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COVER STORY Page 28

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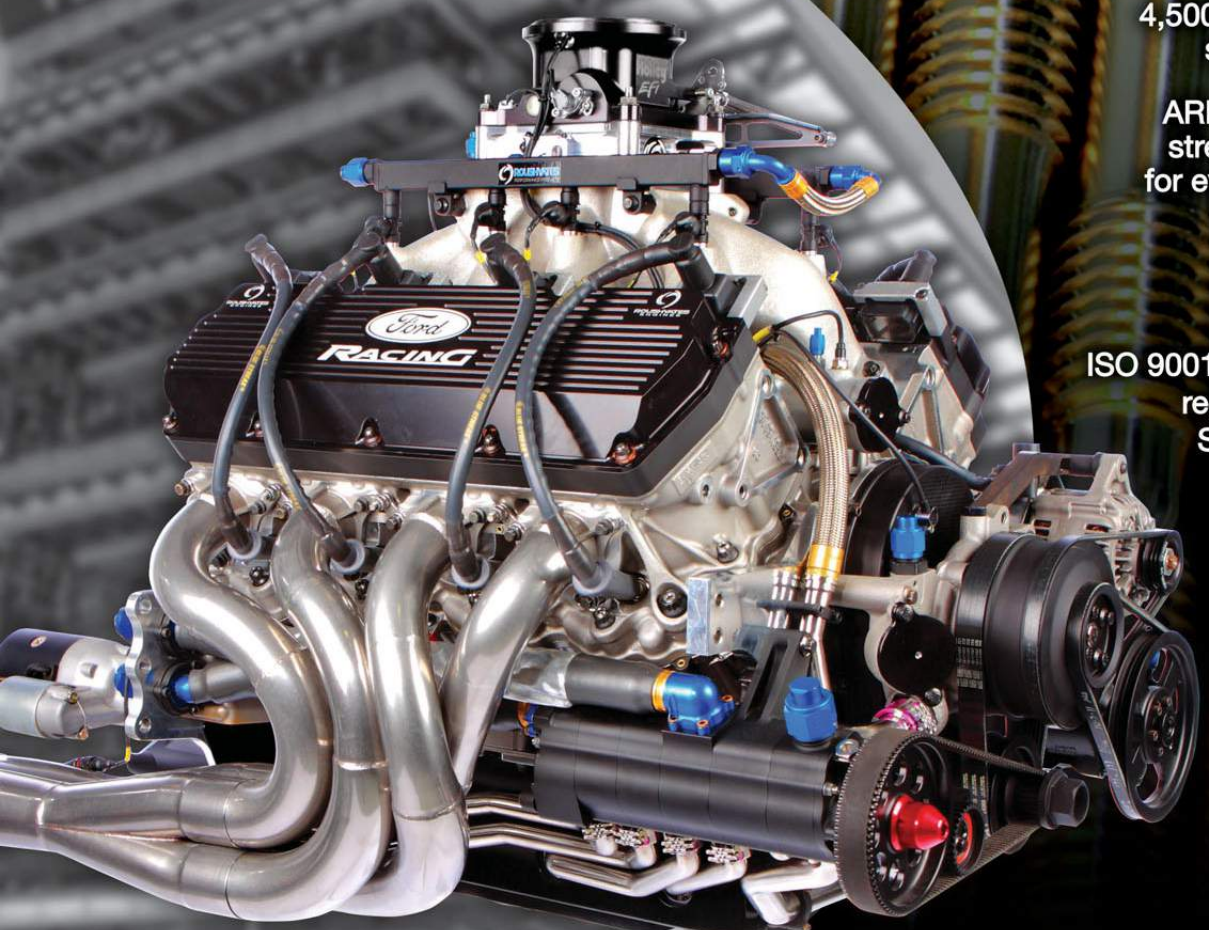

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Saluting a true friend

LAST month I said that we do not acknowledge deaths as we are a technology magazine before going on to talk about Justin Wilson's fatal accident due to the safety implications and the issue of enclosed canopies on single-seaters. As it so happens, I am going to tear up that policy because I now want to talk about someone who has very sadly passed away in a fatal road accident in Italy. He was a colossus among the unsung and often unseen heroes behind the scenes – without whom there wouldn't be racing. He was also a good friend of *Race Tech* and we will miss him terribly.

Don Burgoon was a dynamic and driven man. Over the years I got to know him very well and found him good and gracious company. Always entertaining, what came through was his enthusiasm and passion in what he and his company, Performance Friction Corporation, were doing. In the last few years he was just so proud that his company had become a supplier to Porsche Motorsport, a considerable achievement bearing in mind the competition. I remember him telling me about it a good year before the deal became public. I was obviously sworn to secrecy, which of course I honoured, but when he could finally announce the news, he was still as excited as the day he first told me.

I also remember paying a visit to his plant in Clover, South Carolina where publishing director Soheila and myself were so warmly greeted. After a presentation on new products, we were then given an off the record extensive tour of the entire factory, meeting people who were every bit as passionate about the company as Don was himself. It was extremely uplifting.

I will never forget the support that he gave us personally. As many of you will know, we organise the World Motorsport Symposium, which actually takes a massive amount of organisation, but in 2014 Don and his wife Mary Ann flew across just to join us for the two days as he wanted to show us how much he appreciated what we were doing for the industry. It was a massive morale boost for us.

I was also very proud that we recognised the work his company did by giving him on behalf of PFC the award for the Most Innovative New Motorsport Product of the Year in 2011. It was not a favour but given genuinely for the truly groundbreaking ZR43 zero drag callipers.

I will miss Don enormously, especially when going to the forthcoming Performance Racing Industry show in December where I would look forward to his briefings, which were always detailed and highly informative given by a man at the top of his game. The only comforting thing is knowing that the company is in good hands with Mary Ann now becoming chairman and their daughter Nina, who has been in the business for some years and so knows it very well indeed, becoming president. At the same time they are supported by such stalwarts as Darrick Dong and Tom Davis and the very many others in the business. There's no question that there will be some tough days ahead for all of them, but I am certain that Don's spirit will shine through to guide them. RT

William Kimberley
EDITOR

VW's F1 dream on hold while it fights for life

WOLFSBURG, Germany: Volkswagen has been dealt a crippling blow that not only jeopardises the rumoured takeover of the Red Bull Racing operation in Milton Keynes but could possibly threaten the future of the entire car manufacturing group.

In the afternoon of Friday, 18 September, the Environmental Protection Agency, the US federal agency that writes and enforces environmental regulations based on laws passed by Congress, accused the carmaker of using sophisticated software to cheat emission tests allowing its cars to produce up to 40 times more pollution than allowed. The California Air Resources Board (CARB) separately issued an In-Use Compliance letter to Volkswagen.

The "defeat device" – as defined by the Clean Air Act – software was uncovered after independent analysis by researchers at West Virginia University, working with the International Council on Clean Transportation, a non-governmental organisation, raised questions about emissions levels, and the agencies began further investigations into the issue. In September, after EPA and CARB demanded an explanation for the identified emission problems, Volkswagen admitted that the cars contained defeat devices. Motor vehicles equipped with defeat devices, which reduce the effectiveness of the emission control system during normal driving conditions, cannot be certified. By making and selling vehicles with defeat devices that allowed for higher levels of air emissions than were certified to EPA, Volkswagen has violated two important provisions of the Clean Air Act.

"A sophisticated software algorithm on certain Volkswagen vehicles detects when the car is undergoing official emissions testing, and turns full emissions controls on only during the test," the EPA said in a statement. "The effectiveness of these vehicles' pollution emissions control devices is greatly reduced during all normal driving situations. This results in cars that meet emissions standards in the laboratory or testing station, but during normal operation, emit nitrogen oxides, or NOx, at up to 40 times the standard."

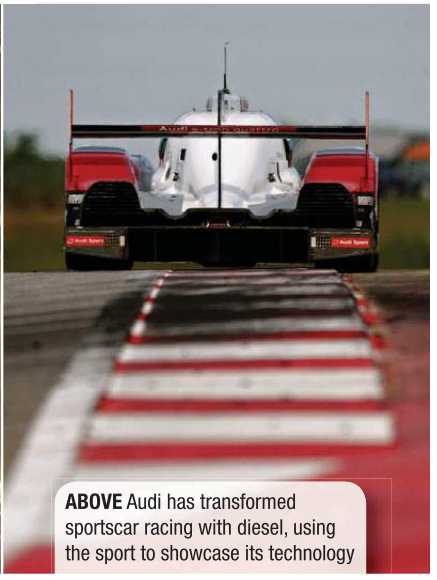
The allegations cover roughly 482,000 diesel passenger cars sold in the US since 2008. VW – the world's largest auto maker by sales – may now be liable for civil penalties and injunctive relief for the violations alleged in the Notice of Violation (NOV) and it has been reported could be facing a maximum fine of $18 billion. Additionally, Volkswagen AG's stock sank as much as 23% the following Monday when the stock market opened in Germany to shave more than €14 billion off its market capitalisation. It is also facing the prospect of now being sued by its own shareholders as well as investigations being opened up in other countries and regions.

VW immediately halted sales of the models involved and issued a statement to say that it was cooperating with the probe and had ordered its own external investigation. Chief executive officer Martin Winterkorn, who has led the company since 2007, said he was "deeply sorry" for breaking the public's trust and that VW would do "everything necessary in order to reverse the damage this has caused." He then resigned.

Meanwhile, negotiations to purchase the Milton Keynes Formula 1 operation from Red Bull was said to have been agreed between all parties on the eve of the Singapore Grand Prix before the news of the EPA accusation had become public.

At the time of going to press, there were no comments from any of the parties involved. RT

BELOW For all its success in the World Rally Championship, Volkswagen is looking to move into Formula 1 by purchasing the Red Bull Racing team, but that could now be in jeopardy following the emissions test cheating crisis hitting the manufacturer



ABOVE Audi has transformed sportscar racing with diesel, using the sport to showcase its technology

Expert Witness analysis

VW has been courted by F1 for years, but the fallout from the emissions scandal appeared to rip up F1's dream ticket of a VW-Red Bull superteam. "Formula 1 is the very last thing VW needs after this," said *Race Tech's* Expert Witness, an F1 insider with a star-studded CV. "Why would you want to very publicly push your performance image when arguably you have overstepped that line already with your bread and butter road car product?

"In terms of housekeeping, you need to make sure everything is healthy and 100 per cent on-message at home before you commit to an F1 programme. Then you use F1 as a showpiece to point back at your organisation to say, 'Look, we are company X, see how fantastic we are!' It's not a project you embark upon when the regulators are crawling all over you. Besides, the drop in its share price immediately wiped out the equivalent of an F1 budget many times over…

"There are actually echoes here of what goes on increasingly on the racetrack, as it does on the road: cars are being designed to pass the test, rather than to improve the actual product.

"In both worlds all sorts of games are played to get the best numbers in a test: it's like a Formula 1 car going to scrutineering and passing the measurements, then deflecting all over the place once it gets back on the track!" RT

New cars, new series for TCR

Andrew Charman

SINGAPORE: The growing TCR International formula has seen another new manufacturer join its ranks, along with two new national series. The Subaru WRX STI debuted at the TCR International Series rounds supporting the F1 Grand Prix at Singapore on 19-20 September, while the announcement of new series in Italy and Germany take to 13 the number of regional/national TCR championships either launched or under serious development.

The arrival of the Subaru marked the sixth different manufacturer to field a TCR-specification car and it was under challenging circumstances. Working to develop the new car prevented Castiglione, Italy-based team Top Run Motorsport joining the TCR freight charter to Singapore, the team planning to fly out the car itself.

However, two attempts were hit by payload and aircraft technical issues, and the flight eventually arrived at Seoul on the Friday of the meeting with no flights scheduled to Singapore in time. So the car was flown to Kuala Lumpur and taken more than 200 miles to Singapore by road.

Arriving just after qualifying had ended, the Subaru lined up for the first of the two races on Saturday at the back of TCR's largest grid yet, 24 cars including entries from the TCR Asia Series. Driver Luca Rangoni was forced to learn the track and the car in the race but still finished 15th.

In the following day's second race Rangoni made further progress before the team retired after five of the 10 laps, a planned move having collected a great deal of development data.

"In Race 1, the gearbox had a very long response time, the brakes weren't functioning properly and the setup was obviously not the right one for this track," said Rangoni following the second race. Today, most of the problems were corrected, and the progress quite visible, despite having only 40 minutes to work on the car."

The revived Italian Touring Car Championship was launched at the Vallelunga circuit near Rome and will be run to TCR rules in 2016. There will be seven meetings, one outside of Italy, and organisers ACI Sport – the motorsport branch of the Italian National Sporting Authority CSAI – is keen to assist the winner of the championship to compete in the following year's TCR International Series.

The German series, known as ADAC TCR Germany, will be jointly organised and promoted by Engstler Motorsport, which competes in TCR International, and German motorsports body ADAC.

According to ADAC Sports president Hermann Tomczyk, the series fills a gap in German touring car racing. "ADAC TCR Germany will make spectacular touring car racing possible at a reasonable cost and is the perfect addition to the ADAC GT Masters and ADAC Formula 4 – we are confident that we can give touring car racing in Germany a new dynamic with the ADAC TCR," he said.

BELOW Flying visit: The Top Run Subaru WRX STI made an encouraging debut in Singapore despite only arriving just before race one

Ford announces its GT race programme for 2016

DEARBORN, MI: Ford's all-new GT race car – revealed at Le Mans in June – will make its European racing debut at Silverstone next April for the opening round of the World Endurance Championship. Based on the all-new Ford GT supercar unveiled in January and powered by the same Ford 3.5-litre EcoBoost engine, the all new Ford GT racecar, that will compete in the GTE class, is engineered from advanced lightweight composites featuring carbon fibre for an exceptionally rigid but light chassis.

"We believe the Ford GT's advances in aerodynamics, lightweighting and EcoBoost power will make for a compelling race car that can once again compete on a global stage," said Raj Nair, Ford group vice president, global product development and chief technical officer. "The same spirit that drove the innovation behind the first Ford GT still drives us as a company today. Let the racing begin!"

As well as competing in the full 2016 FIA WEC, it will contest the IMSA WeatherTechSportsCar Championship, making its global competition debut in January at the Rolex 24 in Daytona.

ABOVE Ford has planned a full season of racing in both next year's World Endurance Championship and the WeatherTech SportsCar Championship

Gibson named 2017 LMP2 engine supplier

REPTON, UK; Gibson Technology has been named by the FIA as the single LMP2 engine supplier from 2017 to 2020. The company will develop and manufacture a new 4.2-litre V8 engine delivering 600 bhp, supplying LMP2 teams in the World Endurance Championship, the Le Mans 24 Hours, the European Le Mans Series and the Asian Le Mans Series (from 2019 onwards). However, in the IMSA WeatherTech SportsCar Championship, the prototypes will be powered by several different engines with the chassis including stylistic elements particular to each engine builder.

In addition to the power increase from the current engine, the new unit will enable entrants to reduce their powertrain costs while taking advantage of all the services linked to running an engine without significant extra charges, such as technical service and presence at the circuits.

Gibson Technology race engines have achieved enviable success in one make formulae over many years, most recently for the prestigious Formula Renault 3.5 Series. In the world of endurance racing the Gibson-Nissan developed VK45 engines have achieved great success with many WEC and ELMS LMP2 teams, with notable victories at Le Mans in recent years.

Cosworth Electronics has been selected as the single electronics supplier by the ACO, the FIA and IMSA. The unique Cosworth electronic unit will also provide a more efficient level of service while enabling the performance of the engines between the ACO/FIA versions and the American engines to be managed.

The aim of the new regulations is to ensure the long-term success and sustainability of this category by achieving cost reductions, stability in the regulations, while increasing the speed of the LMP2 cars to bring them closer to those in LMP1.

In July, the four chassis constructors were selected to supply LMP2s to the ACO/FIA Series and the IMSA prototypes. The successful constructors were Dallara (Italy-United States), Onroak Automotive (France), Oreca (France) and the joint-venture Riley Tech/Multimatic (USA-Canada-United Kingdom).

The full technical specification of the new engine will be revealed at a later date. RT

LEFT Gibson Technology, formerly Zytek Engineering, has won the contract to be sole LMP2 engine supplier outside the US

Swindon and RML awarded BTCC supply contracts

Andrew Charman

SWINDON, UK: The British Touring Car Championship has retained engine supplier Swindon Engines for a further five years and selected RML as its chassis and associated components supplier. The contracts follow BTCC organiser TOCA's 'mid-term evaluation' of its technical partners, the current NGTC regulations having been in force since 2011.

Swindon developed and has been supplying the current 2-litre turbocharged engine – which is available to but not mandatory for BTCC-competing teams – throughout the NGTC era. The new contract runs until the end of the 2021 season and will see the development of a new unit for introduction in 2017, with as now engines available for both lease and purchase by teams.

Nine engine manufacturers entered the first phase of the tender process, from which a four-strong shortlist presented to a review panel comprising representatives from TOCA and nine BTCC teams – including all teams using their own-developed power units. Swindon was selected by a clear majority of the panel.

RML triumphed in the tender process to supply the BTCC's specification chassis, suspension and engine components. The Wellingborough-based company will design and develop new components in time for the start of the 2016 season, the contract lasting six years.

Having developed the original NGTC components for the 2011 season and supplied them ever since, current technical partner GPRM decided not to bid for a continuation of the contract.

RML has already been working for some months to develop new components and make changes requested by the BTCC's Design Group and Technical Working Group, which comprises existing teams and TOCA technical staff. All new components are required to be interchangeable with GPRM items so that teams are not obliged to update their cars.

A car with RML parts was due to compete in the 2015 BTCC finale at Brands Hatch on 11 October and the first upgrade kits will be delivered to teams at the end of October. Both Swindon and RML's contracts require them to supply full spares and technical support to all BTCC events and official test days. RT

RML's return to the BTCC – see page 46

LEFT Future proofed: BTCC technical director Peter Riches (at left) has been busy in recent weeks overseeing the awarding of new engine and component supply contracts

— JakobEbrey/BTCC —

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Drivers vote for NASCAR's low-downforce aero package

Andrew Charman

DARLINGTON, SC: NASCAR Sprint Cup drivers have urged the sport's governing body to adopt a new low-downforce aerodynamics package for the 2016 season, following a second and highly successful trial race with it at Darlington on 6 September.

While as reported by *Race Tech* last month, NASCAR Sprint Cup races at the 2.5-mile Indianapolis and two-mile Michigan speedways with a 'high-drag' package proved inconclusive and sparked little enthusiasm among drivers, the low-downforce package trialled at the one-mile Darlington and 1.5-mile Kentucky tracks earned widespread praise.

The package used at Kentucky on 11 July saw the car's rear spoiler shortened in height from six to three inches, and the front splitter extension panel or radiator pan reduced in size from 38 to 25 in, producing 1.75 in less front overhang than previously. The changes in total were thought to cut approximately 1,000 lb of downforce from the cars.

At Darlington the package was similar, but with a 3.5-inch rear spoiler and a quarter-inch wide leading edge fitted to the front splitter. However, the major change was the combining of the package with a softer tyre compound, adding what supplier Goodyear's racing director Greg Stucker described as "a considerable amount of grip" in an attempt to regain some of the lap time lost to the less-efficient aerodynamics.

While the Darlington race lasted more than four hours, its result was unclear to the end, eventual winner Carl Edwards constantly swapping the lead with rivals Kevin Harvick and Brad Keselowski over the closing 20 laps.

Edwards, a long and loud critic of the Sprint Cup's current aerodynamic package, led the praise of the low-downforce setup. "25 laps to go in the Southern 500, I'm racing with two champions, we're swapping the lead back and forth and I think you're able to do that because there's less aerodynamic influence and the tyres fall off and it's really fun," he said after the race.

Edwards argued that the sport is currently at a major technical crossroads. "This is an opportunity for the sport to go in one of two directions… the cars are easy to drive and everyone's car is about the same and we can basically have Talladega every week (referring to the packs of cars that run at Talladega due to them being all rendered equal by restrictor plates in the engine inlets), or making the cars extremely hard to drive and showing the massive talent of the drivers, the crew chiefs and the pit crews, and I hope that they take the latter."

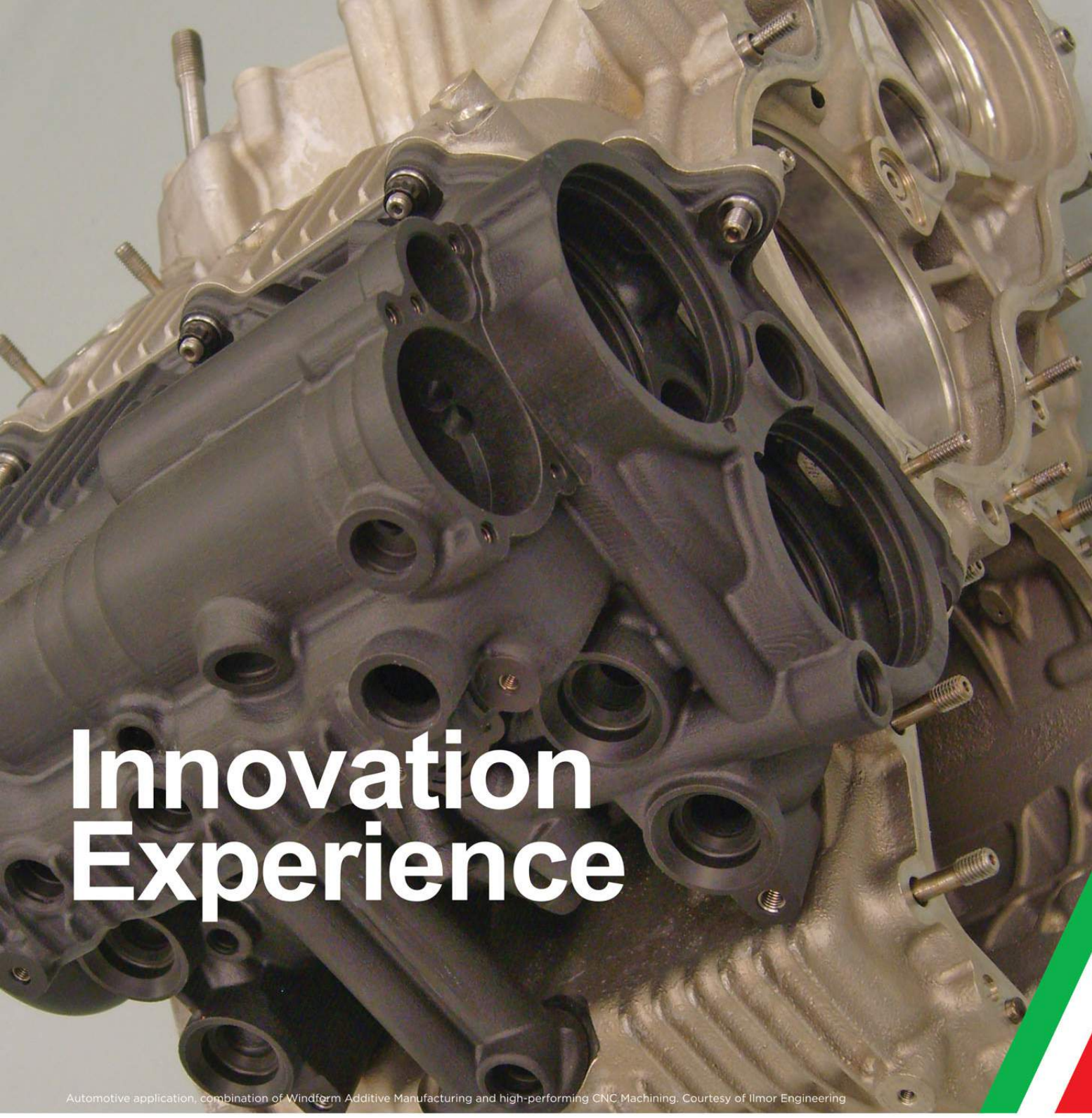
Despite some calls for the new package to be used during the 10-race season ending playoffs, 'The Chase', NASCAR decided to retain the current rules at least until the end of the season, the sport's racing development head Steve O'Donnell telling *Sirius XM Radio* that teams had developed their cars for the Chase basedon 2015 regulations.

"We can take the proper time to evaluate all the things we've looked at for '16 and really dial that in for the '16 package," he said, adding that the possibility of a low-downforce package combined with "something different" for the longer tracks would be considered, and that the influence tyres would be a major consideration.

O'Donnell refused to rule out at least some parts of the high-drag package being a factor in 2016, while admitting that the Indianapolis and Michigan races had produced some challenges for NASCAR. "We're aware of that and don't want to go out and repeat those ever again – there's some things we obviously learned from both those events." RT

ABOVE Air of agreement: After overcoming rivals including team-mate Matt Kenseth (20), Darlington race winner Carl Edwards was full of praise for NASCAR's low-downforce aero package

Russell LaBounty/LAT for NASCAR



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'16 Dakar Peugeot breaks cover

ABOVE The latest evolution of the Peugeot 2008DKR16, which is scheduled to make its competitive debut later in the year

PARIS, France: The latest evolution of the Peugeot 2008DKR16, which is scheduled to make its competitive debut later in the year before heading to South America, is longer, wider, lower and more powerful than its predecessor: presenting a more aggressive stance, with a raft of improvements under the skin as well.

The front and rear overhangs have been reduced, enhancing the car's go-anywhere ability. This is vital when it comes to tackling the varied obstacles such as sand dunes, river beds, and huge rocks that characterise the Dakar, making it one of the last true sporting adventures left on earth.

The vehicle also benefits from improved aerodynamics: the bonnet and roof-mounted air-intake have been heavily revised, in order to provide more balanced downforce between front and rear. The new air scoop also ensures better airflow.

Other evolutions lie under its carbon skin. The suspension has been redesigned to deal more effectively with the different and rough terrains. It also benefits from better weight distribution, as well as magnesium one-piece wheels for the first time, matched to lighter tyres from Michelin. These replace the aluminium two-piece wheels from last year, with the combination resulting in a significant weight saving.

The new car has been a continual work in progress, with development work starting as soon as the original car crossed the finish ramp in Buenos Aires just over seven months ago, at the conclusion of this year's Dakar.

Peugeot's engineers went over the car piece by piece, analysing what could be done better, with the help of its Dakar experts 11-time winner Stéphane Peterhansel, double world rally champion and former Dakar winner Carlos Sainz as well as Cyril Despres, a five-time Dakar winner on bikes.

These improvements were gradually applied and assessed through a series of tests, culminating in a one-two finish for Peterhansel and Despres on the recent China Silk Road Rally using an interim-specification car. This was essentially the 2015 model, with a number of development parts for 2016 added.

There are some surprises under the bonnet as well. Despite the air restrictor, the 3.0-litre V6 twin-turbo diesel engine now has more power. The driveability of the engine is increased too, which will be particularly useful during twisty stages.

Peugeot Sport director Bruno Famin, overseeing the final test in Morocco to sign off the latest incarnation of Peugeot's Dakar challenger, commented: "There isn't one big change that we have made on our car: instead it has been a series of small evolutions in different areas, which together we hope will amount to an overall improvement. The areas we have concentrated on include bodywork and aerodynamics – as a result of which the car looks slightly different compared to last year – as well as engine and suspension, which is all under the skin. The tests we have carried out up to now, as well as our one-two finish in China recently, indicate that we are heading in the right direction. You really cannot compare our state of preparation now to how it was for our first Dakar this time last year, when everything was new to us! Of course you can never say that you are completely ready for the Dakar either because you simply never know what it will throw at you, but certainly this time we are more ready."

Peterhansel and Sainz have driven the new car through the different phases of its development, and found it to be a useful step forward from its predecessor, providing greater driveability, power and traction. RT

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New F1 crash camera ready for debut


Craig Scarborough


Bloxham/LAT

ABOVE & BELOW The camera (above) will record valuable footage to be used in accident investigation

CORBETTA, Italy: A high-speed camera to assist with accident investigation in Formula 1 is on schedule to be introduced for the start of pre-season testing next March.

Speculation surrounding the cause of Fernando Alonso's testing accident at Barcelona earlier this year was partly fuelled by the lack of clear video footage showing what happened. The FIA mandated the use of the camera on all cars from 2016 and tasked electronics company Magneti Marelli with producing the device. It will be capable of recording, in milliseconds, the movements of a driver's head during the crucial moments of impact.

The device, which measures around two centimetres by eight centimetres and is not much bigger than a USB stick, will record 400 frames per second compared to the previous standard of 25 fps. It will be mounted on the top of the chassis, just in front of the row of antennas, facing the driver. The height position of the device has yet to be decided.

The camera can record for up to 90 minutes before it returns to the start and rewrites. The time restriction has been enforced to limit the amount of compression to the file. The video will be stored on the car's black box and will be synchronised to the telemetry so teams can analyse the exact speed and force at the point of impact.

