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Formula E's tech battlefields analysed

Plus

- Tech gamekeeper turns poacher
- Finding a 'lucky' oil
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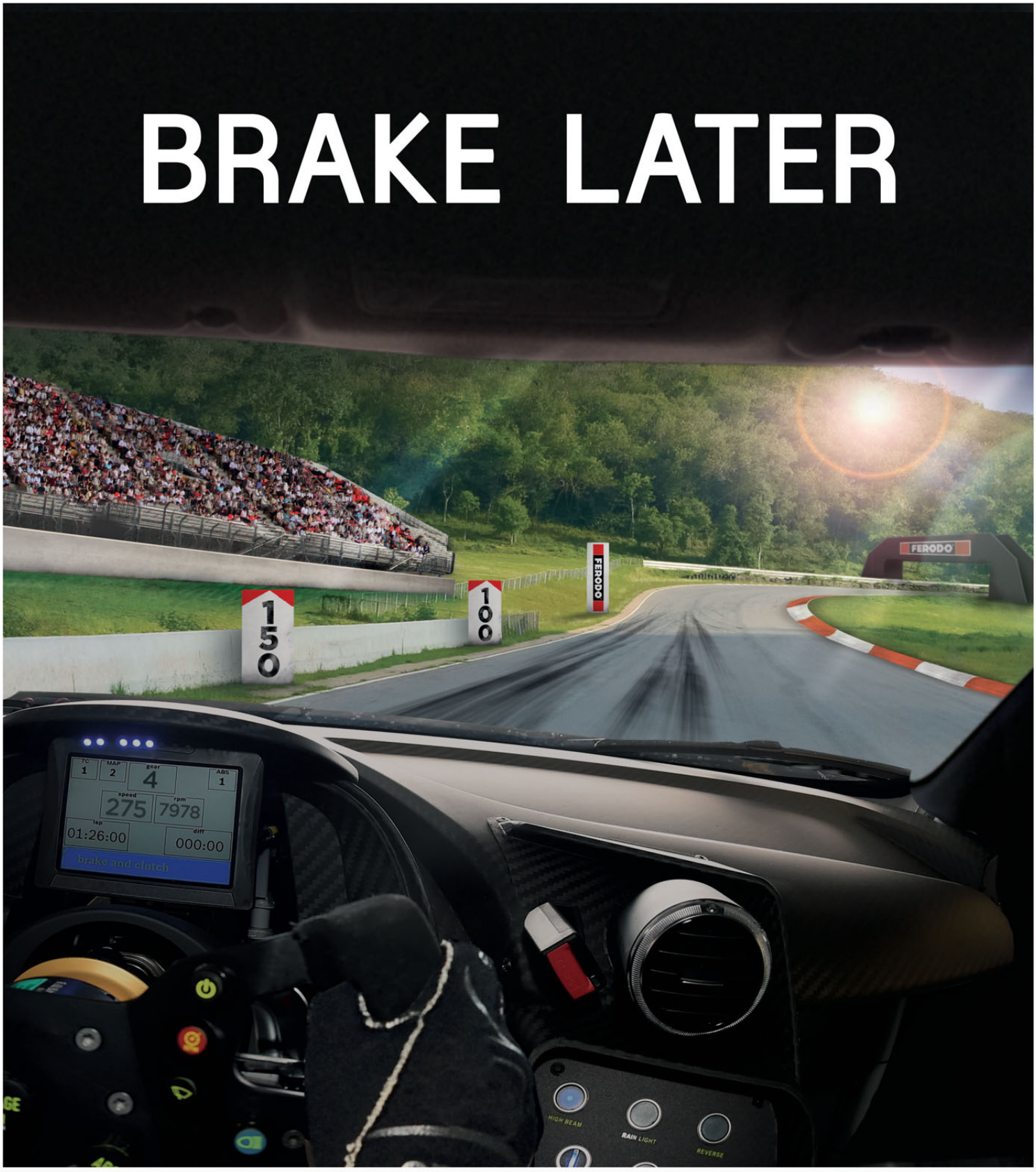

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COVER STORY PAGE 24

Emotion, not emission

The key technical battlefields that Season 4 of the all-electric Formula E series will be fought over

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CONTRIBUTING EDITORS
Andrew Charman

PHOTOGRAPHY
LAT

ART EDITOR
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Mike Norman
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MANAGING DIRECTOR
Adrian Goodsell

PUBLISHING DIRECTOR
Soheila Kimberley

RACE TECH
Motorsport Engineering

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

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Championing the internal combustion engine

IT is that time of the year when our own *Race Tech* World Motorsport Symposium looms large on our horizon, which this year is being held in London. We are very excited by it but at the same time slightly terrified due to the good number of VIPs who have kindly agreed to attend.

I think the basic theme of Back to Basics – Can Mature Technologies Make a Comeback? seems to have attracted quite a bit of interest. By mature technologies, I am, of course, referring to the internal combustion engine, although it isn't the only thing. It's the one, though, that has caught the eye, especially as there is so much anti-engine sentiment being expressed by politicians that it's really obscuring just what the future is when it comes to road transport. The problem with them is that they make these announcements about banning this and that but by the time it comes to be implemented, they have more often than not moved on, leaving others to deal with the practical problems.

In the last issue, Sergio Rinland highlighted this when reminding us that in 1998 in the UK, the British government more or less forced the buyers of new cars to opt for diesel, penalising petrol ones through tax and giving incentives for diesel buyers. Now 20 years on, diesel is the demon. The politicians who 'steered' the buying public in the diesel direction have long since left centre stage. Politicians are driven by the here and now and give little real thought to the future, despite what they claim.

If anything, motorsport can prove its credentials by accelerating the development of hybrid and pure electric technology, but at the same time highlighting the fact that the internal combustion engine still has a long future. I am not just looking at Formula 1, endurance racing or NASCAR Cup here, but motor racing from the grassroots right up to the international series.

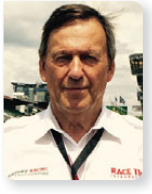
As I have written before, being located in Europe, specifically the UK, it is too easy to be swayed by local political calls when in the bigger wider world, particularly the US, the gasoline engine in particular is not under any threat. For sure, the carmakers are developing hybrid and fully electric vehicles, but only as part of a portfolio.

It is all too easy to be swayed by the likes of Tesla, the glamorous electric car manufacturer that says it is going to set the world alight, but strip away the hyperbole, and you will find it is not even reaching Lotus Cars level of production. This is not to demean the British sportscar maker, because it knows what it is and that is a bespoke manufacturer. Not so Tesla, which has far more grandiose plans.

Consider the facts, though. In the three months to September, instead of the 1,500 cars it was going to produce, it made just 220, and they were mainly hand made. It's therefore a mighty stretch to believe that 500,000 will be sold by the end of next year. Too many people, though, still believe it.

What I am trying to say is that hybrids and electric vehicles have a future, and an increasingly important one, but let's not be swayed as an industry to assume this is the only future. The internal combustion engine will continue to play the most important part in both motor racing and in general mobility and we must do our utmost to champion it as the most efficient form of propulsion. RT

William Kimberley
EDITOR



NEWS

Todt endorses electric technology future

Hal Ridge

PARIS, France: FIA president Jean Todt has confirmed that the sport's governing body is working on a plan to introduce electric vehicle technology into rallycross. It follows FIA World Rallycross Championship promotor IMG revealing earlier this year that it is working with the FIA and a number of manufacturers on the implementation of electric technology into the sport from as soon as 2020.

"The FIA has been thinking about introducing an e-rallycross category, so it's an ongoing programme and I'm optimistic that in a few years we will also have some e-rallycross categories," said Todt. "I mean, electric cars in rallycross is very well adapted because its races are a limited amount of time and we know that one of the biggest problems about electric cars is the range, and you don't face this problem in rallycross, so it's something which would be very good to optimise."

The electric FIA Formula E series is about to begin season four. Todt says that lessons learnt from development in the single-seater championship can help when working on the new electric rallycross concept. "It's a different category of motorsport but, of course, the knowledge will help, I will say more on the expense, reliability and development of the battery. So far, we need to use two cars to make a race in Formula E. Next year, we will do the same distance with only one car, so clearly it will be beneficial to road cars, but also to any other category of motorsport."

Asked about the potential lack-of-noise turn-off for fans of rallycross, with current Supercars renowned for their noisy anti-lag systems, Todt said: "It [the lack of noise] is something which you have to consider, but the fans are evolving. There's quite a strong link with what happens on the road and with what happens in racing. If you take a normal car 30 years ago, it was very noisy. Now I think you would not consider a noisy car on the road. So in racing it's about the same. You have different ways of enjoying racing and you get different fascination as well. With an electric car, you can entertain with your friends, you hear a kind of mechanical noise, which is very interesting, but you get used to that as well. So you must give time to understand and to interpret the way racing happens." RT

ABOVE Todt: Electric racing is part of the future and fans will adapt to it

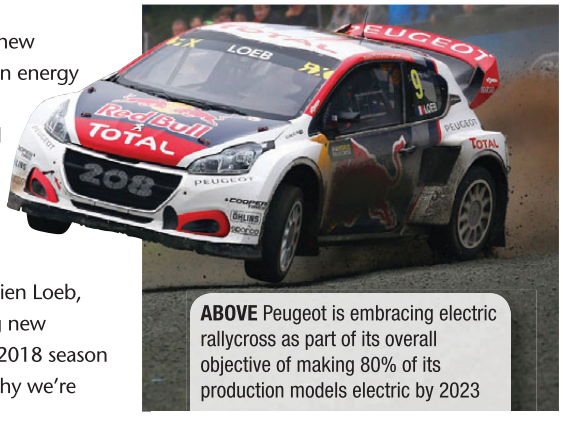
Peugeot RX future includes EVs

Hal Ridge

PARIS, France: Peugeot has announced that it will increase its efforts in the World Rallycross Championship with 'brand ambassador' Sebastien Loeb. Following uncertainty over the French marque's continuation with its World RX programme, it has sited in a statement that the future implementation of electric technology in rallycross 'is perfectly in line with Peugeot's strategy.'

"The brand wants to take on a new challenge to help promote its own energy transition and create stronger connections with new clients and the younger generation," said Peugeot brand chief executive, Jean-Philippe Imparato. "The 'E-WRX' is a perfect fit for the strategy. Our ambassador, Sebastien Loeb, will play a key role in this exciting new adventure. Our objective for the 2018 season is to take home the title. That's why we're strengthening Peugeot Sport's commitments and studying the sports management overseen by the Hansen family since 2014."

Peugeot has been involved in the World Rallycross Championship since its inception in 2014. Together with 14-time European Rallycross Champion Kenneth Hansen's team, running as Team Peugeot-Hansen, it won the Teams' Championship title in 2015. No announcement has been made as to whether that relationship will continue into 2018.

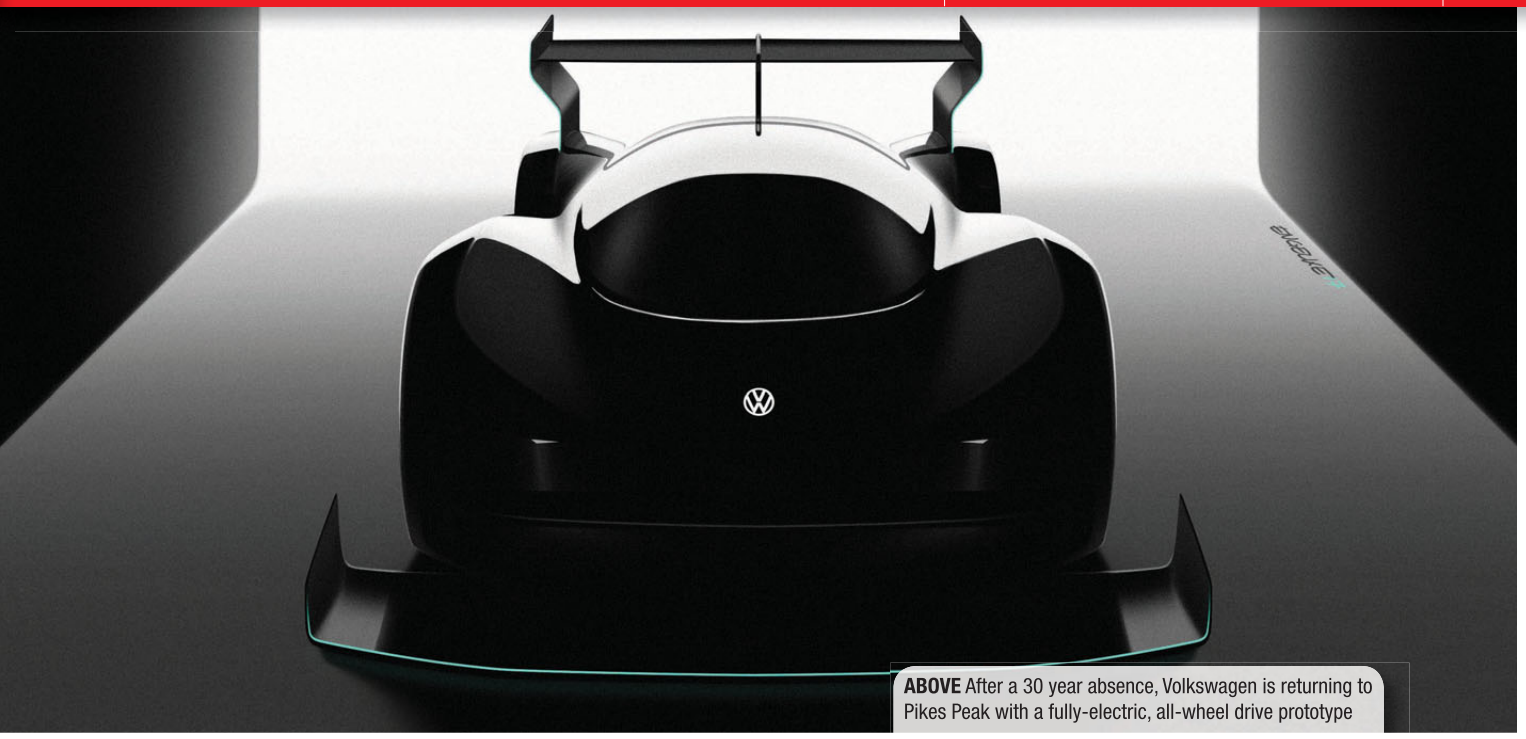


ABOVE Peugeot is embracing electric rallycross as part of its overall objective of making 80% of its production models electric by 2023

The statement said; 'Peugeot has been involved in the WRX since its launch in 2014 and is committed to supporting the E-WRX through its technological plan, which aims to make 80% of its models electric by 2023.'

Meanwhile, Ken Block's Ford Performance-backed Hoonigan Racing Division team will withdraw from the series after the final round of the 2017 campaign in South Africa. "Although we have thoroughly enjoyed competing in the exciting FIA World Rallycross Championship, it's a natural time for us to take a break as the future of the series takes shape," said Dave Pericak, global director of Ford Performance. "To continue in WRX would have required the development of a new race car, and with so much discussion happening around the future of rallycross from a powertrain package standpoint, it made sense for us to pause until it's better defined. Rest assured, we remain absolutely committed to hot hatches and all things performance and think rallycross has a bright future."

Team owner Block confirmed in August that after a disappointing second year in the series, the squad was focusing on the development of the Focus RS RX ahead of the 2018 season, but those plans have now been shelved. RT



ABOVE After a 30 year absence, Volkswagen is returning to Pikes Peak with a fully-electric, all-wheel drive prototype

Volkswagen bids for all-electric glory at Pikes Peak

Hal Ridge

WOLFSBURG, Germany: Volkswagen is developing a fully-electric, all-wheel drive prototype to compete in the Pikes Peak International Hill Climb in Colorado next June. The marque's first trip to the event for over 30 years is with the aim of claiming the record for an electric vehicle. The project falls in line with the German manufacturer's plans to offer 23 fully-electric models of road cars by 2025.

"The Pikes Peak hill climb is one of the world's most renowned car races. It poses an enormous challenge and is therefore excellently suited to proving the capabilities of upcoming technologies," said Dr Frank Welsch, Member of the Board responsible for Development. "Our electric race car will be equipped with innovative battery and drive technology. The extreme stress test on Pikes Peak will give us important findings that will benefit future development, and it will showcase our products and their technologies."

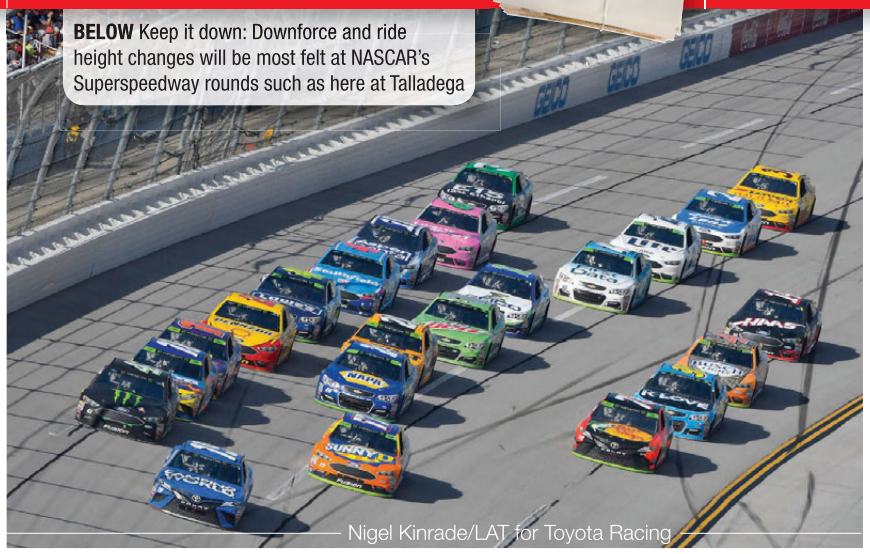
While Peugeot and Sebastien Loeb hold the record for the fastest ever time up the hill, setting a time of 8m 13.878s in a bespoke Peugeot 208 T16 Pikes Peak, the current record time for an electric prototype is held by Rhys Millen, who set a time of 8m 57.118s in 2016.

The new car will be developed by Volkswagen Motorsport, in 'close cooperation' with Volkswagen's Technical Development in Wolfsburg. "The race on Pikes Peak is a new beginning for us. We are developing an all-electric race vehicle for the first time," said Volkswagen Motorsport director, Sven Smeets. "The project is also an important milestone in our new motorsport orientation. Our team is literally electrified about taking on this incredible challenge."

Following the end of its dominant World Rally Championship programme at the end of 2016, Volkswagen Motorsport supplied Polo GTi Supercars to Petter Solberg's World Rallycross team and claimed the Teams' title while Johan Kristoffersson won the Drivers' crown in 2017. Volkswagen has already publically stated that it is interested in the concept of electric rallycross in the future. The German firm last competed on the Pikes Peak event in 1987 with a twin-engine Golf driven by Jochi Kleint in a two-year programme. Having finished fourth in 1986, the car retired with mechanical problems in 1987. RT

Zoe's eRally debut

THE eRally Renault Zoe rally car successfully made its debut on the Adgespeed Stages in Wigan in October to become the first fully-electric car to compete on a stage rally in the UK. Driven by Cameron Davies and co-driver Andrew Blackwood, the 65 kW (88 bhp) car that has undergone limited performance modifications to the suspension and safety additions to satisfy MSA regulations, finished 41st. "This is the first time a pure electric car has competed in a UK stage rally, possibly the world," said eRally co-founder Tristan Dodd. The car is now set for more regular appearances on single-venue rallies in the UK. RT



BELOW Keep it down: Downforce and ride height changes will be most felt at NASCAR's Superspeedway rounds such as here at Talladega

Nigel Kinrade/LAT for Toyota Racing

NASCAR announces 'less radical' 2018 rules package

Andrew Charman

DAYTONA BEACH, FL: NASCAR has delivered its 2018 rules package to teams competing in the headline Monster Energy Series, and after several seasons of major changes principally aimed at cutting downforce, the latest updates are far less dramatic.

The major change will see the adoption of a common front splitter and radiator/oil cooler unit across all cars. This will have the effect of reducing front downforce by what NASCAR estimates as 100-120 lb, or 2-2.5 per cent. This reduction will be in addition to around 150 lb of downforce that is expected to be removed due to the new streamlined scrutineering process and agreed tolerances detailed in last month's *Race Tech*. The new process uses cameras to perform a full scan of the car body.

For this reason, NASCAR has decided against further aerodynamic changes – according to NASCAR vice president of Innovation and Racing Development Gene Stefanyshyn there are further aero developments that the governing body would like to try, but not until at least 2019.

"The 2018 package is not going to be as big a departure as some of the things we've done in the past," said Stefanyshyn. "We are getting in to a world of more mechanical grip. The cars are braking more now, earlier, we can see that at some tracks. Handling the movement of the car through spring and shock selection is becoming more important."

NASCAR will also eliminate the specific minimum ride height rule applied to the Superspeedway races at Daytona and Talladega – the rule was rescinded at other tracks in 2014. This change will improve safety, as the speed at which cars are likely to lift off in an accident is predicted to increase by around 30 mph. It will also allow the bespoke Superspeedway rear spring and damper package to be eliminated, assisting teams with costs.

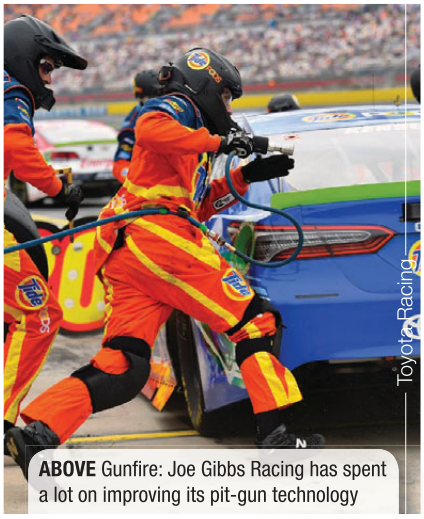
Further safety moves include the connection of incident data recorders to the car's battery, so that they record at all times rather than being triggered by an impact. High-speed video will also now be recorded through a camera mounted to the right of the driver.

Other changes include a reduction in aerodynamic 'fans' located at the corners of the wheels, and changes to the front subframe regulations to reduce aerodynamic development.

Plans to mandate the enhanced vehicle chassis (EVC), which has improved driver footwell protection, have been delayed by a season to 2019. However, any new chassis submitted for homologation after 20 November 2017 must be to EVC specification.

NASCAR announced new 2018 engine rules, which include a requirement to run the same engine over two full race weekends, last month. RT

NASCAR to fire the guns?



ABOVE Gunfire: Joe Gibbs Racing has spent a lot on improving its pit-gun technology

Toyota Racing

DAYTONA BEACH, FL: NASCAR is expected to mandate a standard pit gun to all teams in the Monster Energy Cup Series in 2018. According to reports in the US, the gun will be manufactured by specialist Italian manufacturer Paoli. It will bring to an end significant development in this area by certain Cup teams, notably Joe Gibbs Racing. The team's work in this area is known to have produced an advantage during tyre changes.

Some reports suggest that a standard gun could also be used to record whether lug nuts are sufficiently tightened – loose lug nuts now result in a penalty.

NASCAR issued a statement in response to questions on the pit gun; "NASCAR is working on a number of initiatives to enhance both the performance and safety of our sport. One of the many competition initiatives considered is the future of pit equipment. We will provide an update on some of the initiatives at the end of the 2017 season. In the meantime, our focus remains on the exciting championship battles that are playing out across all three national series."

Rumours earlier in the season suggested that NASCAR was considering replacing the jackman – who raises the car in pit stops using a trolleyjack – with onboard air jacking systems. While not confirmed, the rumours sparked an outcry amongst fans on social media. RT

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ABOVE The new Judd-AIM LMP1 enigne is aimed at privateers who might be competing with the new Perrinn, seen here, or other manufacturers who are building cars for the LMP1 class

Fuel flow issues cloud new Judd-AIM LMP1 engine

William Kimberley

RUGBY, UK: Engine Developments has revived the engine it first offered to LMP1 privateer teams in 2016 but which features some new developments. Continuing the partnership with Japanese company AIM Power, the 5.5-litre V10 is being offered on a lease basis to privateer LMP1 teams.

The new engine incorporates a number of new developments aimed at maximising performance potential under the fuel flow regulations while retaining the excellent reliability record that previous Judd and AIM V10 engines achieved in endurance racing.

"At the current performance level of over 700 horsepower and with a minimum car weight of less than 850 kg, our new normally aspirated 5.5-litre V10 is designed to deliver extremely competitive lap times without the problems of throttle response, complexity and reliability associated with turbocharged engines or the weight and size issues associated with similar capacity normally aspirated V8 and V12 engines," said John Judd, managing director of Engine Developments.

"Developments include a new 72-degree cylinder block developed by AIM, which is significantly lighter than any of our previous designs, a new combustion chamber, cooling system and piston design as well as an updated engine management system with electronic throttle and fuel flow management software.

"There was an expectation that the normally aspirated engines would be given slightly more fuel flow than the turbos but based on the data submitted by the engine manufacturers, both types will have the same allowance. It seems that regardless of the outstanding thermal efficiency figures achieved in F1, the reality is that for small suppliers of 24 hour endurance engines, the practical numbers achieved for either type are almost the same.

"Over the last four years we have put a great deal of effort into this project, firstly with a purpose built 4.4-litre V8 and later with the 5.5-litre V10 when the fuel flow was increased to 110 Kg/hour. This we judged to be too high for the V8 on account of its increased friction and loss of volumetric efficiency of the smaller engine at higher revs.

"We have been assured by the FIA that a robust system of engine parameter monitoring, including torque measurement will be affected to enforce engine operation within the parameters already submitted.

