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COVER STORY Page 30

"The blame culture only made the lead-in to a new car or update more fraught"

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The Flaws in Formula 1

ALTHOUGH some time has passed since the Federation Internationale de l'Automobile (FIA) announced major revisions of its Formula 1 racing specifications, the air of controversy that announcement precipitated shows no sign of clearing. Xxxx xxxx plans to suspend its production of racing engines before the new formula goes into effect next January. And zzzz zzzz has hinted darkly that with xxxx xxxx out of the picture, he foresees no future participation of his racing cars in Formula 1 events.

Well, you might be thinking, this is old news – and yes it is, actually. I have lifted these words in their entirety, including the title, from an article that renowned motorsport journalist Paul Frère wrote exactly 50 years ago in the US publication *Automobile Quarterly*. In case you are wondering, the xxx xxxx stands for Coventry Climax and the zzzz zzzz for Colin Chapman.

So why am I doing this? It's because, I suppose, that for all the posturing that takes place in Formula 1 and in the higher echelons of the sport, nothing has changed. We might consider the political manoeuvrings are a modern phenomenon but this shows that this is far from the case. All that has happened in the intervening years is that the means of communication have sped up so that when Christian Horner, for example, has a pop at Renault, it's absolutely immediately reported by all and sundry.

Dipping back into Paul Frère's article, it does make fascinating reading. The new rules being introduced for the 1966 season were allowing turbine-powered cars as long as they complied with the minimum weight specifications of 1,100 lb set for piston cars. He then goes on to say that "even if gas turbine cars gained wide acceptance, little benefit would be gained from racing with them; the development of the turbine for passenger car use seems to have no practical utility at this point."

The same regulations were allowing both normally aspirated 3.0 litre engines and 1½ litre supercharged and also rotary engines. They also allowed both two and four-wheel drive and automatic transmission. What today's Formula 1 engineers would do to have such open regulations in which to ply their trade. However, as Frère pointed out, "One cannot help feeling though that the new Grand Prix formula is a rather expensive way to put racing car builders and their suppliers to task, quite apart from the fact that it is based on a hardly scientific fist-and-thumb approach handicap: the FIA obviously hopes to broaden Formula 1 racing, to facilitate the use of different kinds of engines, each working on entirely different principles. The motive is praiseworthy even if the result is not."

He ends his article with the following: "Even today, it is extremely difficult for a builder of Grand Prix cars to make a profit; thus it is easy to see why many of them do not look forward to next year with much enthusiasm, and others hope to produce sports cars that use big American modified engines. The latter would seem a much more realistic way to go motor racing at a high level of performance."

It was while working at *Motor Sport* magazine that the late great Denis Jenkinson told me always to look forward, think of the future and just use the past as signpost to see what went right and what went wrong and learn from that. How right he was. RT

William Kimberley
EDITOR

'Scary' race heaps aero pressure on IndyCar

Andrew Charman

FONTANA, CA: The Verizon IndyCar Series' troubled introduction of its superspeedway aerodynamic kits continued at Auto Club Speedway, Fontana on 27 June after a wild race with several major accidents saw series officials come under sustained criticism from drivers.

Last month *Race Tech* reported how modifications had been forced on the aerodynamic kits, which this year are bespoke to each engine manufacturer and approved by IndyCar, after a clutch of accidents during the Indianapolis 500 meeting that resulted in cars flipping into the air after spinning.

Before the race on the 2.0 mile Fontana oval, which has 14 degree banking, IndyCar specified that the aerodynamic configuration would remain as in the rulebook – rear wing main element angles were set between 0 and -10.5 degrees, compared to the -6 to -10.5 degrees that had been specified for the 6 June race on the 1.5-mile, high-banked Texas Motor Speedway oval. IndyCar officials reasoned that the six degrees of extra rear wing angle would add around 300 lb of downforce to compensate for expected afternoon temperatures of 90°F ambient and higher on the track. The previous three races at Fontana had taken place in the evening under lights.

In the race the cars circulated constantly in close packs often running three and four abreast, with some drivers taking what rivals dubbed "crazy risks" to make passes and major accidents resulting.

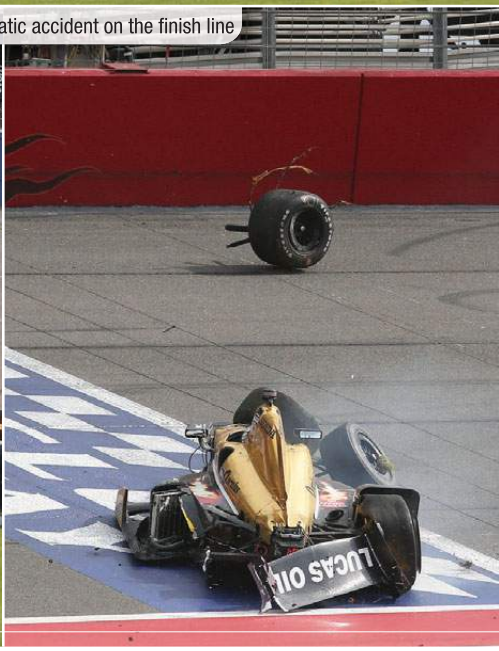
The final and most frightening incident saw the top-five running car of Ryan Briscoe launched into a series of backward cartwheels through the infield after contact with the car of Ryan Hunter-Reay. Briscoe was unhurt in the incident, despite saying afterwards that IndyCar medical official Dr Terry Trammel had told him the car recorded a 50G impact when its nose first dug into the ground.

Despite his crash Briscoe refused to criticise the standard of racing at Fontana, posting on social media service Twitter that the race had been "awesome. A few drivers need to show more respect out there, but the racing was fierce and exciting."

However ,several leading drivers were fiercely critical with veteran Tony Kanaan



ABOVE & BELOW Ryan Briscoe was able to talk away from this dramatic accident on the finish line



Photos: Chris Jones/IndyCar-IMS

ABOVE Wheel to wheel: the Verizon IndyCar race at Fontana was characterised by three and four-wide pack racing

Photo: Chris Jones/IndyCar-IMS

likening the racing to the situation that resulted in the death of British driver Dan Wheldon at Las Vegas in 2011.

The 2014 champion, Will Power, who was eliminated in a collision with Takuma Sata late in the event, dubbed it insane. "You just cannot have to take massive risks to gain track position – that's crazy racing," he said. "We just don't need another incident like we had at Vegas, and running like this it's just a matter of time."

Fourth place finisher Juan Montoya supported him, saying that with the pack racing sooner or later "somebody is going to get hurt."

Kanaan added, however, that no fault could be laid at IndyCar's door as the aerodynamic kits are equally new to officials. "We can't say we chose the right or the wrong aero package because this is new. We went to Texas and it was okay, but I heard a lot of criticism about it being a boring race."

Others too were more supportive, race winner Graham Rahal saying that the format was far better than previous low-downforce configurations that made racing impossible. "It was the closest racing we've seen in a long, long time, but it was very different than the old pack-racing style where it was just flat and you place it where you want," he said.

Series head Mark Miles was not impressed, however, with the anger displayed by the drivers and their team owners. While criticism from fans was fully acceptable, he said, "What I didn't love was our members… by whom I mean representatives of teams and certain drivers… really going too far with their public statements.

"Comments started to be made that weren't so much just opinions about the setup, but were really very, I thought, potentially damaging to the sport, to the series."

His comments came as speculation grows of an increasing distance between drivers and teams and the IndyCar series organisers. RT

Daytona crash destroys fence and Dillon's car

Andrew Charman

DAYTONA BEACH, FL: Safety standards on NASCAR's 'restrictor plate' tracks of Daytona and Talladega are again in the spotlight after a finish-line crash in the Coke Zero 400 Sprint Cup race on 5 July saw Austin Dillon's Chevrolet launched into the debris fencing, ripping out a section of around 60 feet in length and in the process slicing the car into several sections.

The integrity of the cockpit safety cell in Dillon's car was not compromised, however, and it came to rest upside down on the track with its engine and transmission lying several feet away amid a wide debris field. Pit crew members broke regulations to rush to Dillon's aid but despite the severity of the accident he was unable to step out of the car with only minor bruising.

Five spectators were treated for injuries from flying debris, with one briefly hospitalised, and reports in following days suggested some would attempt to sue the circuit.

Officials pointed out that despite the violence of the crash the fence had performed properly by keeping the car from flying into the grandstand. Speaking to SiriusXM radio on the Monday afternoon following the race, NASCAR chairman Brian France said that work had already begun at the sport's research and development centre in Charlotte to analyse what had occurred and how it could be prevented in future.

France added that the aim would be to keep cars from becoming airborne while maintaining the close racing that fans want. NASCAR also confirmed that the crew members who ran to Dillon's aid would be spoken to but not penalised.

Daytona International Raceway president Joie Chitwood said that new escalators installed in the grandstands as part of the latest improvement programme had helped with safety – spectators now walk down to the lower-level seats from the middle level, instead of the former situation in which they were obliged to walk next to the fence during a race. RT

Russell LaBounty/LAT Photo USA for Toyota Racing

BELOW Feel the force: Kyle Busch celebrates victory at Kentucky, his Toyota Camry clearly showing the smaller front splitter and rear spoiler

NASCAR expands search for right force

Andrew Charman

DAYTONA BEACH, FL. NASCAR's search for an aerodynamic package that produces more entertaining racing is to be extended, with four more Sprint Cup races in the 2015 season to be run with bespoke setups. The decision comes as the first race with a changed package, at Kentucky on 12 July was declared a major success.

As a result a similar setup will be run at Darlington Raceway in September, while a new rules package producing higher drag will be produced for the races at Indianapolis on 26 July and at Michigan in August, and at Richmond a month later a different tyre specification will be employed.

The Richmond race on 12 September will provide the final chance for drivers to qualify for the season-ending Chase for the Cup. It is believed that NASCAR is unlikely to experiment with potential 2016 packages in the 10 Chase races, though according to racing head Steve O'Donnell, no decision has been made.

The package used at Kentucky saw the rear spoiler shortened in height from six to 3.5 inches, and the front splitter extension panel or radiator plan 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.

The Darlington package will be similar, but the rear spoiler will be 3.5 in, and the front splitter will have a quarter-inch wide leading edge fitted.

The Indianapolis and Michigan package will consist of a nine-inch rear spoiler with a one-inch 'wicker bill' (a vertical flap) fitted to its leading edge. Rear fascia extension panels will be used in similar fashion to at superspeedway events along with a two-inch leading edge on the splitter and a splitter extension panel of 43 inches.

Despite rain wiping out most of the practice sessions and development time with the new aero package, the Kentucky event was considered one of the best races yet seen at NASCAR's most prevalent 1.5-mile 'cookie cutter' tracks, and particularly at Kentucky which has been criticised for a lack of action in the four previous races held at the track. The 2,665 recorded passes under green flag racing conditions were more than double those in last year's Kentucky event.

Joe Gibbs Racing driver Carl Edwards, a noted critic of previous NASCAR rules changes, summed up the feelings of many of his colleagues, saying: "I felt like a race car driver tonight – I could actually drive the car. I was steering and sliding… I felt like I was doing something, not just sitting in line."

Race winner Kyle Busch was able to catch and pass the Penske Ford of Joey Logano late in the event, closing to a distance that would normally have put his car in the dirty air from Logano's and made it very hard to pass.

"When I got to Logano, I knew he was going to come up and block my lane and take my air," Busch said, "But when he did, it wasn't as bad as it has been with the other aero package where you just stall out and that guy can basically manipulate whatever you're going to do."

Sprint Cup tyre supplier Goodyear had too little notice of the Kentucky changes to produce a softer tyre, which would complement the aero package, and drivers believe this will improve the package further.

* NASCAR has also announced that teams in the second-division Xfinity Series will also use a high-drag package at the Indianapolis meeting. RT

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Citroën to choose – WTCC or WRC

Andrew Charman

PARIS, France: Citroën Racing has announced that it intends to contest either the World Touring Car Championship (WTCC) or the World Rally Championship (WRC) from 2017, but not both.

The French manufacturer has added that its decision – part of a major review which will see the merger of Citroën and Peugeot's motorsport divisions – will be made by the end of this year. Key factors being taken into consideration will include the level of competition, logistics needed to support a programme and the Chinese automotive market, where the brand has major ambitions.

Citroën runs C-Elysee cars, which are sold in China, in the WTCC and the series has announced its intention to add more races in the region to future schedules. The WTCC is logistically less expensive to compete in than the WRC, in which Citroën has a long and successful history, though it has struggled this season.

However, the brand is believed to be unhappy with the level of competition and therefore coverage it is receiving for its WTCC programme – the C-Elysee cars have dominated this year's series and appear set to take both the driver and manufacturer titles for a second successive year.

While reputedly no decision has been made, an unnamed source has told *Race Tech* that the decision is leaning towards WRC.

Citroën's situation has been likened to that of Chevrolet, which dominated the WTCC between 2010 and 2012 and then withdrew from the series.

Meanwhile WTCC head Francois Ribeiro has stated, reports the TouringCarTimes website, that at least three new manufacturers are considering joining the series, one possibly in 2016. Kia and Volvo are believed to be two of these names, representatives of both having been seen at WTCC races and Volvo having run in the series to evaluate it as long ago as 2011.

Ribeiro has suggested that manufacturers have been surprised by the rising sporting standards in WTCC, a level that Citroën has met, and this is possibly causing potential new entrants to consider their plans very carefully. He also suggested that all three new entrants are planning to race with saloon cars, which are considered more aerodynamically efficient than hatchbacks such as Honda's Civic Type-R.

Ribeiro has added that the technical regulations for WTCC are not set to change in the medium term, providing the stability that potential new entrants would want to see. The most recently scheduled meeting of the series Technical Working Group was cancelled as it had an empty agenda. RT

Volkswagen joins growing TCR ranks

Andrew Charman

RED-BULL RING, Austria: Volkswagen has become the latest manufacturer to race a car to the new-for-2015 TCR International Series touring car formula, and secured immediate success.

A two-strong team of TCR spec VW Golfs was debuted by Liqui Moli Team Engstler in the TCR International Series round at the Red-Bull Ring in Austria on 12 July, and with the two having been put onto the front row for race two by the reverse grid procedure, Pol Rosell duly led from start to finish to give Volkswagen its first win in the series.

The Engstler team has been appointed as a partner to Volkswagen Motorsport as the manufacturer evaluates a customer TCR International programme for 2016. Engstler also runs SEAT Leons in TCR and earlier in the year campaigned a pair of Audi TTs under special dispensation ostensibly as an information-gathering exercise ahead of a possible entry by Audi.