Testing of the prototype will continue this year, with particular focus on ensuring it can withstand the pressure of being mounted on an F1 car. It is then hoped a version will be ready for January to allow time for checks and testing on the mounting before it is introduced at the first 2016 pre-season test, which starts at Barcelona on 1 March. RT

IndyCar trials wheel-mounted LED messages

Andrew Charman

SONOMA, CA: The IndyCar Series is continuing its experiments with spectator information systems with wheel-mounted LED display units. During the IndyCar finale meeting at Sonoma on 28 August, the KVSH Racing Chevrolet driven by Sebastien Bourdais ran in the first practice session with LED pods attached to the front and rear wheels. The LED units are manufactured and supplied by UK-based Speed of Light Media Ltd, and IndyCar believes they could be used to display race information or even sponsor words or logos.

During the test, Bourdais' car showed a red and yellow pattern on its front wheels and solid green on the rears, which were clearly visible even in the bright California sunshine.

According to Guy Margetson of Speed of Light Media, the LEDs flash slices of an image in rapid succession. It was first tried on a bicycle wheel and has since been developed to the current automotive-based full-colour units.

IndyCar is actively considering adopting the system for 2016, in similar fashion to the airbox-mounted panels that are now fitted to all competing cars. RT

ABOVE See the light: LED panels in the wheels are IndyCar's latest fan-friendly innovation

Photo:John Cote/IndyCar

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Advanced Engineering update

Bouyant auto sector just one of many drivers for growth in UK's largest annual advanced engineering event

BIRMINGHAM, UK: This 4-5 November, the UK's advanced engineering communities will come together for their own bonfire night display: in this case the 2015 edition of Advanced Engineering UK, including co locating shows Aero Engineering Show; Composites Engineering Show; Automotive Engineering Show; Performance Metals Engineering, together with one of the most comprehensive free conference programmes in the industry.

Rapidly shaping up to be the largest Advanced Engineering to date, more than 700 exhibiting supply chain partners will be meeting and doing business with engineering and procurement management from OEMs and top tier supply chain organisations across aerospace, automotive, motorsport, marine, defence and more.

Providing more feature exhibit areas than any other trade event in its sector, Advanced Engineering UK is particularly well positioned to showcase the kind of innovative technology the UK is particularly known for, with an emphasis on its commercialisation possibilities. Typical areas of coverage will include graphene, wearable/printable electronics, smart materials, additive manufacturing, new approaches to design & manufacturing and much more.

Across the show floor six Open Conference auditoria, including the *Race Tech* one of advanced racecar aerodynamics given by F1 consultant John Iley and TotalSim's Rob Lewis, will host presentations. Be sure to visit the Race Tech stand J71. RT

Autosport International update

BIRMINGHAM, UK: Williams Martini Racing has announced that it will have a major presence at Autosport International 2016 with features celebrating its past, present and future. It will exhibit some of its most celebrated racing cars, alongside appearances from current drivers and famous faces who have played a part in the team's success, including its seven Formula One Drivers' Championships.

As part of a major development of the Autosport Stage, the Williams Martini Racing motorhome will be constructed immediately next to the main stage – the first time it has ever been erected away from a race circuit. A permanent feature for the duration of Autosport International, it will be an amazing sight, standing eight metres tall and bringing even more F1 excitement to the NEC.

As well as interactive features focusing on Williams' F1 exploits, the event will also give visitors an insight into the world of Williams Advanced Engineering, the division that transfers technology from Formula One to market sectors as diverse as defence and renewable energy.

More details of the Williams special feature at Autosport International will be announced in the coming months. The 2016 Autosport International show takes place from 14-17 January at the Birmingham NEC. Tickets for the event, which covers every aspect of motorsport from karting to Formula One and also engineering, are now on sale. RT

BELOW Williams Martini Racing will have a major presence

IN BRIEF

CONTINUING safety improvements at NASCAR tracks saw Darlington Raceway add 4,600 feet of SAFER barrier on the outside walls of the front and backstretch before the Sprint Cup race on 6 September. The track now is ringed by the barrier along the outside walls and also has it on the insides of the two straights. RT

LAST month *Race Tech* reported that Toyota-supported NASCAR Sprint Cup team Michael Waltrip Racing will not field a full-time entry in the Sprint Cup in 2016. Now Rob Kauffman, who co-owns the team with twice Daytona 500 winner and Fox Sports analyst Michael Waltrip, has revealed that MWR is closing completely after Kauffman bought into Chevrolet team Chip Ganassi Racing. RT

AKD Engineering, which was closed by parent company Camellia PLC in June, has been bought by Peter Colby in a "multi-million pound" takeover. His existing firm Polgain – which took on former Zephyr Cams workers – will expand onto the site, with four new people already employed as a result of the takeover. It hopes to employ 32 people on the full site in the next one to two years – some of whom will be apprentices – with Colby describing a 10-year vision to grow the firm and eventually replace the majority of the jobs. RT

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ABOVE Don receives the award for the Most Innovative New Motorsport Product of the Year from *Race Tech* publishing director Soheila Kimberley

"A pioneering and driven man"

Race Tech pays tribute to Performance Friction Corporation president Don Burgoon

DON BURGOON, president of Performance Friction Corporation, sadly passed away in a tragic accident on Saturday, 12 September. A pioneering and driven man, he was a great friend to *Race Tech*, and achieved much in his all too short life. He is already sadly missed.

In the '90s he raced F2000 with Buddy Rice, Dan Wheldon, Sam Hornish and Alex Barron to name a few. His driver coach was Calvin Fish back in the day and he had one of the first Tatuus chassis in the US.

He was also a keen cyclist, one of the fastest in the North/South Carolina area for his age group. At his best condition, he had a resting heart rate of 40.

While PFC is firmly rooted in motorsport, under Don's guidance, it has also been extremely active in OE, including school buses, Fleet, Aftermarket and Military markets where new products were continually introduced, including zero cooper friction products.

PFC was the first brake company to meet the copper legislation requirements passed in California and Washington, having released copper-free pads through major automakers since 2006. Without sacrificing brake pad quality, Performance Friction pads are the most eco-friendly on the market and contain no harmful substances.

Off-highway disc pads were the first pads in production for PFC. It is where the company started. Industrial friction and the vast variety of applications from lawn mowers to haul trucks was the cornerstone of PFC's friction development.

PFC was also first in providing:

- Bonded friction for air clutches
- Non-asbestos friction for industrial clutches
- Non-asbestos friction for wheeled loader disc pads
- Non-asbestos friction for haul truck disc pads
- Non-asbestos friction for gear tooth facings

CAREER HIGHLIGHTS

- 1984 Don Burgoon purchases his father's small friction relining company, which is when the 'PFC Carbon Metallic' brake pad is developed and manufactured
- 1984 Geoff Bodine wins the first race for Hendricks Motorsports and maiden win for the PFC Carbon Metallic race pads in a NASCAR competition. Since then every NASCAR Championship has featured multiple wins with PFC brakes
- 1986 Don moves to a small facility in Gastonia, NC
- 1986 PFC begins to develop race brake pads for Nissan GTP with the famed #80 and #83 prototype racecars. Rumour within the industry is that PFC's 80 and 83 Carbon Metallic pad compounds were named after the works Nissan GTP car numbers. This begins international recognition of the PFC brand
- 1986 PFC starts a technical partnership with Newman/Haas Racing, in CART, ChampCar and IndyCar. Between 1986-2012, when iron brakes were used on road courses, 97% of those races were won with PFC
- 1991 PFC moves into its current Clover, SC facility located on 83 Carbon Metallic Hwy
- 1994 PFC starts to develop iron brake discs with unique dynamic symmetry properties. Years of constant development in geometry, chemistry and patented processes and features are incorporated in the new iron disc technologies
- 1997 PFC wins its first race it participates in with Gary St Amant's ASA Late Model at Langley, VA using PFC Carbon Metallic pads and PFC Racing discs as a combination. This begins the PFC journey into new markets for its disc technologies in race, aftermarket, fleets, OEM and military avenues
- 1999 PFC introduces its race discs to the CART/ChampCar market and through 2007 had 100% of that market on discs and pads
- 1999 PFC iron discs were debuted at the Daytona 24 with Oreca Vipers in GTS to bring it to the attention of the international scene
- 2000 PFC iron discs won overall at the Daytona 24 with the Pratt & Miller Corvette, doing so without a change to discs during the race distance. At the time, this was a first for an iron disc at that race
- 2003 PFC begins work on "Zero Drag" brake calliper technologies
- 2004 PFC introduces the first MMC

6-pot monobloc short track callipers to NASCAR competition
- 2005 PFC introduces monobloc multi-pad MMC. It becomes the standard for ChampCar through to 2007 when the series closes
- 2006 Ganassi DP wins Daytona 24, its first of a record six overall victories. PFC was the first North American brake supplier to have 100% content on the overall win for that race
- 2007 PFC monitors race championships during a one-year period. That year PFC was used in 257 world and national championships including NASCAR, IndyCar, SCCA, IMSA, Grand-Am, CASCAR, World Superbike, Australian V8, Japan GT500 and Japan F Nippon
- 2010 PFC introduces patented "Single strand continuous wound carbon carbon" to the racing industry, totally new technologies unique to the market
- 2010 PFC introduces its patented "pad-retraction" callipers for true zero drag
- 2010 Jamie McMurray wins the Daytona 500 on the debut race of PFC's patented pad retraction in NASCAR
- 2011 Winner of the *Race Tech* World Motorsport Symposium award for the Most Innovative New Motorsport Product of the Year for the Zero 43 (low drag) brake calliper
- 2012 PFC becomes a technical partner of Porsche Motorsports AG. PFC becomes the first and only North American chassis supplier to Porsche AG
- 2012 PFC carbon carbon and callipers debut on the unique DeltaWing at Le Mans 24 Hours in Garage 56 reserved for new technologies
- 2014 Ganassi DP wins the overall Daytona 24 Hours using PFC carbon carbon and PFC monobloc callipers. PFC was the first US brake carbon carbon supplier to have 100% content on the overall win for that race. Ganassi goes on to win that year's LBGP and the COTA races
- 2015 PFC supplies 100% hot end component content to Renault Sport in four of its platforms: Clio, Rally, Renault 2.0L, RC.01
- 2016 PFC supplies 100% hot end component content to Porsche Motorsports AG: 991 GT3 Cup, 991 GT3R, 981 and Cayman GT4CS

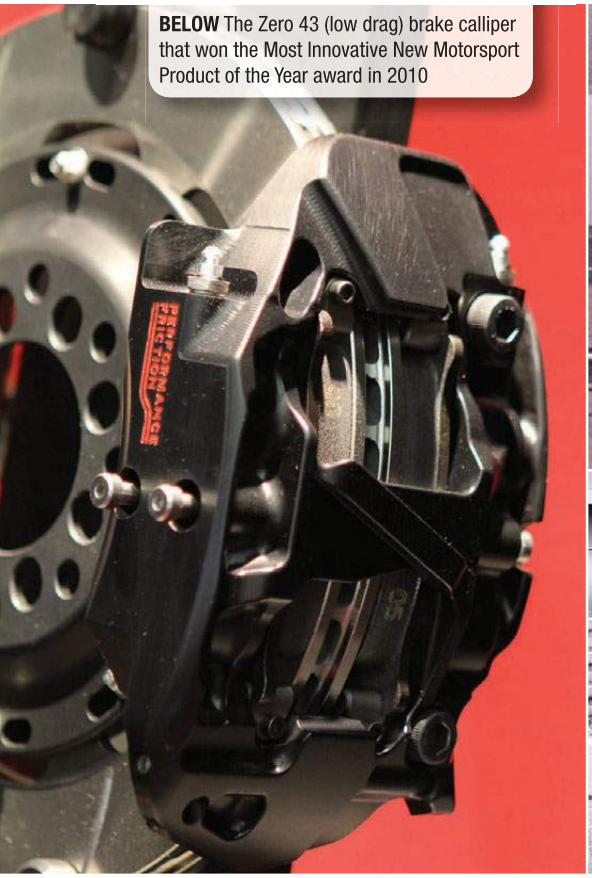
As a husband and father, businessman and sportsman, Don will be sorely missed by everyone. RT

No ordinary man

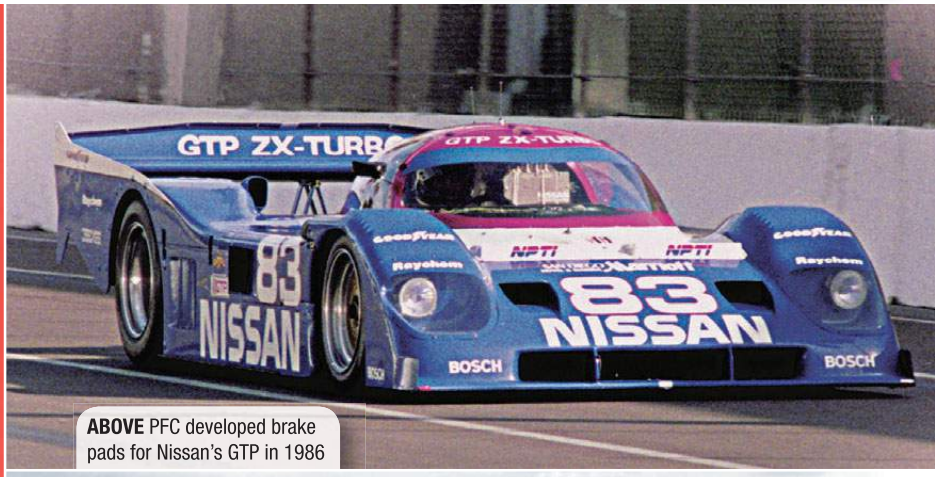
"DON BURGOON was anything but an ordinary man. He is an irreplaceable husband, father and friend. He is the owner and founder of Performance Friction Brakes Corporation "PFC" in Clover, SC. He built PFC from the ground up based on one absolute philosophy: No Compromises. And he lived by that philosophy every day. Don's wisdom and technology in his business earned the respect of some of the most influential people in motorsports.

"Don's ambition and will was equally matched by his humbleness and modesty. He touched the lives of many people, both in business and in his personal life. He was a valued leader, mentor and colleague. He challenged people to be the very best they could be, and not to settle for anything less, because that's what he expected from himself. His energy and passion was second to none and is something that left an imprint on the lives of many people."

Nina Burgoon, daughter



BELOW The Zero 43 (low drag) brake calliper that won the Most Innovative New Motorsport Product of the Year award in 2010



ABOVE PFC developed brake pads for Nissan's GTP in 1986

ABOVE The tie up with Porsche crosses a number of platforms

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THE ROAD TO 2030

What is Motorsport's role in helping define the future?

• Increased hybridisation • Electric vehicles • Fuel cells • Energy storage • Batteries

These are just some of the issues that define future transportation challenges in which motorsport could play a positive role as the developer of such technologies, or is it BACK TO THE FUTURE with a return to noisier, bigger gas-guzzling engines

We are delighted that both **Ulrich Baretzky**, Head of Engine Technology at Audi Sport, and Formula 1 consultant **John Iley** have both agreed to be our Chairmen again, chairing what should yet again be a fascinating debate, judging by the interesting response we have so far received.

We are delighted that the following have accepted our invitation to be Cabinet members:

Bernard Niclot
FIA Technical Director

Vincent Beaumesnil
Sports Manager, Automobile Club de l'Ouest

Peter Wright
Technical Advisor, FIA

Gilles Simon
Engineering Consultant

Pascal Vasselon
Technical Director, Toyota Motorsport GmbH

Steve Eriksen
Vice President and Chief Operating Office, Honda Performance Development

Dialma Zinelli
Chief Aerodynamicist, Dallara Automobilia

Alex Hitzinger
Technical Director, Porsche LMP1 programme

Russ O'Blenes
Senior Manager, Performance and Racing Team, GM Power train

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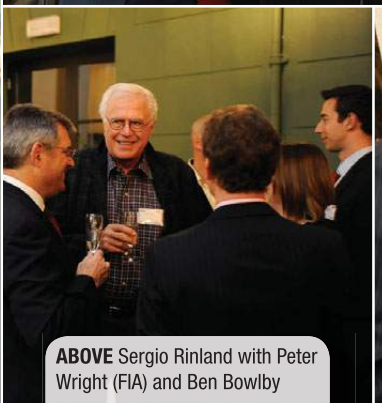
Network with Motorsport's elite....

AWARDS DINNER

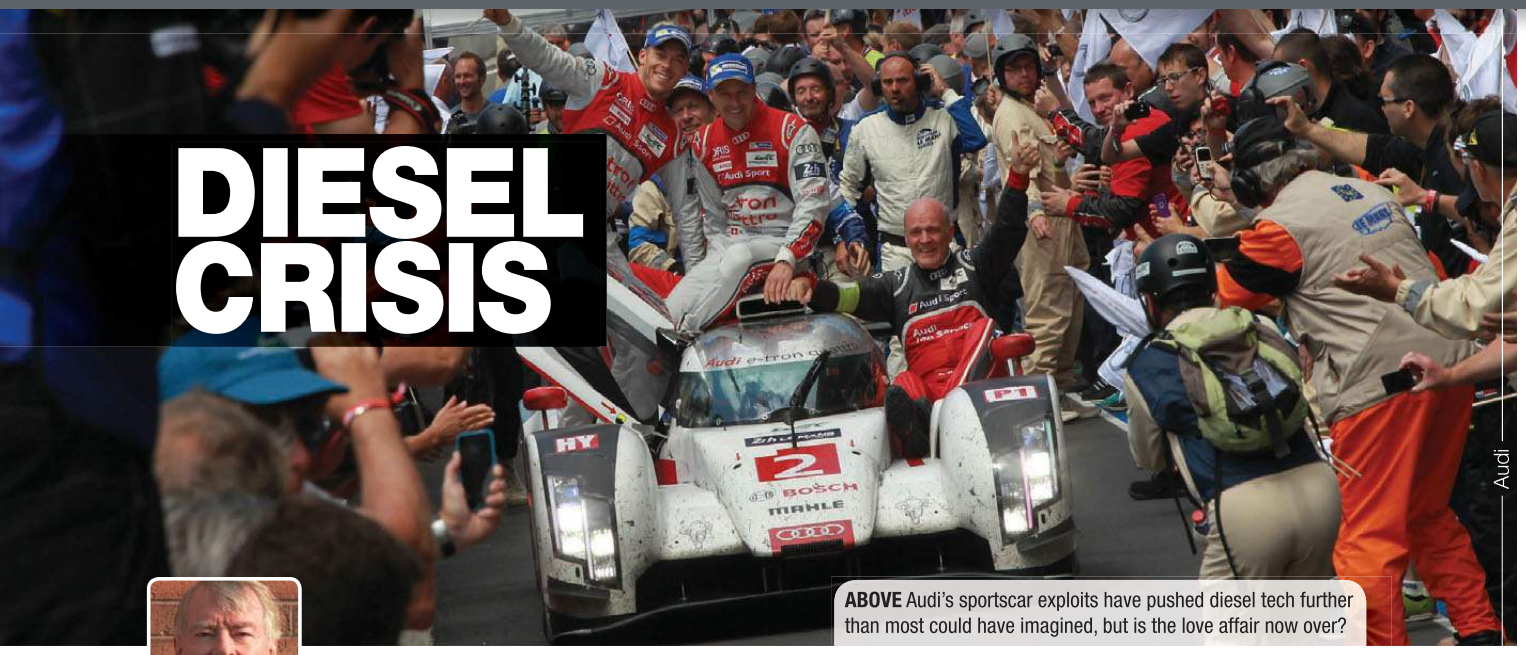
ABOVE Porsche's Alex Hitzinger and FIA tehnical director Bernard Niclot



ABOVE Sergio Rinland with Peter Wright (FIA) and Ben Bowlby

ABOVE Soheila Kimberley and Symposium Chairman John Iley

DIESEL CRISIS



Audi

ABOVE Audi's sportscar exploits have pushed diesel tech further than most could have imagined, but is the love affair now over?

Chris Ellis asks where the VW emissions scandal leaves motorsport

I have the editor's permission to claim I told you so, because we did!

Back in June 2014, considering the various attempts to push diesel engines into motorsport, I wrote:

It's interesting to see the controversy now being played out not just at Le Mans but in the streets of Paris, with the recent serious air pollution being blamed on diesel cars. France has an abnormally high diesel-car population, brought about by a lower level of tax on diesel fuel. It has been alleged that this was done to ward off competition from Japanese manufacturers. Now, at last, there is an acknowledgement by the French authorities that this was a big mistake. It will be fascinating to see how long it takes the FIA to realise the party line has changed. It will also be interesting to see, in perhaps 20 years time, the full impact on the health of the French people.

The basic reason why over 60% of all the diesel cars on the planet are in Europe is because most European governments made diesel fuel much cheaper than petrol. Combine this with lower standards for emissions, and lower income tax (in the UK) for 'keepers' of company cars with low (nominal!) CO_2 test readings, and many Europeans regretfully chose a diesel.

If it wasn't the money, why else would they? Perhaps they assumed, wrongly, that the 'green experts' in the EU and their own governments knew what they were doing.

So an overly simplistic approach was taken, focusing on just one GHG, and picking on cars initially, with little pressure on power stations, buses and trucks. Now there is, but the impression is still being given that cars are at the heart of the Climate Change problem, which they are not.

So what has this to do with motorsport? Motor racing has been used by some manufacturers and establishment bodies to push the fantasy of 'sporty green diesels'. And VW has now admitted trying too hard to turn the fantasy into an apparent reality.

VW is likely to be faced with two options to fix the almost half-million US-based cars: either fit urea systems at ~$5,000 a pop, including labour, or reduce performance significantly by replacing the cheat software with code that respects the emissions limits *continuously*.

The question that bothers me, as an engineer, is: where were the whistleblowers, within VW and elsewhere? Outside VW, there must have been some emissions tests which revealed the true levels. Inside VW, there must have been hundreds of people, some of them engineers, who knew how deceitful the cheating software was. Where was the fight within VW to clean up the Group's act, leave alone one of Merkel's green supporters with enough guts to alert the German government that something was being attempted that would backfire horribly on Germany's economy and reputation? There are various 'professions' which have a reputation for being 'economical with the truth', but I used to take pride in the fact that engineering was not one of them.

Enough wringing of hands! What should motorsport do about this? My immediate thought is that we should ask the talented engineers who have done such impressive work, pushing the boundaries of diesel technology, to explore alternative solutions.

If the FIA and ACO want Le Mans/WEC to retain its technical leadership, here are two benign possibilities. First, allow hydrogen as an optional fuel, effectively replacing diesel, and initially powering ICEs. (See BMW Hydrogen 7: I drove one years ago; lovely, but a bit short of boot space.) This would involve no significant costs for the ACO, only for those manufacturers (Toyota, Honda?) who wish to show they have a truly green future in mind.

The second possibility is what I call the Scalextric option, but contactless, pushing inductance charging to the limit, initially only on the straights. Very expensive, but if the French government wants to flaunt the fact that it has electricity generation fully sorted, a decade ahead of the rest of the world, what better way to demonstrate it?

Hydrogen as a fuelling option could be ready in 2017. My guess is 'Scalextric' won't be technically possible until 2025, at the earliest. But you never know.

A suggestion for VW: why not take the lead in motorsport with hydrogen? First, use the undoubted talent which has won the last six Le Mans to show what could be done with a hydrogen-powered V12, starting in Garage 56. Then a road-legal Bentley for truly green billionaires. Take that, Tesla! And, right now, promise Brussels eye-watering levels of R&D to deliver hydrogen-powered heavy duty vehicles by 2020, to avoid potential EU fines. Even the green Pope may accept this as penance.

The US may not care if VW survives, but Europe does. Even this Brit.

Photos: BMW

ABOVE The new BMW M6 GT3 incorporates many findings from the manufacturer's works racing projects

BMW BITES BACK

As rivals flock to the GT3 banner, BMW unveiled its own new contender in Frankfurt. **Chris Pickering** quizzes BMW Motorsport director Jens Marquardt

LOOKS good, doesn't it? With its blistered arches, belly-scraping stance and that huge rear wing, the new BMW M6 GT3 certainly means business. Launched at the Frankfurt motor show, it's the replacement for the Z4 GT3 and BMW's riposte to the likes of the Audi R8 LMS Ultra and the Bentley Continental GT3.

Even in its final season, the Z4 GT3 remained a competitive package. The BMW Sports Trophy Team Brasil took the fight for the Blancpain GT Series to the final race, while the Ecurie Ecosse car of Marco Attard and Alexander Sims narrowly missed out on a second successive British GT Championship crown.

Not wishing to rest on its laurels, BMW Motorsport has pushed on with the development of the new M6 GT3, but the engineers have learnt a lot from its predecessor.

"The strength of the Z4 GT3 was that it was a very driveable car – a very comfortable car you might say – while still being pretty quick," comments BMW Motorsport director Jens Marquardt. "But as time went on we were towards the edge of the performance window with the old naturally aspirated V8."

The balance of performance in GT3 means that each type of car runs to a different minimum weight and restriction diameter. In the case of turbocharged cars there are also individual boost pressure curves, giving the maximum boost across the engine's speed range. As well as physical data, the cars are subject to aerodynamic coast down tests and track testing from both the manufacturer's drivers and an independent FIA-appointed driver.

> *"You could strap an early '90s V12 F1 car to the roof of the M6 GT3 and still undercut the weight of its production siblings"*

FIA GT3 manufacturers recently gathered at the high-speed Michelin test track at Ladoux for the annual balance of performance test. This generated the initial balance of performance requirements.

Although this is designed to equalise the outright performance of each car there are still advantages to optimising things like the shape of the torque curve. It even raises the question of what power figure you target, because this will contribute to the car's minimum weight limit.

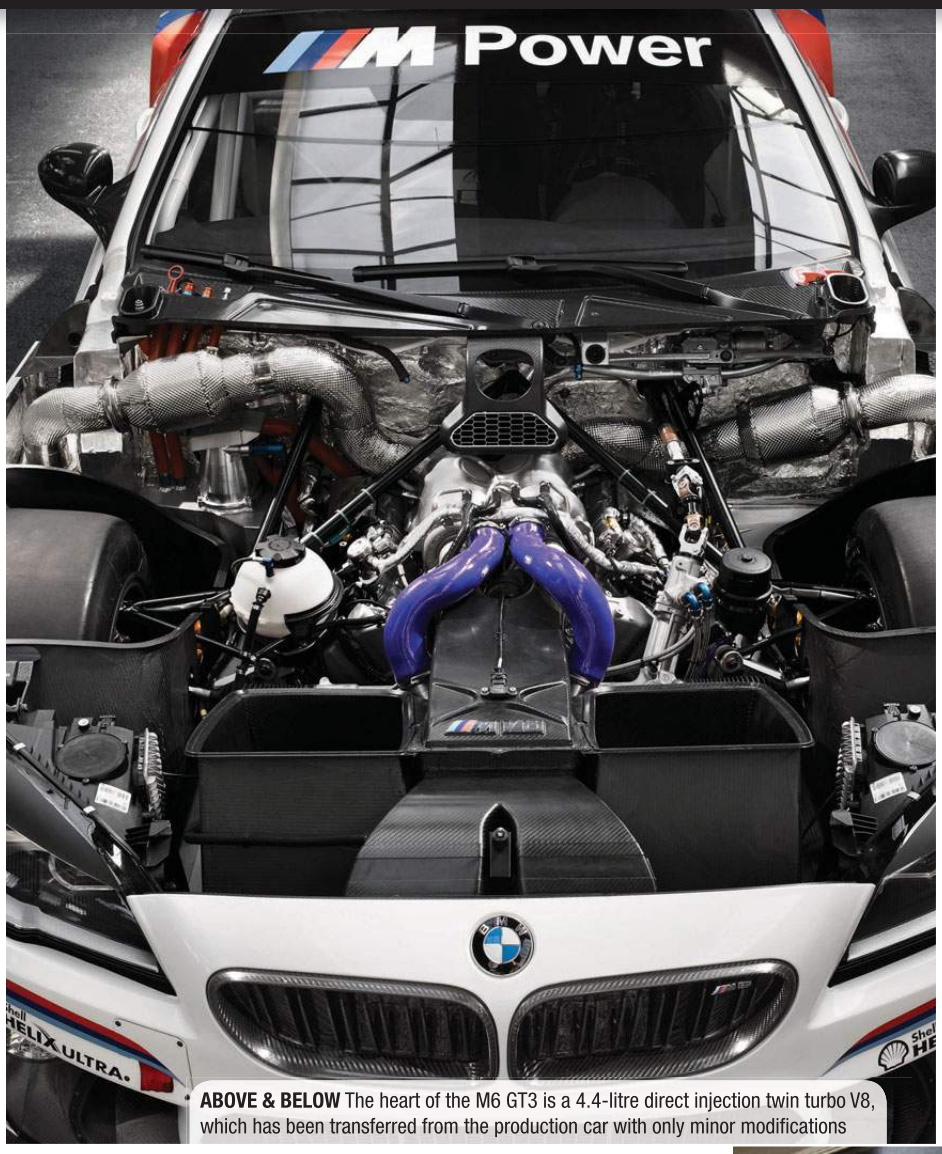
Although the Z4 GT3 remained competitive, BMW found it was being pushed into a corner of the performance balancing regulations as time went on. The engineers were running out of room to manoeuvre in a far more literal sense too – intake and exhaust packaging is far more critical on a naturally aspirated engine and they were running out of space in the Z4's engine bay.