"My personal view is that next year, depending on what Toyota does, it's probably a golden opportunity for a privateer LMP1 car to win, but probably not with a turbo due to sheer complexity which is likely to make it difficult for a privateer car with a turbo engine to have a 24 hour trouble free run. That in itself of course doesn't mean that we will but on past record I reckon our chances are much better." RT

60 miles to celebrate 60 BTCC years

Andrew Charman

SNETTERTON, UK: The British Touring Car Championship will stage a 60-mile race at Snetterton in 2018 as part of celebrations for the series' Diamond Jubilee. The third race of the championship's sixth meeting on 29 July will be run to the extended format, likely to add eight laps to the 12 of a typical BTCC race at the Norfolk circuit. A separate qualifying session will be held for the race, with all cars running at their championship base weights with any success ballast removed, and double championship points will be awarded.

"We are delighted to confirm this special extended race as part of the BTCC's diamond jubilee celebrations," said BTCC series director Alan Gow. "As well, there will be a number of additional activities to celebrate our 60th anniversary throughout 2018 which will be revealed over the next few months." RT

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Fresh blood for wind tunnel

William Kimberley

HUNTINGDON, UK: Lola owner Martin Birrane is looking for fresh blood to move the business on. While Lola Cars International and Lola Composites went into Administration in April 2012, he rescued the rest of the business, which has continued trading. In particular, it is the 50% wind tunnel and 7-post rig side of the business that it still thriving today with customers that have included Penske, Multimatic and Scania Trucks

When Birrane bought Lola 20 years ago, he almost had second thoughts about going ahead with the acquisition, but decided that if he was to proceed then he had to make a statement if he was to show current and future employees that he meant business and really wanted to revive the Lola business. Aided and abetted by Chris Saunders, who remains affiliated to the company as a consultant, he went ahead and built what he considers is still the best commercial wind tunnel anywhere.

"Chris was instrumental in getting it kitted out, and we went for the best possible equipment. No expense was spared. I think it's still the best constructed wind tunnel anywhere, built out of 260 tons of beaten steel."

Wind speeds in excess of 65 m/sec (145 mph) are generated by the tunnel's unique Lola-developed composite fan blades. "We also made carbon fans for others simply because we had made our own one back in the day that others liked, and we saw a nice line of business," says Birrane. "The same went for the model motion system as well."

A six-component overhead balance is at the heart of the wind tunnel's data gathering system, facilitating precise measurement of lift, drag, and lateral forces, along with their associated moments of yaw, roll, and pitch. Heat generated by the main fan is dissipated through a large heat exchanger positioned in the air stream and a 520 kW chiller unit, hence keeping constant temperature in the wind tunnel.

Automated model control enables a wide range of pitch, roll, and yaw attitudes to be evaluated and clients benefit from a secure control room and complete modelmaking shop. A combination of flow conditioning screens and high contraction ratio provides turbulence control second to none for a wind tunnel of this size and type, yielding superior quality, accuracy, and repeatability of results.

The entire rolling road section can be yawed with, or separately from, the model to simulate the aerodynamic effects of slip angles and crosswinds. This data is especially useful for vehicles with less downforce and/or more frontal area, such as Touring Cars.

ABOVE Owner Martin Birrane is looking for a new team to continue the successful Lola technology business that includes a 50% scale wind tunnel and a 7-post rig

Birrane is so confident of how effective the wind tunnel is that before Lola's interest in joining the proposed cost-capped Formula 1 was knocked on the head a few years ago, a great deal of work had been done on the prospective car's aerodynamics.

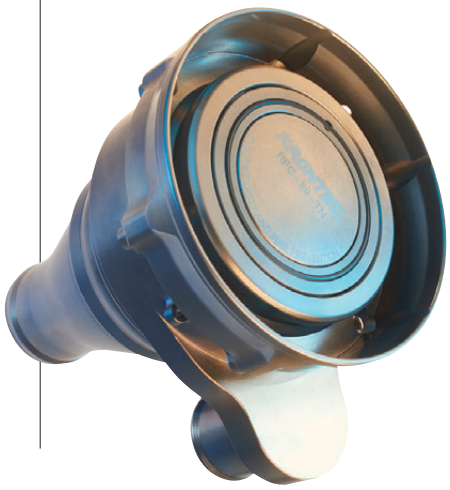
"The day we were turned down with our Formula 1 entry, our 50% scale model had already done 98 runs. I can truthfully say that we wouldn't have stumbled or have been at the back of the grid we were so confident of what we were achieving. Sadly, it was not to be."

The wind tunnel and 7-post rig have remained busy to this day, but Birrane, now 82, has reached the stage where he is looking for someone with the passion and commitment to move the business on.

"We may not be making racing cars anymore, but we still have the facilities and staff for others to do so, so it's a great opportunity for a would-be Formula 1 or aspiring sports car team." RT

New Krontec refuelling system

OBERTRAUBLING, Germany: Krontec, the German company that is well known for its product range that includes fasteners and hose clips, fuel hose fittings and its quick-release steering wheel boss, has developed the second generation of its highly successful RFC 88 refuelling system. Design work started on it in 2015 followed by CFD at the start of 2016. Prototype examples were then fitted to different cars during the course of that year. Applicable for all categories of GT racing including GTE, GT3 and GT Pro, it will also become standard fit on a GT4 car due to be launched by a car manufacturer in the near future.



More compact that its predecessor, it's lighter with a 35% reduction in the car nipple's weight which is down from 1670g to 1080g. Internally there is a new valve mechanism design that controls the valve through the entire closing operation reducing the number of parts and weight. It also offers up to 11% improved flow, although as Krontec managing director Josef Jobst points out, this is not of particular benefit because the Balance of Performance regulations stipulate the refuelling time, so there is nothing to be gained there.

One of the principal features of the new RFC 89 is that the clearance between the parts has been optimised to minimise spillage, which is an important safety feature. Just as importantly for customers with cars running with the RFC 88, the parts between the two are entirely interchangeable.

"It was important for us that we didn't upset existing customers by causing them to change all the different parts," said Jobst. "If they have a new nipple, they can run it with the old coupler or if they have a new coupler they can run it with the old nipple. All the pit equipment needed to empty the fuel drum or for bleeding the fuel hose remains the same."

The new RFC 89 will be on display on the Krontec stand at the PMW Expo in Cologne. RT

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BAR1 Motorsports

ABOVE Having finished the 2017 season with a win in the IMSA Prototype Challenge class, BAR1 Motorsports is turning its attention to LMP2 in 2018

BAR1 Motorsports commits to Multimatic-Riley for 2018

William Kimberley

PLAIN CITY, OH: Two weeks after the team's impressive 1-2 in the Prototype Challenge class at the season ending 10 hour Petit Le Mans at Road Atlanta, Ohio-based BAR1 Motorsports has taken delivery of a Gibson powered Multimatic–Riley Mk 30 LMP2 car to campaign in the full 2018 IMSA WeatherTech Sports Car Championship.

"Obviously this is an important step for us," said team owner Brian Alder. "The move to LMP2 opens up a lot of opportunities for the team. Running in the series' flagship class attracts a higher level of marketing partners, top tier drivers and, for me personally, a chance to return to Le Mans.

"We've chosen to work with Multimatic on its newly updated P2 car. After spending the past few months researching the different options for our move into the Prototype class, we feel this car has the most potential of the P2 cars and is the best fit for our programme in 2018."

Multimatic's continued support from Mazda and its new relationship with Team Joest only enhances the attractiveness of this programme said Alder. "Clearly they learned quite a bit in 2017. I've seen first-hand the changes they have made for 2018 and they are impressive. They have definitely done their homework and the initial testing results from overseas are exceeding everyone's expectations."

The Mk 30, one of the quartet of cars approved by the ACO for the new for 2017 LMP2 regulations, was very uncompetitive in 2017, and under the 'joker' rule will see major revisions to its suspension layout, fit and finish of the bodywork along with improvements in torsional rigidity to make it more competitive.

"The development allowances and the 'joker' rule are very important to us," said Alder. "It demonstrates that the organisers are adamant in their desire to maintain the competitiveness of the class and their ultimate aim to ensure that LMP2 remains a category that contains variety and a high level of competitiveness." RT

PERSONNEL

Carl Faux, who as technical director of Team BMR designed the Subaru Levorg that won the 2017 British Touring Car Championship, has joined Virgin Australia Supercar team Mobil 1 HSV Racing. Faux also designed the BTCC race-winning MG6 and the Team BMR Volkswagen CC that came close to winning the 2015 series. He joins HSV Racing just as it is rebranded as Walkinshaw Andretti United following the buy-in by IndyCar team Andretti Autosport and Zak Brown of McLaren F1.

British race engineer **Allen McDonald** has switched IndyCar teams, moving from Schmidt Peterson Motorsports to Ed Carpenter Racing. Replacing **Justin Taylor**, who has moved to Mazda Team Joest in the IMSA Dpi championship, McDonald will work with team manager **Tim Broyles** – the two were both at Andretti Green Racing in the 2000s.

Virgin Australia Supercars Championship CEO **James Warburton** is to leave the series at the end of the 2017 season. Announcing his departure "with a heavy heart" Warburton did not give a reason, and a replacement for him has not yet been announced.

NASCAR has paid tribute to veteran engine builder **Robert Yates**, who died on 2 October aged 74. As a team-owner Yates won 57 races, 48 poles and the 1999 Monster Energy NASCAR Cup Series title with Dale Jarrett. Yates was also an inductee in the NASCAR Hall of Fame. RT

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Honda and Peugeot TCR updates

JAS Honda

Peugeot Sport

CERVESINA, Italy: JAS Motorsport has begun testing its TCR version of the latest Honda Civic Type-R. The car was shaken down at the Autodromo Tazio Nuvolari in Cervesina, Italy by Roberto Colciago, reigning TCR Italy champion. JAS is building an initial run of 25 cars, based on the latest Civic Type R road model launched earlier in 2017, and will deliver the first batch to customers between January and May 2018. Honda works British Touring Car Championship squad Team Dynamics is also widely predicted to update to the new Type-R in the 2018 series.

Meanwhile Peugeot revealed a TCR version of its 308 Cup car during the championship finale meeting at Paul Ricard on 14-15 October. A version of the 308 Cup machine has been competing in TCR events in 2017, under a special dispensation as it runs a 1.6-litre turbo engine, and this is the centre of efforts to develop the car up to TCR's 2-litre turbo specification for 2018. RT

IN BRIEF

VERIZON has announced that it will no longer be the IndyCar series title sponsor at the end of 2018. It will, however, continue to be a sponsor of one of the Penske IndyCars.

NIISSAN is set to become the first Japanese automotive brand to compete in the FIA Formula E Championship, joining the electric street racing series in Season Five. It sees it as an opportunity to spread its Nissan Intelligent Mobility message.

OVER 5,300 laps were completed by 40 drivers from the Indy Lights Presented by Cooper Tires, the Pro Mazda Championship Presented by Cooper Tires and the Cooper Tires USF2000 Championship Powered by Mazda during the two-day Chris Griffis Memorial Test held at the Indianapolis Motor Speedway in late October. It was the first time that drivers from the three series were on track together. It also saw the highly anticipated debut of the brand-new Tatuus PM-18 – with the first container of 15 chassis sold out and additional cars and conversion kits on the way – that took place to rave reviews. Unofficially, the Pro Mazda track record at the Speedway set in 2016 by Patricio "Pato" O'Ward of 1:22.8800 (105.941 mph) was shattered by almost three seconds by the PM-18.

THE all-new F3 Americas Championship car was revealed at Circuit of The Americas, site of the weekend's finale rounds of the F4 US Championship and the US GP. The new series, which was first announced last month, will feature a Ligier Crawford chassis developed by Onroak that incorporates a version of the halo cockpit protection device, and is a 270 hp Honda Performance Development version of the new Honda Civic Type-R turbocharged K20 motor – a non-turbocharged version of this engine is used in the F4 US Championship.

INDYCAR, European Le Mans and Australian Supercar racing are to come together after long-established Virgin Australia Supercars team Mobil 1 HSV Racing announced a partnership with Andretti Autosport and United Motorsports. The team, which runs two Holden Commodores in the series, will be renamed Walkinshaw Andretti United for the 2018 season.

HYUNDAI Motorsport made an immediate impact in the TCR International Series when the i30 N driven by Gabriele Tarquini won the first race in which it competed at Zhejiang, China. While the team was not eligible for championship points, TCR authorities made an immediate Balance of Performance change to the cars adding 40 kg ballast and reducing engine power to 95 per cent. Tarquini finished sixth, with team-mate Alain Menu fourth. RT

AND FINALLY...

NASCAR has agreed to look at a rule that forced driver Joey Logano to sit in his car in the pit lane for an entire 50-minute long practice session at New Hampshire Motor Speedway on 23 September. Teams are routinely penalised a portion of their practise session for failing scrutineering too many times – the Penske of Logano failed four times so NASCAR decided to penalise him the entire session. The move attracted widespread criticism with Logano himself saying; "I just think it makes our sport look dumb – I think we can accomplish the same thing in a more professional manner." RT

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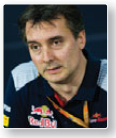

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BACK TO THE DRAWING BOARD

Can Mature Technologies make a Comeback?

Following the announcements by the French and British governments that they are going to ban the sale of new diesel and petrol cars and vans from 2040, what does it mean for the automotive industry and what does it mean for motorsport? What also does it mean to young engineers who are starting their career in the motorsport and automotive industries knowing that their future is unclear and clouded?

What about the racing itself? On the one hand the work of the engineer and the aerodynamicist is to make the car go as fast as possible while that of the regulator and promoter is to make sure that the racing is exciting - and that means close racing with a lot of overtaking. The two aims are not necessarily incompatible.

The blame for the lack of overtaking in Formula 1 in particular is often laid at the door of the aerodynamicists. They do their job so efficiently that it is detracting from the racing itself. Is this fair, though? After all they are only working to the rule book, one of which stipulates that you cannot have two cars in a wind tunnel. With 2021 coming up when things are changing, now is the time to discuss how aerodynamicists can play a positive role in making racing more exciting.

In these revolutionary times, motorsport needs to have a voice and that is provided by the World Motorsport Symposium due to its authoritative independence.

Join the debate and be part of that voice, so put **Thursday, 30th November and Friday, 1st December** in your diary and join us in Westminster at the Institution of Mechanical Engineers.



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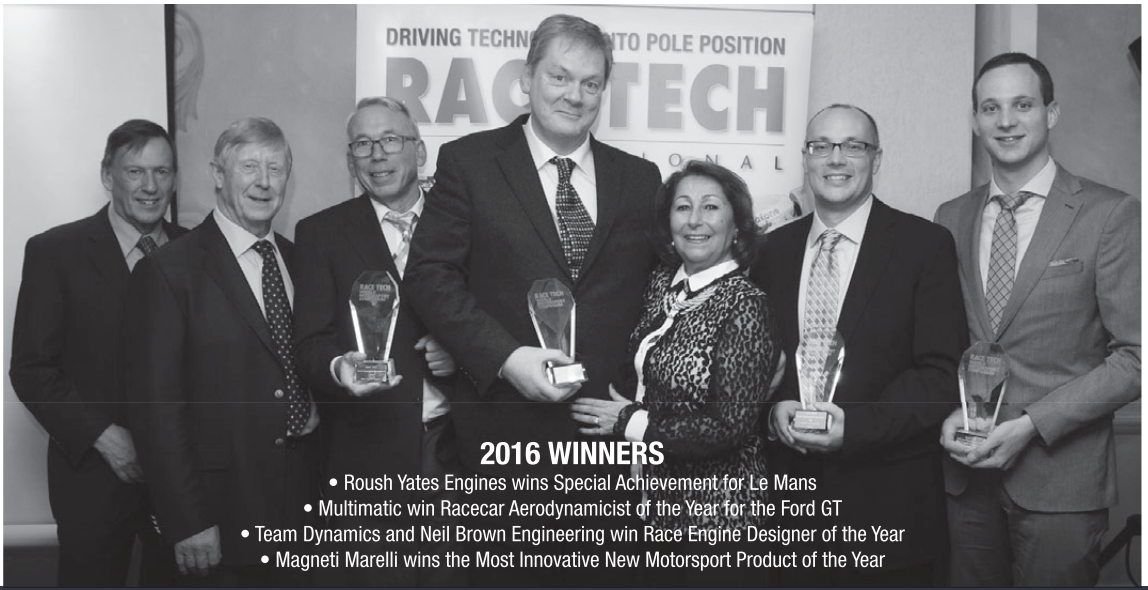


2016 WINNERS

- Roush Yates Engines wins Special Achievement for Le Mans
- Multimatic win Racecar Aerodynamicist of the Year for the Ford GT
- Team Dynamics and Neil Brown Engineering win Race Engine Designer of the Year
- Magneti Marelli wins the Most Innovative New Motorsport Product of the Year

Images: Bloxham/LAT

ABOVE Marcin Budkowski's proposed move to Renault from the FIA, where he was entrusted with other teams' tech secrets, caused a storm

A GAMEKEEPER TURNS POACHER

The fierce row over an FIA tech figure's defection to a team has put F1's handling of Intellectual Property centre stage. Our **Expert Witness** – an F1 insider who is no stranger to 'gardening leave' – examines the sport's evolving attitude to IP rights

MOTORSPORT has an unusual approach to IP protection. It tends to be self-policing, with steps put in place by the competitors to make sure others cannot steal their ideas. Why? Because for as long as there is innovation, design and manufacturing permitted, there is key technical performance advantage to be made.

The teams are all searching for invisible holes in the regulations, for interpretations within the grey that can swing results in a new, different direction. Such information is extremely valuable.

This has become an increasingly serious business. Once upon a time top designers actually turned up at their new team – or were expected to – with rolled up drawings from their previous employer under their arm. One or two cars bore a remarkable total resemblance apart from paint colour, or near identical assemblies in important areas. This has become much less acceptable, if technically more possible with electronic access and miniaturisation. IT departments' cyber security is now focused on preventing unwanted access through the firewall – both getting in, and out.

So what other protection is there? A robust long-term contract to make sure strategic personnel are retained, with clear draconian penalty clauses outlining what happens in the event of that company's information being leaked. Ideas generated while employed belong to the company.

Renewal would be discussed a significant time before the end of the contract and if new terms cannot be agreed by a certain point then an extended period of 'gardening leave' would take place. This removes them from areas of sensitive information for up to a year, pays them the same, but they could even be sent home, hence the expression.

When you leave a team under any circumstances it is a difficult moment. You are hopefully moving on your initiative, but you will still be leaving friends and colleagues behind who do not know or understand the situation. You leave everything you have behind that you have worked on body and soul for the previous years, but not your experience, awareness and knowledge of what is being worked on and why; that stays in your head. Teams actively target opposition personnel for this reason. If a car is successful or a development area is considered best in class, calls are made and head hunters are dispatched.

Therefore, gardening leave becomes important protection, a year making what someone remembers much less relevant due to the rapid development rates and how good their memory is. They have been out of the crucial inner circle for a while.

When IP rules were notably broken between Ferrari and McLaren in 2007, with a person physically taking information from one to the other, the FIA imposed a $100 million fine and stripped the Woking squad of their championship points. Ten years on, if anything the commercial importance of information has increased in terms of business interests, the price of success, or cost of failure.

The ultimate police in motorsport are of course the FIA. Along with FOM they control what happens now and next, they write the rules and decide what technical steps comply. To do this they have technical staff with a background in racing, who have been involved, gained experience, but moved to governance to look after the sport and become neutral. In this role they have unprecedented access not just to entire categories' current geometry and data, but also their future proposals and ideas, a requirement to ensure legality.

This is therefore a considerable position of privilege. So, when it becomes public that the head of the FIA's Formula 1 technical department is to take a senior role at an F1 team, and with only a few months' notice, it is no surprise the nine other teams are rightly up in arms. What price success? Trust, position, ethics and salary, apparently.

Poachers are supposed to go straight and become gamekeepers, not the other way around, exploiting access to all competitors' confidentiality. This was poorly, poorly done: just when F1 is supposed to be improving its image, a gamekeeper turns poacher. RT

BELOW China's WRC return was cancelled at short notice last season

WRC/Red Bull

CHINA: IN THEIR HANDS

Anthony Peacock reveals that the next big manufacturer entrant in rallying could be Chinese…

IT won't have escaped most people's attention that China has been the fastest-growing car market in the world since 2009: currently expanding at something like 10% a year. And more than 60% of these escalating annual car sales are still accounted for by first-time buyers: the Holy Grail for marketeers.

Head out of the cities and it's a completely different story. The donkey and cart is still a common form of transport, but the most ubiquitous way of getting about is the ancient motor scooter, which often still manages to accommodate entire families.

So, what China really needs to do is mobilise the rural population and start exporting its cars: not to encourage more cars to larger and increasingly crowded cities. What could be a more persuasive way to do it than to showcase the robust, go-anywhere, do-anything attributes of the World Rally Championship?

An even more extreme example of this is the Dakar Rally, where Great Wall – China's largest producer of SUVs, which racked up more than a million car sales last year – has regularly competed, with a best result of sixth overall. Although around 70% of its cars are sold within China, exports are on the increase, with the firm even establishing a European base in Bulgaria.

So, it's clear that the next step for a forward-thinking Chinese manufacturer – one that wants to break free of the reputation of building cut-price, knock-off cars specifically for the local market – is establishing an even more global presence than simply a one-shot event like Dakar can provide. A full championship, in other words.

That's why one of the leading Chinese manufacturers has recently approached a well-known engineering firm for a feasibility study to create a model to World Rally Car regulations, although nobody is really saying much for now. There are already several locally-built Chinese Rally Cars competing on the Chinese Rally Championship: a series well-funded enough to have attracted names such as Alister McRae and Mark Higgins.

In China, these cars run to different regulations broadly similar to the old Group A rules: two-litre turbocharged engines, matched to mechanical transmissions and suspension designed more with toughness than sophistication in mind. But a number of local cars such as the Chang Yi Moving XT (which looks suspiciously like the hatchback Subaru Impreza from some angles) and BAIC Senova (essentially the old Saab 9-5, bought from General Motors back in 2009, then matched to Mitsubishi running gear made under licence) have proved to be not only successful but actually innovative.

For example, there's even a class for hybrid cars in the Chinese Rally Championship (complete with a rapid charging point in the service area) as China leads the way when it comes to electrification. In 2016, 507,000 electric cars and hybrids were sold in China, a 53% increase from 2015. Meanwhile, 222,200 EVs and PHEVs were sold in Europe: a mere 14% increase. And here's another startling fact: Byd – the leading manufacturer in the hybrid class of the Chinese Rally Championship and the sixth-biggest car manufacturer in China – builds more purely electric cars per year than Tesla. It's also begun exporting them to Europe.

In this instance, necessity has become the mother of invention: China's issues with air quality are well-documented, and at the current rate of growth – with around 40 million vehicles expected to be produced there per year by 2025 – that simply isn't sustainable. As it is now, there are around 1.3 billion people and more than 160 cities with a population of over a million in China. With motorsport consistently pushing for ways to become more relevant, there's a golden commercial and sporting opportunity out there for a Chinese manufacturer.

Of course, there's a somewhat chequered history between China and the World Rally Championship specifically. Rally China was scheduled to return to the WRC calendar for the first time since 1999 last year, but depending on who you believe, either the roads or the finance wasn't in place – for reasons that weren't made entirely clear – leading to an embarrassing last-minute cancellation, not to mention fury within the corridors of FIA power. Suffice it to say that China wasn't invited back for this year, nor the next.

In that respect, the opportunity has been partially wasted. But, while it perfectly fulfils the brief for making rugged yet utilitarian cars desirable to a global audience – think back to the time when Subarus were primarily seen as quirky transport for pig-farmers – there are other road-relevant things out there in addition to the WRC.

Rallycross is eyeing an electrified future, which might just suit a Chinese manufacturer perfectly, as it's also something that can be done relatively close to large centres of population. Ma Qing Hua has won a round of the World Touring Car Championship and he'll be back in action on the streets of Macau this year (in a Citroen). And a company registered in the UK as 'China F1 Racing Team Limited' recently sounded out the FIA about a potential 11th slot on next year's Formula 1 grid.

Don't expect much to happen particularly quickly – one of the great ironies of motorsport – but all the signs are already in place. If you want to know where the next big manufacturer is coming from, look to the east.

ABOVE Mercedes-AMG's Project One hypercar brings F1 hybrid technology from the racetrack to the road

NOW LOOK WHAT YOU'VE MADE US DO!

Chris Ellis believes Mercedes' sensational new hypercar demonstrates how Formula 1 took a wrong turn

IMAGINE it's 2007, and you are a senior marketing executive in Mercedes. You have just sat through a presentation by some of your engineering colleagues explaining how they have succeeded in making HCCI (Homogeneous Charge Compression Ignition) work properly, and they have demonstrated it in the F700 concept car.

"That's very impressive," you respond, "but there is no market for this in most of Europe, so we will not proceed any further, for now. In a perfect world, this would be a breakthrough, delivering roughly the same fuel consumption using petrol as running on diesel. But most European governments have stacked the deck in favour of diesel by taxing it less. They obviously thought, if they thought at all, that we would never be able to close the fuel consumption gap, so decided to promote diesel as *the* way to lower CO2 emissions from transport. And help keep the Japanese car manufacturers at bay.... So I'm sorry, but we are not going any further with this until the powers that be come to their senses, maybe in ten years' time. Optimistically....."

However, this did not undermine Mercedes' faith in petrol engines. Take the new M256 straight-six. It's brilliant, and it seems almost 'HCCI ready', to me.

Now think what must be going through the great minds at Mazda, as they choose the markets where they will launch SCCI (Spark Controlled Compression Ignition) in 2019, as announced recently. In the EU of 2020, without the UK's 'neutral-on-fuel-tax' volumes, the price of petrol is still likely to average at least 15% more than diesel, which will wipe out the beneficial effect of HCCI/SCCI. So don't be surprised if Mazda focuses on China, Japan and the Americas, until the EU comes to its senses; in 2040?

