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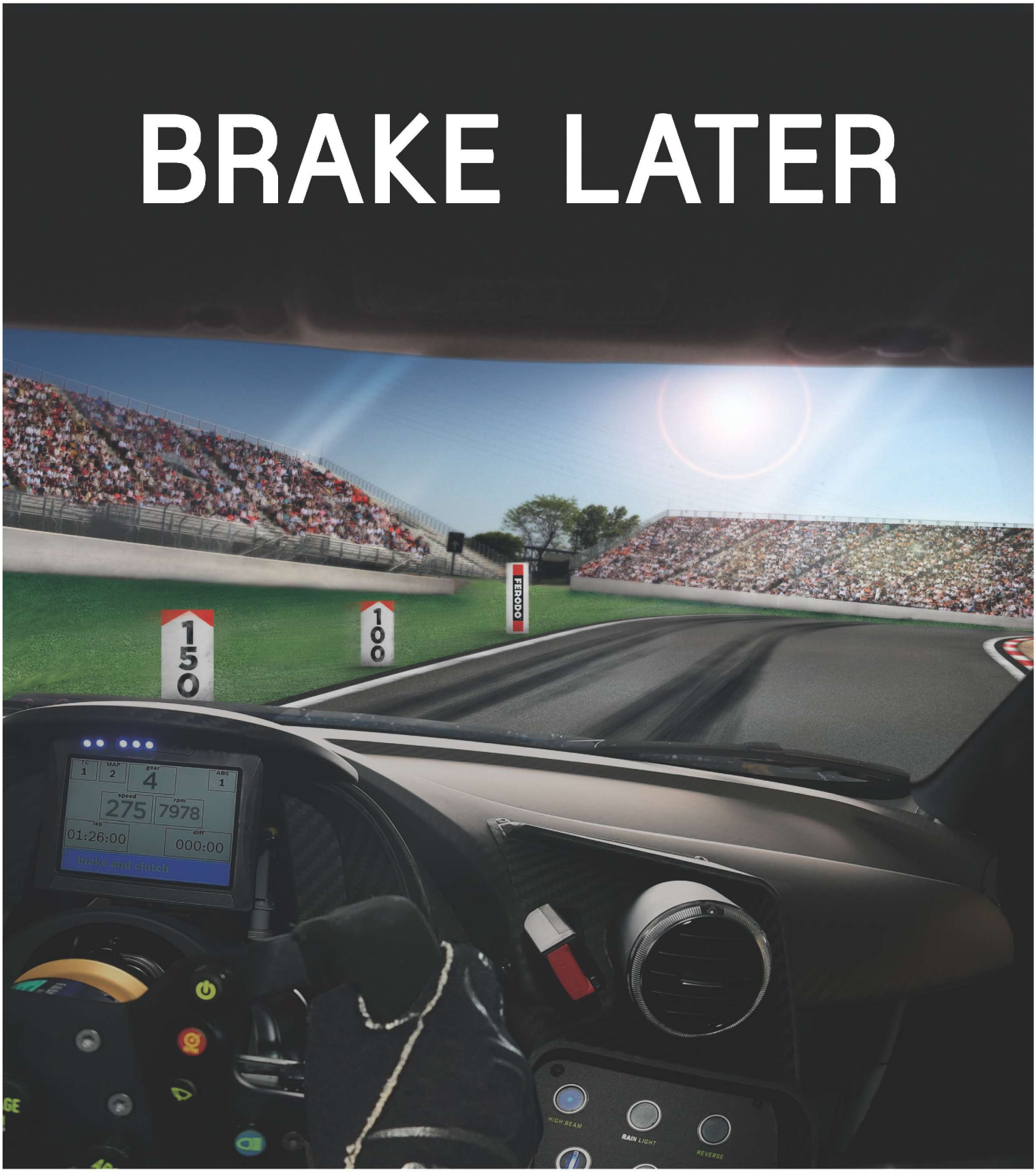

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"Win me the title"

Analysis of the Ferrari built to deliver on a promise to a president

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Deep learning and straining my neural network to the limit

Wearing my *Automotive Engineer* hat, I visited AutoSens, an automotive sensors conference and exhibition in Brussels, and came away with my head reeling. Currently one of the white hot items in the automotive industry is ADAS (Advanced Driver Assisted Systems) and the fully autonomous car and the work going on behind the scenes is breathtaking. Interestingly, it included companies like Google – or a spin-off – being there to see the lay of the land, along with LG, Panasonic and Dell among many other specialist companies.

My learning curve was almost vertical with terms like deep learning, SIPM technology and neural networks among many others being bandied about. Neural networks, which are forecast to become the primary language of computer vision in the future, is a branch of artificial intelligence where the algorithms are trained to recognise objects in a scene using large datasets, as opposed to the traditional method of writing an algorithm for a specific task. It seems that the cost and power consumption for the computation required for vision will decrease by 1,000 times over the next three years, much of this due to neural networks. The slightly scary thing is that it learns as it goes along. It doesn't quite think for itself – yet – but it's well down that road.

I have heard unofficially from one giant player, not necessarily automotive, that while the autonomous car is hot potatoes at the moment, it's not going to happen in their view. The algorithms, no matter how advanced and sophisticated, cannot be trusted to make 100% the correct decision when confronted with the myriad on-the-spot decisions it would have to make when in charge of a vehicle, something we humans do as a matter of course.

We are not infallible, of course, but if we are to relinquish control to an algorithm, then it has to be a trillion times plus foolproof. It needs just one mistake for the trend to be given the red light and stopped in its tracks. Tesla was lucky to get away with the fatal accident that happened in May last year when one of its cars in 'autopilot' mode could not differentiate between the light grey tractor trailer turning across its path on a divided highway in Florida and the light grey horizon. The National Highway Safety Traffic Administration subsequently exonerated the car company, coming to the conclusion that the car didn't cause the driver's death. That was down to not infallible computer vision, which shows just how important this technology is.

Another interesting development I came across at the conference, that has some relevance to motorsport, is the HDR LED flicker-free solution. Under normal circumstances, when an LED light is caught on camera, it appears to flicker, which is unacceptable in the automotive industry. What I saw was a unique CMOS sensor that is capable of combining very high dynamic range with a native full immunity against LED light flicker. Thanks to innovative and patented pixel architecture, a new family of 2 MPixel imagers, able to cope with any LED light source, have now been developed.

I also learnt that by focusing laser light to a brightness one billion times greater than the surface of the sun, it causes changes in a vision-enabling interaction between light and matter. As a result, X-ray pulses are produced with the potential to generate extremely high-resolution imagery useful for medical, scientific, engineering and, of course, motorsport engineering.

Another interesting tidbit I came across was that by 2030 most surveillance cameras will not produce videos as the volume of information that IP cameras generate is becomingly increasingly difficult to transmit and store. It seems that the largest hosters of video are not Facebook or YouTube but mid-sized security video storage companies.

The facts, quoted by expert Michael Tusch from UK company ARM at the Embedded Vision Summit in Santa Clara, California are that 120 million surveillance cameras were sold globally in 2016, all of which can stream in HD and at 30 fps. If all were connected to the internet, it would equate to 1.2 petabites per second of web traffic, or 400 exobytes per month, which is four times what Cisco projects global IP traffic to be this year. The result is that by 2022, all new IP cameras will have some kind of convolutional neural network or otherwise inside them so that by 2030 the vast majority of cameras connected to the internet will not produce any video whatever.

On a personal basis, my own neural network was overworked and overstretched, but I came away with my eyes wide open and the realisation that it pays to keep tabs on what's happening in other industries. RT

William Kimberley
EDITOR

BELOW Citroën has reached an important milestone with the first development tests of the R5

Citroën C3 R5 gears up for rally debut

Hal Ridge

Citroën Racing launched its C3 R5 at the start of September, the replacement to the DS3 R5 that will be homologated in early 2018. Testing began in France for the new machine, released 12 months after designing began.

The French marque will employ a range of drivers, including works WRC pilots Stephane Lefebvre and Craig Breen, to undertake testing and development duties in the coming months. "We have reached an important milestone with the first development tests of the car, which is already close to the finished product," said Citroën Racing team principal, Yves Matton. "The specifications given to the technical teams are clear: we want the Citroën C3 R5 to set new standards in the category, in terms of performance, reliability and controlled operating costs.

"In order to create an entirely new product, we used all of Citroën Racing's experience in the WRC, adding contributions from leading technical suppliers such as Sadev for the transmission and Reiger for the suspension systems. Our works drivers will also be taking part in development of the car."

While the new four-wheel drive machine, which features a 1.6-litre turbocharged engine with around 280 horsepower, has only recently hit the stages for initial testing, the majority of components have already been run on a test mule since early 2017.

"There is a direct link between the C3 R5 and the C3 WRC: for example, the roll cage of the two cars was designed by the same engineer," explained Pierre Budar, development director, customer racing vehicles. "Some solutions have been re-used, whilst adapting them to the constraints of the regulations and small-scale production. Similarly, the engine has been developed in-house, based on the unit used on the production model, therefore providing the greatest potential in terms of performance and reliability."

However, while initially expected to be homologated in time for a Monte Carlo Rally debut in January, that date is likely to be put back. The C3 R5 was designed and launched with a hydraulic paddle-shift gearbox, but in the latest World Motor Sport Council meeting in Paris, on 21 September, plans for automated gearbox controls in the category were revoked and cars will remain with a manual sequential system.

'The introduction of automated gearbox controls for R5 cars has been cancelled, due to the excessive cost of retrofitting on existing homologations,' confirmed the WMSC decisions update on the same day. The PSA Group's previous R5 cars, the DS3 and the Peugeot 208 weren't able to overcome M-Sport's Ford Fiesta or Skoda's Fabia. Volkswagen Motorsport is expected to launch its new R5 Polo in the coming months for 2018 homologation. RT

Prodrive Renault Megane Supercar nearing completion

Hal Ridge

BANBURY, UK: Work has begun on the new Renault Megane Supercar that will race in the World Rallycross Championship next season, built by former World Rally Championship-winning firm Prodrive. The cars, which will be run under the GCK team banner for owner Guerlain Chicherit and a yet-to-be-announced team mate, are being built at Prodrive's Banbury base in the UK.

The first images of the car's bodyshells have been released. The British firm is designing the new car in-house, including the development of its 2-litre turbocharged engine.

"We are delighted with the progress we have made so far on the new GCK Renault Megane R.S. RX," said John Gaw, managing director of Prodrive Motorsport. "We've started work on the first bodyshell. The layout scheme for the whole car is 100% complete and we are well underway with the detail design with the new engine and many other parts already in production."

ABOVE First images of the new Renault Megane Supercar bodyshells have been released by Prodrive

The car was initially intended to be unveiled at the French round of World RX in early September, but has been postponed until early 2018 due to "significant recent technical developments".

Chicherit has been racing a Renault Clio in selected World RX events this year to gain experience for next season. "It's been a really exciting few months and the next will be even better as I finally see my dream become reality," he said. "The guys at Prodrive have a big task ahead of them still, but I have absolute trust in them to deliver the best car possible." RT

European Rallycross TouringCar scrapped

Hal Ridge

PARIS, France: The FIA has revealed that the FIA European Rallycross Championship for TouringCar will be wound up in 2018 and won't be replaced. FIA Off-Road Commission chairman Andy Lasure explained that room will be required in FIA World Rallycross Championship event schedules in the coming years for the introduction of an electric rallycross category.

However, electric rallycross isn't the cause of the TouringCar division's demise. Introduced in 2007, the series for rear-wheel drive, 2-litre naturally aspirated, steel bodied cars had its number of rounds dropped to supporting World RX at five European-based events for 2015 to help boost entries, but only six drivers of 17 points scorers had contested the first four rounds of the 2017 season.

"For many years it (TouringCar) has only been a Norwegian championship. It's not an international championship. One Belgian and one Swedish (driver), but normally just Norwegians," said Lasure. "We will do three races next year, then we will stop it. For three or four years we have spoken about there not being enough TouringCars."

The series will run over just three rounds in 2018. Asked if the category would be replaced, Lasure replied: "Not for the moment, no. Because of electric cars coming and so on."

World Rallycross promotor IMG recently revealed that it is in talks with the FIA about the introduction of an electric rallycross category, possibly as soon as 2020. The FIA European Rallycross Championship for Supercar and Super1600, which are oversubscribed at the majority of events, will continue to support World RX events. RT

BELOW Close action but relatively poor support has led to the cancellation of the European Rallycross TouringCar series in 2018

EV rally car UK debut

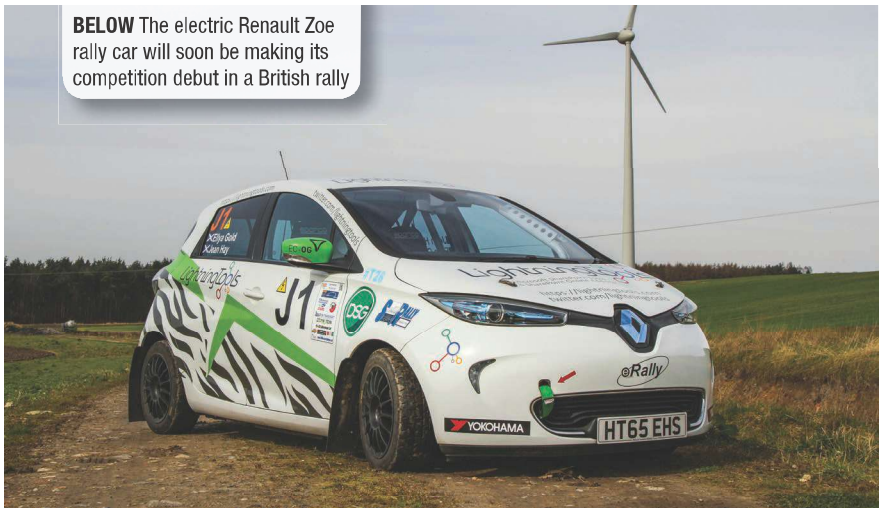
Hal Ridge

WIGAN, UK: An electric Renault Zoe rally car is set to make its competition debut in a single-venue event on 8 October, in the Adgespeed Stages Rally at the Three Sisters Circuit near Wigan, UK. The idea for the electric rally car project was conceived by the founder of the Junior 1000 and Formula 1000 rally championships, Tristan Dodd, and competitor Ellya Gold around six years ago, but the pair were unable to source the required components, until coming across the electric Renault Zoe.

Impressed by its five-star EURO NCAP safety rating and power output similar to that of a Junior 1000(cc) car, Steven Fraser was employed to make a Zoe competition-ready. Remaining largely standard, the car is powered by a 5Agen2 65 kW synchronous electric motor with 220 Nm torque. It has been fitted with GAZ suspension and competition wheels, on top of safety features required to be MSA log booked (roll cage, bucket seats, etc.)

"After lots of testing by Ellya and current and former Junior 1000 competitors Finlay Retson, Zak Hughes, Josh Hislop and Peter Bennet, the car was checked over by senior Scottish MSA scrutineer Willie Greig and the application was sent off to MSA technical director John Ryan for consideration. After discussions with John, the decision has been made to issue a vehicle passport with a restriction for single venue tarmac rallies only," explained eRally project coordinator, Jean Hay.

The car will be driven on its debut by MSA British Junior Rally Championship driver Cameron Davies. eRally has plans to build enough cars to be able to run an all-electric championship in the future, alongside the entry-level F1000 and J1000 series. RT



BELOW The electric Renault Zoe rally car will soon be making its competition debut in a British rally

BELOW Aston Martin CEO Andy Palmer and Red Bull Racing's Christian Horner celebrate a strengthening of the relationship between the two companies

Aston Martin /Red Bull Racing strengthen partnership

William Kimberley

MILTON KEYNES, UK: British carmaker Aston Martin is considering developing a Formula 1 engine for 2021. In an announcement about its further involvement with Red Bull Racing that sees it become the title sponsor for the F1 team from 2018, Andy Palmer, Aston Martin president and CEO said that there are ongoing discussions about his company developing a power unit to be used by the team after being asked by the FIA to join discussions on future engines for F1.

"Title partnership is the next logical step for our Innovation Partnership with Red Bull Racing," said Palmer. "We are enjoying the global brand awareness that a revitalised Formula 1 provides. The power unit discussions are of interest to us but only if the circumstances are right. We are not about to enter an engine war with no restrictions in cost or dynamometer hours, but we believe that if the FIA can create the right environment we would be interested in getting involved."

The successful partnership, that has already produced the sold-out Aston Martin Valkyrie hypercar, will yield future products and an exciting new Advanced Performance Centre that will open on the Red Bull Racing campus in Milton Keynes later this year. It will house Aston Martin's second dedicated design centre and engineering personnel who will be working on future sports cars. The new centre, which will see a further 110 more people being recruited, will allow a closer working relationship between the two leading brands in their respective fields and will embrace the adoption of both F1 and road car technology.

The relationship between Aston Martin, Red Bull Racing and AM Racing began in 2016 after they combined cutting edge F1 technology and Aston Martin's signature sports car design to produce a ground breaking hypercar. The Aston Martin Valkyrie, which sold out on launch and is the first in a line of products as a result of this Innovation Partnership will make its first run in 2018 before being delivered to customers in 2019.

"Our Innovation Partnership with Aston Martin has been a pioneering project from day one," said Christian Horner, team principal of Red Bull Racing. "Having conceived and created the remarkably successful Valkyrie together in 2016, we extended our relationship this year and are now delighted to further strengthen the partnership and see the team competing as Aston Martin Red Bull Racing in 2018. In addition, more than 100 Aston Martin staff will service the new Advanced Performance Centre on our campus here in Milton Keynes and it will allow us to collaborate further with Aston Martin on special, equally innovative, new projects." RT

Alfa Romeo badge returns to BTCC

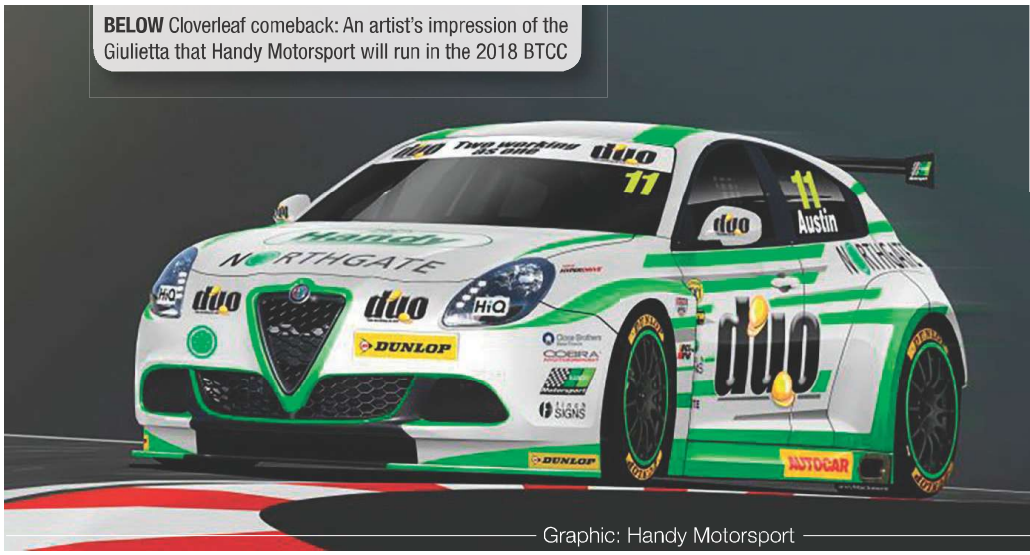
Andrew Charman

SWINDON, UK: BTCC team Handy Motorsport will replace its current 2016-built version of the Toyota Avensis, the model that provided the prototype for the BTCC's Next Generation Touring Car regulations in 2010.

The new car, which will be driven in the BTCC by Rob Austin, is being backed by Alfa Romeo's UK dealer council. Announcing the car, Handy Motorsport team principal Simon Belcher said that the programme also has the blessing of Alfa Romeo UK, though it will continue to run as an independent entry in the BTCC.

"It has been a long project to bring Alfa Romeo back to the BTCC, with many people working on this exciting development for some time," Belcher added. Plans currently focus on a single car programme but a second car could be run at a later date.

Alfa Romeo has plenty of previous history in the BTCC, with the last factory programme in 1994-95 sparking controversy over aerodynamic 'add-ons' that directly led to the adoption of aerodynamics in the series. This controversy was recalled in detail in *Race Tech* 168, November 2014. RT



BELOW Cloverleaf comeback: An artist's impression of the Giulietta that Handy Motorsport will run in the 2018 BTCC

Graphic: Handy Motorsport

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Jaguar electric Touring Car series to support Formula E

Andrew Charman

FRANKFURT, Germany: The FIA Formula E Championship has been busy announcing exciting new plans for the future. One is on the return to racing in Switzerland and the other is the announcement of a new support series with Jaguar.

For decades racing in Switzerland was forbidden, with the last event taking place at Bremgarten circuit in 1954. However, a law change in 2015 lifted restrictions on fully-electric racing and enabled Formula E to organise a race in Zurich.

"Having a race in Switzerland is truly a dream come true," said Sebastien Buemi, Renault e.dams driver and Formula E champion. "I am delighted about this news and still can't believe it. Only a few years ago it seemed impossible because of the local legislation, but thanks to Formula E we have managed to bring racing back to my country. Zurich is the biggest city and racing there will be incredible, I hear the track will look amazing and can't wait to give it a go. In the past years together with Renault I considered Paris to be the race of the year, but I can finally say that in addition to France I will have my home race to look forward to next year."

This announcement comes just days after Jaguar unveiled plans for a fully-electric support series to run alongside select Formula E races from season five. It will see up to 20 examples of the brand's soon-to-be-launched I-Pace competing in effectively an electrically-powered Touring Car series alongside the FIA Formula E championship for electric single seaters.

Jaguar entered Formula E in the 2016-17 season and other premium brands, including Audi, BMW, Mercedes-Benz and Porsche, have since announced plans to contest the series. The Jaguar I-Pace eTrophy will start in the 2018-19 season.

Cars for the series will be built and run by Jaguar Land Rover Special Vehicle Operations (SVO), based in Warwickshire, UK, effectively on an 'arrive and drive' basis. Packages available will include entries into the 10-race global championship, technical support from race car preparation to data engineering, all global logistics for vehicles, spare parts and equipment, tyres and consumables, garaging infrastructure at race weekends, promotion and marketing by Jaguar Racing and Formula E, hospitality for entrants, championship race wear for each driver and dedicated television coverage.

Jaguar states that a typical race weekend will consist of free practice sessions, qualifying and a 30-minute race. Demand for seats in the cars is expected to be high, despite the technical specifications, the race calendar and costs having not yet been revealed – this information will be released in 2018.

Jaguar Racing chairman Gerd Mäuser believes the series will prove the brand's electrification technologies on the track. "Formula E has grown exponentially since we joined as the first premium manufacturer last year, with commitments from Audi, Mercedes-Benz and Porsche," he said. "The Jaguar I-Pace eTrophy will improve the spectacle for the fans and gives young drivers a ladder into Formula E. We expect our series to be a sell-out and an exciting international sporting event." RT

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ABOVE BMW is returning to Le Mans following an absence of many years

BMW reveals Le Mans contender

Alan Stoddart

FRANKFURT, Germany: The Circuit de la Sarthe has provided a dramatic backdrop to a number of BMW's charismatic Art Cars, as well as the V12 LMR which gave the Bavarian company its only ever overall victory at the 24 Hours of Le Mans. In September, at the International Motor Show in Frankfurt, BMW revealed the next car it hopes will bring back silverware from the endurance event, and the World Endurance Championship of which it is a part.

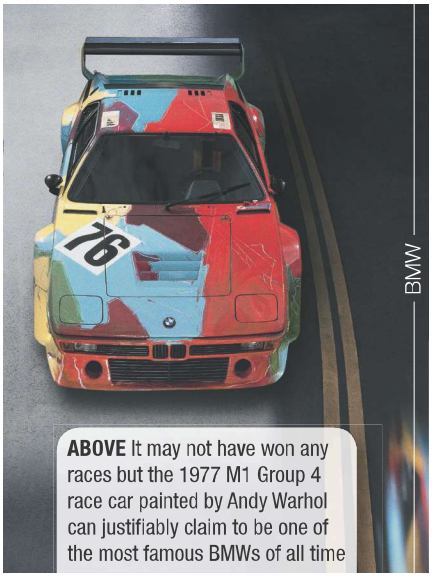
Ready to do battle with the Ferraris, Aston Martins, Corvettes and Porsches, the BMW M8 GTE will use a 4.0 litre V8, with 'TwinPower Turbo Technology', outputting more than 500 bhp depending on classification. The race car uses the cylinder block and head from the upcoming M8 road car, which are produced out of a special lightweight alloy focused on maximising efficiency and durability. The GTE features a Sachs carbon fibre clutch and a six-speed sequential gearbox which transfer power to the road via BMW's 'aero rims' shod in Michelin rubber.

Several advanced technologies have been used in speeding up the development of the racer. The heavily sculptured bodywork has been honed with advanced CFD calculations, which use a new algorithm to allow a great increase in the number of simulations run before the design progresses to the wind tunnel, while an advanced 3D measurement system is used to ensure that the hand built M8 GTE adheres precisely to design dimensions.

Another interesting aspect of the car's progress from conception to finished racer is the use of 'virtual development'. This has involved, among other things, utilising artificial intelligence to optimise the traction control system without ever leaving the lab, and the heavy use of additive manufacturing to give engineers greater freedom in exploring creative design solutions for the car. The use of 3D printing also increased the efficiency of the M8 GTE's development, allowing new parts to be tested just 24 hours after being created in the virtual world.

In addition to the WEC, the M8 GTE will also compete in the IMSA WeatherTech SportsCar Championship, making its debut in that series' first round, the 24 Hours of Daytona in January.

The director of BMW Motorsport, Jens Marquardt, wasn't in any doubt about the significance of the unveiling. "For us, the presentation of the uncamouflaged car at the IAA is the next important step on the road to our first race outing, which we plan to be the 24 Hours of Daytona in 2018," he said. "With the BMW M8 GTE, we are bringing cutting-edge technology to the top international class of GT racing, whilst at the same time tying in with our tradition at Le Mans. The development of the BMW M8 GTE is on schedule, and we can hardly wait to see the car challenging for victories in 2018." RT



ABOVE It may not have won any races but the 1977 M1 Group 4 race car painted by Andy Warhol can justifiably claim to be one of the most famous BMWs of all time

LMP2 Jokers

PARIS, France: LMP2 chassis manufacturers Ligier (Onroak), Dallara and Riley/Multimatic will all be allowed "Joker" upgrades on their 2018 cars in the FIA WEC, ELMS and IMSA series to try and make them more competitive with the dominant ORECA 07. It follows months of investigative work by the FIA/AC technical committee to close the gap on the respective levels of performance. However, a key element is that the chassis in question should not be able to exceed the ORECA's capabilities but still be a potential race winner.