EDGE OF PERFORMANCE

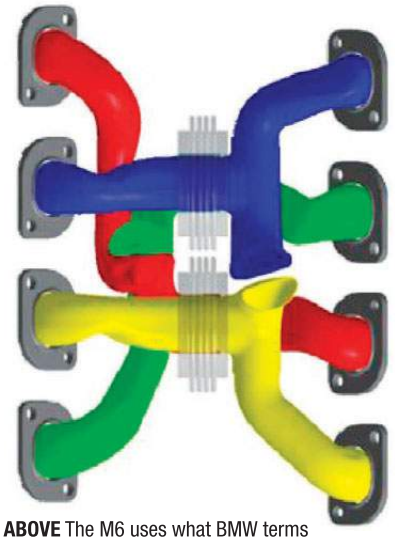
"You don't want to position yourself in an area where the car is at the edge of its performance and it becomes too sensitive to the track layout or race distance," comments Marquardt. "You want something that will work equally well on sprint races, long distance races and all sorts of circuits. At the end of the day, you also have to be careful that the investment you make in performance development isn't cancelled out by the balance of performance."

The heart of the M6 GT3 is a 4.4-litre direct injection twin turbo V8 taken almost unchanged from the production car. Known as the S63, it's an all-aluminium 90° block with a somewhat oversquare bore and stroke of 89 x 88.3 mm that contributes to relatively high engine speeds by the standards of a large capacity turbocharged engine. Peak power on the production engine comes in at 6,000 rpm and it revs to 7,200 rpm.

The valvetrain is a relatively conventional four valves per cylinder overhead cam layout, with variable valve timing and lift (VANOS and VALVETRONIC in BMW-speak). The camshaft itself is a conventional solid unit, but the VALVETRONIC system adds an additional set of rocker arms between the cam lobes and the valves. These arms pivot about a point which is controlled by an additional electronically actuated eccentric shaft, amplifying or reducing the motion of ▶



ABOVE & BELOW The heart of the M6 GT3 is a 4.4-litre direct injection twin turbo V8, which has been transferred from the production car with only minor modifications



ABOVE The M6 uses what BMW terms a 'cross engine exhaust manifold'

very good base to work from," comments Marquardt. "The Z4 GT3's naturally aspirated engine had really been stretched to the maximum affordable level over the years."

The M6 GT3 runs a competition ECU from Cosworth with bespoke software developed by BMW Motorsport. There's also a new dry sump lubrication system and most of the intake and exhaust parts are new, but elsewhere most of the major mechanical components are carried over directly from the road car.

One of the aims of the new car was to place it slap bang in the middle of the performance balancing envelope, with freedom to move in either direction. In production form the M6 ▶

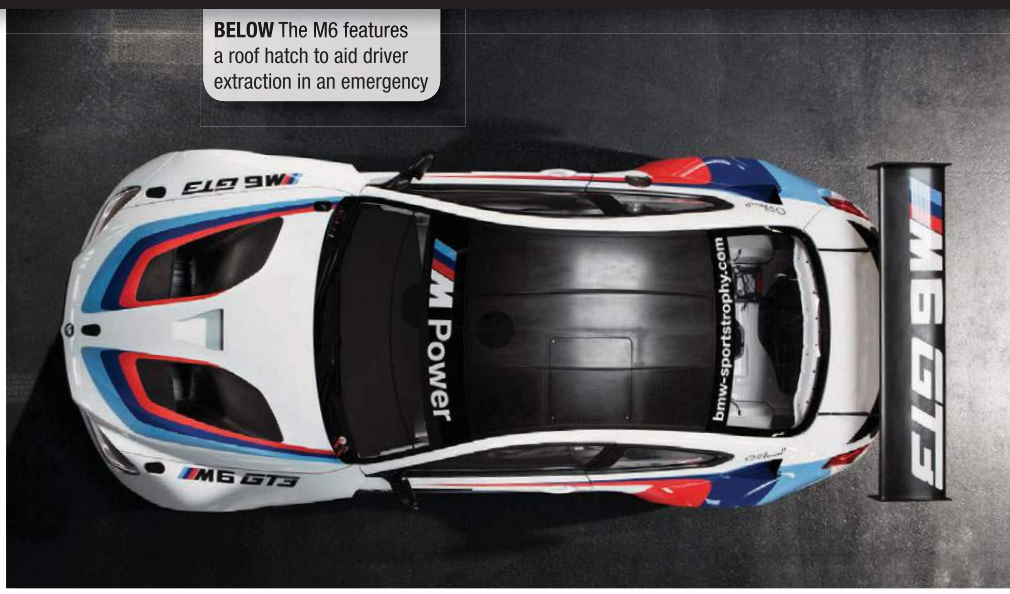
the rockers. VANOS, meanwhile, works by rotating the drive sprocket on the end of the camshaft slightly to advance or retard its timing. Between the two, these systems provide constantly variable lift and timing on both the intake and exhaust valves.

Clever stuff, but so far it's all relatively conventional BMW technology. Where the S63 differs from most M-Power engines of old, not to mention its racing predecessor in the Z4 GT3, is the use of forced induction. Never wishing to do things by halves, BMW uses a pair of variable geometry twin-scroll turbochargers, but what's really interesting is the way that they're fed.

Following motorsport practice, the S63 uses a 'hot vee' layout with the intake ports on the outside of the cylinder heads, the exhaust ports on the inside and the turbochargers nestled between the two cylinder banks. This results in a very short distance between the exhaust ports and the turbochargers, maintaining as much energy as possible in the gas flow.

On the M-Power variant of the engine, as found in the M6, BMW uses what it terms a 'cross engine exhaust manifold'. This means that each of the two inlets on each twin-scroll turbocharger is fed from two cylinders: one on the left bank and one on the right. As a result there's a new exhaust pulse entering the turbo every 180 degrees of crank rotation.

Thanks to turbocharging and a relatively large capacity the engine is a low-stressed unit. "Having an engine with a well-proven reliability record in a road car and taking that over almost directly gives you a



BELOW The M6 features a roof hatch to aid driver extraction in an emergency

now produces as much as 600 bhp, but the balance of performance restrictions in GT3 see the racecar pegged at 'up to 585 bhp'.

In the past we've seen production cars with forced induction running naturally aspirated engines for GT racing, but Marquardt says there was never any question of doing this with the M6: "With a production-based formula like GT3 your first instinct is to use as much of the road car as possible, especially when you've got an engine that's already more than capable of making the power that you need. Plus, with the turbocharged concept you have everything developed for this already. Take that away and you have to start from scratch on the whole top half of the engine."

It's a configuration that reflects where the industry is heading at the moment, he points out: "Direct injection turbocharged engines are the current state of the art in production cars. From three cylinders up to eight cylinders you have turbos everywhere. Clearly it's a bit more challenging [than a naturally aspirated engine] and you have to spend a bit more time on getting the management right, but this is the way into the future. It also brings advantages in torque and efficiency."

The knowledge transfer works both ways, with ideas from the GT3 programme flowing directly back into road car development. "One of the strengths of BMW Motorsport is that we have a very close link to our colleagues on the road car side. We gather a lot of base information," Marquardt remarks.

RIGHT FIRST TIME

Compared to the production car, the engine has been moved quite substantially. It sits lower and further back, while the seven-speed dual clutch gearbox has been replaced with a rear-mounted six-speed sequential transaxle from Ricardo. The steel monocoque is reinforced by an FIA-spec roll cage, with carbon fibre crash structures front and rear. Meanwhile, the engineers have set about shedding every last ounce of unnecessary fat, taking the weight down from a hefty 1,925 kg to less than 1,300 kg. To put it into context, you could strap an early nineties V12-powered Formula 1 car to the roof of the M6 GT3 and still undercut the weight of its production sibblings.

"From a team's point of view, the car has to be well-balanced and easy to drive for drivers of all levels. You also need to keep the costs as low as possible so we tried to carry over as much as we could from the production side," says Marquardt. "Serviceability and durability are also very important and that was tackled in various different ways. Finding a balance between performance, ▶

"The most cost-effective GT racer BMW has ever built"

BELOW The new GT3 racer boasts a raft of improvements, particularly in the areas of drivability and economy

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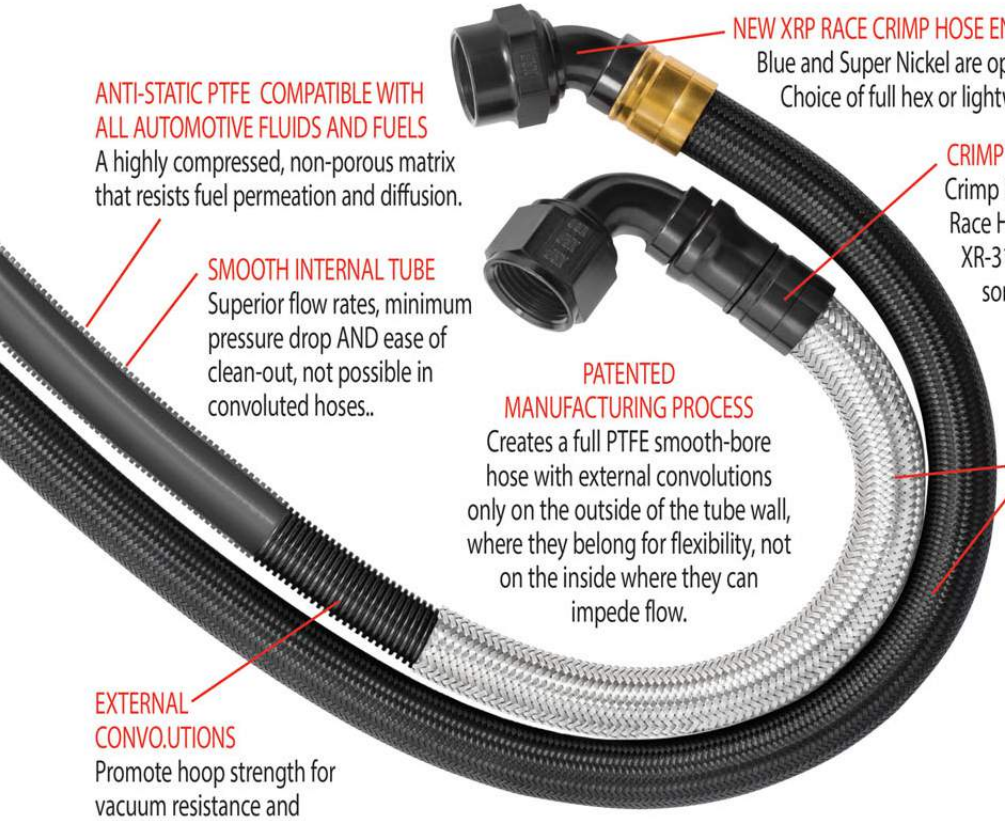

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CLOCKWISE FROM ABOVE A detailed look at the new car, which features a long wheelbase, centrally-mounted seat, and a huge rear wing working in unison with the diffuser

serviceability and cost is a challenge for the engineers. We spent a lot of time in the design phase to achieve those goals, which left us with a very challenging schedule for track testing, but it's worth it to get things right first time."

Obviously cost reduction is something of a relative term. At €379,000 the M6 GT3 is a very serious toy and its upkeep won't be cheap, but BMW Motorsport says it is the most cost-effective GT racer that it has ever built. The powertrain running costs are said to be roughly 30 per cent lower than those of the outgoing Z4 GT3 and the cost of spare parts has been a major consideration right from the start of the development.

This being BMW, even the racecars come with an options list. Among the additional items you can specify are an extra-large driver's seat, a passenger seat package, air conditioning and a tyre pressure and temperature monitoring system. For endurance racing there are also additional bumper-mounted xenon lights and illuminated race numbers.

Suspension on the M6 GT3 is double wishbones all-round, with four-way adjustable Öhlins dampers front and rear. It sits on 13" x 18" BBS alloy wheels front and rear, while tyre choice is dependent on the individual series. Braking, meanwhile, comes from a set of AP racing discs and callipers with a Bosch Motorsport ABS system.

"The suspension design borrows a lot of experience from other projects. It draws on the GTLM version of the Z4 that's been racing in the States as well as the DTM," comments Marquardt. "On the front we've modified the chassis structure (mainly for safety) and we've altered some of the suspension pick up points. On the rear we tried to carry over as much of the production structure as possible, but still make a proper working and performing racecar."

ROOF HATCH

Safety is another major consideration. From 2015 all cars have to feature a roof hatch to aid extraction of the driver in an emergency. The fuel tank is a carefully-shielded FIA-spec unit, while the driver's seat is positioned well inside the roll cage to improve side impact safety.

Those steroidal enhancements to the M6 GT3's carbon fibre bodywork aren't just for show. The deep chin spoiler helps to improve the airflow around the front end, while the giant air intake on the front end feeds the intercooler. At the back, a huge rear wing works in unison with the rear diffuser. It's all the product of an extensive aero development programme, explains Marquardt: "We are in a really lucky position that BMW has very good aerodynamic facilities, including CFD capabilities and the production car wind tunnel that we use quite frequently for any project. We didn't want to go overboard with the aerodynamic development, it's about having a good balance between chassis, powertrain and aero."

There's no doubt the M6 GT3 is a fairly substantial step on from its predecessor in a number of areas, so what does Marquardt consider to be the greatest achievement? "I would say it's the sum of experience of all our recent projects. A lot of it comes from DTM, in terms of the kinematics and the aerodynamics, but we even took inspiration from the M235i Racing."

We'll have to wait a little longer to find out whether the M6 can give BMW the upper hand in the GT3 category. There's no doubt, though, that it'll be one to watch. RT

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SUPERTECH

A CFD Amnesty for teams – ARE YOU SURE?

The announcement of a CFD Amnesty to help finalise F1's new rules is good news, isn't it? Not so, argues our **Expert Witness**, a knowledgeable insider. Here's why, plus his alternative 'plan for success'

WHAT are the F1 rule changes for 2017? Why? Who benefits from them? And will they provide the essential reinvigoration the category needs?

So far, we know a number of technical details have been proposed. They include a wider car, with wider tyres, a target lap time reduction of five to six seconds, more 'aggressive' looks, an increase in floor performance by having a larger exit area and reducing the step plane. Bringing back the beam wing, changing the width and height of the upper rear wing is also on the agenda. So is a 'CFD Amnesty' for the teams to help develop the concept so that rules can be finalised by March 2016.

Being a supporter as well as involved, I am increasingly concerned. Where is the fan, industry or promoter input into this process, in marketing terms what you might call the all-important, allegedly always right, 'customer'? Are these steps guaranteed to increase the health of the category, its engineering contribution and its popularity? Are costs, safety and the future fan being addressed, or will commercial, driver and staff fingers just be crossed hopefully…

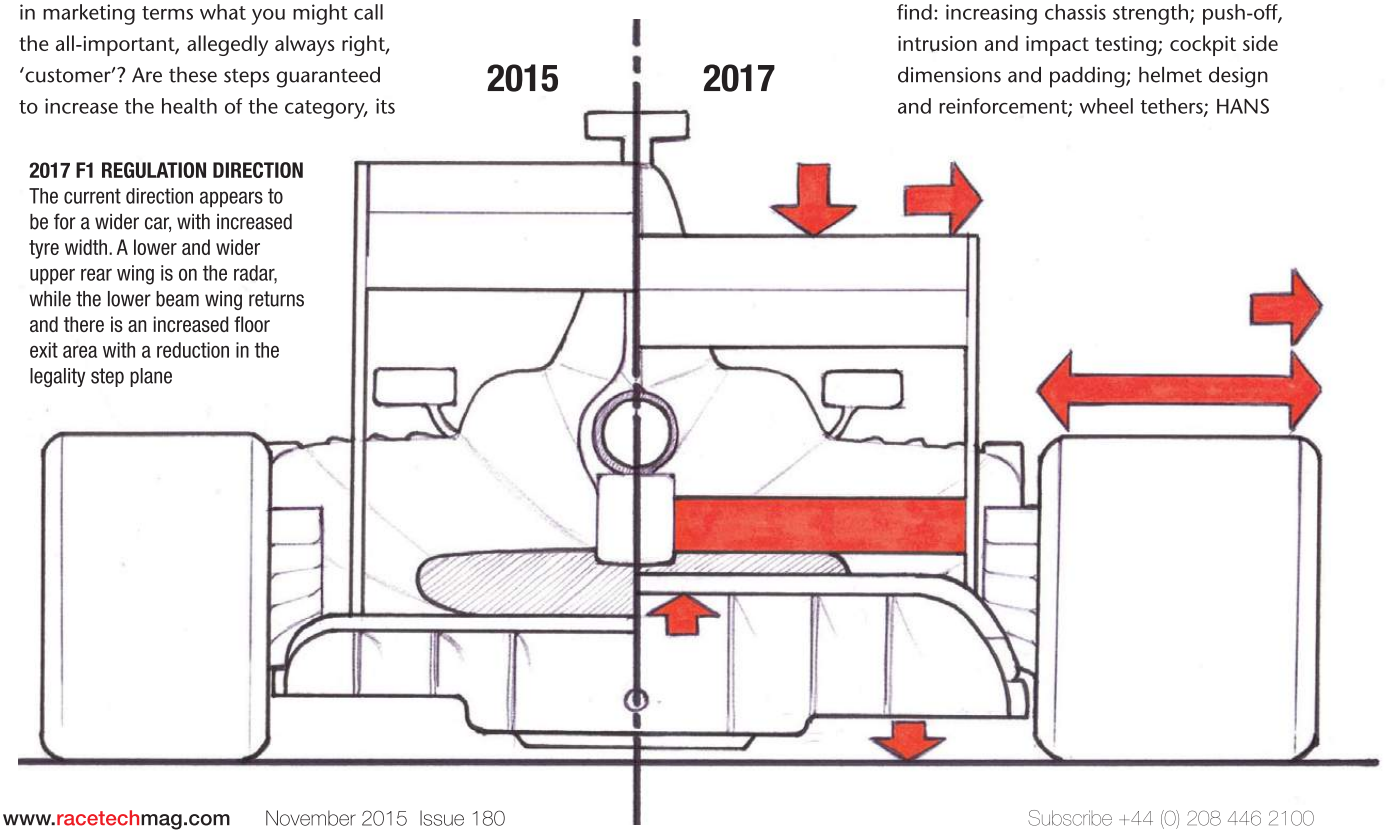
HERDING CATS

Who actually knows the correct way forward? Perhaps a better question then is to approach it from a holistic point of view: what process could give us the best chance of generating the right answers? You could say with the power of the current collective vested interests concerned that a sort of average position can be arrived at by them all (actually no longer all, just the big teams) pulling in their own opposite directions.

The reality is that little or no action is taken as there is no consensus or working majority. Worse, a team with a strong position just blocks every single change to the status quo to maintain their dominance.

Historically the only galvanising factor has been 'force majeure' after a painful tragedy or clearly unsafe narrow escape incident allows a common sense veto on the area concerned. Here we come into the difference of coming up with proactive, preventative measures – offering thinking time and proof of concept with longevity – rather than knee-jerk, reactive decisions based on the latest public image crisis.

Hindsight is easy and there have even been opinions that the sport has become 'too safe', then the accident at Pocono Raceway that befell Justin Wilson reminds us that the road striving for the safest solution is never over. If you trace this one area back you will find: increasing chassis strength; push-off, intrusion and impact testing; cockpit side dimensions and padding; helmet design and reinforcement; wheel tethers; HANS



2017 F1 REGULATION DIRECTION
The current direction appears to be for a wider car, with increased tyre width. A lower and wider upper rear wing is on the radar, while the lower beam wing returns and there is an increased floor exit area with a reduction in the legality step plane

ABOVE Of the tools available, CFD has the least reliable correlation to the racetrack. Furthermore, the teams' non-neutrality can be guaranteed!

devices; barrier development etc. The catalyst more often than not has been an incident response rather than a preventative measure: visor helmet reinforcement was implemented and cockpit canopies are still being researched as a direct result of Massa's accident at Hungary in 2009, but that was six years ago now.

So if safety is one of the few areas that can gain enough focus and majority, can this model be effectively applied to other aspects of future regulation process? I would suggest not until, like fundamental safety and evaluation, it is made neutral and independent of those with a strong and therefore compromised vested interest as to which solution is chosen.

RESEARCH

Until now, and hopefully this will remain protected, Formula 1 has the stipulation that all the teams remain independent manufacturers. Despite an extended quantity of 'listed parts' (ones that may be shared or outsourced), large areas of the car still remain unique to each team. This means that characteristics, aesthetics and IP of the cars are different and independent. The rule book of course creates envelopes of conformity, but precisely because there is diversity of resource, budget and infrastructure, a solution to a problem may work well for one team, but not for another.

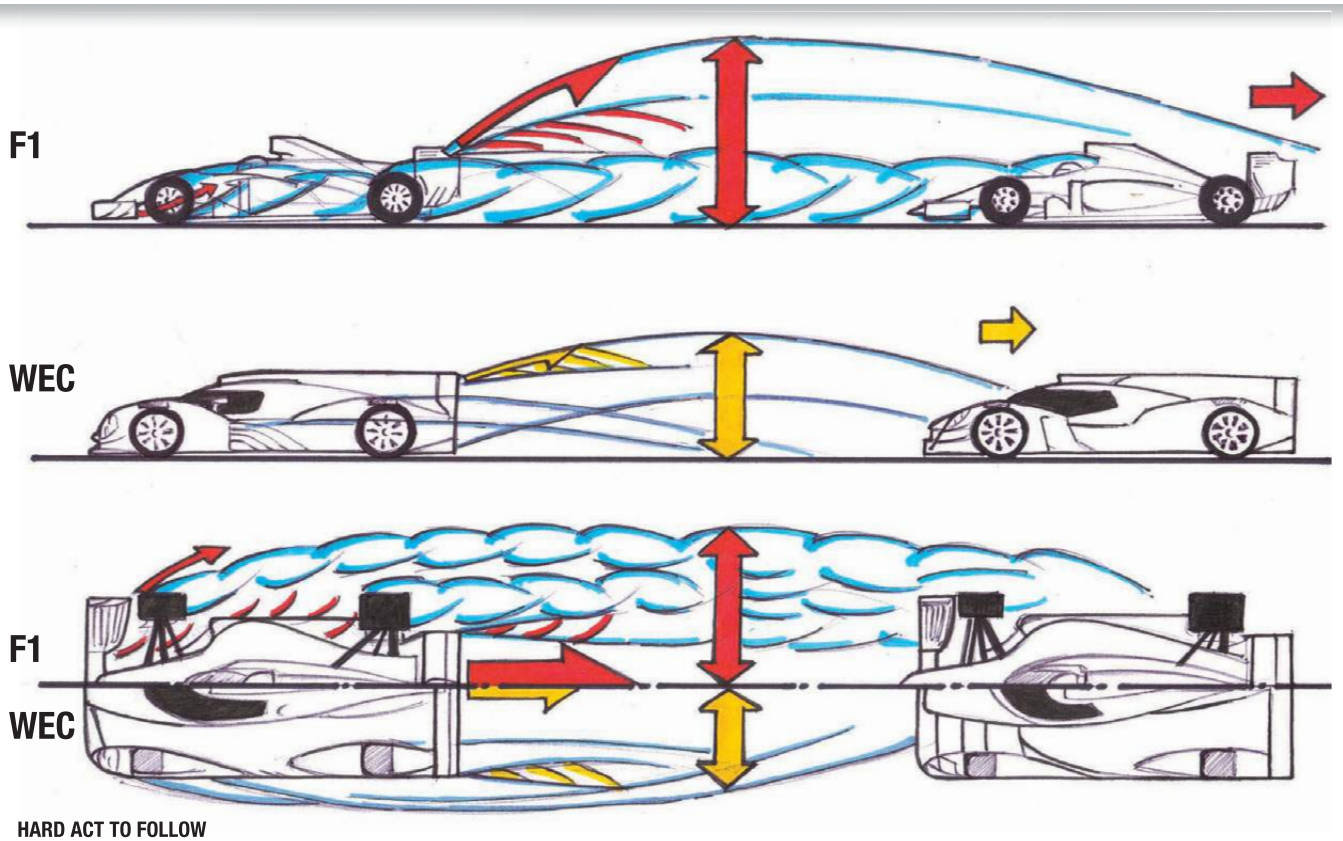
> *"Asking the teams to use a 'CFD Amnesty' to generate the solution will not yield an answer that is neutral or reliable"*

It is precisely this that is regulated out in a one-make or customer category, where you must run identical geometry from the original manufacturer in prescribed positions, the challenge then being getting the maximum out of the same platform. Tuning, driver, strategy, pit stops, but crucially not R&D and development, which is frozen and prohibited.

So, what if you combine the two? Take the expertise and infrastructure of a known *independent* racing car manufacturer, with regulatory guidelines and backing. Ask them to thoroughly research and propose a successful and robust rules envelope for F1 going forward.

CFD AMNESTY

As we know and I have covered on these pages previously, aerodynamic resources have been restricted increasingly over time in order to reduce spending and development, fine. Of the regulated options CFD has been encouraged as a newer and cheaper technology, not actually requiring parts to be manufactured in order to evaluate the geometry, and here lies the first attraction. With the rules still being evaluated it is much easier to experiment with options virtually rather than having to actually produce them, even 60% model scale. However of the tools available, CFD also has the least reliable record regarding correlation, the essential transfer and alignment of results in the toolset to what actually happens on the track. Then, on top of that, of all of the car components most difficult to model correctly is the tyres, the ▶

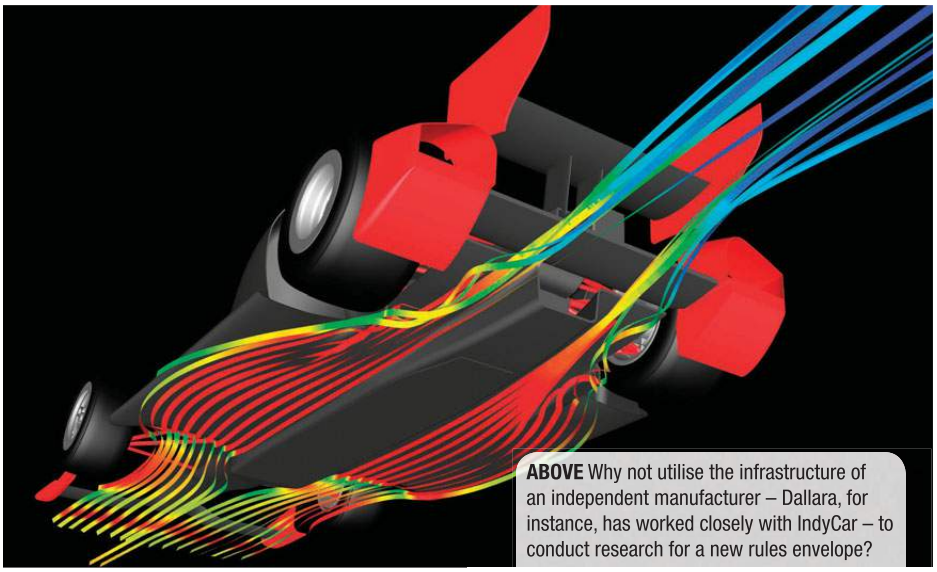


HARD ACT TO FOLLOW
An F1 car produces a high, long, wide turbulent and time-dependent aerodynamic wake, a function of having wing dependence, highly vortical flows and large exposed cylinders (tyres). It's a geometry area that sounds like it will increase for 2017, making it worse for overtaking (red arrows)
A WEC car uses its underside predominantly for aero performance, encloses its wheels and also has a closed cockpit. Aerodynamically, the platform is therefore much more efficient and the wake and ability to race together is improved (yellow arrows)

dynamic shape, sidewall and contact patch being fundamental for correlation.

Monza clearly illustrated this is indeed a delicate topic where safety and performance are diametrically opposite. It showed that, even with a known and stable set of regulations, there are problems if changes are hurriedly implemented. If you then add into this equation 2017 unknowns such as manufacturer, rim size, width and diameter, then the essential FEA characteristics of the tyre at different speeds and pressures suddenly become rather trivial by comparison, which of course they are not.

Possibly, like me, you may also struggle to understand what Pirelli gets out of the current circumstances? As a sole supplier, in this case encouraged to make fragile tyres that are temperamental to use and wear out, requiring multiple changes per race. Does this really favourably promote your road vehicle brand and product? Then teams in search of ultimate performance (as they will always do) push the boundaries to the absolute limit, leading to potentially fatal failures.



ABOVE Why not utilise the infrastructure of an independent manufacturer – Dallara, for instance, has worked closely with IndyCar – to conduct research for a new rules envelope?

Without a rival but with challenging commercial circumstances that have been alluded to, where is the incentive to spend extra on the development to make it more than only just viable? Surely the fact that the product is the same for everyone is enough?

An integral part of the contract is to supply the teams with the technical information on tyre performance, profile shape, its deformation under load and even a governed quantity of wind tunnel tyres of either 50% or 60% scale. With tyre shape and size such a dominant factor in the aerodynamic behaviour of the car, it is therefore hard to foresee worthwhile development of a new configuration until all of this is known in detail.

OBJECTIVES

Removing specifics for a moment, what are the targets that will improve the image, strength and market share of the motorsport industry going forward?