In my opinion, the FIA is largely to blame for the fact that diesel cars, trucks and buses are the cause of so much pollution in Western cities. If it had reacted swiftly to Mercedes' demonstrable success, it would have stopped promoting diesel in motorsport as early as 2007. But, more importantly, the FIA should have been alerting governments to the importance of this breakthrough, and lobbying the French and German governments in particular. Maybe it tried, in which case let the FIA tell us what it did, so that the people of Europe can know where the real blame lies.

"GLOBAL SOCIETY"

Jean Todt, the FIA president, recently stated in the governing body's own journal that, "We have a responsibility to run an organisation monitored by global society". It's the FIA's official mission to speak for *all* of the automotive industry, not just for motorsport. So what were they concentrating on? Thou shalt have no V12s in F1?

Mercedes has recently had to deal with another problem of the FIA's making. When the idea of developing a Mercedes-AMG hypercar was first raised, someone in marketing probably asked that owners should be able to claim "my car has a Formula 1 engine!", and that this should be credible. So the wonderful Mercedes-AMG Project One hypercar is powered by a de-tuned version of the nasty little 90-degree V6 the FIA standardised in F1, even though Mercedes has replaced all of its 90-degree V6s in its road cars with 60-degree V6s, for reasons that need no explaining to this readership.

All 270 Project Ones have been spoken for. But the good news is that the 2021 'Project Two' may have a much better powertrain, assuming the F1 regs for 2021 make more sense than the current ones. Even at £2.4 million each, Mercedes may make a loss on every Project One, but this should prove a relatively cheap way to advertise the qualities that have led to its success in F1.

Bottom line: Messrs Carey, Brawn and Bratches, please be very careful what you ask for in the new regs, because we all may come to regret it. And please feel free to speak for 'global society', because the FIA seems to have no idea what society really wants. RT

EMOTION INSTEAD OF EMISSION?

With the fourth season of the pioneering Formula E series just weeks away, **Craig Scarborough** assesses the key technical battlegrounds

AS FIA Formula E enters its fourth season, the category has matured. Increasingly populated by manufacturer teams, the pioneering privateer spirit from the first season is gone and any advantage from powertrain layout eroded.

Now the cars are converging in their technology and the gains are in the much finer detail. The series makes a step change with a new car and battery next season, with the big guns from Mercedes, Porsche and BMW joining the likes of Nissan (to replace Renault), Audi and Jaguar in Season 5. In the meantime, there are a handful of key technical battlegrounds to focus on: win these in Season 4 and the rewards could be big for Season 5.

LAST HURRAH FOR CAR SWAPS

Season 4 will be the last with the current car, battery and race format, ahead of a new chassis, McLaren battery and races without car swaps for Season 5. With this step change looming, there is little in the way of regulation changes for the coming campaign. The key one is an increase in race power of 10 kW, so the cars will now race with 180 kW (~241 hp), while peak power levels for qualifying and the in-race fanboost remain the same at 200 kW (~268 hp).

While the increase is a reasonable step, some races – especially at double-header events – will be longer, so the available peak power may have to be carefully managed. However, a planned increase in energy harvested from regenerative braking has been dropped, so the cars can still only recover 150 kW per lap. This doesn't approach the sort of leap we will be seeing in Season 5, Mahindra team principal Dilbagh Gill suggesting this year's power increase "does not have a big impact".

There are also revisions to how the software can be used by the teams to control the powertrain, but these are described as very "slight" changes. Lastly on the hardware side, the Williams Advanced Engineering traction batteries have had a refresh for their final season of competition.

In general, the approach to powertrain design is converging on a similar path for efficiency. In terms of layout, all manufacturers (Andretti aside) have opted for transverse-mounted motors and again these are geared directly to the differential. With this setup there are fewer losses changing the direction of the motor's output and no losses from a multi-speed gearbox. From pit garage exit to the starting grid and on to the finish line, Season 4 FIA Formula E should not feature a single gearshift!

Only two of the teams are running unconventional motor types. NIO NextEV and possibly Venturi will employ the axial-flux pancake-type motor, with NIO NextEV appearing to have quite a different layout for this season.

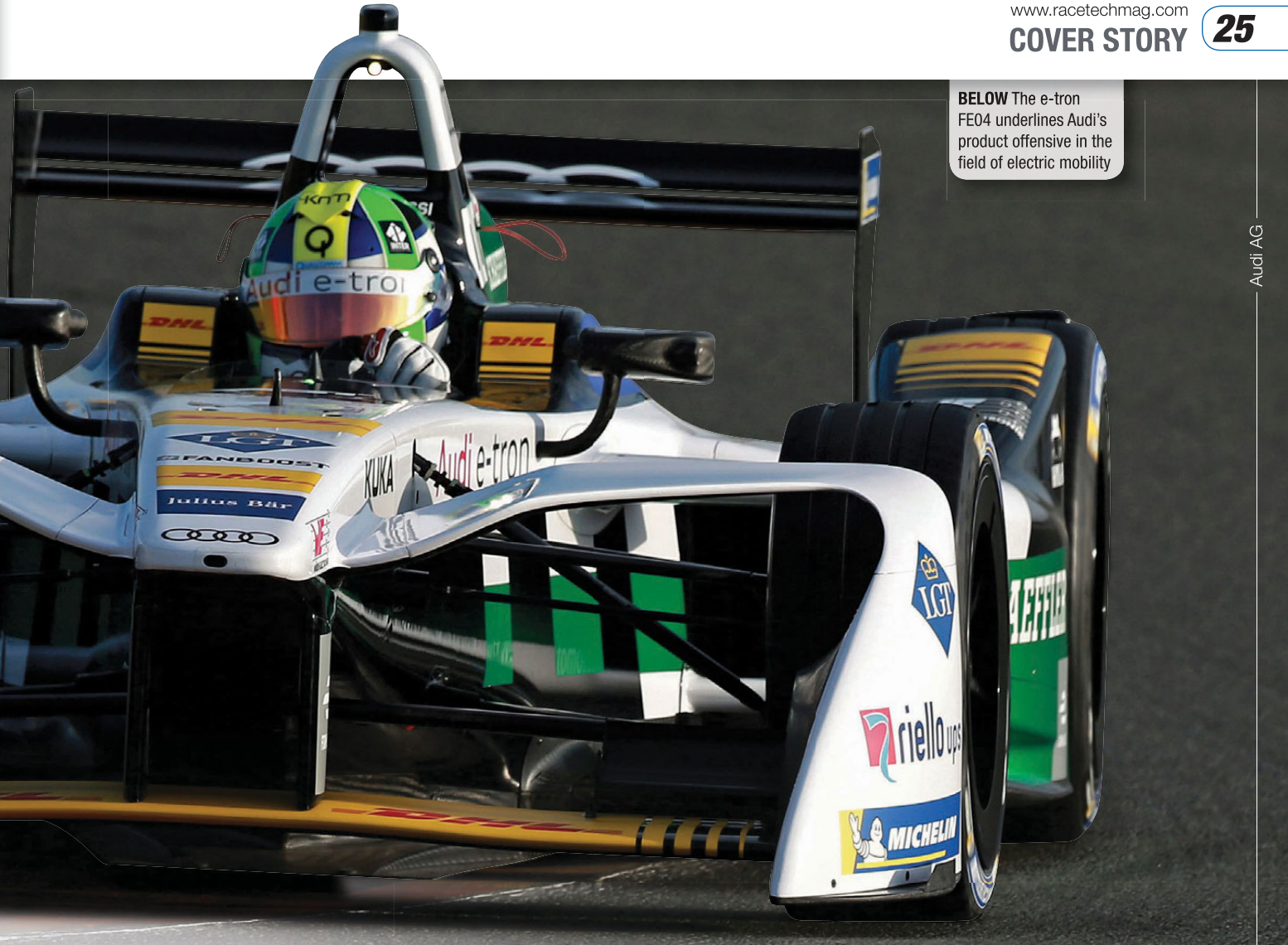
The gains from the layout of the powertrain are on a flattening curve. The big steps in performance are no longer gained from veering away from the Season 1 powertrain layout, but in all the other areas of the car's design and team's operation. Some of these are typical of any motor racing series, but with a specific slant on the electric drive. This goes to show how the series has matured in just a few short seasons.

So, what are the main areas in which the teams will do combat?

Battleground #1

CONTROL SOFTWARE

Controlling the electric powertrain hardware are the electronics and software. Eight of the teams use a McLaren Applied Technologies ECU, all running their own control code. For MAT ECU users there is a new version of the Atlas software coming, although this will only be under evaluation for now prior to formal release for Season 5. This will offer



BELOW The e-tron FE04 underlines Audi's product offensive in the field of electric mobility

Audi AG

teams greater scope for creating their own control code.

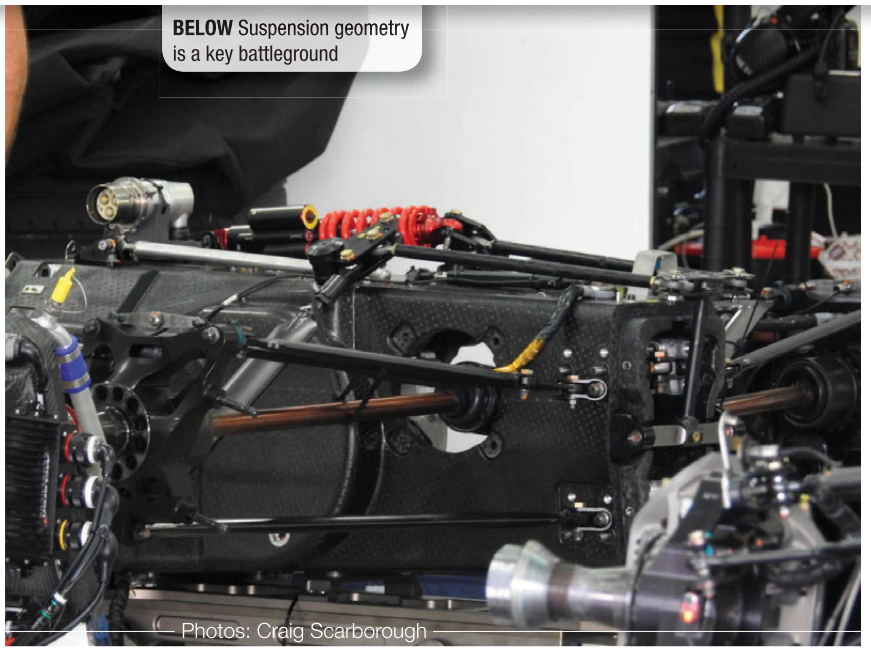
How they decide to operate the powertrain, how to produce the power, when and how to lift and coast and recover energy, is their best-kept secret. Teams jealously guard their IP in this area, but no doubt their biggest investment will be in control software.

One way we can gain a little insight into how the team and driver exploit the energy and power available is through the steering wheel. XAP continues to supply the spec wheel which, as in other racing categories, provides 10 buttons, five rotaries and six paddles, all configurable by the team. Having never had a clutch to control, and with gear-shifting now a thing of the past, the multiple paddles are repurposed from transmission tasks to lift and coast or regenerative braking functions.

Although the method differs between teams and drivers, most paddles are used in similar ways. One pair is set up for lift and coast: as the driver reaches Vmax on the straights and before the braking zone, the driver can lift and coast without engine braking to preserve energy while ▶

ABOVE The steering wheel paddles are repurposed from transmission tasks to lift and coast or regenerative braking functions

Craig Scarborough



BELOW Suspension geometry is a key battleground

Photos: Craig Scarborough

maintaining top speed.

Another pair is set up for regenerative braking, with different levels of energy recovery and therefore braking effort on the rear axle possible. Used tactically to recover more energy or used less to balance the braking into a turn, the driver will pull different paddles to get a different braking/regenerative effect.

For the Formula E driver the approach to a corner is more complex because of the shuffling of the different paddles. Understanding how to set them up and when to use them for best effect is part of the work for a driver and race engineer to extract top performance, and thus subject to the utmost secrecy. As is the function of the remaining paddles, which can be purposed for an overtaking map, fanboost or other equally secret functions.

Battleground #2

SUSPENSION

A useful side-effect of the freedom in powertrain design is the opportunity to rejig the rear suspension. This must remain similar in concept to the Season 1 car, with pushrod-operated coil over dampers and double wishbones. But from the gearcase out to the upright, the geometry and detail design is free.

In the first seasons of free powertrain design, efforts were put into the selection of higher specification dampers, better adjustment and geometry. However, with time comes more focus on the geometry and the method by which to get the rear weight bias, high torque cars to corner effectively. Both these unavoidable traits of the car's design produce oversteer on corner entry and on acceleration.

Paddock whispers have been that top teams are configuring the geometry to help acceleration out of the corners, even if at the cost of compliance over kerbs. As the car rolls through corners, the unloaded inner tyre loses camber and therefore traction. Several teams have revised their geometry to provide more camber (and therefore more castor) gain on the inner wheel, to prevent the instantaneous torque of the electric motor oversteering the rear end out of turns.

At the Audi car's launch Dieter Gass, head of motorsport, dismissed suspension design as a secondary factor. "It's normal development work from one season to another. You want to be looking into mechanical grip rather than aero grip," he said. But looking at the resulting kinematics as laid out on the car it's clear Audi has gone quite dramatically different in this direction to reduce power oversteer. The wishbones are steeply offset, such that the rear lower inboard pickups are virtually on the car's centreline.

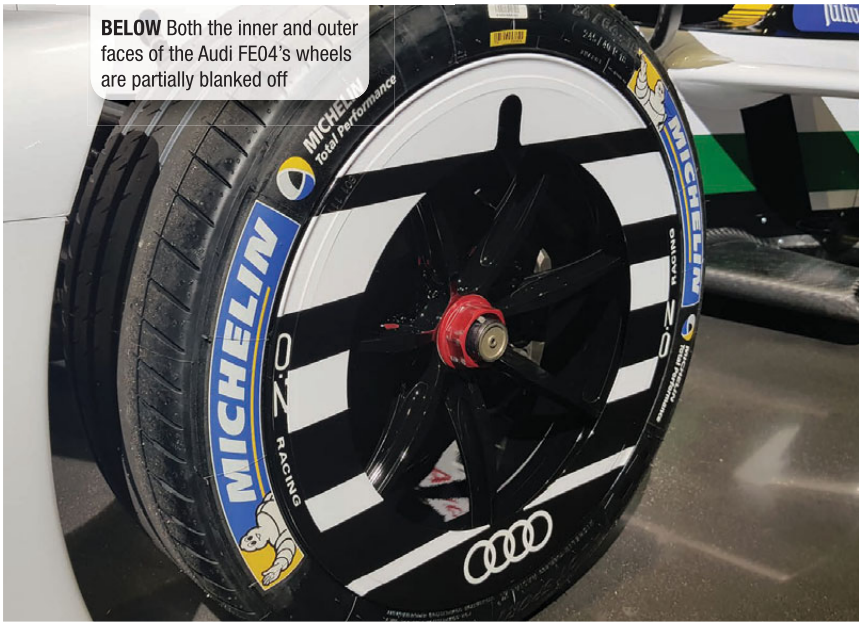
One ex-F1 designer notes that this direction was once quite frequent in F1. "This system was used many times during the turbo time in F1, so as not to suffer roll-oversteer in street circuits," he suggests. "We can see when the car turns, the longer the distance (from static) between front wheel centre and rear wheel centre on the inside of the car. This generates roll-understeer, reducing the typical roll-oversteer during acceleration out of tight corners."

Battleground #3

WHEELS

Wheel design has now progressed beyond brake cooling and the thermal management of the tyres to consider aerodynamics. The cars run 18" wheels but small diameter brake discs, creating a lot of open area between the disc and rim. Last season teams started to create flanged rim designs that closed off part of the open wheel to create an aerodynamic flat-faced wheel.

This is evident again on the new Audi, visually enhanced by the striped livery on the wheel itself, where both the inner and outer faces are partially blanked to streamline the wheel. Any drag on the straights will consume power and energy so, with a fixed specification aero package, ▶



BELOW Both the inner and outer faces of the Audi FE04's wheels are partially blanked off

Automotive ENGINEER

ISSUE 1
RELAUNCH ISSUE

GLOBAL TECHNOLOGY INSIGHT

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reducing drag produced by the wheels is win-win for the team.

In design terms the level of blanking for the outer face of the wheel is a factor of the maximum cross-sectional area allowed for the spokes. The thinner the spokes, the smaller the internal diameter of the rim disc can be. On the inner face of the wheel there is not the cross-sectional area rule, but the wheel does have to fit over the brake and upright, so the flange size is somewhat restricted.

Battleground #4

RACE ENGINEERING

When the series began with the entire car supplied by its manufacturer, Spark, the job for the team was to operate the car to the best of its abilities. While no doubt this was complicated by the new electric powertrain, the task was fundamentally the same as running cars in other spec series such as GP2, GP3 or Formula Renault.

Restricted in the number of staff allowed within the garage, a lean team consisted of: team manager, race engineer, data engineer and mechanics. The long gaps between races and the presence of fewer manufacturer teams meant many chose to hire staff on a contract basis, or used the services of outfits like Carlin or Campos, which would sub out staff from their other race programmes.

As the category has matured, teams have become larger and able to commit permanent staff to both the trackside and design roles – albeit on the team payroll or permanently assigned from the likes of Campos etc. This increased dedication has allowed teams to focus closer on its operations. So much so that the manufacturer teams are attracting top level engineers from F1, such as Chris Dyer (Ferrari and Renault), Jacky Eeckelaert (Sauber F1 and BMW DTM) and Phil Charles (Toro Rosso).

Race engineering is becoming one of the key challenges. Typical Formula E tracks are temporary street circuits, rarely with races on concurrent years, and with no scope for testing. Through the first three seasons we have seen just a few teams compete at the front on a regular basis, but the fortunes of the balance of the field tended to fluctuate, as they got their setup right or wrong at different tracks. There's little doubt the field will inevitably bunch up in Season 4, where the ability to get the car into its correct window from the get-go will be critical.

There is just a short shakedown and two practice sessions at each ePrix before qualifying and the race. This leaves precious little time to be correcting settings that aren't suiting the venue. At this season's double-header race weekends, one of the practice sessions on the second day will be dropped, making recovery from a poor first race even harder to achieve.

The format will place a premium on the experience of the permanent engineers and teams that have raced throughout the four seasons. Without that archive of historical data, new teams could be at a disadvantage in seasons five and six. It's no surprise that the once outwardly independent operations of e.Dams and Abt have very much continued as the same operation under the banners of Renault and Audi. Jaguar found this an issue in its first year as a wholly new ▶

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BELOW Changes to the race weekend format will render existing engineering experience even more precious

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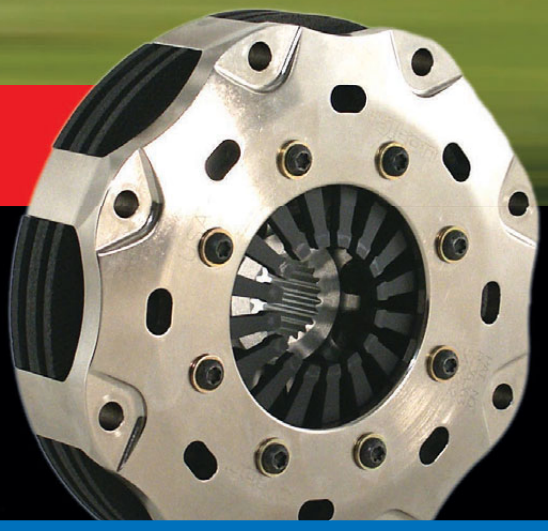

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Jaguar

ABOVE With no back-catalogue of data to draw upon in its first year, Jaguar had to wait until its new car for Season 4 to address issues with balance, weight distribution and efficiency

team: with no back-catalogue of setup data, everything was new at every circuit.

The likes of Porsche, Mercedes and BMW, however, are already wise to this potential stumbling block and have placed their engineers (in some cases drivers too) within existing teams. Andretti Racing will have been running with BMW engineers for two seasons by the time the manufacturer officially enters. Meanwhile Venturi and Dragon have hosted manufacturer engineers, even if they are not the final destination for those personnel, as the newcomers will be wholly new entries in Season 5 and Season 6.

Battleground #5

SIMULATORS

Part of any top race team's armoury is now the simulator. Having the driver in the loop with accurate vehicle dynamics and circuit data allows the team to prepare in a way previously only possible with real life on-track testing.

The approach to simulators varies, as does the technology required. Investment in this area can be considerable, so, just as with personnel levels, teams tackle this depending on their scale. Manufacturer squads invariably have their own, used in other projects, while independents leverage their relationship with the likes of Campos, Carlin, Williams-AE etc, or rent time in a third-party sim such as Base Performance.

> *"Sim work will assess how fast a lap time can be produced for each energy target"*

The goal of using driver sims is not a completely immersive experience with full g-forces recreated, nor simply to allow the drivers to learn each new track. While the latter can be of benefit, the key aim is setting up the energy strategy for the coming ePrix. Drivers will lap the track and try different points for lift and coast and different levels of energy recovery. With the team having an energy consumption goal, the sim work will assess how fast a lap time can be produced for each energy target. This work will be fed into the set-up of the car for the ePrix and steering wheel settings configured accordingly. ▶

Base Performance Simulators

ABOVE The use of simulators has become vital as teams refine their energy recovery and deployment strategies

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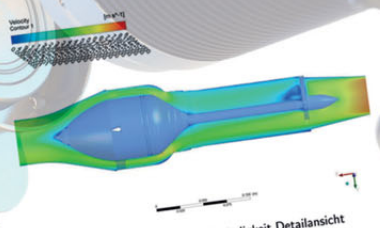

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Battleground #6

TYRES

As both a commercial and environmental message, Formula E uses Michelin's road car-like low profile treaded tyres, there being no need to ship wet weather rubber around the world when they are rarely used.

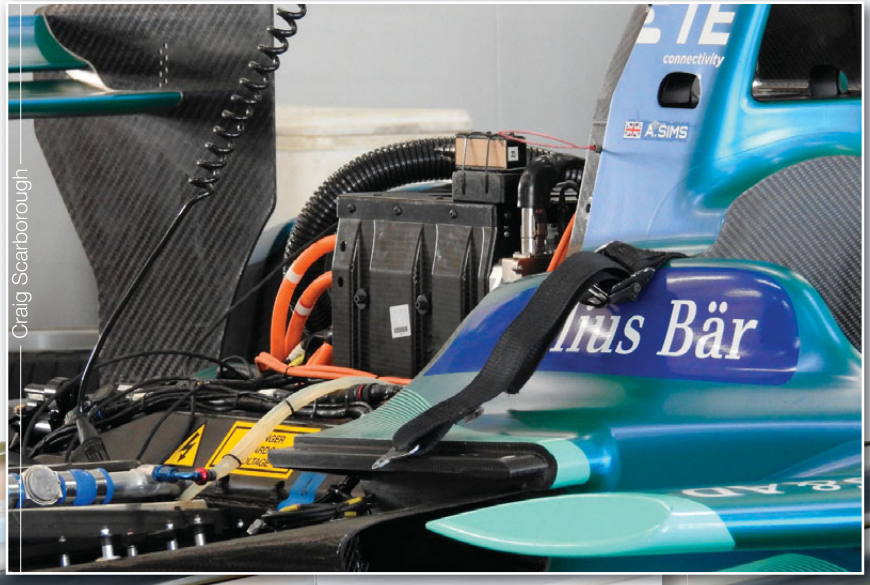
As in any racing category, getting the tyres to work is crucial to performance. A change in construction for Season 3 gave the tyres a different character. This suited some drivers and caused problems for others, but it was for the team with its assigned Michelin engineer to work out how best to manage the tyre. The task was further complicated by the tracks, with no testing possible and large variations in track surface and weather throughout the calendar.

There is no change in tyre architecture for Season 4, so last year's lessons will be carried over. But Season 5 will be a significant step in tyre use: the car and battery will both change and the end of mid-race car swaps means the tyre will have to last the entire race, not simply half of it.

New teams entering the sport will lack the data of how tyres perform at different tracks and in different conditions. Engineers from existing teams and Michelin technicians could become hot property for a new manufacturer team for Season 5.

BIG GUNS

The standard and detail required in FIA Formula E has grown hugely over the first three campaigns, with Season 4 shaping up to be the most technical and competitive season yet. The big guns from the German OEM marques wait in the wings for seasons five and six, but are well aware that it will not simply be a case of throwing money and clever tech at the car, but diligent work in getting the standard parts to perform at every ePrix. It's by no means a certainty that all the new manufacturers will be a success in this growing sport. RT



Craig Scarborough

ABOVE With powertrain tech converging (only Andretti has bucked the trend for transverse-mounted motors), gains have to be found elsewhere

FIA Formula E

ABOVE Getting the best from Michelin's tyres is a crucial skill

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BMW'S BTCC WINNER

Chris Pickering examines the new engine that powered BMW to the British Touring Car Championship Manufacturers' and Teams' titles

IT'S been 21 years since BMW last had a manufacturer entry in the British Touring Car Championship (BTCC). But this season the German company has returned, through BMW UK, with a three-car team run by championship stalwarts West Surrey Racing (WSR) and its BMW M125i M Sports for Colin Turkington, Rob Collard and Andrew Jordan have proved competitive right from the start.

To many, this won't have come as a great surprise. After all, WSR has been running BMWs independently in the series since 2007. But it's more than just a rebranding exercise. Along with the investment comes some technical support from the factory and most importantly a new engine developed by one of WSR's longstanding partners, Neil Brown Engineering (NBE).

The B48 – as the production engine is known in BMW-speak – is a 2-litre, turbocharged inline four with direct injection (DI) and variable valve timing (VVT). It's used in a huge variety of BMW Group applications from the MINI Cooper S to the long-wheelbase 7-Series. And it also makes an ideal base for the BTCC engine regulations.