Volkswagen Motorsport director Jost Capito is impressed by the concept of TCR in which manufacturers produce specification cars for customer teams to buy and run. "The newly created TCR category provides a promising platform for customer racing – on a national and international level," he said. "With exciting races, production-based technology and reasonable costs, it offers a new outlook for private racing teams. When developing the Golf-based concept car, we are able to fall back on the resources at Volkswagen which reduces both development time and costs.

"We will also use the rest of the season to test the car under competitive conditions and evaluate a possible customer racing project from 2016."

The TCR formula appears to be gathering momentum – Volkswagen is the fifth brand to enter the series and a sixth, Subaru is expected at the next round in Singapore on 9 September, while series head Marcello Lotti has told *Race Tech* he expects at least one more brand to appear before the end of the season. RT

Our TCR mid-term report starts on page 56

BELOW Winning start: The new Volkswagen Golf TCR cars impressed potential customers at the Red Bull Ring

TCR Series

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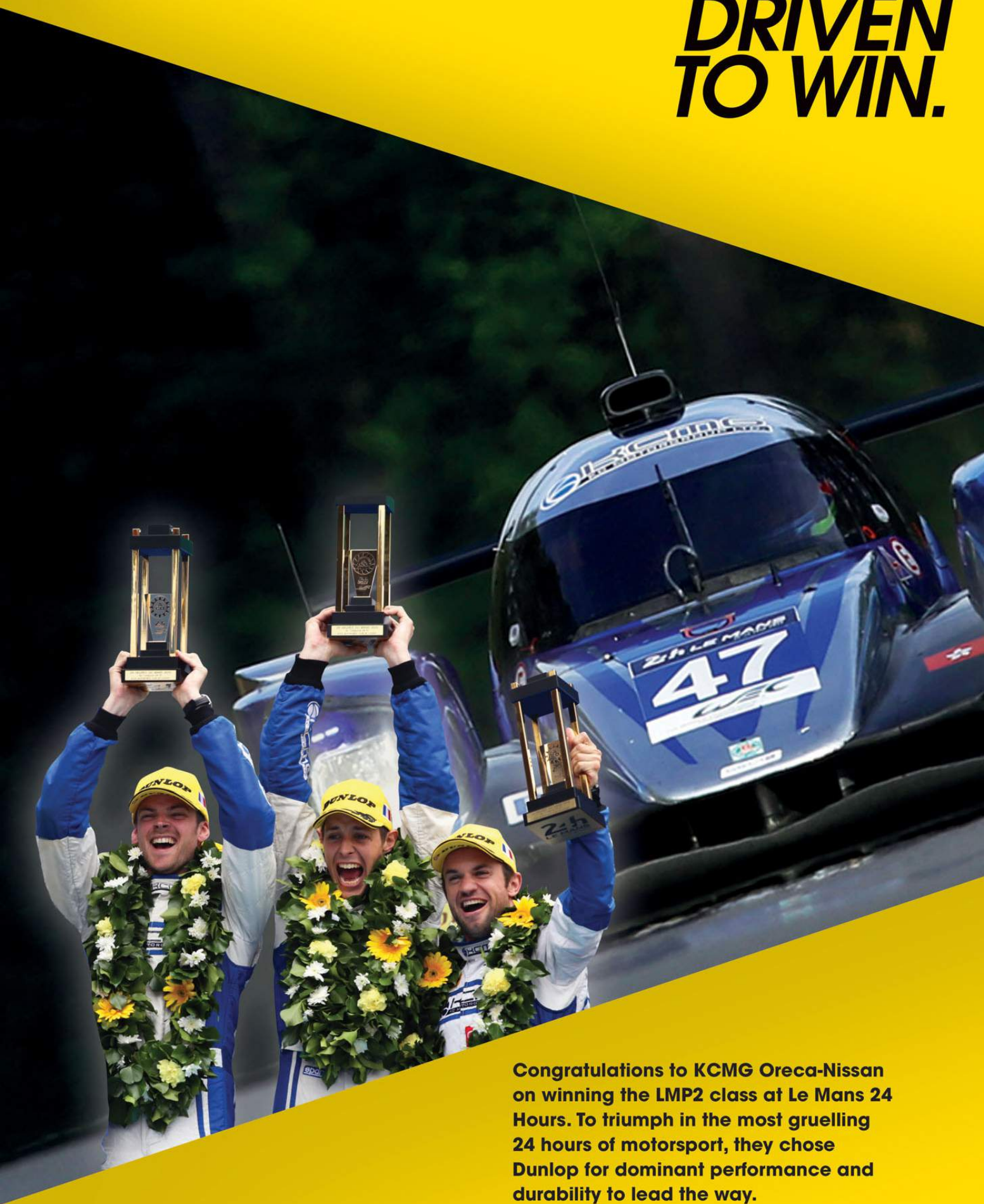

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ABOVE Larger wings and new aerodynamics are on the agenda to spice up the look of World Rally cars in 2017

World rallying to be given dramatic boost

MEXICO CITY, Mexico: This is how World Rally cars of the future could look following the decision of the FIA World Motor Sport Council in Mexico City to approve exciting outline principles of the technical regulations for 2017. A striking aggressive look via a new aerodynamic package which includes a bigger rear wing, and engine power raised to 380 bhp thanks to an increase in turbo restrictor size to 36 mm, are the headline changes.

Cars will be bigger due to a 55 mm increase in the permitted width and a greater overhang at the front and rear, electronically-controlled centre differentials will return and they will be 25 kg lighter. The changes will be the biggest since the current technical rules were introduced in 2011, but FIA chiefs stress they are evolutionary rather than revolutionary.

"There were three main objectives with these regulations: make the car spectacular, be mindful of costs, and maintain, if not increase safety. The cars will be striking, there is no doubt about that, and there are small but always significant improvements in relation to safety," said FIA technical director Bernard Niclot.

Reigning world champion Sébastien Ogier was delighted with the new proposals. "As a racing driver you are always looking for more performance," he said. "I think the larger wing and new aerodynamics will give the car a bit more downforce, more grip and more speed going into the corners.

"This is also good for the show, because the extra power will definitely make the driving more spectacular for the fans, and it will also make the car look a bit more aggressive with a wider body."

WRC promoter managing director Oliver Ciesla said the new cars would look 'distinct and dynamic'. "An already exhilarating sport will become even more so in 2017 and fans have every right to be excited about the positive direction in which WRC is heading," he said. RT

First glimpse offered of V8 Supercar future

Andrew Charman

ADELAIDE, Australia: The Australian V8 Supercars Championship has released the first draft of its proposed 'Gen2' regulations set to be introduced from 2017. They follow on from the Car of the Future programme, which debuted on the track in 2013 and is credited with bringing Nissan, Mercedes-Benz and Volvo entries into the championship alongside the existing Ford and Holden cars.

Gen2 aims to build on this programme and widen the options available to teams, principally permitting them to use turbocharged engines – these will run alongside but not replace the current naturally aspirated V8 units.

The new regulations are still in quite a loose format. Permitted will be four, six or eight-cylinder engines that meet the series regulations of power output and weight. This output is estimated to be 635 bhp at a mandated rev limit of 7,500 rpm.

The cars will be rear-wheel-drive and in a major change to the existing series, teams will be able to use a two-door coupe-style bodyshell instead of the current four-door saloon, so long as the road base car has four seats. It will be mandatory to lay out cockpits in right-hand drive format.

The much-trailed adoption of coupe bodyshells has led to strong rumours that Ford will choose to race its new Mustang in the series and Nissan the GT-R, while an entirely new entry could come from Lexus using the RC F. RT

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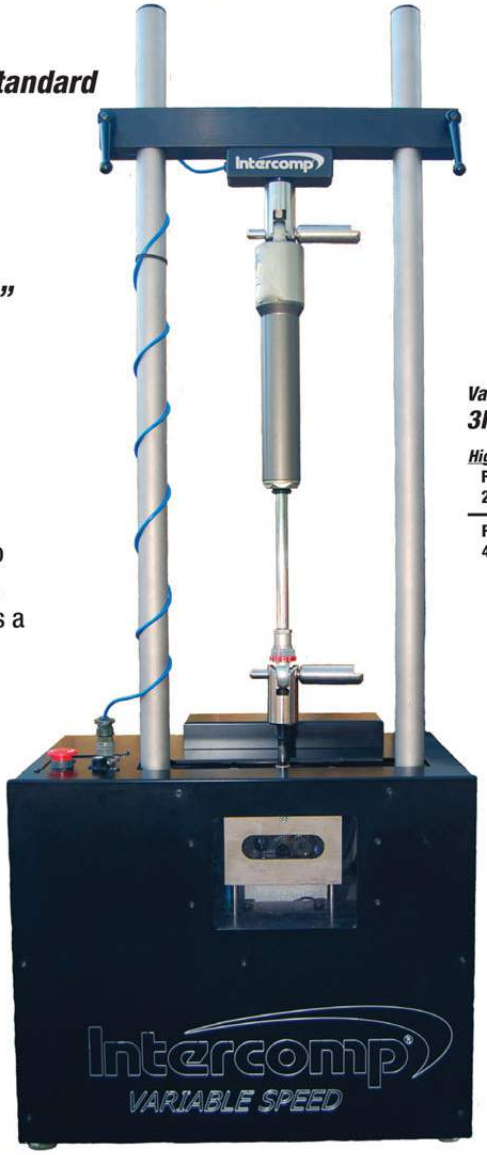

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FIA homologates FlowSonic fuel flow sensor for F1 and LMP1

PARIS, France: The FIA has homologated the FlowSonic Elite ultrasonic fuel flow sensor that has been developed by UK company Sentronics. It is eligible for both Formula 1 and the World Endurance Championship making it an alternative to the Gill Sensors version.

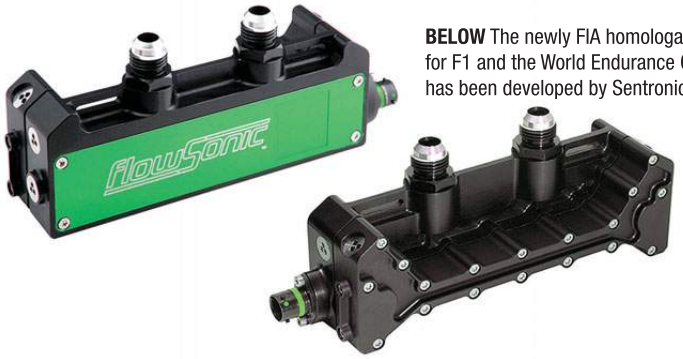
The FlowSonic Elite tops a line of sensors specifically designed to help regulate peak engine power, balance performance and promote energy efficiency in motorsport. Its next-generation technology has been proven in exhaustive bench and track testing, including over 300 hours of in-car running. The FlowSonic is offered in three variants – Elite, Super, and Pro – to suit the full spectrum of racing categories, from F1 to F4 and LMP1 to GT3, as well as touring and rally cars.

Sentronics was formed in late 2013 by the principals of sensor manufacturer Reventec, precision machining firm Mikina Engineering, and US-based renewable racing consultancy Hyspeed with electronics specialist Cawte Engineering joining last year. In early 2009, Hyspeed originated the concept of employing ultrasonics to meet the FIA's anticipated introduction of fuel flow control regulations, which was eventually implemented in 2014. Since then, F1 and LMP1 have seen their hydrocarbon consumption fall by more than 30% thanks to the combination of fuel flow control and hybrid powertrains.

"The FIA's and competitors' experience of the technology in its first year understandably had an effect on the approach to homologating a second sensor," said Sentronics managing director Neville Meech. "Practically speaking, this led to a much more rigourous set of validation criteria for homologation alongside the technical specification itself. Satisfying these requirements has been a challenging and lengthy process, but I can say our end product is all the stronger for it. I'd like to thank the entire team at Sentronics for their efforts in achieving the milestone of homologation, along with the FIA and competitors in F1 and LMP1 for their cooperation and patience during our development of the FlowSonic."

Sentronics chairman and renowned racing innovator – Formula Opel, Nations Cup, DeltaWing – Dan Partel added, "Beyond the appeal to F1 and LMP1 of the improvements offered by the FlowSonic Elite, our three-tier product strategy has already generated interest from championship organisers and promoters in Europe, North America, and Asia. We can meet their demand for performance control and balancing with a solution that promotes efficiency for less than it costs to create inefficiency through the imposition of air restrictors, ballast, or drag. Whatever the product level, we are committed to providing the kind of warranty, service, and support motorsport customers need and expect."

Sentronics is now accepting orders for all FlowSonic models from race teams, sanctioning bodies, series organisers, OEM engine suppliers, fuel companies, and specialist race engine builders. RT



BELOW The newly FIA homologated fuel flow sensor for F1 and the World Endurance Championship that has been developed by Sentronics

IN BRIEF

Strakka Racing will be racing the rest of the season in LMP2 with the latest Gibson 015S chassis. It replaces Strakka's S103 chassis that will now be used for the development of its 2017 LMP1 challenger, and enables the team to continue racing for the balance of the 2015 season.

Volvo has acquired the road-car tuning division of Swedish specialist Polestar Performance and will incorporate it into the main company, launching a series of Polestar-badged Volvo performance models. However, the racing division of Polestar, which competes in the Scandinavian Touring Car and V8 Supercar championships, will continue as a separate entity.

To little surprise TOCA Ltd has retained its contract to manage the British Touring Car Championship, beginning a new five-year contract from 1 January 2017. In the full-tender process carried out by Britain's MSA, TOCA beat rivals that included MSV, owner of four British circuits and organiser of the British Superbike Championship. TOCA's current BTCC contract has run since 2005.

Five bidders have emerged for the five-year contract to supply the stock TOCA engine to the British Touring Car Championship from the 2016 season onwards. Swindon Engineering, that currently builds the engines, faces competition from Cosworth, Mountune, Neil Brown Engineering and RML for the contract which supplies units to those competitors who do not wish to build their own powerplants to the TOCA rules. The contract for supply of stock parts to the series, the majority of which are currently produced by GPRM Ltd, is also up for renewal. RT

AND FINALLY...