I would start with the excitement and quality of the racing. We need to improve the entertainment and desire to watch events, at the track, at home or on a portable device. This is related to cost and accessibility, but from a technical point of view the platform must generate closer, less ▶

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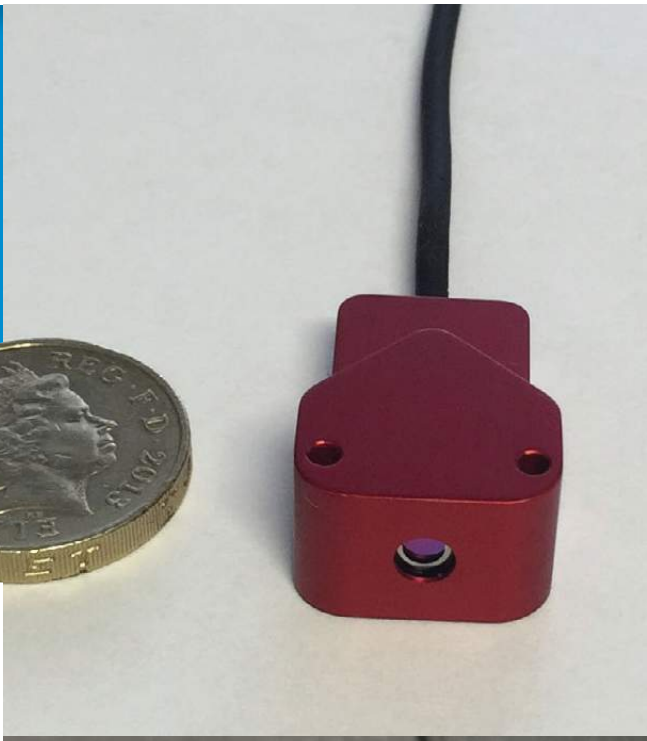

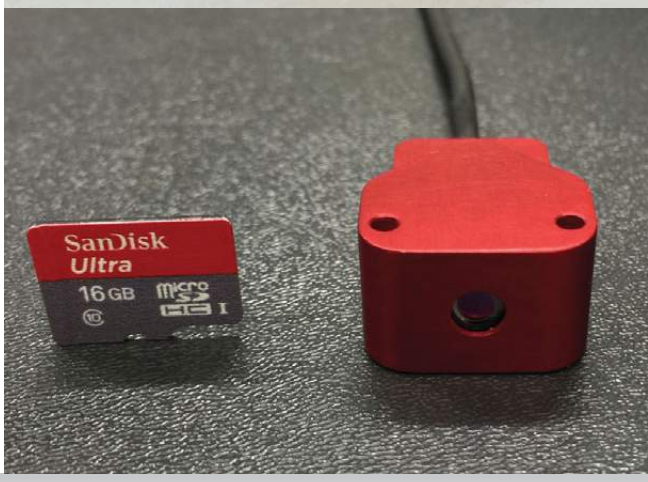

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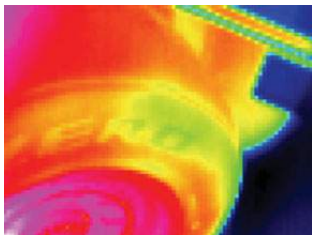

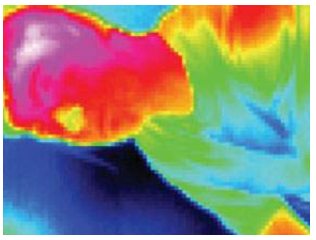

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Dunbar/LAT

BELOW The fresh start offers F1 the chance to properly address the issue of it being difficult to overtake – but only if proper research is performed

predictable racing and put a premium on the driver talent and a team's innovation capability, not on how much you can spend.

The machinery, format and technology also need to be relevant, or at least the proving ground for what happens in the future. I do not subscribe to either short-termism or nostalgia: there is an opportunity here with competition and engineering talent to invent and innovate so that both industry and the public will benefit.

We must never forget to integrate improved safety at every step.

To achieve all this, though, you need an environment, governance and rules framework that allows the system to thrive.

AERODYNAMIC v MECHANICAL GRIP

The proposals for 2017 seem to want to get half of the lap time gain from tyre grip and half from aerodynamics, inflating the current ratio between the two. The common if nostalgic consensus is that if you return to a 1970s situation, with large tyres and limited aero, racing will improve. How aligned is this to development today? Couldn't a more technically advanced mechanism be implemented to create platform stability?

Both of these are variables. Aero, with set up and then obviously speed. Mechanical, also with set up, but dominated by tyre type, tyre temperature and condition and, last but not least, track surface and weather.

The good news is that these parameters are constantly shifting: they are things that differentiate, which can spice up the action on the track – the instruction that was given to Pirelli, if you want. The bad news is that both aero and then, by association, tyres currently suffer when following behind another car; you are faster but cannot overtake or compete. DRS and adjustable front wings (in the past) artificially tried to compensate for this problem, DRS authority being cited as a tuning device in future if overtaking is more difficult.

I would like to draw your attention to a little known statement at the very start of Article 3 of the F1 Technical Regulations:

> *"One of the purposes of the regulations under Article 3 is to minimise the detrimental effect that the wake of a car may have on a following car."*

How is this measured, known, implemented, understood, and improved? Well, quite simply, it isn't.

There may be a perception that teams spend time running two cars in tandem


Jed Leicester/LAT

ABOVE Merc's Paddy Lowe is swamped by the press at Monza as he leaves an FIA stewards enquiry concerning the team's tyre pressures. The affair offered a reminder that quests for safety and performance are diametrically opposed

> *"Cars are developed to run best in isolation, not race"*

in the wind tunnel, in CFD or on the track to better understand the impact on following or the following car. They don't. Instead they develop a sole racecar in as near perfect mesh and flow quality as possible, all the better to understand small geometry changes, but actually making the response to any adverse flow conditions much worse. The cars are developed to run best in isolation, not race.

WAKE UP

The aerodynamic wake of a racecar and its effect on a following car is a primary function of the regulations framework and then how they have then been developed and interpreted. There is a big difference between creating a 'hole in the air', a window useful for slipstreaming, and an area of disturbed turbulence that reduces the downforce effectiveness of anyone trying to get close.

If a research directive was set to the right neutral facility, or even established by a governing body, then targets and solutions could be combined. Technical issues such as safety, ability to race and overtake, lap time, appearance, technology and cost could be connected to commercial aspects. That way, improvements could be made to event format, sporting regulations and new media markets with data and confidence.

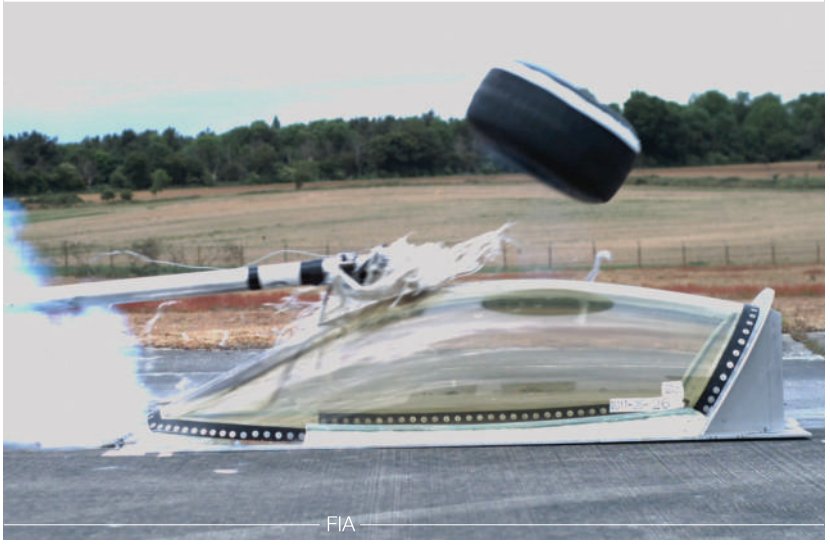
How much aerodynamic load does a current F1 car lose when within three car lengths of the one in front? How much does this inhibit the ability to overtake? What changes to the 2017 regulations would significantly enhance this situation? The learning could then be applied to other categories.

VERDICT

Any next rule implementation window is always an opportunity. Not just for competitors to interpret and innovate, but for improvement of format, technology and safety. For F1, this is supposed to be for 2017, but I am not convinced there is the time to get properly researched, independent solutions in place.

Asking the teams to use a 'CFD Amnesty' to generate the solution will not yield an answer that is neutral or reliable enough. The idea is likely to generate a proposal always carrying with it the in-house bias of what will most suit that team's architecture or, better yet, put a main rival at a distinct disadvantage.

It's time F1 started using its science and technology for the health of the category, motorsport and industry, not just for the benefit of the few. RT



ABOVE & BELOW Accidents inevitably act as the catalyst for research, driving forward developments such as crash testing (above), and continued studies into cockpit canopies (below)

FIA

Powertrain or power pain?

ABOVE Lucas di Grassi used the 200 kW qualifying mode to break the Formula E lap record in pre-season testing at Donington Park

With powertrain rules opened up for Formula E's second campaign, which commences this month, **Craig Scarborough** swaps the whirl of the F1 pitlane for the whir of electric racing

LONDON'S ePrix season finale drew a TV audience of 1.2 million for Britain's first ever all-electric encounter. The figures underlined the claim that Formula E's opening campaign was a success, gaining a high media profile and strong fan following.

The Spark SRT01E cars run by the 10 teams were in identical format, though, aside from the powertrain mapping. This will change for the championship's second season, which kicks-off in Beijing this month, with powertrain development opened up.

THE BASICS

Spark's SRT01E car is in essence a single-spec Dallara chassis made to FIA safety standards. As it's packaged with an electric powertrain, rather than a fuel tank and IC engine, the monocoque is truncated at the driver seat bulkhead, whereupon the electric powertrain starts. A Williams Advanced Engineering battery sits within a removable carbon fibre safety cell, then a McLaren Applied Technologies eMotor and Inverter provide the motive power. The motor sits within a cast bellhousing betwixt battery casing and Hewland five-speed gearbox.

PROBLEMS TO ADDRESS

While the series was popular last season, the car was not without its problems. Some were teething issues, others more fundamental to the car's design.

Even from early testing around Donington Park, it was clear the powertrain was thermally challenged. Keeping everything cool was an issue and this played out all through the season, with motor/inverter performance capped by overheating in qualifying and the battery equally handicapped in the race. Thus thermal management was required by team and driver to maximise the package's performance throughout the one-day ePrix.

Early races were marked by gearbox and suspension failures, these being a mix of driver over-exuberance and unexpected loads from the street racing. Gearbox problems were many, some being caused by the reverse torque from regenerative braking affecting the cluster; more structural issues were related to kerb and wall strikes breaking the casing and

the differential. An early remedy to the breakages was the bolt-on solution of metal tubular structure to reinforce the gearcase against the bellhousing.

Suspension failures were initially common too. They stemmed from similar issues – the proximity of walls around the track and temporary kerbs made from plastic 'sausage'-shaped kerbing. Front lower wishbone failures and rear pushrod failures were sorted with updated and strengthened parts from Dallara.

Other chassis issues were also soon resolved: airflow separation under the front wing was cured with the addition of a gurney flap along the centre of its trailing edge.

Setting up the car was complicated by the simplicity of the suspension arrangement, the chassis sporting a basic inboard set up without heave elements and with limited damper adjustment. Braking setup was equally a compromise, with a mix of balance issues with the regenerative braking and the difficulty of getting enough heat into the front discs.

Perhaps the key problem for every team was developing their control software for the electric powertrain, learning the balance between power and energy usage in the race, braking strategies, battery management and conditioning. Clearly the better-funded teams, with strong manufacturer involvement, fared better with this task. A good example was the NextEV joint venture with Team China Racing. The mid-season technical tie-in soon gave the team the step it needed to challenge for the championship.

> *"The risk-reward of going aggressive means stepping into uncharted territory"*

OPPORTUNITIES

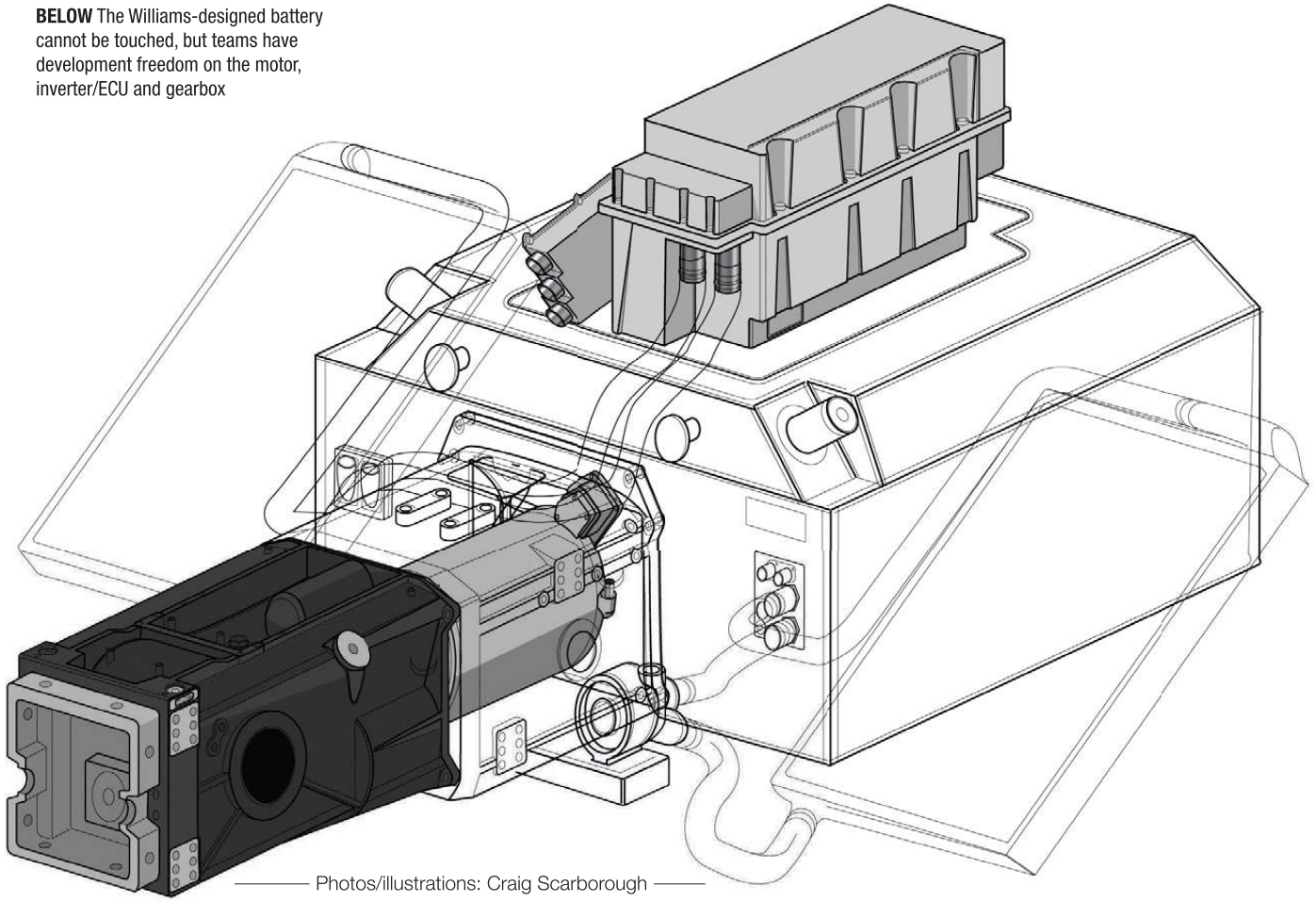
Season two for the championship opens up powertrain development and, with it, some aspects of the chassis too. Manufacturers can now produce their own eMotor and inverter. With it come potential changes such as a new ECU, cooling, gearbox and rear suspension. The rest of the chassis and the battery pack remain a fixed specification.

There is the option to retain all or part of the season one powertrain. In either scenario the motor still needs to drive through a single differential, as direct drive and torque vectoring are not yet allowed in the still maturing series.

Opportunities to boost performance cannot come from more power, as the series is power-capped, but efficiency will still be rewarded. Gains can come from resolving the cooling issues: this means being able to use the motor to its full capacity in qualifying, and not overheating the battery in the race. Freedom in motor design can also provide a change in power delivery and different torque characteristics.

For any manufacturer associated with the series, there now comes the question of how far do they go with the changes in the ▶

BELOW The Williams-designed battery cannot be touched, but teams have development freedom on the motor, inverter/ECU and gearbox



Photos/illustrations: Craig Scarborough

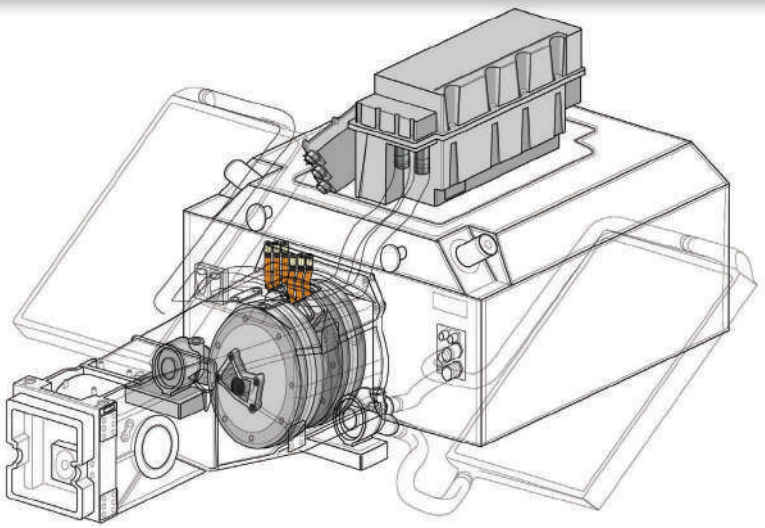
powertrain for season two? Going conservative somewhat undermines the ethos of the formula, which is to develop the technology of electric vehicles: the season one powertrain is not without its issues and not 100% reliable.

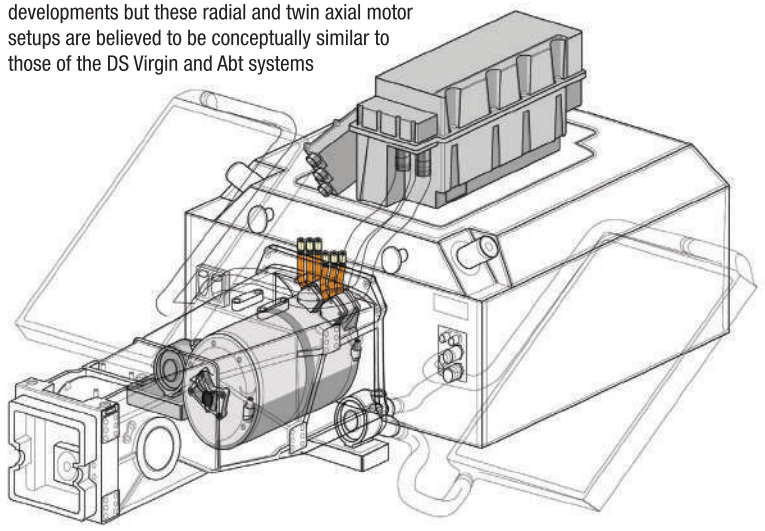
The risk-reward of going aggressive means stepping into uncharted territory. Enhancing everything upon homologating a new concept could mean either unreliability or a competitive advantage. It is worth remembering, though, that this is just season two of a five-season development roadmap, which means a competitive powertrain for the second season could be usurped in later campaigns when regulations open up more opportunities.

Luckily it seems the field is split between teams continuing to run the S1 powertrain, lightly modified S1 powertrains, and much more exotic setups with a nod to the future.

Planning for a new powertrain revolves around the motor and gear setup. The S1 powertrain uses an efficient but small motor, requiring a gearbox to multiply the torque. A larger motor with enough torque to negate the need for a gearbox seems attractive from a packaging point of view, but internal efficiency losses as well as weight/CoG could easily offset any gain.

Another route is to multiply the small motor with a twin motor setup. This provides the additional torque while still capitalising on the efficiency of the small motor. Gearbox requirements for a ▶





ABOVE & BELOW Secrecy shrouds many of the new developments but these radial and twin axial motor setups are believed to be conceptually similar to those of the DS Virgin and Abt systems

LEFT & RIGHT Damage and cooling challenges played a key role in the first season's racing

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ABOVE Magneti Marelli's prototype six-phase/twin motor is conceptually similar to those being developed by e.dams and Abt

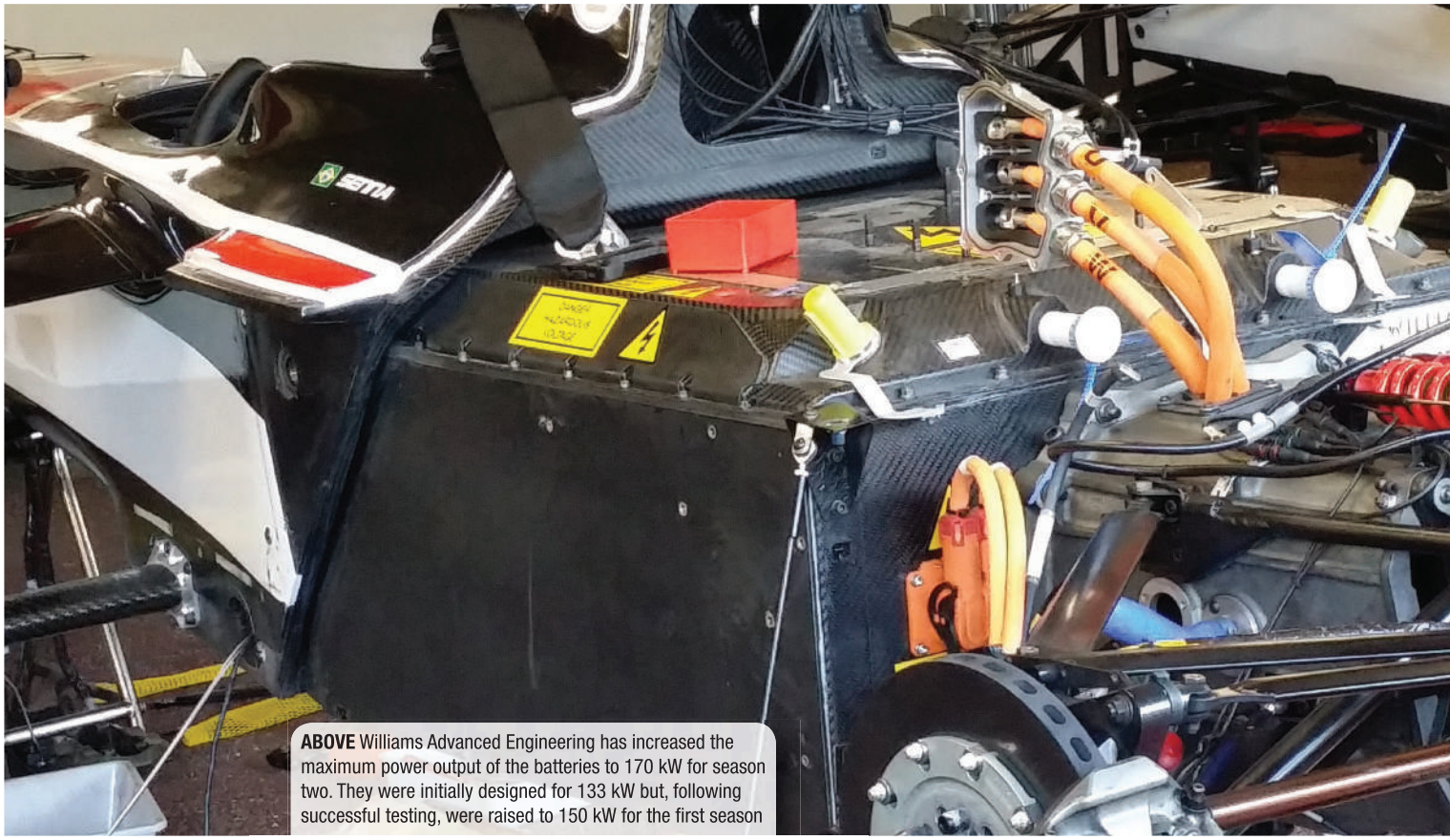
two-motor setup could sit between the five-speed and single gear options of the other motor setups. A tantalising prospect for two-motor setups is the tuning of motors for different torque characteristics, with a high torque motor for low speed acceleration and higher-revving powerful motor for end of straight speed, all managed through the inverter and the ECU control.

Despite the dual motor description, it seems the motors are not physically separate, such as two standard motors coupled on a common shaft – which would be hard to package within the available wheelbase – or two motors mounted in parallel and geared to a common output shaft. Instead, the motors are shorter and wider and in series on a common shaft. With each motor receiving its own power cables, the windings are kept short for efficiency, offering the best of both worlds between small and large-sized motors.

> *"A tantalising prospect for two-motor setups is the tuning of motors for different torque characteristics"*

Such a concept was developed by Magneti Marelli, albeit without a current application in FE. This motor was described as six-phase, due to the two three-phase connections, one for each internal motor.

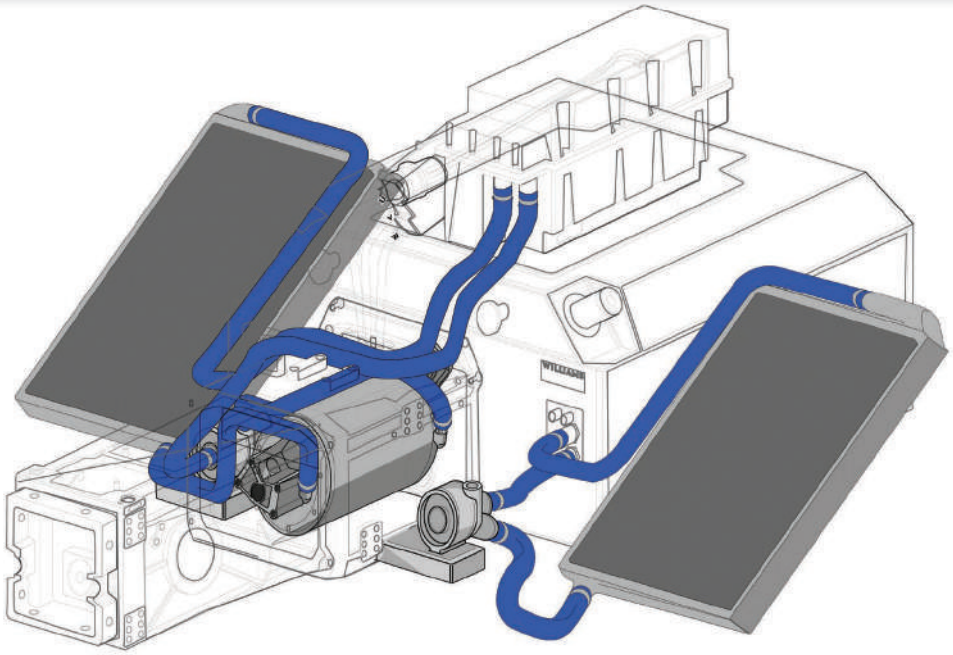
A three-phase permanent magnet setup is ubiquitous in Formula E, but the direction of the windings is a key decision. Most eMotors we are familiar with in motorsport are axial flux, whereby the windings run along the shaft axis, creating a long, slim motor. The other option is the radial flux layout, which ▶



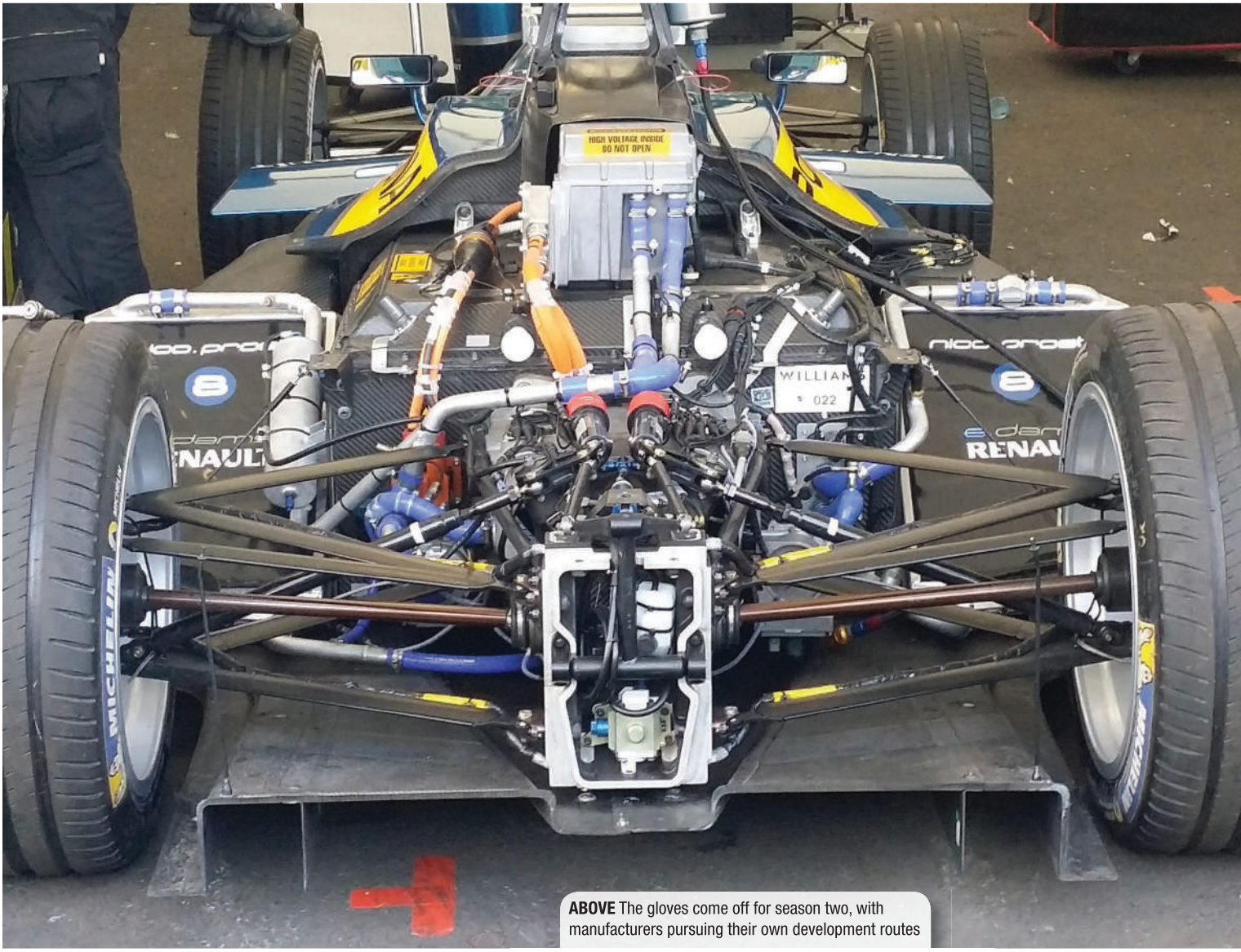
ABOVE Williams Advanced Engineering has increased the maximum power output of the batteries to 170 kW for season two. They were initially designed for 133 kW but, following successful testing, were raised to 150 kW for the first season

sees the windings projecting radially away from the centre shaft, creating a flat large-diameter motor. With rotor speeds being a limiting factor due the stresses in the metal structure, for axial flow the lesser diameter means higher rotor speeds. The radial flux format means lower axial speeds but more torque. This shape, RPM and torque makes the radial flux motors a future option for direct hub drive.