"The B48 is a very good starting point," comments Neil Brown, managing director of NBE. "It's a good strong unit, and it's been designed for turbocharging from the outset. The block is a closed deck design, which greatly aids its rigidity."

The team's previous engine was turbocharged under the BTCC rules, but it was based on the naturally aspirated BMW N43 unit. Like most older production engines this was an open deck design, which provides limited support for the top of the cylinder liners. However, with the B48 the engineers found they had a ready-made solution.

"It's generally easier starting with a turbocharged base engine," comments NBE design engineer Tom Morris. "Most OEM engines are now designed specifically for forced induction, so they put a lot of effort into things like cylinder head sealing. It means that there's a lot of good components in there that we can continue to use. The boost pressures encountered in the BTCC aren't greatly dissimilar to those on the road car – we've done the calculations to check, but in the end we could use stock parts for cylinder head fasteners, for instance."

The BTCC regulations carefully control the modifications that can be carried out. Teams can use any engine within the road car manufacturer's family that satisfies the basic requirements: two litres, four cylinders and a maximum engine speed of 7,000 rpm. Substantial portions of the base engine have to be retained, though. The block and cylinder head castings have to be carried across essentially unmodified, as does the crankshaft unless a waiver is issued on the grounds of durability.

"Production crankshafts can work very well in racing these days – particularly in turbocharged formulas where the revs aren't usually that high," notes Morris. "The stock crankshaft in the B48 uses very good quality materials and processes. It features rolled fillets and the big end bearings have a polymer coating designed to make them more robust for the road car's stop-start function that helps to cut down friction."

As per the BTCC rules, the engine uses BMW's standard cylinder head casting without any modifications to the breathing or port geometry. There are also minimum weights for components such as the pistons and connecting rods, as well as certain geometries. Elsewhere, wet sump systems are mandated as well, so the BMW engine carries over the production design, albeit with a series of baffle plates added to aid oil control under the rigours of racing. The oil pump also has to be a standard item. ▶

Jakob Ebrey/BTCC

LEFT & RIGHT Neil Brown Engineering (NBE) worked its magic to take a new BTCC engine to glory for the second season in succession, BMW's B48 powering the M125i M Sport (left) to the Manufacturers' and Teams' titles

"A variety of clever techniques were used to fast-track the development process"

JEP/LAT

ABOVE Colin Turkington's spectacular battle with Ashley Sutton for the Drivers' title produced one of the best ever BTCC races at the Brands finale

TIGHT SCHEDULE

Work on the engine began in mid-October 2016. As is so often the case in motorsport, this gave NBE precious little time to get it up and running before the self-imposed target to begin dyno testing in mid-February.

The first task was to define the piston and connecting rod geometry, explains Morris: "The piston bowl shape is very important on a DI engine, and the other factor we had to bear in mind was logistics. Pistons tend to have quite lengthy lead times, and with the Christmas break looming, we wanted to start getting the first engine together."

NBE collaborated with Omega Pistons, which pulled out all the stops to get the parts ready in time. Although significantly different in competition form, the design does draw inspiration from the stock pistons.

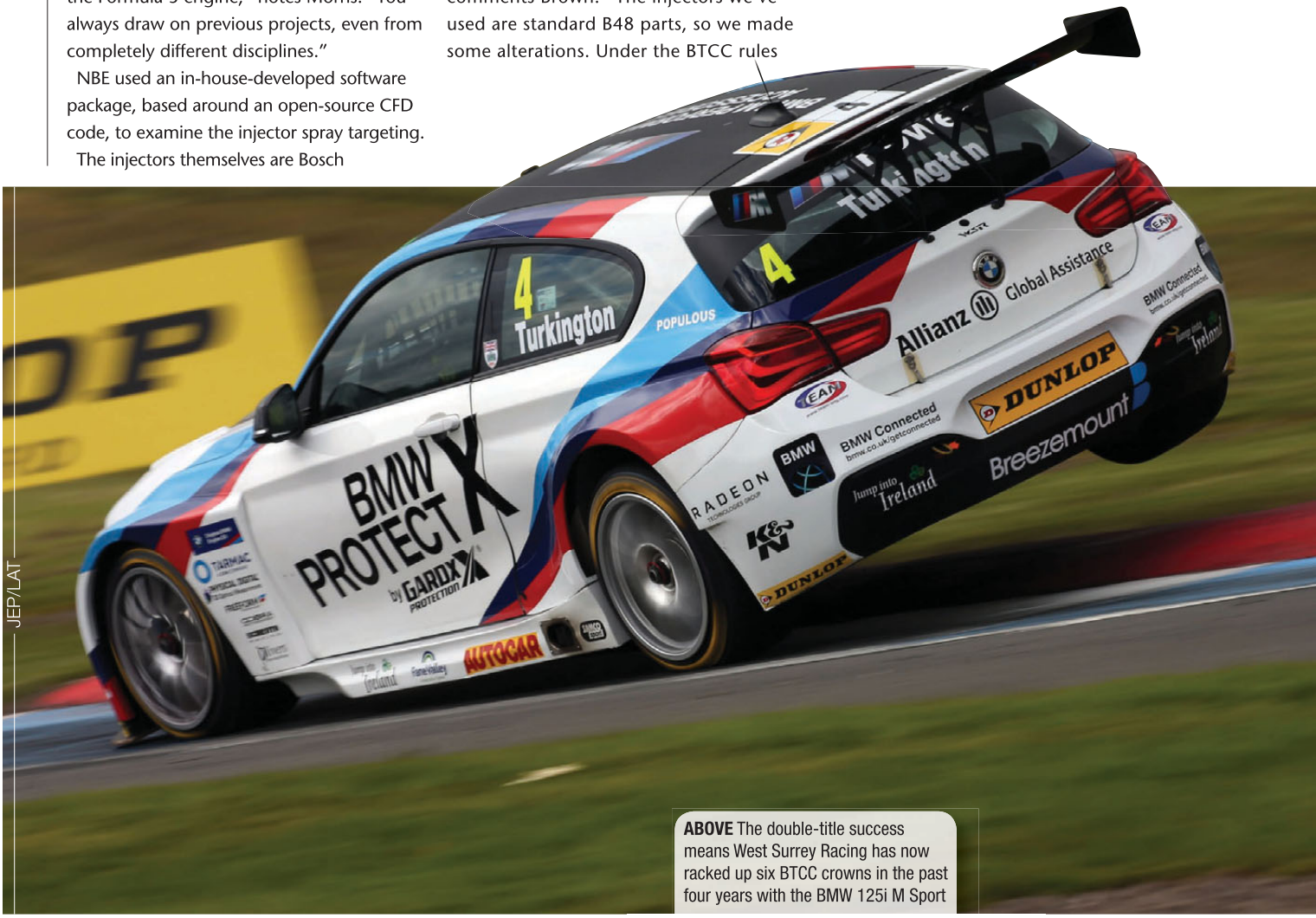
"The OEMs spend a lot of time on piston bowl design, so we used the stock design as a guide, but we've also built up a lot of experience in-house – particularly with the Formula 3 engine," notes Morris. "You always draw on previous projects, even from completely different disciplines."

NBE used an in-house-developed software package, based around an open-source CFD code, to examine the injector spray targeting.

The injectors themselves are Bosch production items from a BMW road car. Unlike a lot of road car engines, which typically use side-mounted injectors for DI, the injectors on the B48 are vertically mounted, projecting into the top of the combustion chamber near the spark plug. This has benefits when it comes to spray targeting, but it also brings a few practical challenges.

"There are a lot of injectors available for side-mounted DI systems, but we found there are a very limited number of off-the-shelf injectors that will fit this engine," comments Brown. "The injectors we've used are standard B48 parts, so we made some alterations. Under the BTCC rules we're allowed a maximum of 200 bar rail pressure [as the production engine has] but ideally we would have liked more due to the flow restrictions of the injectors."

The connecting rods, manufactured by Arrow Precision, were designed in tandem with the pistons. Again, these draw quite heavily from the production engine in their design. In particular, the small end of the connecting rod features a tapered profile, very similar to that of the road-going parts. "It adds slightly ▶



JEP/LAT

ABOVE The double-title success means West Surrey Racing has now racked up six BTCC crowns in the past four years with the BMW 125i M Sport

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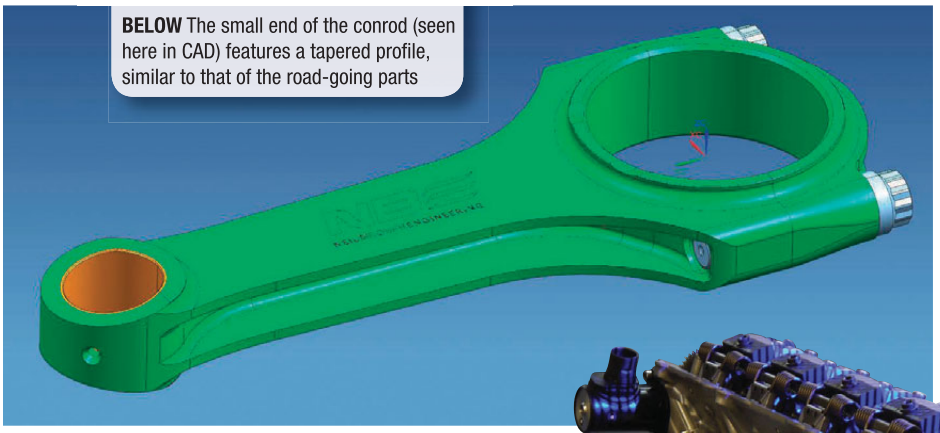


BELOW The small end of the conrod (seen here in CAD) features a tapered profile, similar to that of the road-going parts

more machining steps than a typical OEM design, but it helps to reduce the mass of the little end. It's a neat little feature that we found useful," notes Morris.

VALVETRAIN

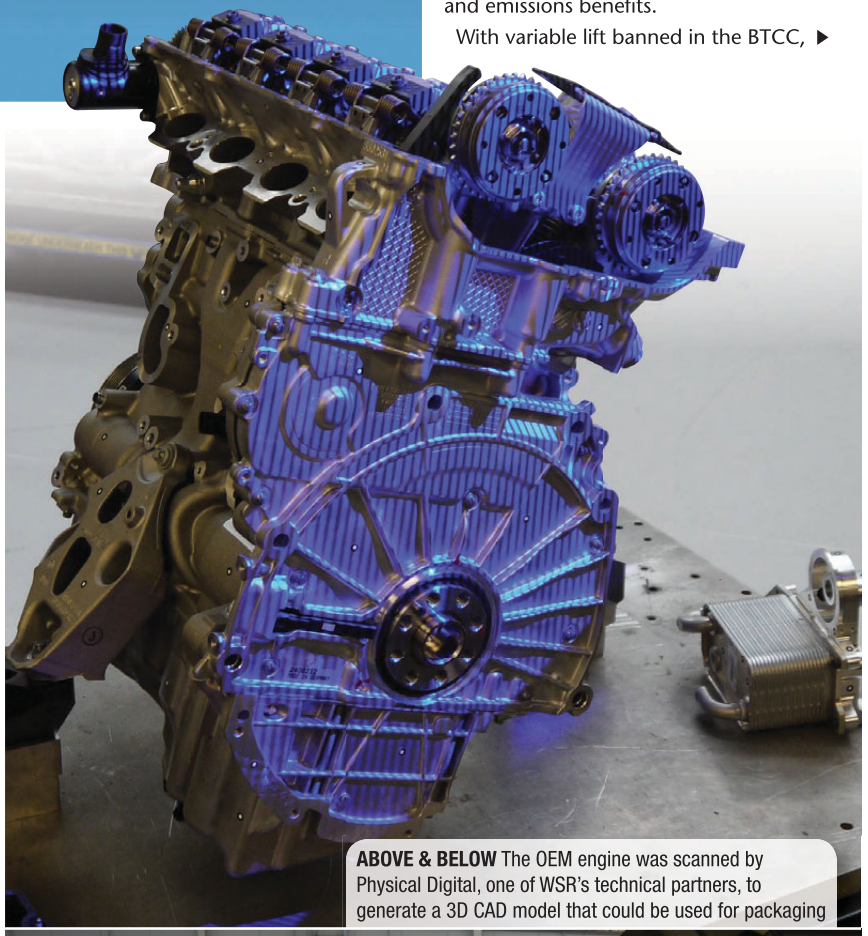
Camshaft development is probably the single biggest area of development for BTCC engine builders. The chain-driven cam drive on the BMW engine is essentially taken from the production unit. It features one chain running up to an idler sprocket and another driving the camshafts. However, the NBE engineers have already made some changes to the system for the initial homologation and they're keeping a close eye on it for the future.

Once you get to the cylinder head things become somewhat more complicated. The B48 uses BMW's VANOS oil-driven variable valve timing system on both the intake and exhaust camshafts. In each case, this ingeniously simple system sits between the timing sprocket and the camshaft. It's a mechanical coupling, consisting of one helical gear running inside another, with a hydraulic piston controlling the depth to which the two gears are engaged. Using the piston to move the inner gear backwards and forwards causes the outer gear – attached to the camshaft – to rotate slightly, due to the diagonal cut of the helical gears. This advances or retards its timing relative to the inner gear connected to the sprocket.

It's a well-proven system, used on both road and track since the early nineties. NBE has carried over the BMW VANOS mechanism unmodified, and we're told it's a relatively straightforward task to control it using the mandatory BTCC Cosworth ECU and wiring loom.

In production trim, the B48 also uses BMW's Valvetronic variable valve lift system on the intakes. This places an extra set of rocker arms between the valve stem and the camshaft. The pivot point of the intermediate arm is constrained by the position of an eccentric cam driven by a servo motor; altering its positions scales the valve lift up or down with infinite adjustability across a range of 0 to 10 mm. It's a fascinating system, which allows the road car to run unthrottled, with efficiency and emissions benefits.

With variable lift banned in the BTCC, ▶



ABOVE & BELOW The OEM engine was scanned by Physical Digital, one of WSR's technical partners, to generate a 3D CAD model that could be used for packaging

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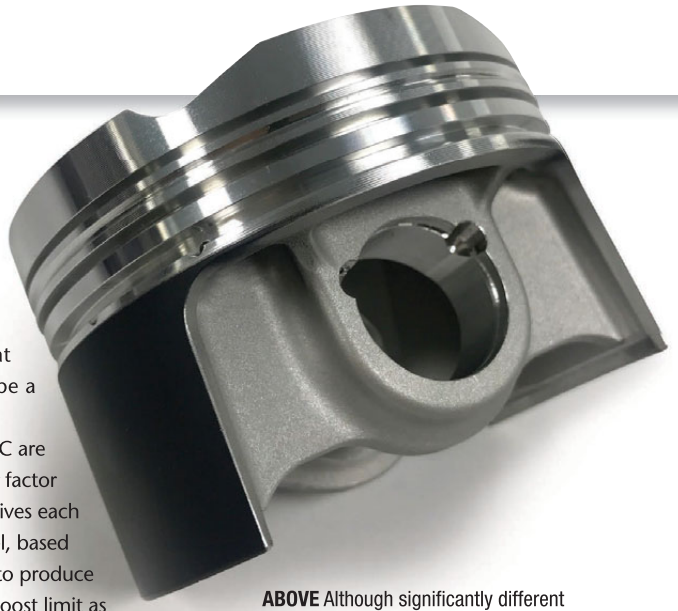


ABOVE Although significantly different in competition form, the piston design draws inspiration from the stock items

NBE did consider simply locking the variable lift system in a fixed ratio, but this was quickly discounted, largely on the grounds of weight. Engine speeds were also a factor, with the production unit red lining somewhat below the 7,000 rpm limit allowed for the BTCC.

"The production valvegear is a very clever design, but we realised at a fairly early stage that it wouldn't be suitable for what we needed it to do," explains Morris. "It was easier to start from scratch."

NBE's solution was a conventional finger follower arrangement, using the production head's camshaft location. The rocker shaft now resides where the eccentric cam previously sat. Working out the geometry caused a few sleepless nights and a degree of head-scratching, but the finished design could have been made for the purpose.

"There is a fair distance from the camshaft down to the valve tip, but the geometry worked out very nicely in the end," notes Morris. "We ran a couple of simulations using Lotus Concept Valve Train to ensure that the rocker geometry and the mass would work at the elevated engine speeds with the valve springs that we had. It turned out to be a really good solution."

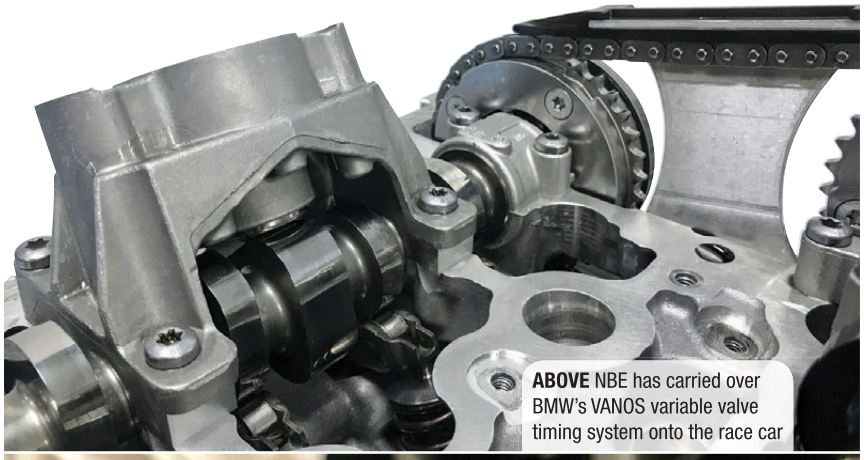
All the engines in the BTCC are subject to the series' power factor calculations. In short, this gives each engine a specific boost level, based on its theoretical potential to produce power. There is no global boost limit as such, although all engines have to use the same Owen Developments turbocharger and the mandatory PWR intercooler core.

The power factor calculation takes into account the cylinder head's flow characteristics, plus the lift and duration of the valves. It's not exactly performance balancing – the emphasis still rests on the engine builder to realise this potential, but it does create a level playing field.

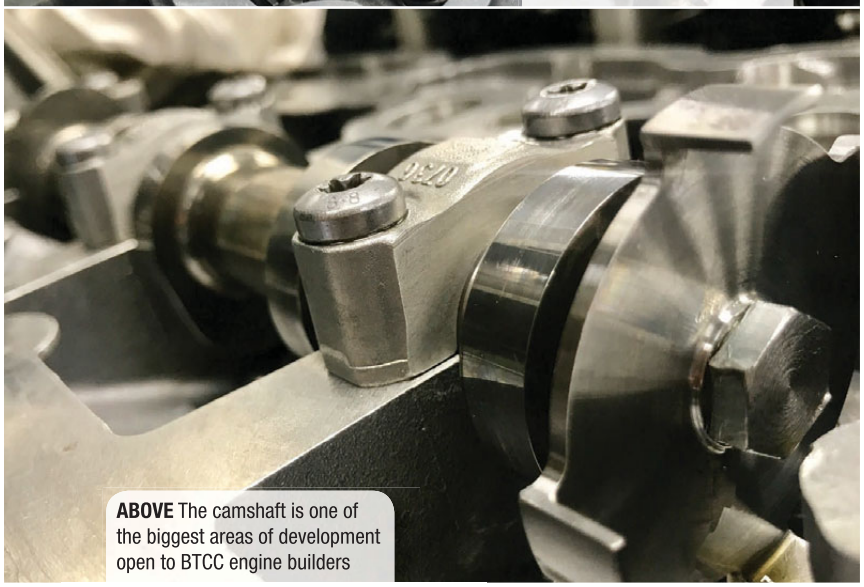
The engine builders, of course, are wise to this and there's quite an art to ensuring that the boost pressure that the team is awarded suits the engine's characteristics. Go too aggressive on the camshaft and the resulting boost limit can be so low that the turbo struggles to operate effectively; tread too carefully with the cam profile, however, and it can push the boost up too far. At that point, detonation becomes more of an issue, temperatures start to rise and the increased cylinder pressures create more of a durability challenge for things like gaskets and head fixings.

"We don't tend to open the valves too aggressively," comments Morris. "If the lift curve is too extreme you're just going to compromise the boost limit. The maths behind it isn't that complicated, but trying to get the best compromise is deceptively tricky."

One of the considerations is that boost pressure has an effect on turbulence. Typical production heads seem to favour quite high boost pressures, Morris explains, because it creates more tumble, which improves the mixing.



ABOVE NBE has carried over BMW's VANOS variable valve timing system onto the race car

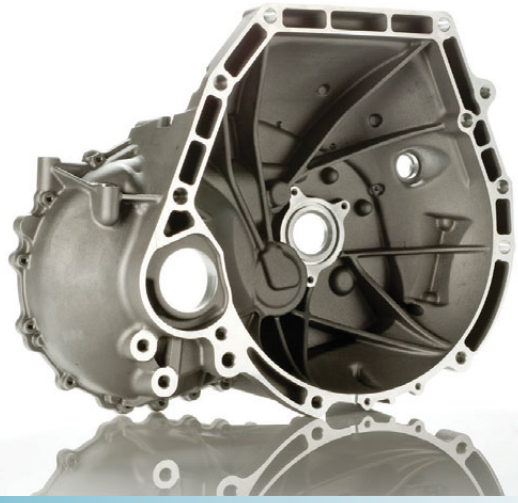


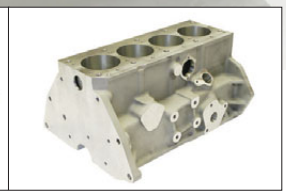
ABOVE The camshaft is one of the biggest areas of development open to BTCC engine builders

ENGINE BUILDS

NBE carries out a lot of its production in-house. This even extends to cam grinding, so the engineers were free to experiment, at least within the limited time constraints. Elsewhere, a variety of clever techniques were used to fast-track the development process.

First, the OEM engine was scanned by one of WSR's technical partners, Physical Digital, to generate a 3D CAD model that could be used for packaging. One of the things this highlighted was that the stock intake manifold would be tricky to accommodate, so the decision was taken to ▶





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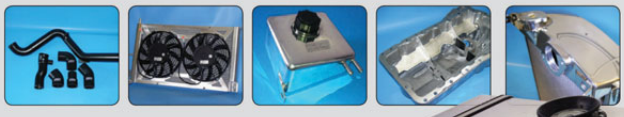

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ABOVE Behind the scenes 31 people were directly involved in West Surrey Racing's racetrack operation

produce a bespoke item. This was produced in aluminium using a rapid casting process, with 3D printed sand cores, carried out by Hadleigh Castings in Suffolk.

"The rapid casting process turned out to be ideal, we were very pleased with the results," says Morris. "It helped to meet the tight deadlines that we were looking at. The whole process – from the initial design to a finished part sat on the desk – took 21 days."

Somewhat unusually, NBE also produced the bellhousing, which was machined from a solid billet of aluminium. Doing this in-house freed up the engineers at WSR to focus on other areas of the installation. The drivetrain is mostly BTCC spec components, with the clutch coming from AP Racing, the gearbox and differential from Xtrac.

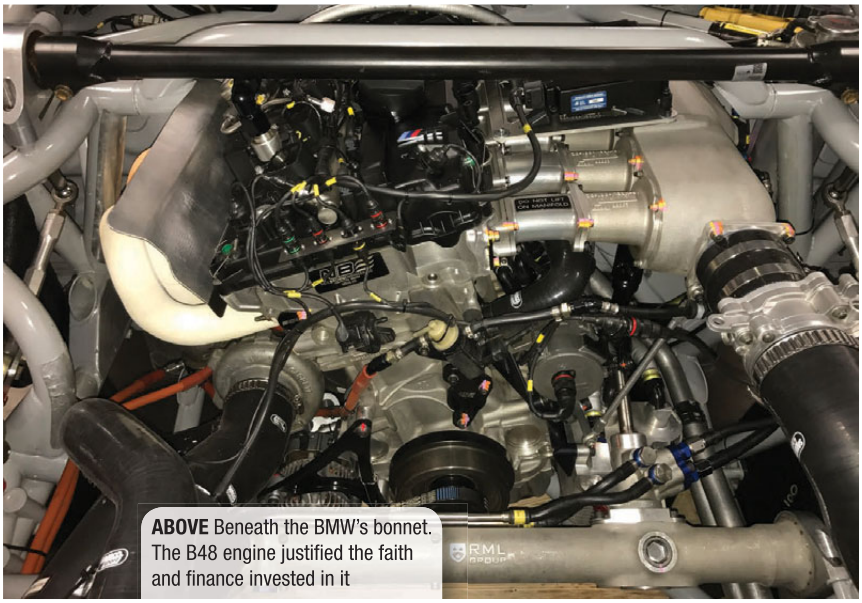
In the end, the NBE engineers met their target of mid-February for the start of dyno testing, but time was still quite tight. Once the finished engines were in the cars there was only time for one day of testing before they rolled onto the grid at Brands Hatch. Fortunately, however, things worked out well, with Jordan winning the final race of the opening weekend.

"The lads here really worked hard to get these engines out," comments Brown.

"We're very happy with the results. We've got a head rig that we'd used for testing valve gear and we'd done a certain amount of work on the dyno, but the time constraints meant we didn't have a chance to do any real endurance running prior to the engine being fitted in a car. It's testament to the base BMW B48 engine that the project has come together so quickly."

Each driver is permitted two engines during the course of a BTCC season. With that in mind, the teams typically remove the first engine around halfway through the year, but leave it sealed so it can be used later on without incurring a penalty. It's a tribute to the reliability of the B48 that none needed to go back to NBE during the season, although this did make it harder to determine what was going on inside.