The KV Racing IndyCar team was fined $5,000 by series organisers following driver Sebastien Bourdais' win at Milwaukee on 12 July after the car was found to be 3 lb under the 1600 lb minimum weight limit in post-race inspection. The team put the cause down to post-race victory doughnuts performed by Bourdais stripping the tyres of their rubber. An IndyCar official said later that the lenient fine reflected the minor nature of the infraction. RT

Meeting F1 customer demands

William Kimberley

LENTUS Composites has developed some new products specifically for high-end motorsport applications. They include carbon fibre composite pressure vessels, prop-shafts and the new Superflex flexible driveline coupling. It follows a period of massive investment in the facilities, people and equipment located in the heart of the Motorsport Valley in the UK. "We've always known how to design and manufacture these parts and we've now got everything in place to be able to go ahead and deliver to our customers," said Mike Dewhirst, chief technical officer at Lentus Composites.

The pressure vessels produced are the pneumatic bottles used in Formula 1 and Moto GP for the pneumatic valve systems and hydraulic accumulators typically for gearshift applications in LMP1 cars.

"From a personal point of view, many of the Formula 1 teams who know myself and the guys that work for me were struggling to get what they wanted, so I was asked what we could do to help. It's been unusual to be asked to supply particular items because normally we invent something and then try and make the market accept it, but this time it's been a real pull from the customers."

Lentus Composites has applied years of experience in the field of design and manufacture of filament wound high performance composites to develop the range of prop-shafts and the Superflex transmission coupling. Lentus' designs deliver high-performance parts that have high temperature stability as demanded by GT teams, each part is a bespoke design tailored to suite each application.

"It's quite a separate product range to everything else that we do such as the moulded and autoclaved pre-preg components that we design and produce. The autoclaved structural components and aerodynamic parts are made for Formula 1 and other high end motorsport applications," said Dewhirst. "We have also developed a range of components and technologies for use as magnet retention systems for motor and generator applications in ERS and KERS systems." RT

ABOVE CFRP prop-shaft with Superflex® disc coupling

ABOVE CFRP Pneumatic reservoir and hydraulic accumulator cross section

Pneumatic emergency clutch release system

AP RACING has introduced a new Pneumatic Emergency Clutch Release system. The CP9810 family of actuators fulfils the FIA's requirements for external clutch disengagement, providing race marshals with a simple and efficient process when moving stricken cars. The system enables clutches to be released externally, without the necessity to press the clutch pedal/pull the clutch paddle from inside the car.

The new system is fully compatible with AP Racing's CP4623 type master cylinders without the need for modifications, however master cylinder bore sizes need to be calculated from clutch release load and travel.

The unit requires an air source of 8 to 10 Bar, along with a 9v power source and an externally mounted activation switch that is accessible to marshals. These are not supplied with the units, however an air source can be provided by AP Racing. Appropriate AV mounts should be used if the unit is to be attached directly onto a gearbox or engine.

Clutch opening times are controlled by the amount of air pressure, the type of master cylinder and clutch specification, with the electrical response time of 10 ms. The clutch is released once the power is removed using a push to break switch.

The CP9810 family comes in four variants: CL9810-2:AS (Ø14mm Bore), CL9810-3:AS (Ø15mm Bore), CL9810-4:AS (Ø0.625") Bore and CL9810-5:AS (Ø0.700" Bore). RT

ABOVE AP Racing's external clutch release system that aids race marshals when moving stricken cars

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THE ROAD TO 2020

Environmentalism in motorsport - a quest for the impossible?

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 lively debate, judging by the interesting response we have so far received, including:

- After the important step of introducing energy based rules, the next step has to follow as soon as possible, which might mean a C02 limit, which are, of course, related to consumption but not just restricted to that. The introduction of fuels from renewable sources and other steps could give motorsport again a dramatic push, engaging young generation people and secure the attention of both spectators and industry.
- Back to the Future: do the fans really care about motorsport being globally relevant for the society at large or do they just want a recurring remake of the first 'Mad Max' film?
- The current F1 and WEC Regulations were built as a first step toward reconnecting motor racing with the road cars industry. Now let us think about the next step and try to define who the fans are today and who will be the fans in the near future.

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

Bernard Niclot
FIA Technical Director

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

Gilles Simon
Engineering
Consultant

Pascal Vasselon
Technical Director,
Toyota Motorsport GmbH

Dialma Zinelli
Chief Aerodynamicist,
Dallara Automobilia

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UK

THE 'PERFECT AIR' APPARENT?

As the quest continues for the acceptable face of motorsport, **Chris Ellis** believes Formula E or a hydrogen successor could take the heat off F1

ABOVE The need to switch cars is embarrassing but Formula E can still do the rest of motorsport a favour

WHEN Formula E was first announced, most fans of motorsport, myself included, expected it to prove technically irrelevant and unexciting. So far, this seems to be the reality, although the racing may improve next season. However, I overlooked the potential for Formula E to provide the rest of motorsport with 'insulation' from interference by those who think motor racing has a significant role to play in minimising Climate Change. Now, all the irrelevant demands can be forwarded to Formula E. How convenient!

The FIA has imposed various fuel consumption limits on Formula 1 and the World Endurance Championship. These decisions seem to be based on a fantasy that advances in combustion technology at over 12,000 rpm and maximum power are likely to result in lower fuel consumption in (mainly diesel?) road engines typically running at less than 30% peak power, at less than 3,000 rpm. An unintended consequence has been a massive increase in racing engine development costs, one of the factors threatening the viability of some F1 teams. And the unbalanced (polite for crazy) result is unnecessarily efficient engines in absurdly inefficient cars…

Formula E now provides a focal point for efforts to demonstrate how to minimise emissions and energy consumption at the point of use, potentially relieving the rest of motorsport from irrelevant limits. It seems silly that the FIA imposes costly fuel efficiency targets on engines, and then allows this laudable efficiency to be squandered on excessive downforce.

Imagine a 2018 Formula E car, complete with an F1-derived energy recovery system delivering over 300 kW, in and out, via all four wheels. Add a 200 kW battery, and a 2018 FE will have a total of over 500 kW for acceleration. That's nearly 700 bhp. 'Adequate' then, even by Rolls-Royce standards. And the 2018 car will go further on a single battery charge, *assuming top speed remains limited*, because the energy recovered per lap will have doubled. Consequently, a battery capacity increase of less than 60% may be enough to do away with the current embarrassment of each driver needing two cars to finish a race. If the battery suppliers are to be believed, this should be achievable by 2018. Or 2019+?

Several major manufacturers, including BMW, Toyota, Honda and GM, are already investing heavily in the development of fuel cell vehicles. Energy storage is the key to widespread use of renewable energy, and renewably-sourced hydrogen may be the 'perfect' future fuel for trucks, buses and high-powered cars. A high-profile way of demonstrating this would be 'Formula H'. Install a fuel cell and hydrogen storage instead of a battery pack in a 2018 FE car, and you could have 90-minute races on proper race tracks, not on narrow paths through city parks. Hydrogen from renewables is much 'greener' than electricity derived predominantly from fossil fuels, which will still be the dominant generation process in most countries for decades yet. Except in France, of course, where most electricity already comes from nuclear power. Perhaps we will see, soon, a fuel cell car in Garage 56 at Le Mans. Funded by the EU or the French government? Or perhaps a V12 running on hydrogen (see BMW's Hydrogen 7).

A prediction: Formula H will overtake Formula E. In the minds of most governments, Formula H could succeed Formula E as the acceptable face of motorsport. And it could be almost as spectacular as F1, with 140+dBA sound generators fitted. These could be V12 engines, or just synthesisers. And why not begin every F1 race day with an FH race in the morning? The 'perfect air' apparent? RT

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FAST CAR, THICK SKIN!

F1 has lost its way, say its detractors. It is losing spectators, the racing is boring and the engines are too quiet. **William Kimberley** talks to Andy Cowell, managing director of Mercedes AMG High Performance Powertrains, at a sold-out – and enthralling – British GP

AS the person heading the operation that produces what are unquestionably the most efficient, fast and reliable Formula 1 power units, Andy Cowell has developed a thick skin.

The opponents to the current powertrain formula, introduced last year, are influential and vocal. But, as far as he is concerned, the technology his company is producing has far-reaching implications for his parent company and the motor industry in particular.

He shrugs off the sometimes shrill and emotional complaints, which are perhaps noisier than his engines. Instead, he points to the fact that what is being achieved on the tracks during a Formula 1 race has far greater implications than just providing the weapons for the likes of Lewis Hamilton and Nico Rosberg to battle it out.

He points to the fact that last year the Mercedes-Benz PU106B Hybrid power unit could be counted among the most thermally efficient gasoline powertrains ever produced, with a claimed thermal efficiency of greater than 40% for the 1.6-litre V6 hybrid turbo. It is even more thermally efficient than a roadgoing diesel engine and compares very favourably to the 29 per cent achieved by the outgoing normally aspirated 2.4-litre V8 Formula 1 engine.

"I think that the fundamental change to the Formula 1 regulations that were introduced last year is that it's all about thermal efficiency," says Cowell. "The previous regulations concentrated on a simple mechanical limitation such as engine capacity. The challenge then to produce the most effective engine was mainly one of flowing as much fuel and air through it as possible; the manufacturer who achieved that could be expected to dominate. This led to very high-revving engines that had limited relevance to road cars.

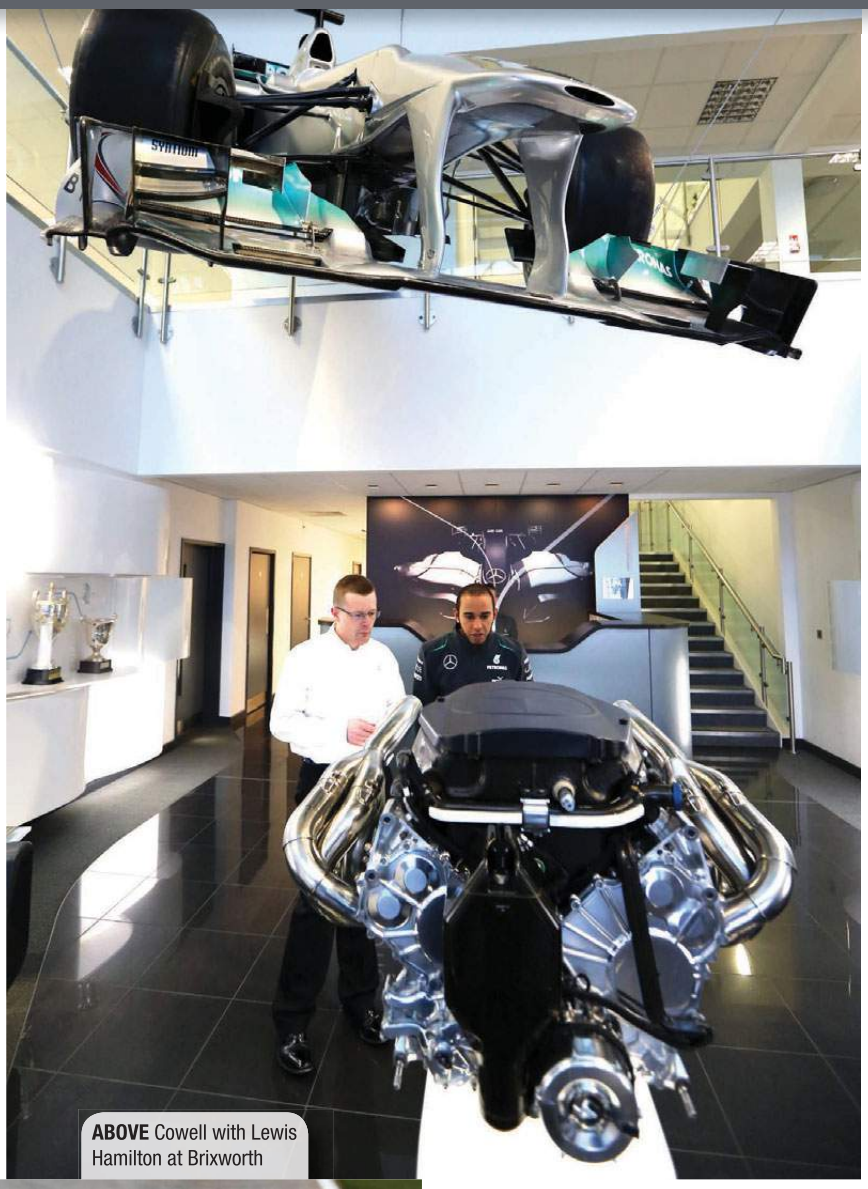
"The new regulations specified a maximum fuel flow rate so that the best engine would be the one that obtained the most power from that specified quantity of fuel and so, for the first time, performance became aligned with thermal efficiency. The best Formula 1 engine would be the one that converted energy the most efficiently. This is also exactly the same mission as the powertrain people in the road car world because of the challenging CO2 per kilometre regulations that are being introduced around the world. 2020 is a major milestone and we've got Formula 1 regulations that are taking us up to that year, so I think we should be encouraging thermal efficiency rates, which is what we've got right now."

Cowell agrees that by making a commitment

> *"In 50 years we'll be laughing at people that only had brake discs – what a preposterous idea to have a device that dissipates all the energy to the air!"*

Photos: Daimler

ABOVE Cowell believes the waste energy on the car's front axle (here Rosberg's discs glow in Bahrain) should be harnessed



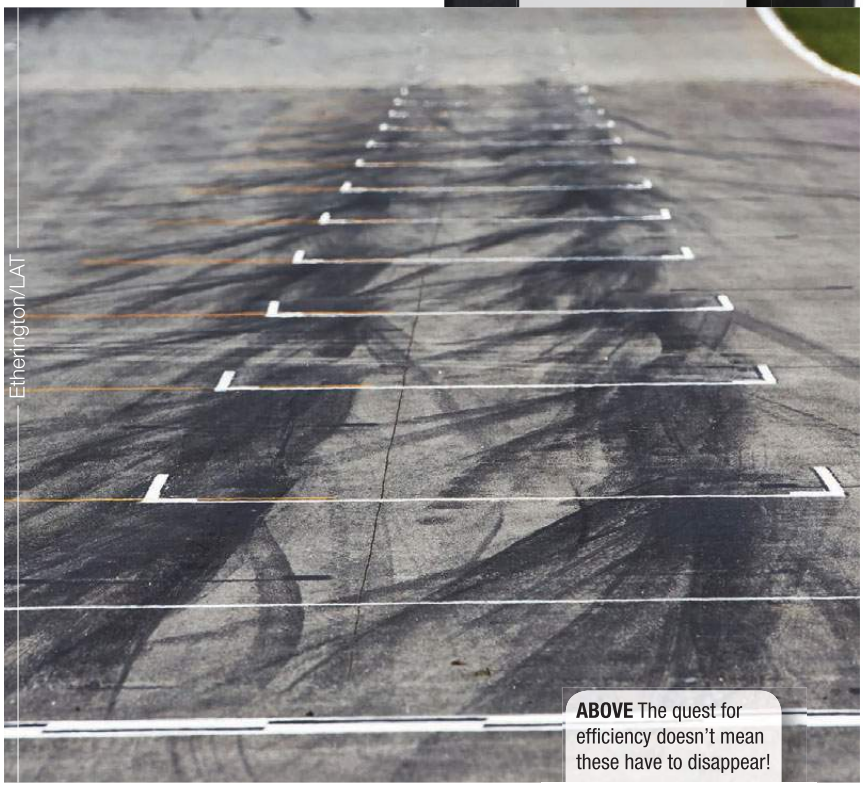
ABOVE Cowell with Lewis Hamilton at Brixworth

to work on the new power unit when it was first proposed, Mercedes is still reaping the benefits 18 months into the formula. "In motor racing what is the key aspect?" he asks. "The answer is how much you can achieve in a unit of time. While key performance indicators might be thought about in every business, for us fundamentally it's all about increasing the thermal efficiency of the power unit versus time. If you start late, it's a steeper gradient than for those who start earlier.