With the energy cycling between power and harvesting inside the motors, inverter and electronics, the rewards for resolving cooling issues are also critical. A team simply running the S1 powertrain without the cooling constraints could find a significant amount of performance, for little investment. This could be derived from the added powertrain performance, but also from weight and aero drag reduction from smaller coolers mounted in the sidepods.



ABOVE Two cooling circuits are used: the one on the right, driven by its own electric pump, cools the battery; the other cools the inverter and McLaren motor. Teams like Mahindra have worked hard to take weight out of the package



ABOVE The gloves come off for season two, with manufacturers pursuing their own development routes

ABOVE Hewland remains the dominant gearbox supplier

TEAM BY TEAM

In the gap between the last ePrix in London and the homologation date, teams have been able to test their new powertrains. But an air of secrecy prevails as the manufacturers safeguard their technology, not just the finer details but even fundamentals such as motor format and number of gears. The following is our best understanding of what's under the skin of the new powertrain designs.

DS VIRGIN

Paired with the Citroen DS sub-brand, the Virgin team has gone for a twin motor setup, with what's believed to be a single gear setup. It's also known that the electronics are managed by a Marelli ECU, rather than the McLaren Applied Technologies unit from season one.

ANDRETTI

The famed US operation will run season two with a season one powertrain. This came as something of a surprise, as the team is set up as a manufacturer and did develop a bespoke powertrain for season two. However, development issues could not be resolved before the summer homologation date.

It's understood the new powertrain was a single motor setup with a four-speed transmission, with the motor developed by Mechatronics and the gearcase being a carbon fibre structure. Rumours also suggest the gearbox was a cartridge-like setup, with the metal gearcase containing the cluster sitting inside the outer carbon structure. This is an approach pioneered by Mercedes in F1 and Porsche in LMP1.

By not submitting the powertrain for homologation, there is no route to racing the newly-developed powertrain for season two. The next opportunity will not be until the homologation for season three.

RENAULT E.DAMS

The constructor's championship-winning team from season one, backed by RenaultSport, was always going to develop its own powertrain. With its F1 experience in ERS, the availability of a small axial flux motor no doubt aided the decision to run a twin motor setup in season two. It will be mated to a two-gear transmission.

NEXTEV TCR

Having made great strides by winning the drivers' championship together in season one, the pairing appears to have the most aggressive powertrain for the next season. Although the twin motor, single gear set is not unique to the team, the componentry definitely is. It appears to be the sole team running radial flux motors, the two motors in series on a single shaft, the top of the motors visible as two humps ahead of the drivetrain when the bodywork is removed. The single speed transaxle is believed to be of a skeletal design, as it carries no cluster or selection mechanism.

AUDI SPORT ABT

Another road car manufacturer-backed team, the German Abt squad runs a single motor coupled to a three-speed transmission. Albeit a simple set up, the team has set fast times in testing and has significant technical backing.

MAHINDRA

A sensible reworking of the season one powertrain has been Mahindra's approach for the coming season. Using the basic format from last year, McLaren has reworked the motor, while Hewland has reduced the gearbox to four speeds and reinforced the internals for reliability.

VENTURI

Like Mahindra, Venturi has revised the season one powertrain. The motor is now badged as its own, albeit understood to have been developed with support from McLaren. Hewland has revised the gearbox to four speeds and remains the dominant gearbox supplier in the category.

DRAGON RACING

As allowed within the regulations, Dragon is buying in the Venturi powertrain.

AGURI

The Anglo-Japanese setup is retaining the season one powertrain.

TRULLI

A lack of running in testing left us unclear if Trulli was running its Motomatica motor in an updated powertrain, or in the standard season one powertrain. RT

Supply and demand

RML is back in the BTCC, but in a very different way, as **Andrew Charman** discovers

RML, the motorsport engineering specialist founded by Ray Mallock in 1984, has a long and glorious history in touring cars and particularly the British Touring Car Championship (BTCC). Now, the Wellingborough, Northants-based company that has taken eight BTCC titles for the likes of Vauxhall, Nissan and Chevrolet is re-entering the series, not as a competitor, but a supplier.

The catalyst is the BTCC's Next Generation Touring Car (NGTC) regulations, which have been in force since the formula was introduced in 2011. The '10-year plan' announced at the time scheduled a mid-term review of the series' major technical partners, principally the supplier of the specification chassis, suspension and associated components fitted to all competing cars, and of the 2-litre turbo engine available to teams who choose not to build their own power units.

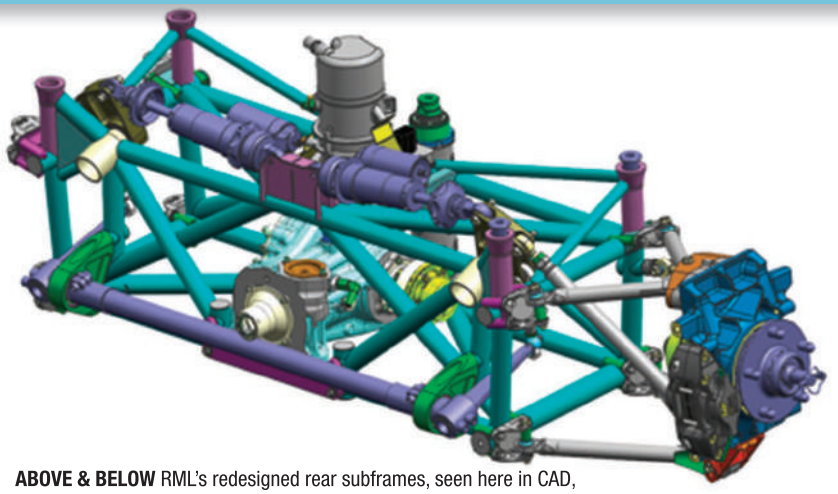
That review process was initiated by series organiser TOCA – itself required this year to make an ultimately successful tender to continue running the championship, Britain's MSA awarding a new five-year contract in July. Early in 2015 TOCA issued an invitation to tender for the chassis and engine contracts, and with current chassis supplier GPRM Ltd declining to bid to retain its contract, the field was open for a new entrant. RML's success at being awarded Technical Partner status was announced on August 28.

"Our NGTC regulations have been incredibly successful for the BTCC – no doubt they are one of the most important milestones in its proud 58-year history – but success is never achieved by merely standing still," explains BTCC series director Alan Gow. "That's why this 'mid-term' review was always scheduled into our 10-year NGTC programme.

"Actually, it's great testament to the concept of the regulations that they remain largely the same after five years, without requiring any more than some fine-tuning to take them through the next five. Very, very few top-level championships have technical regulations

Jakob Ebrey/BTCC

ABOVE The sheer variety of cars racing in the BTCC poses a major challenge for RML, designing chassis components to suit them all



ABOVE & BELOW RML's redesigned rear subframes, seen here in CAD, form part of a 'mid-term review' of the BTCC's popular NGTC regulations

that are as fundamentally sound and enduring as ours have proven to be."

In truth, RML has never been away from the BTCC – its last works programme, with Chevrolet, may have ended in 2011, but it has been engineering for teams ever since. A prime example is the Team BMR Volkswagen Passats that are keeping Jason Plato challenging for this year's title, the shells of which were built in Wellingborough. RML personnel also work on a contract basis for many BTCC teams in the pitlane.

FEAST OR FAMINE

Nonetheless, going from competitor to official technical partner would appear to be a major change for RML, though talking to the company's Group Commercial Director Simon Holloway at the Wellingborough headquarters, it quickly becomes clear that it was an obvious step to take.

"For RML it's interesting because it's a long-term contract, a six-year term, and it provides stability," Holloway tells Race Tech. "The timescale also allows us to do a lot of clever things with regard to production, stocking and selling spare parts over the six-year period. We need to produce cost-effective manufacturing techniques in order to build bigger batches of parts and stock them."

In some respects the new BTCC contract can be compared to RML's recent experience in the World Touring Car Championship (WTCC). Having run works and then an independent programme for Chevrolet up until 2013, in 2014 the company designed and built a Chevrolet to the new TC1 regulations, but as a customer car, selling it to teams and providing an engineering and spares backup operation, but not running its own team.

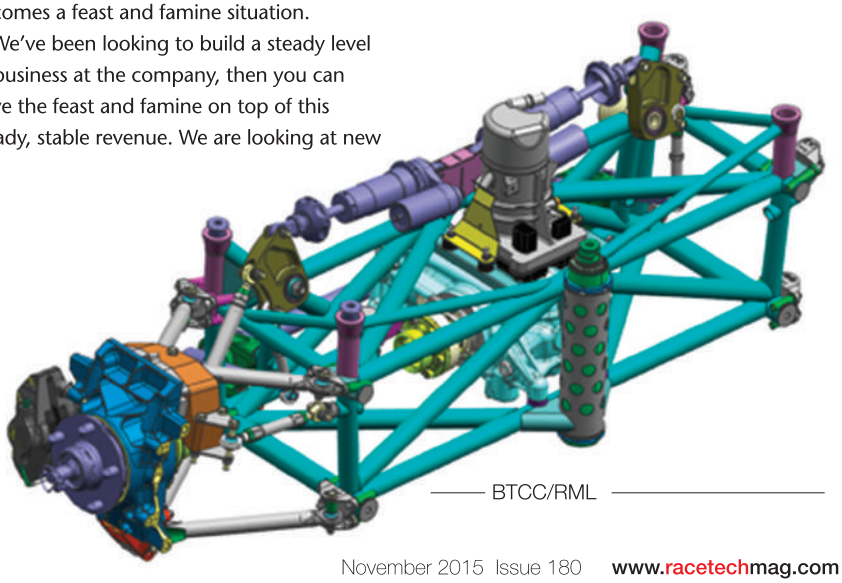
> *"Success is never achieved by merely standing still"*

Holloway, however, does not see the recent WTCC and new BTCC programmes as necessarily a shift in emphasis at RML. "OEM contracts come along and go away very quickly," he says. "Most are over three years, or rolling contracts and as a business it becomes a feast and famine situation.

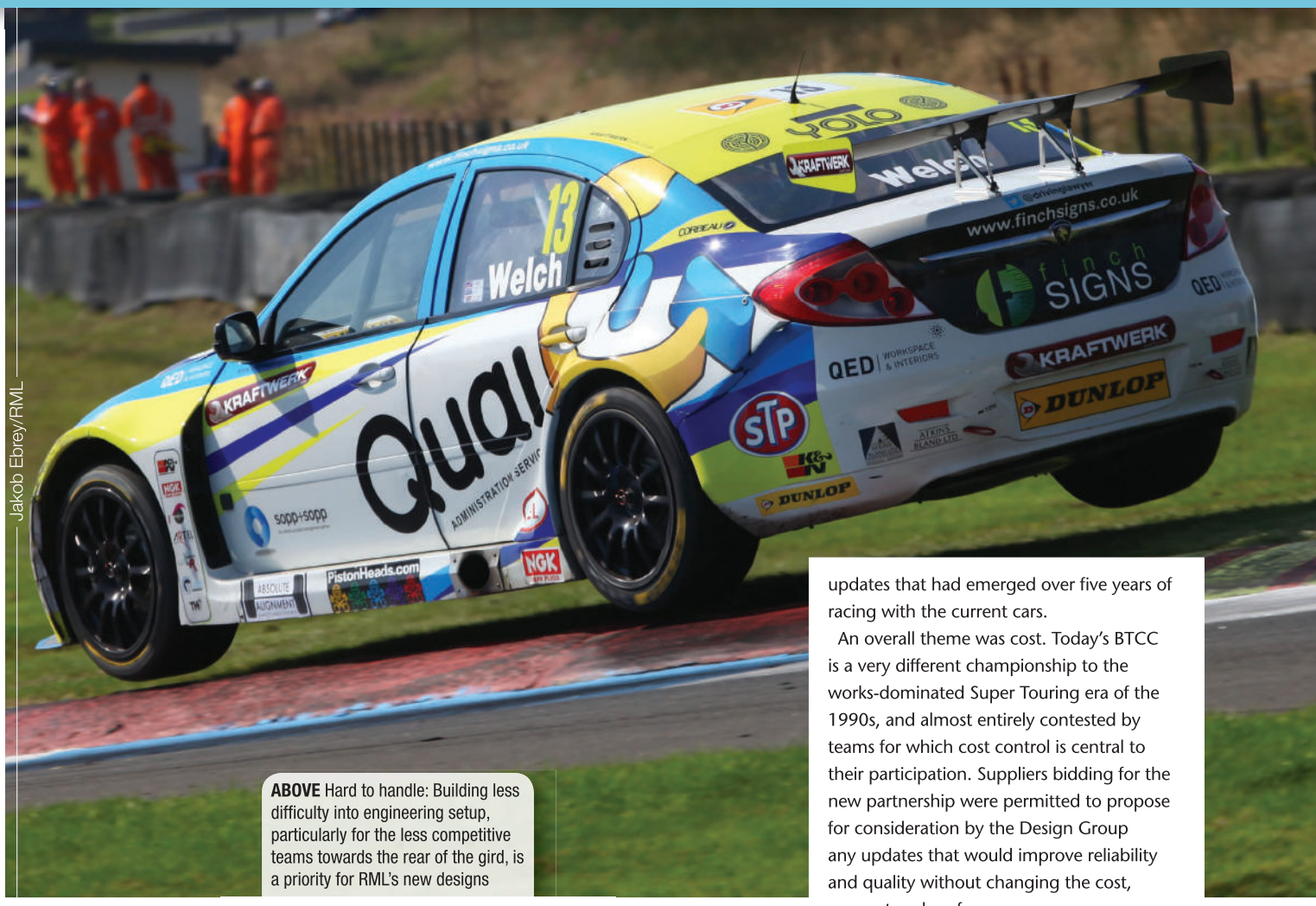
"We've been looking to build a steady level of business at the company, then you can have the feast and famine on top of this steady, stable revenue. We are looking at new markets, other sectors we can grow into, especially in automotive, and that spreads the business very nicely. It is something I was used to doing at Cosworth before I moved here a year ago."

So what does the new technical partnership with the BTCC involve? The contract encompasses all of the specified chassis and suspension components on the NGTC car, including the front and rear subframe, rockers, pushrods, uprights, wishbones, all of the carryover parts, hubs, wheel bearings and stub axles. The supplier is also responsible for the power steering system that formed a major item in the tender document as we'll see shortly.

The BTCC's technical direction is controlled by the championship's Technical Working Group or TWG. Representatives from all of the competing teams sit on it, along with the technical partners and TOCA personnel, led by series technical director Peter Riches. A sub-group of the TWG is the Design Group, which consists of the car designers from each team, and it is this sub-group that decided the awarding of the new technical partnerships and crucially requirements for ▶



BTCC/RML



Jakob Ebrey/RML

ABOVE Hard to handle: Building less difficulty into engineering setup, particularly for the less competitive teams towards the rear of the gird, is a priority for RML's new designs

The upgrade package

COMMERCIAL confidentialities prevent Simon Holloway offering too many specifics as to how the RML update kits differ from that offered by GPRM, but he can describe the overall changes.

The new update kit consists of fewer components, which helps with cost control. The non-linear falling-rate rocker suspension system, which has proven very difficult to set up correctly, is making way for a linear-rate system. A specific requirement of the tender document, this is described by Holloway as "a playing-field leveller – everyone in the field will be getting used to the new setup. The old system needed custom progressive springs to make it work and cars were being run on bump stops most of the time."

This change has in turn led to considerable alterations to subframe load points, their locations determined through finite element analysis (FEA) work. In similar form the wishbones are now fabricated instead of machined billet, creating a fuse point that in the robust wheel-to-wheel competition environment of the BTCC prevents inevitable collision damage being transmitted through the entire frame and thus keeps costs down. Cost reasons are also behind the change from a billet to a cast upright.

The tender document insisted on improvements to the power steering, a long contentious area with teams. RML has switched from an electric system to effectively the same hydraulic one used on its WTCC Chevrolet cars, Holloway reporting: "A proven hydraulic system gives better feedback and reliability – it's the same system we've run on our WTCC cars for years." RT

LEFT Simon Holloway is in charge of making RML's new technical partnership with the BTCC work

updates that had emerged over five years of racing with the current cars.

An overall theme was cost. Today's BTCC is a very different championship to the works-dominated Super Touring era of the 1990s, and almost entirely contested by teams for which cost control is central to their participation. Suppliers bidding for the new partnership were permitted to propose for consideration by the Design Group any updates that would improve reliability and quality without changing the cost, concept and performance.

In fact, TOCA was looking for the price of a complete 2016 kit to be less than that of a 2015 equivalent – and this including the steering which was not a part of the GPRM-supplied kit. The supplier was also to absorb all of its design costs.

COMPATIBILITY

Equally, all of the new components were required to be completely cross-compatible with the existing equivalents. A team that decides not to update any part of its car for 2016 and then suffers damage at any time in the season must for example be able to purchase replacement RML subframes and fit them with a GPRM-designed wishbone.

The tender document has addressed specific issues too, principally changing the suspension away from a non-linear setup due to a great deal of difficulty experienced in effectively engineering the previous version at circuits. Some subframe issues were required to be resolved, including reviewing load paths to achieve increased reliability and reviewing the shear plate system used to join suspension to frame. Notably, the power steering has been changed, from an electric system to a ▶

The designer's view

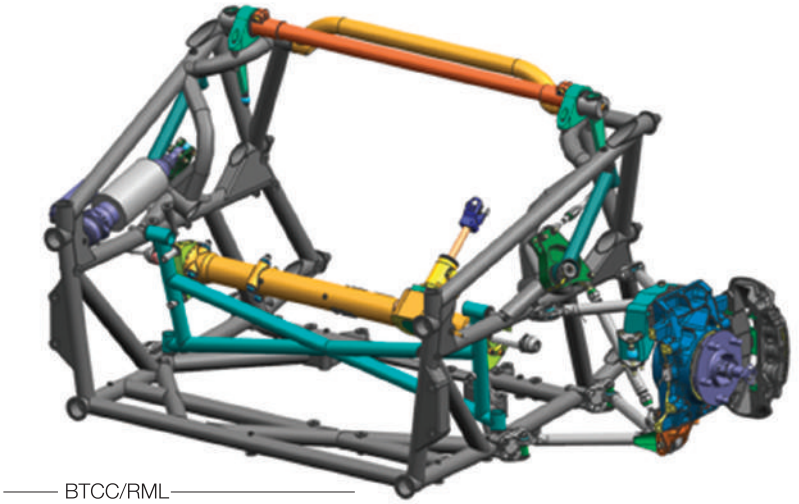
GEORGE Fairgrieve-Sealey is one of the design team working on the BTCC contract and admits that it has been much more of a challenge than anyone at RML expected.

"When GPRM was setting up the original NGTC kit they could pretty much design what they wanted and the teams then had to buy it and make the GPRM designs work in their particular shell," Fairgrieve-Sealey tells Race Tech.

"That data, those components now exist and over the years teams have come up with ways of fitting them and/or working around them, making engine installs work and such like. We now have to make all of our new components suit those various installs, while not making identical copies of the GPRM parts.

"It massively compromises what we do – in an ideal world we would like to simply design a new part. In a number of instances we've created an improved design, sent it out to the teams for comments and one or two have come back with comments such as, 'I have a throttle body there, you'll need to move it'. So we move it and another team then has a problem, a component that clashes with it – it's a really difficult challenge trying to satisfy all of the existing teams."

So how difficult is it to make what are basically specification parts fit across a range of bodyshells? "Very difficult," comes the reply. "The uprights are a case in point. We wanted to produce a single design to fit all corners, one upright for four locations in each car which would offer cost advantages for both the teams and us.



BTCC/RML

"Feedback from the teams, however, revealed there would be other requirements. These led to us having to tweak the designs and eventually make individual uprights for front and rear-wheel drive cars. We spent a great deal of time, analysing strengths and weaknesses, FEA work, load cases, combined braking and partial cornering loads and such like, just to ensure the new parts will cope with loads going into them."

Of all the components the front subframe has proved most challenging, due again, Fairgrieve-Sealey says, to the variety of engine installations: "Particularly the steering rack install – the relation between rack and steering wheel in each car is different and retro fitting very difficult."

He admits too that working with designers across several teams throws up its own challenges. RML's design process is guided by the championship Design Group: "You can get differences of opinion team to team and even within a single team – in the initial meetings everyone wanted to go their own way, but after a few meetings things started to move forward."

Nonetheless changes have added to the pressure on the RML design team. An example has been the replacement of the current suspension rod ends with staked joints, RML's perceived preference for the latter leading some observers to suggest they would add costs for teams while reducing adjustability. In fact, the championship's TWG rejected the RML plan, preferring to retain rod ends, only to change its mind some weeks later, insisting on a return to staked joints due to rod ends offering too much adjustability.

All of which keeps Fairgrieve-Sealey's mind highly focused… RT

Andrew Charman

ABOVE, LEFT & RIGHT Of all the components the redesign of the front subframe (above) has proved the most challenging, due to the variety of engine installations (the 2014 Honda Civic and Audi S3 are shown here)

hydraulic one, to address reliability issues.

Not surprisingly, RML started with almost a clean sheet of paper, redesigning all the components with the major compromise being that need to ensure cross-compatibility. The tender document specified that the first 12 upgrade kits be available for delivery to teams by the end of October. With TOCA unable to award the new contract until its own continuation as series organiser was confirmed by the MSA, meeting the deadline meant starting work several months before winning the business. "We had to start the design at risk," suggests Holloway. "We did six months of work with several staff at the risk of not getting the contract. I did have some sleepless nights…"

WORKSHOP GUINEA PIG

Throughout the process RML's team worked at close quarters with the series Design Group. Its development even included borrowing the second Infiniti Q50 of the Support Our Paras team, made redundant after funding issues resulted in the loss of its TOCA entrant's licence. This has served as a workshop guinea pig on which to trial-fit parts but, as designer George Fairgrieve-Sealey states in our sidebar, all of the upgrades had to work across the 12-plus different models of car competing in the BTCC, causing major challenges. "Any upgrade work has to be as easy as possible – it's an ongoing process," Holloway says.

"Generally decisions are made by a majority vote, and on many things they all give approval, having probably had a lot of discussions outside the meeting. I go to every round of the series and our designers come with me. At Rockingham, for example, I was visiting each team with a steering pump to examine the installation issues. They give me input at the circuit that we then bring back here. It's all about customer contact – so long as you keep your customer informed it works well, and that's been reflected in the uptake of the upgrade kit."

Holloway reports that while there is absolutely nothing to stop a team racing in 2016 with a car boasting no RML parts, the uptake of the new kits is very encouraging, suggesting that teams see the expense of upgrading as worthwhile: "More than two thirds of the grid have already placed orders, and while the order form allows them to choose selected components if they wish, upgrading piecemeal, they are choosing complete kits. And it's teams towards the rear of the grid, who you would consider the most cost-conscious, that have been quickest with their orders."

And what if cars running with the new kits prove to be significantly quicker than the 2015 spec cars? "You would then potentially be into making a balance of performance calculation, but that would be a decision for TOCA to make," he says.

The final stage of development will see a Power Maxed Racing Chevrolet Cruze trial a complete RML upgrade kit in the final round of the 2015 series at Brands Hatch on October 11. "If we had chosen a front-running team, other teams would have accused them of stealing an advantage," explains Holloway. "Anything we learn from this test will be fed back to all the teams."

The first 12 upgrade kits will be dispatched together at the end of October, each team which has placed an order receiving a single kit to ensure there are no claims of particular squads gaining an advantage by being able to test earlier with the new components. A second batch of orders will be fulfilled between four and six weeks later.

RML will also be required to offer a spares service at race meetings, in fact similar to that the company already provides as part of its current WTCC programme. A truck and two staff will be involved and Holloway believes they may end up carrying components from the championship's other technical partners.

BREAKING NEW GROUND

"We will also potentially offer some servicing to teams, bearing replacements and such like, wishbone parts, which has not been done previously," he comments. "Parts received on Friday will be serviced by Sunday and to start with at least we will also provide some assistance to teams with setup."

It is a matter of public record that RML also tendered for the TOCA engine contract but was unsuccessful, TOCA electing to remain with current supplier Swindon Race Engines. Holloway admits that not securing this contract was a disappointment, but has no effect on the firm's chassis programme, the two tenders created under separate business models.

"I can see why the decision was made," he says. "It's not always good to have everything under one roof and if they had gone with anyone other than Swindon there would have been upgrade costs. To a certain extent continuing with the same engine has made it easier for teams to swallow the chassis upgrade."

He adds that RML could still provide its own base engine to BTCC teams, and could continue to engineer and build cars such as the Passats and the Chevrolets running in the series. "We just can't enter our own team." RT

Jakob Ebrey/RML

ABOVE Side loadings are a significant factor in the BTCC…

GUESSING GAME?

PART 2

Getting the valve events of a single cam engine has appeared a black art known to only a select few. The reality, says **David Vizard**, is that it is just 'engineering'

IN the last edition of Race Tech I dealt with the typical 'experience plus best guess' method commonly employed to come up with a cam spec for a single cam engine. Being a single cam of course means whatever events are on the camshaft is it, as there is no independent adjustment of the intake and exhaust. Having a good or even a very close idea of what the engine may need beforehand can mean a shorter development time to a given output level and a far more positive initial result. This can get the engine builder close to optimum first time around and almost eliminates the need for multiple cam tests and the consequent expenses involved.

OVERLAP AND LCA

Cycle pressure traces taken from the intake, cylinder and exhaust of a high-performance engine have shown that the exhaust plays a much stronger role towards starting the induction event than is often supposed. This makes the overlap of the exhaust and intake a very important factor. The big question here is just what proportion of the intake and exhaust opening duration do we assign to the overlap period compared to the post-BDC period?

To answer that let's consider the cam's opening duration as comprising of three distinct parts. Assuming it is the intake, the first section is the number of degrees the intake starts to open before the piston reaches TDC. The next section, which always takes 180 degrees, is the part of the duration where the piston is travelling down the bore. The third and last section is the number of degrees past BDC to valve closure. As may be suspected, the best results are when the number of degrees occurring before TDC as compared to those after BDC best suits whatever *the engine wants*. This ratio of degrees before TDC compared to degrees after BDC is, on a single cam engine, controlled by the cam's Lobe Centreline Angle or LCA (also known as the Lobe Separation Angle or LSA). This is the angle between peak intake opening and peak exhaust opening and is quoted in cam degrees not crank degrees.

From the foregoing we can see that, where there is an exhaust-driven intake event, though the overlap is critical the balance of pre-TDC duration versus post-BDC duration is even more so. That being the case it makes the cam's LCA the most influential element towards determining near optimal valve events for a single cam engine.