"The engines were doing well, but one ▶



ABOVE Beneath the BMW's bonnet. The B48 engine justified the faith and finance invested in it

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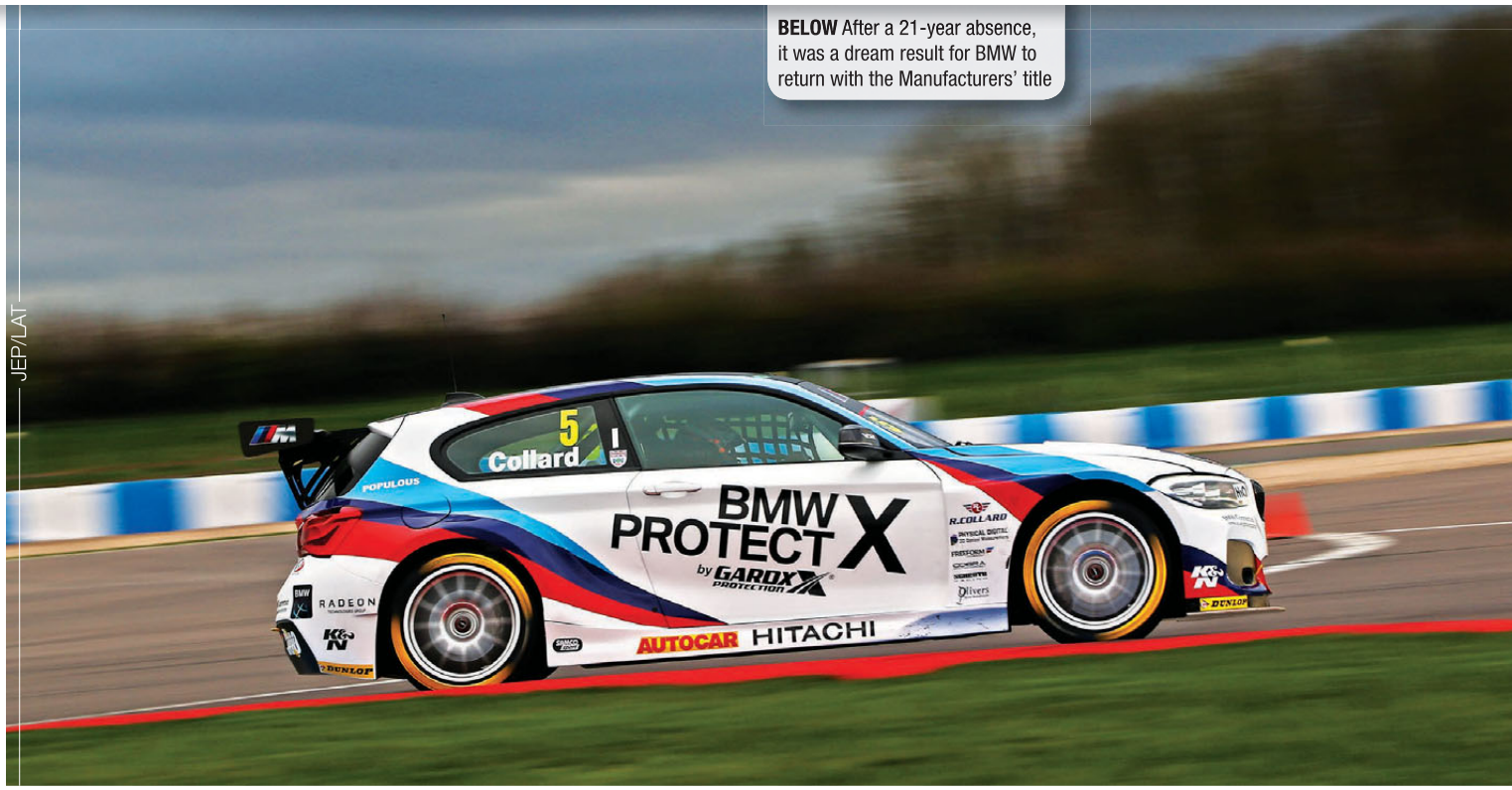


JEP/LAT

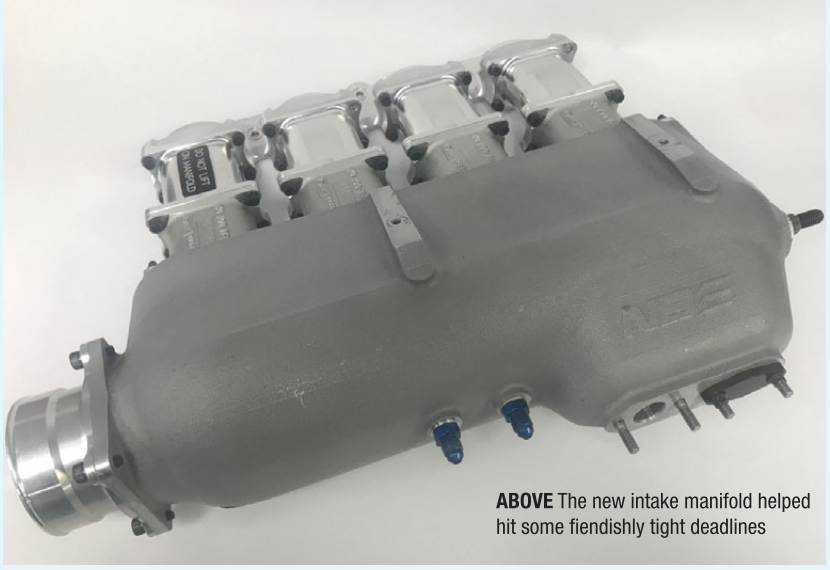
BELOW After a 21-year absence, it was a dream result for BMW to return with the Manufacturers' title

18 days that saved a season

TIME was the biggest constraint when Neil Brown Engineering needed a new intake manifold for the B48 race engine. Faced with a technically complex design and the first race looming, the traditional method of creating new CNC foundry tooling was not an option.

"We quickly recognised between us that the only solution was to utilise our tried and tested Rapid Deployment Facility to support NBE with its immediate requirement for components," comments Chris Warnes, managing director of Hadleigh Castings.

"This facility utilises the latest 3D mould printing techniques, so the parts could be manufactured using a tool-less hybrid casting process providing a small batch quantity of fully heat-treated production sand castings (not printed prototypes). The castings were ready for machining in only 18 days, supported by non-contact laser scan reports verifying the dimensional specifications and providing NBE with the confidence that the parts were correct to CAD." RT



ABOVE The new intake manifold helped hit some fiendishly tight deadlines

thing we were keeping an eye on was the timing chains," explains Brown. "Analysing the data, we could see a bit of camshaft oscillation, which increased as time went on, but we couldn't check without breaking the TOCA seals put on by the scrutineers."

Impressively, the production camshaft position sensor provides enough resolution to accurately measure this oscillation. Nothing else showed up, though, and WSR's results speak for themselves, winning the Manufacturers' and Teams' Championships, with Turkington only missing out on the Drivers' title when he was the victim of another car's accident in the final race of the season. For BMW that amounted to a very welcome return to the series.

"What a remarkable effort," concludes WSR team principal Dick Bennetts. "We came into this season a little late, turning a wheel for the first time on March 15, just one day before the official BTCC media day! With BMW's new B48 modular 2-litre production turbo engine and our trust in our engine partner, NBE, less than nine months later WSR and Team BMW won not only the 2017 Manufacturers' and Teams' championships, but also finished second and fifth in the Drivers' series.

"It was magnificent work from everyone involved. I would like to thank all of those partners who helped us achieve these fantastic results: BMW UK, NBE, K&N Filters, Physical Digital, Samco Sport, Atec, BTB Exhausts, Racelooms, Majenta PLM and of course everyone at WSR." RT

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CHANGE IS IN THE AIR

William Kimberley talks to Sauber F1 technical director Jörg Zander about the challenge of restructuring the Swiss team

WHEN Jörg Zander received a phone call from Sauber F1 team principal Monisha Kaltenborn, he was actually sitting on a plane about to take off for his summer holiday.

At the time he was the technical director at Audi Sport. Change was in the air, though, with the team pulling out of Le Mans and the World Endurance Championship to go into Formula E. Besides, this call was about bringing him back to Formula 1.

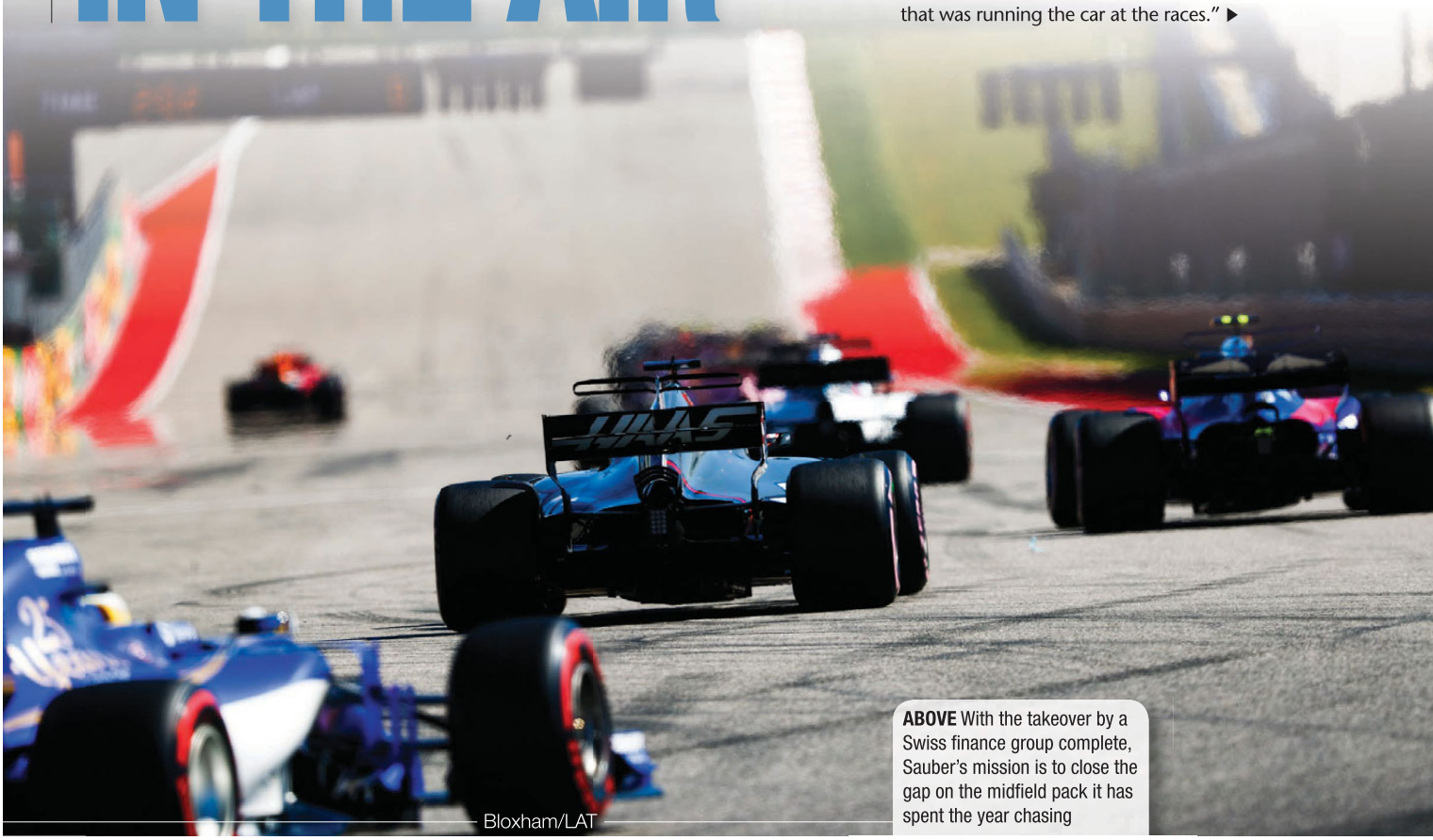
As he explains, it was like rejoining the family. He had initially entered F1 around 15 years ago when he came to Toyota before joining BAR in 2003. He then moved to Williams F1 as chief designer, then BMW Sauber in the same role, Honda F1, and then stayed with the team when it became Brawn F1.

"Formula 1 is high-end dynamics, quick decision-making, all about teamwork and making sure you're focused, bringing all that together, which is what I really like about it," he says. "You know what you want to do and then you go and do it. There's no lengthy debate. If you take too long to make a decision, you just get left behind."

The invitation to join Sauber also worked for him personally as he lives just 12 km from its factory in Hinwil in Switzerland. Although it was some time since he'd worked with the team, there was still quite a large group of people there with whom he had remained in contact over the years. The difference, though, was that Peter Sauber himself was no longer involved and even Kaltenborn was soon to depart as the new owners asserted themselves.

"On joining the team, it meant personally for me there was a period of time to understand who was doing what and how it all worked, along with getting my head around the processes and so on," he admits. "Then with the new owners it was understanding and explaining that there would be a different way of doing business. It takes time for any new company culture to work its way through an organisation. Part of my time is to ensure everyone within the technical department remains motivated."

It was altogether quite different from Audi Sport, which had a long and well established way of doing things with the resources available to it through being part of a major car manufacturer. "In the Audi organisation we had a well established racing environment so in my role there I was concentrating more on research and development, engineering and the technical progress on desigining the car," he says. "The racing side was more in the hands of Dr Ullrich along with the Joest team that was running the car at the races." ▶



Bloxham/LAT

ABOVE With the takeover by a Swiss finance group complete, Sauber's mission is to close the gap on the midfield pack it has spent the year chasing

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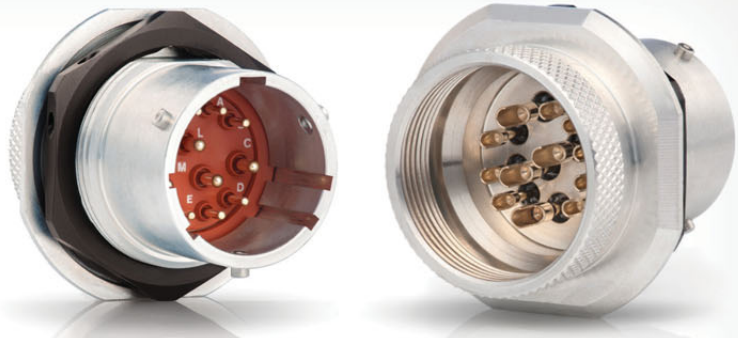

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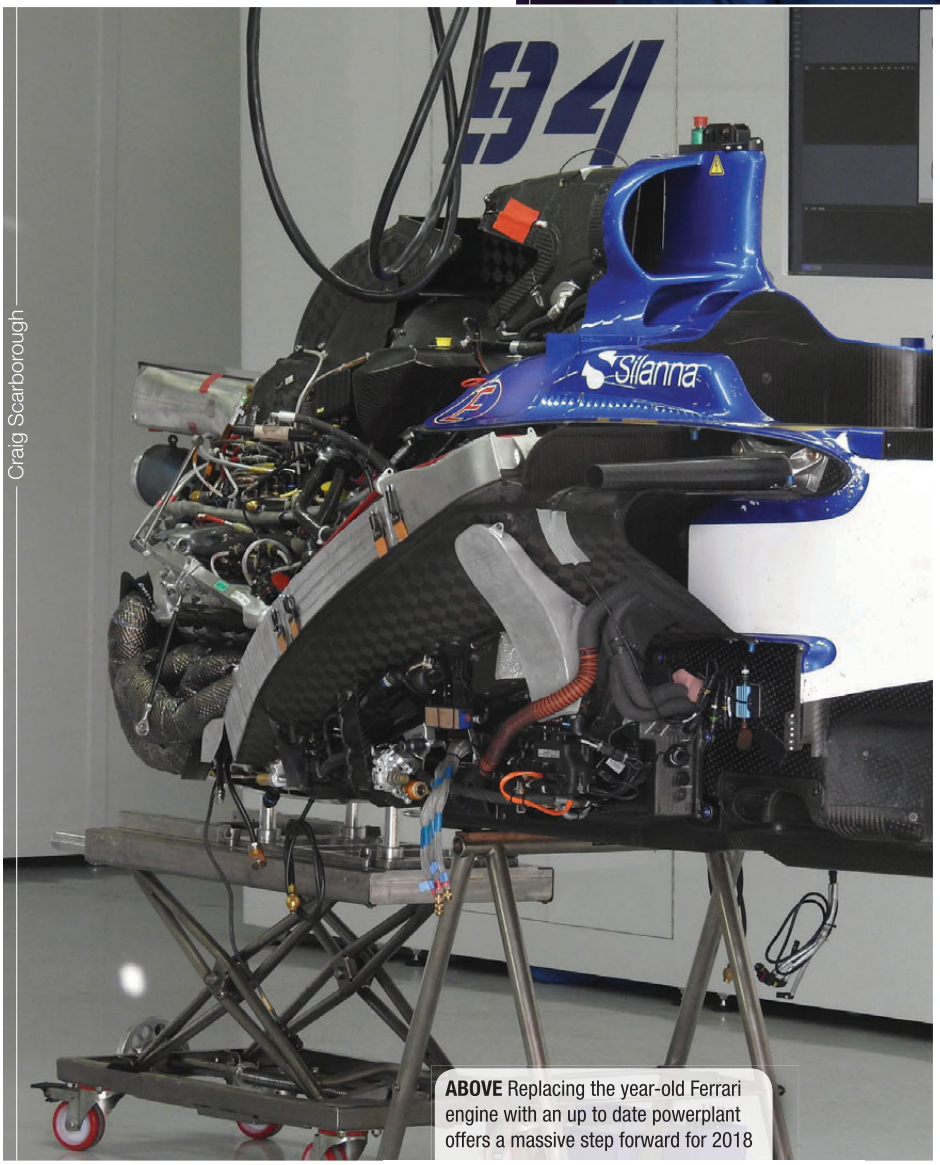
BELOW Zander's return to Sauber, after a decade away, was seen as an important step in the rebuilding mission

It meant there wasn't any need for him to be at every race, a situation he now finds himself in again. He decided that remaining back at Hinwil is more important than going to the races on the other side of the Atlantic at the tail end of the season.

Part of that is due to the state of flux the team is in. To say that he inherited a challenging situation is probably an understatement. Apart from the upheaval of new ownership, the biggest factor was running Ferrari-powered cars this year but with last season's power unit.

"When I arrived at the beginning of January, there was nothing I could do at this stage except perhaps judge the concept, although I think some of the things I suggested were already in the pipeline anyway," he says. "Work had started quite late on the car because some people had left, so it was pretty tough on everyone. However, the team still boasts a base group of very talented and experienced engineers who've been there a long time and know what they are doing.



Craig Scarborough

ABOVE Replacing the year-old Ferrari engine with an up to date powerplant offers a massive step forward for 2018

"As a technical director, though, I'm not a dictator but have decision-making procedures in place that consider various people. My number one priority was to make sure the organisation was structured in a way that it would work efficiently and cope with the high-pressure daily requirements. I think it's really fundamental to achieve this if a Formula 1 team is to be successful. Everyone has to have the same goal. It's a challenge because everyone has their own character, but you've got to ensure that they gel with each other and put the interests of the team first.

"In the good old days, the person in charge of aerodynamics, which was a huge contributor to the car's performance, was calling the shots. However, vehicle dynamics, simulation and virtual aspects all play important roles today. So you have to make sure that from a global functionality aspect, as far as the vehicle is concerned, all these elements are included in the decision-making process.

"We also needed to validate our development processes because we established new ones and needed to see whether they worked well. If they didn't we knew we had to change something for next year, but if they did, then perhaps it was a question of refining them further and to be more confident in what we were doing."

By the summer break, as with pretty well every team, most of the resources were ▶

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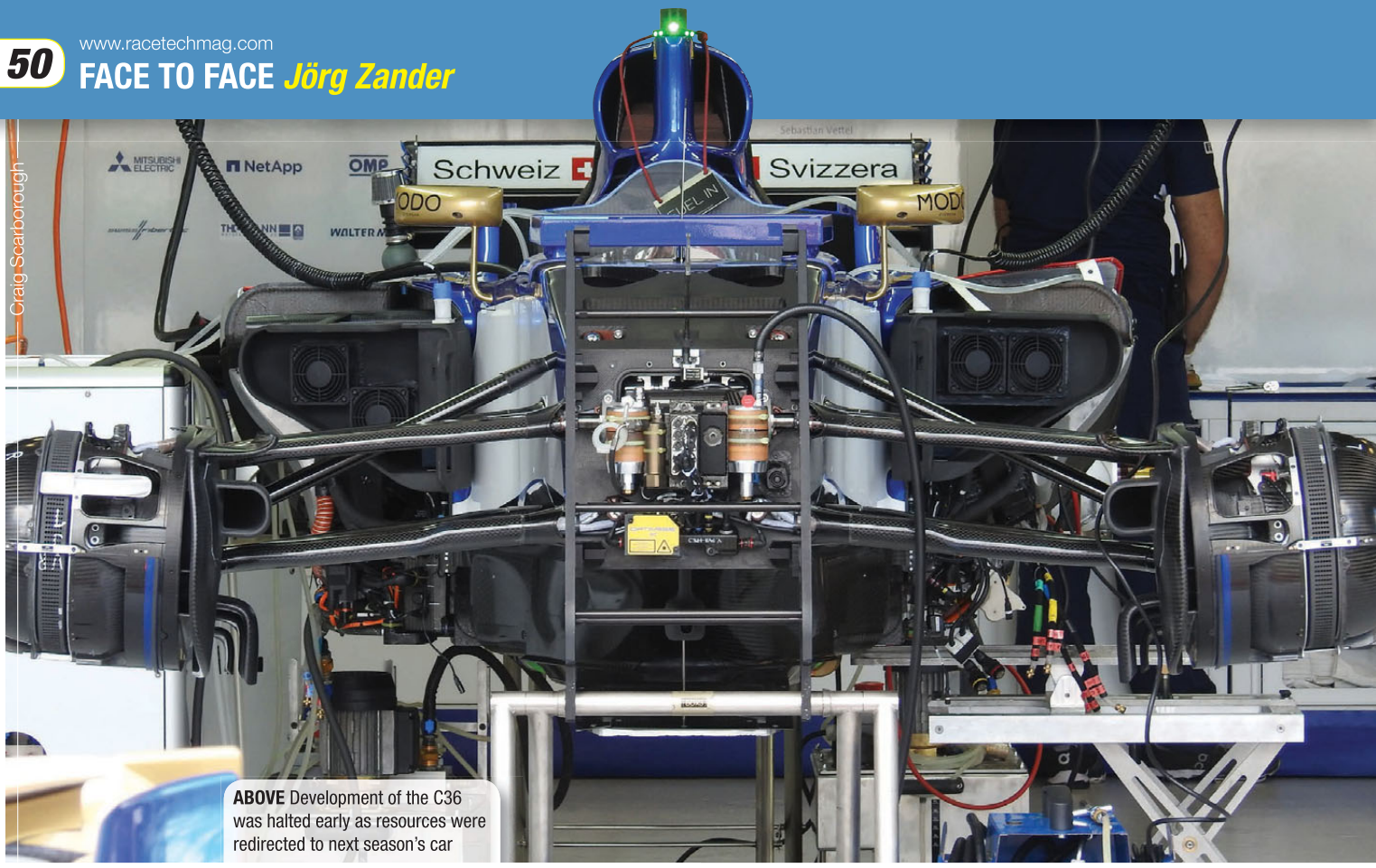

Craig Scarborough

ABOVE Development of the C36 was halted early as resources were redirected to next season's car

> *"Everyone has their own character, but must put the interests of the team first"*

being put into next year's car. The rest of the 2017 season was considered a bit of a write-off, with just a few upgrades coming through the pipeline.

"In fact, it wasn't too hard a decision to make to concentrate on next year's car," says Zander. "2017 is a transfer phase for the team, which I'm happy to accept, but we had to move on."

There's no question that having to run last year's engines really hurt the team. While aero plays a very significant role in today's Formula 1 cars, if the horsepower is massively down, no amount of clever aero work will compensate.

"This isn't a criticism of Ferrari as the decision was made to go with last year's engine," says Zander. "But we couldn't compensate for the power deficiency, and as the season wore on it became harder as the other teams appeared with upgrades that we didn't have."

Work commenced on the 2018 car in late April, initially by just a small group of people who are not integrated in the standard design process. "Led by the chief designer their job is to examine the concept," says Zander. "Then there is a committee with the head of vehicle performance (vehicle dynamics) and the head of aero and the chief designers, along with myself, where we discuss the car's concept.

"Of course, we are only working to a certain level of detail, so that we have a perspective on the suspension design that we can do on CAD and see how it integrates. Then there's an element of functionality as far as kinematics and compliance are concerned. At this stage it's all pretty crude and not the finer detail, but it gives an idea on the direction and gives us a chance to make some macro decisions on the concept."

What was a variable at this stage and during the second quarter of the year was that the choice of power unit was still up in the air. For a while it looked certain that the team would give up its long relationship with Ferrari and go to Honda. Ultimately, it announced it wasn't going to partner up with the Japanese engine manufacturer but instead remain a Ferrari customer. Unlike this year's deal, though, it was agreed that it was going to get current-spec engines and gearboxes from 2018 on.

Furthermore, the team could extend the collaboration – a move which would obviously lead to improved performance. In return, Sauber could help Ferrari with its driver development programme, most notably, giving a ride to Formula 2 champion Charles Leclerc along with fellow junior Antonio Giovinazzi.

PREVENTING AN ARMS RACE

In an effort to curtail an arms race in aero development, the FIA imposed restrictions on CFD usage and wind tunnel time, in order to help teams like Sauber. However, it's not an eact science, as Zander explains.

"It's megaFLOP allocation unit per hour as opposed to teraFLOP, but if you are trying to evaluate the processing power that's been used by different processors and different software, that's quite difficult to achieve. The FIA is trying to normalise this but it's enormously complex and while some of our hardware is now outdated, we need to see what the outcome is before deciding on what to do. We have to make sure that the hardware for our CFD processors is up to date and reasonably huge in volume.

"Another reason for this is because we do third party projects who use our wind tunnel and our CFD analysis processors, and is another way of engaging with business partners."