GREATER FREEDOM

"When the current power unit regulations were originally drawn up, the simple idea was that we were going to be given 100 kg an hour of fuel. That was it! While it made the pure science engineers smile, it was the commercial engineers with some sense of responsibility who felt that it was sensible to restrict areas where there were small opportunities but give greater freedom where there were greater ones.

"So, for example, the engine configuration, bore size and crankshaft centre line height were fixed to stop everyone wasting their time in this area where there were no efficiency gains to be had. Instead the focus was to be in areas such as waste energy in the exhaust flow from the internal combustion engine, where a turbine could be put in to recover some of that energy, use it to drive the compressor and improve the engine's efficiency. So I think we ended up with a set of regulations where the missions are aligned in terms of technology transfer and engineering and manufacturing processes being shared."



Etherington/LAT

ABOVE The quest for efficiency doesn't mean these have to disappear!

To reinforce the relationship between its Formula 1 activities and the road car side, the chairman of Mercedes AMG High Performance Powertrain is Dr Thomas Weber. He is also the Board member responsible for Mercedes car development while Bernhard Heil, who is responsible for powertrain development, is also a Board member. "We have regular Board meetings that provide a formal communication update point in which we try and keep finance and business matters to just 10 per cent of the time and technology at 90 per cent," says Cowell. "Both Thomas and Bernhard also regularly visit us at Brixworth.

"Probably more important than this, though, are the working relationships that have built up between us and the road car side of the business. I go back to KERS (kinetic energy ▶

recovery systems) when we didn't really know which system to develop. Should it be flywheel and CVT, ultracapacitors, lithium-ion or something else? This is where the knowledge within the Daimler R&D centre helped us, and that's done at a working level and feeding the information back over the subsequent years.

"It was the same with the V6 turbo. The turbocharger group within Daimler helped us tremendously build the engineering knowledge within Brixworth, and then we fed back what we had learnt, showing them what our operating maps are and where we operate in them, the efficiency that we are running at on the compressor and the turbine. This isn't done as formal papers or presentations but at working level engineer group discussions."

ABSORB EVERY JOULE

While he is upbeat about the power units being raced in Formula 1 today, it is but the starting block from where he believes Formula 1 should be heading. "There's a lot of waste energy on the car's front axle – spot the discs glowing!" he says. "Having an MGU-K there would tie in well with road car relevance. Why not aspire on all cars to have electric machines that have the ability to absorb every single joule?

"The storage of energy is going to be one of the key issues in the future and Formula 1 can play a role. In 50 years we'll be laughing at people that only had brake discs – what a preposterous idea to have a device that dissipates all the energy to the air! Energy should be stored on a device that's got just enough capacity and then deploy it and use small, highly thermally efficient engines to provide the rest of the propulsion. You will always need a hydraulic braking system as a failsafe but this could be another avenue to explore.

"If we get nervous about deploying power to all four tyres, a solution could be that we harvest off the front but only deploy at the back so there can still be the power slides and the black stripe up the tarmac and so on for the show. At the end of the day, for it to be raced in Formula 1, as it is in the World Endurance Championship, makes a great deal of sense. It's clearly a challenging concept to introduce but that's partly what we are here to do."

An important element in the success of the Mercedes engine is Petronas, the fuel and lubricant supplier. It is one of the best ▶

Living the dream

ANDY COWELL could well have ended up as a road car engineer had fate played another set of cards.

"I class myself as exceptionally lucky to be working in the motorsport industry," he says. "When I was at school I didn't imagine that it was possible. It was only when growing up that I came across the likes of Patrick Head, who I admired in terms of his approach and determination and what he was achieving on track. However, I didn't ever really think that it was an industry I could ever work in. My father was advising me that I should be studying electronics because it presented greater opportunities.

"It was only by chance that I ended up working in motorsport, initially at Reynard after taking a year out from university. When I went back to Lancaster University I focused on mechanical engineering, really understanding how you could apply classroom learning to the real world scenario but I only joined Cosworth on graduating because I thought it had a good graduate scheme. I saw it as a stepping stone perhaps leading to the road car industry." Fate was to determine otherwise.

Encouraging the young into engineering is important for Cowell. Mercedes AMG High Performance Powertrains takes in 15 undergraduates a year for a year's internship and then recruits 10 graduates every year. It has accreditation from the Institution of Mechanical Engineers for its apprenticeship scheme and its graduate training scheme. It is also a sponsor of Formula Student.

ABOVE Efficiency equals performance: as F1 takes drastic steps to improve efficiency, so does Mercedes-Benz production car development

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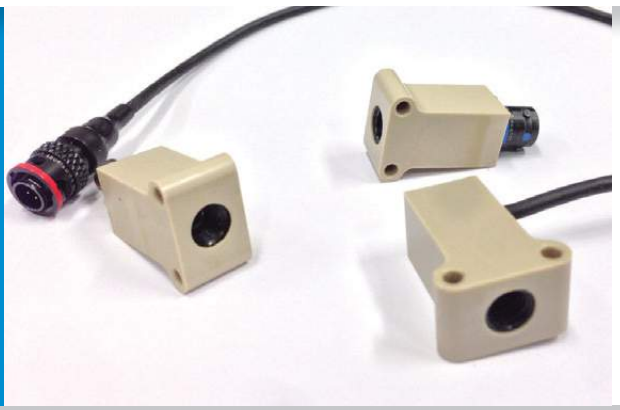

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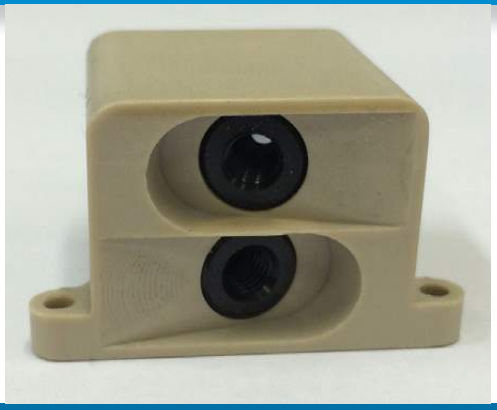

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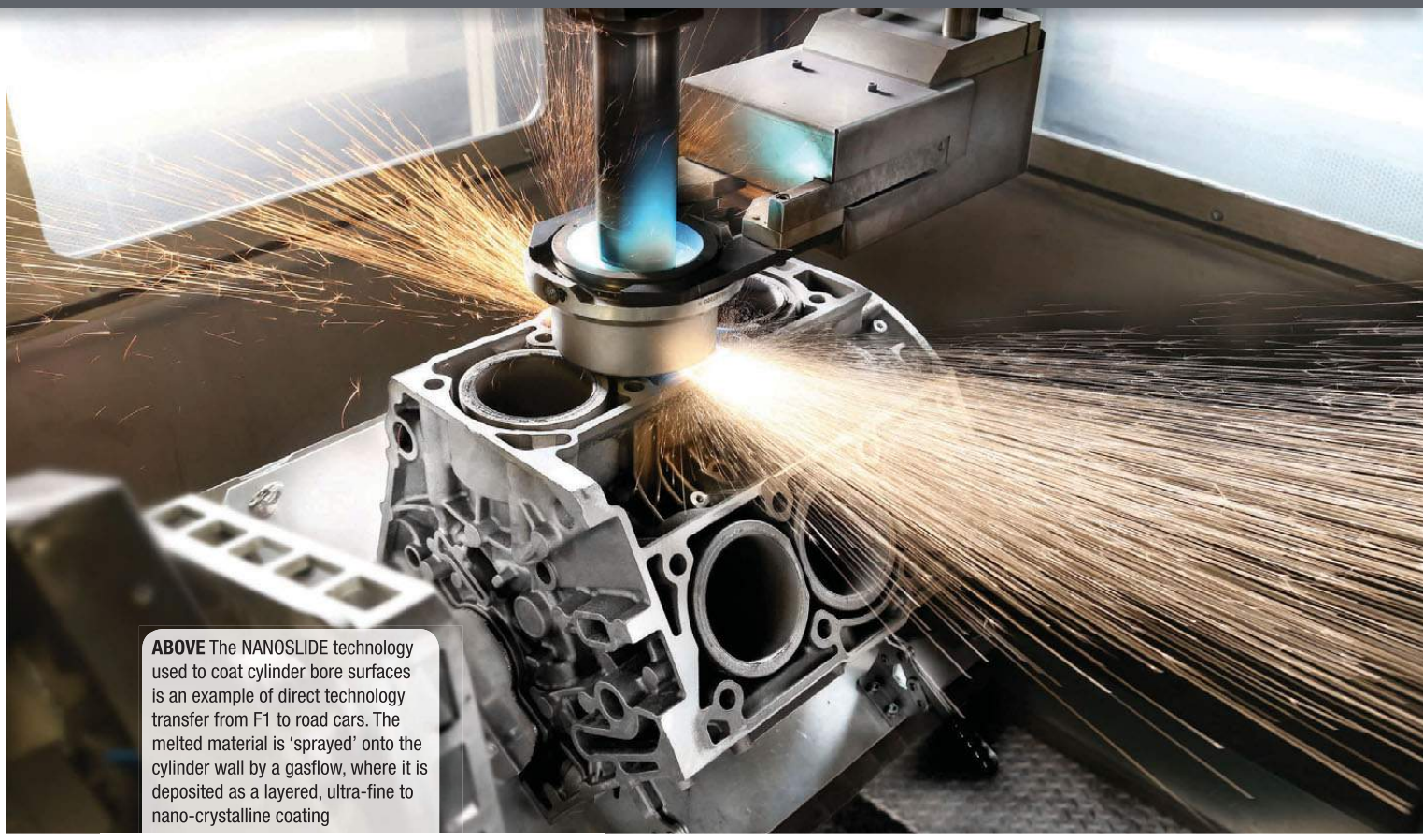


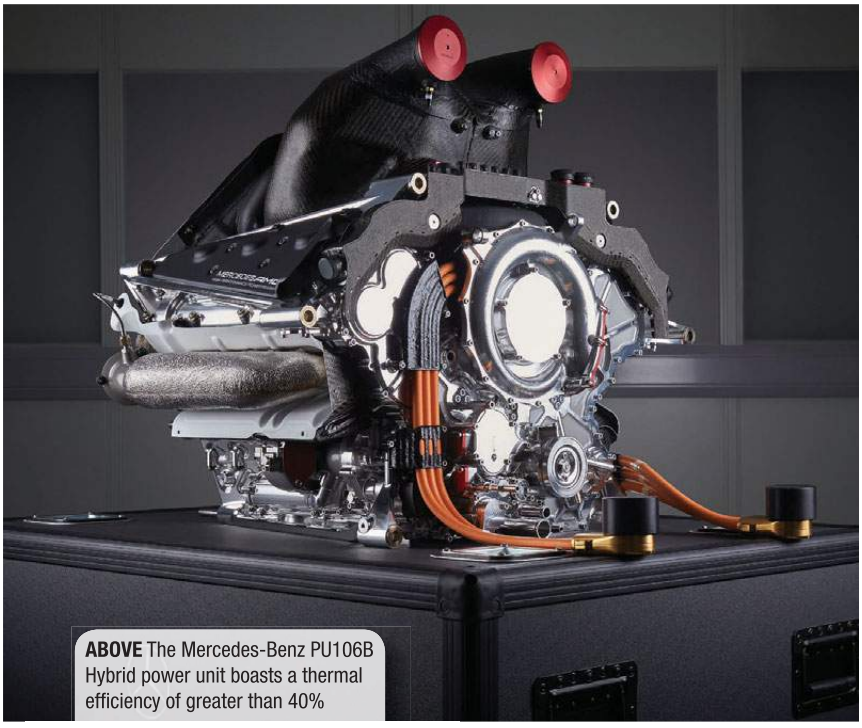
ABOVE The NANOSLIDE technology used to coat cylinder bore surfaces is an example of direct technology transfer from F1 to road cars. The melted material is 'sprayed' onto the cylinder wall by a gasflow, where it is deposited as a layered, ultra-fine to nano-crystalline coating

partnerships that Cowell says he has ever experienced. "We first started the relationship in 2010 and they've been great to work with. They quickly introduced an oil that year and followed it up with good fuel. That was in the naturally aspirated V8 era but the relationship has been tremendous during the development of the turbo V6. The fuel regulations are the same, but it requires deep understanding of chemistry and the combustion process. The collaborative effort between the engineers from both sides has been a significant contributor to our success.

"It's the same on the lubricants side. We've tried hard to minimise friction and the longevity that's required from the power unit is significantly larger than ever before to the point where we could now do Le Mans. In fact, over a 20-race championship we are doing the equivalent of four Le Mans and we can't afford to DNF and lose points or end up with a grid penalty. So it's in providing that knowledge of where the characteristics of protection are across the temperature range from low to high load where Petronas has helped."

The relationship between the chassis and engine groups in the Mercedes team is well documented, the two working hand-in-glove, but a little known element is the importance of the tyres in the mix when it comes to the power unit strategy. "We keep an eye on tyre improvements because if they get significantly better, the full throttle time increases and so the amount of fuel used per laps increases and you might become more challenged by the total 100 kg of fuel allowance," says Cowell. "If tyre degradation gets worse then fuel consumption per lap drops, at which point you start recommending less than 100 kg of fuel for the race. There's a relationship there that we watch and make sure that we are building into our fuel consumption models."