If you are one of the thousands that call a cam company for a cam spec you will quickly understand that the cam industry in general considers the LCA to be a somewhat fluid value in that wide angles are better for the street and tighter ones for competition for all but very high compression ProStock-style engines. The reality is that testing has shown near conclusively that this is just not the case. Many cams used on the street have a wide LCA so that the idle and low speed qualities of the engine are what can best be described as street civilized. In practice it is the overlap that determines idle quality, not the LCA. The reality here is that the price for civility by spreading the LCA is reduced torque and hp. A better choice would have been to choose a shorter duration cam and have it on the optimal LCA.

After hundreds of LCA tests it has become clear that there is only

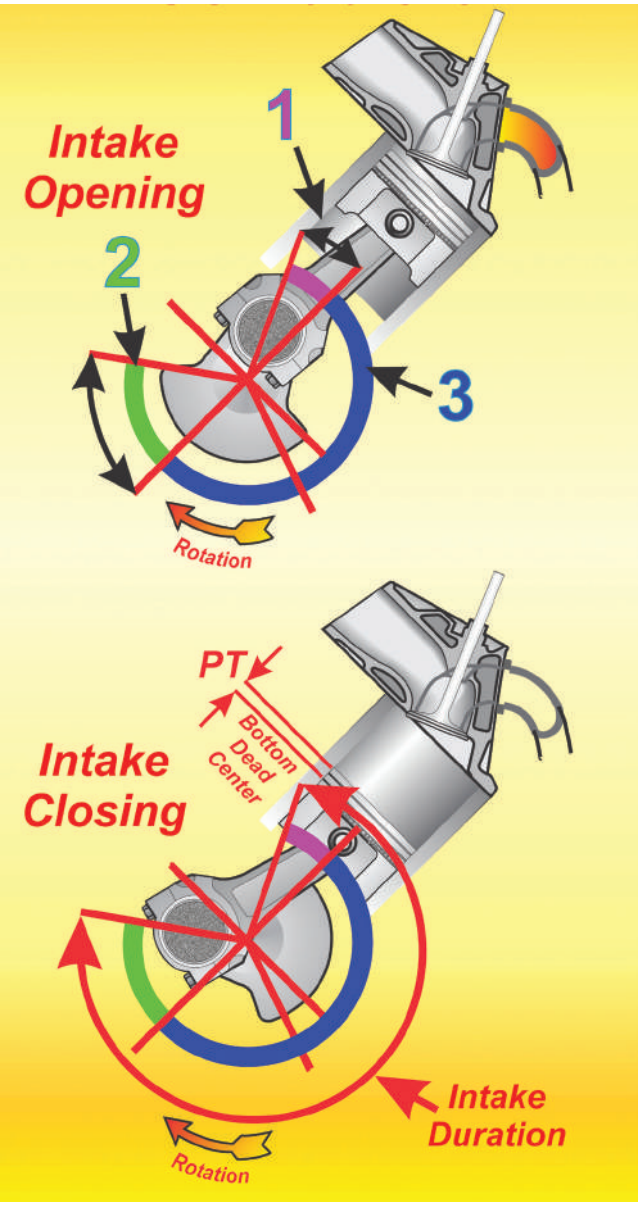


FIGURE 1 Shown here are the opening phases of interest when making a cam event selection. 1, Opening duration prior to TDC – this is part of the overlap cycle and the exhaust is still exiting the cylinder. 2, Opening duration post-BDC. Section 3 will of course always be 180 degrees. The events shown here are for a cam of about 270 degrees duration

one optimal LCA for a given combination of major engine components such as displacement, heads, CR etc. This applies over a wide range of intake and exhaust duration figures. Most of the test data has been with 'off-the-seat' intake duration figures of as little as 252 degrees to as much as 304 degrees. Over this range the data suggests that the optimal LCA is almost a straight line.

DETERMINING LCA REQUIREMENTS

At this point it appears reasonably safe to assume that getting the LCA right is the #1 priority for a single cam engine. The question is what factors affect it and if we can know that how can it be applied?

With all the test engines involved in this lengthy cam testing the engines' head flow characteristics from right off the seat to well over the lift likely to be used were well documented. Study of the relevant figures indicated that there was a very strong relationship between the intake valve's flow capability from just off the seat on through the intake's overlap degrees. Once the exhaust valve had closed there appeared to be little to no further influence on the LCA, no matter how much additional intake flow one head may have had over another. The greater the low lift flow was in relation to the displacement of the cylinder it had to feed, the wider the LCA called for.

This means that, for a given cylinder head(s), the bigger the cylinder, the tighter the LCA required. The tighter LCA also means more of the cam's overall intake duration has to occur in the overlap period. If we throw in the influence of the exhaust, we find that the ratio of low lift flow of the intake to exhaust dictates the advance/retard positioning within the engine. If the flow ratio of intake to exhaust is on the low side then the cam will need to be advanced and vice versa if the exhaust flow at low lift is high compared to the intake.

The difference in cam timing required due to this factor can be quite substantial. My own experience here is that, for a given exhaust seat, a high efficiency intake valve seat can require as much as five degrees of cam retard compared to a conventional multi-angle intake valve seat. In a nominally 700 hp V8 that increase in low lift flow along with the five degrees retard can represent 25 hp gain, so it is not a factor to dismiss lightly. ▶

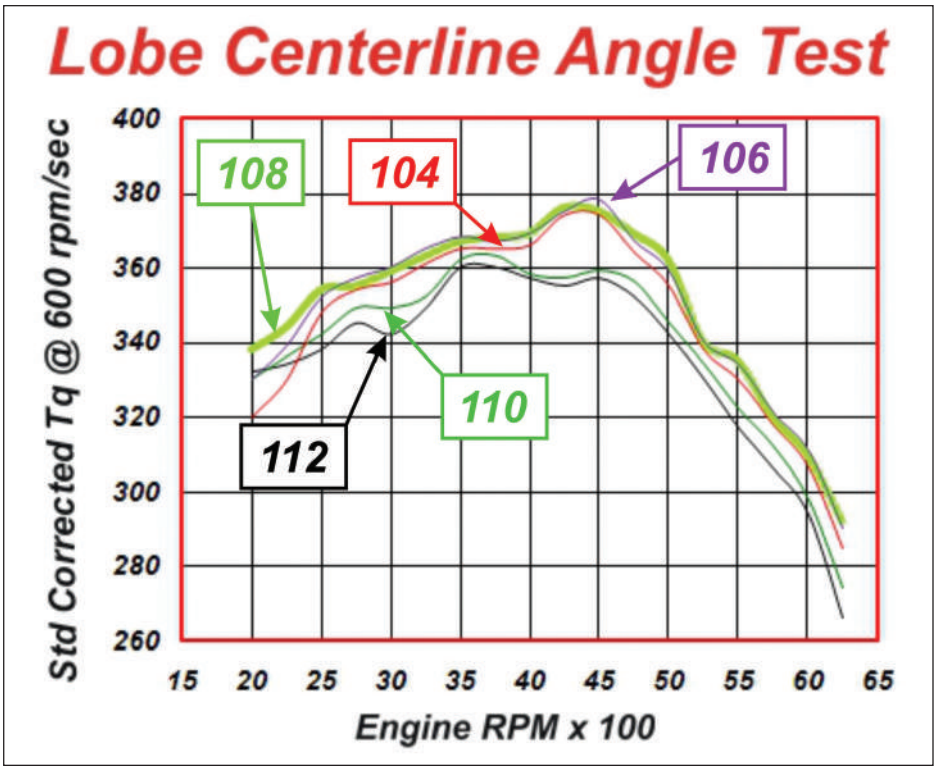
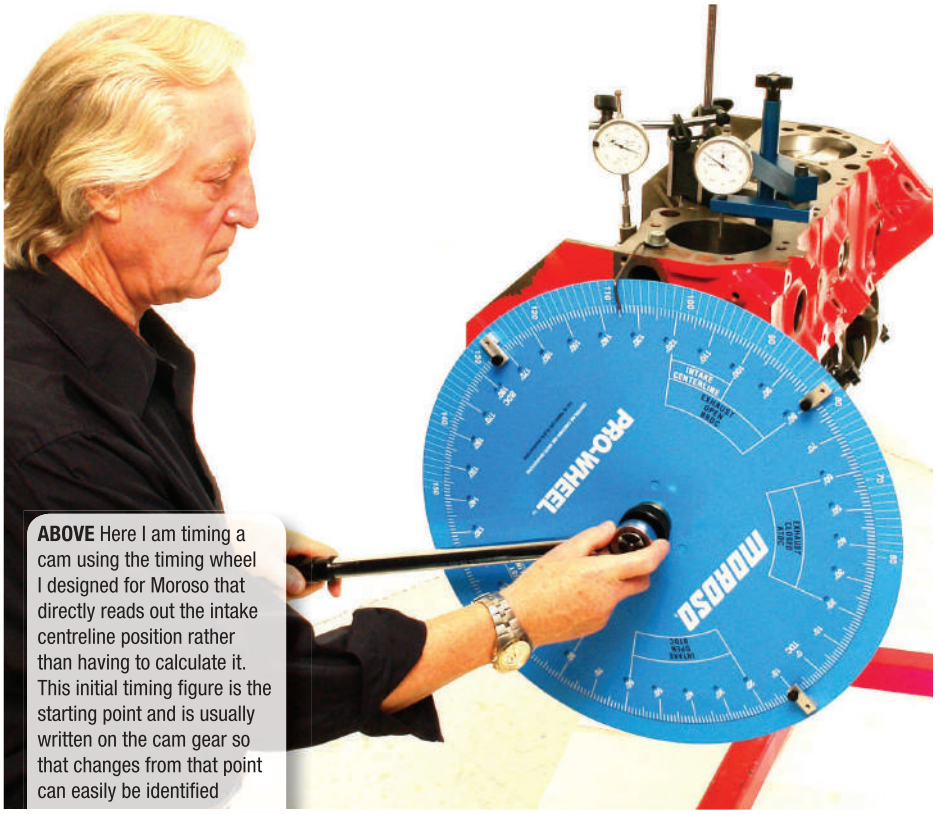
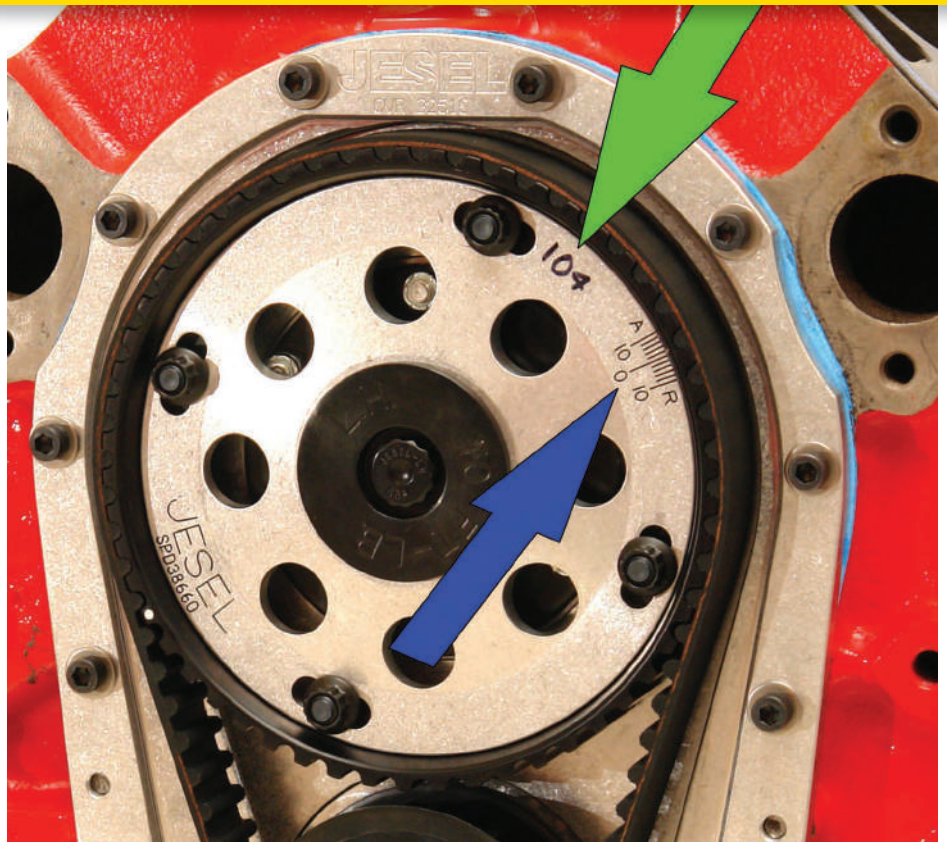


FIGURE 2 Here are some test figures from a basic 9.6/1 350 CID small block Chevy. Heads were iron 186 casting from the 1970 era with 2.02/1.6 valve sizes. Cams tested were hydraulic flat tappet single pattern grinds with 270 degrees duration.

Cams typically sold for this engine are on a 110 to 112-degree LCA. As can be seen here a 108-degree LCA produced significantly better torque output throughout the 2,000 to 6,250 rpm range tested. Going tighter (106 and 104) on the LCA produced very similar results over the 2,500 to 6,250 rpm range but started to show significant output reduction at the lower rpm. Idle quality also suffered. Although the wider 110 and 112 LCA cams gave a better idle they were, compared to the 108 LCA cam, down about 20 lbs-ft of torque throughout the rpm range tested



ABOVE Here I am timing a cam using the timing wheel I designed for Moroso that directly reads out the intake centreline position rather than having to calculate it. This initial timing figure is the starting point and is usually written on the cam gear so that changes from that point can easily be identified



ABOVE What you see here is a Jesel adjustable cam timing setup. I consider this the most important tool in my arsenal of cam testing equipment. The '104' indicated by the green arrow is the intake centreline existing when the indicated cam timing degrees (blue arrow) is at zero. Knowing this means knowing the cam advance/retard at any single moment during testing

What this means is the cam timing figures given by the cam manufacturers are nothing but a good estimate of what is required for an *average engine*. Since my goal is to show readers how to build better engines, the 'average engine' scenario just does not fit into my work agenda and that is why virtually every engine I build goes on the dyno with an adjustable cam timing system of one sort or another.

It also means that if you are testing a head that has a significantly better low lift flow than the one it is replacing, the power is very likely to be significantly down unless the cam's advance/retard is re-evaluated. Also big low lift flow improvements will need a slightly wider LCA, so simple 'A' versus 'B' tests of cylinder heads with higher low lift flow intake valves are often invalid: they do not show the real potential of increased low lift flow on an engine's output.

To sum up the primary factor controlling the optimum LCA we can say that, for a given displacement, increasing the low lift flow means widening the LCA and decreasing means tightening. If we hold the heads constant then increasing the displacement of the cylinder means tightening the LCA and decreasing it means widening. This is one reason why the cam that worked so well in say a 327 small block Chevy is well below par when the displacement of the long block is increased to say 383 cubic inches. Such a change typically requires the LCA to be about three degrees tighter if a comparable specific torque output is to be retained or even improved on.

Although COS-Cam, the program I have written to compute cam events, uses flow figures for the most accurate results, not everyone has flow figures for the heads on their engines. Although marginally less accurate we can use valve sizes as a LCA determinant. If plotted out, the graph, for typical multi-angle valve seats (and consequently discharge coefficients), produces a curve as per Figure 3. Since the line between 102 and 110 degrees of LCA where most 10.5/1 parallel two-valve ▶

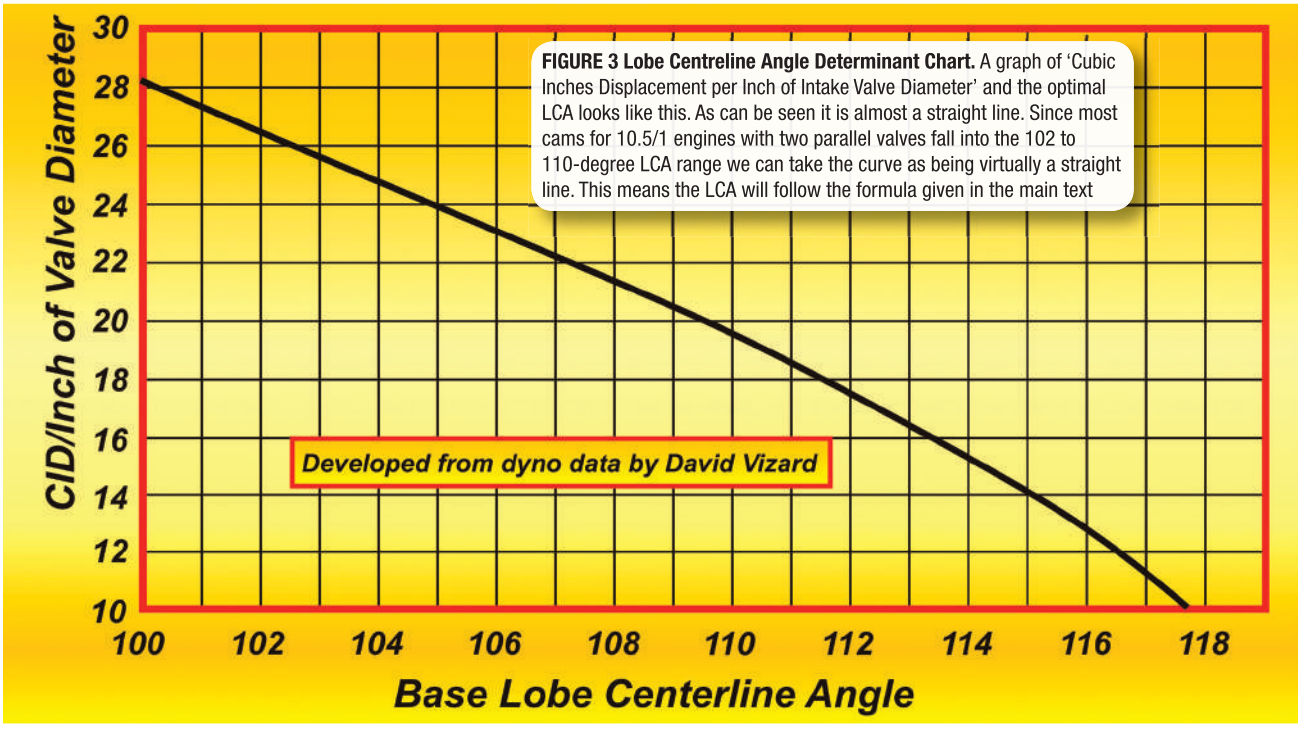
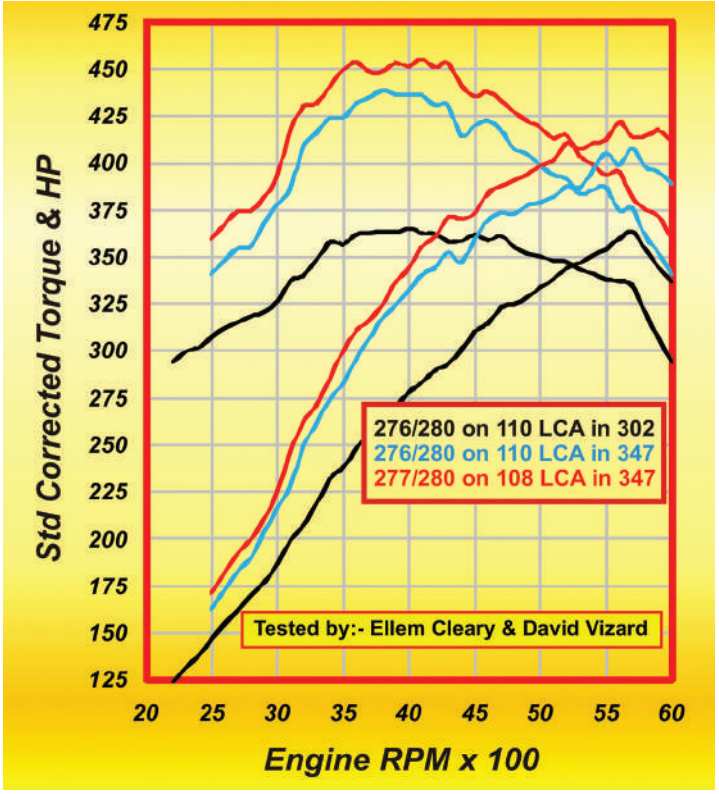


FIGURE 3 Lobe Centreline Angle Determinant Chart. A graph of 'Cubic Inches Displacement per Inch of Intake Valve Diameter' and the optimal LCA looks like this. As can be seen it is almost a straight line. Since most cams for 10.5/1 engines with two parallel valves fall into the 102 to 110-degree LCA range we can take the curve as being virtually a straight line. This means the LCA will follow the formula given in the main text

ABOVE If you have one of these engines ('A'-series) then calculating the LCA becomes a nightmare as the siamese ports cause cylinder-to-cylinder interference. This means the cam that seeks to optimize valve events needs to have different strategies for each cylinder. This is what Kent Cams' 'Stagger Pattern' cams do. In a typical 1275 the staggered timing is usually worth some 7-10 lbs-ft everywhere in the rpm range over a conventional cam

FIGURE 4 302/347 Small Block Ford LCA Cam Test. This graph demonstrates what just two degrees change in LCA can do for the output of a typical stroker 5.0 Mustang engine. Getting the LCA right by means of a COS-Cam selection as opposed to accepting a cam with timing that is 'common practice' resulted in a 20 lbs-ft and 20 hp increase. It is worth noting that the cost to grind a cam with the right events is no more than one with the wrong events



> *"It makes the cam's LCA the most influential element towards determining near optimal valve events for a single cam engine"*

engines fall is virtually straight, we can say that the LCA = 128 - (CID/# of Cylinders/In Valve dia. in inches x 0.91).

Given that the cylinder heads have typical low lift discharge coefficients then the 128 number is probably the most important fact you need to know when speccing out a cam. If the seats are better than average, that number can go up to about 131; if worse, down to about 125. However if, for a pushrod V8, the 128 figure is adhered to the cam LCA you will come up with will, in nine cases out of 10, be far nearer optimal than a catalogue cam. If we also take into account that being a little on the tight side does little to hurt performance, whereas a little too loose cuts performance far more noticeably, then the 128 figure is as good as it gets short of having real world flow numbers.

CR INFLUENCES

The second most influential factor towards determining the optimal LCA is the CR. That is the reason I have so far quoted results from a typical 10.5/1 engine. As the CR increases, so the optimal LCA required becomes wider. This means that less of the overall cam duration is apportioned to the overlap. Although other ▶

lesser factors still play a part, the principal reason here is that the smaller the combustion chamber, the less spent charge there is to scavenge. This is one of the reasons why we see very wide LCAs in the order of 114-117 degrees on 16 and 17/1 ProStock engines.

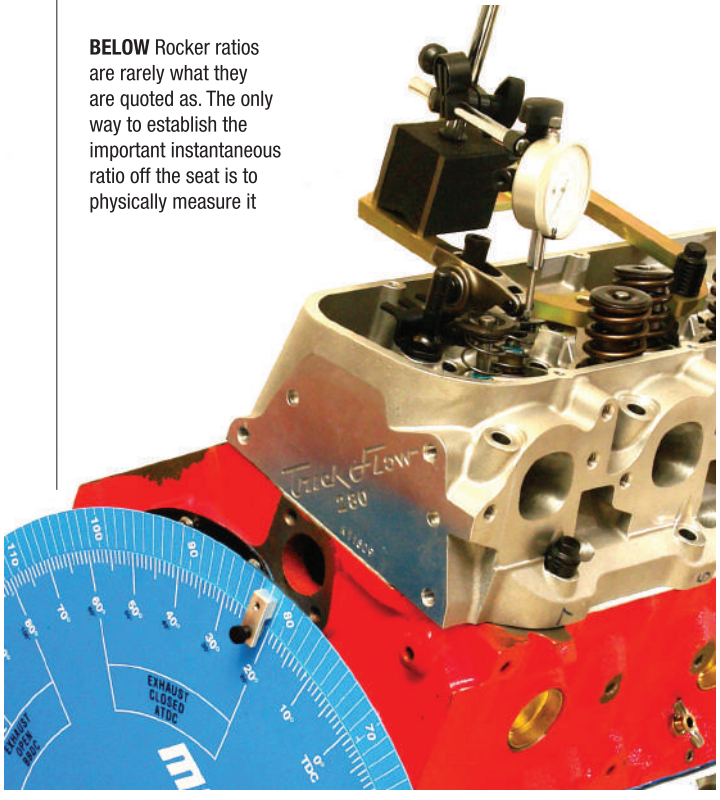
If tomorrow all ProStock engines had to run 87 octane fuel the required 10/1 or so CR would, with the valve configurations used, call for LCA in the 109-110-degree range. As a guide here one can assume that for every ratio above about 11/1 the LCA will need to be spread by between 0.5 to 0.7 of a degree. If we use the average of 0.6 of a degree, the end result will still be very close to optimal in almost all cases.

OTHER LCA INFLUENCES

The last factor of any real significance is the acceleration of the valves off the seat and on through the overlap period. This is especially so for the intake. If the intake valve acceleration is increased the LCA needs to be spread, and if decreased, tightened. For an example consider a typical pushrod engine hydraulic cam profile with a 0.006 to 0.050-inch tappet lift taking place in 45 degrees and operating through a 1.5/1 rocker. If the LCA was optimal with the baseline cam and rocker system then increasing the area that takes place during the overlap period by 10% will typically call for a spread in the LCA by one degree.

If the intent is to achieve this by an increase in rocker ratio, be aware that the instantaneous rocker ratio at the point lash is absorbed is often far from whatever the rocker may have stamped on it for its supposed ratio. The ratio spread here can be very influential as, for a supposedly 1.7/1 rocker, the initial ratios can have a spread of 1.01 on the low side to 1.735 on the high side.

For those interested in big block Chevy engines, I cover the characteristics of all the major brands of rockers in detail in my big block Chevy performance book recently published by SA Design.



BELOW Rocker ratios are rarely what they are quoted as. The only way to establish the important instantaneous ratio off the seat is to physically measure it

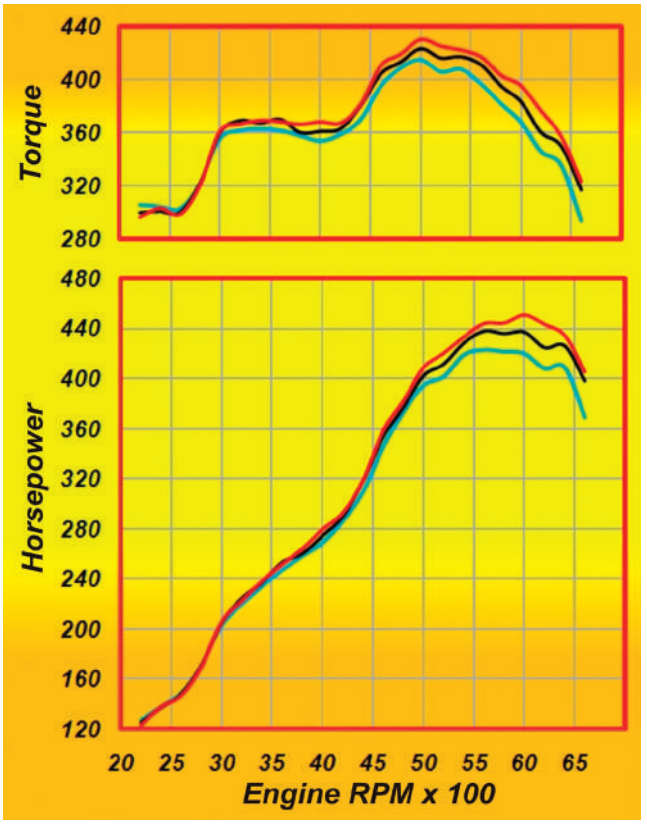


FIGURE 5 Valve lift test. Parallel two-valve heads thrive on lift. Assuming a well-developed port, such a valve layout produces an airflow increase up to typically 0.35 to as much as 0.38 of the intake valve diameter. The test results shown here are from a 350 CID small block Chevy with factory iron heads with little more than a clean-up and a good valve seat job.

The valve lifts used were 0.490, 0.525 and 0.560 inches. The increase in valve lift occurs after the overlap period so the inch/degree overlap area remained constant for each test. With highly developed ports, race spec big block V8s are using as much as 1.25-inch intake valve lifts and turning to over 10,000 rpm

Another factor that affects the LCA called for is the rod/stroke ratio being used. At first sight it may seem like this is an important factor to take care of. In reality tests indicated a very substantial change in the connecting rod length was needed before a difference in required cam spec was actually measurable on the dyno. For instance, a rod length change of one inch on our test engine barely showed a difference of one degree for the optimal LCA. That being the case, its effect can almost be ignored.

CONCLUSIONS

Once the optimal LCA has been determined for the engine in question it is only a case of selecting a suitable duration of cam to meet the operational requirements. Most engine builders are sufficiently experienced in this area to make a fairly accurate determination of the duration that may be needed.