ABOVE The ORECA 07 will not benefit from any "Joker" updates as it is the car to beat

Riley receives the most generous "Joker" that will enable Multimatic to effectively re-design the entire car. Onroak will be able to update both the Ligier JS P217's regular and Le Mans aero kits, while Dallara will only be allowed to amend the Le Mans-only aero kit on the P217. The upgrades will be tested in the Windshear wind tunnel in North Carolina later in the year where the modifications will be sanctioned. No further updates will be allowed for the remaining period of the homologation. RT

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ABOVE Flange-fit: The new composite body panels are expected to save teams significant amounts of money

ABOVE Security tag: Hexagonal patterns on critical aerodynamic areas will prevent teams modifying the new composite panels

NASCAR composite shells make race debut

Andrew Charman

RICHMOND RACEWAY, VI: NASCAR's new flange-fit composite body kits made their competition debut in the second-division Xfinity Series race at Richmond on 8 September, with several teams immediately replacing their steel shells with them and series management declaring the debut a success.

Speaking to media ahead of the race, NASCAR senior director of R&D Brett Bodine explained that the new kit consists of 13 pieces, formed of a strong composite laminate blend and made by Five Star Bodies of Twin Lakes, Wisconsin, which already supplies composite bodies to teams in NASCAR ARCA competition.

The bodies are exactly the same shape and dimensions as the existing steel body panels used by teams, ensuring that there are no cost issues as existing templates can be used. As well as the governing body, all teams have their own set of templates to ensure their bodies meet regulations.

The new bodies also have hexagonal security marks built into critical areas, where manipulation could improve aero flow. These marks must remain visible at all times and ensure that teams have to use the bodies exactly as received.

NASCAR anticipates major cost savings for teams compared to using the current steel panels, particularly in terms of accident damage as with the new kit the damaged section will be able to be simply unbolted and replaced by a new one – currently steel panels are welded to the chassis tubes.

Rebuilding damaged cars after a race weekend will now take much less time – effectively meaning that teams may be able to re-use cars rather than having additional cars built up for a following race weekend, as is currently the case. Damaged panels will also be able to be returned to Five Star and repaired at a much lower cost than at present.

According to Bodine, the current steel bodies could potentially retain a competitive advantage over the composite version as teams will not be able to modify the new shells in a similar fashion to what currently occurs. However, NASCAR intends to ensure through weight and aero regulations that use of the composite body is an advantage.

"From the very beginning, all the teams wanted to make sure that there was no chance that they would want to maybe run a steel body," Bodine said. "They wanted to go all in on the flange-fit body right away, so that's why we're making sure that the competition adjustments between the two are accurate and enough to make you want to run a flange-fit body."

Following the Richmond race the flange-fit body was due to be available for the Xfinity races at Dover and Phoenix, and then to be optional for the entire 2018 season except the superspeedway races at Daytona and Talladega. RT

Engines to last longer in NASCAR

Andrew Charman

DAYTONA BEACH, FL: Teams competing in the 2018 NASCAR Monster Energy Cup will be required to run the same engine over two full race weekends.

Currently teams must use a single engine over an entire race weekend. If for any reason the engine has to be changed between practice/qualifying and the race then the car has to start at the rear of the field, regardless of where it has qualified.

The only exception until now has been the season-opening Daytona 500, at which the grid is set by 125 mile qualifying races. Teams have until now been permitted to change the engine between the qualifying race and the 500, but from 2018 the single-engine rule will be applied.

Cup teams will be required to use 13 short-block engines across the 26-race main season – the 'engine' being regarded as block, crank and camshafts, connecting roads and pistons. The teams will be permitted to select which two races each engine will be used in and each unit will be sealed after the first race to ensure no modifications are made.

Similarly, the same long-block engine (block, crank and camshafts, connecting rods, pistons, oil pan, cylinder heads and valves) will be required to be used for the two major non-points races of the season, the Clash at Daytona in February and the All-Star Race at Charlotte in May.

NASCAR speeds up race scrutineering

Andrew Charman

Chicagoland Speedway, IL: NASCAR rolled out a streamlined scrutineering process at the Chicagoland Speedway meeting on 14-17 September.

Series management believe that the new system will be more efficient – there have been numerous recent instances of teams missing qualifying laps or only just making race grids due to difficulties passing Inspection, partly blamed on teams pushing their cars to, and beyond, the limit of what the regulations allow.

The new system reduces the current five inspection processes to three. The new stations will focus respectively on engines, chassis and templates/LIS (laser inspection station) and it is in the template/LIS section that the major changes are being made.

NASCAR is debuting a new enclosed structure to check that the body meets the dimensions previously measured by the template grid, and that the car's weights and skew are within required limits.

The new unit is fitted with 17 high-definition cameras and eight projectors – taking eight pictures per second, these make a full-body scan of the car and produce a report for both NASCAR and the team. A traffic-light system indicates conformity, with areas showing up red suggesting further checks are required.

The time taken to pass this individual station is expected to be slashed from six minutes to around 90 seconds, and the time taken to proceed through all the processes from 12 minutes to four minutes.

The new system was used for the headline Monster Energy Cup series at Chicagoland but the 16 cars that had qualified for the sport's season-ending playoffs continued to be inspected in the current format. NASCAR wants to dial in the system with at-circuit tests but does not want to do anything to complicate the preparations of teams competing for the championship.

The new process is expected to be standard for the 2018 Cup series and in time migrate down to the second-level Xfinity Series. RT

Jerry Markland/Getty Images for NASCAR

ABOVE Close-fit: NASCAR is streamlining its current five-stage scrutineering process

IndyCar teams budget for 2018 bodies

Andrew Charman

Reports in the US suggest that each Verizon IndyCar Series team are to be given two of the new-for-2018 standard aerodynamic kits free of charge, with enough components included to meet the different specifications for road, street and speedway races.

Subsequent kits, supplied by IndyCar chassis manufacturer Dallara, will cost teams $90,000. This is significantly above the previously suggested $60,000 price. However, teams were previously budgeting anything from $125,000 to $165,000 for the Chevrolet and Honda specific kits used until the end of the 2016 season. The $90,000 price is also frozen for three years.

Teams will also be required to spend around $5,500 on chassis updates, both to provide mounting points for the kits and modify the front of the floor to a newly specified profile.

New electronic requirements will add further costs but predictions suggest each team will be able to budget around $200,000 less per car than in 2016. RT

Chris Owens/IndyCar

ABOVE Cash flow: Teams are set to save money on the 2018 aero kits, seen here on the Chevrolet chassis at the recent Mid-Ohio test

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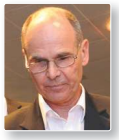

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BACK TO THE DRAWING BOARD

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 provided by the World Motorsport Symposium is becoming increasingly more authoritative due to its 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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Evening of Thursday 30th November
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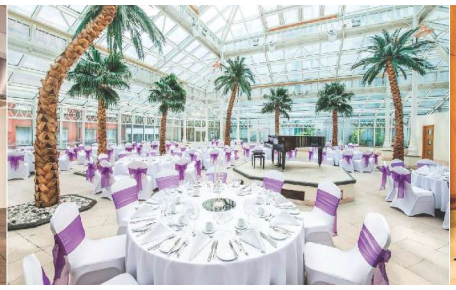


The **RACE TECH** World Motorsport Symposium networking Awards Dinner has become renowned for gathering most of the key influential leaders in the motorsport industy who get together and network in a friendly setting while enjoying fine dining. It is also an evening to celebrate the past year's race engine designers, racecar aerodynamicists and ground breaking technologies where the winner in all three categories will be announced during the awards ceremony.

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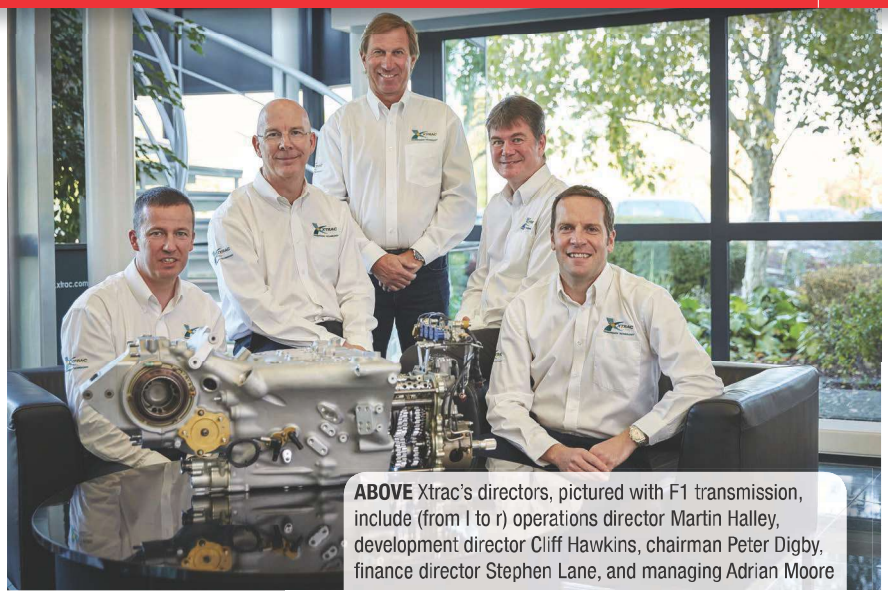
- Multimatic win Racecar Aerodynamicist of the Year for the Ford GT
- Team Dynamics and Neil Brown Engineering win Race Engine Designer of the Year
- Magneti Marelli wins the Most Innovative New Motorsport Product of the Year



ABOVE Xtrac's directors, pictured with F1 transmission, include (from l to r) operations director Martin Halley, development director Cliff Hawkins, chairman Peter Digby, finance director Stephen Lane, and managing Adrian Moore

Xtrac buyout to allow stronger growth

Andrew Charman

THATCHAM, UK: Transmission company Xtrac has been bought out by Inflexion Private Equity, backing the company's well-established management team who will remain with the business.

Inflexion's investment will help fuel Xtrac's future expansion, supporting its rapidly growing high-performance road car division and increasing its team of 330 in the UK and US. There are plans to extend the factory and purchase additional world class machinery along with accelerating the development of the next generation of high-end automotive transmission systems and advancing its capabilities in hybrid and electric vehicles.

"We are proud of the leading global business Xtrac is today," said Xtrac managing director Adrian Moore. "Persistent innovation and exceptional customer service remain our highest priorities. Inflexion shares our values; its investment will accelerate our ambitious growth strategy, developing the next generation of high-end automotive transmission systems and expanding our coverage of the high-performance hybrid and electric car transmission market. This partnership with Inflexion supports Xtrac's ethos of employee ownership, and our team look forward to a new chapter in the continuing development and growth of our company."

"Xtrac is a truly exciting business, leading its market with superior design capabilities and a blue-chip global client base," said Simon Turner, managing partner at Inflexion. "We bring experience from across the specialist engineering sector with businesses such as Shimtech and Aspen Pumps, and an extensive track record in growing teams to promote sustainable growth. We are delighted to partner with the Xtrac team." RT

Ganassi halves his IndyCar team

Andrew Charman

INDIANAPOLIS, IN: Leading Verizon IndyCar Series team Chip Ganassi Racing has made more than 40 staff redundant after confirming its intention to reduce from four to two cars in 2018. Team principal Chip Ganassi said in a statement that the team needed to return to its core business of running two championship-calibre teams.

Drivers Charlie Kimball and Max Chilton have both left the team, along with their sponsorship – Chilton is predicted to be setting up his own team with Carlin Motorsport and employing some of the staff released by Ganassi.

It is not thought that the released staff will experience difficulty finding new employment – some could be relocated to Ganassi's programmes in NASCAR, IMSA and Global Rallycross, while the IndyCar Series is expected to see at least three new teams and expansion from existing organisations in 2018. RT

ABOVE Change of scene: Several crew left out of work by Ganassi's decision to reduce from four to two cars could find roles in a new team reportedly being set up by driver Max Chilton

PERSONNEL

Effective 1 September, the FIA made changes to the structure of its technical division, redistributing responsibilities for sporting and technical matters across the Federation's single-seater championships.

Gilles Simon, who had been working for Honda in Sakura, Japan, has become the FIA's Head of Technical. He previously worked for the FIA in 2010 as technical and powertrain director before leaving to join Propulsion Universelle et Recuperation d'Energie (PURE), a new F1 engine supplier with the aim of designing, developing, and launching F1 power units for the 2014 and 2020 engine regulations.

"Reporting to the Secretary General for Sport, Gilles Simon will be acting as FIA technical director," the FIA said in a statement. "As such, he will contribute to the development of the FIA championships, proposing ambitious and pragmatic technical solutions in line with the FIA's strategic and sporting vision for its championships. To that end, he will work in close cooperation with the FIA departments responsible for the global management of the championships, as well as with the safety department."

Charlie Whiting is heading up a new single-seater department. It follows the 2017 launch of the FIA Formula 2 championship which is aimed at bringing the various single-seater Formulae (Fs 1, 2, 3, and 4) under the same umbrella, completing the single-seater pyramid that was one of FIA president Jean Todt's 2013 election platforms.

Whiting's brief is to "strengthen the links between the grassroots levels and the top of the pyramid; optimise the processes and the synergies of these championships; and benefit from the increased integration of the F1 Department within the FIA," the Federation said in a statement.

The single-seater department will itself be split into two distinct branches: technical, which was to be headed by **Marcin Budkowski** but at the time of going to press had left the FIA with instant effect, and sporting and championship management, run by **Laurent Mekies**.

Frederic Bertrand, formerly head of the FIA's Single-Seater Commission, is now turning his attention to other categories, including Formula E, the World Endurance Championship, and touring cars.

Leading NASCAR Monster Energy Cup team Hendrick Motorsports replaced **Keith Rodden** with **Darian Grubb** as crew chief to the No 5 Chevrolet entry of Kasey Kahne on 18 September, ahead of the final nine playoff races of the season. Grubb is the third most successful active crew chief, with 23 wins and the 2011 championship to his name. He worked at Hendrick in 2003-2009 and returned to the team in January 2016, overseeing race car manufacture. Hendrick added that Rodden would be assigned other duties, and the 5 team's 2018 crew chief is yet to be decided.

Veteran NASCAR crew chief **Richard 'Slugger' Labbe** has joined Toyota Racing Development as manager of teams and vehicles support. His duties will encompass all Toyota's US racing programmes including NASCAR, NHRA drag racing, USAC and rally series.

Former NASCAR team owner **Tommy Baldwin** has been appointed competition director and crew chief of the no 15 Premium Motorsport Monster Energy Cup team. Baldwin closed his team before the 2017 season and all of its assets have now been acquired by Premium Motorsports team owner Jay Robinson. RT

IN BRIEF

NASCAR Monster Energy Cup team Furniture Row Motorsport, which this season has run the 77 Toyota of Erik Jones, is expected to close before the 2018 season due to lack of sponsorship. Reports suggest that the team's charter necessary to compete in the series has already been sold to an unnamed third party. RT

The NASCAR Monster Energy Cup team run by veteran star of the sport Richard Petty will not renew the lease on the race headquarters it currently occupies in Mooresville, NC. The 78,000 square feet building is said to be too big for the team's requirements but a replacement has not been revealed. Richard Petty Motorsports recently lost its Smithfield Foods sponsor but has denied rumours circulating of a merger with fellow team Richard Childress Racing. RT

AND FINALLY...

NASCAR is investigating after cars competing in the final regular-season round of the Monster Energy Cup at Richmond on 9 September headed for the pit lane during a caution period, and found a parked ambulance blocking their way. Some cars managed to avoid the vehicle while others ran into each other – the damage to the bonnet of Matt Kenseth's Toyota effectively ended its race. RT

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AP RACING

"WIN ME THE TITLE"

Craig Scarborough examines the SF70H, a car that has carried Ferrari tantalisingly close to fulfilling its president's demands

FERRARI has endured a rocky period, without a championship but with a revolving door for the exit of star drivers, engineers and even presidents. But now it is reaping the fruits of its most recent restructure, with a 'failure is not an option' philosophy handed down by president Sergio Marchionne to a team fronted by Maurizio Arrivabene and steered technically by Matteo Binotto.

The result has been the competitive SF70H, the unique design of which has been both aided and hindered by wrangling over rules interpretation.

HEADS ROLL

Ferrari's management structure over the decades would be the ideal basis of a book. And what a weighty tome that would be.

After the disaster of 2014, Ferrari looked to James Allison and some of his ex-Renault

ABOVE The 2017 World Champion? There could be huge repercussions if not...

colleagues to form a technical team to lead it to another championship. The theory was that a more agile, less politically active tech group from a small British F1 team would restructure the Scuderia in a way similar to the successful Todt era.

On paper, this seemed logical and should have brought Ferrari to where Marchionne wanted it to be: winning. But after a winless 2016 season, and with Marchionne now in secure control, the pressure was really on. This is where the credible tech team fell out with the dictatorial style of its president. Marchionne simply demanded that Ferrari must win the 2017 championship and directly questioned each top-level engineer, asking, 'Can you do that?'

A simple question, perhaps, but not if you wanted honesty yet were interested in only one answer. A drawn-out process saw Allison leave for Mercedes and much of his group also departed. The resulting purge was accompanied by the news that no new 'star' technical director would be appointed. Instead, ex-engine department head Matteo Binotto assumed the lead technical role. To date the move has proved not the disaster critics feared, but a revelation.

Rather than Binotto being the head in a design-supremo role, he has become a man-manager coordinating the departments. Notably, he is aided on technical direction by long-time Ferrari consultant Rory Byrne, who has the confidence of Marchionne. Even working on what he describes as a part-time basis – which probably equates to more hours than a usual person's full-time! – Byrne remains an influential figure. He was retained with a new contract in order to develop a number of R&D projects, whilst guiding the design team through the process of meeting the new rules.

Rather than Ferrari's win-at-all-costs direction resulting in a gun to the head mentality, harmony appears to have broken out. Reports from insiders suggest that Binotto's calm hand has brought the team together and the results are evident: the titles have been tantalisingly within its grasp throughout the first year of the structure.

Photos: Craig Scarborough

BELOW The SF70H's sidepod packaging differentiates it both from its predecessor and any other 2017 car

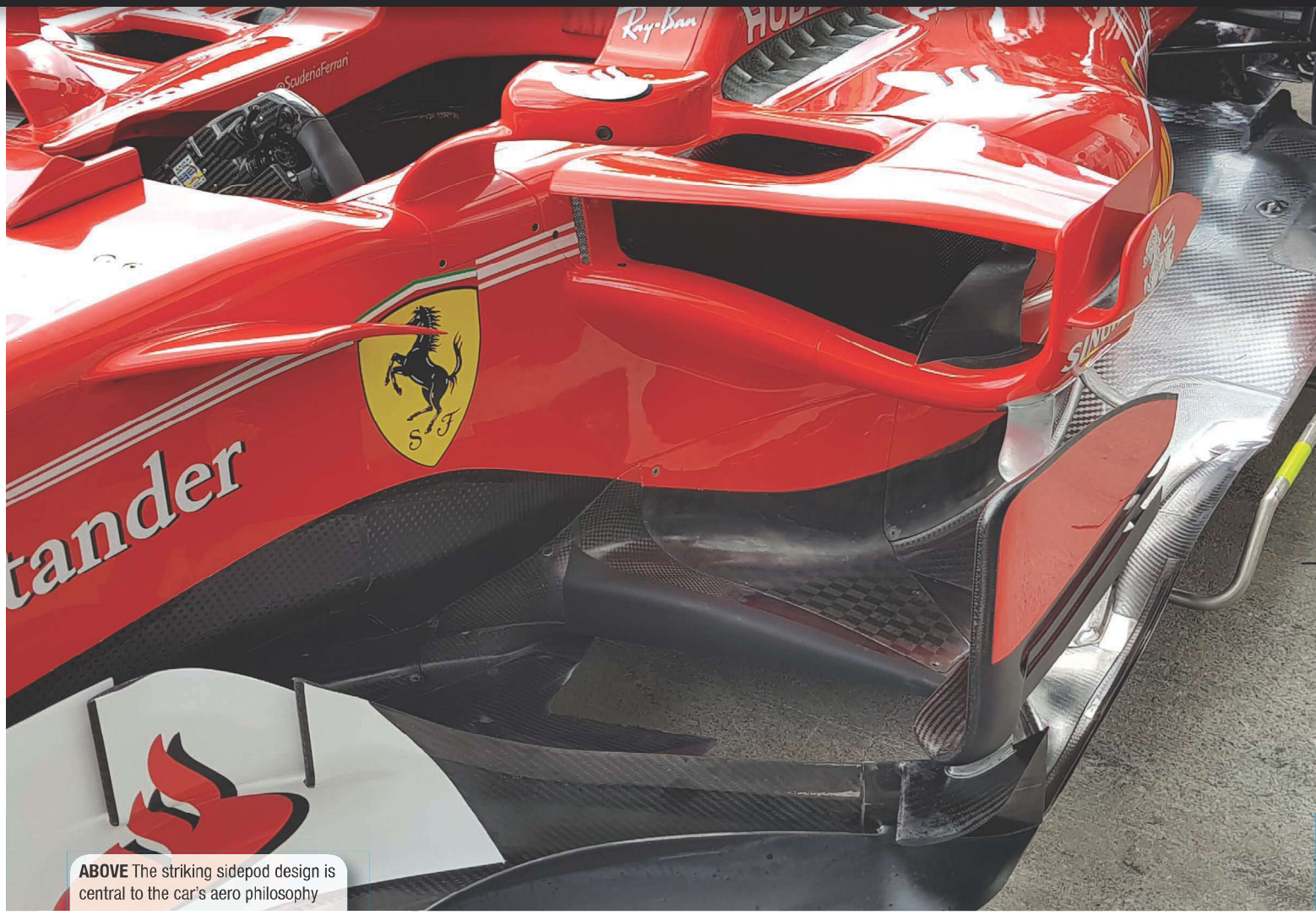
> *"The unique design has been both aided and hindered by wrangling over rules"*

SF70H PERFORMANCE LEAP

With the 2016 SF16H winless and major rule changes over the winter, the 2017 SF70H is a departure in many respects from recent Ferraris and many of its rivals. The team made quite a performance step over the close-season, while rivals stumbled over the new regulations and the winter suspension directive. This has brought the front of the pack much closer together on pace.

With its restructured and harmonious management, Ferrari won the first race and only lost the lead of the drivers' championship at round 12 in Belgium. If the SF70H hasn't always been the fastest car, it's been consistent, reliable and always around to pressure Mercedes should it make any mistakes.

Ferrari's excellent race tyre management has been carried over from 2016, being able to run the compounds at the softer end of Pirelli's range in hotter conditions without the drop-off that Mercedes had suffered up until mid-season. While this rewards Ferrari in the races, it's one of the factors that hold it back in qualifying: with the battle so close, pole position and a good start are often enough to keep the lead for the race win. Late season efforts were therefore aimed at a different balance in race-to-qualifying tyre use to help ▶



ABOVE The striking sidepod design is central to the car's aero philosophy

beat Mercedes to pole.

The 2017 car's basic layout isn't far from that of its predecessor, rule changes excepted. It is a little longer and retains the high rake setup philosophy. Mercedes, conversely, had gone in the other direction with a wheelbase believed to be some 160 mm longer than Ferrari at 3,760 mm and prefers not to run an extreme high rear ride height.

Many point to the wheelbase difference as a factor in competitiveness at tracks with different layouts (tight street venues or open, fast circuits). It's more likely, however, that factors such as balance shift, traction and tyre management have rewarded Ferrari on tighter tracks.

The SF70H's sidepod packaging differentiates it both from its predecessor and any other 2017 car. Although its sidepod inlets strike you almost immediately, the aero philosophy at work here starts nearer the nose and ends up at the back of the car. Typically F1 cars, like most single-seaters, have sidepods to house the cooler package. These start with a rounded inlet facing forward at the front of the sidepod. In contrast, Ferrari has a high upward-facing inlet, creating a tall, undercut shape below the bewinged inlet.

Other F1 designers suggest this undercut is crucial to the design. Working with the bargeboard package, a powerful downwash effect is created that drives airflow over the diffuser area. With the bargeboard area freed up in the new regulations, larger and more powerful vanes can be fitted in the space to the side of the cockpit. As Ferrari's bargeboards are working with the unusual inlet setup, they in turn are different to other teams' packages. By driving more airflow low around the sidepods, increased pressure can be created over the diffuser and its trailing edge features are driven to lower the pressure behind the car to pull more airflow under the floor for more downforce.

This sidepod undercut feature appears to work, but does come with a number of issues that need to be resolved. Firstly, getting airflow into the shallower sidepod inlet; pushing the

ABOVE The outer edge of the diffuser features feather-like fins

inlet to be higher and wider helps, but the resulting duct opening is still too small to act as a purely forward-facing inlet. So, Ferrari effectively points the inlet upwards, such that some of the airflow entering the sidepod actually passes through an extra inlet formed into the top surface. Thus, the sidepod is fed by airflow initially rising up from the front wing, that in turn needs to be turned down to enter the sidepod. So other front end aero devices – mirrors, fins etc – are all needed to redirect the upwash into a downwash.

Secondly, the high inlet position competes for real estate with the side impact protection spar. Two of these FIA-specification parts are needed each side of the car, one just above floor level and one higher up, to protect the driver in a T-bone accident. Typically, teams place these at the top of the sidepod, above the forward-facing inlet, which offers the spar a convenient structural location. Ferrari has had to lower this upper spar to midway up the sidepod, thus it sits as low as the regulations allow and below the high inlet. This places the side impact spar in the middle of the flank of the monocoque, a less easily supported area for the crash test. Design sources inside F1 suggest this is still practical, but will cost several kg reinforcing the tub for this mounting location.

Lastly, the coolers within the sidepods in a typical slanted position would be poorly fed with airflow from the high inlet. However, Ferrari had already been running a compact radiator package in 2016, with a larger upper slanted cooler and a shorter, lower radiator mounted below to form a 'V arrangement. In this orientation the coolers for engine, ERS, turbo, gearbox and hydraulics are efficiently fed with air from the unique inlet.

The beneficiary of the airflow off these unique sidepods is the diffuser. This is a much larger volume for 2017, so the net effect of the size increase and improved onset flow really multiply the efficiency of the underfloor package. Compromising other areas of the car for a more powerful underfloor is a wise direction in F1, as the improved downforce is balanced front to rear and produced with very little drag. Thus, the car's L/D ratio is improved overall as less rear wing load is required and less drag incurred.