The drivers are also an important part of the equation, Cowell saying that at the concept stage items like the hardware, sensors and cold strategy were born out of discussions in which the drivers were involved. "They're the ones who have got to drive the car around the track under extreme pressure," he says. "We need to make sure we are delivering our side of the bargain to help them and that the relationship between their right foot and what the power unit is doing is trustworthy." RT



ABOVE The Mercedes-Benz PU106B Hybrid power unit boasts a thermal efficiency of greater than 40%

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‘ONE-YEAR WONDER’ MYTH IS BUSTED

Soheila Kimberley catches up with Pat Symonds, chief technical officer at Williams F1, at Silverstone’s British Grand Prix

2015 has been a year of high expectations for the Grove-based Williams Martini Racing team. After an outstanding season where it dragged itself up the grid against all expectations, to the point where it challenged and then beat Ferrari to finish third in the 2014 championship standings, there was but one question on most people’s lips: could it be sustained?

When the team appeared to have fallen behind the Italian squad in the first half of the season, out came the naysayers suggesting that the British team had peaked. However, as Pat Symonds points out, if you were to compare his team’s points accrual at the same time of the season last year, just before the British Grand Prix at Silverstone, it was doing really rather well.

“What I find interesting is the fact that there is this perception that Williams isn’t having such a good season,” says Symonds. “In actual fact we are far ahead of where we were on points last year and so much firmer in our third place, which commentators forget. However, it’s a good perception as it means that people are expecting more from us.

“Last year was fantastic. It was great to see Williams back at the leading edge again and if it had been a one-year wonder, then I don’t think we could have been pleased at what we’d achieved. This year has been all about consolidating

ABOVE Symonds has overseen a Williams renaissance

our position, not just on the track but financially as well, so I would say that at this point, mid-season, we are well on track in doing that. It's also no secret that Mercedes has been instrumental in the renaissance of Williams. It's a fabulous power unit that is reliable, flexible, economical and powerful. It's everything you want.

FIGHT WITH FERRARI

"In the fight with Ferrari, they certainly outperformed us at the beginning of the year and while here at Silverstone we are ahead of them on the grid, I think that they are still a little bit ahead of us and there is still more to do. But there's also more coming from us in the pipeline.

"Just like last year, the thing that Williams has been very strong at, even with the very small budget we work on, is a fabulous development programme. Last year it really moved us forward, particularly in the last part of the season, and this year I hope we can do the same. I know what's in the pipeline at the moment for the last quarter of the season and am reasonably happy with it.

"From a management point of view it's also been about keeping people on the right path. People do get distracted and they can forget the good things of where they've got to, so you've got to keep on top of that. You also have to handle expectations. It wasn't easy getting third place in the championship last year; in fact, it was incredibly difficult. We are racing against people who are spending two or three times as much as us and that's quite a challenge, and while I take pride in what we are doing, I want to win and that's where we've got to move to. It's not impossible to do it, so we must continue to reinforce all those good elements we put in last year."

> *"When we started the KERS project I thought it was a Toyota Prius-type thing but, as we got into it, I became convinced that it was the way for supercars to go"*

Around about mid-July is the time when decisions need to be made about diverting serious resources to next year's car. For some teams that are having a difficult season, that is not too difficult a decision to make, but for Williams, which is still in the hunt for the championship runner-up place, it's a different matter.

"It's always a difficult decision to make about when to divert resources to next year's car," says Symonds. "It's much more difficult to make now for two reasons: one is the fact that the aero test restrictions within the Sporting regulations mean that you are doing significantly less work and therefore each wind tunnel test has to count for more, and each one you are taking off the current car and applying to the next car is a bigger proportion of the whole.

"At the same time there is the spectre of 2017. There is a short-term CFD amnesty to work on 2017 but in an incredibly busy period, so in a sense we are running three projects."

While Symonds is highly regarded within the Formula 1 community for his progressive and forward-looking thinking, he is opposed to further power unit development for the time being. Especially to the idea of harnessing ▶

BELOW Massa leads the field at the British GP. It was a measure of how far the team has come that it left Silverstone disappointed not to have won

All photos: LAT/Williams F1

energy from the front axle, as happens in the World Endurance Championship.

"What is the objective in doing this?" he asks. "Pretending to develop technology? Simply adding another MGU will increase performance but will it do anything for us? Will it improve the show? Will it improve technology transfer? I think the answer is probably not. I'm certainly not one who subscribes to the idea that 1,000 hp will be spectacular. WEC LMP1 sportscars have 1,000 hp with a lot of downforce but they're not spectacular and there's nothing to shout about.

"Then if you start to add things like a four-wheel drive system arguably the cars will be far less spectacular, so I don't think that's a good thing from the show's point of view and I don't think it does anything for the technology. What we are trying to do is save weight and improve packaging, which we are doing anyway, so I don't think that's necessarily an answer.

> *"A short-term CFD amnesty doesn't erase the spectre of 2017"*

"Personally I'd like to see the challenge improved by reducing the amount of fuel we use and be happy if we slowly decreased the amount up to a point. I know that people will say that it will spoil the show, with drivers lifting and coasting and driving to fuel limits, but we've always done that, it's just that we are talking about it a little bit more nowadays.

ABOVE & BELOW Bottas, here diving in for tyres at Silverstone, has emerged as a formidable competitor. Massa, below going wheel to wheel with Hamilton's Mercedes, is the perfect foil

"WE EDUCATED MANY PEOPLE"

"We are reasonably free in many areas and I think that when we first introduced KERS in 2008, we educated many people, and I include myself in this, about the technology because it showed what an incredibly good combination the electric motor and internal combustion engine is due to the different torque characteristics being so complementary to each other. I remember when starting the project that I thought it was a Toyota Prius-type thing but as we got into it I became convinced that it was the way for supercars to go, and that's exactly what's happened.

"I think the hybrid is very useful technology and a fabulous way of getting good performance without throwing loads of fuel at it. It means we've done the right thing but let us get on and incrementally develop it for a while."

The core car concept, a plan that was mooted a few months ago about some of the smaller teams sharing under-the-skin technologies, was an interesting idea. But Symonds visibly bridles at the phrase 'core car' being in the same sentence as 'Williams'.

"With reference to the core car, we are constructors and enjoy designing cars and don't see a core car as a solution. It's far better to look at how we can reduce the cost of being a constructor to suit every team."

He is very complimentary about his drivers, saying that they have played an important role in the team's new-found competitiveness this year and last. "We have a great driver combination. I was really pleased when we signed Felipe (Massa) and he has been very much what marketing people call on-message in what we have set out to achieve and I knew that he was really good. I know Fernando (Alonso) very well and anyone who can race and occasionally beat him as Felipe did has to be good. Valtteri is a formidable competitor and Felipe gives as good as he gets.

"The two of them also still get on very well and they're really good to work with. They're very good with the engineering team and say exactly what they think and are very straightforward, which is reflected in the way they do their debriefs."

As Williams heads into the second half of the season, there is still everything to play for and it will be fascinating to see whether it can challenge Ferrari for second place in the championship. RT

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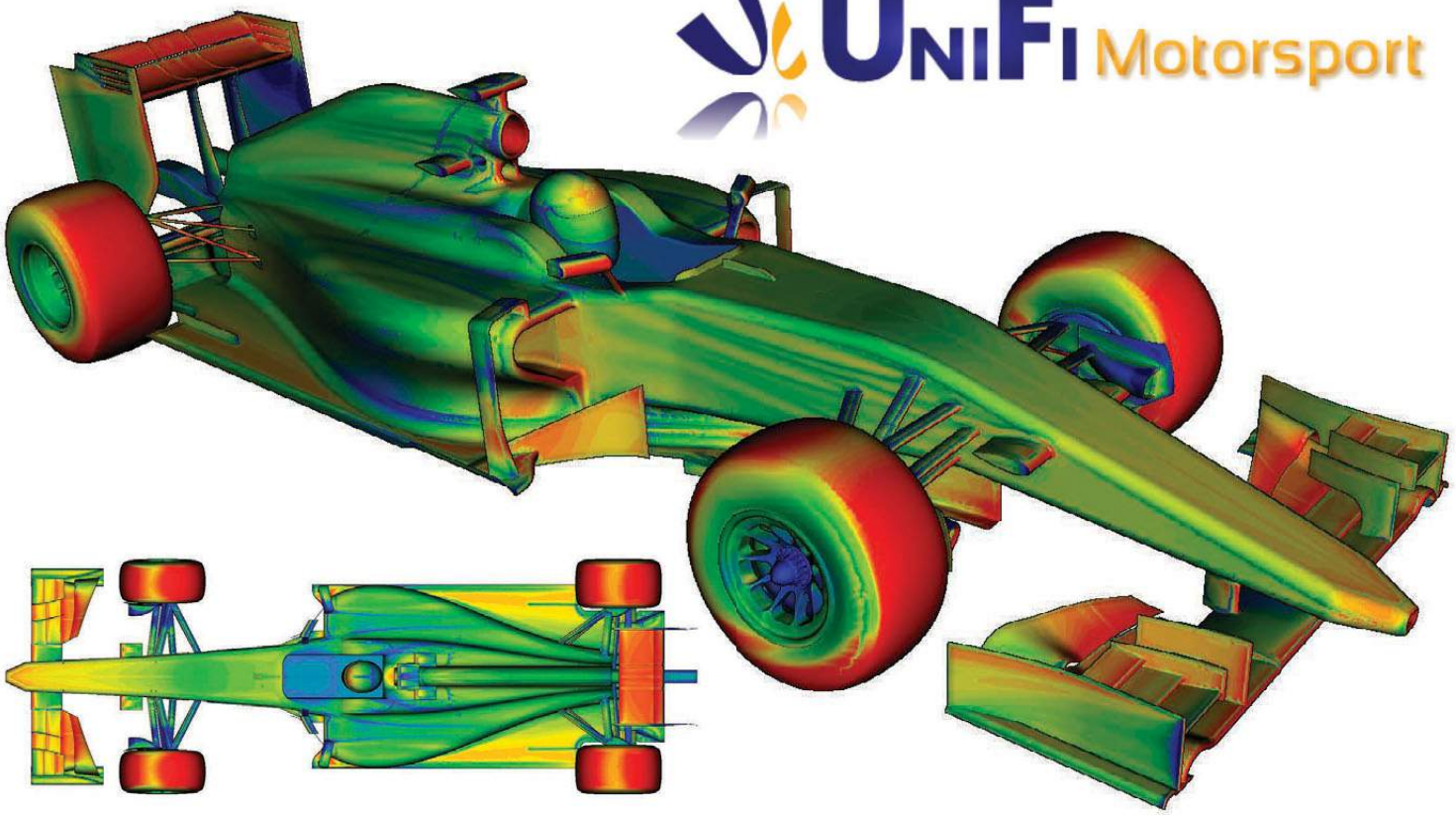

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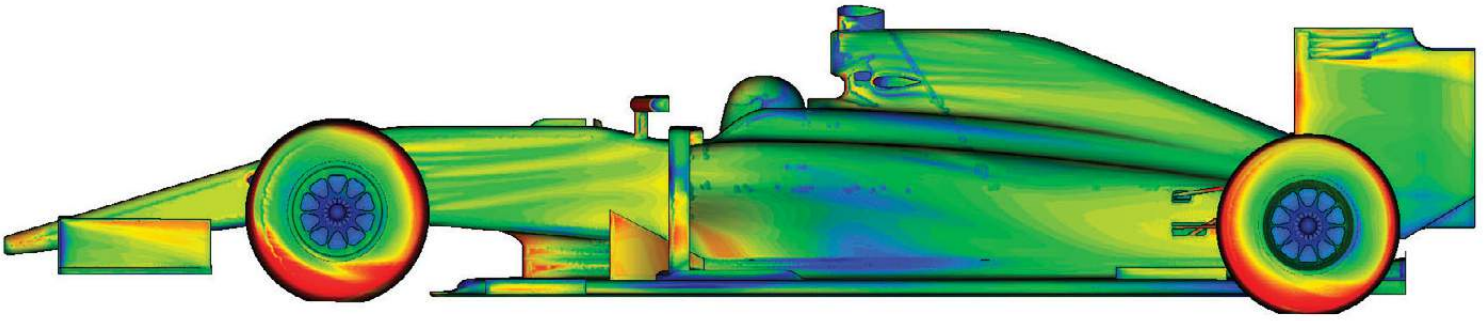

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ABOVE Alonso walks disconsolately back to the pits after his retirement at Monza last season, his career at Ferrari effectively over

FERRARI'S FALL & RISE

Craig Scarborough pieces together the inside story of Ferrari's remarkable resurgence – with a package inspired by the men it fired!

AFTER looking strong in pre-season testing, Ferrari has added a welcome wildcard element to Formula 1 with its early season form and stunning victories in Malaysia and Hungary.

Little wonder the previously dominant Mercedes drivers struggled to hide their surprise, for the wins were very much against the Scuderia's run of form since its last championship success in 2007 and the near-miss of 2008. This had been Ferrari's last hurrah in the complex aero and non-hybrid era, for rule changes in 2009 rendered any advantage gone and the team has endured six years of un-competitiveness. So how did it return to form in this new era of simplified aero and hybridised power units?

BACK FROM THE BRINK

To understand how Ferrari came back from the brink, we need to appreciate how the team was run during its last era of success and also in those intervening years. F1 is nothing if not cyclical and Ferrari went from nowhere to a historic run of success at the turn of the millennium – Michael Schumacher's title triumph in 2000 was its first for 21 years.

The chemistry of the personnel running the team during this era is well-documented: from Luca di Montezemolo at the helm, to Jean Todt, Ross Brawn, Rory Byrne and Gilles Simon running the team and the technical departments, each has been recognised on the pages of Race Tech. The team functioned as a well-oiled machine, relatively free of politics and internal strife that had afflicted it during its years in the wilderness. Instead, it preferred to reserve its Machiavellian traits to influence people outside of Maranello's walls to quite some effect. Although spearheaded by strong management and design values, this period of success is perhaps best known as the Schumacher era.

As the years went by and the key members of this technical squad decided to pursue other career directions, a succession plan was put in place. Managers and engineers working under the Brawn/Byrne regime were groomed to maintain continuity. It was largely this team that carried Ferrari from 2006 through to last year: Stefano Domenicali, Aldo Costa, Nicholas Tombazis and Luca Marmorini, all still under the direction of di Montezemolo. They were gifted with factory resources, plus the working practices and a car design good enough to win or challenge for world championships in 2007 and 2008.

