewhere. The team finished as runner-up while Dolan ended third in the series. The following year the team competed in the European VdeV Series and the UK Speed Series with a Ligier JS49, its only race with the LMP1 Zytek being at Lime Rock where it finished third overall.

In 2010 JOTA Sport signed a multi-year agreement to become an Aston Martin official partner team, initially with a GT4 car, winning its class at Spa and fifth overall and second in class at the Silverstone 24 Hours. Dolan and co-driver Hancock also competed in the VdeV series with a best finish of third at Circuit Paul Ricard.

"The intention was to upgrade to the GT2 car in 2011, the deal being that we would do GT2 and then get involved in its LMP1 programme," says Hignett. "However, when that didn't happen for whatever reason we were left with a 'what do we do now' situation which is when the whole Zytek relationship started again. So in '12, '13 and '14 we ran the LMP2 Zytek Z11SN that became the Gibson 015S in 2015 and while it might seem a backward step going back into that class, the LMP2 car is now so advanced that it's just another level of technology and needs a serious engineering team to get the most out of the car. For example, the amount of data that's produced is so enormous that we've got ▶

Photo©AdrenalMedia.com

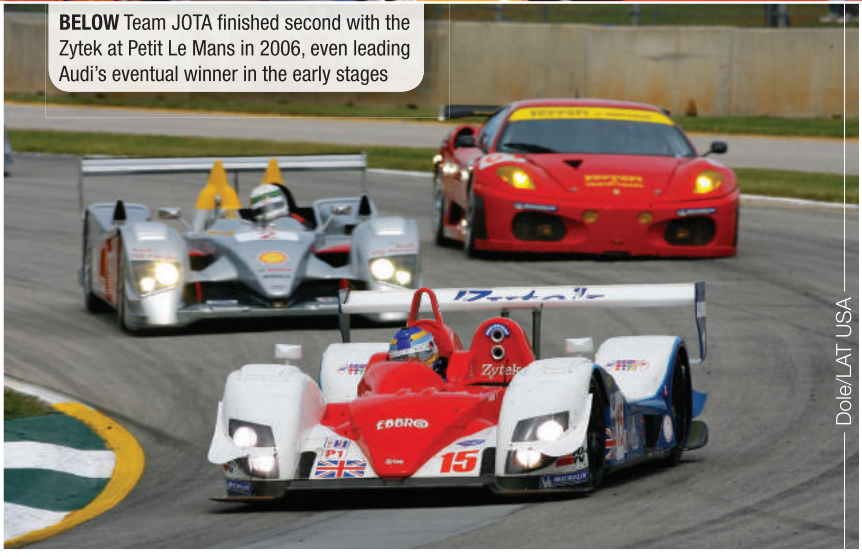
BELOW Glory days: the JOTA-run G-Drive ORECA-Nissan qualified on LMP2 pole at Spa, with Rene Rast having lapped over half a second faster than anyone else in class

to the stage where we've got to have a full-time IT guy on events.

"However, this time last year it was becoming clear where LMP2 was going and for us it's almost a glass ceiling because LMP1 Lite isn't an option as its stands at the moment and there's no logic for us to do that. Our business plan is therefore to be the very best LMP2 team so that if an OEM wants to come in, we are hopefully on the receiving end of a phone call, very much in the Joest/Audi, ORECA/Toyota manner. I do believe that's the correct way to go and so we pitch ourselves as such."

A step in that direction is the deal with G-Drive, leading to the team for the first time racing under a Russian licence in G-Drive colours while as title sponsor Gazprom Neft is maintaining a trackside presence alongside the wider JOTA Sport team at each event. "In the third quarter of last year we started talking with Roman Rusinov and the guys from G-Drive about their plans. It quickly became apparent that they wanted to be in the best car in LMP2 and very quickly the G-Drive GazProm deal evolved," explains Hignett.

"Their stipulation was that we had to have two cars at Le Mans while we could also offer ▶



BELOW Team JOTA finished second with the Zytek at Petit Le Mans in 2006, even leading Audi's eventual winner in the early stages

Dole/LAT USA

The Arden link

IN September last year JOTA Sport and Arden International Motorsport, a leading player in various single-seater categories including GP2, GP3, Formula Renault 3.5 and MSA Formula, formed a partnership. The aim was "to help develop the careers of young, talented drivers moving forward in the sport", both in sportscars and in single-seaters.

"As sportscar racing continues to grow, the void between single-seater and sportscar teams is shrinking," says Sam Hignett. "We view this as a natural progression for both JOTA and Arden." RT

them more European coverage as we were committed to ELMS, so the whole thing came together very nicely. Under the regulations, though, we can't enter as JOTA Sport G-Drive but only as one entity, so it's G-Drive in both ELMS and WEC with a Russian licence, but it's JOTA Sport running the operation."

The unique thing about this, though, is that the team will be running both an ORECA and a Gibson, which is pretty well unheard of in modern racing. This has come about due to the change in LMP2 in 2017 leading to some fundamental decisions by Hignett and fellow directors having to be made as Gibson decided against putting in a bid to be one of the four constructors. It was a blow and as Hignett points out, he attributes a third of their success to date to the team, another third to the drivers and the final third to its relationship with the manufacturers – Zytek, Nissan and Dunlop.

SING FROM THE ROOFTOPS

"I told my partners in the business that if we merrily carry on with the Gibson this year, which is a very logical thing to do, who are we at the end of this year? Just another team with a million euros to buy a couple of cars to go LMP2 racing. I was very nervous that the likes of KCMG, TDS and Signatech-Alpine had already committed to LMP2 and I didn't want to be left out. We can sing from the rooftops how good we think we are, but fundamentally we need to prove our value to everyone. So we committed to buying the ORECAs – with LMP2 you always buy two cars to run one – with the original intention of competing in the World Endurance Championship, then looked at running the cars in ELMS.

"As part of the business model I always wanted to evolve into a two-car team because if we threw our eggs into one basket and if – and I don't think this will happen – Dallara pulled something out of the bag this year, then we have a million euros tied up with the wrong car; whereas with our situation now, we will buy a new car for ELMS but we are building a relationship with ORECA. I firmly believe it will produce the best car but at least we've kept one pot of gold dry if Dallara did come up with something special. I'm confident I can sell two ORECAs to the US market but if I had four of them, it would be much more of a struggle, which is why we have decided to run one ORECA and one Gibson this year.