As with the sidepods, Ferrari's diffuser treatment is unique, with an almost organic feathered treatment to the outboard trailing edge. Diffusers work not just with the diverging shape expanding the airflow, speeding up the flow under the car for lower pressure, but with a vortex formed along the outboard edge of ▶

ABOVE Devices upstream of the sidepods create downwash to direct to the undercut

ABOVE Some of the air enters the sidepods from this inlet on the top surface

ABOVE Unlike its Mercedes rival, the Ferrari retains the high rake setup philosophy of its predecessor — Ferrari

> *"Ferrari compromises other areas of the car for a more powerful underfloor"*

the diffuser, which entrains airflow under the floor. This increases the underfloor flow and hence downforce. Both the expansion of the airflow and the formation of the edge vortices are enhanced with flaps on the diffuser's trailing edges. These are limited in height by the regulations for both the diffuser and the flaps around it.

Ferrari uniquely works the outboard edge vortices with a cascade of small flaps mounted above and to the side of the diffuser exit. They are orientated to help curl the airflow up to power the edge-vortex formed inside the diffuser. These flaps are driven by the improved airflow off the sidepod's undercut and work with the edge vortex to help produce more downforce, even though the diffuser itself is compromised by being a little narrower to help package the flap setup.

SUSPENSION CONTROVERSY

With the car angled with the high rake setup, the suspension has the job of controlling the aero platform: it manages the front wing working in ground effect, the expansion of the airflow under the long underfloor, and keeps the front splitter off the track. While its two key rivals, Mercedes-AMG and Red Bull Racing, were exploiting some very complex ride control systems in 2016, Ferrari was behind the curve in this area.

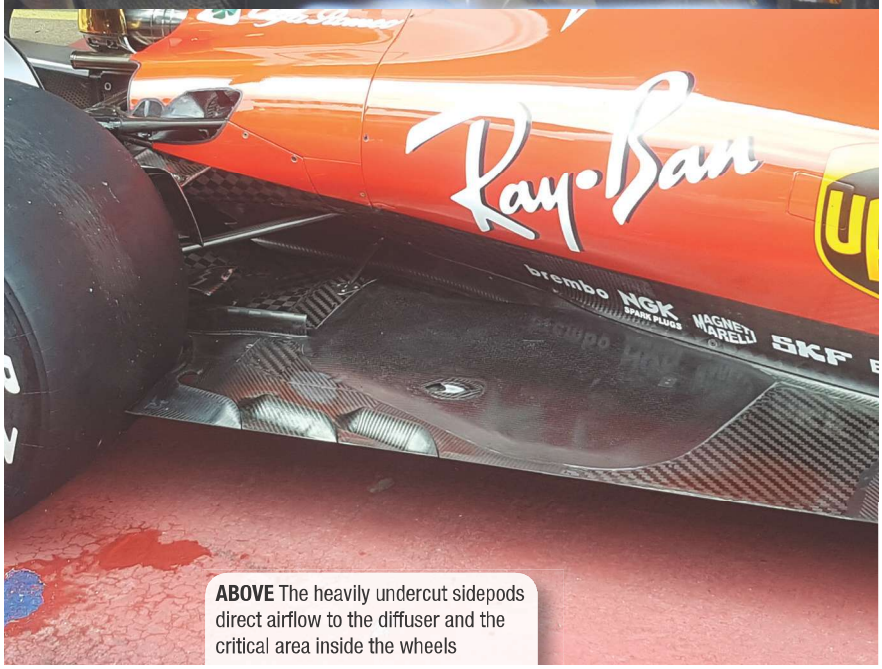
Through the latter part of the 2016 season the FIA became increasingly concerned. It believed that these complex suspension systems were overstepping the regulatory vision of what the suspension is supposed to do, ie control the tyre contact patch. Complex hydraulic links between the front and rear suspension – a system known as FRIC – had been outlawed in 2015, but it was clear teams were creating passive unlinked systems throughout 2016 in order to chase the resulting aero gains.

Over the winter the FIA issued more technical directives, setting out what it expected suspension to do and what it should not do. Ferrari accelerated this process by querying some interpretations of these hydraulic suspension systems. It was widely painted that Ferrari were the bad guys in fuelling this simplification of suspension systems but, while it certainly stoked the fire, the blaze was already set alight by the FIA at the end of the 2016 season. That said, Ferrari certainly gained performance relative to its rivals with this regulation change. This helped make the championship tighter in the first half of the season.

In developing the SF70H, Ferrari repackaged the suspension front and rear. In geometry terms the wishbones are not as aggressive with their setup compared to many other teams, no doubt to the gain of mechanical grip. While the compliant elements were wholly repackaged, this is most evident at the front, where the heave and roll setup was moved to be external to the footwell – a solution adopted by most teams in 2016. Although this makes it more difficult to keep the hardware secret, it certainly aids access. The primary reason is raising the pushrod rockers for a more efficient installation angle.

It can be seen that the pushrods operate very short rockers, with levers working a heave element, anti-roll bar and internal dampers around the internal torsion bar springs. Having been hidden before, it's evident that the centre heave element is a multi-function device with a heave spring, hydraulic spring, damper and inerter built into one compact unit. Making this component work is a key ▶

BELOW The V-shaped radiator package is a key part of the sidepod layout



ABOVE The heavily undercut sidepods direct airflow to the diffuser and the critical area inside the wheels

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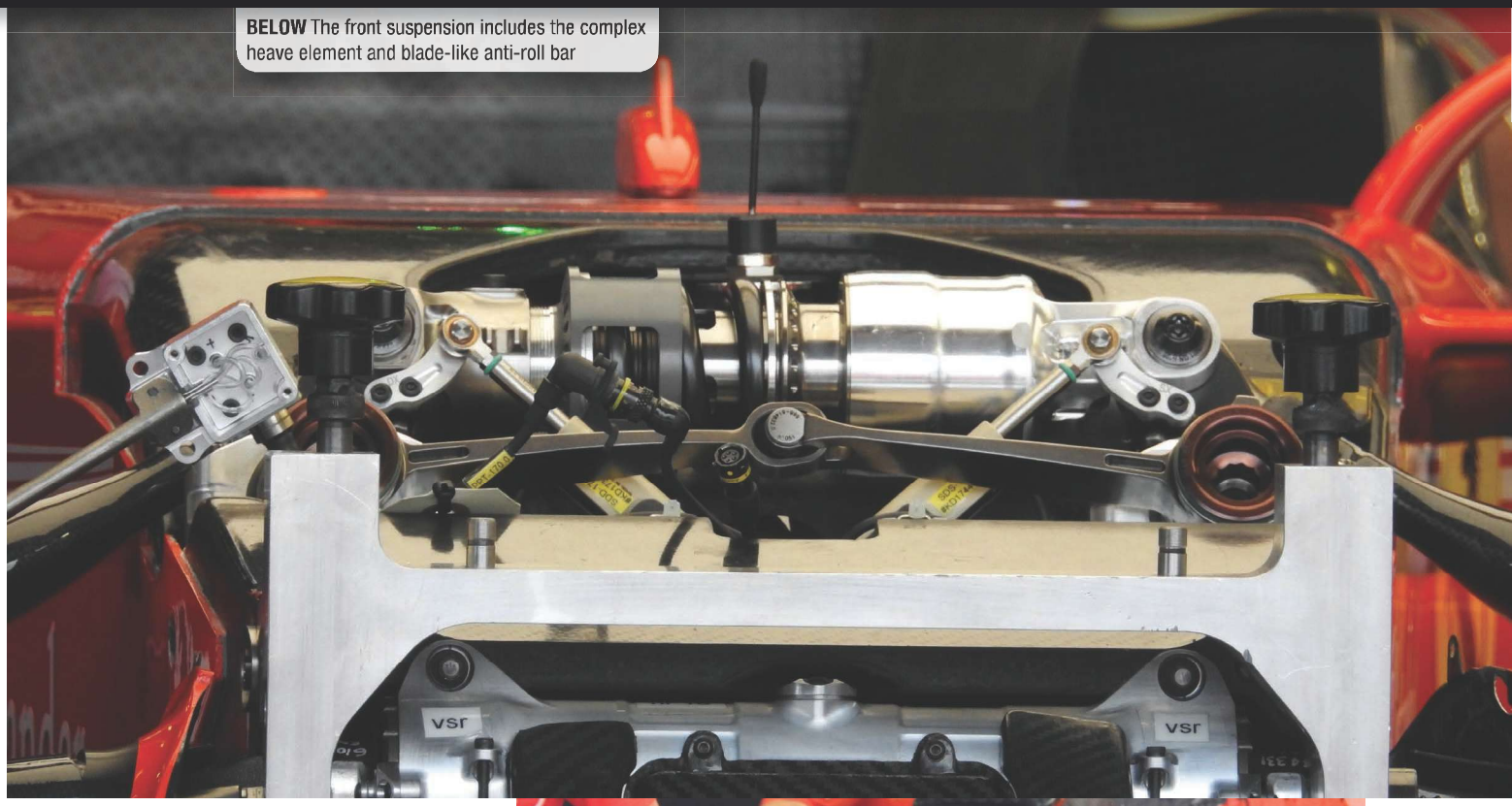


BELOW The front suspension includes the complex heave element and blade-like anti-roll bar

part of modern F1, especially the hydraulic spring, which although restricted in its use for 2017, is still linked through valves to a sidepod-mounted accumulator to control the front ride height in heave.

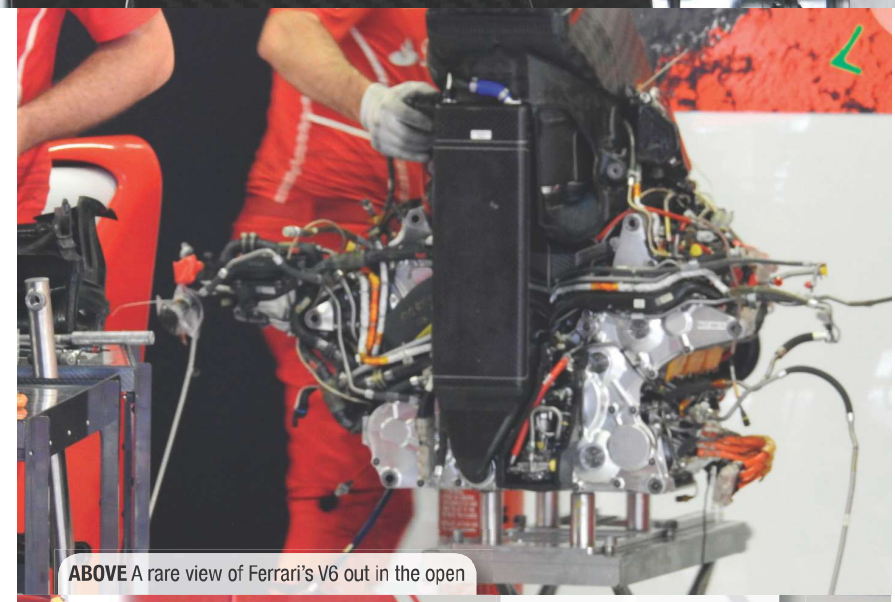
Ahead of the heave unit is the anti-roll bar setup. Each rocker has interchangeable blades that are linked with a roller bearing and bend to resist the roll motion as the car corners. Not visible are the side dampers mounted vertically inside the footwell.

At the rear, a similar suspension system is fitted inside the carbon outer gearcase. To achieve the long wheelbase, the casing is overlong for the tiny cluster that's within it. Such is the length of the rear end, relatively short pullrods operate the compliant elements, which are mounted to a machined plate that bolts in midway along the casing.

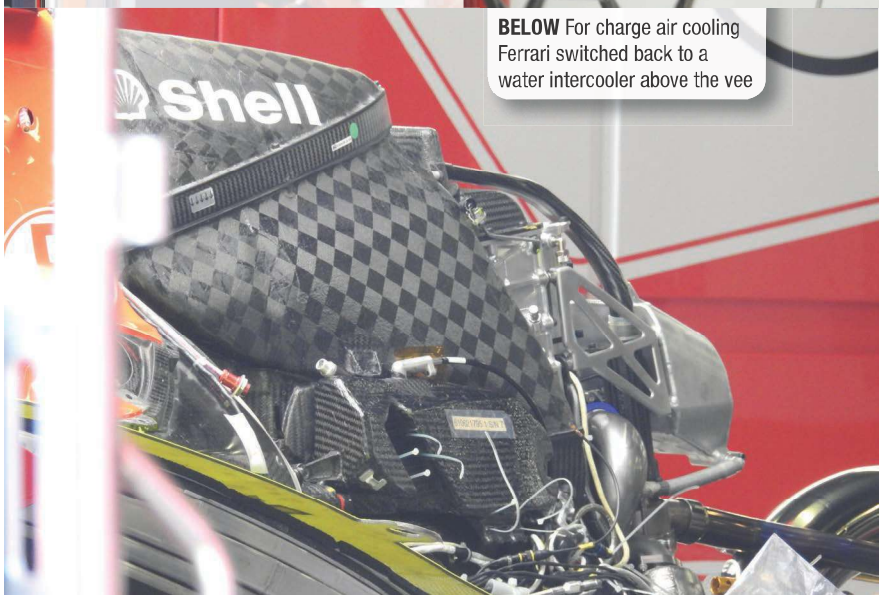
062 POWER UNIT

Ferrari's 062 Power Unit (PU) is the fourth version of its powerplant since the major rules shake-up in 2014. The Scuderia's first stab at the 1.6-litre V6 turbo, with a double hybrid system, was something of a failure. It didn't have the horsepower or ERS range to keep up with the benchmark Mercedes-AMG power unit. Seasons two and three of the current era saw a step improvement in the PU. The 2016 specification was a strong contender in terms of ICE power, hybrid range, packaging and reliability.

All that was needed for 2017 was merely a refinement of the package and Ferrari has ▶



ABOVE A rare view of Ferrari's V6 out in the open



BELOW For charge air cooling Ferrari switched back to a water intercooler above the vee

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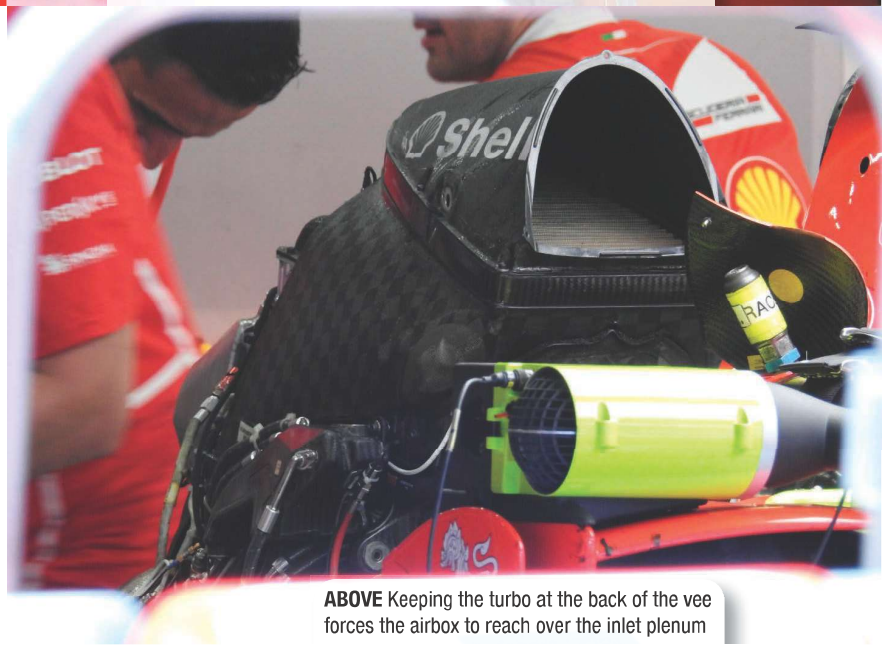
ABOVE Ferrari uses a single longer clutch paddle, visible below the steering column

ABOVE A separate gearbox cartridge removes from within the rear outer carbon casing, complete with heatshield to protect it from the turbo



ABOVE Keeping the turbo at the back of the vee forces the airbox to reach over the inlet plenum

nearly delivered in every respect. In race trim, the PU has close to the same power characteristics of the Mercedes. Reliability-wise, the pair have been relatively equal.

In terms of packaging, Mercedes-AMG retains the split turbo concept, with the compressor stage mounted at the front of the V6. The exhaust-driven turbine is at the rear, mounted on a torsion bar along with the ERS-H motor generator unit (MGU) mounted within the engine's vee.

Ferrari, meanwhile, retains a close coupled turbocharger mounted just behind the engine, with the ERS-H MGU sitting ahead of them within the engine's vee. For charge air cooling (CAC) Ferrari has switched over the years, the first two PUs having a water-to-air charge cooler mounted between the inlet plenums within the vee. Latterly it employed a split CAC setup, with an air-to-air cooler behind the engine then a water-air unit ahead. It appears for 2017 the CAC setup reverts to a refined version of the earlier unit, with a water-to-air cooler mounted within the vee. This is more compact than the 2016 solution and also takes up less external space than the Mercedes water-to-air CAC which is mounted within a recess in the fuel tank area ahead of the engine.

Of course, all the F1 engine manufacturers now employ pre-chamber combustion technology. Ferrari is known to be using Mahle's Turbulent Jet Ignition (TJI) technology in this area, allied to Shell fuel and oils, to achieve the high levels of power output with the lean burn regulations. This results in a thermal efficiency nearing 50% and power outputs close to 1000 hp (including the 160 hp ERS power contribution).

Ferrari's current engine, used by the factory team and the Haas customer squad, can be instantly recognized in the pitlane, not by sound but by its exhaust smell, with a distinctly paraffin-like aroma that almost burns your eyes! This unusual sensory assault is new for this year, as proven by Sauber – which runs the 2016 Ferrari customer engine – not having this scent. It's believed to be the result of the regulatory demand for bio content in the fuel, with Shell uniquely using a paraffinic bio material, as a by-product of bio diesel production.

Mated to the engine is the gearbox, Ferrari being a pioneer of the cartridge format rear end, whereby the gearbox itself is self-contained inside a carbon fibre cartridge. This is then mounted inside the outer carbon fibre structure that joins the engine, suspension and rear crash structure together. With the clutch being mounted to the tail of the crankshaft, the higher crankshaft axis demanded by the 2014 PU regulations allowed the gearbox to be able to sit well above the floor axis. This aids aerodynamics as the airflow tucking in around the slim sidepods can pass under the cantilevered gearbox and provide a better airflow to the diffuser. Although the actual gear shaft positions are largely defined by the regulations, Ferrari's gearbox structure sits high above the floor, more so than evident on other cars, afforded by less sump structure under the gear cluster.

The clutch release mechanism is critical for race starts. Over recent years regulations have tightened up external support on advising the driver before the race with information on clutch conditioning, bite point and surface grip on their grid slot. It's now down to the driver to set the clutch controls on the steering wheel according to the conditions of the clutch, tyres and track. Moreover, the rule also enforces starts to be controlled with a single clutch paddle. Before, two paddles were being used: ▶

> "A thermal efficiency nearing 50% and power outputs close to 1000 hp"

one for the first half of clutch travel, the second for its final disengagement.

Ferrari has adopted a single clutch paddle setup, there being one longer clutch paddle operating a rotary sensor. This has certainly aided Ferrari with consistent starts but, as with most areas of weakness, Mercedes-AMG has engineered a solution to catch up. Now there's little inherently between the two cars at the race start, it being simply down to the driver to get it right on the day.

Ferrari, like many teams, has notes inside the cockpit to remind the driver of steering wheel settings for starts, restarts and other race strategy calls. At Monza, there was a note about the number of burnouts to be carried out on the warm-up lap, dependent of tyre temperature. This detail extends to half a burnout, for certain tyre temperatures!

OIL BURN INTRIGUE

The FIA's clampdown on overtly complex suspension systems may have worked to Ferrari's favour, but such clarifications cut both ways. Once the season was underway, the new rules and tight championship battle inevitably prompted different 'interpretations' to emerge. Further technical directives have been issued, not always to Ferrari's advantage.

Ferrari has struggled compared to Mercedes-AMG through mot having a high-power engine mode it can use in qualifying and tactically during the race. Its rival continues to be able to gain +20 hp in final qualifying in order to lap some 0.2s faster to grab the vital pole position.

It's been the paddock suggestion that part of Mercedes' high power mapping gain has been in boosting the combustion process via engine oil. Although widely called oil-burning, this hasn't been to use engine oil as a fuel, but rather to pass additives that are not allowed in the fuel regulations into the engine's airbox via the oil breather system.

Red Bull appeared to be the whistle-blower on this practice, with FIA directives being issued during pre-season testing to limit oil burning. With cars losing some five litres in oil consumption during the race, the FIA introduced a race oil consumption limit. This was later updated to specify an instantaneous oil consumption of 1.2 litres per 100 km, thus impacting the shorter qualifying sessions.

It appears Ferrari's solution to gain from oil additives in combustion was to have an extra oil tank, in addition to the main engine oil talk and the usual auxiliary tank. Paddock rumour suggested this tank held a different specification oil which was used in the combustion process for more qualifying power. Quite how this oil was transferred into the combustion chamber was never explained, as it was either with an overt valve/venting system or it had to mix with the larger volume of the main engine oil.

Regardless, the FIA had the practice pointed out to it and the concept of two engine oil formulations run simultaneously was banned. The wider issue of oil burning was further addressed with the consumption rate reduced for engine specifications introduced after Monza to 0.9 litres per 100 km, then to just 0.6l per 100 km across the board from 2018 onwards.

Ferrari was expected to introduce a major specification update to its power unit for Monza, in order to keep pace with Mercedes. Its rival had brought in a new V6 ICE spec just before Monza and thus was still able to burn up 1.2l of oil per 100 km. Tip-offs suggested that part of Ferrari's upgrade was to be based around a new piston design. Not simply a steel piston replacing the current aluminium part, but a 3D printed one at that.

Very little information has emerged about this prospect, with neither the race engine nor additive manufacturing industries backing up the claims. Ferrari's piston partner Mahle does have a patent with a hybrid material piston, but this falls short of the 3D printed version touted in the Italian press.

Theoretically a steel piston could withstand higher cylinder pressures and temperatures, thus allowing a means for higher BMEP, if cooling and hot spots could be controlled. F1 pistons are already heavily cooled by oil sprays directed into the pockets on the piston underside, but limited by the small surface of the 8-10 pockets machined under the piston crown. Perhaps the aim would be a 3D printed lattice structure added to the piston underside to further draw heat from the crown and potentially structured to ease any hot spots unavoidably created on the crown? As yet, this remains a rumour and Ferrari has yet to introduce any update to its power unit.

2017 CHAMPIONS?

At the time of writing the championship was still tight but perhaps Ferrari's fast start to the season has been overcome by Mercedes-AMG engineering-out its initial issues. Ferrari arguably gained from regulatory clarifications over the winter, but they have tended to work against it mid-season.

The challenge for both teams over the hard slog of the final flyaway races is to find performance in their chassis and manage their tyres; at the same time they are extracting new performance from their engine programmes within the oil burn rules and the cap of four power units for each driver through the season. On all of these counts the balance of performance between the two teams is so close that either a single upgrade or one retirement could decide the drivers' championship.

Ferrari has a consistent and capable racecar, plus the resources and personnel. It also has pressure: having affirmed that yes, they could win the title, the management team must deliver. There is a risk that failure in the closing races could have consequences for them not only this season, but for their continued tenure in 2018. RT

Lee/LAT

Dunbar/LAT

ABOVE A single retirement could decide the title. Did Vettel's hopes ebb away with the fluid pouring from his car after that Singapore start?

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

CADILLAC'S IMSA WINNER

A 6.2-litre naturally aspirated V8 has dominated smaller, turbocharged counterparts in the first season of IMSA's headline Daytona Prototype international (DPi) category. **Chris Pickering** searches for the secret of Cadillac's success

NORTH American sportscar racing turned a corner this year. After a turbulent couple of seasons trying to balance two different prototype concepts, the new one-size-fits-all Daytona Prototype international (DPi) category has proved to be the success everyone hoped it would be.

Unlike the World Endurance Championship's LMP2 category, with which it shares its basic chassis regulations, the top tier of the WeatherTech SportsCar series allows multiple engine manufacturers to compete against each other.

This season, the Cadillac DPi-V.R. has

been the package to beat – thanks in no small part to its 6.2-litre naturally aspirated V8. Developed and produced by ECR Engines, it follows a no-nonsense formula, with an 'overhead valve' pushrod layout, port injection and two valves per cylinder. This has proved more than a match for its smaller, turbocharged counterparts, and indeed the LMP2-spec Gibson V8 that also competes in the series.

Rumour has it that Cadillac contemplated using a turbocharged V6 itself at one stage, although the idea was rapidly dropped in favour of a V8 layout, loosely inspired by its CTS-V and Escalade road cars. At that point, ECR was called in. The North Carolina outfit has longstanding links with Cadillac's parent company, General Motors, through both its NASCAR Cup Series engine and previous Daytona Prototype (DP) programmes.

The DPi engine was to be 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.

> *"The idea was that if the whole of the chassis electrical system went down and the car was immobilised, the engine would still be running"*

Although it shares some fundamental architecture with the previous DP engine it is essentially all-new, explains ECR's director of engineering, Matt Wiles.

"Virtually every part on this engine is bespoke, but we have drawn upon expertise from our Cup programmes – particularly in the valvetrain development," he says. "The design of the reciprocating assembly, bearings and oil pump has also been influenced by that. The same people who work on the R07 [NASCAR Cup Series] engine are involved in this programme, including the design engineers, technicians and trackside personnel."