The rule upheaval for 2009 changed the landscape. Simplified aero and the introduction of KERS required new thinking and stronger ideas than simply evolving an existing design. Thus the F60 car launched for that season was a conservative design, with no obvious failings – except the opposition, such as Brawn/Red Bull and Mercedes on the powertrain side, had completely rethought the concept of an F1 car.


Coates/LAT

ABOVE Ferrari has a new hero: Vettel basks in the adulation of fans and his new colleagues after a sensational success in Malaysia

Ferrari was being left behind and this stagnation continued through to 2014, another year with seismic changes in design, with more aero revisions and the complex turbo hybrid power units being introduced. Again, Ferrari found the paradigm shift difficult to deal with.

Monza 2014 was a watershed moment. Amidst question marks over the position of its drivers and management, denials and affirmations were rendered empty when in the race Fernando Alonso retired in front of the home crowd. Within weeks a major shake-up restructured Ferrari.

WHERE DID IT ALL GO WRONG?

During these years Ferrari had been using its own wind tunnel and had operated a strategy of using two chassis design teams, each taking responsibility for alternating cars. Plus, of course, there was the engine department working uniquely under the same roof as the chassis division. Each design team had its own management and reported to di Montezemolo.

This design strategy was typical for a large F1 team and for most it works well. But suddenly Ferrari was falling down and ▶


Tee/LAT

BELOW Plenty of sparks have flown at Ferrari in recent years – most of them away from the racetrack. The red cars' ability to race wheel-to-wheel with Mercedes at times this season has reinvigorated F1

> *"Ferrari is on a par with Mercedes on power units in 2015, despite having had in the region of a 45 hp deficit in 2014!"*

ABOVE The end of a period of aero rule stability, which had been epitomised by Ferrari's development of a ducted central nose for 2008, hastened the dynasty's decline

Ferraro/LAT

this could only lead to poorly performing racecars. Cracks started to appear in departments which had worked so well under the Brawn/Byrne leadership. Only if everyone is working in unison will this or any other team organisation function effectively and failures in the post-Brawn championships saw good engineers such as Costa and Chris Dyer fired.

The suggestion from insiders is that in this environment sound requests for project funding were rejected for no obvious good reason. What had been a first-rate wind tunnel was by now starting to provide results which departed from the evidence seen on the racetrack. Yet requests for tunnel upgrades were turned down by di Montezemolo and performance unsurprisingly suffered.

Equally, the alternating design team setup began to operate increasingly independently of the rest of the design office. So much so that nearly all of a new car's design was complete before being handed over to Tombazis, head of chassis design, for in-season development – clearly too late for him to influence or validate the design. If it were a first-rate design being proposed, this wouldn't be an issue, but a culture of conservatism had crept in as rival departments politicked.

As a result Ferrari's racecar often looked a year behind its rivals in its design details. Given a car below its expectations, the design office then had a failing wind tunnel in which to develop new parts. A cycle developed of initially-slow cars with hopes pinned on major updates that would fail to perform on the track. The blame culture only made the lead-in to a new car or update more fraught.

Ferrari was not blind to its failings on track, firings being mirrored with signings. Key of these during this period was Pat Fry, poached from the well-operated McLaren team. After an initial consulting period, Fry was signed as technical director, working between di Montezemolo and the technical staff.

Some of the results of Fry's initial tenure were the use of Toyota's wind tunnel, investment into Ferrari's own wind tunnel and new validation processes set up to improve simulation to track correlation. Ferrari's fightback had started but progress was slow as its problems ran deep.

2014: THE IMPLOSION

During this upheaval preparations for the 2014 car, with its major design changes, got underway but mistakes were clearly made. Still the dual design teams were in operation and were working with the engine department: the decision was taken to make the complex power unit fit the chassis in order to gain an aero advantage. Simulation suggested a loss in power would be offset by a better chassis. There were disagreements between chassis and power unit departments, but eventually it was agreed. Compared to Mercedes' 2014 programme, which had started long before, Ferrari's project began late and this merely compounded its existing problems.

The F14-T was unveiled and again the car was outwardly conservative, but with adventurous internal packaging explained by the chassis/powertrain compromise. Of course history now shows that Mercedes had invested wisely and its car dominated the championship, losing out only to Red Bull on the three occasions its car faltered in races. Ferrari was not second to Mercedes, nor even behind Red Bull, but outpaced by

Williams for much of the season.

By now James Allison had been signed as technical director from Lotus and he has been widely hailed as the key to the team's resurrection. With the Maranello wind tunnel coming back on line and design processes changing, the team was regrouping for 2015 – but there was still the remainder of the 2014 season to be navigated.

The car's lack of pace was proving to be equally chassis and power unit-related. With its low wedge-shaped nose, minimal sidepods and bulky engine cover, the chassis did not deliver the performance advantage the engine was compromised for, despite the Toyota wind tunnel being used. The Ferrari power unit was down on power, lacked drivability and did not recover energy as well as its rivals.

As running is now so restricted in F1, a lot of aero testing goes on in public. Early season runs with the fluorescent flow viz paint sprayed over the rear of the car allow us to gain high resolution photography of the results. For the F14-T some observers, far better versed in aerodynamics than I, interpreted a worrying lack of flow attachment and directional control from the streaks of green around the car. During the year the scattergun approach of introducing new parts was more controlled: typically new parts tested would go on to race and it was merely the number and complexity of the updates that was reduced. Therefore the development rate was slow, with the car never catching its rivals on pace through the season.

On the mechanical side Ferrari still exhibited low-speed understeer and poor traction, although the latter can somewhat be explained by the engine's drivability. Typically tyre use was better in the race, less so in qualifying, normally an attractive balance if it wasn't for the car's powertrain failings.

Having agreed to create a power unit installation that was as small as possible, to allow a forward mounting of the unit along the wheelbase and with minimal cooling to reduce sidepod size, the resulting 059 power unit was a big compromise. The need for it to fit within a small volume meant conventional packaging was out of the question, thus the packaging of the unit is a fascinating design, unlike any other V6 turbo unit I'm aware of.

Firstly, the Honeywell turbo was mounted behind the 1.6-litre V6, in itself a logical choice, but Ferrari chose to split the turbo with the MGU (Motor Generator Unit) for the ERS-H setup. This nestled within the bellhousing area of the elongated carbon fibre gearbox casing. Three exhausts exited the ports of each of the V6's cylinder banks, curling up to meet the 3-into-1 collector over the cylinder heads. The exhausts then split to feed the twin entry turbo and a sizeable pipe entered a large wastegate mounted high over the gearbox.

The turbo's compressor had a single exit to feed a Mezzo water-to-air intercooler, mounted between the inlet tracts within the 'V' of the engine. Carbon fibre ducts exited the front of the intercooler casing to feed the dual inlets, each topped by a single throttle butterfly per bank. With this setup the front face of the 'V' was completely flat, to allow it to sit forward in the car's wheelbase, a means to tighten the rear bodywork for aero benefit. To add to the clean front face of the motor, a horseshoe-shaped oil tank was mounted inside the gearbox bellhousing area, flanking the turbo.

This area also provided space for the MGU for the ERS-K (what was KERS), ▶

> ***"The alternating design team setup began to operate increasingly independently of the rest of the design office"***

Coates/LAT

ABOVE 2014 was a nightmare campaign for Ferrari, in which the F14-T registered only two podium finishes. Here Raikkonen fights Ricciardo's Red Bull, but it was the latter that picked up any crumbs dropped from Mercedes' table

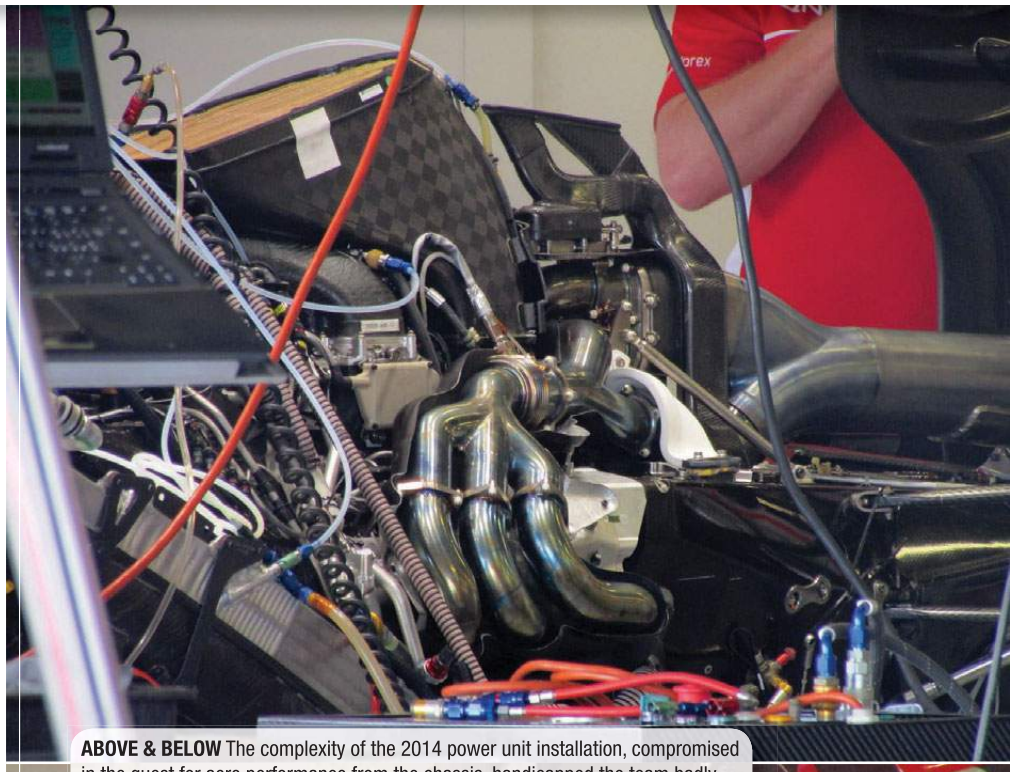
which sat between the engine and clutch. Additionally the 'V'-mounted intercooler reduced sidepod volume, only requiring a small water radiator in the sidepod. Marelli provided the Power Unit electronics, the car being fitted with separate powerboxes and ERS controllers for each bank of the engine.

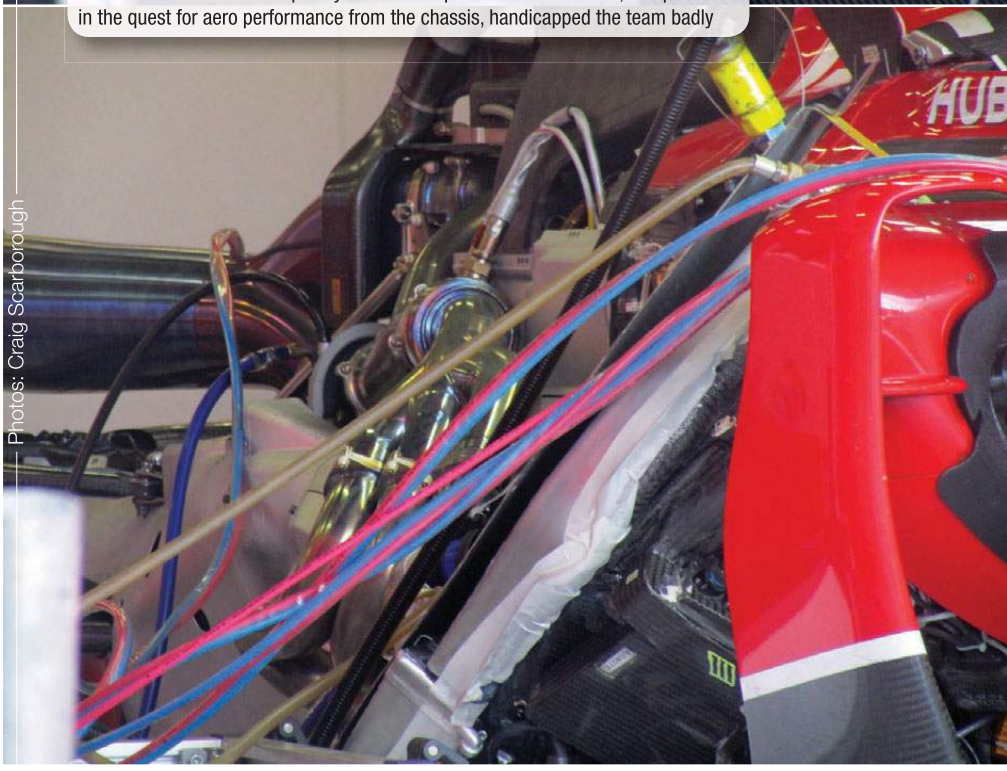
With this compact setup, however, the motor was handicapped. The exhausts were very long and homologated without heat shielding or a heat-retaining coating. Pressure in the exhausts was able to drop with the cooling of the gasses inside the pipes, robbing power. The twin inlet tract shapes were awkward, to clear the intercooler. Heat transfer was undoubtedly a problem and robbed power too: with the intercooler in close proximity to the inlets, the MGU-H was coupled to the hot turbo turbine, as was the oil tank. The lack of power was matched to a tricky power delivery. The drivers struggled in the early season with drivability, the power coming in suddenly with knock-on effects to traction, tyre management and chassis balance.

WASTEGATE TRICKERY

The turbo wastegate was a problem too, both with its installation and operation. Being high-mounted, the sizeable twin port wastegate and pipework added bulk to the engine cover, its hydraulic Moog valve and actuator requiring a dedicated cooling duct on the spine of the engine cover. The unit's unusual through-flow design caught the eye: why would a wastegate, almost superfluous with the drag effect of the MGU-H coupled to the turbo, be required with such little back pressure?

It transpires from a research paper that Ferrari opted to run the engine in full power node, with the wastegate part open, the reduced exhaust back pressure maximising power from the IC engine, then using the MGU-H to spin the turbo back up to speed. This again at first was an obvious route in using the ERS-H to maintain turbo speed. But other teams were using the MGU-H as a wastegate at full power, the exhausts being easily able to provide enough pressure to spin the turbo to create boost, the waste energy being recovered by the MGU and the energy either stored or sent direct to the MGU-K to extend the ~33s of 160 hp it can provide.





ABOVE & BELOW The complexity of the 2014 power unit installation, compromised in the quest for aero performance from the chassis, handicapped the team badly

Photos: Craig Scarborough

Thus Ferrari's wastegate strategy optimised IC engine power, but failed to recover any electrical energy from it. In qualifying, with a full battery, this was not an issue, but in races Ferrari lacked the ERS energy to match its qualifying pace. Despite its tyre management advantage, the Ferrari was often slower in the race. By contrast, Mercedes and Renault both maximised race power with their ERS setups.