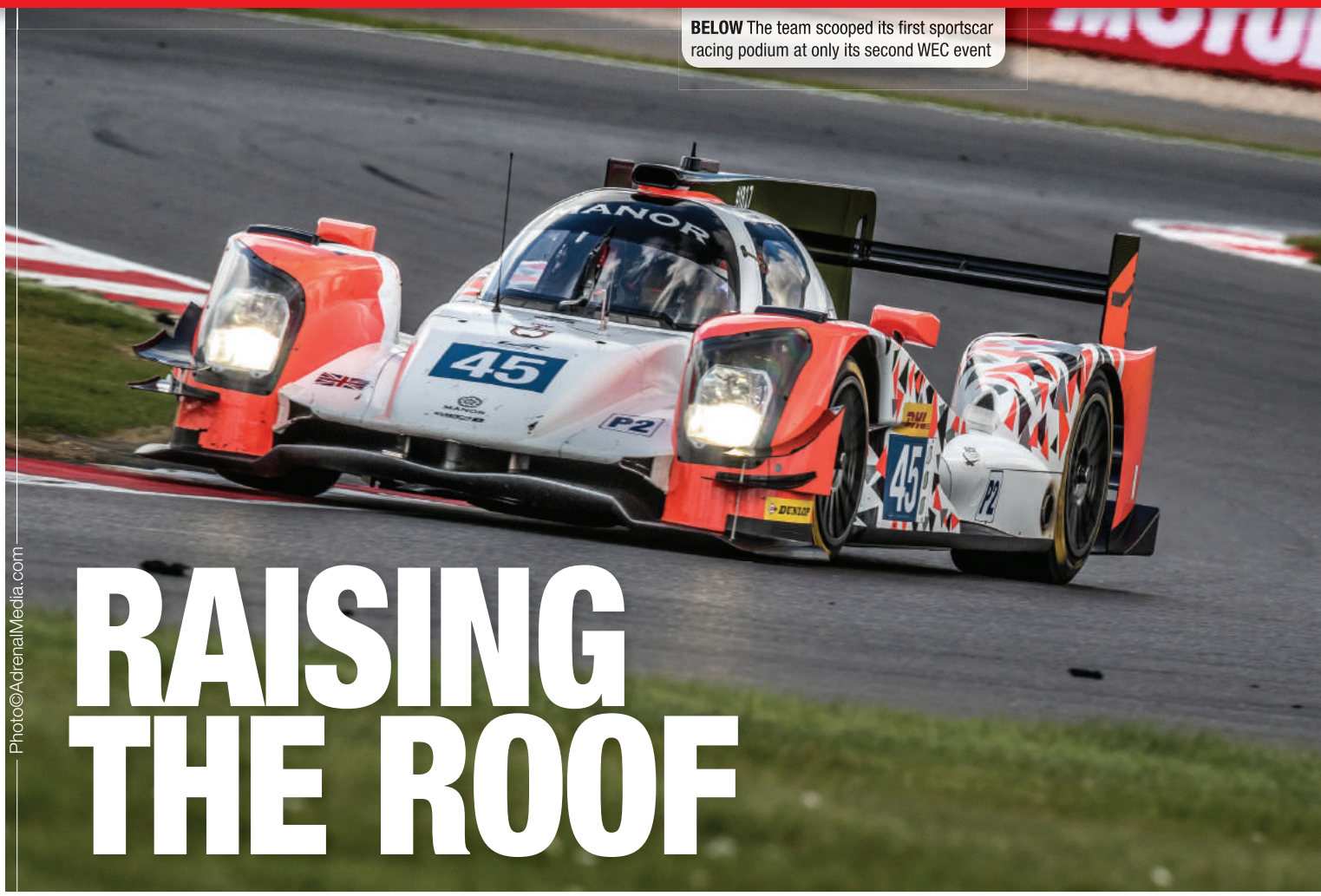
ABOVE & BELOW Such is the level of technology in LMP2 that serious engineering is required to get the most out of the cars. A glance into the cockpits reveals why JOTA has a full-time IT expert on hand

"What we are finding in the differences between the two chassis is that they behave entirely differently on the same tyre compounds. It underscores why we need to have two different teams that have to be run independently of each other. What we are doing at Le Mans, though, is bringing an additional performance engineer in to tie the two together, to act as a type of mediator so one team doesn't feel at a disadvantage to the other. However, I genuinely don't know which of the two cars will be quicker round Le Mans."

While it is easy to overhype the importance of this year to the team, there is no question that there is a lot riding on it. After all, it has expanded to a two-car team competing in two different championships with two different cars, with an important new partner backing it.

"2016 is an incredibly important year for us as we not only take on ELMS once again but have also set our sights on WEC," says Hignett. "Our operation has essentially doubled in size while we have invested in a vast amount of new equipment and dramatically increased our capacity as a commercial sports operation, so it's all systems go as we up the level."

All that are now needed are the results.



BELOW The team scooped its first sportscar racing podium at only its second WEC event

Photo©AdrenalMedia.com

RAISING THE ROOF

For the first time since its inception 26 years ago, Manor Motorsport is getting to grips with a racecar that has a roof. **Seb Scott** reports

WHAT on earth would possess you to leave Formula 1? Then, having defected to WEC, why would you ignore LMP1 and instead set up shop in LMP2? Some would suggest a temporary lapse of sanity; others might brand it a lucky escape.

Manor Motorsport sporting director Graeme Lowdon actually holds a deep-rooted and undying passion for sports cars, but one still poses the question, why would you up sticks and simply walk away from what some describe as the pinnacle of motorsport? The answer, or at least certainly a catalyst, he explains, is Allan McNish.

"I was sat next to Allan on a flight to somewhere and we talked quite a bit about sports cars," Lowdon reveals. "He said, 'If you ever want to come along, give me a call.' I thought, 'You know, I'll have a look at Bahrain', so Allan kindly arranged an invite with Audi."

Whilst there, he met with WEC CEO Gérard Neveu, Pierre Fillon, president of l'Automobile Club de l'Ouest, and Sir Lindsay Owen-Jones, president of the FIA Endurance Commission. "I flew out of Bahrain with a really strong idea that WEC was a championship that would be both a challenge and rewarding," recalls Lowdon. "The discussion with them was really interesting. First of all they were very welcoming, but secondly their view was, 'It's not our championship, it's owned by the competitors; go and talk to them and see what they have to say.'"

Le Mans itself has a special place in Lowdon's heart as the race represents a significant moment in Manor's history. Back in 2009, when the team was given the go-ahead for its 2010 Formula 1 entry, he actually took the phone call while at the Circuit de La Sarthe.

> *"Just sit all the accountants down at the start of the season and they can tell you who's going to win"*

"Sports cars have always been something that I've been fascinated by since I went to my first Le Mans in 1990. I can remember it so vividly; I've still got some photographs. It was a Jaguar one-two; the Martin Brundle car won. Every sort of feeling and emotion that's good about motor racing was heightened watching that race. I just thought it was something very, very special and so I kept going back as a spectator, year after year after year, right up until 2009," reflects Lowdon, with a subtle, warm smile.

Returning from Bahrain, he and Manor team principal John Booth still had the remainder of the 2015 Formula 1 season to see out, and a lot of thinking to do. "We made the decision to leave Manor Marussia, which is never an easy decision to make. Certainly Formula 1 in particular, it's a formula that takes so long to understand the details and the nuances," explains Lowdon.

The deal-breaker, however, was obvious: "We didn't want to be in a formula where you could just be out-spent. It gets pretty ▶


Ebrey/LAT

BELOW Graeme Lowdon: big sportscar racing fan

tiresome, pretty quick. It's not what it's meant to be about. If you're in a formula where there is a direct correlation between performance and finance, then just sit all the accountants down at the start of the season and they can all compare balance sheets. Then they can pretty much tell you who's going to win."

The burning question from here is, why WEC? Furthermore, why LMP2? "Whatever championship you go into, you've got to have healthy respect for it, which we absolutely do with WEC," he says. "There's an awful lot for us to learn, there's no two ways about it, but there's nothing that scares us from getting stuck in. I think it provides a lot of ticks in boxes; it's a proper world championship. That's a level that we're used to working at."

With WEC and Le Mans set firmly in Manor's sights now, there was still one vital component missing, one essential for any team to actually be able to go racing. A car. A competitive one.

PLAYING IT SAFE

With time being of the essence, the team needed to act quickly, with informed decisions to get a car together in time for testing. One obvious choice, though, was the engine. With all of the WEC LMP2 teams running the Nissan VK45DE 4.5-litre V8, and just three out of 14 teams in the ELMS bucking the trend, it was a complete no-brainer to strap the Nissan engine to the back of their tub. The question was, what chassis?

"We set ourselves some pretty ambitious timescales to come into it," says Lowdon. "A lot of the decision making on something like the chassis is down to gut feel. I think all of the products in LMP2 are good. We just felt that the level of support that we would get from ORECA would be high."

Manor now joins a list of a select few teams that are experienced in using both a customer chassis and overseeing the design and manufacture of their own. This undoubtedly gave the team an edge during chassis selection in comparison to other LMP2 newcomers.

"Really these products are first-class, no matter who you're getting them from," says Lowdon, "there were just lots of small things. I have to say at a personal level we've really formed a good relationship with all the guys there. Hugues de Chaunac, he's a proper racer and so I think we got on straight away with him: he wants to see us do well as a team and we want to do well with his cars."