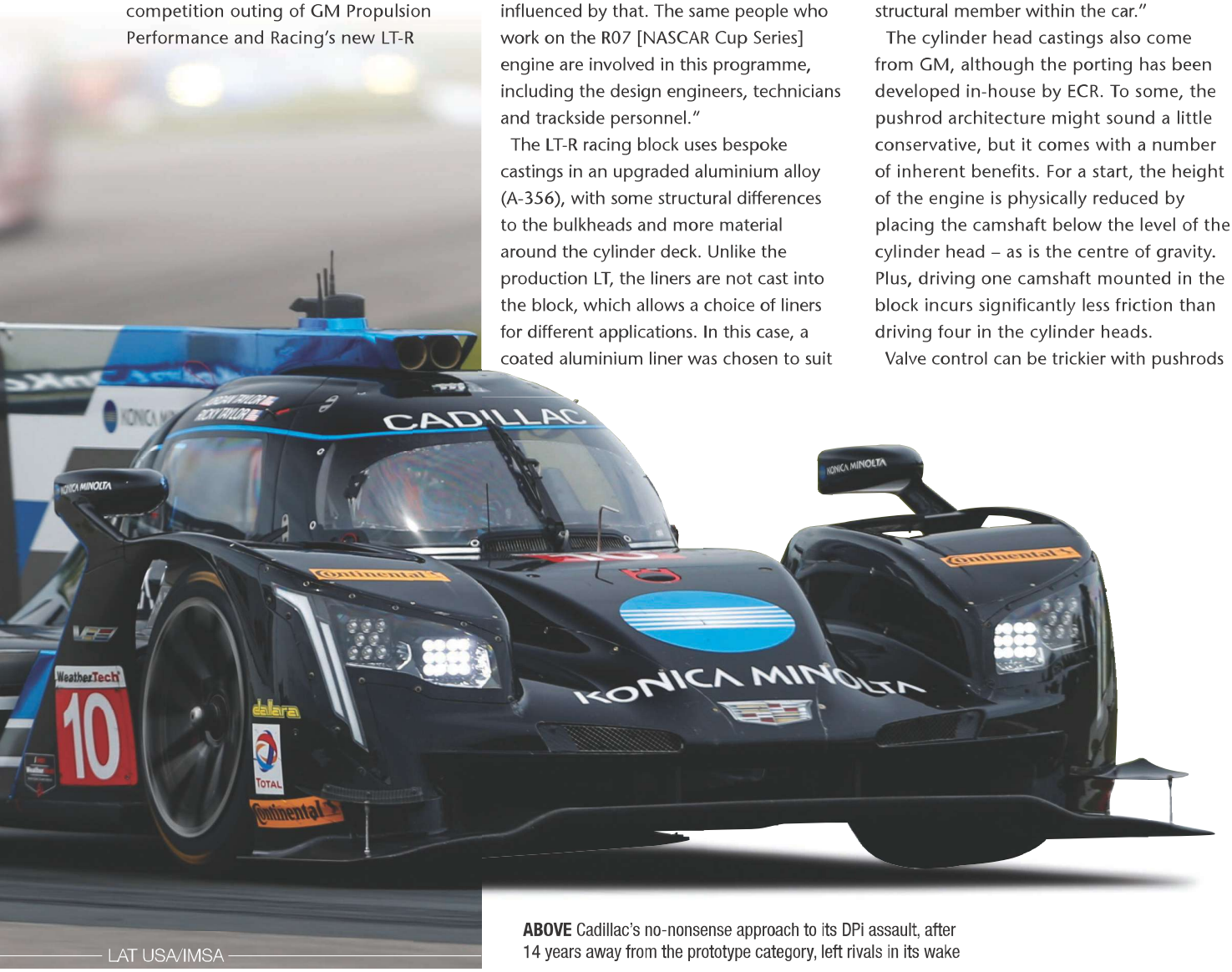
The LT-R racing block uses bespoke castings in an upgraded aluminium alloy (A-356), with some structural differences to the bulkheads and more material around the cylinder deck. Unlike the production LT, the liners are not cast into the block, which allows a choice of liners for different applications. In this case, a coated aluminium liner was chosen to suit the thermal expansion characteristics of the block and to reduce weight.

Another useful modification is the addition of a fully enclosed cam tunnel. This can be machined away if required for the specific application, but for the DPi engine it's retained. That helps to reduce windage, because it gives better control of where the oil drains, compared to a conventional pushrod design where the camshaft tunnel is open to the crankcase. However, its primary role is to increase the longitudinal stiffness of the engine.

"The fully enclosed cam tunnel was a factor in our decision to use this block," comments Wiles. "Unlike our old DP engine, this is a structural member within the car."

The cylinder head castings also come from GM, although the porting has been developed in-house by ECR. To some, the pushrod architecture might sound a little conservative, but it comes with a number of inherent benefits. For a start, the height of the engine is physically reduced by placing the camshaft below the level of the cylinder head – as is the centre of gravity. Plus, driving one camshaft mounted in the block incurs significantly less friction than driving four in the cylinder heads.

Valve control can be trickier with pushrods ▶



LAT USA/IMSA

ABOVE Cadillac's no-nonsense approach to its DPi assault, after 14 years away from the prototype category, left rivals in its wake

at high engine speeds, but this is something that ECR is well versed in thanks to its NASCAR programme. More to the point, with 6.2 litres to play with, and no specific incentives in the technical regulations, there simply wasn't the requirement to rev the DPi engine especially high.

"The maximum engine speed for this application is below 8,000 rpm," notes Wiles. "We can do that quite easily for a very good distance with a pushrod engine. It's a technology that we're very comfortable with through our involvement in NASCAR, whereas some manufacturers would look at it and go 'we don't want to get involved with that'."

The idea is not without its drawbacks. Notably, the ports on a pushrod engine tend to be narrower to allow the pushrods to sit between the intake ports, but this clearly hasn't proved to be any great impediment.

In terms of pure packaging, a V8 is arguably the hardest solution of those currently employed in the DPi category. A turbocharged inline four would be around the same length but narrower, whereas a V6 of comparable overall width would be shorter.

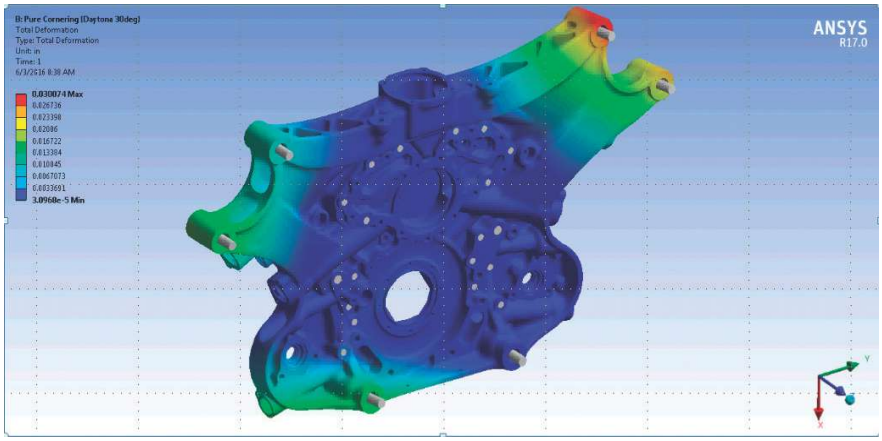
"We had to use the packaging space that was offered to us by the chassis," comments Wiles. "That gave us 640 mm of longitudinal space. Considering our engine block is 520 mm in length that didn't leave a huge amount of space to package the front drive system for the ancillaries or the mounting structure. We had to support approximately 50 per cent of the chassis loads of the vehicle, so coming up with a design that could handle both the structural requirements and the fluid routing was quite a challenge. In the end we overachieved in our packaging target with an overall engine length of 605 mm, which is testament of the creativity and prowess of our team."

DESIGN CHOICES

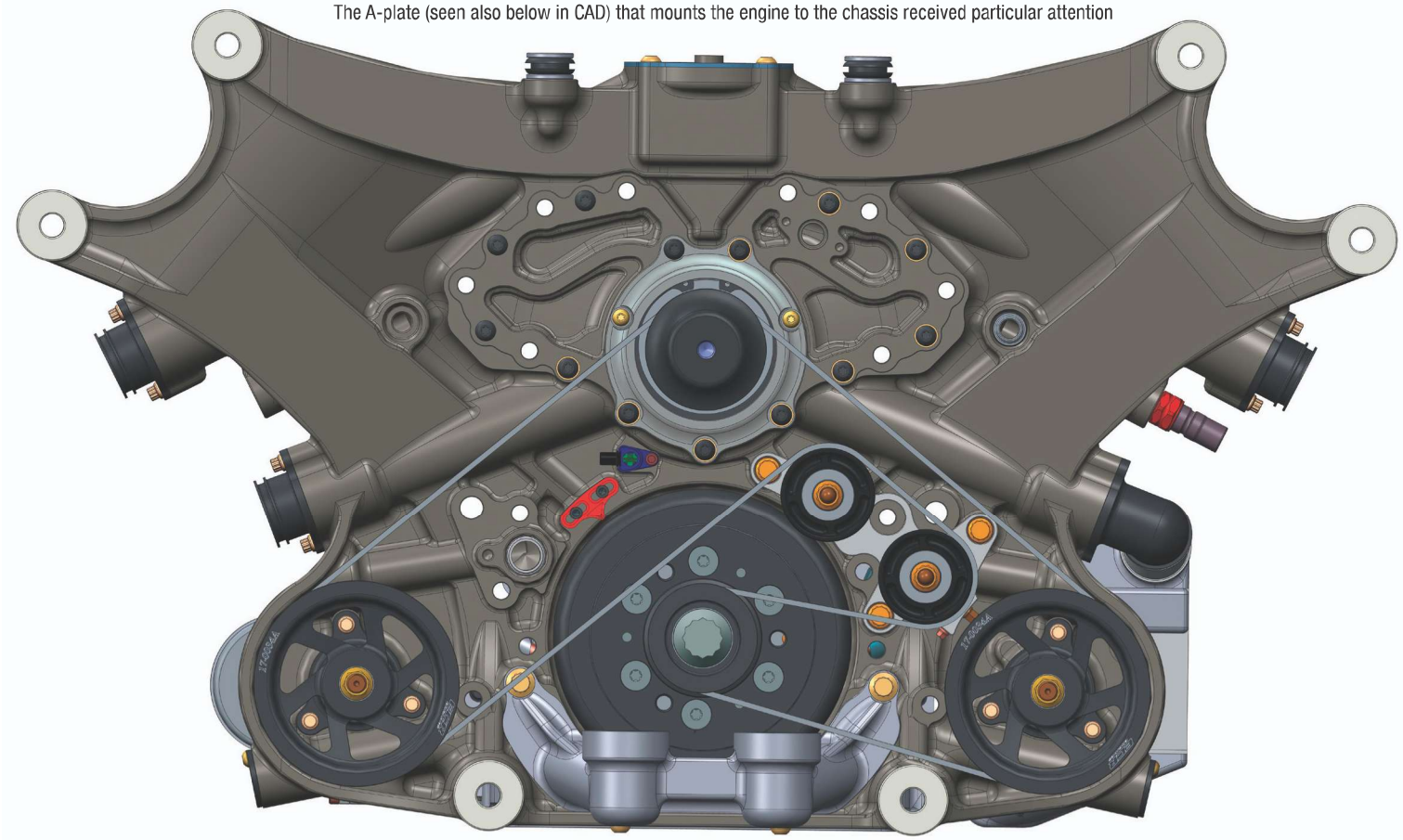
The IMSA technical regulations are relatively free when it comes to things like material choice. There are a few basic limitations, but the engineers say they never felt constrained.

"We wanted to deliver the engine at a good price point for the teams so we tried not to use anything too exotic," comments Wiles. "The weight has always been on our minds, but at the same time we didn't want to push things to the point where durability became a concern."

Naturally, the base engine is heavier on a V8 than it is on a smaller, forced induction design. However, the ECR engineers say ▶



ABOVE & BELOW Finite element analysis (FEA) was used extensively to develop the engine's structural role. The A-plate (seen also below in CAD) that mounts the engine to the chassis received particular attention



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> *"If the opportunity opened up, Le Mans would be the next thing on the bucket list"*

they're not entirely sure how the all-up package weights of the other solutions compare. With a full oil load – monitored by Reventec level sensors – the DPi engine assembly is said to tip the scales at around 450 lb (204 kg) but that's a full package, complete with all ancillaries.

ECR's approach has been to incorporate as much as possible onto the engine package. Each unit comes complete with a Tilton racing clutch and flywheel so the teams only have to connect the electronics, the water pipes and one fuel line. Each engine comes with a completely closed lubrication system, including the associated oil tank and cooler. They're even filled with oil before they leave the ECR factory, which means that the teams have zero maintenance and servicing to carry out.

The engines are designed to cover the whole of their planned 3,400-mile rebuild life without an oil or filter change. Impressively, all three Cadillac DPi teams managed this for the four-race stretch from Sebring in March to Belle Island in June. During that time, each car covered more than 13 hours of wide open throttle and around 36,000 upshifts. In fact, the engines have proved so reliable to date that ECR says it's thinking about upping the mileage between rebuilds.

ECR worked very closely with Dallara during the engine development to get the packaging right. Part of the thinking behind the engine-mounted oil tank was to make the best use of the available space. Likewise, the powertrain engineers spent a lot of time with cooling system provider PWR to perfect both the water radiators and the engine-mounted water-to-oil cooler.

The overall heat rejection to the engine compartment is thought to be lower than a turbocharged engine. To improve matters further, ECR has used a ceramic lagging material from SSTT. This is encased in foil and welded directly to the exhaust system, which is produced by Howerton Racing Products.

"One of the reasons for merging the oil system with the engine was to get a universal solution. At one point with the old DP programme we had seven different programmes running. Back then the oil systems were part of the cars, so you can imagine how complex that became," comments Wiles.

They've taken a similar approach when it comes to the electronics. Not only is there a bespoke engine wiring loom, designed in-house by ECR and manufactured by DC Electronics, but also a special sub-harness for various cockpit-mounted electronic systems that are powertrain-dependent.

"We decided we wanted to control the powertrain electrical system from the battery terminal all the way to the engine," says Wiles. "The idea was that if the whole of the chassis electrical system went down and the car was immobilised, the engine would still be running. We wanted to make sure we would never be the cause of a race failure. The accelerated timeline on this project also played a part – we wanted to use systems that we were already familiar with."

Most of the chassis electronics come from Cosworth, while the engine ECU is a tried and tested Bosch item from the DP era. The whole system is connected via a CAN network and we're told the various platforms integrated without any issues. ▶

BELOW A ceramic lagging material is encased in foil and welded directly to the exhaust system, seen here being put through its paces on the dyno

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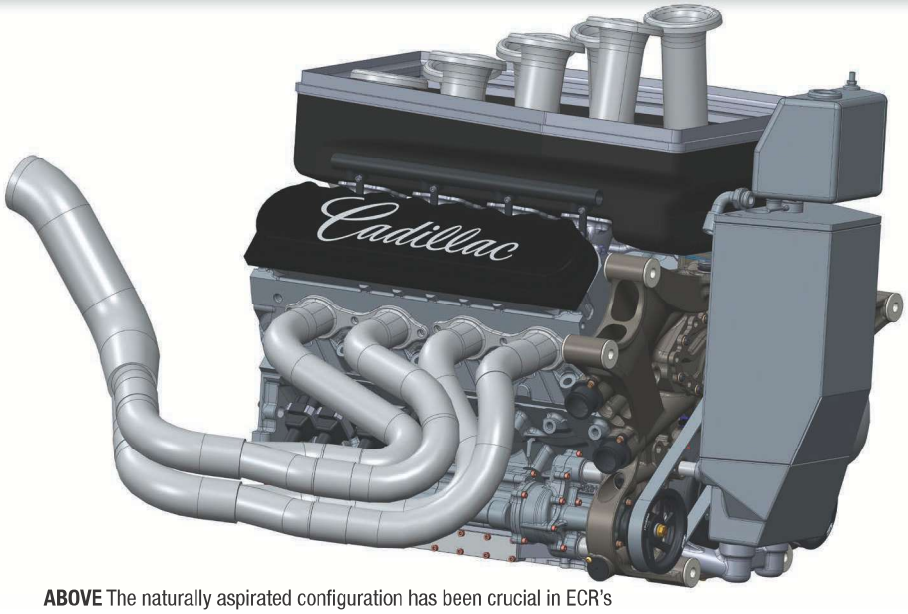


ABOVE The naturally aspirated configuration has been crucial in ECR's quest for durability and driveability in a performance-balanced category

CHALLENGING TIMESCALE

Design work for the project officially began on 11th January 2016. Less than nine months later, on 5th 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.

Simulation played a part in this fast turnaround, Wiles explains. In particular, finite element analysis (FEA) was used extensively to develop the engine's structural role.

"The most critical aspect was ensuring the engine was sufficiently robust to handle the chassis loads," he says. "We had numerous iterations of the A-plate that mounts the engine to the chassis. We used a lot of FEA to balance material properties, looking at fatigue, ultimate strength and mass."

By May 2016, ECR had built the first test engine based on the LT-R cylinder block. It was a basic development mule, without some of the finished engine's ancillaries, but it provided a starting point for developing things like intake and exhaust systems, along with the camshaft profiles. That was used for about three weeks, but after that the engine didn't fire again until 30th August. Two days later it ran in the chassis for the first time at Dallara's facility in Indianapolis and later that week the car began testing.

"Our designers really knocked it out of the park getting everything ready and integrating everything into the Dallara tub," comments Scott Meesters, ECR's sports car programme co-lead and lead trackside engineer. "The first test went really well. We did make some minor updates afterwards, as any programme would, but every single mile of that test was successful."

Alongside the track testing, ECR carried out a full 30-hour lap simulation on its AVL engine dyno, based on data from Daytona. Following on from the initial test at Putnam Park in Indiana, the programme moved on to the National Corvette Museum's track and Watkins Glen.

"The Corvette Museum test was the first time we really saw what this vehicle was capable of," says Meesters. "We knew it was going to pull much higher cornering ▶

BELOW With the engine block alone totalling 520 mm in length, packaging the V8, ancillaries and mounting structure was no mean feat

Suppliers

Cooling system	PWR
Oil pumps and sump	Precision Racing Components
Intake system	Kinsler
Piston rings	Total Seal
Pistons	Mahle
Fasteners	ARP
Connecting rods	CP-Carrillo
O-rings	Cometic
Seals	Race-Tec Sealing Ltd
Liners	Capricorn
Cylinder block and heads	GM Propulsion Performance and Racing
Clutch	Tilton Engineering
Exhaust	Howerton Racing Products
Thermal lagging	SSTT
Oil level sensors	Reventec
Engine wiring loom	DC Electronics
Engine ECU	Bosch
Chassis electronics	Cosworth
Crankshaft	Bryant Racing Inc.
Crankshaft damper	ATI
Camshaft	COMP Cams
Pushrods	Smith Brothers
Rocker arm	T&D Machine Products
Camshaft followers	Jesel
Oil	Lucas
Valvesprings	PSI Springs
Valves	Del West

loads than the old Daytona Prototypes, but we were very impressed with the outcome. Following that we did a durability test at Charlotte Motor Speedway. Most people know it as an oval, but it also has a road course; using sections of both we were able to subject the car to very high speeds and loads to test all the load paths. We wanted to make sure everything was going to be okay by the time it reached Daytona."

BALANCE OF PERFORMANCE

As part of IMSA's performance balancing process, each of the manufacturers are given a target power output, which was around 600 bhp in the case of the Cadillac. The engine manufacturer then has to produce a package that can hit that target, allowing for a little adjustment in either direction.

"IMSA has done a good job in enabling different architectures and balancing against each other," comments Wiles. "We've tried to really draw on our strengths and our knowledge of the overhead valve architecture to balance performance, durability and efficiency."

Both fuel tank capacity and refill rates are controlled under the balance of performance system, so there are no particular drawbacks to running a larger engine. In fact, the Cadillac's fuel efficiency is said to be surprisingly good – something that the ECR engineers again attribute to the low-friction single camshaft design.

In a performance-balanced formula the key technical battlegrounds are reliability and drivability. The naturally aspirated configuration bodes well for both, Meesters points out: "Forced induction tends to put more stress on the engine. Providing you've got enough capacity to keep the revs down, a naturally aspirated engine will often have the upper hand in an endurance event. We've seen that in the past with our DP programme and we've seen that this season in DPi. It's about getting the power curve smooth and predictable so the drivers can apply it well on the racetrack and the teams can get the gearing right, and then focusing on durability so they can bring it home for the win."

Cadillac's results this season speak for themselves. As this issue goes to press, with one round of the WeatherTech series left to go, the car has only been beaten twice. Naturally, this hasn't gone unnoticed by the governing body. So far, the Cadillacs have been given three restrictor changes, along with a reduction in fuel tank size and a smaller refuelling restrictor. Uniquely, they have also been given mandatory first and second gear ratios to offset a low-rpm torque advantage.

"IMSA is doing well in the face of a large task," admits Wiles. "They've demonstrated that they've kept a somewhat level field. We've had multiple winners now this year. We couldn't expect to win them all – it would have been a storybook result, but we knew it would come to an end."

The cars' recent success is not just down to outright speed, he points out: "Arguably, they weren't the fastest in terms of lap times or top speeds, but it came down to durability and our teams and drivers executing on-track."

Entering the season finale, Cadillac led both the drivers' and manufacturers' titles in the WeatherTech SportsCar championship. Next year, however, the teams will face an even tougher challenge, with Acura joining the series with an ORECA chassis and a twin-turbocharged HPD V6. Beyond that, rumours that the ACO is open to greater commonality between the DPi class and LMP2 in the future could see a development of this engine compete further afield.

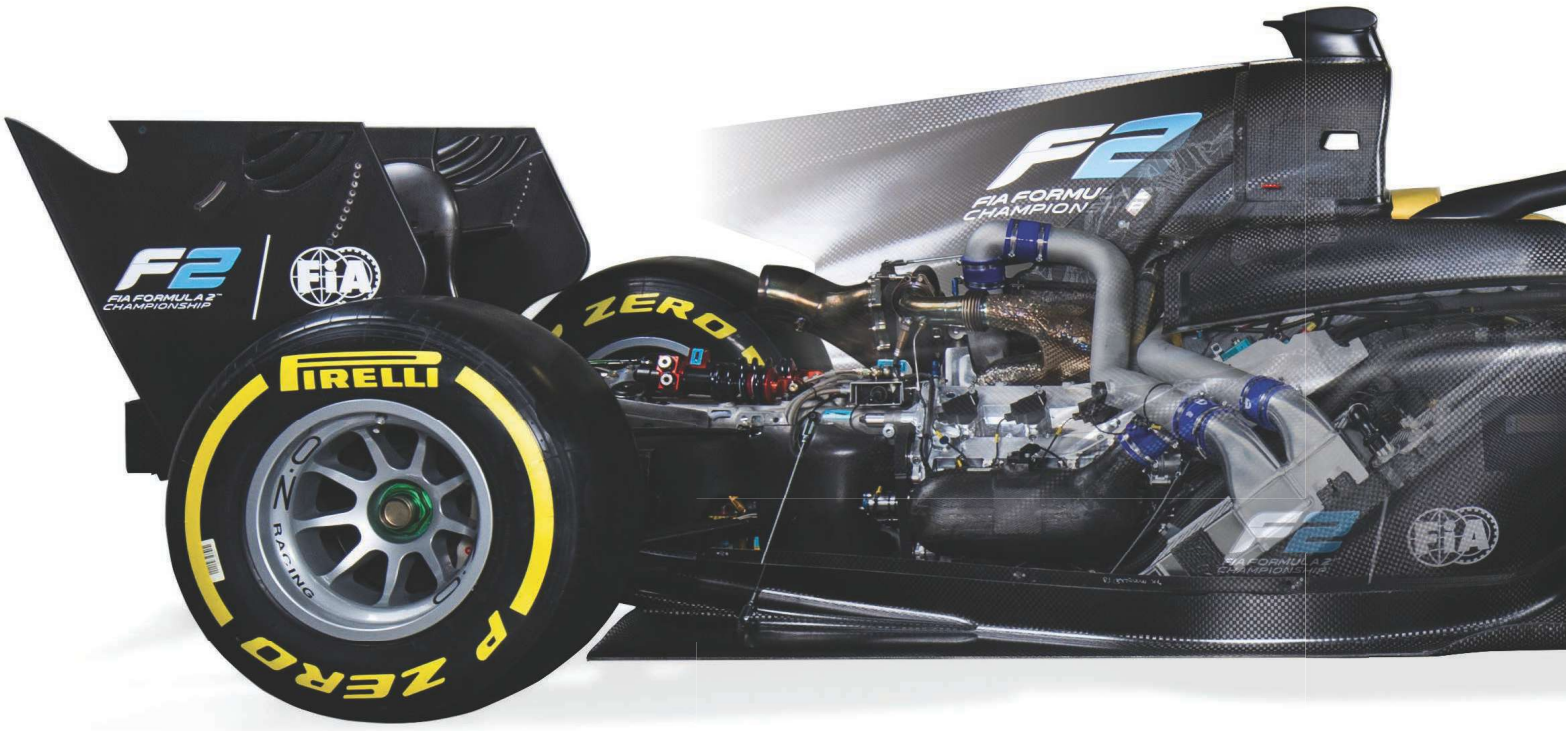
"From our perspective, as an engine manufacturer, we'd be ecstatic if this engine ever went to Le Mans, but the ACO and the FIA hold the cards there," says Meesters. "If in the future the opportunity opened up, though, it would be the next thing on the bucket list."

For the time being, though, the attention rests solely on clinching the WeatherTech title. If that goes to plan it will be testament to the success of ECR's approach. And whatever happens, the DPi formula has proved itself to be a worthy addition to the world of sportscar racing.

> *"The engines proved so reliable that each car covered more than 13 hours of wide open throttle and around 36,000 upshifts"*

BELOW Despite three restrictor changes and a reduction in fuel tank size, the Cadillac package has been the class of the field

LAT USA/IMSA



THE NEW TWO

Matt Youson reports on a new car, complete with Halo, created to help Formula 2 leave the GP2 tag firmly behind

THE metamorphosis of GP2 into Formula 2 has, so far, been a low-key affair. So low-key, in fact, absent of the new logo, few people remember it has happened: the faces are the same; the cars are the same; and, much to the exasperation of the FIA, people still refer to the series by its old moniker more often than not. This may change next year, however, with the series, whatever you care to call it, getting its first genuinely new car since 2011.

The business model for GP2 was based around a single-make car lasting three seasons. The original Dallara GP2 car was launched in 2005. It was superseded by the GP2/08 and then the GP2/11. There should have been a new model in 2014 but, for cost reasons, it was decided to run a double stint with the GP2/11, adding a DRS flap but extending the third model's life to six (later seven) seasons. As a consequence, GP2 began to drift out of correlation with F1, a blast from the past looking not unlike a simplified version of the F1 cars from the beginning of the 2009-2013 regulation era.

While a single-make series has no particular requirement for periodic updates, GP2's position as the primary feeder series to F1 required it to remain vaguely aligned with the premier category. That alignment extended beyond technology, performance and handling, and into less quantifiable realms, such as the look and feel of the car. If that has been misplaced over the last few years, the new Dallara F2/18, unveiled at the recent Italian Grand Prix, re-establishes it very firmly.

The new car features a narrower front wing, a lower nose, and a wider, lower rear wing. The width of the car increases from 1800 mm to 1900 mm. Mecachrome's venerable 4.0-litre naturally-aspirated V8 is retired, with the company instead supplying a 3.4-litre single-turbo direct injection V6. The total package will weigh around 30 kg more than the outgoing model, with much of that coming from extra cockpit intrusion protection panels and the addition of a Halo.