With the 2014 championship slipping away, Domenicali resigned as early as April. Marmorini, meanwhile, appears to have been the scapegoat for a power unit that was down on power by dint of its chassis. The Italian was fired in July, replaced by Mattio Binotto. Post-Monza, when the long-time head of the marque, di Montezemolo, was also replaced, nearly all of the old guard from the Schumacher era had gone. By now Allison was firmly in charge as technical director. The Englishman had begun to unify the fractious sub-departments, no doubt aided by Fry acting as engineering director and Tombazis being retained as chief designer. ▶

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2015 COMEBACK

Design work started early on the 2015 car in order to make the step change required for the new season. This time, however, it was the Greek Tombazis who did the initial design work, the dual design team setup being dropped and Allison having no direct hand in the car's design. The team had identified key areas for improvement: aero, cooling, engine power, engine drivability and race ERS.

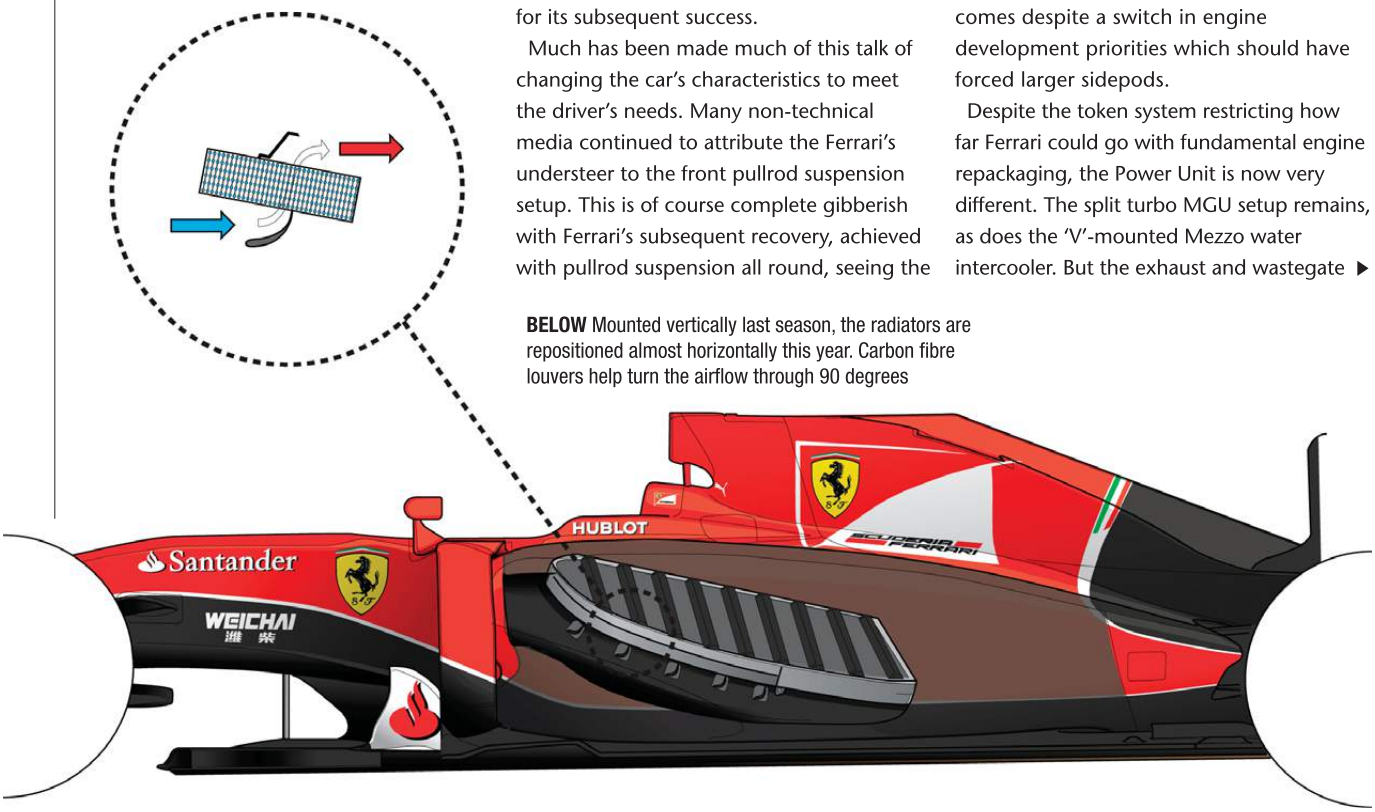
As design work progressed and 2014 drew to a close more changes were afoot, both Fry and Tombazis being released. The timing was peculiar for the latter as he departed the same day that a new team principal, the enigmatic Mauricio Arrivabene, stated that he had met the designer (the team now headed by Simone Resta). "I asked, 'What can you do to transfer weight a bit more to the front?'" said Arrivabene. "I said that Kimi [Raikkonen] likes to feel the car this way and Sebastian [Vettel] is more or less the same."

What made this comment strange, aside from the preposterous technical suggestions, was that the car had been largely designed by then. Yet Tombazis was given no credit for its subsequent success.

Much has been made much of this talk of changing the car's characteristics to meet the driver's needs. Many non-technical media continued to attribute the Ferrari's understeer to the front pullrod suspension setup. This is of course complete gibberish with Ferrari's subsequent recovery, achieved with pullrod suspension all round, seeing the drivers enjoying a far more positive feel from the front axle in 2015.

From the moment the 2015 car was unveiled, it was clearly a step forward. In design terms, the SF15-T's detail matches that of its rivals. Although its long nose now remains unique on the grid, this is at best a visual detail and not a primary performance-related one. When comparing flow viz runs on the new car to those of the car a year before, the streaks are all attached and ordered, showing the reality on track is now matching that seen in CFD and wind tunnels. This aero improvement comes despite a switch in engine development priorities which should have forced larger sidepods.

Despite the token system restricting how far Ferrari could go with fundamental engine repackaging, the Power Unit is now very different. The split turbo MGU setup remains, as does the 'V'-mounted Mezzo water intercooler. But the exhaust and wastegate ▶



BELOW Mounted vertically last season, the radiators are repositioned almost horizontally this year. Carbon fibre louvers help turn the airflow through 90 degrees

Graphic and photos: Craig Scarborough

ABOVE Much of the F15-T's performance gain comes from the power unit and its packaging

BELOW A glimpse of the team's intercooler

Photos: Craig Scarborough

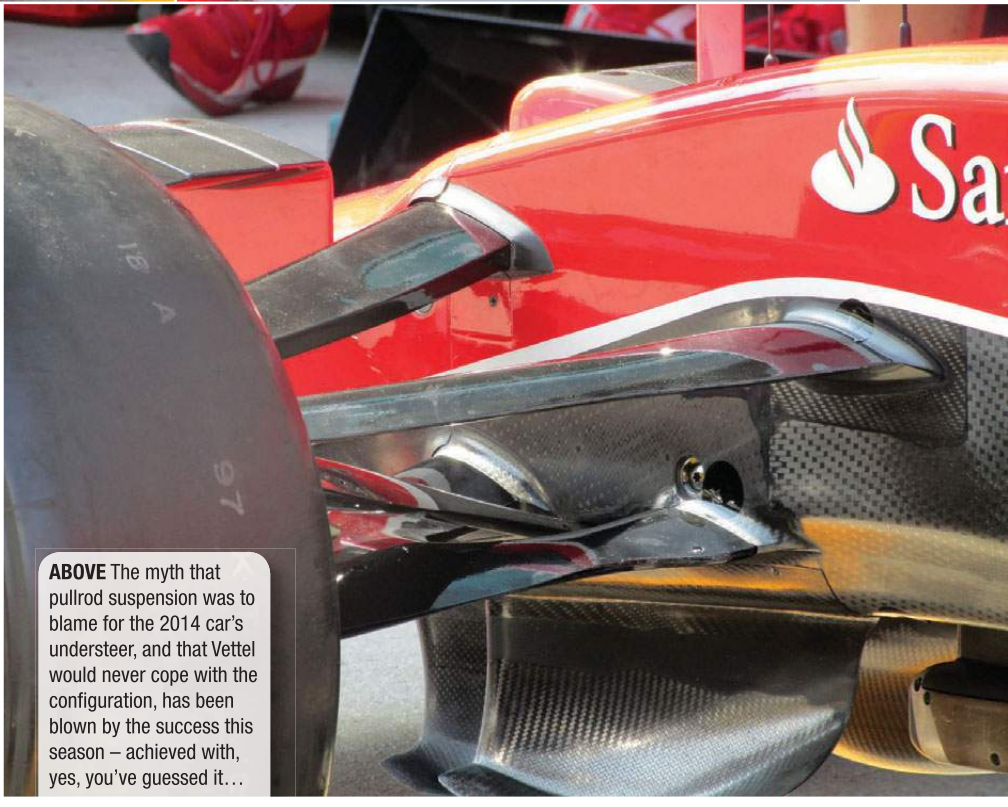
ABOVE & BELOW Aerodynamically, the F15-T takes some cues from its rivals but has also benefited from wind tunnel investment not lavished on its predecessor

setup is revised. Far shorter exhausts now reach directly rearwards, entering through the side of the gearcase to feed the turbo, still co-developed with Honeywell.

The wastegate strategy has changed to increase energy recovery in race conditions, with the MGU-H being used more as a wastegate to prevent exhaust gasses over-speeding the turbo. The oil tank has been re-sited at the front of the engine, with revised Shell lubricants and fuel allowing the unit to run hotter and produce more power.

Cooling has also been reviewed to make more efficient coolers and create a smaller sidepod package. Radiators have been mounted nearly flat in the sidepods, the torturous path for airflow to pass through them being aided by micro-management of the airflow, with carbon fibre louvers under and over the core to turn the airflow 90 degrees as it passes in and out of the core.

The gearbox case now needs more openings to facilitate the exhausts passing



ABOVE The myth that pullrod suspension was to blame for the 2014 car's understeer, and that Vettel would never cope with the configuration, has been blown by the success this season – achieved with, yes, you've guessed it…

in and out of the turbo. Last year's case had an open top to allow the exhaust packaging. This forced tight bends in the pipework and the gearcase structure was weakened by having open space between its top mounts. Now the case has a bridge between the top mounts, which braces the structure and also allows the tailpipe exit to be moved rearward, straightening the pipe for reduced back pressure.

Unchained from the 2014 chassis integration compromises, the package's power, drivability and race ERS use has improved. It can be argued that Ferrari is on a par with Mercedes on power units in 2015, despite having had in the region of a 45 hp deficit in 2014! This is a huge step, particularly with drivability, given that Ferrari elected not to use any development tokens to introduce variable geometry inlets this year.

Equally, the chassis has improved, while track and factory operations appear to be back to full strength and effectiveness. There's still a sizable performance gap to Mercedes, but the step taken this year suggests Ferrari will continue to close the gap to the current dominant team.

LOST TALENT?

Welcome though Ferrari's comeback is, one question lingers: did it throw the baby out with the bath water? Several key senior engineers are no longer with the team, figures who have – or could have – aided the Scuderia's recovery in a less political environment.

Ferrari's current success is often directly attributed by the media to Allison, who has modestly rejected this. Often in a failing team it's the engineers who bear the brunt of the blame, when more often it is management issues that prevent otherwise good engineers from excelling. Allison and Arrivabene appear to have overcome its internal wrangling. This perhaps is the key change and not an easy one in an organisation as large and political as Ferrari.

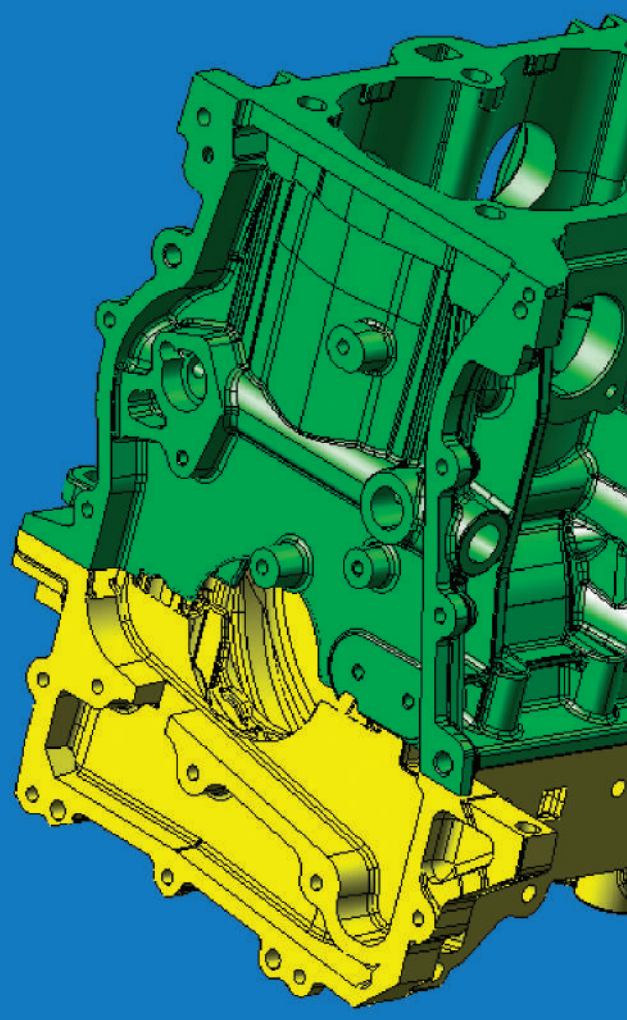
In this less fractious environment, engineers have been able to get on with their work, leaving the technical directors there to direct the staff. So yes, Allison deserves huge praise for Ferrari's progress and yes, good engineers are no longer with the team, which has to be a sad state of affairs. But the team now has equally good staff working in these roles and the results of the changes can be seen in race-winning performance.

Staley /LAT

TOP & ABOVE The depth of Ferrari's descent into the doldrums was indicated by the fact that Vettel's Hungary victory was the team's first win at the track since 2004

The engine that secured the future of rallycross

New teams, tracks and TV deals have catapulted rallycross into the limelight. But, behind the scenes, safeguarding a continued supply of 2-litre engine blocks against a backdrop of industry downsizing was a real concern. **Chris Pickering** reports



SPEAK to any of the major road car manufacturers these days and there are a handful of terms that are virtually guaranteed to crop up. You know it's only a matter of time before someone pulls out one of the buzzwords that collectively define the modern car industry. And nothing – absolutely nothing – in this game of automotive bingo trumps 'downsizing'.