Lowdon's story behind the acquisition of a gearbox is similar to that of sourcing a chassis, except this time it was a matter of rekindling old relationships: "We're running an Xtrac gearbox. We worked really closely with Xtrac, Pete Digby and the guys before in our first year in Formula 1. So we know them well and that scenario, I think, is more important than anything else. The transmission on this car looked very strong from what we could see in terms of its design and performance."

Sticking to what you know is a theme also behind the choice of tyre supplier made by Manor. Selecting Dunlop comes as no surprise when you analyse the rest of the ▶

BELOW The team's #44 ORECA 05-Nissan held the class lead for a considerable part of the race at Spa

Staley/LAT

BELOW Manor's familiarity with the circuit in Mexico through F1 could give it an edge over WEC rivals

WEC LMP2 field, according to Booth. "We definitely haven't taken any data from the F1 team, however the biggest crossover for us is tyres. Not the specific tyre, but the circuit characteristics for the tyre. I mean Silverstone uses a high amount of lateral energy and quite high wear and that experience crosses over definitely," he says.

Coming from a formula dominated by high tyre degradation, the new set of rubber Booth is working with now is very much to his liking. "The Dunlop is a bloody good tyre," he observes. "We did a lot of mileage on each set at Paul Ricard. I was very impressed with the durability of the tyre, how quick it warms up: the drivers don't have any warm-up issues. The new tyre gives something extra, but then the tail off is not dramatic at all. We took a lot of advice from people we know with experience in WEC and that was the direction that became fairly obvious."

The one area on an LMP2 car where the team can make a real difference, in terms of vehicle performance, is suspension. In the LMP2 technical regulations suspension is specified primarily as 'Free', with restrictions only placed on onboard adjustment and active ride height, both of which are forbidden.

"There's quite a range of things you can do: standard roll bars, springs, torsion bars, dampers," summarises Booth. "We did about 1500 km at Paul Ricard; the bulk of it was mainly reliability running. Certainly at the end of the first day we started looking at some combinations for the suspension setup."

One difference Booth faces in sportscar racing as opposed to single-seaters is the fact that one car is shared between three drivers. "Here you find the right setup for the car and the driver has to adjust to it. I think what you want is to have a car that's easy to drive. It's probably more important to have a car that's easy to drive than the ultimate quick car," he explains.

The impression both Lowdon and Booth give off, is that of respect for WEC and LMP2, and with that, that they have really done their homework on what's working for other teams. One could argue that going with what's in vogue means that Manor can only match its rivals, however you'd be wrong. In a field that's as deep and close as LMP2, it is imperative to have the chance to be able to be just as competitive as the rest of the grid straight off the bat. You could say that this is the essence of LMP2.

One place that Manor could have an ace up its sleeve is Mexico. This will be the second visit to the circuit for both Booth and Lowdon and they already have a good idea of what to expect. "Mexico is a new circuit for almost everybody," says Booth, "there's a bit of extra testing being planned for there, I think. With the level of professionalism in the pit lane, it won't give us too much of an advantage. What we will know is the best place to go for steak of course!"

Steak houses aside, Booth has first-hand experience of how the altitude will affect engine and aerodynamic performance. "It was quite hard because of the low density of air; it was very hard on brakes, because of the lack of downforce and the straight line speed," he adds, drawing from his Formula 1 experience there. "We won't have quite the same brake problem because, having lost so much power with having the normally aspirated engine, we'll lose speed at the end of the straight."

ACID TEST

The 2016 Six Hours of Silverstone, the team's maiden WEC race, was a tale of mixed fortunes for Manor. Car 44 retired early due to a powertrain issue, however car 45 was able to finish the race, crossing the line sixth in class.

"I'm very happy with the result for car 45," reflects Booth. "Everybody did a great job and the times we were setting towards the end of the race were comparable with those set by the guys on the podium. We are racing against experienced teams and we have shown that we can compete against them. We learned a lot from the weekend and we'll put that to good use in the coming races."

The debut was a successful one, especially when you consider that three months prior to the race the team didn't even have a car.

In the second round, at Spa, the team displayed yet more promise. It grabbed its first WEC podium and, more encouraging still, led the race. "Although we could view it as unlucky not to win LMP2, I prefer to think of it as a massive achievement for a team that barely existed three months ago to be standing on the podium of a World Championship event," says Booth.

"We still have a lot to learn though and we will keep working hard to improve in all areas. Our next stop is Le Mans and that will throw an entirely new set of challenges at us, but we will approach the race in the way we always do and look to perform well in what is going to be a very strong LMP2 field."

A sixth position in its first race; a podium the following event: what does the Le Mans 24 Hours hold in store for the gutsy British LMP2 team? RT

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ABOVE & BELOW Ricardo is best known in motorsport for its transmissions and drivelines

FIGHT NIGHT

For 24 hours the cameras will capture the battle between manufacturers and teams. Behind the scenes, though, the competition is every bit as fierce when it comes to their suppliers, as **William Kimberley** reports

GEARING UP FOR THE FUTURE

AUDI vs Porsche vs Toyota or Aston Martin vs Chevrolet vs Ferrari vs Ford vs Porsche are what make the headlines. But behind all these names are a myriad of suppliers who are working just as hard to win, not just for their customers but for themselves, even if it often does not come into the public domain. One such supplier that operates under the radar is Ricardo.

This British company, which celebrated its centenary last year, is very well known to virtually every single car manufacturer in existence as at some time or another it has been involved in developing technologies, systems and even the occasional entire vehicle for them. From its work on enhancing the engine of a World War I tank, when the company was founded, to the cutting edge hybrid and EV technology of today, Ricardo engineers have played their part. This also applies to motorsport, specifically transmissions and driveline solutions, but it also extends to racing bike and car engines.

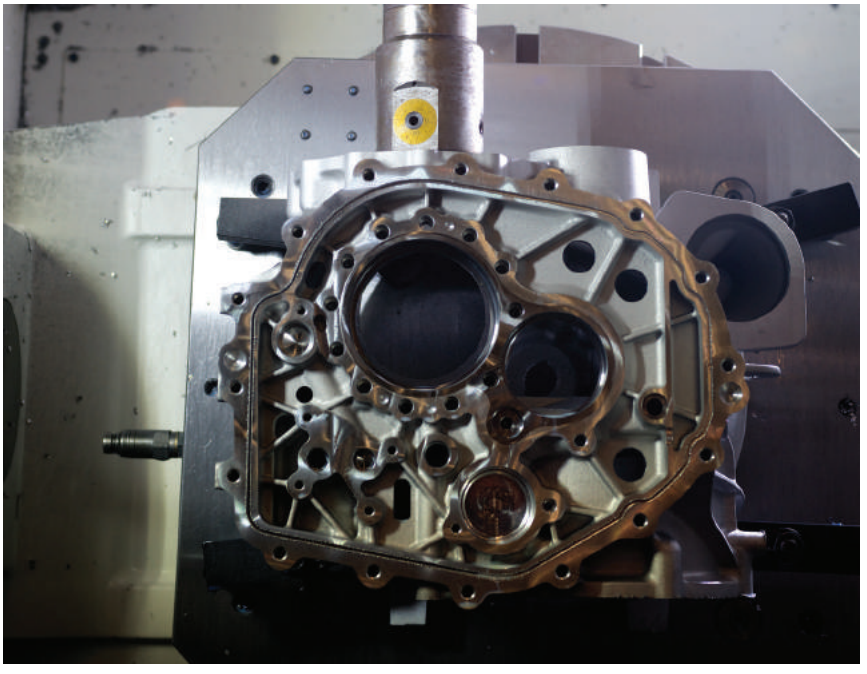
Ricardo's products can be found in a wide variety of race cars, particularly in endurance racing where it supplies teams in every category. Although it does not name the LMP1 team as such, it is not difficult to work out by a quick process of elimination that it is in fact Porsche, with which it also works in the GT class. It has also had a close partnership with the LMP2 team Greaves Motorsport for the last eight years, responsible for the design, ongoing development and support throughout the season for the complete driveline and the transmission, the visco-mechanical differential, clutch shaft and drive shafts of the team's championship-winning Gibson 015S.