"We needed a car that looked modern – something that looked like an F1 car," says F2 technical director Didier Perrin. "We've made the wings to a typical F1 design of 2017, and made the car wider. We decided to not go all the way to the 2m width of the F1 car because without the wider tyres it would have looked bizarre – but we have increased in proportion and kept the aspect."

GOING TURBO

The obvious discrepancies between Formula 2 and its big brother are located behind the driver in the form of the new engine: there is no particular desire for Formula 2 to go hybrid and thus, while downsized and turbocharged, the new Mecachrome powerplant looks distinctly old-school.

"A single-make series has to guarantee two things," says Perrin. "We have to guarantee equality and deliver the same performance within a very narrow margin, and we have to be able to keep costs down. With engines, the bigger the capacity, the easier it is to guarantee very little discrepancy – and it's easier to reduce costs because a bigger engine gets more mileage between rebuilds. Start with an engine capacity that's too small, you ask more of the engine and it becomes more difficult to have good reliability and good repetition of ▶

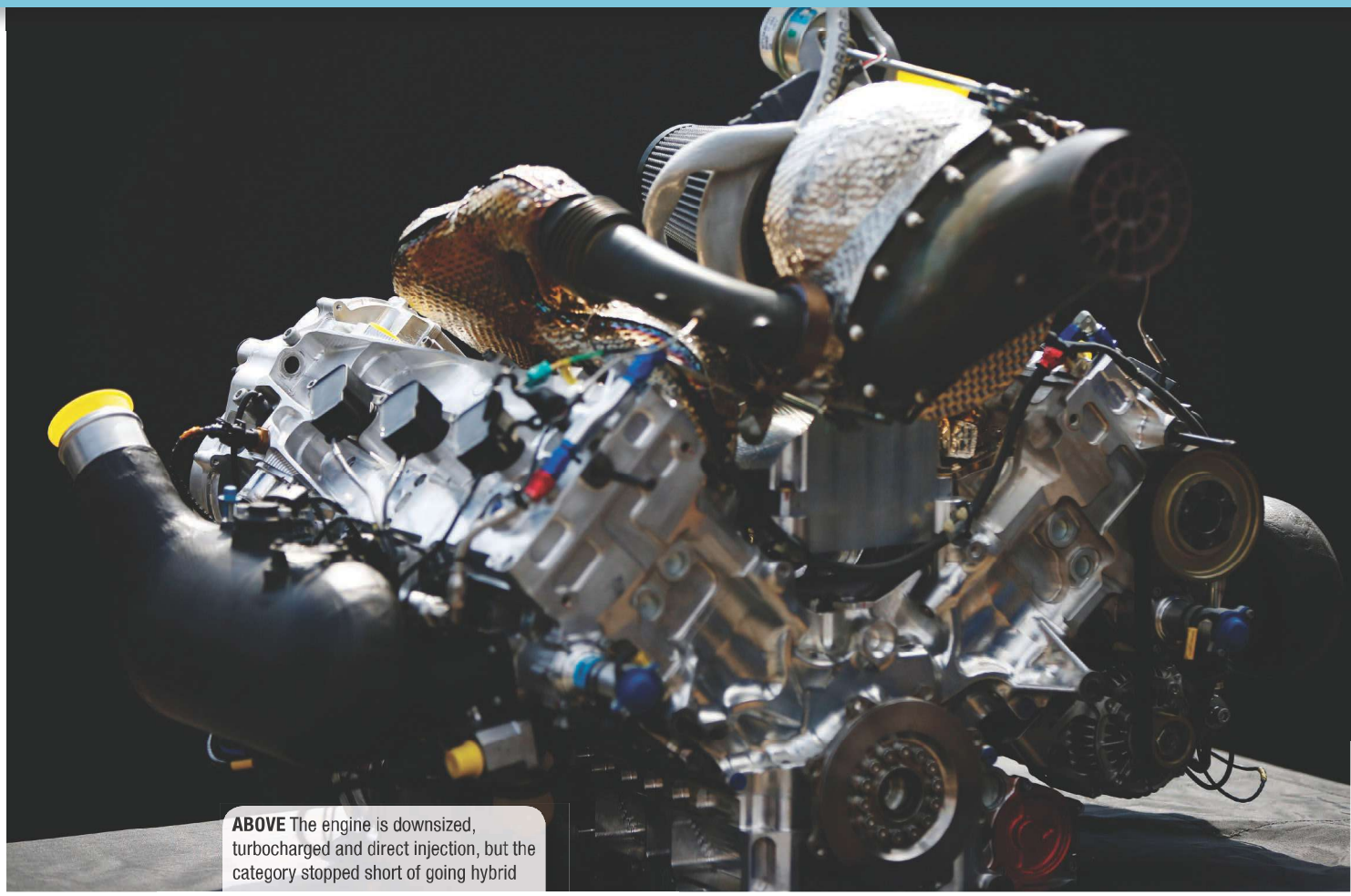
BELOW A cutaway showing the architecture of the new car, which is powered by a 3.4-litre turbocharged Mecachrome engine

Mauger/FIA Formula 2

> *"Dallara worked with two models to ensure it created cars that could follow and overtake"*

ABOVE F1 big-hitters Ross Brawn and Charlie Whiting quiz F2 technical director Didier Perrin on the new V6 turbo engine

Bloxham/FIA Formula 2



ABOVE The engine is downsized, turbocharged and direct injection, but the category stopped short of going hybrid

performance. This is the reason why, from the beginning of GP2 and GP3, we always worked with big capacity engines."

The engine is rated for max 620 hp, the same as the outgoing model, though the power curve for the turbocharged unit is, of course, very different. The intention is this will compensate for the extra weight of the car, and deliver lap times very similar to those achieved this year. This, very much, was the goal.

"We think the position of the current F2 car is correct," says Perrin. "We were not trying to get a faster car. The car will definitely be heavier due to the additional safety items on it, and the engine power will be the same. We expect to be in a similar performance lap time due to the fact the engine power curve is different. We don't need to be faster than the current F2. What we need is a cost-effective car, a safe car, and a car that provides a good show. Being two seconds faster per lap doesn't bring anything to the series."

LATE CALL ON HALO

While the new F2 car has been in the pipeline for a while, the addition of the Halo was a relatively late decision. In mid-July the device received formal approval to feature in F1 next year, with a stated intent from the FIA that it, like other F1 safety technologies, would filter down to other series in due course. With the F2/18 planned to last three years (but quite possibly longer), to not include it on this car would result in a sizeable delay. Necessarily, the decision was taken to push ahead with a Halo for 2018. With the way testing schedules are organised, the device will most likely make its debut in structural form on the F2/18 before it appears at an F1 test.

A supplier has yet to be appointed for the Formula 2 Halo, and with the first tranche of cars due to be delivered in January, this gives some indication of how close to the wire the decision was taken. Formula 2 race director Laurent Mekies – who is also the FIA safety director and, as such, the primary architect of the FIA's Halo research – argues including the device was not an opportunity that could be missed.

"After the decision to go ahead with Halo in F1 in 2018, it was always very clear that we wanted to cascade it down to the other single-seater formulas," he reasons. "We ▶

BELOW Aero testing focused on maintaining the category's reputation for this kind of wheel-to-wheel racing

Bloxham/FIA Formula 2

develop stuff in F1 because there we have all the firepower to do difficult things and to find solutions to technical challenges. Normally it takes a bit more time to cascade it down.

"The thing that is very specific about this car and about 2018 for Formula 2, is that in the end it will deploy at the same time as in F1, and there have been a very limited number of cases where we have done that in the past. It was a difficult call but we could not miss that opportunity. I think it is a great signal to be able to deploy things at the same time on single-seaters.

"What it means is that there is a very significant technical challenge to be able to cascade it down at the same time. It was on the late side for F1 and it is very late for F2. There is a slightly later start to the F2 season of course, we gain a month, which will help, but certainly it will be a challenge. But we will make it work. It is the first step towards a very rapid cascade into the other single-seater formulae. It ▶

ABOVE The Halo could make its debut in structural form on the F2/18 before it appears at an F1 test

Dallara F2/18 specification

Dimensions
- Length 5224 mm (was 5065 mm)
- Width 1900 mm
- Height 1097 mm including FOM roll hoop camera (was 1072 mm)
- Wheelbase 3135 mm (was 3120 mm)
- Weight 720 kg (including driver)

Engine
- V6 3.4-litre single turbocharged Mecachrome engine
- Rated to 620 HP @ 8750 rpm
- Fly-by-wire throttle system
- Rebuild after 8000 km
- Maximum torque 600 Nm

Performance
- Acceleration 0-100 km/h, 2.9s
- Acceleration 0-200 km/h, 6.6s
- Maximum speed 335 km/h (Monza aero + DRS)
- Max braking deceleration -3.5 G
- Max lateral acceleration +/- 3.9 G

Gearbox
- 6-speed longitudinal Hewland sequential gearbox
- Electro-hydraulic command via paddle shift from steering wheel
- ZF Sachs carbon clutch
- No on-board starter, anti-stall system
- Non-hydraulic ramp differential

Steering system
- Non-assisted rack and pinion steering system
- XAP steering wheel with dashboard, gearchange and clutch paddles, marshalling & VSC display

Safety standards
- Full FIA F1 2017 safety standards
- Halo F1 specification

Monocoque and bodywork
- Survival cell - Sandwich carbon/aluminium honeycomb structure made by Dallara
- Front and rear wing - Carbon structures made by Dallara
- Bodywork - Carbon-Kevlar honeycomb structures made by Dallara

Fuel cell
- FIA standard
- Premier FT5 125 litres

Electronics
- Magneti Marelli SRG 480 ECU/GCU including data logging system
- Magneti Marelli PDU 12-42 power supply management unit
- CAN data acquisition pre-equipment
- Beacon receiver

Suspension
- Double steel wishbones, pushrod operated, twin dampers and torsion bar suspension (F) and spring suspension (R)
- Adjustable ride height, camber and toe
- Two-way (F) / Four-way (R) adjustable Koni dampers
- Adjustable anti-roll bar (Front/Rear)

Brakes
- 6-piston monobloc Brembo callipers
- TBC carbon-carbon brake discs and pads

Wheels and tyres
- O.Z. Racing magnesium rims
- 13" x 12" front F1 2016 standard wheel dimensions
- 13" x 13.7" rear F1 2016 standard wheel dimensions
- F2-specific Pirelli slick/wet tyres

Dunbar/FIA Formula 2

ABOVE The GP2/11's life was extended on cost grounds, but as a consequence GP2 fell increasingly out of step with F1's design ethos

will arrive in Formula E midway through next year, for season five, and then it will be implemented in Formula 3 in 2019."

TORQUE CURVE IMPACT ON TYRES

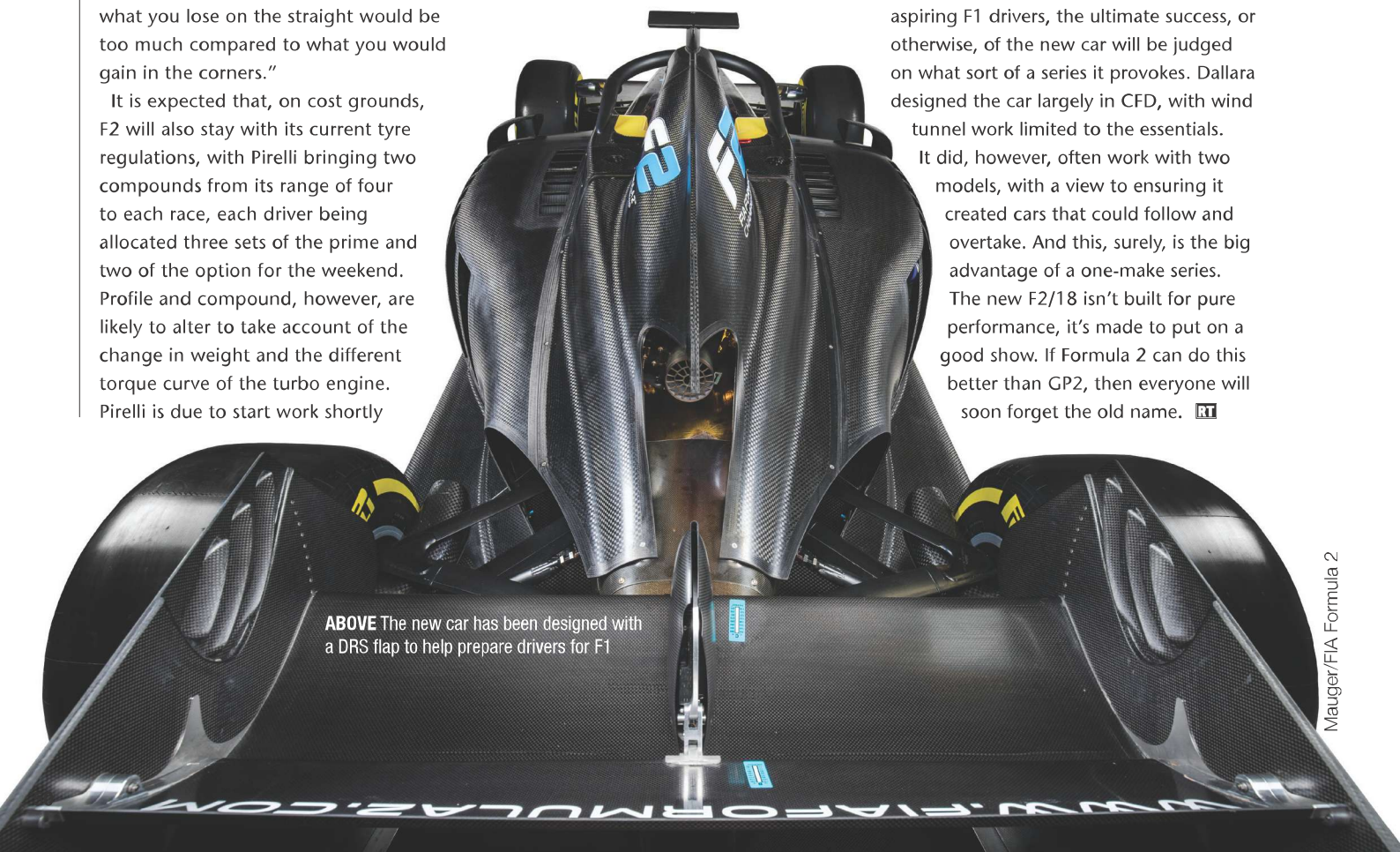
One area where F2 hasn't followed F1 is in the size of its tyres. It will continue with Pirelli rubber of similar geometry to that used on the GP2/11, albeit of a different composition. Practical considerations rather than aesthetics have driven the decision.

"It's simply that bigger tyres create more drag," explains Mario Isola, racing manager at Pirelli Motorsport. "The air resistance from the wider size would be too much for a car like that – so we believe the correct choice is to stay on the old F1 sizes. It's not the same for Formula 1 where you have more power – but in F2, what you lose on the straight would be too much compared to what you would gain in the corners."

It is expected that, on cost grounds, F2 will also stay with its current tyre regulations, with Pirelli bringing two compounds from its range of four to each race, each driver being allocated three sets of the prime and two of the option for the weekend. Profile and compound, however, are likely to alter to take account of the change in weight and the different torque curve of the turbo engine. Pirelli is due to start work shortly with the prototype car, in a series of tests running up to Christmas.

"Probably we need to have a look at the profile," says Isola. "I remember when we started to develop the tyre for Formula 1 with the hybrid engine, we realised the additional torque was causing the tyre to overheat in the centre of the tread, especially on the rears. The turbo engine for F2 will have an impact on the tyres, how much we will assess during the test sessions. The timeframe is quite tight but the cooperation with Formula 2 has always been good, and we'll be able to come up with a final product that's good for them and good for us."

Beyond the goals of pushing costs down and providing a good training ground for aspiring F1 drivers, the ultimate success, or otherwise, of the new car will be judged on what sort of a series it provokes. Dallara designed the car largely in CFD, with wind tunnel work limited to the essentials. It did, however, often work with two models, with a view to ensuring it created cars that could follow and overtake. And this, surely, is the big advantage of a one-make series. The new F2/18 isn't built for pure performance, it's made to put on a good show. If Formula 2 can do this better than GP2, then everyone will soon forget the old name. RT



ABOVE The new car has been designed with a DRS flap to help prepare drivers for F1

Mauger/FIA Formula 2

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CAN THIS CAR CARRY ALFA BACK TO THE TOP?

Hal Ridge reports on a new rallycross project that blends pragmatism with passion

MOTOR vehicles are inanimate objects, held together with nuts, bolts and sometimes a dose of love too. But, when it's an Italian brand in question, you could be forgiven for believing that cars are bonded together by substantial amounts of passion.

That is certainly the case with Tedak Racing's new project. Having embarked on rallycross in 2014 with a pair of rally-derived Renault Clio Super1600 cars, the Italian squad has just launched a pair of unique Alfa Romeo MiTos, and has plans to carry a brand synonymous with success in high-level competition back to the top in world motorsport.

The FIA European Rallycross Championship for Super1600 was formed in 2003, based on the rally regulations for the category. As in the top level Supercar class, the diversity of competitors is substantial. The series is also very competitive, with professional teams running drivers aiming for the highest echelons of the sport.

Several of the top drivers in the FIA World Rallycross Championship today, including Timur Timeryanov, Reinis Nitiss and Andreas Bakkerud, have all graduated from the Super1600 division. Now Tedak Racing is planning to do that too, but with its whole team rather than just the drivers.

"After a few years with the Renaults, we decided that it was time to go to an Italian brand. Alfa Romeo is the history of competition in Italy, after Ferrari, so we decided to use this car. The target is to try and be as reliable and competitive as possible now, but thinking also about the future and maybe the next step is to do Supercar. We've tried to build this car thinking about a Supercar, so we have many solutions that are possible to use in

Johan Dingenen

RIGHT The debut of the MiTos at Loheac might have been low-key, but the team's ultimate ambition is to take Alfa Romeo's supermini to the top

a Supercar too, just in case," says Tedak owner, Andrea Carretti.

The Super1600 category is governed by relatively strict regulations, but not as constrained as the fully-homologated rally class was, when it was part of the World Rally Championship. The most significant rules in the rallycross version surround location of suspension pick-up points, total weight (1100 kgs inc driver) and that power is driven via the front wheels by an engine that remains 1600 cc and naturally aspirated, using a block from the original manufacturer.

FRENCH LESSONS

Having made significant developments to the Renault Clio Mk2s within its in-house structure, capable of manufacturing and machining, Tedak built a Clio Mk3 in 2015 and made podium appearances. The squad has carried lessons learnt in developing the French cars into the new MiTo.

"The knowledge we took from the Renaults is very important for the base of this car. We got to something that was okay and ▶

BELOW The engine was a massive job, developed over a 10-month period

Hal Ridge

> *"After Ferrari, Alfa Romeo is the history of competition in Italy"*

we continued to use, so the front of the car (with MacPherson strut suspension, lower A-arm, bespoke machined aluminium uprights and three-way adjustable Reiger dampers) is an evolution of that. But the back is completely new," he says, having ditched a beam axle configuration previously implemented for a MacPherson setup at the rear too, much like many current Supercars.

Historically, cars in Super1600 have been either based on existing rally machinery, or have used the same concept to develop into different cars (multiple champion SET Promotion moving from a Renault Clio to Twingo, for example). But fully-designing a car in CAD [computer-aided design] is uncommon in the category, as is building a car that could be developed into other classes in the international structure. For that reason, Tedak can be confident it has the platform to be able to grow into Supercar, when the time is right.

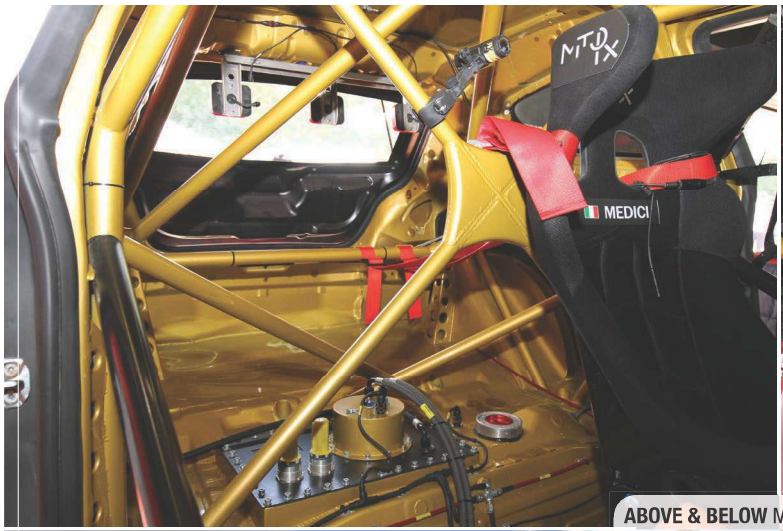
Designed to work effectively on a variety of surfaces, rallycross suspension is a constant compromise. That is highlighted even more by just having two driven wheels instead of a Supercar's four. "It's difficult to find the right setup every time and every day in rallycross the conditions are different, so you have to sometimes find the solution at the last minute," acknowledges Carretti. "But we think that the base is very good. We've chosen the same suspension [Reiger] as most of the Supercars too."

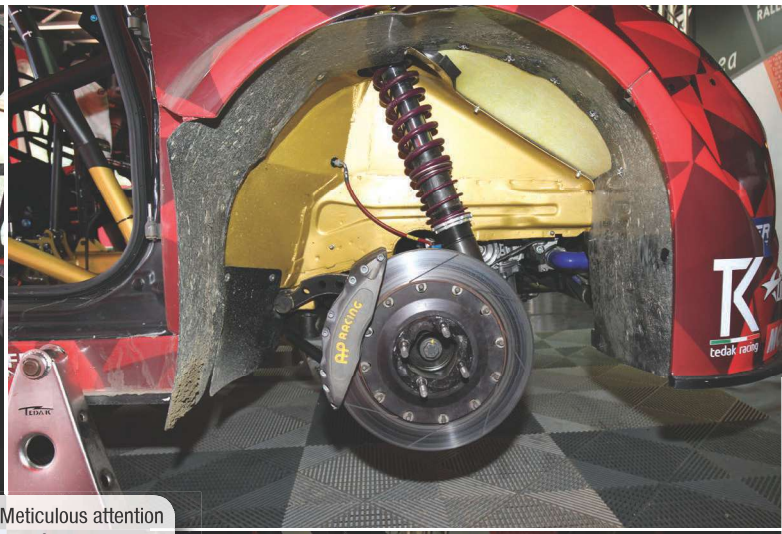
"PERFECT" DIMENSIONS

The MiTo runs blade-style anti-roll bars, again made in-house. According to Carretti, the chassis has the "perfect" dimensions. "The old Clio (Mk2) was too short and the new Clio (Mk3) was too long. This is in the middle. We have designed and tested everything in CAD and it's a bit between a Super1600 and a Supercar. It's much wider than standard, to the maximum of the rules, but not longer." The car sits on 17x7.5 wheels, wrapped with the championship's control Cooper Tires, housing AP Racing four-pot callipers and vented discs at the front, single-pot callipers at the rear with lightweight single-skin discs.

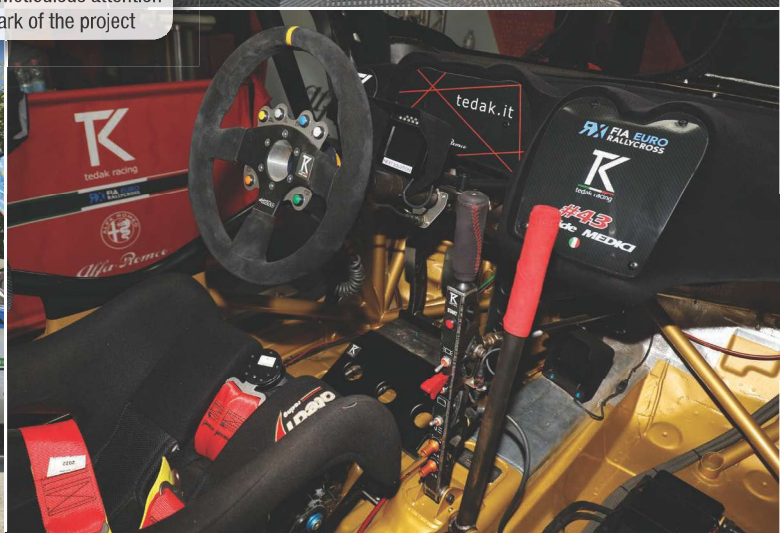
Bolted to a six-speed sequential Sadev gearbox – the transmission of choice in the category – via a triple-plate carbon clutch, the 1600 cc engine in the new challenger has been developed over a 10-month period (a similar time to the chassis) by Autotecnica Motri.

"We wanted to keep an Italian engine. The base is the Alfa Romeo 1.8 turbo engine, from the Giulietta or 4C, so the only original thing is the block. The head has been completely machined, and the rest has been completely redesigned and developed. It was a massive job – it took at least nine months just for the project construction, and then some months on the dyno," says Autotecnica Motri owner, Giovanni Delfino. He confirms that as with the chassis, the engine has been developed with the future in mind, despite a Supercar running a two-litre turbo unit: "The philosophy is something which is guiding us into the future. We wanted to start from ▶





ABOVE & BELOW Meticulous attention to detail is a hallmark of the project



Photos: Hal Ridge

BELOW & RIGHT The team's impressive paddock facility betrays its ambition

an engine which is 1.8 and be able to make whatever we want."

'Pub talk' figures aren't uncommon in motor racing, especially when it comes to outright power. Six hundred horsepower is the figure that surrounds the headline Supercars, but from a Super1600 engine, paddock wisdom suggests the best put out 240 horsepower, achieved at around 9,000 rpm (original works rally machines had c.230 horsepower). Delfino won't be drawn on the MiTo engine's vital statistics, but says: "The figures are good. On the dyno we are completely comparable with all the other manufacturers, but we have to work again to increase the performance a little bit."

LOW-CAPACITY SCREAMER

Asked if 240 horsepower from the low capacity screamer is realistic, he says, "It is, not for everybody, but when you want to be on the top you have to be there. On the dyno we pushed the engine to 9,500, but we are running something like 9,200 now."

Pistons, connecting rods and other internal components have been sourced from "the best motorsport parts producers", many designed in cooperation with Tedak and Autotecnica. The exhaust ports from the cylinder head exit from the front, with long exhaust headers leading over the gearbox and under the car's floor, similar to a factory-built Citroen C2 Super1600.

Delfino agrees that in an ideal world, the engine would be orientated the 'other' way round, so the inlet would be at the front, fed by air naturally forced into the front of the car by forward movement. "To go from the front to the rear, the exhaust system is very long. What we are trying to do is to shorten the exhaust in order to have best performance at higher rpm," he says. "Unfortunately, yes [the engine is the 'wrong' way round]. We'll see if it [rotating the engine] is something that we're able to do because unfortunately when you turn the cylinder head, the cooling ducts are not symmetrical, so you have to turn all the engine. It's quite a challenge, something that we are trying to do in the next few months."