Once the duration has been decided on, the amount of overlap will become a fixed consequence of the combination of duration and LCA. For the COS-Cam program mentioned earlier there are algorithms that determine the duration of both intake and exhaust based on flow ratios and peak power rpm required. If access to the COS-Cam spec results are needed for a precise cam spec, go to www.waltersengines.com. RT

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Land of hype and glory

Announcing a sabbatical from the BTCC, Motorbase vowed to return with a Mountune-prepared engine capable of winning the title. Marketing hype? Think again, says **Chris Pickering**

BACK in March Motorbase Performance team principal David Bartrum faced an unenviable task. With barely more than a week to go, he had to explain that the team wouldn't be contesting the first half of the 2015 British Touring Car Championship (BTCC) due to funding issues. But, he pointed out, they would be back later in the year. What's more, he said, they had a potentially championship-winning package waiting in the wings. At the time it must have seemed like bravado.

When the revised car broke cover at the Snetterton tyre test in July it became clear that there was real substance to the promises. "I think we opened a few people's eyes when we turned up at Snetterton and posted the fastest time," comments Motorbase Performance team manager Oly Collins.

The first race back, also at Snetterton, wasn't quite as successful for the team, but two weeks later at Knockhill things improved again. Mat Jackson came tantalisingly close to snatching pole and ended up finishing the three-race weekend with two podiums. Spin forward another fortnight to Rockingham and Jackson claimed the team's first ever BTCC pole followed by a commanding lights-to-flag victory. There was no question the outfit had been given a new lease of life.

Much of this newfound fortune is down to the team's new Ford Ecoboost engine, developed just the other side of the Thames by Mountune. Featuring a raft of new technology, it addresses all the weak points of the older Duratec unit that the team had been using since 2011.

The Duratec engine can trace its roots to the LPG unit that Mountune built for Arena Motorsport in 2010 and it was originally designed to run slightly higher boost than it could in NGTC form, explains Collins: "The peak output was okay, but the power curve wasn't very linear. We didn't have much low-down torque and the drivers sometimes struggled for traction when the boost came in."

Mountune carried out its own feasibility study before coming to the team with a proposal to use the Ecoboost engine. "When we first tested the engine in the car late last year everything that Mountune had suggested would be an improvement turned out to be true," says Collins.

PSP Images

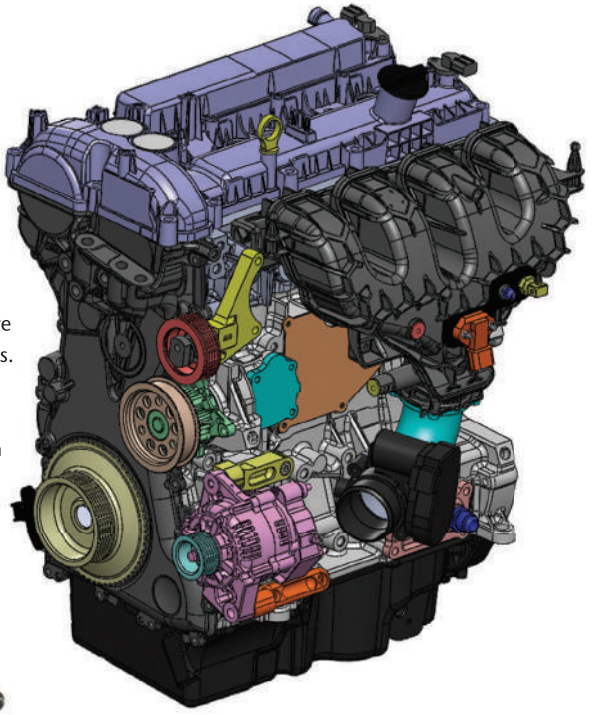
ABOVE Jackson's Rockingham victory was achieved without the hindrance of success ballast but nevertheless sent shockwaves through the BTCC paddock

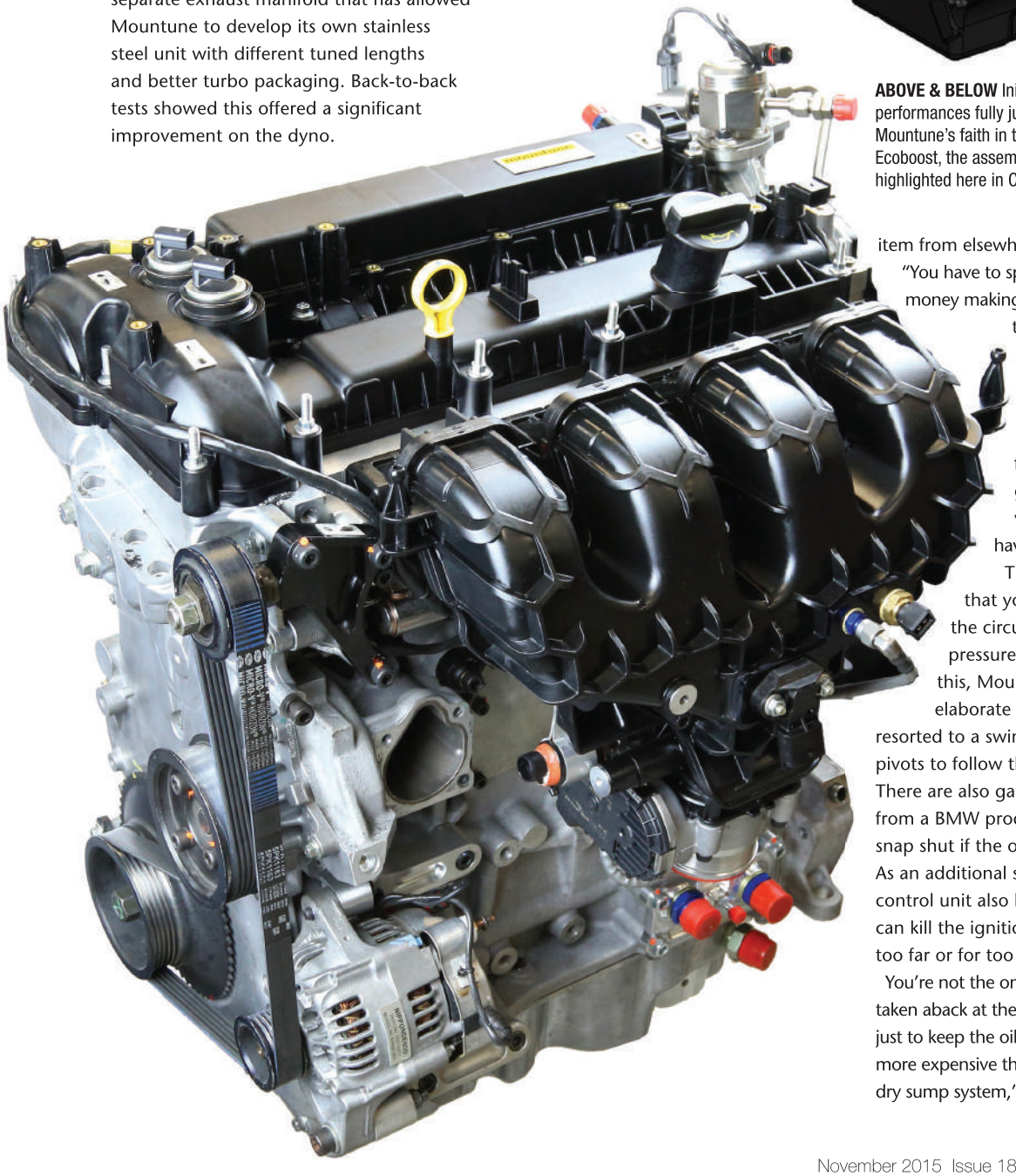
DESIGN CLASSIC

The term Ecoboost covers a whole family of engines ranging from a 1-litre triple to a 3.5-litre V6. In this particular 2-litre four-cylinder 16-valve incarnation there are actually two sub variants – the Value and the Classic. As is now commonplace in the automotive industry, the Value – found in the Focus – uses an integrated exhaust manifold cast into the cylinder head. That's great for cold start emissions but less than ideal for performance tuning. Consequently, Mountune went for its older brother, the Classic, which normally lives in the Ford Mondeo and the Land Rover Evoque. It's identical apart from the separate exhaust manifold that has allowed Mountune to develop its own stainless steel unit with different tuned lengths and better turbo packaging. Back-to-back tests showed this offered a significant improvement on the dyno.

This new engine is entirely different to the Duratec unit that preceded it in the Motorbase cars, but there are a number of similarities. The block bears a distinct family resemblance – the size and location of the crankshaft bearings are basically the same, as are most of the external mounting points. There are subtle differences in things like waterways and oil paths, but on the whole it's a question of evolution rather than revolution.

The Next Generation Touring Car (NGTC) rules require the use of a wet sump, so Mountune has raided the Ford parts bin for a production item from elsewhere in the family.





ABOVE & BELOW Initial performances fully justified Mountune's faith in the Ecoboost, the assembly highlighted here in CAD (above)

"You have to spend a lot of time and money making a wet sump work in touring car racing," comments Mountune founder and technical director, David Mountain. "The braking and cornering forces these cars are now generating makes things very difficult. You always have a degree of oil surge."

This effect is so pronounced that you can virtually map out the circuit from the engine's oil pressure trace. To try and combat this, Mountune has fitted an elaborate array of baffles and even resorted to a swinging pick up pipe that pivots to follow the movement of the oil. There are also gates with flap valves taken from a BMW production engine, which snap shut if the oil rushes towards them. As an additional safety measure, the engine control unit also has a cut-off function that can kill the ignition if the oil pressure dips too far or for too long.

You're not the only one if you're slightly taken aback at the level of complexity required just to keep the oil in place. "It all works out far more expensive than putting in a proprietary dry sump system," admits Mountain. ▶

Cost control is a major consideration, he explains: "We sell or lease an engine for about £30,000. Bearing in mind that Super Touring engines were twice that, we don't have the luxury of throwing money at things any more. The whole philosophy is to use production parts, but the challenge then is getting the best performance."

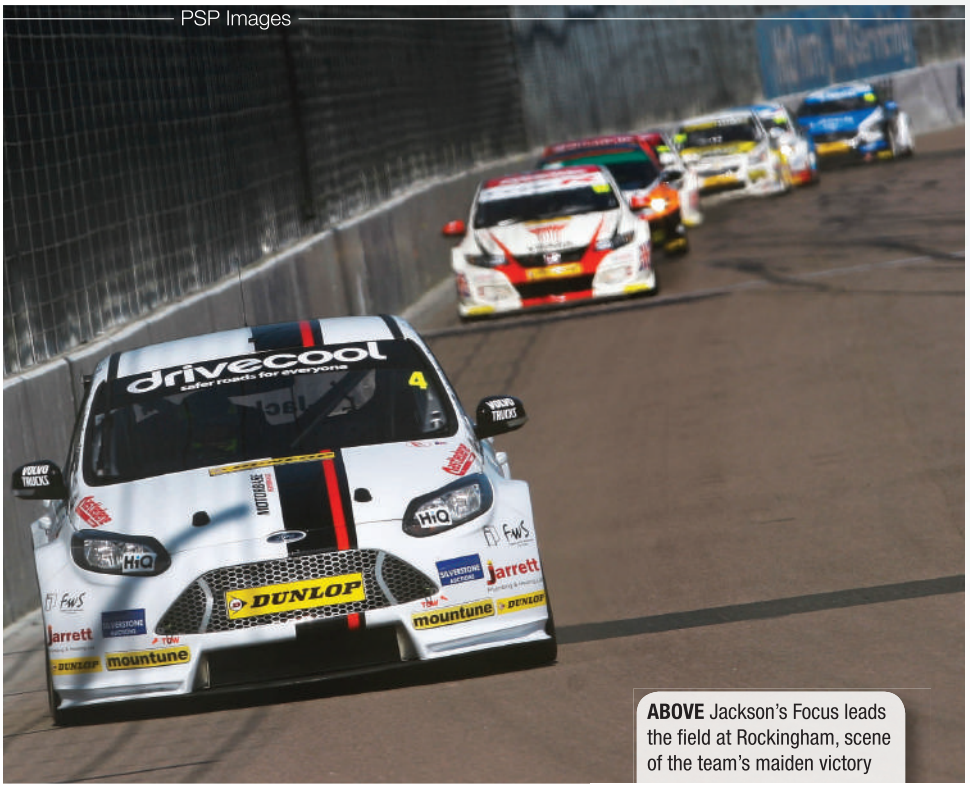
To that end, the production crankshaft is retained. The NGTC rev limit is a very modest 7,000 rpm so the loads on the reciprocating assembly aren't that different to a high-performance road engine. The sintered connecting rods from the production car, however, are replaced with steel rods from Arrow Precision.

From the combustion chamber upwards the Ecoboost engine starts to look a lot different to its predecessor. It introduces direct injection and variable valve timing – both of which are taken largely from the produc1tion engine.

"On the old engine we had to come up with a compromise between peak torque and peak power," comments Mountain. "We were quite surprised just how much more efficient the combustion chamber is. It's very noticeable, not just in terms of dyno testing but out on the track. The weaknesses of the old engine were response and torque, but between the variable cam timing and the direct injection we've made a big leap forward." ▶

> *"Between variable cam timing and direct injection we've made a big leap forward"*

PSP Images



ABOVE Jackson's Focus leads the field at Rockingham, scene of the team's maiden victory

ABOVE Mountune went to great lengths to optimise the bowl shape on the top of the pistons

ABOVE The block might bear a family resemblance but this Ecoboost is a very different beast to its predecessor

DIRECT APPROACH

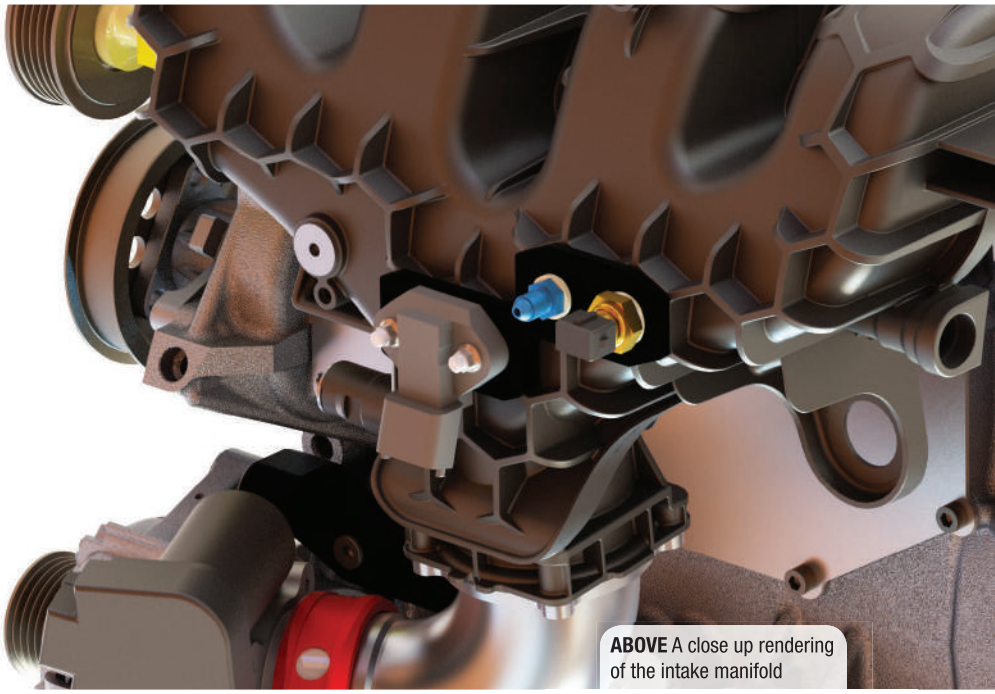
The TOCA rules don't allow any modifications to the cylinder head casting, so the ports are completely standard, as is the roof of the combustion chamber. Arguably more important on a direct injection engine, however, is the design of the pistons and here the teams are given free rein. Mountune went to great lengths to optimise the bowl shape on the top of the piston. This work was largely done in-house but with input from injector supplier Bosch and piston manufacturer Capricorn. Meanwhile, the standard injectors have been swapped for another road car pattern from the Bosch parts bin, which means the engineers were able to avoid turning to more costly motorsport-specific items.

"We ended up developing the pistons around the fuel injectors," comments Mountain. "The piston shape is quite different to the production engine. It has a central bowl, like the production engine, but it's more offset. We did quite a lot of CFD work looking at how the injector sprays into that bowl."

With stringent limits on boost pressure and compression ratio the cylinder pressures in the new engine are far lower than those in Mountune's rallycross engines. Even so, minimising blow-by and optimising the sealing proved to be quite a big job.

"We did three or four different variations of piston while we were testing, looking at things like ring positioning," says Mountain. "Because it's a siamesed block it suffers with bore distortion when it gets hot. That means we have a rather strange elliptical shape to the top of the piston to suit the bore. You want to absolutely minimise the clearance, but you can only really do that by taking an engine, running it for hours on the dyno and then looking at where it's scuffing. We've done all the usual deck plating and hot honing, but the fact is you cannot mimic the bore distortion; it's far from perfectly round when the engine is actually in use."

According to Mountain, getting the new engine to seal took a lot more work ▶



ABOVE A close up rendering of the intake manifold

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than the previous port injected unit. He has a theory that this may be due to bore washing from the direct injection system: "When we did the LPG engine for Arena we were almost having problems with cold seizure – certain areas of the piston crown were actually being super cooled and picking up on the bore. It might be something along those lines. Certainly getting the piston shape right has been tricky with this [Ecoboost] engine too."

The piston rings are a fairly conventional design from NPR. Most of the work has gone into the top land, which is not only barrelled but markedly elliptical. The road car uses a similar philosophy, but here it's taken to much greater extremes.

PERFECT TIMING

The variable valve timing system uses a solenoid valve to control the flow of oil into a hub bolted onto the intake cam's chain drive gear. This works a bit like a piston with oil pressure on both sides – increasing the pressure on one side rotates the cam in the opposite direction, allowing you to advance or retard the valve timing. The whole system is basically carried over from the production engine, albeit run at higher pressures to improve the response time.

> *"It drives beautifully because we're able to put the cam exactly where it needs to be"*

The total amount of adjustment is surprisingly large (something in the order of 45 degrees) although only the timing is affected. The camshaft itself is a bespoke item developed in conjunction with Piper Cams that uses a fixed lift and duration.

"We've had a lot of people comment on the idle," explains Mountain. "The old engine idled very much like a traditional race engine, but this one sounds like a road car. It also drives beautifully and that's because we're able to put the cam exactly where it needs to be."

Here, again, it is a question of building an engine to the specific nuances of the TOCA regulations. A maximum of 11 mm valve lift is allowed, which means the teams try to get as close to this as possible, particularly on the inlet valves. The rest of the design is free, but the boost pressure assigned to each engine under the performance balancing regulations is partly dependent on its intake valve duration. The teams have now got wise to the fact that running a shorter duration will give them more boost. Consequently it becomes a trade-off between increasing the boost pressure and keeping the intake valve open for longer.

"There's a homologation form that you can submit once a year, and over the last two seasons we've seen a lot of people changing their cam profiles," comments Mountain. "They started off following the logic you'd normally use for building a race engine and found they didn't get much boost. It didn't take them too long to work out how the performance balancing worked, at which point the cam profiles got shorter and shorter with less area under the lift curve."

Taking this approach too far can lead to durability issues. Running maximum ▶

BELOW The turbo is run some distance from the engine and an anti-lag strategy employed

> *"A trade-off between increasing boost pressure and keeping the intake valve open for longer"*

lift with a short duration results in very high acceleration rates, which can cause instability in the valvetrain.

The BTCC is quite unusual among production-based series for allowing the use of variable valve timing, although it is only permitted where the road-going engine uses the same technology. This, along with the direct injection system, is controlled by the mandatory Cosworth SQ6 ECU.

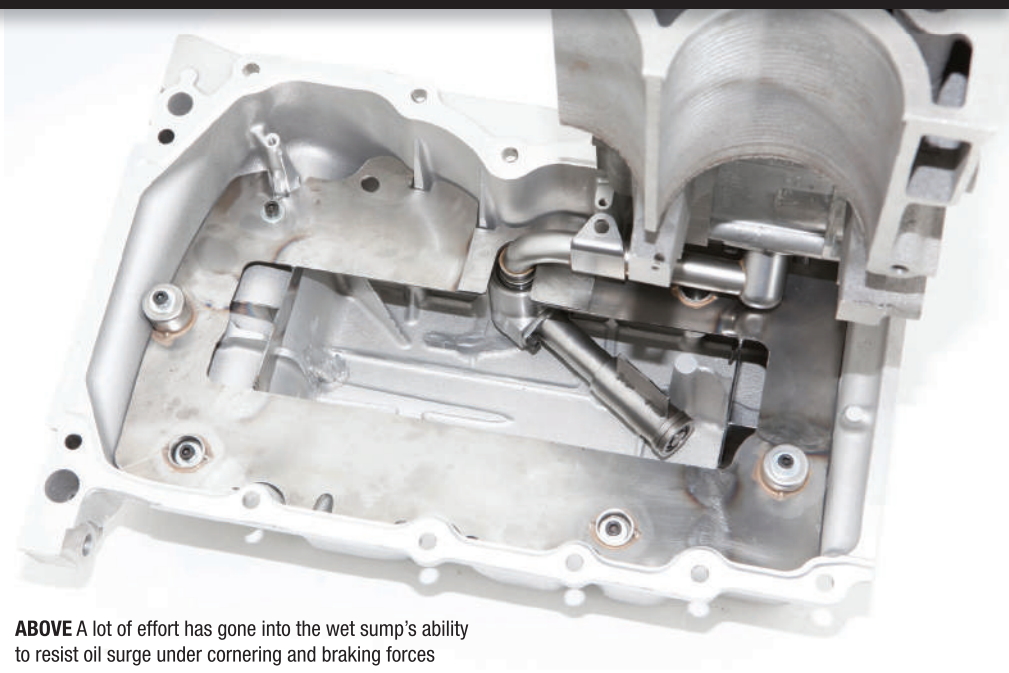
The turbo is another spec part. It's a Garrett unit modified by Owen Developments, featuring roller bearings and a lightweight vee-band turbine housing. The end result is said to be fairly similar to Garrett's own motorsport units but at a fraction of the cost.

Conventional wisdom dictates that the priority is to get the turbo as close as possible to the exhaust ports, but Mountain says they've found benefits from paying more attention to tuned lengths in the Milltek-produced system. "We try and optimise the power output first, which means running the turbo some distance from the engine," he explains. "If you did that on its own you'd end up with lots of lag, but we counter that with anti-lag strategies in the ECU."

Exactly how the anti-lag strategy is carried out remains a secret, but one of the benefits of running direct injection is that you can add small amounts of fuel on the exhaust stroke. This would clearly combust in the hot exhaust manifold, generating the necessary energy to spin the turbine.

OTHER BENEFITS

With the new engine, Motorbase has also found a number of other benefits. The packaging of the air path and the cooling system has been improved substantially, explains Collins: "It's a much tidier package. The positioning of the intake plenum means we can get the plumbing a lot neater. We've also managed to get much more efficient routing for the air and water hoses, which have improved the cooling and brought temperatures down in the engine bay."



ABOVE A lot of effort has gone into the wet sump's ability to resist oil surge under cornering and braking forces

By grafting Hydraflow's clamshell couplings onto flexible silicone hoses from Samco Sport the team has produced a cooling circuit that combines quick-release convenience with the impact absorption required to survive the rather physical world of touring car racing. Also on the cooling side, new intercooler tanks from Pro Alloy combined with the mandatory PWR intercooler core have resulted in tangible benefits. Meanwhile, a new air filter design from DNA Filtration has reportedly resulted in both greater airflow and improved filtration.

All this has added up to a package that has proved itself capable of winning races outright and claiming podiums even with 75 kg of success ballast onboard. Turning up halfway through the season may have put paid to the team's championship hopes, but recent performance suggests those dreams were indeed realistic. With more yet to come from the Ecoboost engine, who knows what 2016 may hold? RT

BELOW A long wait, but the team is now enjoying the spoils of success

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COMING TO A HALT

William Kimberley's update on brake technology

From F1 to Supacat

THIS year is proving to be remarkably successful for Alcon Components, the UK-based brake and clutch manufacturer. Having made further inroads into the OEM sector with Audi, Brabus, Jaguar Land Rover, Bentley with the Continental GT and Peugeot – first with the RCZ-R and now with the 308 GTI, described as the fastest, hardest production hot hatch to date – it has also helped Volkswagen Motorsport on its way to its third successive World Rally Championship. The feat was accomplished with the second generation VW Polo R that features a state-of-the-art Alcon braking system, including master cylinders and balance bar.

Meanwhile, in a completely different sector, it has worked with Supacat, a UK high mobility vehicle specialist, to deliver 89 Alcon-equipped "Jackal" Special Operations Vehicles. They are unique in being convertible to either a 4x4 or 6x6 configuration to meet different operational requirements.

As sales director Jon Edwards puts it: "At Alcon we have a reputation for delivering premium braking systems for the British defence industry. Winning this contract with Supacat for the Australian equivalent is clear evidence of our ability to transfer our motorsport knowledge into other extreme sectors."

It is motorsport, though, that runs through the brake pipes of Alcon. Its interests extend from Formula 1, the World Endurance Championship and NASCAR to Formula E where, as the sole supplier, Alcon is in a superb position when it comes to working with car manufacturers on their electric road car programmes.

"Formula E has been fantastic for us and is right up Alcon's street from a technical point of view and there's a great deal more to it than might meet the eye," says Edwards. "As suppliers of complete braking systems across all the teams, we've had to be right on our mettle. Take my word for it, these cars are quick – so our brakes have to perform consistently at their peak. With the controlled energy that the cars have at their disposal, it's essential that everything on the car is as efficient as possible. When it comes to brakes, as with all other rotating components, it's all about drag reduction, no matter how minute that may be. As a result, brakes are the subject of a huge amount of research as the off-brake drag – their mass, inertia and resistance – is key in all this.

"This has great implications when it comes to road cars. There's a great synergy between what is happening on the track and on the road because drivers of high-performance luxury electric cars require a similar braking approach. For example, at the onset of braking you don't want to have drag and you don't want to see daylight between the discs and pads, so controlling that so that there's a free-running brake with good feel takes work. It's one of the things that we've had to work on. We are also working with customers that have unconventional installations."

F1 CHALLENGE

As the supplier to a couple of Formula 1 teams, Alcon is still very much in the mix when it comes to keeping up with the required level of technology in the championship. Edwards is unable to talk about the details other than to say that it supplies brake-related components that are

a little bit smaller, a little bit lighter with a more bespoke packaging that enables the teams to do things slightly differently to the others and gain small advantages.

"As is typically the case with Formula 1 it means greater attention to detail on weight and the component, whatever its size, can be packaged with the rest of the car," he says. "The materials used are generally similar to other forms of top level motorsport, but just that little bit further in terms of mass reduction and package space.

ABOVE Trophy Truck racing is part of Alcon's North American expansion

LOWER FRICTION

"Anywhere there's a seal or a piston – and that doesn't necessarily have to be on a calliper – it's all about lower friction, better coatings and with a quite high service life with the long service intervals in Formula 1."

The company also supplies a number of teams competing in the World Endurance Championship, including one of the German LMP1 squads. It is also supplier to the LMP3 Ginetta, the company having a close affiliation with the British sportscar manufacturer.

Alcon's current expansion in North America has seen the company's growing involvement in top motorsport competition, supplying braking systems to major teams in headline attractions across the continent. They include off-road events such as Pikes Peak and Mexico's recent Baja 500, Trophy Truck racing being an area it is expecting to develop.

It is in NASCAR, though, where it is making quite an impact as a supplier to Joe Gibbs Racing, which has all four of its cars in the Chase at the time of writing. Its new short track/road course callipers have proved to be very successful, notching up a series of wins in the Cup.

"It's the first season of a new generation of a product that was sanctioned by NASCAR and which is now being used by Joe Gibbs Racing, plus others," says Edwards, "and it's working well for us." ▶

LEFT & ABOVE Defence has been a key word for Alcon this season, be it with the Jackal special operations vehicle (left) or the defence of VW's world rally crown (above)

Still at the cutting edge

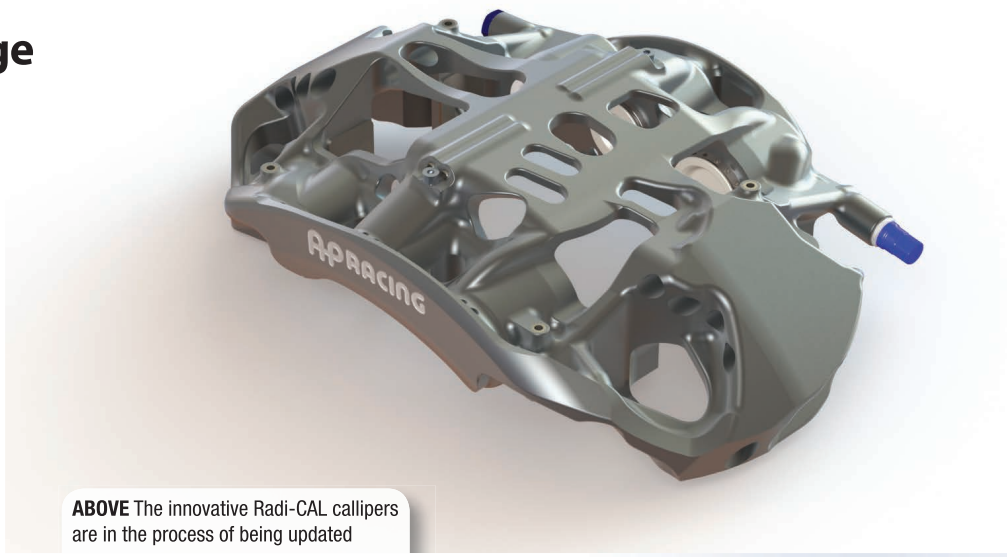
WHEN it comes to research and development, time does not stand still for AP Racing. Active in all forms of motorsport, it is constantly seeking to enhance and improve its products. For example, its patented range of Radi-CAL callipers, which were ground-breaking at the time of their introduction just under 10 years ago and which are still the cutting edge, are now in the process of being updated.