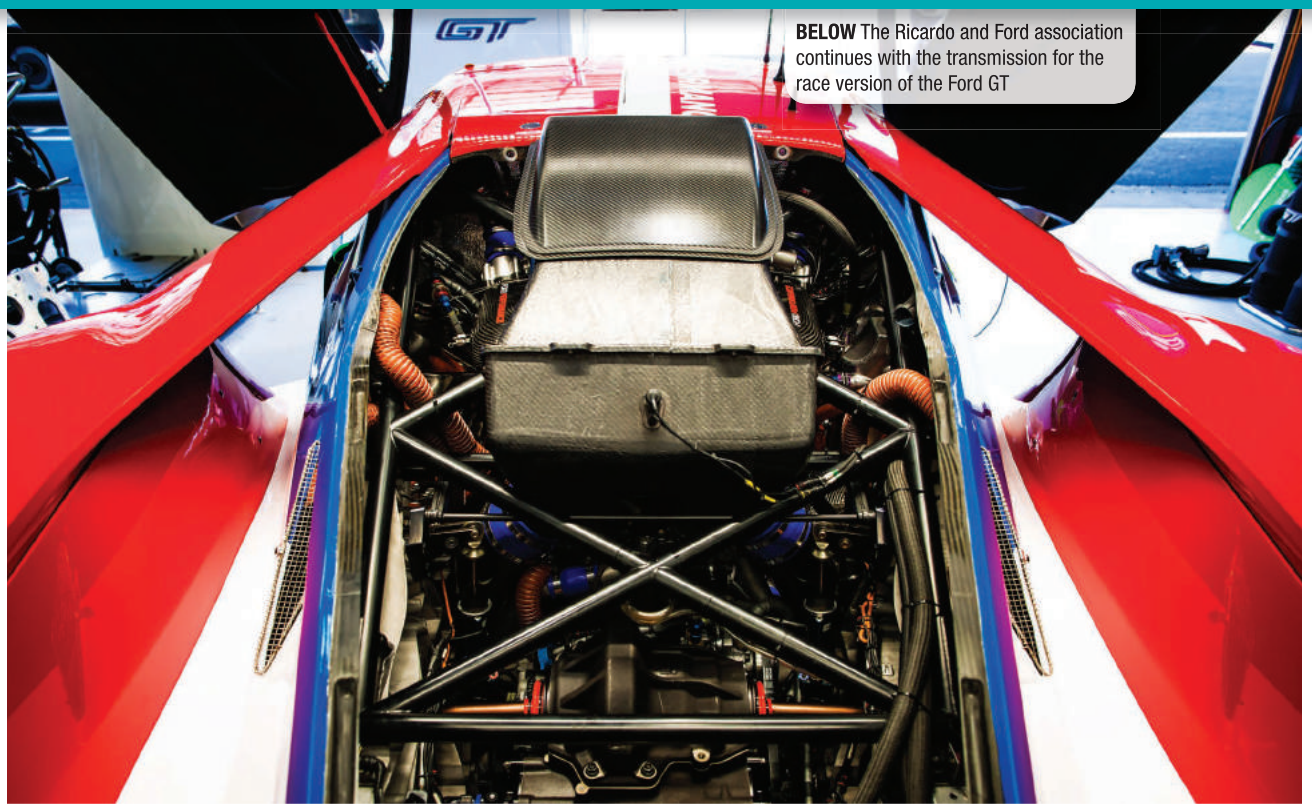
Another open secret is that it is also the supplier of the transmission for the racing version of the new Ford GT, the road car being equipped with the Getrag unit. Larry Holt, Multimatic's charismatic vice president and the person responsible for executing the programme, says the reason to go with Ricardo was because of the company's expertise in producing racing gearboxes. There was also some history as Ricardo and Ford had worked on the earlier Ford GT project 10 years earlier.

"One of Ricardo's greatest strengths is the collaborative approach that we take with our clients," says James Sundler, head of sales of performance products at Ricardo. "Typically what would happen is that there is a very outline specification of the transmission requirements for the vehicle and things like packaging space, input torque and engine speed are loosely defined. From that we will develop the most efficient and most lightweight transmission possible within the confines of the specification gearbox.

"At this stage our engineers are in almost constant contact with the client. This ensures that the layout of the transmission, the packaging and the incorporation of the ancillaries all suit that particular application for that specific vehicle to provide the biggest competitive advantage possible. It's not a case of one size fits all.

"This is a process that normally takes a ▶





BELOW The Ricardo and Ford association continues with the transmission for the race version of the Ford GT

number of weeks until we get to the point where the design is agreed and signed off and prototype production and tooling up start. We may or may not test it on a rig, after which production starts."

According to Sundler, it typically takes 30 weeks to go from a blank sheet of paper to a prototype transmission being installed in a car. Of those, 12-15 are on manufacturing and tooling and around 10 to 12 weeks on design and development.

Outside motorsport, with its interests in different sectors such as automotive, marine, defence, aerospace and rail, Ricardo is also involved in various research projects but which can have an impact on its motorsport activities. For example, there is the ULTRAN, the Ultra-Lightweight Transmission and driveline research project that aims to accelerate cost-effective lightweight drivetrain technologies in order to reduce the powertrain weight of future vehicles.

The unit is a clean sheet design, based around a lightweight differential mounted within a compact, single-piece skeletal casing with tough, lightweight plastic covers. In addition to being 25 per cent lighter than current production units, it is considerably more compact and hence frees up valuable package space.

"It's all about blue sky thinking and reducing weight wherever possible, material usage, manufacturing the gears and casing, everything," says Martin Starkey, Ricardo's business development director for performance products. "Not everything will be applicable to a motorsport transmission due to the regulations, but we are still learning valuable lessons."

While this has been developed for the automotive industry, some of the knowledge gleaned in the process could benefit motorsport applications. "While some of that's not appropriate for motorsport, elements of the research have already proved to be useful," says Starkey. "The lessons learnt on further weight saving ideas, the use of new materials and things like that have already proved to be really useful when it comes to motorsport."

Other valuable input comes from the hybrid and electric systems division at Ricardo. As the motor and transmission become more of a single entity through the continued hybridisation of cars, Ricardo is well placed to capitalise on this.

"We have numerous road car programmes where we gain knowledge that can be used in support of our motorsport customers," says Starkey. "There's been a lot of activity in the automotive industry for a long time now and it's this knowledge we can bring to motorsport when it comes to integrating e-drive systems into what would classically be called the transmission as there's an amount of cross-fertilisation."

One of the biggest challenges and where the work done to date has proved valuable is in heat management. "Heat dissipation can be a problem," says Sundler, "especially as the packaging gets tighter and there's less airflow going through the vehicle. If you start to put e-systems where transmissions used to go rather than where you would like them go, you very much change the cooling requirements for the vehicle, and that can be a challenge.

"Where it does help, although it's not always possible, is to get as involved as early as possible right at the start of the vehicle design programme. This way, certain things can be flagged up and at least addressed. Of course, the design of any car, whether it's a racing car or a road car, is always a tug-of-war between the powertrain engineers and the aerodynamicists and/or stylists. However, even if we do get called in and given our 'space' later in the programme, we just get on and work with what we've been given."

Starkey is keen to point out that while Ricardo works with the works teams, it also works with less well-funded privateers. The requirements may not be quite the same, but the service offered by Ricardo is just as focused. "While we would never share a customer's IP, our attraction to the smaller teams is that due to programmes we have done in the past with much larger organisations, it has given us access to technology that can be leveraged by the smaller teams, something they might never have done from a small independent company," he says.