> *"The platform to grow into Supercar"*

The water radiator lies at 40 degrees in the front of the car to achieve best cooling from the low-slung front grille in the composite front bumper. As with many of the car's components, the bodywork, aside from the steel shell, driver's door and roof, is of composite materials.

Tedak's passion-based project to return Alfa Romeo to a World Championship is one of intent. That's highlighted by its impressive paddock facility that resembles that of a far more developed and financed team, a fully-enclosed solid wall workshop area partitioned from hospitality and dining.

Planned to originally debut in the first round of the 2017 season in April, the two-car outfit hit the track at round five, in France last month. Ultimately, the squad elected to be "reliable and competitive" rather than "early".

Current links with Alfa Romeo extend to the supply of drawings and data for the standard MiTo, but there are hopes of attracting more backing. As a motorsport parts manufacturer, the Super1600 project is as much about what Tedak can do, a moving advert if you will, than attracting support

right now. Carretti's firm knows it will take time. There are plans to market Super1600 kits and parts, while looking to a potential World Championship future too.

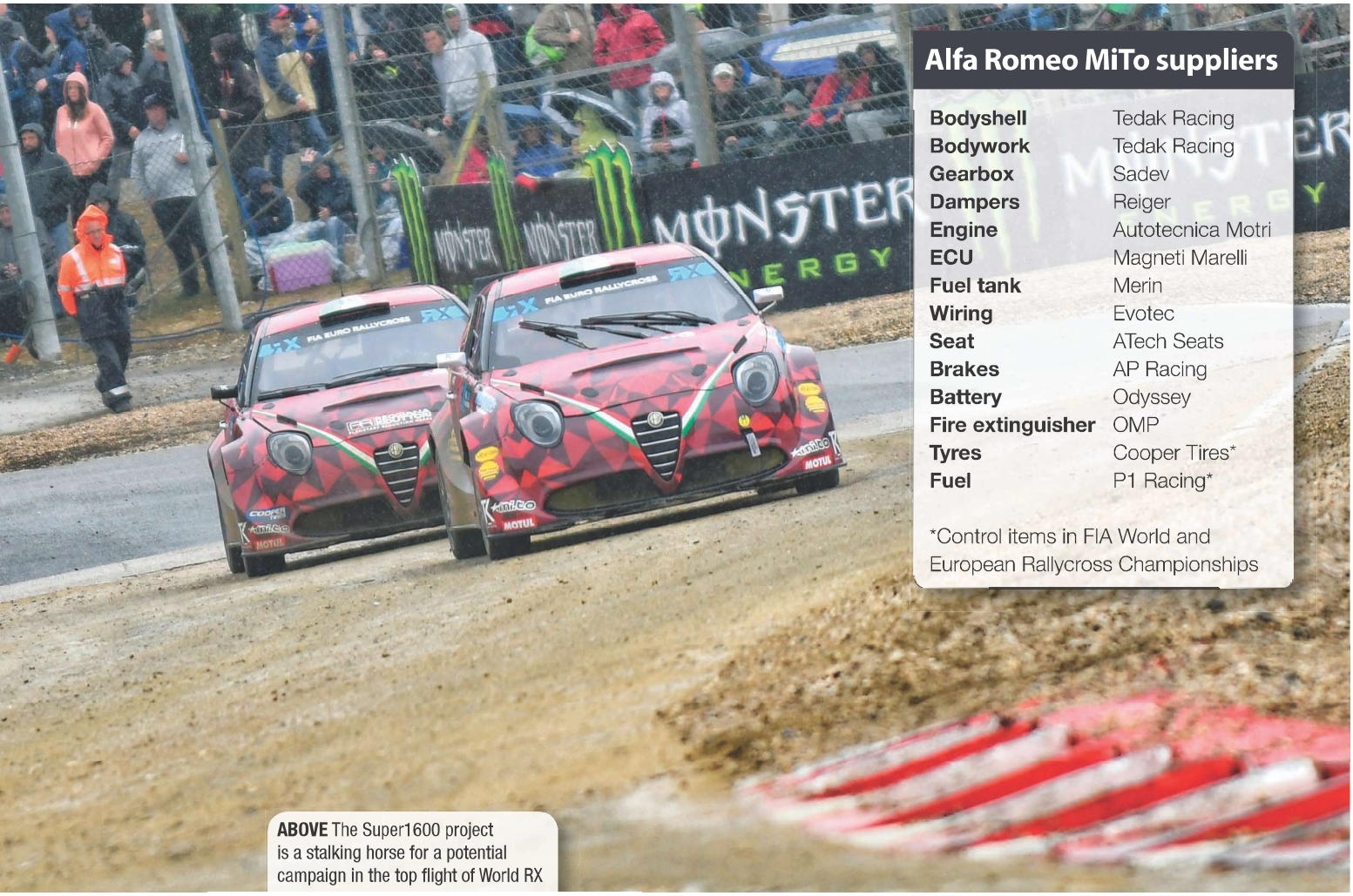
Most manufacturer support in World Rallycross, be it in the shape of Peugeot, Volkswagen or Audi, has joined existing teams and infrastructures. Mattias Ekstrom only got support from Audi after he'd won the world title with the marque's cars.

"We presented the project to Alfa Romeo in the very first months. They were really interested. But, there is a lot of bureaucracy starting from the bottom. It takes a long time to get to the top," says Carretti. "We hope that this winter, after we have done two or three races, they will have more interest and there will be a better chance of cooperation.

"Some guys in Alfa Romeo love the project, but it's difficult to arrive at the end to discuss a concrete situation. We delayed when we would be ready and we have tried to arrive [with the MiTo] on a really professional level and we will see what happens for the future."

Although Super1600 is a lower tier of rallycross than the headline Supercar act, Tedak Racing is on the right path. Its attention to detail is rivalled by only a few in the front-wheel drive class. Its mindset is highlighted, for instance, by the switches being located on the gear lever, an imaginative way of making the controls easy to reach for the driver and out of the way at the same time.

The MiTo's first event in Loheac, in a capacity 35-car field, included usual 'debut teething troubles' for a car fresh from the box. But both drivers, Davide Medici and Luciano Visintin, finished inside the top 30, completing the qualifying stages, Medici setting a 16th best time in Q2. The team plans to develop further ahead of a full 2018 campaign. But, as has been made abundantly clear, this is just the beginning of a longer-term plan in its bid to return Alfa Romeo to the big-time. RT



ABOVE The Super1600 project is a stalking horse for a potential campaign in the top flight of World RX

Alfa Romeo MiTo suppliers

Bodyshell	Tedak Racing
Bodywork	Tedak Racing
Gearbox	Sadev
Dampers	Reiger
Engine	Autotecnica Motri
ECU	Magneti Marelli
Fuel tank	Merin
Wiring	Evotec
Seat	ATech Seats
Brakes	AP Racing
Battery	Odyssey
Fire extinguisher	OMP
Tyres	Cooper Tires*
Fuel	P1 Racing*

*Control items in FIA World and European Rallycross Championships

NEVER SAY NEVER

In less than three years the TCR formula has mushroomed around the globe, and now it is coming to where it said it would not – the UK. **Andrew Charman** finds out why

IN January 2015 when Race Tech interviewed promoter Marcello Lotti about his newly created global affordable touring car concept, TCR, the questions inevitably included whether a series running to the format could be created in the UK, home of the globally-renowned British Touring Car Championship. "The BTCC is legendary," the Italian replied, "the UK does not need anything from anywhere else, there would be no sense in trying to run a UK TCR Series…"

Less than three years on, TCR is now a worldwide success. The international championship has a solid grid of 20-plus cars while the regional and national series have mushroomed – there are now well over a dozen, with more to come, while in TCR Germany, a series only in its second season, grids regularly number more than 40 entries. And in 2018, those championships will be joined by TCR UK.

When we tackle Lotti on the subject of the UK, he insists his view has not changed. "I still consider the BTCC a legendary and very successful series. However, since then (2015) we have had the time to prove how good the TCR concept is for customer teams.

"A lot of people – also in the UK – have realised that (TCR) provides an excellent compromise between real competition and affordable budgets. As a consequence we have been approached by a number of competitors who pushed for a TCR UK."

This is a view shared by the promoter of TCR UK, someone who should know what he is talking about. Jonathan Ashman was until 2010 president of the FIA Touring Car Commission, and back at the start of the 1990s an architect of the two-litre formula that became the global phenomenon of Super Touring.

Ashman hints that the UK was never completely off the list of countries TCR wanted to expand into, but was always at the bottom: "Marcello had always been extremely sensitive to the UK, which

BELOW Initial interest in TCR UK suggests it could reach the grid-filling status of TCR Germany

ADAC TCR Germany


Ebrey/BTCC

ABOVE The BTCC is the standard bearer of UK motorsport – a position TCR insists it is not trying to usurp

obviously has the BTCC. He didn't want anyone to think we were treading on toes or trying to be too clever."

THE BIGGEST LAST?

Ashman adds that the UK is regarded as a 'major market' – these also include the USA, which is set to launch a TCR series next year, and Japan which is rumoured to be starting in 2018. He also hints that even in Australia, home of the Supercar, TCR talk is starting.

Such major markets had to be left to last, principally due to the explosive growth of TCR taking everyone involved by surprise, and leading to the very real issue for manufacturers of the cars of keeping up with the demand from teams.

Under the TCR concept a single constructor represents each brand, either that OEM's sporting department or an appointed specialist, and they are required to be able to build a run of cars to the tightly controlled technical regulations, for sale to teams. As Lotti says, the idea is not to "win the race but win the market".

The 'early adopters', SEAT and Honda, have now been joined by more than a dozen other brands, the latest being the Renault Megane unveiled as this feature is written. The success of the TCR concept is most clearly demonstrated by Audi's customer programme, which was launched with the TCR RS3 at the Paris Motor Show in September 2010 and had sold 100 examples by mid 2017.

"TCR provides an attractive and affordable budget touring car series around the world with these 350 hp machines," says Chris Reinke of Audi Sport Customer Racing. "We can produce these cars in significant numbers to sell to customers while at the same time can enter new markets in the Benelux, Scandinavia, Southern and Eastern Europe as well as some Asian countries. To have produced 100 of these cars within seven months is impressive. I obviously do not expect us to grow at the same rate in the future because once a team has the car then they should hopefully be very happy with it for a while."

"The demand for TCR series around the world was far beyond the manufacturers' capacity to build cars," Ashman says. "Jaime Puig (sporting director of SEAT) told me at one point they had staff on three eight-hour shifts a day building body shells and still couldn't meet the demand. They've done over 200 now. We now have more ▶


TCR

ABOVE TCR founder Marcello Lotti (left) feels the time is right for a UK series headed by the widely experienced Jonathan Ashman (right)

ABOVE Competitive grids ensure there is no shortage of action in TCR…

Why has TCR worked so well?

THE TCR formula certainly seems to have found its mark, evolving rapidly round the world. So what makes it so globally attractive?

"The key is a very clear concept right from the start," says TCR UK promoter Jonathan Ashman. "You had to have an affordable formula, not to make the mistakes of the past in the Super Touring days, where each country started interpreting the regulations in their own way."

The example he offers of the ' straw that broke the camel's back' in Super Touring, concerned a manufacturer in the German series that instead of mounting the battery low down in the boot effectively hung it under the floor. "To enable this they added what they called a 'battery protection skid' – what it actually created was a complete flat floor across the rear of the car.

"A British steward would have laughed at it but they got away with it in Germany and the technical creep became a gallop. The cars became more and more expensive because everybody made the same move and ended up spending a lot more money to be in the same position."

Such a situation cannot occur in TCR, Ashman contends, a pillar of the category being the ability to use the same cars in every series, in different countries. "Marcello Lotti ensures that the technical regulations are completely and tightly controlled, so there is no technical creep.

"A team can go onto the TCR website, buy an 18-month-old DSG-gearbox SEAT Leon for £50,000, and they will be in the mix at the races. Then at the end of the UK season they can rent the car out to for example run in the Middle East championship held through the winter."

Depreciation, or the lack of it, in TCR cars is also a major factor. "Having run that used SEAT for a season and then rented it out at the end of the year, if it's still the same shape the team will likely still get £40,000 for it. "That is a problem the BTCC has – the cars don't have a used value," says Ashman. "The value is the price of the mandatory components – you'd strip out the components you have to have and would re-use, the rest is scrap."

Both Lotti and Ashman believe the TCR technical regulations are set and no major changes needed. "We have to keep in mind that more than 500 TCR cars have already been produced and any significant changes to the regulations would result in a dramatic impact on such a large field," says Lotti. "This is why we have decided to completely freeze the technical regulations, as well as the homologation forms, for the next three years at least." RT

than 500 TCR cars in existence and we are only halfway through year three – it's beyond astonishing."

So with TCR series established across the globe, and a strong inventory of cars, both Lotti and Ashman feel the time is right to answer demand from the UK, and to launch a series that they say will be a stepping stone to the BTCC, not challenge its place as the UK's leading series.

"We believe there is a substantial gap in the market below BTCC, purely on a financial basis," says Ashman. "The jump to the BTCC from say even the most expensive programme in Renault Clios or Ginettas (both support categories on the BTCC package) is enormous. We are very much closer to those, nowhere near the BTCC – there will always be a place for that series, it's got the big TV deal, the massive crowds, it's not us."

BIGGER THAN THE GRIDS?

The immediate interest that has been generated in TCR UK would appear to support this. Ashman admits to being overwhelmed by the level of enquiries, and is now confident enough to say that grids in the initial 2018 championship will definitely number at least 20 to 25 cars – but could go much higher.

"We started out by suggesting we'd exactly follow the format of TCR International with


Ebrey/BTCC

ABOVE Motorbase team principal David Bartrum is seriously interested in TCR, but not entirely convinced yet

two races per meeting, a tried and tested format," he says. "We never contemplated ending up in a situation of being at a track with more entries than the grid could accommodate. But then people started contacting me wanting to pay deposits to ensure they have an entry."

He has no intention of turning away any team who wants to enter TCR UK: "A driver that gets their act together and buys a second-hand car that complies with the regulations, will be assured of two races at each meeting. If entries exceed the grid we will run two heats and an A and B final. No-one will be turned away."

This situation has in turn forced a revised view of the role of TCR in a race meeting. "Initially we thought we would be a support race to another series, the obvious one being British GT," he suggests. "But GT takes a lot of the timetable, and many UK venues do not have the physical space in the paddock to accommodate a support race of the size ours could be. British GT would have the garages, we would be out in the paddock and that is a problem.

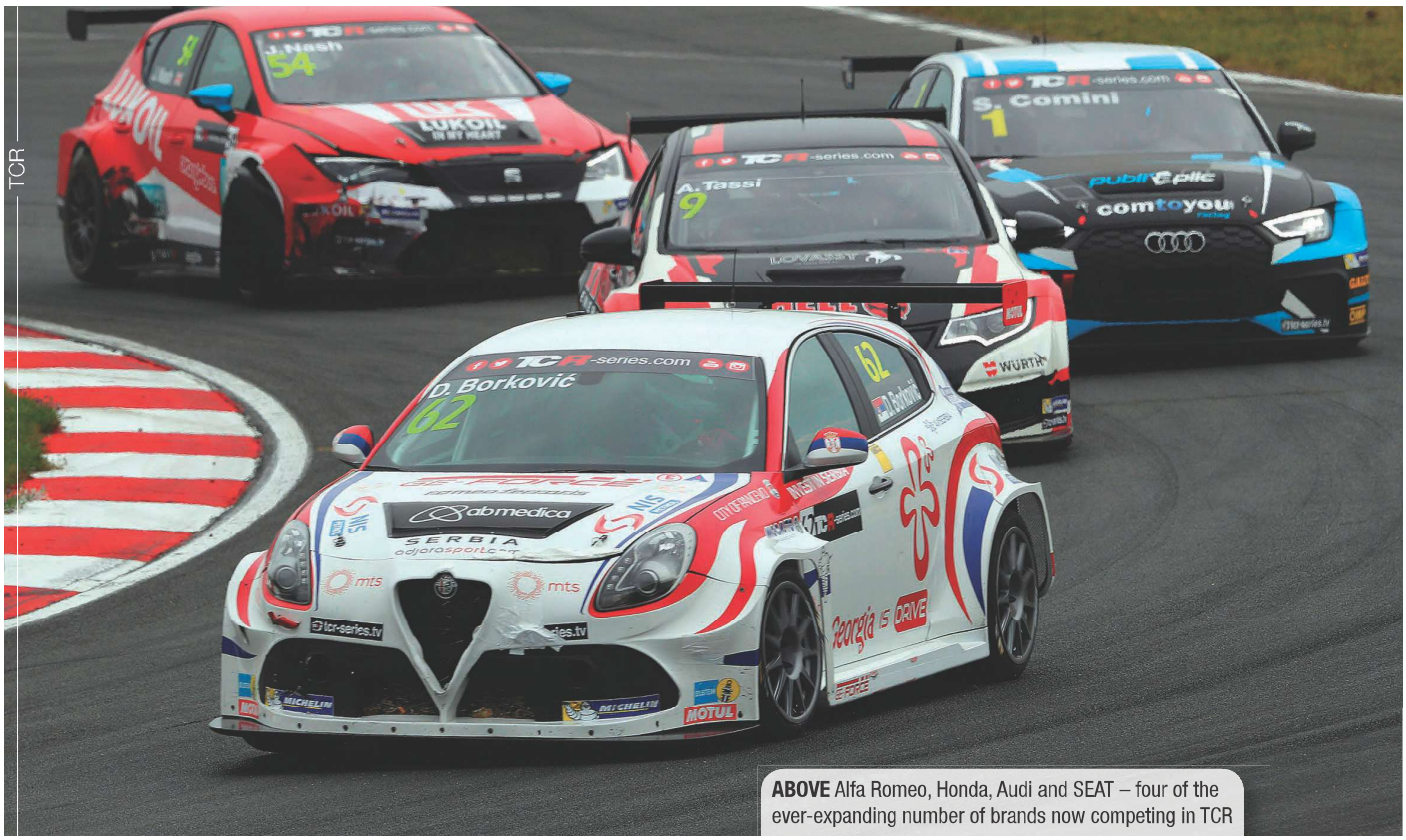
"We were keen to go with GT and I think GT would have been happy to have us, but it was sheer practicality – we just would not fit into paddocks."

So TCR has taken the apparently bold decision to head up its own race meetings, in the process posing a challenge for the British Racing & Sports Car Club, which will be running the series and is currently trying to tie down the calendar for the first six-to-seven meeting season. There are further challenges, particularly the desire to spread the rounds across the UK.

"Manufacturers like to go to parts of the country where they will attract guests for hospitality, so they don't want to go to remote places," says Ashman. He quotes the example of Castle Combe, which is close to Honda's UK factory and has a large population in easy reach, so is very appealing from a manufacturer point of view. But with a lack of infrastructure, for example no pit garages, it will be less popular with many teams.

He also doesn't want to visit a particular circuit just before or just after the BTCC to avoid inevitable comparisons, and he states that a fundamental of the calendar will be to avoid running on BTCC race weekends – because several BTCC teams also want to do TCR.

Just as this feature went to press TCR UK revealed its provisional 2018 calendar, which ▶



ABOVE Alfa Romeo, Honda, Audi and SEAT – four of the ever-expanding number of brands now competing in TCR

consists of seven rounds, none clashing with BTCC weekends. The series is set to open at Silverstone on 31st March/1st April, head to Knockhill in Scotland on 12th/13th May, then Brands Hatch on 2nd/3rd June and Castle Combe on 14th/15th July.

Restrictions at Oulton Park will require the series to cram its meeting into a single day on 4th August, followed by Croft on 8th/9th September and a finale at Donington on 13th/14th October.

ADDITIONAL ATTRACTION

Ashman says that TCR UK has so far been contacted by 10 BTCC teams: "None of them want to leave the BTCC and come to us, but they have the workshops, the mechanics and trucks and can see TCR as a profitable second string, running a couple of cars for other people."

Team Hard and Maximum Motorsport are among BTCC outfits that have already firmly stated they will run cars in TCR UK. The most high-profile team so far to make public its interest is Motorbase Performance, currently running three Ford Focus cars in the BTCC backed by household name Shredded Wheat.

Principal of the long-established Motorbase team, David Bartrum, says that the TCR series has to be looked at. "You can't ignore something that works across Europe – and having recently ended our GT programme, we have the workshop space, manpower, and equipment. I like TCR – I've done quite a lot of homework on it, made ▶

Keeping the balance

ONE aspect that has caused some controversy amongst TCR teams is the Balance of Performance regulations. TCR stages a BoP test for all marques at the start of each season, bidding to equalise them through performance data and testing on rolling road and track. Then at each round the series can further adjust the BoP, through weight, horsepower and ride height changes.

Predictably these in-season changes leave some teams feeling unfairly penalised. But Lotti is not particularly worried. "It is impossible to make everybody happy. I will be very worried the day that nobody complains about something," he says. RT

ABOVE All cars undergo a rolling-road test as part of the Balance of Performance before the start of each TCR season

TCR

BELOW Motorbase's three-car presence in the BTCC comes at a cost – could a TCR programme help with the revenue?

Ebrey/BTCC

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Damage bills no accident

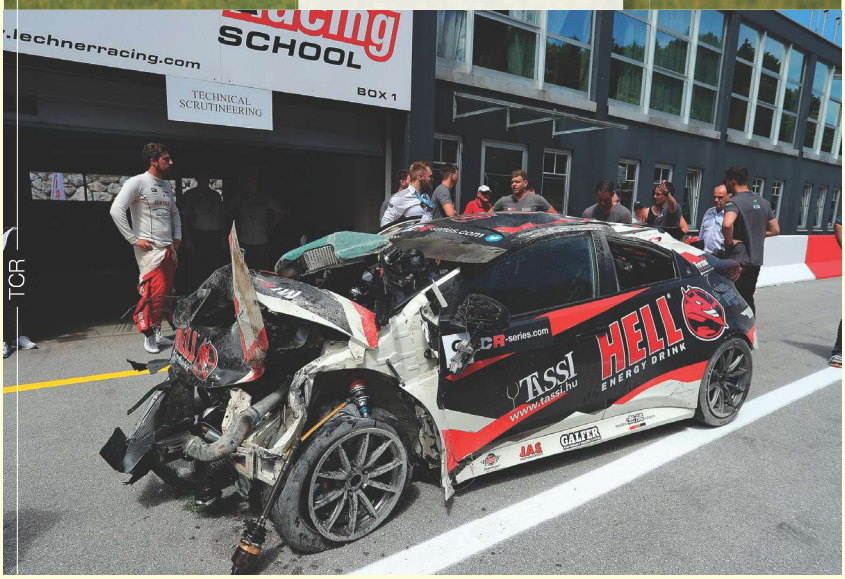
ONE of the reasons offered by those who claim that TCR could become the lead Touring Car formula in future, and supplant the current BTCC, is the cost of competing in the British series – this runs to its own NGTC (New Generation Touring Car) formula.

At the BTCC round at Rockingham on August 27 the writer was surprised to hear one of the leading and most successful teams in the series openly questioning its costs, and in particular the amount of accident damage that occurs. Motorbase Performance team principal David Bartrum agrees that the BTCC is an expensive championship, but doesn't accept the accident damage argument. "I agree with (BTCC series director) Alan Gow, it's the teams that need to sort their drivers out," Bartrum says.

"If your drivers have no responsibility for the difference in how a car leaves the circuit and how it turns up at the next one, they are not going to care. My drivers bump with the rest of them, but I don't just let them do it with no consequence – we bring them in the office to be told when they are wrong, and they get a bill for the damage.

"It's a case of looking to your own management before looking to (BTCC promoter) TOCA to sort accident damage out. If it's bad driving and against the regulations, only then is it TOCA's problem." RT

Ebrey/BTCC



TCR

ABOVE & BELOW Some BTCC teams are openly questioning the amount of accident damage in the series. TCR (below) sees prangs too…

several visits to the German series and spoken to three manufacturers."

Bartrum insists, however, that Motorbase running a TCR programme is not yet set in stone. "The question will be whether we can get the budget that is needed when there are so many other vibrant series around, such as Clios and of course the BTCC itself.

"It is also crucial that Jonathan Ashman and the BRSCC pick the right circuits and that will be a tough job. Circuits spread around the UK and a bit obscure will add overheads to a team's budget.

"Going to, say Mondello Park in Ireland adds a day either side to your truck, travel and hotel costs. Then if you add in say Knockhill in Scotland and Anglesey in Wales, a seven-round series will present more logistics costs than doing the BTCC. The budget will decide who is in and who is out."

ROOM FOR TWO

Despite TCR's declared place in the UK motorsport hierarchy, the direct comparisons with the BTCC refuse to go away. British driver Josh Files, a title contender in the TCR Germany series, has even claimed that TCR could become the BTCC "in three to four years maximum". But Bartrum agrees with the writer's view, on the evidence of working at every BTCC meeting this season, that the series is hardly in decline, particularly with new multi-year contracts being signed with major suppliers such as RML Ltd and Dunlop.

"This championship is full up, there are 32 cars on the grid, and there's all sorts going on, the BTCC is strong," insists Bartrum. "But it's perhaps not that wild a suggestion – the cars will evolve, and I believe they (BTCC management) will look at costs, and maybe the TCR format might fit."

Ashman believes competing in his series will make commercial sense to many a BTCC team, and both will feel the benefit. "If a BTCC team puts a couple of TCR cars in its workshop, rents them out and makes some money on them, that will be good for us and also good for the BTCC as it will improve the commercial viability of their teams," he says.

Bartrum agrees that the new series offers a lot of potential: "If the budget in TCR is right, then there's room for both series. Overall TCR is a good thing with all the potential as a business. You have a car there that you can use all over the world, which you haven't got with British Touring Cars." RT

42 million kilometres!

That's how much virtual testing one company estimates it racked up last year. No wonder **Alan Stoddart** finds competition hotting up in the simulator sector

WITH simulation such an essential part of motor racing, who better to meet teams' requirements than a world-class racing driver?

Factory Aston Martin Le Mans GT winner Darren Turner thought so and founded Base Performance Solutions, which now works alongside World Championship-winning race teams and drivers to help them learn circuits, fine-tune car set-ups and keep race-sharp. From its Banbury base, BPS blends cutting-edge simulator technology with expertise from a team brimming with experience from F1 and top-level sportscar and touring car racing. The company is the first UK specialist to fit its pair of simulators (the BPS4.8+ motion single-seater and BPS GT) with the very latest Panthera software from Cruden.