"We are improving and refining them and while the originals were a big leap on from anything that had gone before, we are updating them," says Richard Bass, chief engineer - brakes at AP Racing. "We've got many new callipers and when you look at these compared to the original designs, they are quite different. For example, the fixation points during optimisation are treated differently. However, one of the biggest evolutions is the improvement in driver confidence by refining the calliper stiffness characteristics under different operating conditions."

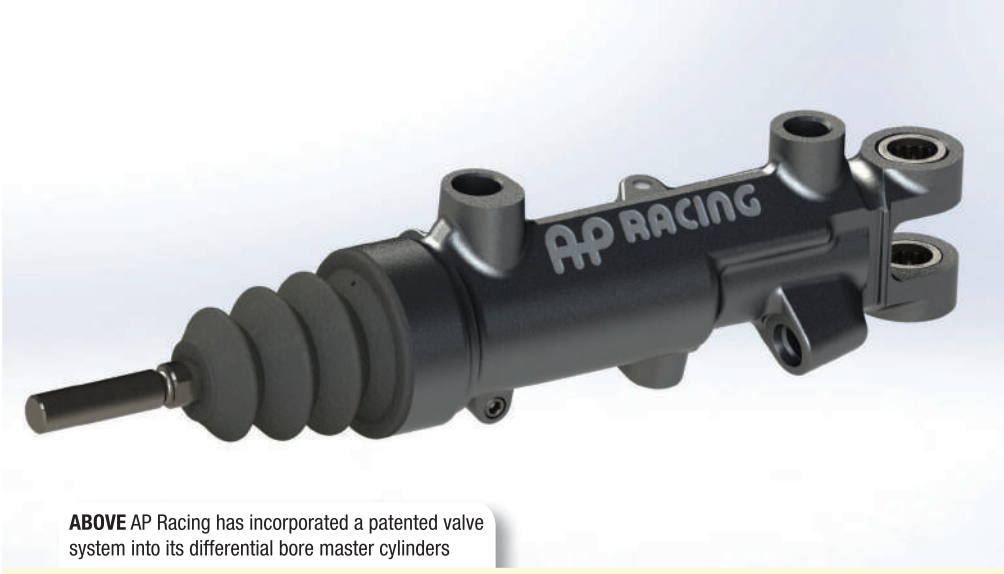
Last year AP Racing released the Pro 5000R callipers, the range being the entry-level, two-piece non Radi-CAL, cast aluminium type. "Using our Radi-CAL design principles we updated this range which has produced not only a superior technical product but also one that remains affordable for all levels of motorsport," reports Bass. "We initially designed and produced three different calliper solutions and are currently developing a new smaller four-piston version suitable for 13-inch wheels."

Bass says that AP Racing has been looking at differential bore master cylinders for quite some time. "They are not new and go back as a design more than 20 years, but have struggled to gain much market share for numerous reasons, not least cost and driver feel," he comments. "A differential bore cylinder comprises both a large and small bore. The large bore efficiently removes the long pedal travel associated with low pressure losses such as seal retraction, piston knock back, compression of any air left in the system and seal squash that occurs at the start of braking.

"When the brake pressure transitions into the high pressure range, it moves over to a smaller bore through a system of valves and then switches back again as the pressure comes back down; as the driver brakes into the corner, the cylinder can switch between ▶



ABOVE The innovative Radi-CAL callipers are in the process of being updated



ABOVE AP Racing has incorporated a patented valve system into its differential bore master cylinders

ABOVE AP's Pro 5000R calliper

bores dependent on braking pressures which can be detrimental to driver feel. AP Racing has incorporated a patented valve system so that it switches over as the pressure increases and then stays closed on the way back until the driver comes completely off the brakes.

"To date the parts have been produced as prototypes from billet and are relatively expensive. But we are moving into a position where we believe the product has been developed sufficiently to productionise and produce as a forging, allowing the product to be sold at a more competitive price."

Bass also says that the company has improved its cast-iron brake disc, the S (Sinusoidal) vane disc that runs disc temperatures up to 70-100°C cooler than conventional vane patterns, providing significant improvements in performance, wear rate and reliability. "The vanes of a disc are normally a standard radius but these feature a curved vane that we first introduced in NASCAR with two or three different versions featuring a different number of vanes and disc thicknesses. This type of design was then introduced into Touring Cars and GT. Our latest design offers discs up to 408 mm in diameter, although the initial design from this casting will be a 390 mm version. The production of these castings is technically challenging to ensure we maintain core stability through the process."

AP Racing is also working on a sliding pedal box solution to comply with the potential new safety regulation of a fixed driver seat in GT Racing. This solution will still allow the accommodation of different height drivers in the same car.

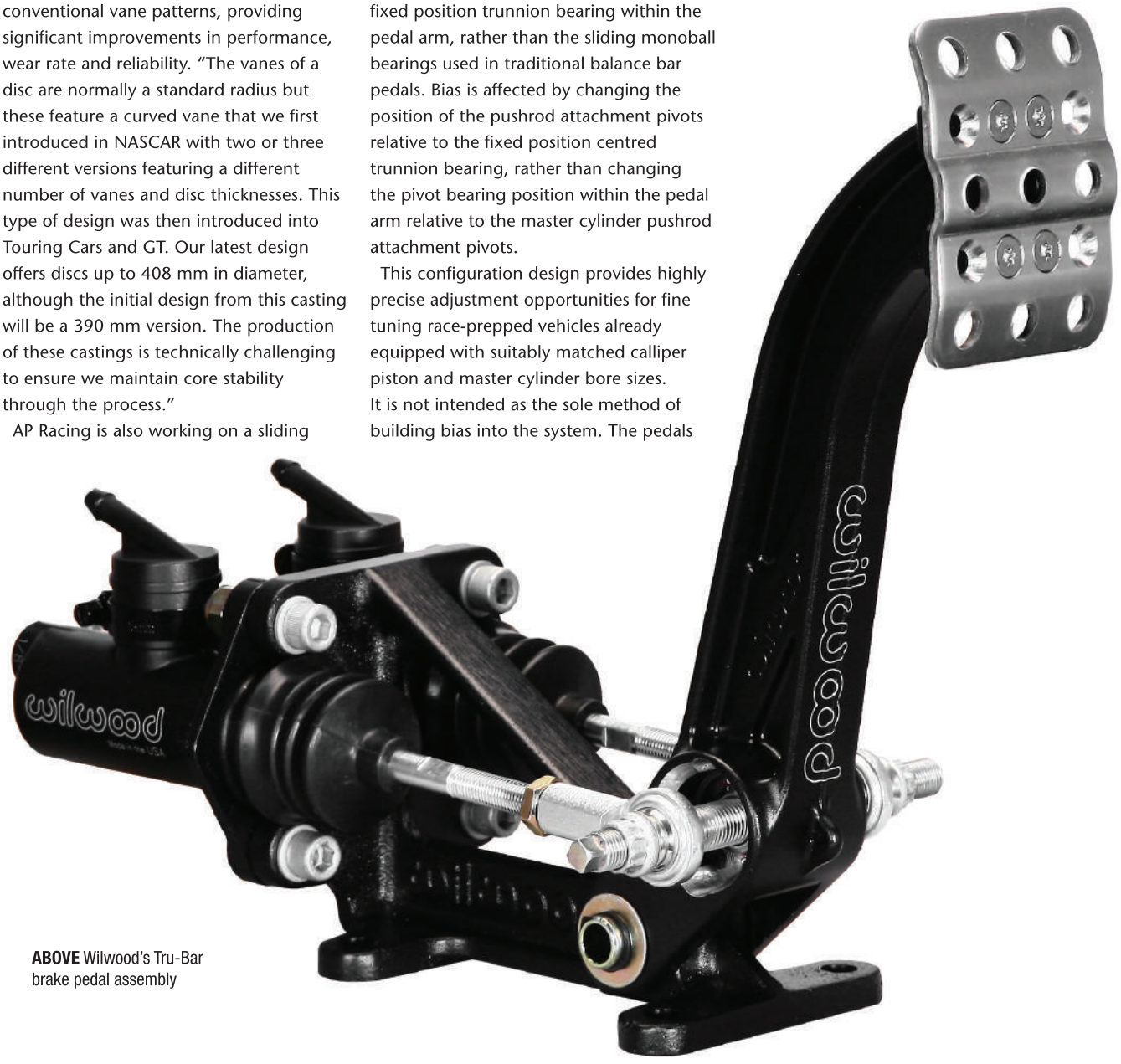
"Our initial design did not require the integration of a throttle pedal, however we are currently in the process of designing a generic version that will incorporate a throttle and our pull-type master cylinders," says Bass.

Stopping the Wilwood way

IN August Wilwood released its Tru-Bar brake pedal assemblies that incorporate a fixed position trunnion bearing within the pedal arm, rather than the sliding monoball bearings used in traditional balance bar pedals. Bias is affected by changing the position of the pushrod attachment pivots relative to the fixed position centred trunnion bearing, rather than changing the pivot bearing position within the pedal arm relative to the master cylinder pushrod attachment pivots.

This configuration design provides highly precise adjustment opportunities for fine tuning race-prepped vehicles already equipped with suitably matched calliper piston and master cylinder bore sizes. It is not intended as the sole method of building bias into the system. The pedals have the same mounting dimensions and requirements as their sliding monoball counterparts and can be bolted directly in place, without modifications, and use the same remote adjuster cables.

According to Wilwood, its balance bar provides the ultimate in precision control, feel and adjustment accuracy on twin master cylinder brake pedals. Other features include step-shouldered adjustment bar ends that provide a positive stop to attach all traditional 3/8-24" thread adjuster cables, zero balance migration, overall improved feel, accuracy and response from the stiffer, close tolerance assembly and forged arm pedals with adjustable no-skid stainless steel foot pads. RT



ABOVE Wilwood's Tru-Bar brake pedal assembly

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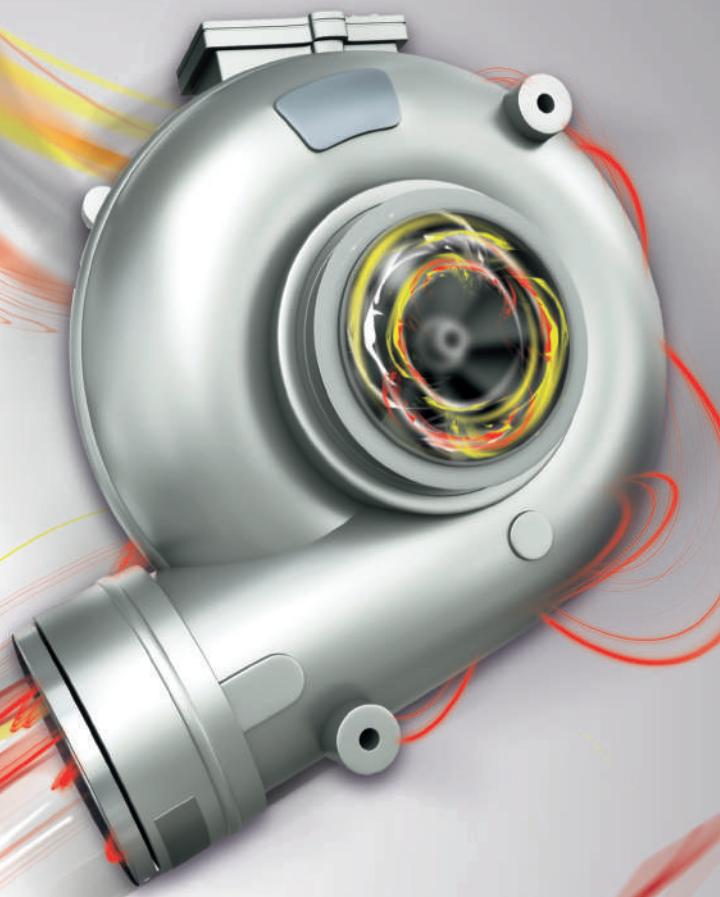

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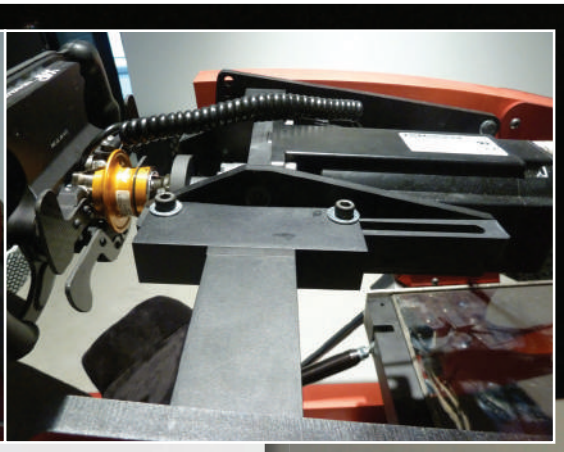
COME THE EVOLUTION

Pro-Sim's Evolution II is a completely new design of simulator that has evolved out of the UK company's flagship model

ENGINEERED from the ground up, the Evolution II is basically a one-size-fits-all so that it can transform from a GT driving position into Formula 1 at the touch of a button, with the perfect seating position and comfort in both forms. As with all Pro-Sim products, the new Evolution II is being manufactured to ISO 9001 specification and is only built using the best materials and techniques available.

With the Evolution II, Pro-Sim set out to make a high-strength frame that could be used for race driver training and be capable of taking extremely high loads. It is



ABOVE & BELOW Easily-adjustable pedal feel and a high strength frame are key ingredients of the Evolution II

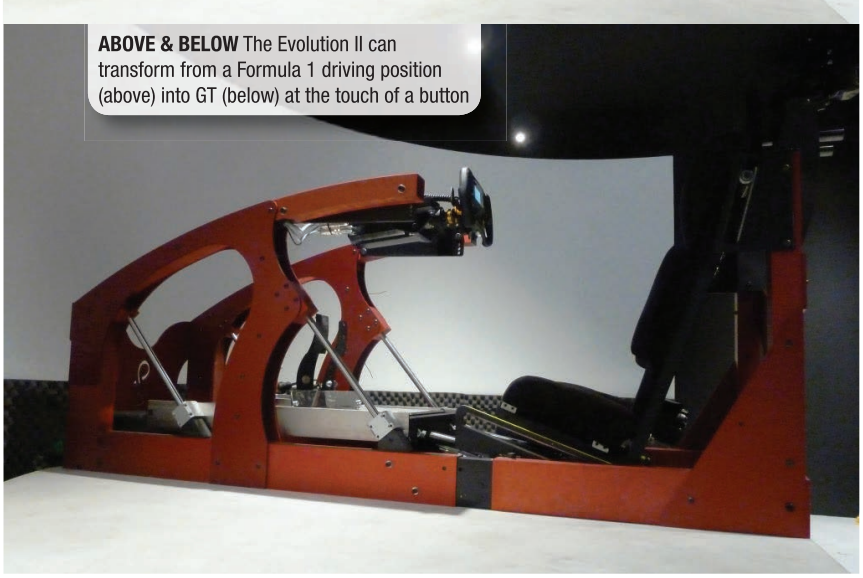
completely solid, its unique shape using the latest and best stress analysis tools to ensure that the frame can take the maximum braking loads and achieve zero flex. "Nothing is worse than braking hard and having the frame flex under your feet as all the realism disappears at that moment, but this is not something you will have to worry about with the Evolution II," says Pro-Sim boss Adrian Quaife-Hobbs.

The Evolution II uses many concepts and parts from Pro-Sim's main simulator. These include the same pedal set that features its latest brake design where the pedal feel can be completely adjusted in around five seconds and can easily take over 200 kg of force. Pro-Sim has calculated the pedal feel for each type of car with five different variations in different colours.

The throttle pedal has three positions of force that can be adjusted to suit the driver's requirements. "We use the highly regarded sim steering force feedback system using our specified motor for the perfect inertia matched to our frame for the ultimate feel of the road," says Quaife-Hobbs. The steering is also supported from the sides, allowing comfortable left or right foot braking.

He goes on to say that the manual gearchange option delivers unparalleled realism by utilising a Quaife gearchange mechanism that gives exactly the same feeling as a real sequential gearbox. "We also have two lengths of gear lever available for either GT or single-seater gearchange," he says.

The Evolution II can be adjusted in every way possible to ensure everyone can find the perfect driving position, no matter what size, to achieve the best lap times possible. The steering wheel can be adjusted up/down, forward/back, as can the seat which can also be reclined. It also features a tactile feedback system so that every bump on the road can be felt through Pro-Sim's special profile that uses the car's physics to provide feedback.



ABOVE & BELOW The Evolution II can transform from a Formula 1 driving position (above) into GT (below) at the touch of a button

> *"A truly revolutionary development"*

"Our simulators are truly unique in the fact that nearly every part of them has been designed and manufactured in-house," says Quaife-Hobbs. "With this approach it has allowed us to spend time developing the best possible. When we looked at all the simulators and companies already on the market, we realised that although they all have good points, there wasn't one that had all the good points in one package and that is where we've come in. We meticulously went through every detail on all the available simulators and then thought of a way to make our one better, which is when the Pro-Sim simulator was born.

"We are also soon launching a truly revolutionary development for our simulator which is G-force applied through the helmet. Wearing one of our specially designed helmets in our simulator the driver will be able to feel the same G-force as experienced on the racetrack in the simulator in real-time. This has huge benefits for feeling exactly what the car is doing through constant cueing and also in driver fitness." RT

The game moves on

Scotty Whitelaw meets one of those behind-the-scenes companies supplying much of the technology that goes into a huge variety of simulators

LEO Bodnar Electronics is a designer and developer of universal joystick/game controller PCBs, simulator force feedback steering systems and supplier of components such as push buttons, rotary encoders and switches. Being based at Silverstone, it works closely with and meets the needs of race teams, drivers and simulator manufacturers.

"We supply our systems to many race teams as well as to the majority of top race driver trainer centres in the country and also others around the world," says company director John Beeson. "It's difficult to give an exact number of different race drivers who have used our system over the past few years but it really is very many. The chances are if you've used one of the simulators at a race driver training centre it was probably our system you used. We receive a great deal of feedback from our customers and make any necessary improvements that may be required either on a per customer basis or as a general improvement for all customers if necessary."

Beeson explains that what differentiates his company's products is the level of sophistication. "Internally our device processes around one million positions per turn and we are unaware of any other system that even comes close to this.

"Our force feedback steering system consists of an industrial-grade servo motor with a very high resolution feedback device along with our integrated control box and power supply unit. The control box communicates to a PC via USB and is presented to Windows as a generic force feedback game controller device, meaning that it is compatible with nearly any form of race simulation software or game. Customers can mount their own steering wheel to our force feedback system or they can purchase one of our range of simulator-specific wheels which also communicate via USB. We have a range of motors available that can output enough torque to simulate real life forces for all types of motorsport, and beyond if necessary for strength training."

Leo Bodnar Electronics has a standard range of wheels but it is able to customise them to individual requirements. "We use real steering wheel hardware from XAP, which supplies wheels to many race series, including GP2, GP3, Formula 3, Formula E, Renault World Series plus many more," says Beeson. "We then install our own electronics into the wheel hardware and turn them into simulator-specific devices allowing customers to have exact 1:1 replicas of what they will use in the car.

"We also supply a range of GT-style wheels but as there are so many different types used in the real world these are a bit more generic; we then match them to our customer needs, giving a very similar look and feel to the real thing. We have received feedback from some customers stating they prefer these to the real ones."

Most of the other force feedback systems that are available to buy off the shelf have been designed for home use and tend to mostly be made of low-cost components. "While some of these are adequate for a bit of fun, they do not provide anywhere near the amount of feedback or reliability required in a professional environment," comments Beeson. "Our system comes from the other end of the spectrum where a customer requirement for a high end system specifically for driver training came about and over the years we have perfected it into what it is today. Having said that, our system can also easily be installed at home as it is very much a plug-and-play system and a lot of drivers have bought it for their own home training.

"We are also very flexible with customer requirements. For example, we were recently asked to make changes to allow for many turns of steering lock for an America's Cup boat simulator."

Over the past year the company has developed a new SimSteering2 system with very high resolution feedback that has recently been made available to purchase. It also has some additional features including inertia and friction effects giving the driver a dramatic increase in the amount of realism felt through the steering feedback.

"We are constantly making improvements and adding new features to the system too and we also welcome any specific requests that customers may have," suggests Beeson. "Next year we are looking at making another step forward with the technology but at this stage I don't have too many details." RT

BELOW The SimSteering system was born of a demand for high-end equipment for driver training purposes

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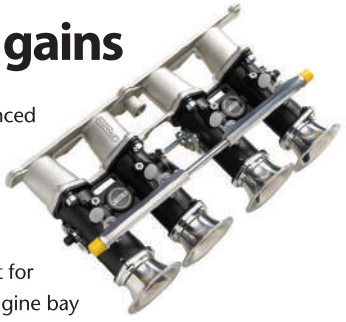
Taking a breather

FILTRATION expert Pipercross has reminded us all of a small-but-perfectly-formed performance essential in the form of its stainless steel crankcase (or valve cover) breather. This simple but effective part has been designed to fit onto existing engine crankcase breathers and oil catch tanks to allow oil vapour to vent to atmosphere rather than back into the engine inlet, thus protecting the engine and allowing it to run more efficiently.

Made of sintered stainless steel it has a clever rubber inlet neck with a simple clamp mechanism for securing and a built-in stepped neck to fit 13, 16 or 19 mm pipework. The filter inside is infinitely reusable, and easily cleanable, making it perfect for high-stress, track day and motorsport use. The complex foam structure used draws heavily on Pipercross' BTCC experience, as the firm is supplying almost every leading team on the grid for the 2015 season. Best of all, each filter is lovingly hand-crafted in Pipercross' UK factory. RT

Pinto power gains



JENVEY Dynamics has announced the launch of a new manifold and throttle body (ITB) kit for the popular Ford Pinto engine that is highly modular by design and perfect for configuration for a range of engine bay packaging requirements or aesthetics. The company claims that it provides power gains, improved throttle response and reliability, and is ideal for road, track or race use as a modern alternative to a traditional twin carburettor setup. The kit includes the new fuel injection inlet manifold, a pair of twin 45 mm throttle bodies, a single-piece aluminium billet fuel rail and 40 mm long trumpets. Being modular by design, standard manifolds have additional aluminium to allow for port-matching to modified cylinder heads, machining for throttle bodies up to 50 mm and feature undrilled bosses on the underside for air/vacuum take-off.

"Jenvey is proud of its innovative reputation, and we invest a lot of time talking to customers to establish where there is a need for new Jenvey products, or where we believe we can make significant improvements to what is already available – the new, Pinto ITB kit for distributorless ignition is a perfect example of Jenvey bringing another exciting new product to market," says Jenvey Dynamics managing director, Mike Jenvey. "The overhead cam Ford engine has been used for decades in a huge range of vehicles on both the road and track, and is as popular now with race engine builders, track day hobbyists and Ford enthusiasts as it has ever been. Jenvey's new ITB kit brings modern technology to a trusted and popular engine, and as a direct alternative to traditional twin-carburettors provides an added dimension for tuners whether they are seeking an increase in power, improved driveability or simply greater reliability for road use." RT

Getting lit up

LAZER Lamps has released details of its Triple-R 750 duo of Standard and Elite models that have been granted E-mark certification and are therefore fully legal for use on public roads. Each one possesses over five times the peak intensity of the equivalent model in its popular ST/RS range of driving lights. Even the Triple-R 750 Standard delivers enough illumination (1 lux) to read a newspaper 430m away from the light source, while the Elite model features higher output LEDs that are 20% more powerful. This long-range optics means the Triple-R 750 range is a superb aid to night-time vision on public roads. The larger Triple-R 1000 Standard model has also been submitted for E-mark approval with positive approval expected in the next few months.

Lazer Lamps has also announced that the entire Triple-R range is now available in an alternative colourway – a new black outer finish. This hardwearing colour option will be welcomed by those looking for more discreet, OEM-style integration of their auxiliary lights, without losing anything in terms of lighting performance. RT

ABOVE The Laser Lamps R 750 Elite that is now fully road legal

Superior resistance for Japanese models

ON their launch in 2013, the jointly-developed Toyota GT86 and Subaru BRZ coupes were acclaimed as genuinely engaging driver's cars. Although they were developed to display oversteer-biased handling, a flexible relationship between braking performance and the road surface is detrimental to safety and driving enjoyment. However, despite the performance potential of both cars, the original equipment list does not include technically superior and race-proven armoured brake lines. However, Goodridge has developed a braided stainless steel brake line kit that it claims offers superior resistance to abrasion and corrosion, unrivalled braking efficiency through greater reliability, and a complete absence of sponginess through the brake pedal, irrespective of how hard the brake fluid is worked. Furthermore, with a choice of 10 different colourways, Goodridge offers owners the opportunity to be proud of both the look and performance of their brake lines. RT

IndyCar

How to make a small fortune

Sergio Rinland argues that motorsport's tried and trusted business model simply doesn't work anymore

HOW do you make a small fortune in motorsport? Many people will tell you the answer is "start with a big one"!

The motorsport business model of the past few decades is no longer working. We always had rich teams and poor teams but, because the amounts are so big today, the gap is too large to fill with the current model.

In the first 60 years of the 20th century motorsport at the top was financed by the big automotive manufacturers, tyre manufacturers and fuel suppliers. It was enough because the costs were contained, not by rules or regulations, but by the times and technologies. The lower feeder formulas were inexpensive and simple enough for people to build their own racing cars and for small teams of friends to help them on the weekends.

All that started to change in the 1970s, with the advent of non-automotive sponsors (initially tobacco companies). All of a sudden, there was more money to spend. All the commercial sponsors wanted to see was their brands on the side of the cars, which was enough to complement their marketing campaigns.

The technology started to get more complex and specialised, not only to build the racecars but also to service them, initiating the era of larger professional teams in F1, sportscar racing, IndyCar and in the lower feeder disciplines. Racecar manufacturers became more professional and more dependent on winning for survival, incrementing the costs of cars and development to the point that in the 1980s we started to see controlled one-make series with the aim of reducing costs and maintaining the status quo. I have to say, they never succeeded!

At that time, F1 started to grow as a major business thanks to television and the efforts of Mr. B Ecclestone, who still runs the business today. The motorsport industry worldwide became enormous as a consequence.

We are now well into the 21st century. Television viewers are declining, easy tax-free money for sponsorship is no longer available, and corporations have different needs and ways of marketing. Cars are increasingly more expensive to build and run and motorsport is starting to feel the pinch, beginning with the lower disciplines and the smaller teams at the back of the grid in F1, IndyCar and sports cars. This points to the fact that the business model of the last part of the 20th century is not working: we need to change tactics.

Reduce the technology content to be more economical? I do not believe that is the answer, particularly when the automotive manufacturers who develop high technology content in their vehicles seem to be again one of the few anchors we have as a business.

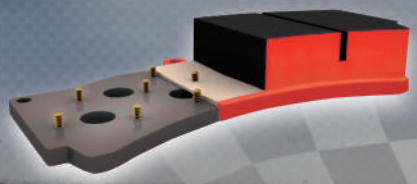
Any businessperson worth his salt will tell you that to make money you have to generate revenue; saving money was never a way of 'making' money. SSS (Stop Stupid Spending) yes; saving, and as a consequence sacrificing the business, surely not.

> *"Promote motorsport for what it can do today, instead of force-feeding corporations with a product that was good 40 years ago"*

We need to change the business model and look for revenue elsewhere: use the cars as technology demonstrators and developers; look at how social media and IT businesses are earning their fortunes and try to tap into similar strategies. Promote motorsport for what it can do and give to the public and corporations today, instead of trying to force-feed them with a product that was good 40 or 50 years ago but for which the 21st century no longer has the appetite. Give them the opportunity to use motorsport for their benefit, instead of the other way round, as it is today. In short, a different business model.

PAGID RACING

Brake control from green light to chequered flag.



PAGID RST

Double DTM Champion Mattias Ekström has clinched his first-ever FIA World Rallycross Championship victory after a flawless drive in the Audi S1 EKS RX in Holjes, Sweden. In his RX campaign, Mattias relies on the supreme stopping power of PAGID RST racing brake pads – high initial bite, constantly high friction over temperature with excellent modulation over the whole temperature range. With the highest degree of braking performance, PAGID RST racing brake pads deliver the competitive edge that successful drivers demand.

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