While the competition will be fierce at Le Mans this year in every category, Ricardo will be crossing fingers that it will be one of its many cars that takes the chequered flag first, even if half the world will not know about it. ▶

FUELLING THOUGHTS

It may just be a fuel tank to some eyes but the philosophy is the same as with every other component on a racing car: make it as light as possible, while also taking into account packaging considerations and maximising the space available.

"What we do is take a slightly different philosophy to an endurance tank," says James Gornall, sales manager at Aero Tech Laboratories. "They may look similar on the outside but inside they can be quite different. For example, we may need to compromise on weight and include redundancy with a secondary pump that can come into play should there be a problem with the primary pump, so the car won't stop on the track.

"Additionally, we are now innovating with fuel collection and lift pumps. Where a standard fuel cell might have four lift pumps running into a collector, we are able to replace some of the lift pumps with our ATL Jet Pumps. At Le Mans, for example – and this type of system has already won its class twice on Ferrari's 458 GTEs – it is possible to run Jet Pumps for the majority of a stint with the strategy being to only turn on the lift pumps when the fuel level has depleted towards the end of the stint.

"This method minimises current draw and reliability is improved as there aren't any moving parts on our Jet Pump. They're also lighter, so it's win-win-win. We are now installing more and more of them into endurance cars, and the technology is being transferred into the other industries we operate in too."

Gornall explains that they went through quite a development stage because the trick with the Jet Pump is its efficiency. "Anyone can make a venturi, and there are plenty of low pressure venturis kicking around on road cars and some people put them in their race tanks, but getting it to work as efficiently as possible at different pressures is key to the way in which we use them. We have two variants, three to six bar and one for use at eight bar.

"We also ensure mid-race component changes are as fast and easy as possible. To do this we use push-fit connectors, for example, which are commonly used in the automotive world, as they're lightweight and quick and easy to use. If a pump change is needed, it can be taken out without the need to undo or replace hose clips, with just a couple of bolts in the bottom of the tank to hold the components down. Add to this the carefully designed pump packs we create and it makes it a very fast change if necessary.

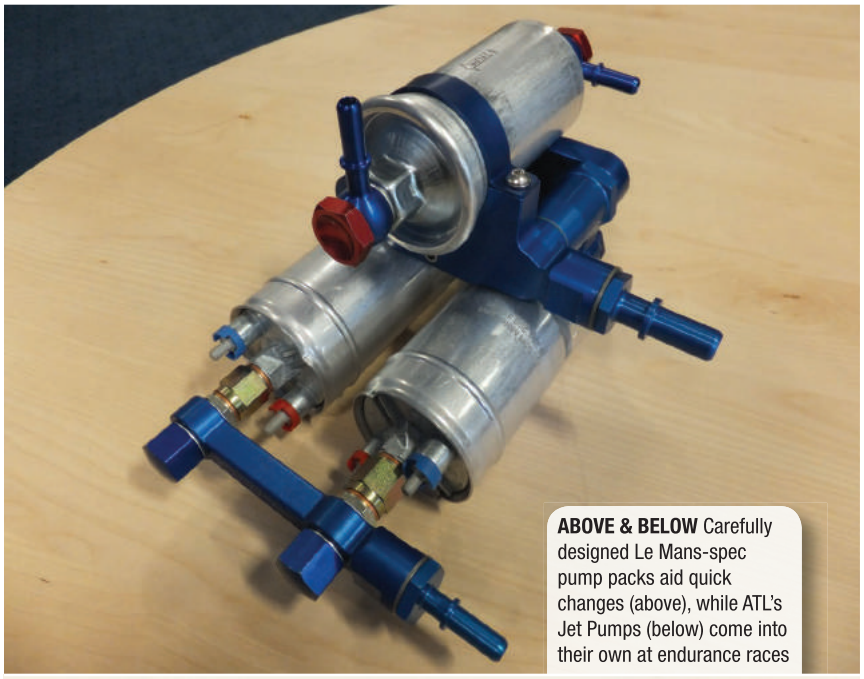
"Beyond that we look closely at refuelling. We need to consider everything inside the fuel cell and ensure that it is all optimised for a fast flow. Our customers will see some of the clever, yet simple methods we can use to ensure refuelling is as fast as possible. This includes some well-developed additional components, or optimisation of items which can be seen in most racing fuel cells.

"It is even possible to replace a fuel cell relatively quickly should it be required. Fuel cells are housed in different ways depending on the formula, and for example an LMP fuel cell might have to fit into the chassis through a small 6 x 10-inch aperture. This means that the internals are removed from the cell before fitting or extraction, which needs to be considered in the design. Car manufacturers are obviously looking to keep the access hole as small as possible to keep the structure as rigid as possible, and this is where our extremely robust lightweight materials come into play. We have a huge number of proprietary materials to choose from.

"An endurance race car needs a fuel cell that will meet the challenge of being used for long periods without issues. Making sure that a fuel cell fits correctly is important to its wellbeing and reliability. We work hard with our customers to get the best possible fit, readily making suggestions on what design elements are robust, or risky.

"ATL fuel cells have successfully completed thousands of 24-hour race distances, so we have absolute confidence in the methods we use to ensure the longevity that is required. We do see fuel cells for service, and some of these have completed multiple 24-hour events."

As Gornall remarks, though, if there are sharp edges inside the cockpit or cavity, then there's the potential for damage. "We will always explain to our customers that they should dress the cavity/container, making sure it's ▶



ABOVE & BELOW Carefully designed Le Mans-spec pump packs aid quick changes (above), while ATL's Jet Pumps (below) come into their own at endurance races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ABOVE LED enables lower power consumption for a higher light intensity

smooth and use tank tape if necessary to cover anything that could be a bit suspect. Maybe also putting talcum powder on the tank before putting it into the car. We hope that manufacturers pass these details on to their customer! Preparation is key, and any issues are accentuated by the long-distance races.

"Improving fit increases not just reliability, but also performance. Our work has been demonstrated by two great case studies. ATL created a custom tank for one private team at Le Mans that was able to control and scavenge enough fuel to do one extra lap when compared to the fuel cell originally supplied with the car. Additionally, we did the same with a GT3 car for the Nürburgring 24 Hours. The ability to run an extra lap on one tank of fuel is a huge advantage, so not surprisingly we are now chosen by the manufacturers of these cars to be part of the original supply."

GETTING LIT UP

Every driver will tell you that at Le Mans, or in any endurance race that goes into the night, good visibility is crucial. There are a number of specialist companies that cater to this market, Dutch company Verpoorten Motorsport Development being one of them, developing, designing and producing what it claims are the best motorsport LED lights.

The advantage of LED over conventional lighting is that the power consumption is much lower for a higher light intensity. The optics and lenses that Verpoorten uses are specially made to create the ideal light pattern while all housings are machined from billet aluminium to ensure perfect heat transfer and a low product weight. There are no additional electronics or ballasts required to control its products. As well as offering custom designs tailored to pretty well every application, it currently boasts a good range of off-the-shelf parts covering every lighting need.

Its miniature high-beam is an ideal additional light for distance illumination, but it can also be used as a driving beam on its own, offering the low weight of 290g, low power <15 W and high light intensity of 42+ kCd, all in a miniature package. This product has proved itself and is frequently used at the "Nordschleife" in Germany.

For even more long distance lighting power, Verpoorten claims that its double high-beam as used in GT and sportscars worldwide is the ideal driving light. It offers a light intensity of 70+ kCd for a power consumption of less than 35W and a weight that is below 600g.

For illuminating the apex and for foggy conditions, Verpoorten has also specially developed a wide/fog light that still offers the high brightness of 22+ kCd, but with a wider beam pattern. The highly consistent beam pattern is perfect for near field illumination. Its low weight of less than 470g coupled with a low power consumption of under 40W make this another winning product.