Both the simulators use a powerful brushless, direct drive servo motor to provide steering feedback; an essential part of any accurate simulation. This feedback is tuneable to the physics model of each car, including the feeling of understeer. Tiny variations in road surface, camber changes, bumps and kerbs can all be felt through the steering – allowing the driver to feel what the car is doing through his whole body.

The 4.8 single-seater simulator uses a proprietary pedal box, which features an interchangeable PU element to alter the brake feel. This element can be quickly changed to match the driver's preference, and replicates the typically solid pedal felt in unassisted formula car braking systems. The driver's brake input is measured via a strain gauge on the pedal in the case of the single-seater, and via a hydraulic pressure sensor on the GT sim, utilising the very same pedal set up found in a racecar.

The visuals on both simulators are provided by three HD ultra-low latency projectors, creating an image two metres tall, on a 180-degree arc of nearly eight metres. The image is so large it provides full visual immersion.

Racing cars are loud, and with drivers using the sounds of the engine to time gear changes, and variations in tyre noise to provide information about the track surface, accurately recreating the aural experience

BELOW Base Performance Solutions is the creation of factory Aston Martin GT driver Darren Turner

of driving is essential to the authenticity of a simulation. To this end, BPS uses a professional-quality PA system for audio.

Base's 4.8 single-seater simulator sits atop a 6 DOF motion platform, which is able to momentarily deliver 1.5g in any direction. Although impossible to recreate sustained g-forces on a simulator, BPS's proprietary API enables accurate motion cues to be given to the driver instead; a sharp movement will suggest a heavy brake input, yaw in oversteer or understeer, a kerb rumble, an undulation in the track surface, and so on.

BPS is currently in partnership with Cruden to help develop its Panthera software, which is used in the BPS4.8+ and BPS GT simulators. This dedicated, state of the art simulation software package offers incredible visuals, accurate physics modelling and features aero and tyre modelling, live DIL set up changes – meaning non-stop driving while altering the car's set up or balance, live telemetry, live lap and sector timing and live GPS tracker.

Base also prides itself on creating its own car physics and track models. It is able to keep both its car and track catalogues up to date through working constantly with customers to ensure every detail in the driving experience is there. This means that it isn't just modern racers who benefit from using BPS simulators: a wide range of historic machinery is now available, as well as the circuits used for top-tier classic racing, such as Goodwood, Silverstone's historic layout and the legendary Nürburgring Nordschleife.

THE MENTALITY OF RACING

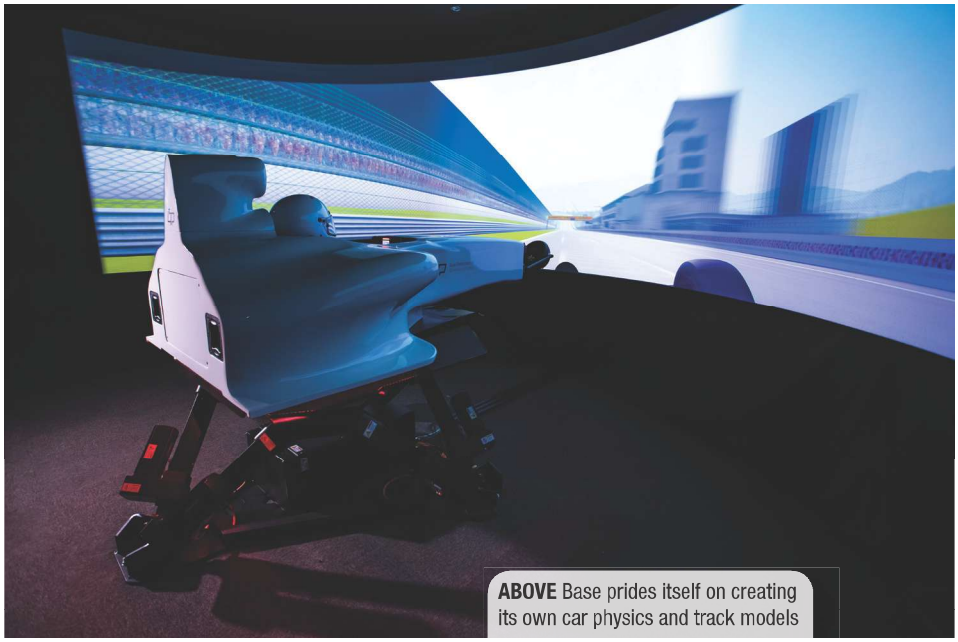
Ansible Motion's approach to virtual testing differs to that of many other manufacturers of driving simulators. The company starts with the premise that for a simulator to be an effective engineering tool, as well as providing motion, it must generate 100% driver mental engagement. Ansible has therefore focused on stimulating the driver's senses, in particular the vestibular system, which contributes to the sense of balance and spacial location.

"Only when a driver jumps out of a simulator, detailing the aerodynamic and suspension changes that need to be made have we done our job," says Phil Morse, technical liaison, Ansible Motion. "From the outset, we understood that to achieve the highest level of mental engagement between the driver and the simulator, we had to create the machinery and systems to align with the expectations of the driver's senses."

By avoiding legacy hexapod architectures, a carry-over from the aircraft industry in the 1960s that some manufacturers use, Ansible Motion believes its industry-unique stratiform motion system delivers a novel and compelling experience. With use by multiple clients in F1, NASCAR and numerous OEMs underlying its strength in the basics, its focus has now turned to the supplementary cues that add an additional layer of realism to the simulations.

"The big cues such as motion and graphics are well understood but we found that using our R&D simulator in our quest to create the ultimate virtual driving experience, it was the small details that are now delivering the sense of realism craved by drivers and engineers alike," says Morse.

In addition to the more pertinent Helmet Loading System that Ansible Motion has started delivering to motorsport clients in the past year, the firm has recently introduced additional refinements with options such as rear-view emulators and deeper hardware-in-the-loop integration for steering wheel functionality. "Offering rear view via wing mirrors or a centre mirror – a mainstay in OEM work – has unexpectedly delighted the racing and test drivers coming through our facility," adds Morse. "For categories such as WEC or NASCAR where looking behind is as crucial as looking forward, we can now replicate the driver ▶



ABOVE Base prides itself on creating its own car physics and track models

ABOVE Ansible Motion's stratiform motion system is used by numerous OEMs as well as race teams

workload and total field of view. It's another piece of the jigsaw to create a more realistic scenario of what happens on track."

Professional drivers are impressed by what Ansible Motion is delivering. "Dean Stoneman commented that our Delta sim 'coaxed' him into behaving as if he was in a real car and he could study performance in the sim just as he would in the real car. We hope this means there's real value to a session," says Morse.

In addition to the rear-view emulation, Ansible Motion has been developing accurate simulator connectivity for the increasingly complex steering wheels used nowadays, another aspect that adds to driver engagement. "Engineers like not only being able to replicate the functions found in the real car, often integrating hardware to give representative results for features such as traction control, virtual safety car or battery management, but also to monitor how the driver copes and what can be done within the rules to optimise this," adds Morse. "In Formula E, for example, it can make a big difference to performance and we can help teams determine this in the most realistic way, short of on-track testing."

"It's clear from driving the simulator that the engineers at Ansible Motion truly understand the issues faced in simulation," states FIA F3 front-runner Callum Ilott. "Drawing on their experience has helped them to create something very different from a normal simulator."

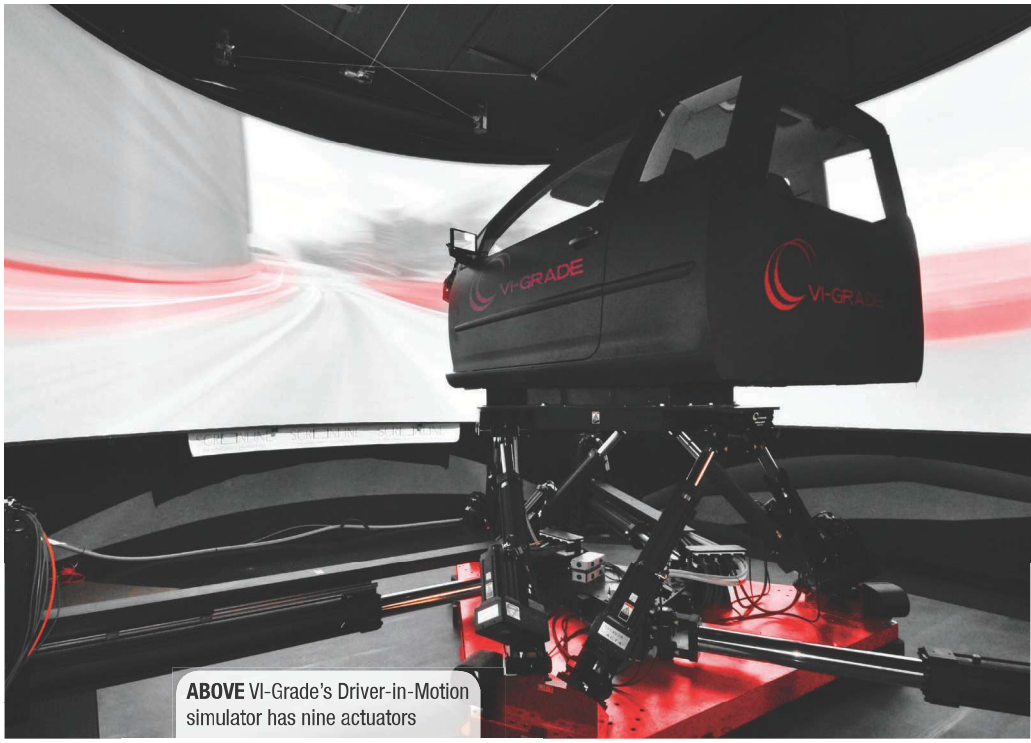
THE PERCEPTION OF MOVEMENT

Some simulators, meanwhile, are more tailored to the engineers. The products on offer from VI-Grade, for example, give automotive engineers a set of integrated driving simulators which take a new approach to system-level simulation. Its product range focuses on enabling companies to bridge the gap between virtual prototyping and testing.

VI-Grade's simulators prioritise the reproduction of vehicle movements to enable the driver to "feel" the dynamics of a car. To this end, the company patented a revolutionary design named DiM – Driver-in-Motion. The DiM simulator has nine actuators, three more than is common for hexapod designs, which allows the simulator to have a larger workspace whilst maintaining high stiffness – critical for accurate reproduction of movement. The DiM, which is engineered and manufactured by Saginomiya, makes it possible to study both low frequency vehicle dynamics as well as high frequency ride on the same motion platform.

The simulator is a very powerful machine that uses electrically driven actuators to deliver high performance and high-fidelity motion to the driver. To bring the simulator as close as possible to reality, VI-Grade utilises its own motion cueing algorithm which uses the entire range of the simulator's actual movement to maximise the driver's perception of movement. To add to this feeling, the entire DiM tripod slides about on airpads. This also makes the simulator very reliable, silent and extremely stiff at the same time. Furthermore, by using airpads, VI-Grade was able to avoid the use of multiple rails which can add cost, complexity, friction, latency and noise.

Changing vehicle parameters and testing hundreds of different set-ups as is physically done at the proving ground is ▶



ABOVE VI-Grade's Driver-in-Motion simulator has nine actuators

one of the fundamental uses of a racing simulator. To ensure this requirement was met, VI-Grade developed VI-CarRealTime. However, if a customer prefers, it is also possible to integrate third-party vehicle models within the DiM environment. This integration means that 'laboratory-like' consistency is achievable.

The simulator precisely depicts the movement of the vehicle at as much as 50 Hz. Moreover, VI-Grade has developed interfaces with the most popular traffic simulation software, meaning the simulator can also be used for Advanced Driver Assistance Systems testing. This aids the speedy development of assistance systems and means that they can readily be tested in a huge range of different environments.

Currently, the DiM driving simulation technology from VI-Grade comes in three different variants: the DiM 150 is a simulator for integrated active/passive vehicle dynamics and ride development, as well as for ADAS and NVH applications; the DiM 250 has the same architecture as the DiM 150 but features extended linear actuators making it suitable for applications which require longer time exposure to steady state accelerations; and finally, DiM C gives the longest sustained acceleration on a DiM driving simulator, and is able to simulate steady state events as well as highly dynamic manoeuvres. All of these simulators are fully scalable, enabling customers to upgrade from a static simulator to a full dynamic simulator, all while reusing components that have already been installed.

RACKING UP THE MILES

It really is hard to overstate the value of simulation. Last year rFpro estimated that it has run 42 million test kilometres in F1, NASCAR, Indy, Super GT, IMSA, WEC and Formula E. That's approximately one hundred man years of flat-out test driving, a figure simply unattainable in the real world.

rFpro is dedicated to helping its customers get more points per pound invested in the engineering development of the car, by allowing them to test more in the safety of simulation, without having to spend money on physical prototypes and test cars. The programme also enables teams to increase the scope of their testing to pursue ideas that might be too expensive or risky to test in the real world, until the performance gains are established in a simulator.

> *"The fastest solution on the market"*

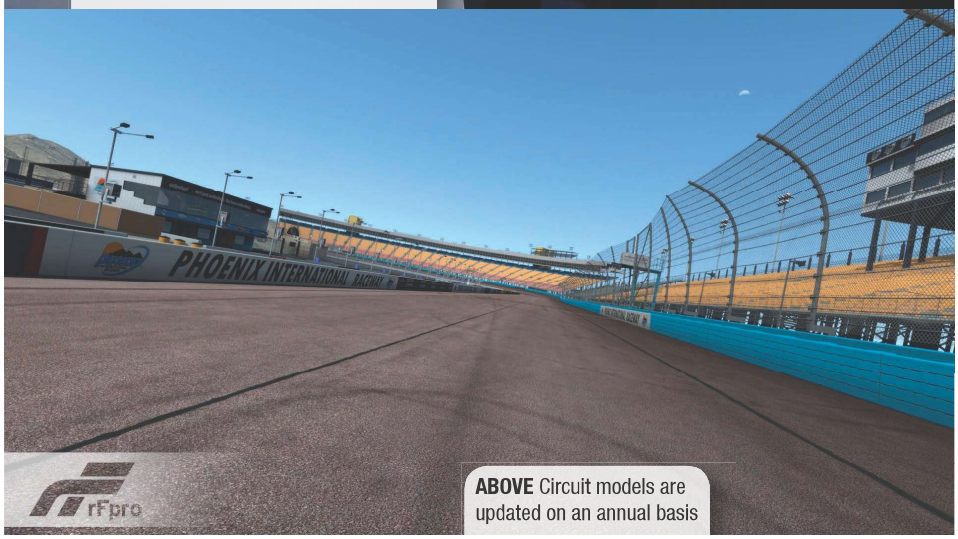
rFpro started in F1 in 2007 and, with an eye on continual development, grew to support all other major race series. This emphasis on development is still prevalent. For example, this season saw the introduction of support for the Formula E series. The project depended on substantial investment, and required a commitment to scan and build all the racetracks on the calendar before a single customer order had even been placed.

This commitment paid off. Already, rFpro has signed up five Formula E customers, proving the value of this sort of forward looking investment. This success also enables the company to offer circuit maintenance contracts for the 2017-18 season. Under these deals, which are also offered to its F1, WEC and NASCAR customers, rFpro updates the circuit models on an annual basis to reflect any changes made to the real world circuit. These up-to-date models ensure that teams can get the most out of the simulation, and be prepared for the actual track they will be competing on.

The underlying technology in rFpro is focused on delivering high quality graphics to the driver, and offers an optically-correct display and minimal delay between the team's vehicle model and the video fed to the driver. In the background, rFpro is also delivering accurate data to the vehicle model. Road surface information, which is based on a laser-scanned point-cloud across the entire drivable road surface, is calculated in real-time for each tyre contact patch.

The Ferrari F1 team is one of many racing outfits that rely on rFpro's accurate simulation. "I think Ferrari's tests are the most demanding faced by any vendor," commented Giacomo Tortora, Ferrari's head of simulation, when the switch to rFpro was made. "We tested video bandwidth and latency, road surface data quality and visual accuracy for the digital circuit models. ▶

ABOVE rFpro products have racked up a phenomenal amount of test mileage in the last year. This is Ford's WEC simulation



ABOVE Circuit models are updated on an annual basis

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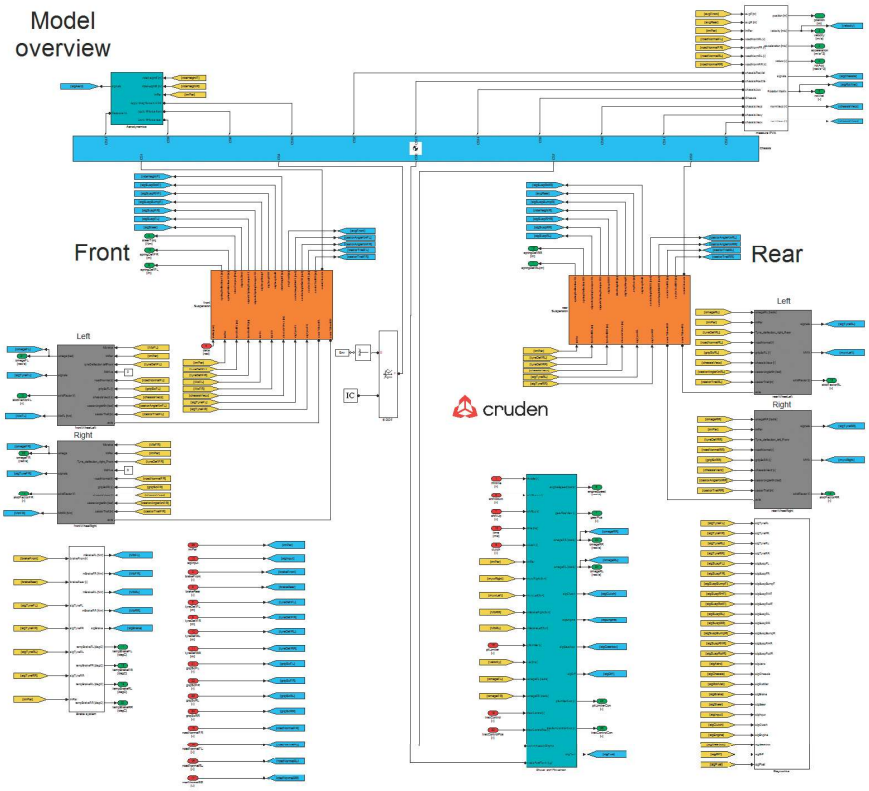
"It is important that the circuit model captures the road surface accurately, but also that it can be validated to ensure that our vehicle model is running on the same road surface as the real car. The way in which rFpro's TerrainServer captures every LiDAR scanned data-point within the tyre contact patch, and integrates them all to provide our vehicle model with accurate road input, improves correlation with our measured data and also feels more realistic for the driver."

Tortora added that Ferrari was equally demanding of the response speed, or latency, of the system. "Video bandwidth is very important to us because we run multi-channel stereo projection and also wanted the fastest possible refresh rate," he said. "rFpro are able to deliver the maximum video bandwidth, in stereo, at very high refresh rates with just a single frame of latency between our vehicle model and the projectors. This is the fastest solution on the market: video bandwidth is probably an order of magnitude greater than a traditional OpenGL-based solution."



ABOVE Cruden's Panthera open architecture software works with any vehicle model

FUTURE-PROOFED

The ubiquity of simulator use means that most race teams and motorsport engineering companies at some point face simulator investment decisions, regardless of budget and formula, and whether they are starting out from scratch or considering an upgrade.

Cruden reckons that when these decisions are being made, all too often there is an obsession with the simulator equipment to the detriment of engineering capability, which has a far greater impact on performance. There is a problem if a team feels that the limits of its simulator, defined by size, motion specification, visual system, vehicle model, number of vehicle mock-ups, track fidelity and library, is a limit to its overall performance.

Simulators – even highly dynamic, multi-million dollar rigs with a raft of up-to-date LiDAR tracks and seriously complex physical tyre models – don't automatically make cars and drivers go faster; the competitive advantage is achieved by engineers doing smart things with the tools at hand, at any budget.

Because of this, there is something to be gained from Cruden's driver-in-the-loop (DIL) simulation at any level. The company urges teams to invest wisely and incrementally in components that bring their current setup to the next level in a way that still enables the simulator to be developed for future needs. Cruden believes this is the best approach to motorsport simulation, and highlights that it is as appropriate an approach at the top – where the next step might be adding alternative cueing devices for sustained acceleration cues, or transitioning to hard real-time systems to integrate ECUs – as at the bottom, where the next step is adding professional simulation software and high fidelity vehicle models.

Ask: do you need LiDAR tracks for driver training, 4g peak acceleration and 5m of stroke on a 10-DOF system? For every goal, budget and level of expertise, there is a suitable upgrade plan to lift the DIL simulation programme.

Rome wasn't built in a day! Teams need time to get to where they need to be and can learn a lot of very useful things along the way. Cruden advises making an upgrade plan, for example first upgrading the software, then the models, visuals, adding motion and then the models again. Customers also need to consider where on-track gains can be made. These could be in many areas such as setup optimisation, racecar development, energy management, improved driver performance (racing skills, driving technique, dealing with procedures such as safety cars, etc), engineer to driver communication and both engineer and driver technical understanding. That way, Cruden can help improve the simulator setup in such a way that it enables the biggest potential performance gains to be unlocked first.

However, team owners should manage expectations of their simulator programme, taking investment advice from and supporting their engineers, giving them the necessary time to develop the simulator instead of demanding results straight away. This might be nine months in the case of developing and dialling in a physical tyre model. Engineers should be supported to obtain and analyse the data required to populate their complex vehicle models.

Engineers should talk to their peers, and experts such as Cruden, which has helped a large number of teams, from junior formulae to touring cars and Formula 1, to educate themselves about the various 'big ticket' technologies and the usability of their equipment, so they can present fact-based arguments to their superiors. "Bigger is better" or "It's what the other teams are doing" shouldn't cut it.

Instead, Cruden maintains that gaining a competitive advantage through DIL simulation is achievable for everyone. RT

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BURNING QUESTIONS

The precision monitoring required to quell F1's oil burn controversy has highlighted the role of sensors in motorsport. Gill Sensors is one of the companies relishing the spotlight, as **Alan Stoddart** discovers

THE attributes of a racing car's fuel and lubricants are important to its performance, but what good is a superior fluid if it cannot be managed properly?

Gill Sensors has been supplying oil and fuel level sensors to Formula 1 for about 13 years. It started by producing a very lightweight, capacitive fuel level sensor for one of the championship's 'better known teams'. Since then, the company has grown and developed into other fuel level applications, before finding a home in the last eight years with oil level monitoring.

Gill's oil level sensors are of capacitive design, which eliminates the need for moving parts. In the sensors, only the dielectric material and surface area between the plate alter capacitance. Given that the surface area is fixed, changes in the capacitance are down to changes in the dielectric value as a result of the amount of oil in the sensor changing. Microprocessors in the sensor then process that information to accurately determine the oil level.

Using this solid state technology avoids the need for reed switches or floats, which have several problems, including sticking, and moving with the slosh. It also makes the sensors a very reliable and accurate way of measuring fluid level in unforgiving environments – perfect for inside a Formula 1 car then.

Another of Gill Sensors' specialities is offering sensors that can stand up to the rigours of racing while maintaining a very low weight. In its top flight oil level sensors, this means carbon fibre. The sensors used to be constructed wholly out of aluminium, but since then, Gill moved to more exotic materials like titanium, before perfecting a sensor predominantly constructed out of carbon fibre.

"This was a big step change, literally cutting the weight of the sensor by 50 per cent," reveals Motorsports Business Development Manager Simon Peaty. To get to this point Gill had to overcome some significant technical hurdles, chief among which was bonding the carbon fibre to aluminium, which is still used for some elements of the sensor. Improvements in adhesives made this easier, but the company also had to develop its own particular method to ensure the two materials were jointed strongly enough in the finished sensor.

"It's not just that we have a good adhesive, we have a special way of doing it," says Peaty. "It's a very special way of ensuring that we are not just relying on the adhesive to form the joint; there is actually some mechanical retention as well. That is something we've developed in-house that has been fundamental in making the product really very robust."

As the majority supplier of oil level sensors for the Formula 1 grid, Gill's role has recently been highlighted with rule changes surrounding oil use. ▶

ABOVE Gill Sensors' range of 4223 Lightweight Liquid Level Sensors, with interchangeable flange mounts

> *"Carbon fibre was a step change, cutting the weight of the sensor by 50 per cent"*

ABOVE F1's oil burn controversy, like fuel monitoring before it, has propelled the precision measurement of fluids into the spotlight

> *"It's nice for us in a lot of ways that there is a lot of focus on the product we supply"*

Ongoing rumblings suggesting that some teams were burning oil as fuel to set faster qualifying lap times culminated in changes to rules for next season, which stated that "the measurement of the oil level in the main tank must be supplied to the FIA at all times". This change has turned the spotlight on Gill's sensors.

Peaty says the company welcomes the extra attention: "It's nice for us in a lot of ways that there is a lot of focus on the product we supply... We're not necessarily changing the technology or anything as we're already offering the best on the market, but there is quite a focus on what we're doing."

BETTER UNDERSTANDING

The changes have also had the knock-on effect of further cementing relations between Gill and the Formula 1 teams, as they work to get the best out the sensors. "It's prompting a lot more questions for us from the teams on how they use the sensors. How can they use them in a better way, how can we start to look to improve calibrations, and these sorts of things," adds Peaty. "It's allowed us to build a much stronger relationship, giving them a much better understanding of the capabilities of our product."

The time and effort invested in perfecting the oil and fuel sensors that are used in Formula 1, LMP1, and many other series, as well as the close relationships with the teams running in those championships, is subsequently utilised in every product in Gill's line. This means that Formula 1 performance is available for any series of motorsport.

"All of the work and all of the knowledge that we have from Formula 1, is available in our standard range of products. All of that history and all of that know-how is available to anybody in any series through our range of standard products," concludes Peaty. RT

ABOVE The 4223 lightweight, solid-state capacitive liquid level sensor shown in a cutaway tank to illustrate a typical installation

SIGNAL OF INTENT

William Kimberley reports on Bosch Engineering GmbH's new µLC Test System, including software for the simulation of most sensor signals in the automotive sector

BOSCH Engineering has recently given details of its latest hardware-in-the-loop (HIL) test system, a compact open-loop test system for quality assurance of control unit development.

The fast processes such as knock-control modelling can be made in a closed loop in the big HIL, but not in this small test system. The big difference to the vehicle is that normally not all sensors can be correctly simulated physically due to the lack of a detailed closed loop model, but what Bosch Engineering is offering in the µLC Test System is a system that stimulates the control unit with certain simulated sensor signals. It facilitates the measurement of both the control unit signals (analogue, PWM, BUSes) and internal variables of the control unit. It provides the possibility of a complete automation through Lua scripts and an application programming interface (API). This API fits the existing control software and offers both a graphic interface and the opportunity to operate the µLC Test System.