This year has perhaps been one of the hardest in the team's history in Formula 1, but it is not sitting back and licking its wounds. While being a front-runner for 2018 and beyond might be a stretch, the focus has been on getting the right ingredients in place. With the likes of up-to-date Ferrari engines, the talents of people like Willem Toet – who is back on board – and Jörg Zander, along with two inexperienced but quick drivers, it is within the bounds of reason that Sauber should start challenging the midfield runners once again. RT

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BELOW The new breed of WRC cars evoked memories of Group B. Ford's Fiesta WRC led the way

WRC/Red Bull

THE ARCHITECTS OF A BRAVE NEW WORLD

William Kimberley reveals the nominations for Race Tech's technical awards, to be presented at this month's World Motorsport Symposium

A DEEP intake of breath accompanied the beginning of the 2017 season, for this was a year defined by a fresh start in so many of world motorsport's categories.

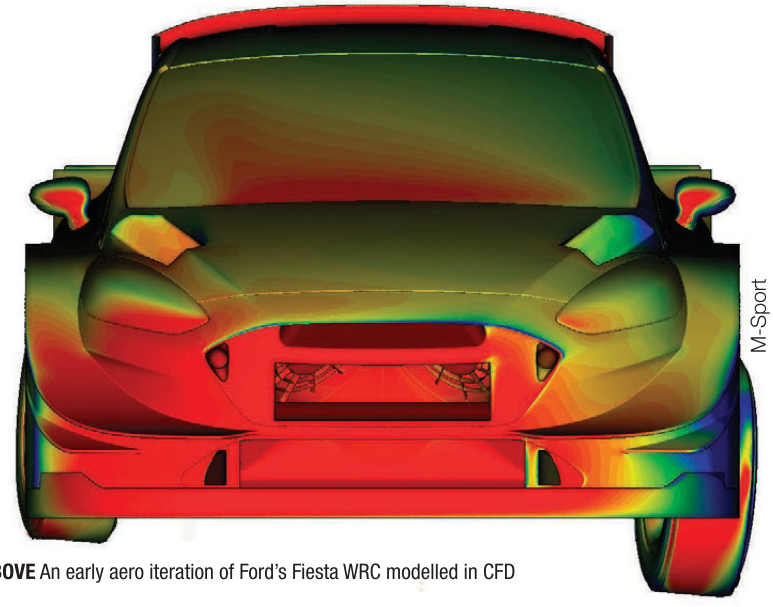
Both Formula 1 and world rallying introduced new cars, with the emphasis on greatly increased aerodynamic performance. On the sportscar stage, meanwhile, there was massive upheaval too. A new generation of LMP2 chassis and engines were produced, shaping the sport on both sides of the Atlantic.

In spite of the potential for things to go wrong, most observers deemed the brave new world to be a big success. That is reflected in the shortlist for this year's awards.

The new cars are more powerful than their predecessors, but it was the dramatic aero kits that immediately caught the attention when the manufacturers took the wraps off their 2017 challengers. Wider, longer and more aggressively styled, they capitalised to the full on aerodynamic regulations that permitted a larger rear wing, rear diffuser and front splitter. The result has been spectacular action, record average speeds and, in some cases, the advent of chicanes on the faster stages.

Traditionally, aerodynamics has been a key battleground in Formula 1, but not in rallying. At their zenith, the Group B cars of the '80s did feature air dams at the front and monstrous rear wings. However, the high ride heights and extreme yaw angles at which they operated meant they were unsuited to development with a scale model in a wind tunnel.

So what's changed? Advances in computer power. Computational Fluid Dynamics (CFD) was one of the key weapons in M-Sport's armoury when it developed its striking new Ford Fiesta WRC. It was a car which, like its rivals, appeared to betray a touch of Formula 1 influence. Unlike its rivals, though, M-Sport's contender was not backed by the ▶



M-Sport

ABOVE An early aero iteration of Ford's Fiesta WRC modelled in CFD

DINO TOSO RACECAR AERODYNAMICIST OF THE YEAR

M-Sport nominated for the Ford Fiesta WRC

THE dawn of an exciting new era in the World Rally Championship this season has placed an emphasis on aerodynamic development like never before. And nobody has exploited the opportunity better than British firm M-Sport.

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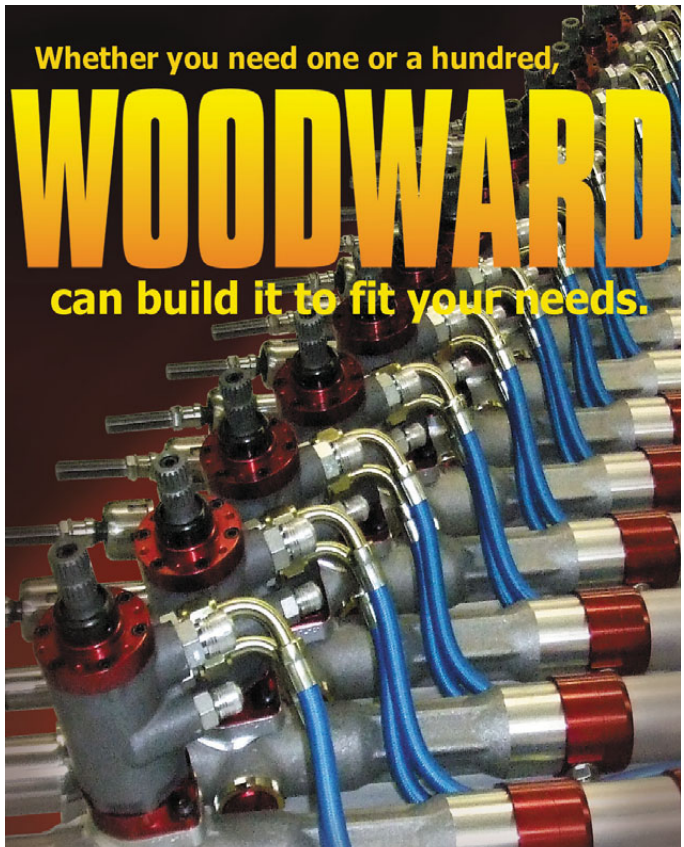

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Ferrari

BELOW The SF70H's sidepod packaging differentiates the Ferrari from any other car on the 2017 grid

full might of a factory, a fact that has made its success all the more impressive.

With diveplanes, flicks and complex aero appendages proliferating on the new machinery, one of the main challenges was to develop an aero package robust enough to survive the pounding of a rally environment. Initial tests of the Volkswagen, for instance, left shards of carbon fibre all over the countryside. Furthermore, the aerodynamic package had to operate over a wide range of yaw and pitch angles without any significant drops or sudden changes.

Citroën's C3 dazzled on asphalt, Toyota's Yaris excelled on occasions, and Thierry Neuville was able to master Hyundai's i20 like none of his team-mates. By contrast, the Fiesta WRC was a threat on every terrain and in the hands of all of its drivers. As we went to press, M-Sport was closing in on both the Drivers' and Manufacturers' titles.

Ferrari nominated for the SF70H

FERRARI was the toast of many fans as Formula 1 entered new territory in 2017. The cars looked great, having undergone a huge aerodynamic overhaul in the quest for greater downforce and speed, but would the outcome still be a procession? The performance of Ferrari's SF70H quickly dispelled those worries.

Ultimately, poor reliability proved the team's undoing. Yet the spectacular disintegration of Ferrari's title challenge serves to mask the fact that it not only carried the fight to Mercedes-AMG, but actually led the championship for the first 12 rounds.

Although the SF70H retained the high rake setup of its predecessor, it marked a departure in terms of aerodynamics. At the heart of that philosophy was the striking sidepod packaging, with a high upward-facing inlet, creating a tall undercut shape beneath that differentiated it from all the other cars on the grid. The approach compromised other areas of the car in the quest for a more powerful underfloor effect, but it worked.

Without doubt, Ferrari had been the beneficiary of the governing body's rulings on technical squabbles over the close-season. During the course of the campaign, though, it was arguably Ferrari that suffered most from further clarifications as it, like the other heavy-hitters, pushed to the limit with its development of both suspension and bodywork.

The Mercedes-AMG powertrain has been the benchmark for others to aim at throughout the hybrid era. It still is, with its ability to run a higher mode in qualifying particularly invaluable. But for Ferrari to have pushed it that far, for that long, suggested that its car was better than a rival that even Mercedes conceded had "diva" tendencies. On circuits like Monaco, Hungary and Singapore, where the chassis rather than brute power prevailed, the Ferrari – like the Red Bull and McLaren – showed its class.

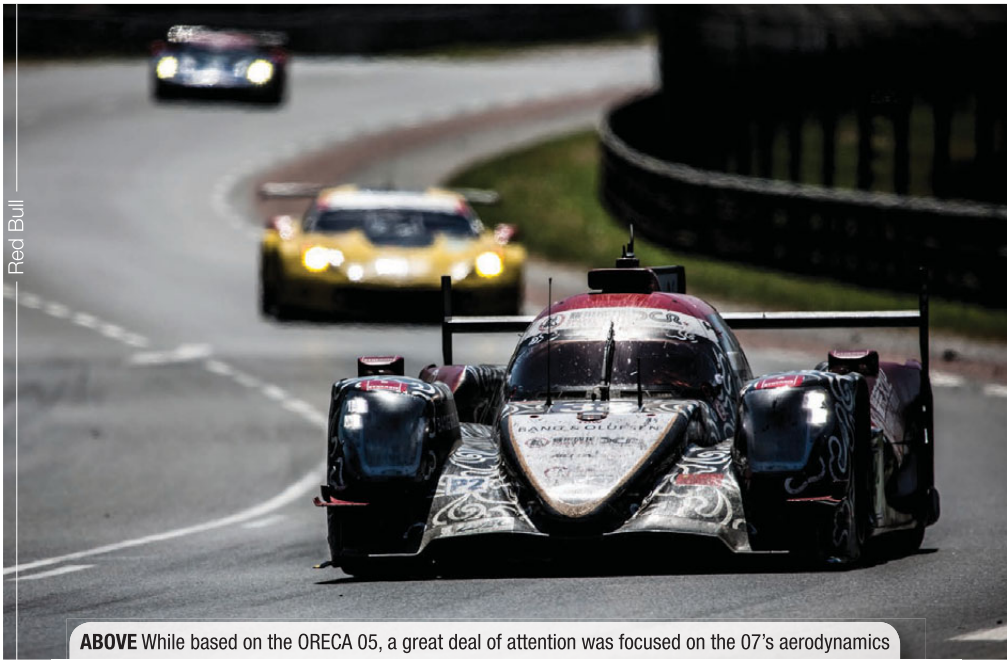
ORECA nominated for the 07 LMP2

IT is a reflection of just how successful ORECA has been this season with the 07 that it has been denied the closed season 'joker' upgrades that have been granted to rival LMP2 manufacturers Ligier, Dallara and Riley.

The trouble is, ORECA is just too good at what it does. When the Vaillante Rebellion 07 took the chequered flag at the end of this year's FIA WEC 6 Hours of Mexico in September, it marked the French constructor's 50th LMP2 win in just six years.

While the ORECA 07 was conceived around the successful ORECA 05's monocoque and shares a certain number of its mechanical components, one of the main differences was that it incorporated radically different aero. The package featured significantly increased efficiency and downforce. The car was developed totally in-house, using exclusively CFD.

"The ORECA 07 benefits from the experience and knowledge that we have developed from previous projects," said ▶


Red Bull

ABOVE While based on the ORECA 05, a great deal of attention was focused on the 07's aerodynamics

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technical director David Floury. "Yet all previous prototypes have been designed within relatively different contexts. The ORECA 03 was our first LM P2. It was based on the monocoque of the ORECA 01 and was an open-cockpit prototype. Its conception dates back to 2010. At that time, the rules were very different in terms of the selling price being fixed by the cost cap. Since then, the standards in terms of aerodynamics have also changed a lot, looking to ensure better stability in hairpin bends. So changes in rules and regulations have a strong impact on performance and aerodynamic concepts too."

RACE ENGINE DESIGNER OF THE YEAR

ABOVE The extensive NASCAR experience of ECR Engines, particularly in valvetrain development, underpins Cadillac's all-conquering 6.2-litre naturally aspirated V8

ECR Engines nominated for the Cadillac DPi 6.2-litre V8

THE Cadillac DPi-V.R. has been the package to beat in the first season of IMSA's headline Daytona Prototype international category, thanks in no small part to its 6.2-litre naturally aspirated V8. It won the first seven races of the season, including the Daytona 24 Hours.

Although it shares some fundamental architecture with the previous DP engine, it is essentially all-new. It follows a no-nonsense formula with an 'overhead valve' pushrod layout, port injection and two valves per cylinder. The design work for the project officially began on 11 January 2016 and less than nine months later, on 5 September, the car was running on track.

During that time, the ECR engineers had designed a new bespoke engine, validated it on the dyno, produced the parts and liaised with three different customer teams. They drew upon their expertise from the company's Cup programmes, particularly in the valvetrain development. The design of the reciprocating assembly, bearings and oil pump has also been influenced by that.

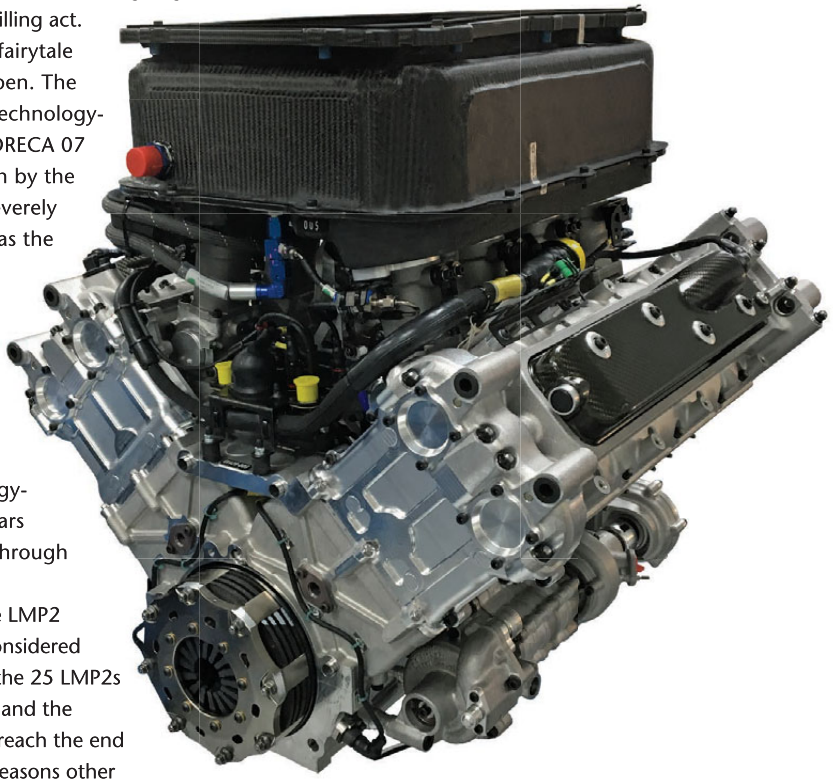
This DPi engine is the first competition outing of GM Propulsion Performance and Racing's new LT-R cylinder block, which will be shared across various racing programmes. This is based on the all-aluminium two valve per cylinder LT-series production engines found in the Chevrolet Corvette and the Cadillac CTS-V among others.

Gibson Technology nominated for the GK428 V8

THERE was almost an upset of seismic proportions at this year's Le Mans 24 Hours when it looked for a while as if a Gibson-powered ORECA LMP2 car was going to perform a giant-killing act.

In the end, the fairytale finish didn't happen. The leading Gibson Technology-powered LMP2 ORECA 07 was hunted down by the one remaining severely delayed Porsche as the race entered its final phase. The German car took the lead with just 20 laps remaining. Remarkably, the Gibson Technology-powered LMP2 cars finished second through to seventh.

Traditionally, the LMP2 cars have been considered fragile. Yet 21 of the 25 LMP2s finished the race, and the four that did not reach the end dropped out for reasons other than engine issues. Together, the LMP2 cars completed 143,400 km in a combined total of 719 hours and 27 minutes, which is something like circumnavigating the globe three and a half times. Furthermore, oil consumption was kept to a minimum, most teams adding just half or a whole litre of oil to the engine during the 24 hours.



ABOVE Gibson Technology's GK428 came so close to springing an upset at Le Mans

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It was in June 2016 that Gibson Technology was announced as the sole engine supplier to all LMP2 teams competing in the FIA WEC, ELMS and the prestigious Le Mans 24 Hours. The GK428 is also being supplied to LMP2 teams in the IMSA WeatherTech SportsCar Championship. The brief from the FIA was that the 4.2-litre V8 engine – the first such configuration that Gibson Technology, or Zytek Engineering as it used to be called, had ever designed and built – had to develop 600 bhp. That figure had to be sustained throughout the race, and part of the deal was that engine rebuilds were only allowed after 50-60 hours.

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

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

Neil Brown Engineering nominated for the BMW B48

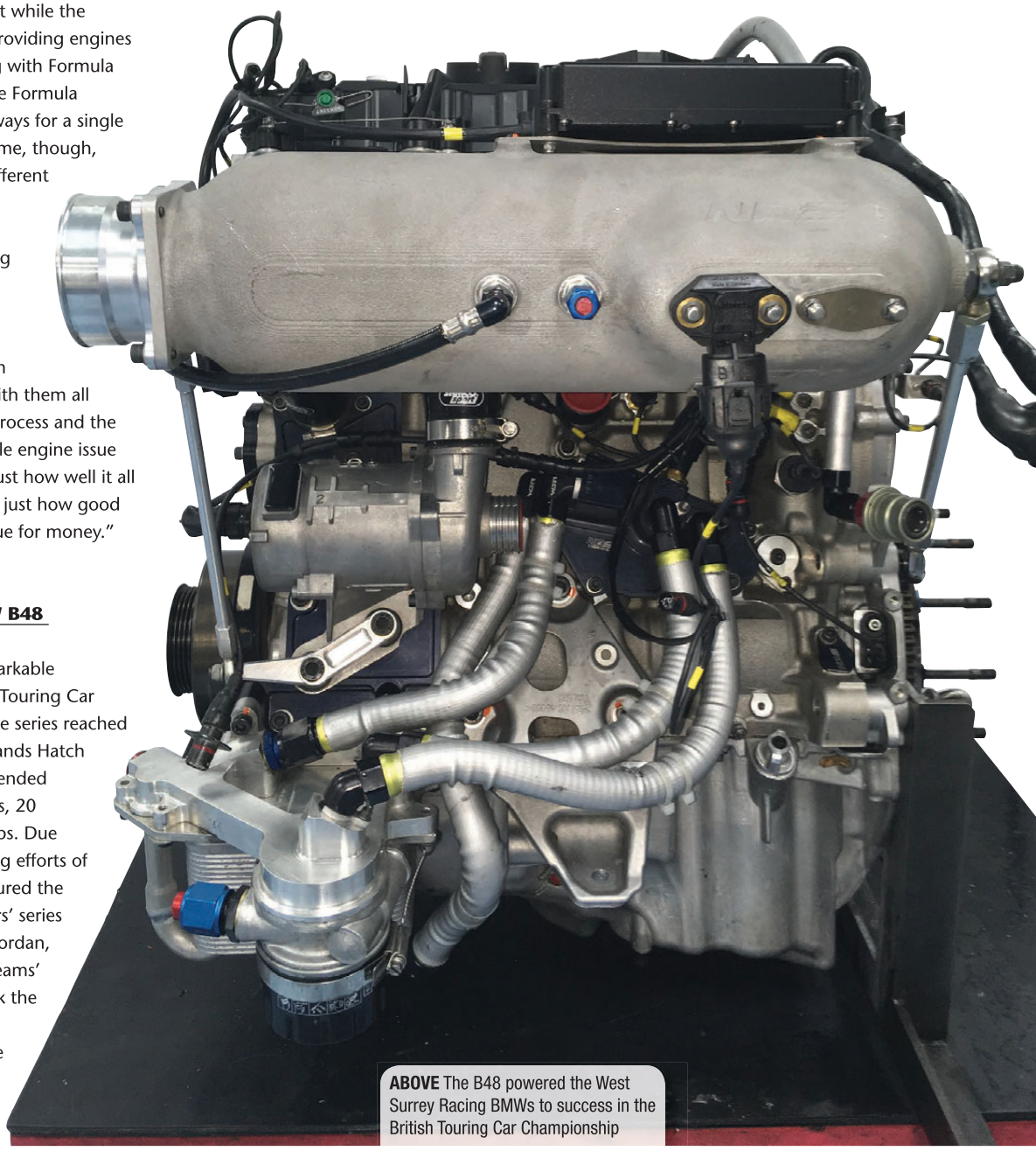
TEAM BMW claimed a remarkable double Dunlop MSA British Touring Car Championship success as the series reached a dramatic conclusion at Brands Hatch in mid October. The squad ended the season with five victories, 20 podiums and nine fastest laps. Due to the combined season-long efforts of Colin Turkington – who secured the runner-up spot in the Drivers' series – Rob Collard and Andrew Jordan, Team BMW was crowned Teams' Champions while BMW took the Manufacturers' crown.

It has been 21 years since the German manufacturer last had a works entry in the British Touring Car Championship (BTCC), but this season it returned with a three-car team campaigned by West Surrey Racing which has been running BMWs independently in the series since 2007. However, it was more than just a rebranding exercise because along with the sponsorship money came technical support from the factory and, most importantly, a new engine developed by Neil Brown Engineering (NBE), one of WSR's longstanding partners.

The B48 is a 2.0-litre, turbocharged inline four with direct injection and variable valve timing. It's used in a huge variety of BMW Group applications from the MINI Cooper S to the long-wheelbase 7-Series. It also makes an ideal base for the BTCC engine regulations.

"The B48 is a very good starting point," said Neil Brown, managing director of NBE. "It's a good strong unit, and it's been designed for turbocharging from the outset. The block is a closed deck design, which greatly aids its rigidity."

The project's tight timescale was aided by the scanning of the production engine by Physical Digital, one of WSR's technical partners, to generate a 3D CAD model that could be used for packaging. RT



ABOVE The B48 powered the West Surrey Racing BMWs to success in the British Touring Car Championship

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BRIGHTEST SPARKS OF INNOVATION

William Kimberley considers some of the nominations for the Don Burgoon award for the Most Innovative New Motorsport Product

ABOVE The DDU 10 features 10 additional LEDs on both sides of the device

ABOVE The nanoDaq-LT utilises the latest technology in digital transducers

2017 proved to be yet another innovative year with a huge variety of products coming to market. Those shortlisted at the time of going to press include:

Bosch

Nominated for its DDU 10

The Bosch DDU 10 integrates a programmable full colour dashboard display with a data logging system for motorsport applications. A whole new library of graphical elements for the individual design of display pages have been implemented and an all-new user-interaction menu has been developed for the device.

A configurable input activates the menu structure and the user can reset, for example, lap time, fuel consumption and many more features, without having to connect a laptop to the DDU. Users can also install their own graphics, pictures and other images on the 12 freely configurable display pages.

For quick data transfer from the car, such as during a pit stop, data copy to a USB stick is available as an option. The stick is connected to the wiring harness for the DDU 10.

Chell

Nominated for its nanoDaq-LT pressure scanner

Chell's new pocket-sized nanoDaq-LT, a low cost multi-point pressure measurement scanner, complements its existing range of MicroDaq pressure scanners.

Weighing only 37g and measuring 59.5 mm x 27 mm x 12.5 mm (excluding tubulations), it's only one third of the cost of Chell's top end instruments. It means that many more businesses and applications can take advantage of this latest technology in digital transducers as it's affordable for a much wider range of aerodynamic testing applications. It is also suitable for on-vehicle and wind tunnel applications where the class-leading accuracy of the MicroDaq/TE DTC scanner is not required.

Its size and rugged construction mean the pressure scanner is perfect for use in harsh environments, while reconfiguration of the port outlets allows measurements to be made more conveniently in tight spaces. There is also the option of having port plate connections rather than tubulations. The nanoDaq-LT makes aerodynamic pressure testing much more affordable and versatile.

Cosworth

Nominated for its EtherCAT communications protocol

Cosworth has implemented the EtherCAT communications protocol for its on-vehicle data acquisition and control systems. EtherCAT is used to connect Cosworth's latest high-performance data logger and controller, the Central Logging Unit (CLU), and Synchronous Junction Unit (SJU). The result is greatly improved synchronisation ▶

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ABOVE EtherCAT is used to connect Cosworth's CLU and SJU

of data and increased bandwidth available when using distributed system architecture for sensor installation.

Precision is a key benefit, with precise synchronisation by exact adjustment of distributed clocks. Each slave node has its own clock, which is adjusted to maintain sync and speed – max transmission rate 2 x 100 Mbit/s (Fast Ethernet, Full-Duplex).

Simplicity is another important factor with its faster set-up with no address setting required, as is its reliability – all time-critical functions implemented on ASIC or FPGA so network performance is unaffected by application micro-processor performance.

The final attribute is its efficiency – minimal protocol overhead means bandwidth is efficiently used.

Toray Industries

Nominated for its fire-resistant material

With a long background in the aerospace industry in the US, Japanese company Toray Industries, the world's biggest producer of carbon fibre, has turned its attention to motorsport.

The gameplan is to exploit its expertise in materials and it has already notched up success, delivering a fire-resistant product into NASCAR. It's not a traditional flame retardant resin because halogenated components that can decrease the performance of the matrix and are toxic aren't used.

There were three principal goals in its development other than fire resistance: high Tg (glass transition temperature); fast curing; and cost. The high Tg would allow it to be used in more demanding applications and the quick cure allows teams to lower costs as the shorter cycle time enables a single mould to produce more parts a day, which can reduce tooling costs.

Grainger & Worrall

Nominated for its high-performance cylinder head castings for racing applications

GW has evolved the technology for manufacture of cylinder head castings for high-performance applications.