BRINGING COLOUR TO THE ENGINE BAY

Look in the engine bay of a good many cars at Le Mans, and there will be one thing that stands out and that is the colourful hoses that adorn many of the engines. This means just one thing: they are using Samco hoses.

Based in South Wales, it is a well known name as the supplier of motorsport hoses, but there is a pretty big misconception when it comes to its colourful coolant hoses. This is because they are more than just there to look pretty as there is so much more that goes into the construction of each handmade one.

Made using 100% motorsport grade silicone, each and every hose is manufactured by hand, Samco being one of the biggest spenders on this type of silicone in Europe. There are no ▶

ABOVE The telltale Samco hoses under the bonnet, every one made by hand

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fillers to pack out the silicone, ensuring that there are no weak spots. The silicone is pressed through a calender machine, which is like two huge rolling pins that are close together, with woven fabric that helps bind the silicone. This machine produces a flat piece of material that has its width measured every 30 cm to ensure that it is correct for the hose that will be made using it.

It is then cut to sizes that depend on the size of the hose that will ultimately be made from it. The same process is used for making the inner part of the hose. Looking at a Samco hose up close it is possible to see that the inner is the company's blue colour, which is a little thinner than the outer part of the hose.

The material then reaches the production line proper. Each hose is made from a strip of material, starting with the inner blue section, by wrapping the material lengthways – not round and round – along a 'tool', which is basically a mould in the shape of a length of hose.

The cut-to-length material is worked in quite tightly against the metal mould but only wrapped once with a tiny overlap, which is ultimately the seam. However, this is never seen as this area is worked in by hand to ensure a smooth finish.

The outer section is then applied over the top in a similar fashion. The Samco logos are applied by hand and then the hose is stamped with an internal reference number. It is then wrapped in a cellophane-type tape from one end to the other, the finish thus leaving many people to believe that the hose is manufactured by wrapping the material around the mould, which is certainly not the case.

The tape is used to keep the silicone from splitting or drooping and is removed from the 'tool' using an airline and some washing up liquid. The hose is then cured in one of the ovens for a specified time depending on its size.

Between all the above stages, the person making the hose will visually check for any inaccuracies as he builds it before moving on. Any imperfections found later on will mean that the hose is discarded and never leaves the factory.

After it is cured the cellophane tape is removed and this tape also ensures a nice shiny finish. A final inspection is made and in the case of the 'Race Fit' hose kits available for motorsport, a camera is inserted into the hose to check the joins of the Y-piece internally. It then makes its way towards the packing area to be married up with other internal part numbers for each kit or automotive application.

Samco boasts 700+ of these for practically every race car, including LMP1 and LMP2s, GTs, Formula 1 and MotoGP. They are also found on some supercars as original equipment, one of the biggest selling points being that they come with a lifetime guarantee, which is extremely unusual in any form of motorsport.

ABOVE & BELOW Quentor's Fast Track Banner Panel System, above. Below, an entire race series neatly packed away and ready for shipping

THE RACE AGAINST TIME

In motor racing, only one thing is valued above all else, holding so much value that it actually relegates bank balance to second position: time.

Lap time saved on the racetrack is clearly the priority. To this end, the more time that can be spent working in the pit garage, rather than on erecting it in the first place, is also vital. This is where Quentor products really come into their own.

The company's 'Fast Track Banner Panel System' can help save a team vital hours in the build of a pit garage, especially when you consider the plethora of corridors and rooms a pit garage encompasses. Constructed from aluminium honeycomb, the panels are lightweight, yet strong, and an intuitive system means they can be mounted without the use of any tools.

The main ethos behind Quentor is to cut down four fundamental factors a team faces when calculating logistics: time, space, weight and money.

Space and weight are saved under the same vision, with the idea that everything must serve a purpose. For instance, Quentor is able to use what would normally be empty flight cases, as desks, reducing the need to bring desks along. Clever design and engineering are much in evidence. Take a pitwall, for example. Quentor supplies WEC and Formula 1 teams with bespoke pit lane boxes, with preinstalled racks for computers and screens, while the entire stand can fold away into its own flight case.

Money, of course, is the factor at the back of everyone's mind reading this: how much is a system like this? The reality is that a Quentor pit garage, for instance, would be an investment. Yes, of course there is the upfront cost, but a team would soon reap the benefits of reduced logistical budgets thanks to less shipping weight and volume.

Then there is the aspect of time. Due to there being more space in a pit garage, how much time could be saved when work is carried out on a car? How much could be saved on wages with a system that is quicker to setup and breakdown? RT

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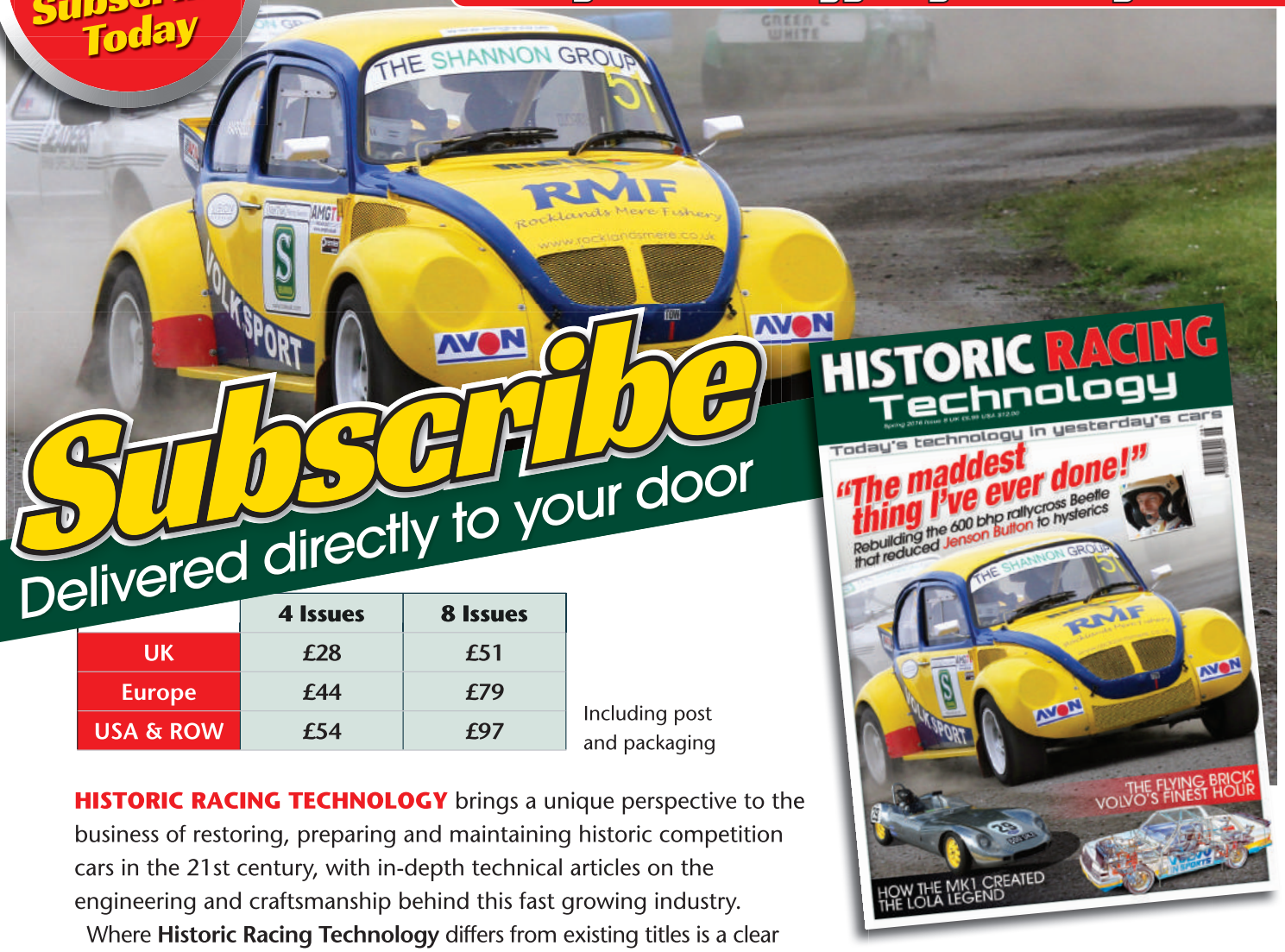

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HIDDEN ASSETS

William Kimberley talks to international lawyer Simon Vumbaca about the merits of having access to good legal advice at all times

ABOVE Vumbaca has a high-profile client list

TEAM principal, chief engineer, head of aero, engine director, pit crew chief, team manager and the drivers are just the tip of an iceberg when it comes to those involved in a professional motorsport team at whatever end of the spectrum it is.