It has been developed in the powertrain department so its focus is the ECU – the crankshaft and camshaft being very important – and it can simulate engine speed up to 20,000 rpm. There are two crankshaft and four camshaft sensors, each independently configurable, and an oscilloscope trigger signal for easier monitoring. As well as the ECU, it is currently also used in the development of transmission control units (TCU), vehicle control units (VCU) and others.

"The first version had an 8-bit microcontroller inside and we built some additional PCBs and so it was physically bigger," says Bosch Engineering engineer Stephan Hübner, µLC Test System expert. The second generation had only one crankshaft and camshaft and could only go up to 7,500 rpm diesel. However, this third generation goes up to 20,000 rpm, has two crankshafts and four camshafts.

A friendly user interface for easy operation and evaluation, it combines the simulation of all typical automotive sensors and communication protocols in one unit. It is especially used for automotive control units with typical interfaces for sensors and BUS systems such as analogue/digital inputs and outputs, PWM signals, SENT, CAN, LIN and speed sensors. Software is also included in the package.

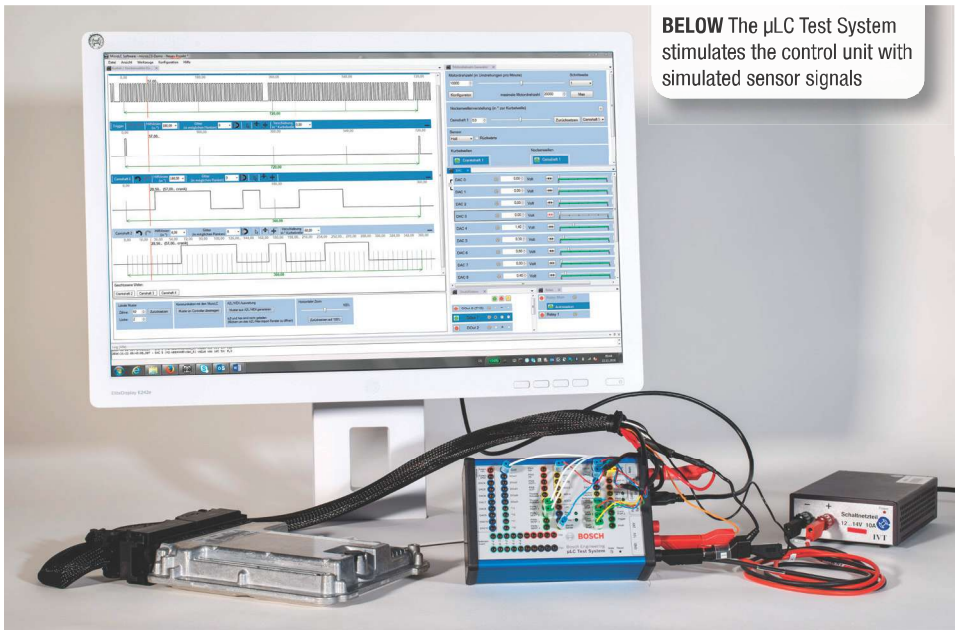
"Our product is a hardware-in-the-loop system which is pretty easy and compact to use so that it can even be used on a desk," says Hübner. "Its basic function is to simulate a car surrounding as in the usual HIL system. For example, it can simulate a temperature sensor or any kind of engine sensor that's sent from the µLC Test System to the ECU, and then depending on which software is being used, it can be seen whether the control units react in the right way following the stimulation of the sensors."

The device is connected via a USB directly to the PC so that all the outputs can be controlled via the user interface. The idea was that it had to be as easy as possible for each user to operate the system and lessen time spent on learning it, although complex things can be achieved if you go deeper.

"For complex tests a big HIL is still needed, but this is an easy option to test part of the software more quickly," says Hübner. "It's therefore very useful for the development engineer who wants to test new functions. There's also the possibility of adding extension boards with additional functions. At the moment we are working on an expansion board with servo signal for EV motors, which is a new feature that will be included. We can also simulate the torque sensor.

"We have a lot of new sensors that are of the SENT protocol, which is very complex, but our user interface takes less than five minutes to configure. The whole idea is that the user should spend less time configuring the system and more time on working on solutions and being altogether more efficient.

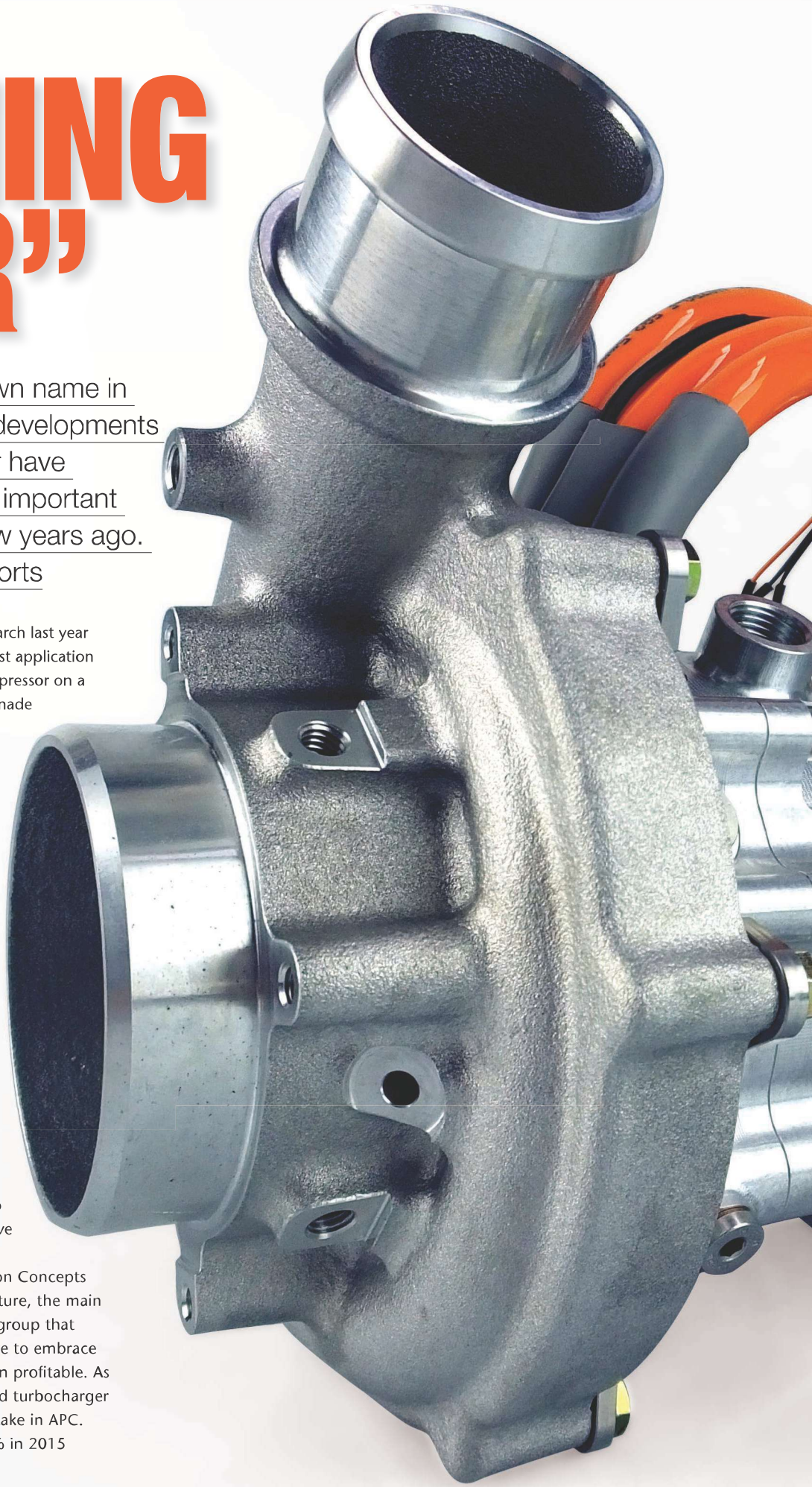
"Maybe a customer has a BUS system that can't be found on it so we can develop the hardware and software and give him additional functions. In other words, it is customisable to meet individual requirements. Customers are notified on any software updates, not just for the PC but for the device itself, around six times a year." RT



BELOW The µLC Test System stimulates the control unit with simulated sensor signals

"SHINING STAR"

Pankl is a very well known name in motorsport, but recent developments in the automotive sector have highlighted just what an important investment it made a few years ago. **William Kimberley** reports



WHEN Audi announced in March last year that it was launching the first application of an electric-powered compressor on a series production car in 2017, it hardly made any ripples in the motorsport sector. The car has now arrived, though, and while it has not involved Pankl in the development of the EPC (electrically-powered compressor), the presence of this technology in the first diesel "S" version of Audi's flagship SUV, the seven-seat Q7, complementing a pair of sequential turbochargers to boost output to 320 kW (429 hp) and peak torque to 900 Nm (664 lb/ft), is highly significant. It sets a marker of what we can expect in cars in the future.

Austrian company Pankl has been producing conrods for the motorsport industry since 1985, since which time it has expanded its portfolio of products so that it has become a leading supplier of engine and drivetrain components and systems for the racing market. It also supplies the high-performance automotive and aerospace industries as well.

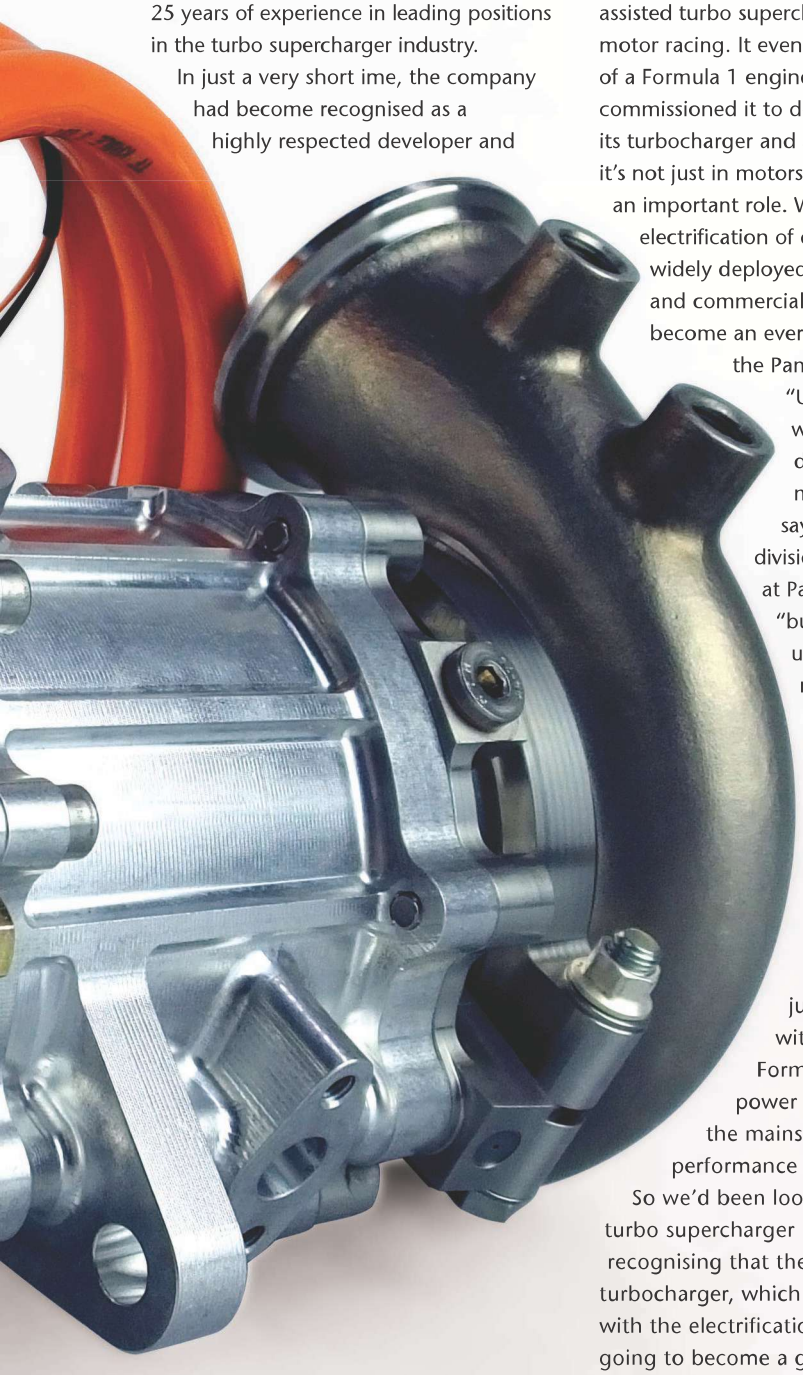
The investment in Advanced Propulsion Concepts GmbH (APC) was with an eye to the future, the main board directors at KTM Industries, the group that owns Pankl, aware that they would have to embrace new technologies if they were to remain profitable. As a result, it entered the supercharger and turbocharger business in 2012 by acquiring a 51% stake in APC. The shareholding was increased to 70% in 2015

when the company was renamed Pankl Turbosystems (PTSYS).

Pankl Turbosystems GmbH was founded in Mannheim in 2009, its core competency being the development of advanced superchargers and air management systems for combustion engines. Key people in the management, design, development and engineering departments have more than 25 years of experience in leading positions in the turbo supercharger industry.

In just a very short ime, the company had become recognised as a highly respected developer and manufacturer of complex, electrically-assisted turbo supercharger systems for motor racing. It even caught the eye of a Formula 1 engine supplier, which commissioned it to design and develop its turbocharger and ancillaries. However, it's not just in motorsport that it plays an important role. With the increasing electrification of drivetrains being widely deployed in automotive and commercial applications, it has become an ever more shining star in the Pankl portfolio.

> *"We recognised that the electrification of the turbocharger, which goes hand in hand with the electrification of the vehicle, was going to become a gamechanger"*



ABOVE Technology transferred from F1 MGU-H application to the automotive sector: Pankl Turbosystems GmbH's electric-assisted turbocharger

"Until the millennium we were almost wholly dependent on the motorsport industry," says Werner Bruck, division manager engine at Pankl Racing Systems, "but with so much uncertainty and with new technologies coming into the sport, we knew we had to change our strategy and diversify.

"We identified that turbocharging was likely to play an increasingly important role, not just in motorsport, with its return to Formula 1 as part of the power unit, but also in the mainstream and high-performance automotive industry.

So we'd been looking to enter the turbo supercharger business since 2007, recognising that the electrification of the turbocharger, which goes hand in hand with the electrification of the vehicle, was going to become a gamechanger.

"In PTSYS we discovered the ideal combination of its extensive know-how with our production capabilities, global presence and networks opened significant possibilities for us. It meant we had all the systems from energy recovery and e-boosting or a combination of that with different voltages from 48 to 800. However, we are not looking for mass production but for high-performance cars, much more of a niche market."

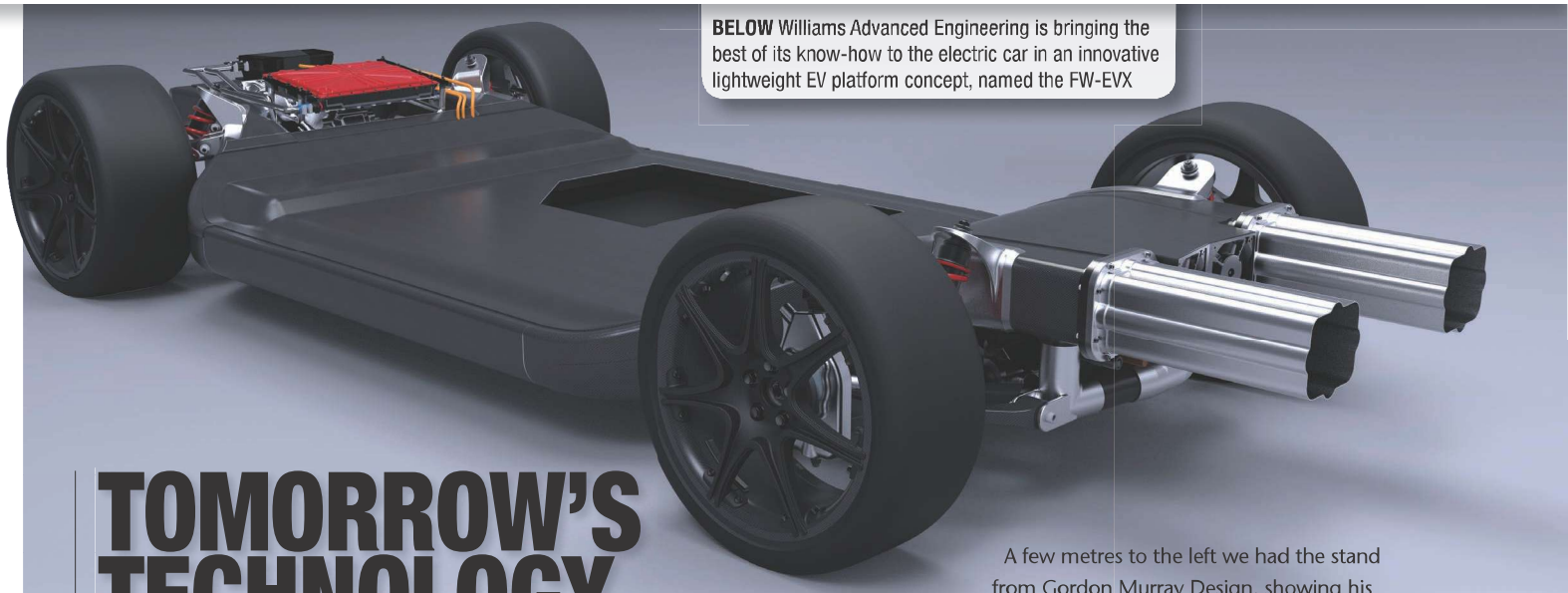
Pankl Turbosystems consequently became the development, testing, validation and assembly centre for the group's turbochargers and electrified turbos, while also producing prototypes. "It's not a manufacturing plant which is done elsewhere within the Pankl group, except from some parts that are outsourced," says Bruck. "It assembles, tests and verifies with sophisticated documentation every product that's released to the customer."

QUEST FOR INNOVATION

While Bruck acknowledges that the Audi product is for mass production, he recognises its significance. "It may be a cheap version that's just driving a few seconds whereas our concept is on the higher technical level whether it's permanent boosting or energy recovery, but it's the start of something that will be rapidly mushrooming in the next few years although I don't think we will see cars with such complexity on the mainstream market before 2020."

The quest for innovation does not stop with the electrically-powered compressor, though, and the group wants to capitalise on its core competencies in electric assisted turbocharging, fuel cell boosting systems and wastegate accessories, such as boost and pressure control. "We are looking outside the box so doing things in connection with new propulsion systems and the entire electrification of the car," says Bruck. "This includes fuel cells – let's call it the range extender of the future – some of which have the possibility of regenerating the energy so the efficiency of the whole system can be improved.

"We are also looking completely outside the automotive industry where there are some really challenging situations where we can contribute our expertise." RT



BELOW Williams Advanced Engineering is bringing the best of its know-how to the electric car in an innovative lightweight EV platform concept, named the FW-EVX

TOMORROW'S TECHNOLOGY

Can motorsport still influence the cutting-edge technology shaping the mainstream automotive sector? Yes, says **Sergio Rinland**. Here's how...

I recently attended two events within the space of a few days. From the outside, they had little in common but they were joined by an invisible umbilical cord.

They were the Cenex LCV (Low Carbon Vehicles) 2017 conference and show and the Goodwood Revival meeting. I am passionate about both and will tell you why.

I love motorsport. Cars are my life, technology my passion. I never miss a Goodwood event. In a nutshell, it reminds me why I fell in love with motor racing in the first place. The smile I wear at those events lasts me a long time afterwards.

The Revival celebrates the two decades when Goodwood was an active circuit and motorsport developed into the industry we have today. From 1947 to 1967, names like Cooper, Lotus, Brabham, Cosworth, Jaguar, Aston Martin, Ford and hundreds of smaller car manufacturers – from F1, F2 and F Junior, to sports cars and touring cars – had one thread in common: they were innovators.

Added to all those from the UK we had Ferrari, Porsche, Maserati, Alfa Romeo and Mercedes-Benz, and small manufacturers from Italy, France, the US and Germany. I love looking at those cars to see how they evolved and how they found diverse solutions to the same problems, with similar success and failures.

During those two decades we saw motorsport developing technologies which today are common in every passenger car around the globe: brake discs by Jaguar; fuel injection by Mercedes-Benz; monocoque structures by Lotus... the list would be too long to catalogue here. It was in motorsport's DNA and it carries on to these days.

This brings me to the LCV event, where we could see the latest innovations in electric and hybrid vehicles. And motorsport innovation? That was everywhere!

We saw the latest lightweight electric car platform from Williams Advanced Engineering, a subsidiary of the Williams F1 team. The motorsport DNA was all over that vehicle, with Xtrac transmission, YASA motors, innovative composite manufacturing processes for its structural components and a cooling system which could only come from minds used to solving two problems with one component.

Walk a few metres further and we encountered the fantastic new Ariel P40 hybrid electric supercar. Four 200 kW motors from Equipmake (of Ian Foley, former Lotus and Williams engineer), a 120,000 RPM turbine generator from Delta Motorsport (of Nick Carpenter, former Reynard engineer) and aerodynamics from TotalSim (of Dr Rob Lewis OBE, former Reynard and Honda F1 engineer). A typical example of minds trained in motorsport.

A few metres to the left we had the stand from Gordon Murray Design, showing his innovative iStream Carbon manufacturing method for lightweight vehicle structures. In the entrance hall we could see aluminium structures innovation by Jaguar, composite chassis by McLaren and endless developments by Ricardo plc, a company with racing in its DNA.

You may by now be asking, 'Good week Sergio, it looks as if you enjoyed yourself, but where are you going with this?' I am going to my favourite subject, which is how motorsport can contribute to mainstream industry. In the old days it was by developing components to use on roads cars. To a certain extent that is still the case, but where motorsport is really contributing is by developing engineering disciplines and minds to innovate on the technologies of tomorrow.

Can motorsport continue on this path? My answer is definitively YES. For as long as we continue training engineers who have to find solutions for 'next weekend' and design, develop and build new racecars in eight to 10 months, we will contribute.

Granted, today in motorsport, for reasons of costs and regulations, we don't have as much opportunity as before to innovate outside of racing's needs and develop components for mainstream automotive. But the training and mindset of racing is all that an engineer needs to solve problems which he/she has never seen before and to create the innovations which will, yes, find their place in the automotive and transportation sectors. RT

RIGHT Motorsport might not deliver the direct technology transfer it did in the days celebrated at the Goodwood Revival, but the racing mindset can still shape tomorrow's technology

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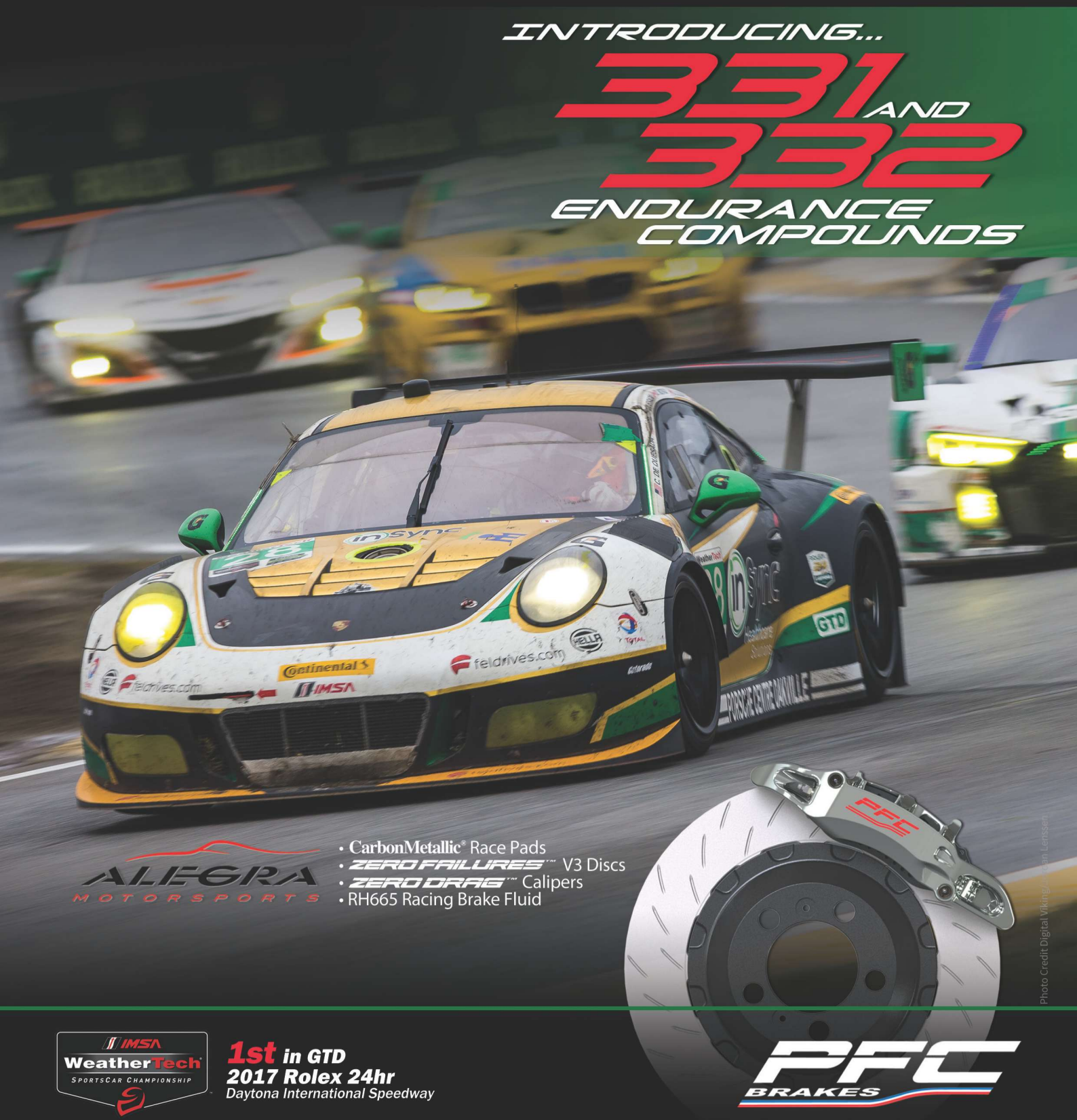

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