Utilising unique High Hot Strength sand printing technology within an optimised production process, GW can produce complex internal form without conventional tooling constraints. This gives complete geometry freedom to create the cooling systems for the latest small capacity, turbocharged racing engines for the highest levels of motorsport.

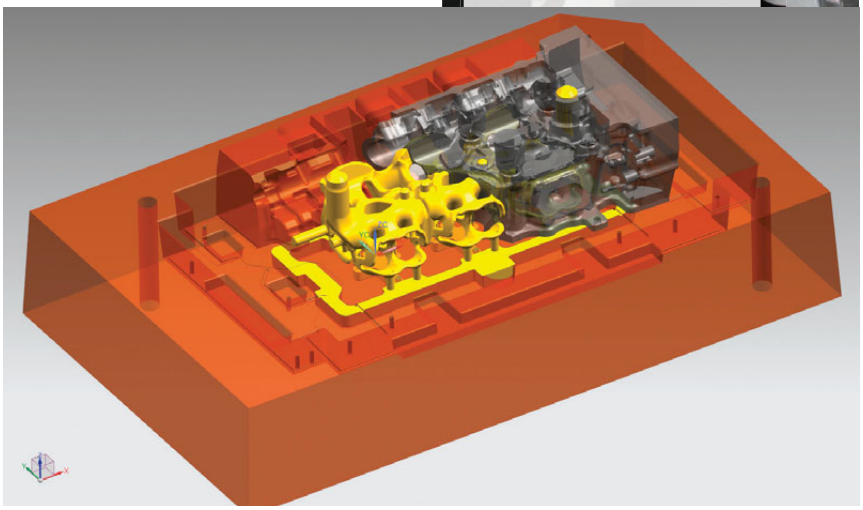
Fine detail, filigree cores are produced without draft taper or core joints, allowing designs to be optimised for performance and weight. Without the need for tooling, rapid and concurrent iterations are possible, reducing lead-times and enhancing development programmes.

Due to the highly stable results achieved from this core manufacturing technology, and used in combination with alloys developed for high temperature, high stress applications, GW produces consistent, high integrity, racing castings.

Part quality is validated via GW's extensive inspection technologies. GOM Optical scanning is used for dimensional controls of Digitally Printed Sand cores to ensure accuracy prior to use. Industrial grade Computer Tomography (CT) is used as a 100% control of cast parts for material integrity.

These technologies, used in concert in this very specific way, allow GW to produce next generation, racing-grade parts for championship-winning applications right now. RT

ABOVE & BELOW GW can produce complex internal form without conventional tooling constraints



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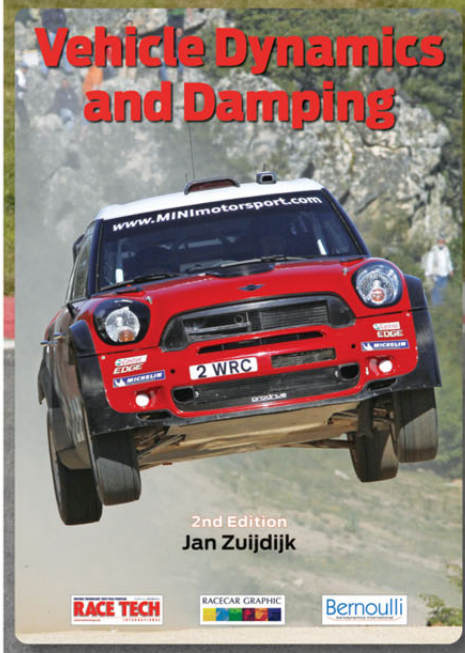

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THE ELECTRONIC ADVANTAGE

Engines may be getting ever more complex, but, as **Alan Stoddart** learns, innovation in electronics means they are also increasingly manageable

GETTING IT RIGHT

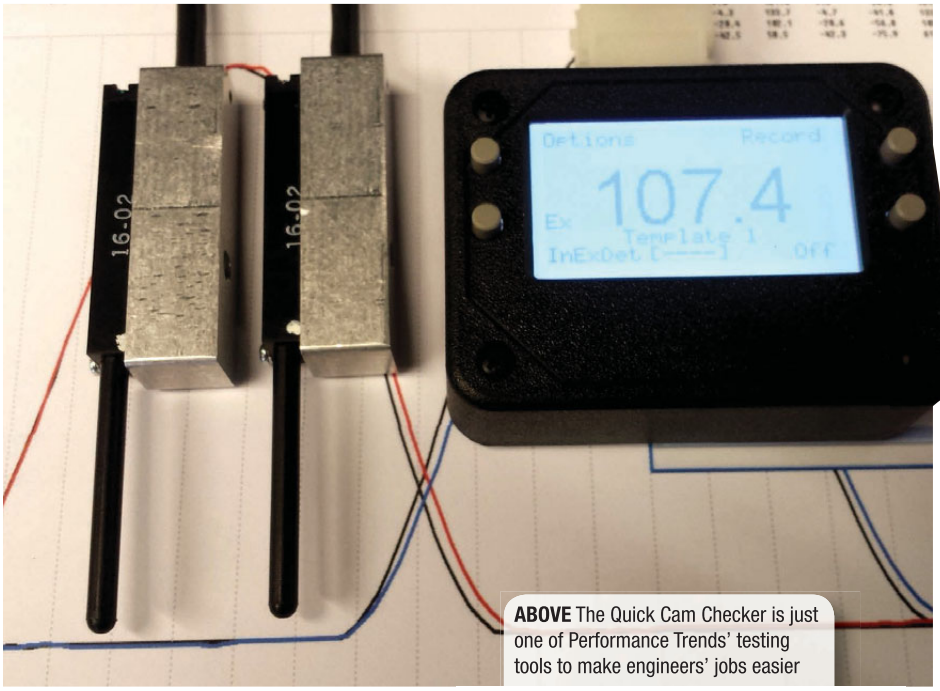
To get the best performance from an engine, it is not only crucial to monitor the engine while it is running, it is also critical to properly calibrate the engine. To this end, Performance Trends offers, among other things, specialist testing equipment that enables engineers and race teams to easily and accurately check vital measurements deep within the powertrain.

The company's new Quick Cam Checker is a quick and affordable way to measure the camshaft. One of the things that sets the Cam Checker apart is the ease of use. It only requires two valve lift sensors to be placed on the retainers, a rotary sensor on anything that spins with the engine, such as the pulley, or the belt, and a pressure sensor to be inserted in place of a spark plug. To make the actual recording, all that's needed is a press of a button and a couple of revs of the engine with the starter motor. The simplicity of this system, as well as the fact that it requires very little teardown of the engine to be completed, also makes it ideal for track inspectors.

Another new addition to Performance Trends' range of tools is the A/F Checker, which enables engineers to easily check the calibration of the wide band air fuel ratio sensor. By using propane and shop air and installing the A/F sensor from the data logging system, engineers can dial in any air to fuel ratio from 10 to 17:1, as well as verifying that the A/F measurements are accurate. An additional benefit of Performance Trends' A/F Checker is that it checks the system from end to end including sensor function and calibration settings in the data logger and software, this is a key feature for dyno operators using wide band A/F sensors.

The Valve Seat Pressure Spring Checker also uses advanced technology to facilitate easy and repeatable measurement. Unlike traditional seat pressure checkers, which rely on the user 'feeling' when the valve unseats or reseats, Performance Trends' Pressure Spring Checker does that through advanced computer algorithms. All the user needs to do is pull the handle until the valve unseats and then let it reseat before the pressure number is displayed. This ease of use results in a completely unbiased, repeatable number, regardless of who is doing the measurement.

Tools like this from Performance Trends ensure that cars can start races finely tuned, while this sort of detailed testing can also help identify problems before the race starts.



ABOVE The Quick Cam Checker is just one of Performance Trends' testing tools to make engineers' jobs easier

READY TO RACE?

As important as monitoring the condition of the engine is checking the state of a racecar's tyres. For over 10 years bf1systems has met this need by offering tyre pressure and temperature monitoring systems to all levels of motorsport, ranging from Formula 1 through to club level racing.

The company's current range of products ensures that teams are able to understand the state of their tyres both when they are fitted on the running vehicle, and also prior to going out on track.

The standard Tyre Pressure Monitoring System provides reliable, accurate data on tyre pressure and air temperature. For open wheel race cars, a positioned system is used which requires only two receiving components fitted onto the chassis of the car. For closed wheel racers the learning system, which has a trigger antenna fitted into each wheel arch, means that teams are able to simply fit any wheel sensor onto any corner of the car and the system will automatically detect where the sensor has been located and start monitoring.

In addition to TPMS, bf1systems also offers its InfraRed Tyre Pressure Monitoring and Temperature Monitoring System with either ▶

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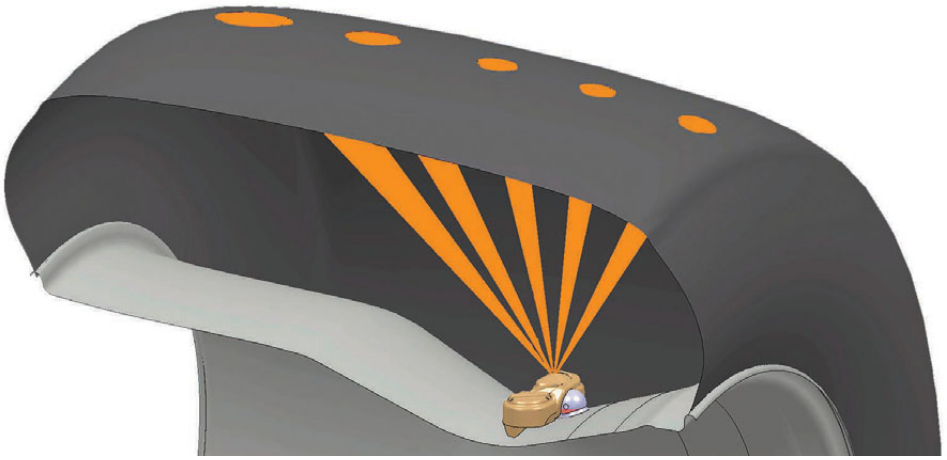

ABOVE The InfraRed Tyre Pressure Monitoring and Temperature Monitoring System from bf1systems can measure the tyre carcass at five customer-selectable points

a single measurement point on the inside of the tyre carcass, or with five selectable separate measurement points on the inside of the tyre carcass. The single point and five pixel IRTPTMS wheel sensors are compatible with either the positioned or learning systems, and have been used extensively by engineers scrutinising differences in a tyre's behaviour as a car setup changes, as well as assisting tyre engineers with understanding tyre behaviour in more detail.

The two sensors have also become widely used by tyre manufacturers because they provide consistent measurements regardless of the conditions, and are not affected by environmental conditions such as dust and water.

Providing data on tyres when they are on the vehicle is, however, only part of what teams require these days. Optimising their workflow and ensuring that the tyres are in their optimal condition before being fitted to the vehicle is also becoming increasingly important.

To make a team's life easier, bf1systems supplies tools such as the Garage Monitoring System which provides a networked system allowing all team members to check on the status of all their wheels from their own computer, and removes the requirement for the tyre engineer to individually check the status of each wheel, which potentially allows temperature to escape from tyre tents or blankets. The system also provides easy to see warnings, should a tyre pressure or temperature stray outside of its specified limits, keeping engineers in the loop at all times.

BELOW Lane's range of size 01 connectors and accessories is designed to retain reliability when every gram counts

JOINING THE DOTS

Of course, having the most advanced electrical components brings no benefits if the connections that enable them to function cannot be depended on. To meet the demands of motorsport designers, who seek more complex cable harnesses fitted with smaller, lighter and more versatile connections which are still reliable in the extreme environments within racing engines, Lane Motorsport has introduced the 8STA circular connector series.

These new product developments will be utilised in the connection of engine control units, communications equipment, data acquisition systems, fuel pumps, starters, alternators and batteries throughout all levels of motorsport. In these applications, Lane Motorsport says the ultra-miniature 01 Souriau 8STA circular connector series offers 20 percent weight and size savings compared to the 02 series, yet still retaining that product's performance advantages such as its anti-vibration design and resistance to motorsport fluids. These size 01 connectors accommodate three removable #26 contacts that are compatible with wires from 24 – 39 AWG, and feature a positive locking mechanism with locked colour indicators.

For even more weight saving, Lane has also made a single flange version available. This has a single hole fixing which will save space in many applications, enabling users to better optimise their electrical architecture.

Further adding to the utility of the interconnection package is a range of accessories made by HellermannTyton and Weald Electronics. These accessories include protective caps, gaskets, nut plates and heat shrink boots which are adhesive lined and made of fuel-proof material. There is also a special version of the boots designed for use in high temperature environments. These boots, which are distinguished by their yellow dot, are manufactured from flexible flame retarded fluroelastomer, which can operate continuously in a temperature range of -55 to +200°C. ▶

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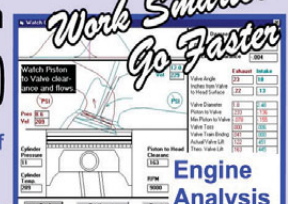

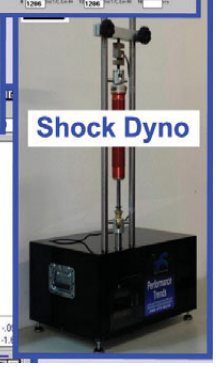

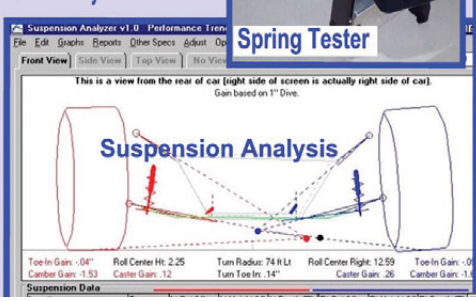

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KAlibrated solutions for motorsport

ABOVE The CAS-M3 from Bosch can make racing safer with just a glance from a driver

Furthermore, because they are designed to meet the requirements of MIL-81765/4, DEF Stan 59-97 and BSG198 Part 5, the heat shrink boots also feature excellent resistance to chemicals, ensuring that many hours into a closely contested endurance race, a faulty connection is one thing that the driver won't have to worry about.

IMPROVING AWARENESS

Advanced electronics systems also enable drivers to keep their focus on the race in other ways. Bosch's Collision Avoidance System, which was first developed alongside Pratt & Miller for their Corvette WEC cars, helps to prevent the most common causes of collisions in sportscar racing. The use of a mid-range radar sensor for a wide field of view in the close-up range, a high-performance Bosch Motorsport display for fast video processing and a fast response high definition camera with a 78-degree field of view, ensures drivers are given a wealth of information.

The system improves safety for drivers by showing them at a glance how many cars are following them, how far back each one is, their closing speeds and whether or not they are in a faster class. In addition, flashing arrows show drivers when a car is moving to overtake. All of these features work just as well at night or in the rain, when the driver's visibility is severely reduced. The radar used by the CAS-M 3 tracks up to 40 objects and marks up to four objects on the display at once, and provides the real time gap of marked objects approaching from behind.

"Motorsport is not only about going faster but also about safely completing the race," explains Keith Andrews, regional president, Bosch Engineering North America. "This successful cooperation with Pratt & Miller demonstrates how production-based technology (the Bosch LRR3) can be adapted to motorsport applications to provide a safer environment for the driver and teams."

By providing drivers with this sort of detailed, situational information, Bosch aims to reduce the amounts of incidents in races between cars driving at very different speeds in very different categories. The driver's mental workload is therefore reduced, so he is able to better focus on the racing itself.

PREPARING TO WIN

Informative electronic systems aren't just for race days however, with data loggers a critical tool in performance analysis, which can help unlock significant gains. This is just one of the reasons Racelogic has made some significant changes to the way it delivers CAN information for use with its VBOX Video HD2.

The top of the range video data logger has the ability to log up to 32 incoming CAN channels directly from the vehicle bus – but for some people the perceived complexity in setting up their unit has been a barrier to getting the most out of it.

Racelogic has a large database of vehicle signals across most manufacturers that allow drivers to log information such as throttle, RPM, brake pressure, steering angle and so on, synchronised to their video and GPS data and allowing for deeper on-track performance analysis. With the recent update, configuring an HD2 to take advantage of this has become much more accessible.

The whole database has been cleaned up, with every vehicle now correctly listed alongside its available channels and connection information. Some Racelogic users will have already noticed – thanks to the setup software's automatic update – that the database has also been imported into the HD2 setup software, allowing for really simple channel selection when creating a 'scene', in which graphical elements are overlaid onto the video created when racing or testing.

The update means that all that's now needed is to select the vehicle, choose which channels should be logged, and assign them to a scene element.

As well as selecting CAN channels for logging via a bare-wire or OBD cable connection, support has also been introduced for a Bluetooth OBD module which allows for a set selection of channels to be logged. This unit works on vehicles with a standard OBDII diagnostic socket, but it isn't just 'listening' to the CAN bus: instead it is requesting information which is then converted for use in the HD2.

Racelogic is constantly updating and improving the number of CAN signals that can be used with its VBOX Motorsport products, so alongside the general CAN update, it now also integrates with the range of AiM loggers and dashboards. The full range of signals is available so that drivers who have an AiM unit fitted in their cars can now use an HD2 and plug directly into the vehicle bus.

Racelogic is also continually updating its software. Upgrades coming in the next few months will bring support for a Bluetooth heart rate monitoring system as well as the addition of new tracks to its circuit overlay database, bringing the number of layouts now available up to 600.

ABOVE Racelogic's updates ensure that customers can get the most out of their VBOX Video HD2 video data loggers

KNOWING WHAT'S GOING ON

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BELOW By using carbon fibre, Gill was able to halve the weight of its liquid level sensor

more critical. Gill Sensors & Controls assist in this need by offering a comprehensive range of capacitive liquid level sensors suitable for use in all tiers of motorsport. Some of these sensors are standard, off-the-shelf products but many are custom designed to suit particular installation or performance characteristics. What all the sensors have in common though is dependable high accuracy, mechanical reliability and light weight.

One of the recent developments made by Gill, which the firm has now offered to customers, is the use of carbon fibre for the sensor probe. The benefits and use of carbon fibre are widely understood and implemented in many industries for structural applications, but what advantages does it offer to something as relatively prosaic as a liquid level sensor?

The obvious benefit is weight. Typically – compared to an aluminium sensor – a sensor with a carbon fibre probe is half the weight but, combined with the additional strength and rigidity the carbon fibre offers, is even more durable.

The dimensional stability is another key benefit. Gill has enhanced the electronics in the sensor to take full advantage of carbon fibre's low coefficient of expansion to improve the sensor's accuracy over the full temperature range.

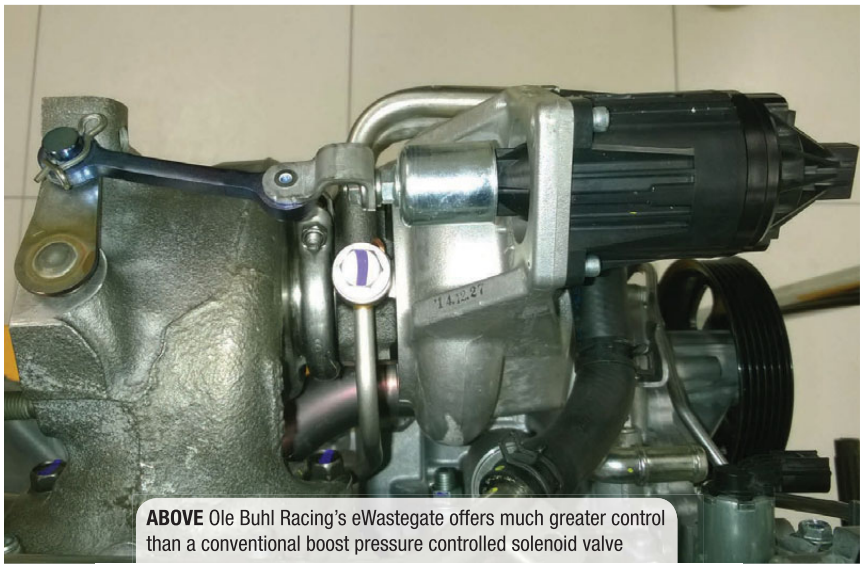
In order to get the carbon fibre sensors to work dependably, however, Gill had to develop new design and manufacturing techniques to manage the mismatched expansion rates between the carbon fibre probe and aluminium flange. The bond between the two components is crucial, not only to the mechanical integrity of the sensor, but also to the measurement performance of the probe. This required many design iterations combined with extensive laboratory and in-car testing to ensure the sensor will meet the demands of motorsport.

Utilising the significant weight reduction has also allowed Gill to add additional functionality to the sensor. Using proprietary technology, Gill has added liquid temperature measurement to the output from the sensor, which measures directly into the fluid giving an accurate and real-time reading.

Carbon fibre sensors are at the pinnacle of capacitive liquid level measurement and may not be the right choice for all motorsport series. However, the level of technological expertise that goes into them is reflected in the entirety of Gill's product range.

GREATER CONTROL

This increasing complexity has also become apparent in the level of control drivers and engineers require. In recent engine projects Ole Buhl Racing has seen an increased demand for control of a greater number of actuators and sensors on an engine than ever before. In the past the company was only concerned with the basic requirements needed for the engine to run; the crank sensor, cam sensor, temperature and throttle position sensors, for example.



ABOVE Ole Buhl Racing's eWastegate offers much greater control than a conventional boost pressure controlled solenoid valve

Nowadays however, the company is developing controls for many new functions for use in motorsport. New strategies have included production based actuators such as Variable Displacement Oil Pumps (oil pressure control) as well as Electronic Throttle Valves using SENT (Single Edge Nibble Transmission) technology to relay valve position data to the ECU. This SENT protocol is also used by Ole Buhl Racing on a number of other sensors in its range, such as its TMAP sensors for example.

Another area Ole Buhl Racing has focused on is centred on the use of eWastegate actuators. Most new turbocharged engines are equipped with electronic control of boost pressure, not just an electronic solenoid but an electrical actuator, which is similar to the micro throttle valve inside a turbo housing, that can be programmed to reach any desired wastegate position, regardless of the negative or positive system pressure in an extremely fast and very accurate way. These types of EWGs ensure minimal leakage and consequently rapid boost pressure build-up. The boost pressure control becomes immediate and extremely responsive, as well as enabling the wastegate to be opened completely.

MAKING THINGS EASIER FOR ENGINEERS

Knowing the forces acting upon key components, as well as understanding the effects of those forces, is another area where the correct use of sensors brings significant gains. Texense has considerable expertise in this area, having 20 years of experience working with strain gauging different materials such as steel, carbon fibre, aluminium and titanium used for pushrods, drive shafts, input shafts, strut ▶

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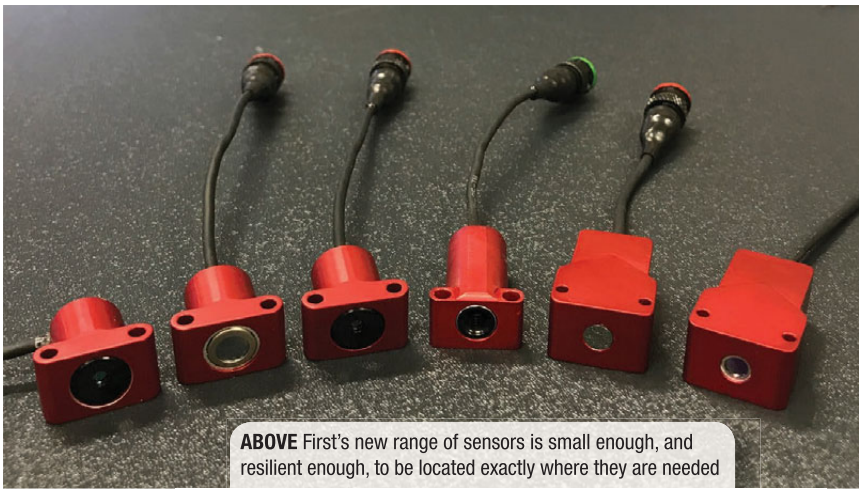
tops and forks.

The company's strain gauge installation relies on its proprietary XN4 digitally controlled intelligent amplifier and its sequential thermal compensation/calibration cycle process, which is unique and aims to minimise the demands placed on track and performance engineers.

"With our XN4 amplifiers the calibration data is coded and stored within the part allowing for significantly less input from the track electronics team when parts are changed; no new calibration data needs to be entered," Texys UK business manager Jason Mowle explains.

The system also provides the team a clear method to interrogate the gauged parts and identify any potential accident or over-load events by storing and displaying any offset shift, which is read through a supplied Texense switch-box or via a simple Hyper Terminal connection.

As a growing business, the company has recently extended its facilities which has doubled its capacity, and has also invested in the very latest Instron tension/compression calibration equipment. The new machinery allows the company to pre-load automated test programmes, which improves workflow, while also offering a higher accuracy of ± 0.5 percent. Together these improvements have enabled Texense to streamline its strain gauge installations and provide its clients with a quicker turnaround – vital for motorsport teams rushing to be ready for a race weekend.