While we typically think of the engineers and mechanics and the marketing and media folk, there is a whole raft of people who manage things behind the scenes without which a team would not function. This includes the finance and accounts people and human resources. However, there is yet another component that is vital in the day-to-day running of a team, although often flying way under the radar, and that is the lawyer – and the motorsport lawyer is a special breed of it.

Having access to a legal representative is not the first thing that springs to mind when thinking about a motorsport business whether it's a team, a circuit, a regulatory body, a driver or a sponsor, but actually, to participate professionally in any shape or form in motor racing unquestionably needs the services of one. However, it's not really a question of visiting your local solicitor. The motorsport industry is so diverse, so varied and so international that it would be beyond the wits of most high street advocates to deal with it. This is where the likes of Simon Vumbaca and ASV Law enter the scene.

Italian by birth, with professional experience in France, Spain and the UK, his practice is located in the heart of London. Vumbaca is a lawyer who decided at an early age that he wanted to specialise in sports. A member of the British Basketball League Executive Committee, BBL Foundation, and Legal Counsel Partner of the World Trade Centre London, he is also a licensed agent and acts on behalf of football agents worldwide. ASV Law is also a member of the International Licensing Industry Merchandisers' Association and helps people put brands together to extract brand equity through contracts. It is also equally present in the music and entertainment industries.

After heading-up several international legal teams at other practices, he decided to set up his own firm, ASV Law, a few years ago. In spite of its relatively short life, it can boast a client list that includes the likes of the FIA and FIM, Formula 1 circuits and teams, plus MotoGP drivers along with athletes, football agents, high-profile individuals, and governments.

Vumbaca specialises in helping individuals and bodies maximise their commercial value while also protecting their interests. When it comes to motorsport, all aspects are covered, such as event sponsorship, the maximisation of media and marketing rights, the drafting and negotiation of rules and regulations for series and competitions.

"The breadth of our client base and industry connections built up over the years means we are able to see a case from many angles so when it comes to contract and other negotiations, our perspective is invaluable," he says. "We are also known to handle delicate and urgent situations where significant individual and business financial and reputational damage are threatened as can often happen in motorsport."

Vumbaca makes it clear that he is not one of those lawyers who are desk-bound, but is prepared to travel with his client if the situation demands it. "We are in an industry where teams will spend their night working without sleeping if required, so how can I be a pompous lawyer always sitting behind my desk during office hours only?" he asks. "What is required is an international knowledge and being prepared to jump on a plane whenever necessary. Sharing the client experience has really added to my own knowledge, which in turn helps them succeed in achieving their goals."

All this implies that Vumbaca and ASV Law specialise in high-end clients, whether it be nation states or multi-million-pound race teams and regulatory bodies, but he makes it clear that his services are available to everyone. "You don't have to be the biggest team, but if you are committed to become one, then it becomes a collaboration where I am almost a partner and happy to assist. At the end of the day my job is to make it easier for my clients, protect them whilst making sure all avenues to make them successful are explored and that we extract revenues from all possible angles."

With decades of experience in the motorsport industry, ASV Law and Vumbaca can advise clients on the best way forward, furthered by an understanding of the law across the world. As an international lawyer with experience, which is very hard to find but absolutely crucial for a client with international operations, it is no wonder that ASV law and Vumbaca are in high demand.

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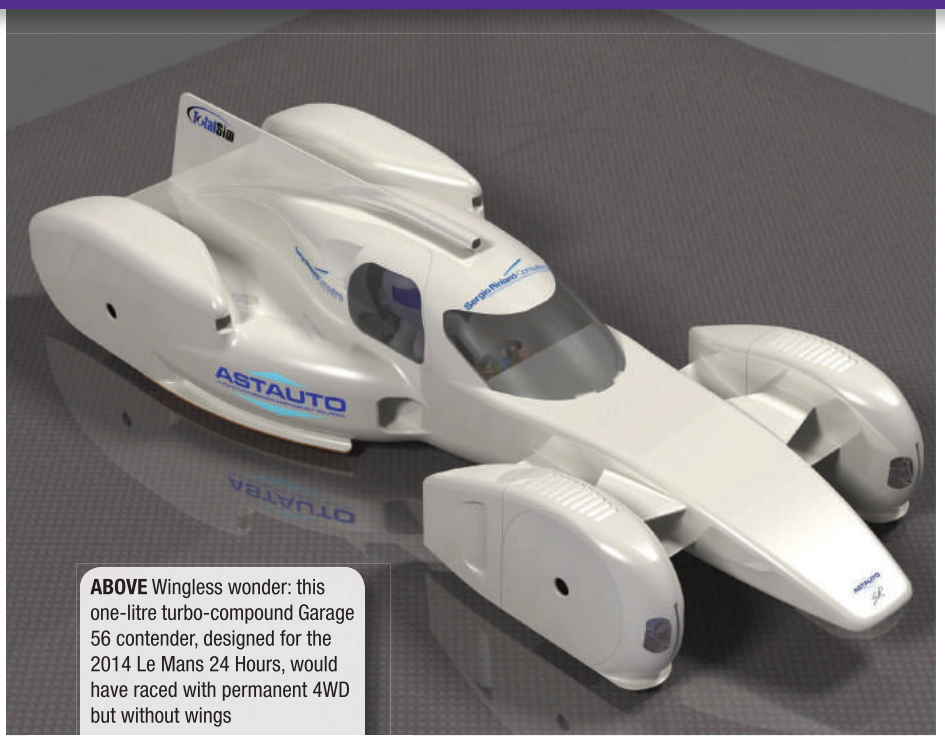


ABOVE Wingless wonder: this one-litre turbo-compound Garage 56 contender, designed for the 2014 Le Mans 24 Hours, would have raced with permanent 4WD but without wings

56 REASONS TO DREAM!

Sergio Rinland argues that the ACO's 'Garage 56' concept is a welcome throwback to days that inspired the current generation of designers

THE Automobile Club de l'Ouest's 'Garage 56' initiative is fantastic. Especially in this day and age, when all racing series are controlled formulas and the two top disciplines, F1 and LMP1 – particularly F1 – are the type to implement the ruling that 'what is not prohibited, is mandatory'.

We have seen two presentations so far, the DeltaWing in 2012 and a hybrid development of that in 2014 with the same philosophy, both sponsored by Nissan, a great contributor to motorsport. In 2013 the G56 entry was going to be the Green GT Hydrogen Fuel Cell car, but development problems postponed its appearance until further notice. In 2016, we will see an LMP2 car equipped to be driven by quadruple amputee driver Frédéric Sausset. For 2017, the entry will be a car running on liquid bio methane.

The only conditions (not restrictions) for a G56 entry are that the performance level should be sufficient not to bother the qualified competitors, preferably between LMP2 and LMP1 level, and to comply with the LMP1 safety and cockpit regulations. Apart from that, all is free! A dream come true which only if you are old enough to remember Can-Am, could you comprehend.