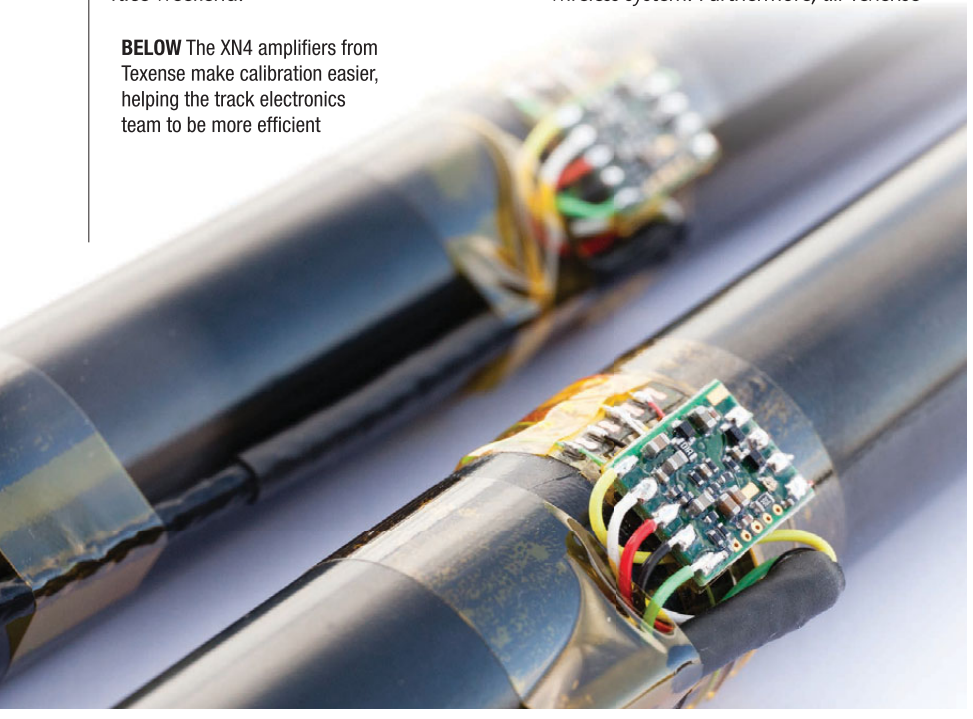


ABOVE First's new range of sensors is small enough, and resilient enough, to be located exactly where they are needed

Texense also offers a wide range of small embedded sensors for racing, testing, automotive and industrial applications, including aerodynamics, inertial, wireless and infrared sensors. These all utilise the very latest PCB technology and compact lightweight packaging.

The firm has also been increasing the number of sensors with wireless capabilities, developing new multi-point tyre IR sensors, wireless multi-channel differential pressure sensors and thermocouple conditioners. A typical wireless installation could see two wireless 8-channel tyre temp sensors, and two wireless 8-channel PDIFF sensors paired to the same receiver. For increased compatibility, these sensors all work in synergy with a custom-designed tri-band auto-tuning wireless system. Furthermore, all Texense wireless CAN sensors are user configurable via an Android app, making it even easier for engineers to use them effectively.

BELOW The XN4 amplifiers from Texense make calibration easier, helping the track electronics team to be more efficient



WHERE THEY'RE NEEDED

Equally important for engineers is being able to locate sensors in the right place. First Sensors bore this in mind with its updated range of infrared sensors, which have upgraded electronics that enable higher operating temperatures, but are still lighter and smaller, with half the range now 50 per cent smaller than before. Two new sensors have also been added to its range. The first is a wide angle 16 pixel array for closed wheel cars, or bikes where the sensor can only be positioned close to the tyre. This is a close mount device that can be as close as 80 mm, yet still measure a whole tyre. The second new sensor is a 32 x 1 pixel array for tyre measurement, which offers two choices of field of view.

Meanwhile, First's brake sensors' operational range has been extended to 155 °C before a safe shut down, preserving the sensor from electrical damage due to ambient overloads. All the sensors are also reverse protected on input supply and use less current.

In the tyre measurement range, there is now a choice of 8, 16, 32, 80 pixel sensors all with an output via a CAN bus. First says that these are now the smallest multi-pixel measurement devices on the market, making them ideal to fit in front wings, floors and wing mirrors.

All the sensors are programmable and have distance setting as standard that allows the end user to set the distance between the sensor and the measured object. The software can then compensate and adjust the centigrade output to suit the chosen distance. RT

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FINDING A LUCKY OIL

Alan Stoddart discovers that the latest developments in fuel and lubricant technology are helping race and rally teams make their own luck!

No engine should ever fail because of the motor oil. When you hear of a racer having "good luck" using a particular oil in his engine, he means his engine has not broken. In reality catastrophic failures should only happen if the completely wrong type of oil or viscosity is used. As such an engine designed for 0W-20 filled with 75W-140 gear oil will not be "lucky" at all.

Since any quality motor oil of the correct viscosity should prevent lubricant-related engine failure, why not just use the cheapest one? Engine wear is not merely pass or fail. The difference in a racing engine lasting 3,000 miles or 300 miles is due to wear rate, the understanding of which is the key to obtaining greater engine longevity. Simply put, selecting an oil that lowers the wear rate, like Driven's XP9 racing oil – which uses mPAO base oil technology to make the oil more stable despite temperature fluctuations – enables an engine to live longer.

So how does a motor oil lower an engine's wear rate?

There are no 'magic molecules' that eliminate wear. Wear rate is reduced by matching the oil chemistry to the specific operating environment of the engine. There is no one-size-fits-all "best oil". This may sound odd, but think about running. One would not prepare for an Olympic sprint or a marathon by training for the other. A marathon runner who trains by running sprints or vice-versa will not win. Even the shoes are different. The same goes for motor oil.

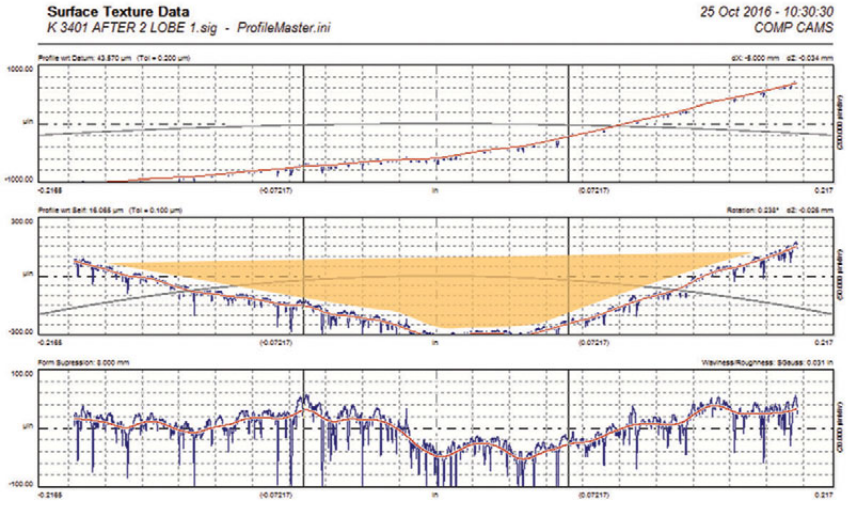
Chemically, a race oil is like an Olympic sprinter. Driven's XP10 qualifying oil, for example, is specifically formulated for high intensity operation for short durations. In contrast, road car spec oil is more like a marathon runner: low intensity operation for long durations. The best results happen when the specialist matches the specialty. Thus it should not be surprising that racing formula motor oil works better in a racing engine than a road car spec oil would. Diesel oils are tested and formulated for diesel engines. Likewise, racing oils are tested and formulated for racing.

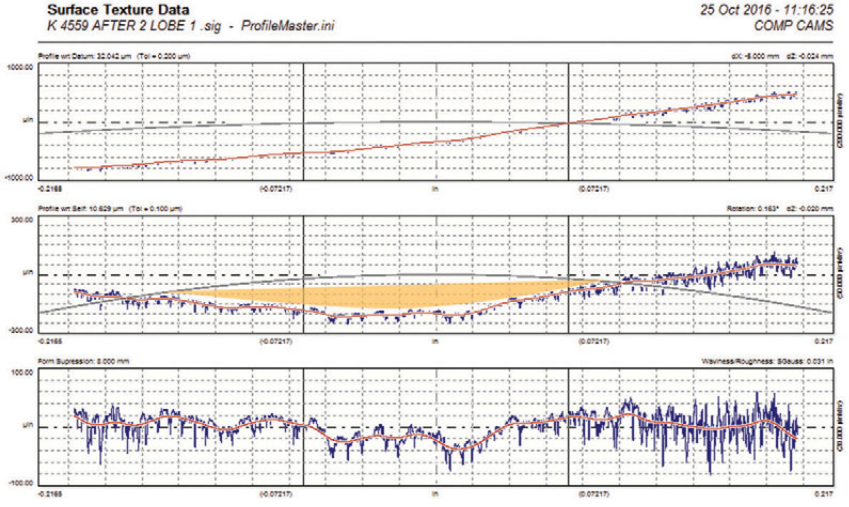
A common road car oil test is the ASTM sequence IIIG, which is a steady state, 100-hour test. This is no good when a typical race lasts less than three hours, so a test for race engine durability should be shorter and more intense.

When Driven tests a lubricant it therefore accurately simulates its actual application. In testing its XP6 race oil for example, the oil is subjected to a high intensity two-hour race simulation, which helps the company match the chemistry to the needs of its application. By doing this, the wear rate is reduced without the need of any 'magic molecules'.

Recently an independent race engine builder tested several oils in a high performance engine, and the wear on each camshaft was measured with an Adcole and Zeiss profilometer. Given the importance of matching an oil to its purpose, it's not surprising to have a wide range of results in a performance engine running a high intensity test, rather than the standard ASTM wear test.

Remember, just because an engine hasn't blown-up doesn't mean it's wearing at a ▶





ABOVE & BELOW Profilometer data taken at max lift, with the orange area representing wear area. Above, a synthetic, high zinc, API-licensed oil; below, data from Driven's XP9 racing oil

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ABOVE FUCHS uses its ties with the likes of Shane 'Shakey' Byrne in British Superbikes to continually test and evolve its oils

low rate. High performance engines wear at a much higher rate than stock engines, which is why high performance oils, such as Driven's XP9, which has been tested in high performance applications, are needed.

THE IMPORTANCE OF ANALYSIS

With different engines so dependent on particular oils to run at their best, it is no wonder that FUCHS is utilising its ties to elite motorsport to continually test and refine its oils under the most extreme conditions.

The company is heavily involved in motorsport right from grassroots to the highest level, including Adam Morgan and the Ciceley Motorsport team in the British Touring Car Championship, and Shane 'Shakey' Byrne and the PBM BeWiser Ducati team in British Superbikes.

Andy Brown, UK automotive technical manager at FUCHS Lubricants, emphasises that the sponsorships are about much more than simply putting the FUCHS logo on a race car or bike. "Some companies look at motorsport sponsorship as just putting a sticker on a car and hoping that it's caught on camera. That's okay and exposure is certainly part of sponsorship, but we are more interested in using it as a way of profiling and testing our products," he says.

"Most of our sponsored racers and riders, including Shane Byrne and Adam Morgan, will send us oil samples after each race. "We are then able to use our sampling service. Using this system, we look at viscosity,

> *"There are no 'magic molecules' that eliminate wear"*

additive levels, wear levels, oxidation and contaminants such as fuel dilution, dirt ingress and coolant (if used). All of these things can tell us the condition of the oil and the condition of the engine, gearbox or hydraulic system," Brown explains.

"When we take samples over a long period of time, it increases our knowledge of the oil and the application and it's then possible for us to see ways that an oil can be tweaked and improved in a variety of ways: better wear protection; release more power; better temperature control; or a better or more controlled torque band. It might be a fairly minute change to the formulation, but when you are operating at the very top end of motorsport, a tenth of a second can make a big difference.

"For motorsport competitors at the amateur end of the spectrum, sampling oil in this way can highlight problems with the car or bike before they become big, expensive issues. For example, if there is a lot of dirt in the oil, maybe the air filter hasn't been changed or perhaps they've got a split somewhere in the air intake system."

PBM BeWiser Ducati team co-ordinator Stuart Bland emphasises the value of this support from FUCHS Silkolene. "I've been with the team for 19 years and we've used Silkolene for almost all of that time," he says. "We develop the products with Silkolene. We use the engine oil, the brake fluid, the chain lube and all of the cleaning products.

"Silkolene take oil samples and monitor the performance. The Ducati requires a slightly thicker oil, so Silkolene have analysed that and the product they've given us works excellently."

BTCC ace Adam Morgan is also appreciative of FUCHS' in-depth services: "FUCHS have formulated a gearbox oil for us which has helped us fine tune all of our data and engineering and helped us to find that bit extra.

"There is so little between the front and the back of the BTCC grid these days that we have to try and get as much as we can from every component and having FUCHS on board with their technical support is a massive bonus."

AN EVERYDAY ADVANTAGE

Working closely with manufacturers also has tangible benefits in other, more humble applications. Motul's expertise has helped several car makers improve the efficiency of their engines and lower polluting emissions by lowering viscosity grades to reduce engines' internal friction.

One of the ways the company has sought to improve engine efficiency is by creating four new specific 100 per cent synthetic low-viscosity lubricants. The products, which are 0W-20 and 0W-30, provide ▶


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significant fuel savings of up to three per cent and an increase in efficiency of around four per cent. Thanks to the lubricating properties and their additives, the new lubricants also limit deposit build-up, which reduces wear and allows longer life of the lubricant's intrinsic characteristics. Each of the new oils is part of a the Motul Specific range, which is not only designed to meet standards but is also tested and approved by original equipment manufacturers.

Motul Specific 5122 0W-20, for example, is specially formulated to ensure optimal lubrication of the latest generation Jaguar Land Rover petrol engines. In testing, the oil provides a fuel saving of over 3.8 per cent while exceeding the stringent requirements of the previous Ford 925A specification. Likewise, Motul's Specific 508 00 509 00 0W-20, Specific LL-14 FE+ 0W-20 and Specific LL-12 FE 0W-30 oils are all specially formulated for particular engines, and, compared to reference oils, offer fuel savings of 1.5 per cent, three per cent and 1.5 per cent respectively.

These new formulations build on Motul's considerable experience. As early as 1971, the French firm was pioneering the formulation of a 100 per cent synthetic lubricant for automotive engines. Since then, Motul has utilised the experience gained as the official supplier of many racing teams to further refine its products and facilitate continuing technological development of its motorsport oils.

ABOVE Motul has created four new Specific 100% synthetic low-viscosity lubricants

THE RIGHT COMBINATION

As well as finding the best oil for any given engine, it is also important to find the best fuel. ETS Racing Fuels is best known for developing top flight racing fuels. However, in order to satisfy a wider range of teams, the company has added to its portfolio with a range of more accessible products, and developed two fuels for the latest generation of direct injection turbo engines. ▶

Hyundai

ABOVE ETS has enjoyed worldwide success. Its TBX6 R5 fuel featured in the new generation Hyundai i20 R5's first victory, on the Rallye du Var

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ABOVE Sunoco is the largest manufacturer of racing gasolines in the world

EXTRA MAX is a fuel specifically designed to offer high performance and very high levels of consistency for medium-budget direct injection cars. The fuel is used by many drivers and is a good fit for cars like the Skoda Fabia R5, Ford Fiesta R2 and Ford Fiesta R5 and Citroen DS3, as well as the Renault Clio R3T, which uses the fuel in its title series in France and Switzerland.

TBX6 R5, meanwhile, is a premium fuel developed for R5 rally cars. It is manufactured with very high purity molecules, which contribute towards the fuel's exceptionally high batch to batch consistency. Furthermore, the fuel has shown tremendous torque and horsepower gains when compared to RON 98 pump fuel, as well as compared with many of ETS's competitors' FIA regulated fuel. One factory team even reported that its R5 rally car, which is using TBX6 R5, is delivering more torque than its 2016 WRC car develops using the current WRC control fuel.

TBX6 R5 has been praised by many drivers for its power and responsiveness in acceleration. It has also been proven in competition. In 2017 Jan Kopecký from Skoda Motorsport's factory team won every event in the Czech Republic Rally Championship (including the ERC Barum Czech Rally) thanks, in part, to ETS' TBX6 R5. The fuel has also contributed to success in the latest generation Hyundai i20 R5. The i20 R5 claimed victory at the Rallye du Var in France in November 2016 when it was driven by Kevin Abbring and Seb Marshall. This, the first time the i20 R5 ever tasted victory, was also the first time it had used ETS's TBX6 R5.

The passion of the ETS Racing Fuel team, combined with the technical partnerships and the outstanding quality, consistency and performance of its products, has paved the way for more than 20 world championship titles, as well as hundreds of national titles. The company's new fuels look set to continue this streak.

TWEAKING THE RECIPE

While it is all well and good analysing the minutiae of a fuel to ensure it is competitive this season, it is also important to think about the future of fuels, especially given the hastening trend among manufacturers toward greener electric and hybrid powertrains. Sunoco and R Racing fuels, which are distributed in the UK and Europe by the Anglo American Oil Company, are keen to ensure traditional fuels can still be attractive.

Sunoco is unique in that it has its own specific distillation tower. Instead of starting with crude oil, then refining it to get a clean fuel, Sunoco starts with a refined outlet made from gasses of the distillation process, and then re-refines it once more to make an outlet that is exceptionally clean. This is what forms the foundations of all of the company's race fuels.

This ability to produce almost all its own raw materials, and blend them itself enables Sunoco to offer absolute consistency batch to batch. It also means that Sunoco can formulate fuels with specific beneficial properties. One of the company's new products is called Sunoco Optima, which is a very simple fuel that's been designed to remain stable when stored in fuel tanks for up to five years. It's also been formulated to be ethanol free, so it doesn't affect or corrode any rubber or aluminium hoses or seals. The formula for Optima includes low amounts of double-bonded aromatics, like Toluene and Xylene, which means that the fuel burns very cleanly, and very quickly. This would make it a great motorcycle fuel, for example, but its motor octane number is 92 while the FIM restricts MON to 90.

As such, in certain areas you have to use less refined ingredients to ensure the fuel meets regulations. Anglo American managing director Anders Hildebrand explains that some small changes could make racing a whole lot kinder to the environment. "If the regulations allowed higher octane fuels, the fuel manufacturers could make purer and cleaner burning fuels," he says. "Engine manufacturers could make engines with higher compression ratios to accommodate cleaner, higher octane fuels which would increase efficiency. The result from an environmental point of view would mean lower consumption and cleaner emissions."

There are, however, some fuels that Sunoco doesn't make. Anglo American's R Racing brand has therefore been established to fill these gaps by making fuels for very particular applications or specific markets. For example, in the historic sector, performance is not the top priority, instead car owners prioritise looking after their engines. So R Racing blends some MSA and FIA leaded race fuels, using lower octane streams to give a fuel that is not as 'racy' as the top quality Sunoco products. It still has more power than normal pump fuels, and it is much more consistent, but it is not as extreme as some of the Sunoco fuels.

R Racing also offers some specialist fuels that Sunoco cannot manufacture because they contain chemicals restricted by the USA, such as MTB. In America, companies are not supposed to sell fuel that contains MTB, even though it's not, as Hildebrand emphasises, "super toxic". It is, however, a great oxygenate. "So we have that in our turbo fuels," he says. "Sunoco cannot make that particular type of fuel. We have to do it ourselves under our own brand. The R Racing brand was established to make fuel that Sunoco hasn't got anything similar." The brands are therefore very complementary, further empowering racing teams of all levels to run the right fuels for their engines.

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ABOVE & BELOW Both LMP2 and IndyCar (below), previously playgrounds for constructors, have gone down the 'spec' route

Brian Simpson/IndyCar

THE MERITOCRACY OF MOTORSPORT

Sergio Rinland argues that the same mistakes are ruining LMP2 and Indycar racing

IF we look at the *Collins English Dictionary* for the meaning of 'meritocracy' it says: 'A meritocracy is a society or social system in which people get status or rewards because of what they achieve, rather than because of their wealth or social status'. Does this definition apply to motorsport?

I was not in favour of the current LMP2 regulations because they only benefit four manufacturers and leave out anyone who would like to try out their talents in such a fantastic series. The excuse, as usual, was to save costs. Whose costs? The cars are only 10 to 20 per cent of the budget, plus are homologated and cannot be modified during the season. That is probably a good policy for years two or three of the regulations, but to freeze designs before the cars actually turn a wheel is wrong.

As it happens, ORECA did a good job and made a versatile car that is the best of the crop. But because the other manufacturers were not allowed to develop their cars, customers went and bought ORECAs. It is logical and it would have happened if there were 10 manufacturers, so, whose costs are they saving?

Now, to rub salt in the wound, the ACO and FIA allow all but ORECA to develop their cars to catch up. This is worse than BoP (Balance of Performance) – it is a death wish.

I accept balance of performance in GT or touring cars because the prime purpose of the design of those cars is not racing, but all the other attributes that sometimes conspire for one machine to lap a race circuit faster than others. Hence, some sort of adjustment is needed to make possible a series where we can showcase brand diversity and OEM support. But outside of this situation, motorsport should be a meritocracy, particularly in a formula called 'Prototypes'.

We have been so engulfed by single-make controlled formulas in the last few years in the name of 'economy' that we tend to see that as 'normality'.

The ACO keep shooting themselves in the foot: first by allowing LMP1 to spiral out of control; then by doing the complete opposite with the heart and soul of prototype racing. It is time for them to stop for a minute, look around, see who they are, ask what the purpose of this kind of racing is, and let participants and spectators enjoy it as it should be.

This is a fantastic opportunity for the ACO and FIA to mend the mistake. They could open up LMP2 as it was, allowing other manufacturers in and permitting a certain amount of development for those who did not get it right first time.

NO NEED FOR A CHAPERON

We never asked them to save our money by not allowing us to build our own LMP2. If one wants to do so, we are adults and we are supposed to know what we are doing. We don't need chaperons. We need a governing body to keep performance and safety in mind.

Something similar is happening with IndyCar, the top US motorsport – a completely controlled single-make formula. Who are they helping? Whose money are they saving? For the last few years they allowed Honda and GM to compete not only with engines but also with aerodynamics, but with such controlled regulation that they ended up favouring one of them. Now they are going back to a unique bodywork for everybody. Is that a meritocracy? Surely not, when the same teams keep winning year after year. Ingenuity is prohibited, the rest is mandatory.

Last time I was there was in 2003/2004, when it was still possible to build your own car, or, if finances did not permit, one was able to buy a Dallara or a G Force and modify it to search for that 'unfair advantage' as Mark Donohue used to call it. Before that, Champ Car was even better. Was it more expensive? I doubt it – it failed for other reasons.

Now we have a Formula 3 on steroids, with even less freedom than F3. Something has to be done. Stop for a minute, think, analyse the recent history of 'false economy' and do the right thing for the good of motorsport – a meritocracy like no other! RT

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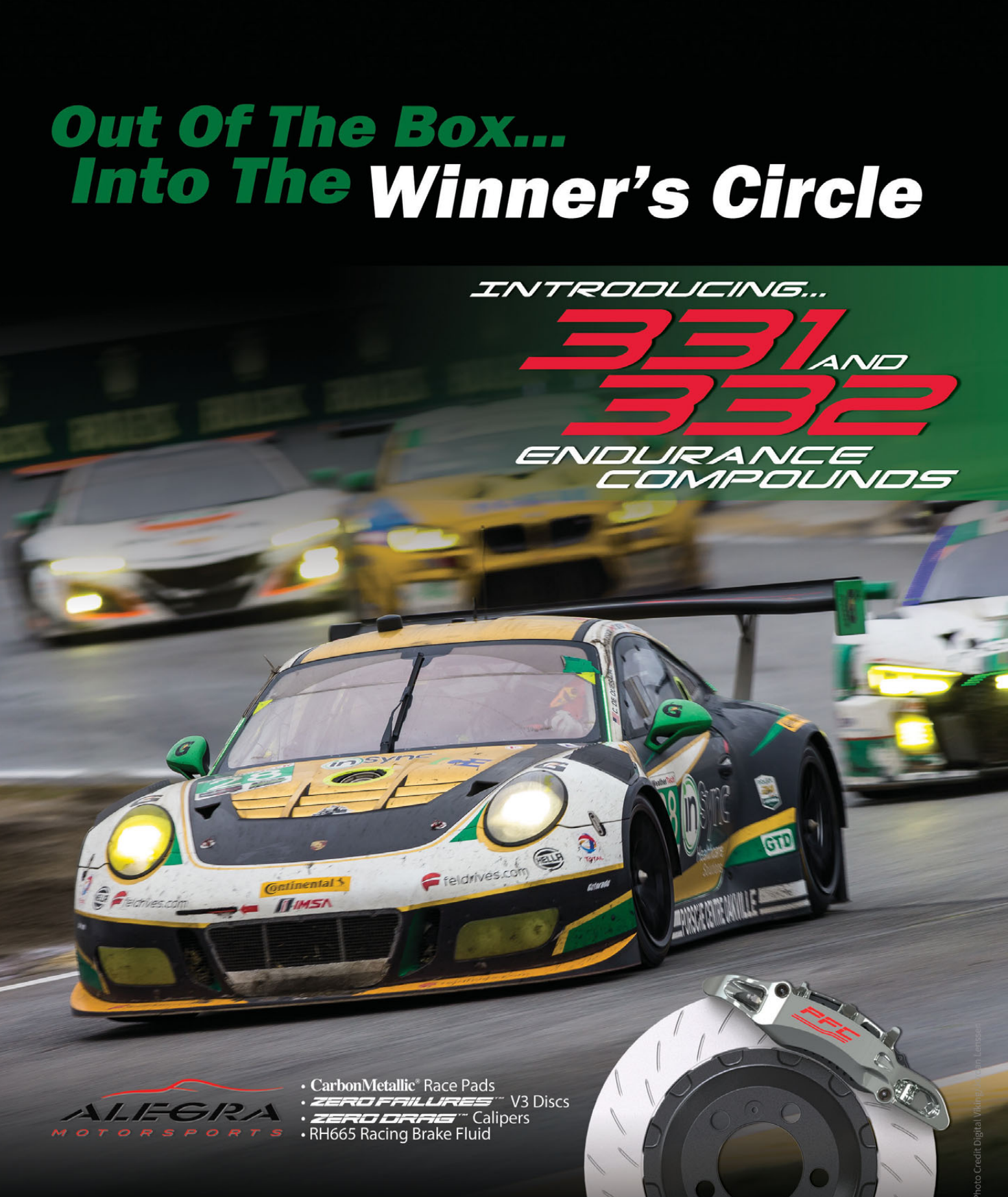

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