In 2012 my company designed a car and applied to participate in 2014. This would have been a Series Hybrid with four electric motors (one per wheel, inboard) and permanent 4WD. It would have featured a one-litre turbo-compound engine running a generator and a combination of batteries and supercapacitors to harvest the maximum energy from both axles.

> *"A great inspiration for would-be engineers"*

As well as the drivetrain being different to what is currently allowed by LMP1, the aerodynamics were going to be wing-less. They would have relied only on ground effect and adaptive bodywork for downforce, with efficiency superior to current LMP1 machinery.

The power coming out of the four electric motors was 250 kW (335 HP) and the one-litre turbo-compound engine (putting the power back to the crankshaft) was to develop 170 kW (228 HP). Unfortunately, at that time, the ACO was favouring G56 entries backed by a promise to compete in mainstream LMP1 in the following years. We could not guarantee that, while Nissan could. That is no longer the case.

In 2013, we were hired by a well-known R&D company developing Series Hybrid vehicles to design a car using the same technology but following the LMP1 rules, with the clear intention to participate in 2015 as a Garage 56 and in 2016 as an LMP1 contender. It was a great project only hampered by lack of proper finance.

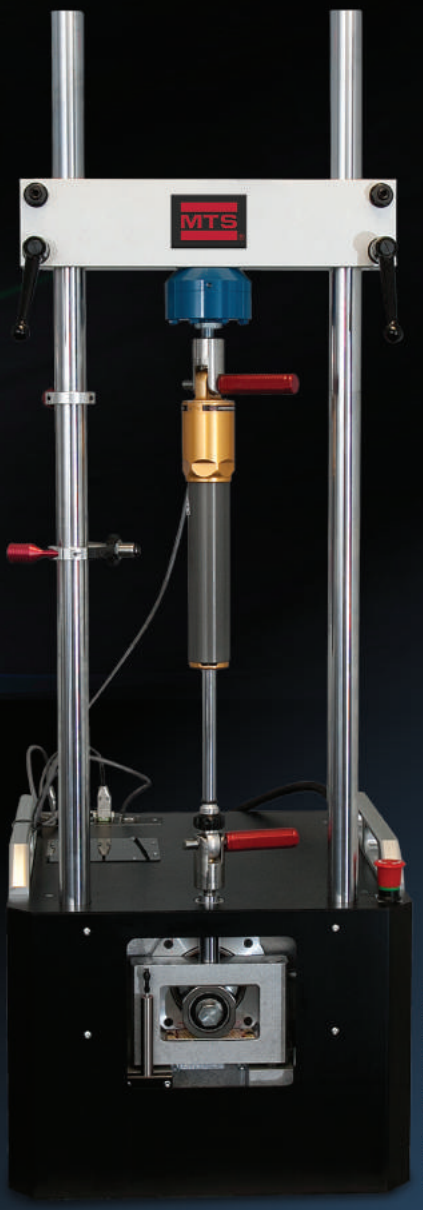
Why do I insist on this idea? As someone coming from a time where more freedom was given to the design and build of cars, I long for those days. This opportunity given by the ACO makes me their number one fan.

Current motorsport rules, with the possible exception of LMP1, are so restrictive in the name of economy (unsuccessfully, I have to say) that they have put a stop to innovation seeking the "unfair advantage". It has therefore killed a philosophy that was common currency in the '60s and '70s in Can-Am, F1 and Le Mans prototypes.

I do not agree with the idea that motorsport is just a sport or an entertainment: it is also about technology and a great inspiration for would-be engineers. We need more engineers to boost our economy; everybody knows this. This is the reasoning behind the STEM (Science, Technology, Engineering and Mathematics) programme for education. What is better than using motorsport to inspire young talents to become engineers? And what is more fitting than the Garage 56 scheme promoting independent technology-driven companies and individuals to test and prove their concepts for the future of transportation? What could be better than a test ground of 24 gruelling hours running flat-out in the middle of France?

And would it not be a great idea for other top racing series to follow in the ACO's footsteps, like Indianapolis or (God forbid!) Formula 1? Keep dreaming, Sergio, it is free! RT

The Original



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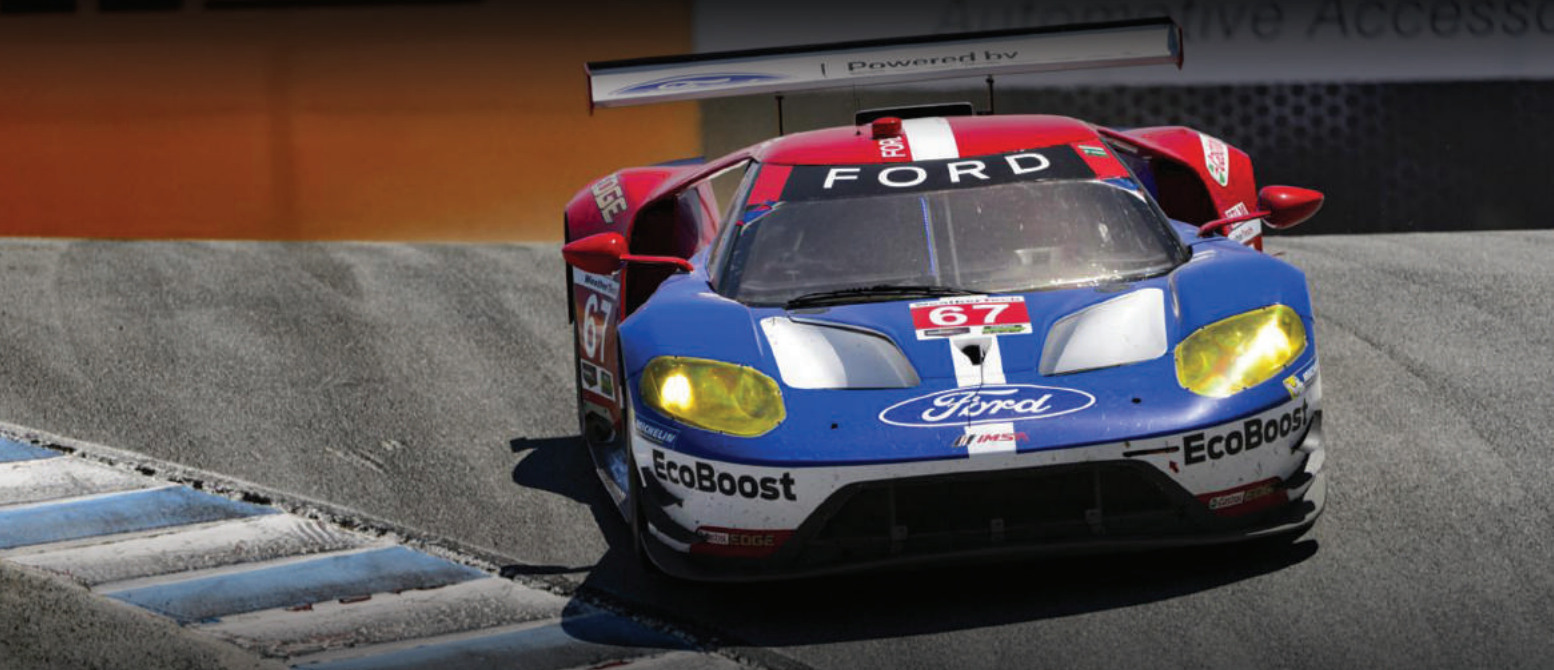

Ryan Briscoe Richard Westbrook
Mike Hull Mike O'Gara Mel Harder Brad Goldberg
Ryan VanKlompenburg John Hennek Ken Brooks Brett Knostman Phil Binks
Jessica Mace Chris Snyder Tyler Montgomery Kevin Edgley Reid Esquivel
Shelby Tracey Robbie Fast Bob Terrando Spence Hall Tyler Rees Damon Elff
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