The problem with ever-decreasing engine sizes in production cars is that the list of units suitable for motorsport is rapidly shrinking too. While most model ranges once included an engine of at least two litres, that's by no means guaranteed anymore, and the production engines that are out there are not necessarily suitable for the demands of competition. So what do you do?

It's a dilemma that weighed heavily on the minds of those tasked with creating the World Rallycross Championship back in 2013. Smaller 1.6-litre units had been allowed into the series, but the sport was rooted in 2-litre production-based engines and these were becoming harder to find.

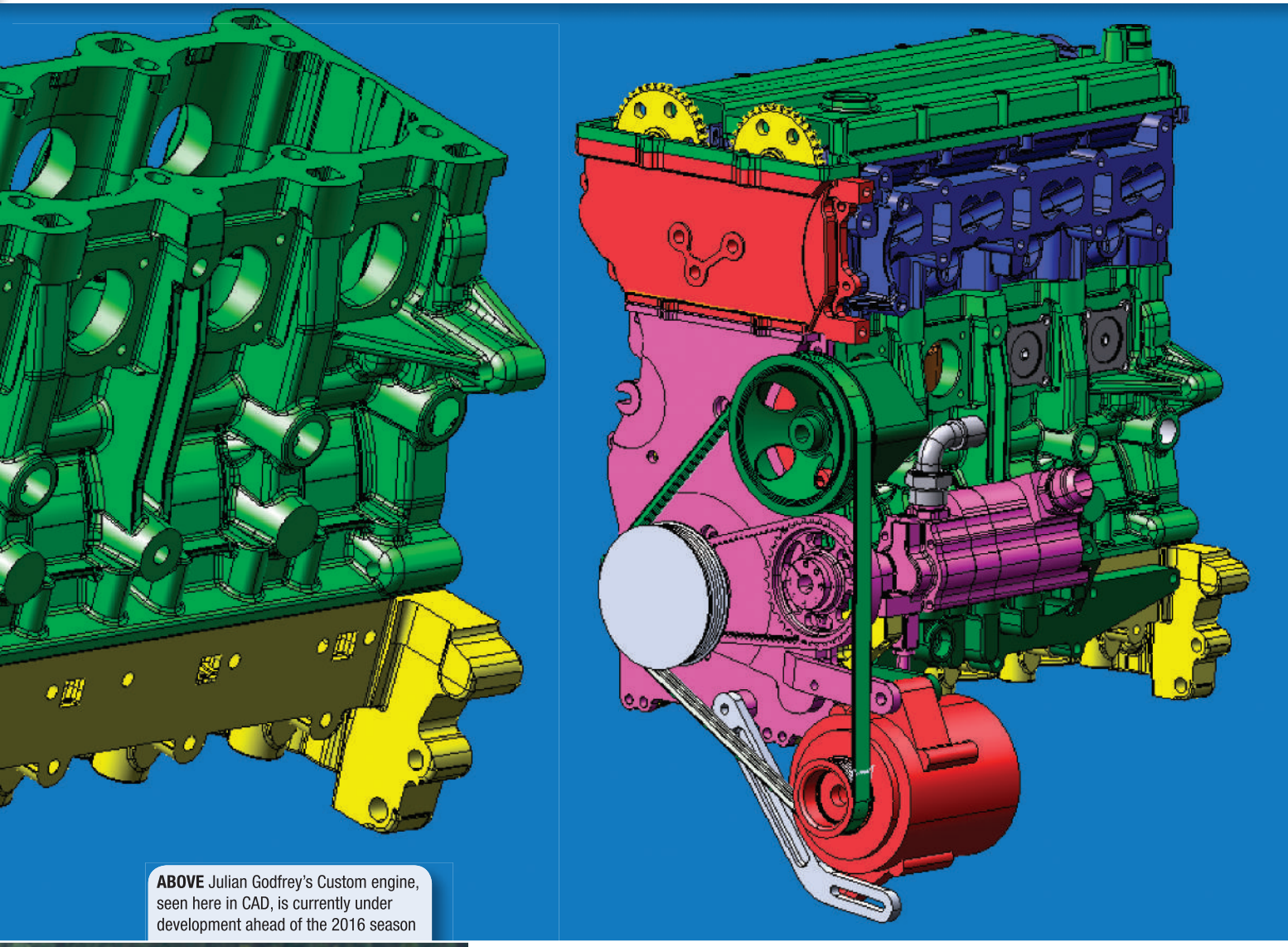
That summer a technical working group was formed, comprised of delegates from the eight permanent World Championship teams, plus representatives from the FIA and series promoters IMG. One of its top priorities was to find a solution to this dwindling supply of potential powerplants.

"Everyone agreed that the performance of the cars needed to be maintained and it was felt that the best way to do that was to safeguard the 2-litre engines," comments championship co-ordinator Tim Whittington. "The technology was already present in rallycross and it was a key technical aspect of the cars."

Part of the problem was that the existing rules required the base engine to come from the same manufacturer as the car itself. To get over this, the group began drafting a new set of regulations that would allow teams to produce their own bespoke engines. Introduced at the beginning of this season, the so-called Custom engines are designed to run alongside the existing 2-litre production-based units.

The 1.6-litre engines will also remain legal, although their future looks uncertain as the lighter minimum

ABOVE The inaugural World Rallycross Championship has captured the fans' imagination with spectacular action but the dwindling supply of engines was a disaster waiting to happen



ABOVE Julian Godfrey's Custom engine, seen here in CAD, is currently under development ahead of the 2016 season

> *"The more people that see it and understand exactly what it is, the more seem to embrace it"*

weight limit that currently allows them to be competitive against the larger engines will be withdrawn next year. Some have suggested the established teams lobbied to have this done to prevent an influx of World Rally Championship (WRC)-derived machinery. Whatever the case, it looks like 2-litre engines will continue to dominate rallycross for the foreseeable future.

The Custom regulations are designed to ensure parity with the existing production-based engines. There's a maximum capacity of 2,000 cc for the new units (as opposed to 2,058 cc for the production-based regulations), with a bore of 81 to 87 mm, a minimum bore spacing of 92.9 mm and a maximum compression ratio of 12.5:1. There's also a whole host of minimum weights and dimensions for the internal components, including the connecting rods (no less than 550g with bushes, bearings and screws), pistons (at least 400g with pin and rings) and the crankshaft (13 kg). Overall, custom engines must weigh at least 82 kg, while the total mass of the production-based units is free.

Turbo design is almost completely free, albeit subject to a 45 mm intake restrictor. BorgWarner and Garrett are the two main suppliers at present and both offer a sufficient range to cover just about any conceivable design philosophy.

"We drew on the experience of people at the FIA who'd been down this route with Formula 3 and the Global Race Engine," comments Whittington. "We wanted to block off any avenues of unnecessary expense."

Change can often be controversial in ▶

motorsport, but support for the Custom engine was unanimous among the existing World Rallycross teams. "The more people that see it and understand exactly what it is, the more seem to embrace it," comments Whittington. "That said, it was always intended to be a win-win situation and there's no reason why this would deny anyone the possibility of using a [traditional] production-based engine."

One of the aims of the new regulations is to make it much easier for the independent teams to move from one manufacturer to another, carrying their Custom engine over as they do so. Similarly, it means that engine builders can serve more teams with the same unit, rather than having to stockpile parts for a range of different manufacturers.

"If you were tied in with a manufacturer deal for three years and that's just ended you can now transfer all that technology across and effectively re-body the car," notes Whittington.

Of course, these new rules don't just impact the World Rallycross Championship. Domestic rallycross series vary quite a lot, but some just adopt the FIA rules lock, stock and barrel, which means they will undoubtedly embrace the Custom engines. Others cherry pick from the FIA rulebook, but Whittington expects the uptake of the new engines to be strong. Elsewhere, the US-based Global Rallycross Championship uses FIA rules (albeit with a few waivers to allow additional manufacturers to compete) so it's likely the championship organisers there too will be interested.

But what does this mean for the long-term future of World Rallycross? Will we see the Custom engines taking over? "Personally, I think so," says Whittington. "Over a period of time I think we'll see most people running Custom engines. Eventually, I suspect the only teams running stock blocks will be those where there really is no option or where there is a commercial justification. It just seems more logical to use an engine that's designed specifically for the job."

A MINI ADVENTURE

The new Custom rules could have been designed for teams like JRM Racing. Best known for its endurance racing exploits, the British outfit expanded into World Rallycross earlier this year with the MINI Countryman RX. Based on the MINI John Cooper Works WRC car, it uses a development of the same 1.6-litre powerplant.

With all cars having to run the same 1,300 kg minimum weight next year, JRM believes it will have to move to a 2-litre engine to remain competitive. Until recently the largest gasoline engine in the MINI range was 1.6 litres. Parent-company BMW did have a couple of potential engines in its range, but it's always been a bone of contention as to whether these can be considered part of the same range or whether MINI is classified as a separate entity. What's more, the BMW engines were all designed for longitudinal installation in larger, rear-wheel drive applications and enlarging the existing MINI ▶

BELOW The new engine rules offer a quick and easy solution for teams entering rallycross. The Eklund Motorsport VW Beetle is one of the first cars to take advantage of the unit

ABOVE One of the strengths of JRM's current 1.6-litre MINI engine is its compact packaging. The development of a Custom engine will enable the switch to two litres without the compromises brought by using an existing conventional alternative

unit wasn't feasible due to the compact bore spacing. It seemed the only option was to develop a new Custom engine.

JRM's head of advanced engineering, Paul Eastman, is a big fan of the new regulations. "The freedom in the World Rallycross rules is excellent," he comments. "Back when the FIA first defined the Global Race Engine regulations the philosophy was really good, but there were a number of restrictions aimed at capping performance that actually made things more expensive. The rallycross regulations, on the other hand, make life so much easier. And when things become easier they inevitably become cheaper too."

Since JRM entered the series MINI has introduced a 2-litre engine to the production car line up, but Eastman is wary of using an un-tested unit. Taking a completely standard four-cylinder production engine and modifying it to produce upwards of 500 bhp and 600 Nm of torque is not the work of a moment. "We want an engine that's already been proven in motorsport – although not necessarily in rallycross – that we can adapt into a bespoke unit for the MINI," he explains.

"We've got a few options in mind at the moment. We're looking at it in terms of ultimate performance, drivability and reliability. Part of [engineering] that reliability is development and sign off – if we were to start from a totally clean sheet I don't think it would be possible in the time we have available."

> *"I'd say it's the one formula where you really need a decent driver"*

Three different engines are understood to have been shortlisted as the basis of the new project. One is a purpose-built competition engine, while the other two have production origins. The decision is expected to take place early in the autumn, giving JRM just over six months to develop the new powertrain.

Eastman says that one of the greatest strengths of the current 1.6-litre engine is its compact stature; the centre of gravity is said to be very low and it tips the scales at just 82 kg. This is something the team is keen to repeat with the new engine.

"There are proven rallycross engines out there, which already meet the performance targets, but the MINI is very tightly packaged and they just won't go in without compromising the chassis – at least not to my mind," says Eastman. "This exercise is all about being tough on the installation so we get the right overall package."

He believes it would be possible to meet the minimum engine weight with a purpose-built competition engine. Were they to go down the production-based route, however, it's likely to be significantly heavier.

Either way, the team will have to re-engineer the installation quite substantially to get the right airflow and cooling. At present, the air has to follow quite a convoluted path, with the intake at the back of the engine up against the bulkhead and the exhaust manifold with the turbo positioned at the front. The likelihood is that the new engine will feature a more conventional layout with the exhaust at the rear, helping to simplify the routing. It's this attention to detail that Eastman hopes will give them the competitive edge. "We won't necessarily have the best performing engine on the dyno, but we want it to have the best chance of replicating those dyno figures ▶

once it's installed in the car," he says.

Drivability is another major focus. There are effectively two different schools of thought in rallycross, with some teams favouring slower-revving engines with more torque, while others go with higher-revving designs optimised for top end power. Eastman, however, reckons there could be a sweet spot between the two.

"I personally think a lot of the teams rely too heavily on boost," he says. "You can get away with that on a clear lap – or for that matter alone on a rally stage – but the conditions in rallycross are so inconsistent that the driver needs to be able to react instinctively to changing grip levels and unexpected opportunities – I'd say it's the one formula where you really need a decent driver. But if you're running very high boost levels you can get issues with lag and the driver can't take advantage of those opportunities. At the same time, you don't want to go too far the other way and end up with a very peaky, high-revving engine that struggles to get traction."

ABOVE & BELOW The Custom engine is vital to JRM's plan for its MINIs to move to 2-litre units next season when hew weight limits are introduced. Here its existing 1.6 engine is seen being inspected

THE ENGINE BUILDER

It's one thing building your own engine, but what if you supply them to other people? Julian Godfrey has worked in rallycross for over 20 years and supplies engines to a wide range of different teams. He too sees the new rules as a positive step: "At present we build engines based on five different manufacturers. That means we've got a huge stock of parts. Using the Custom engine should dramatically reduce the number of parts we need to carry, making it cheaper for us."

He says this enthusiasm is shared with his customers, who have one eye on the prospect of being able to switch bodyshells without investing in a new engine design.

As we speak, work is well underway on the development of Godfrey's own Custom engine, which should be ready to run sometime in the autumn. The cylinder head uses a bespoke casting produced in the UK by Swedish company Motor Design (MDS), but it's based on the Ford Duratec.

Things like the head bolt locations have been carried over from the Ford engine, but in all other respects the block is a clean sheet design. It uses a two-piece construction with the main bearing caps integrated into the sump to reduce weight and improve stiffness. The block itself is an aluminium ▶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alloy unit produced by Grainger & Worrall with wet liners made from Nikasil-coated steel by Perfect Bore. Following production car practice, steel inserts have been cast into the block to house the main bearings.

Godfrey is one of the best in the business, yet he reckons his engines will still come out around 15 kg over the new weight limit.

"This block is very light, but it's still going to be difficult to get it down to the minimum weight with the materials we're using at the moment," he comments. "For now, the main thing is to make it strong and reliable. After that we can start spending more money on the materials to try and get it down to the minimum weight."

Casting bespoke blocks has added some cost to the engine, but not to the extent you might expect. "You have to do so much work to a production casting – we convert the Cosworth YB engines to wet liners and put in long studs, for example – that the difference between the finished blocks is only about £3,000," he says. "The new block can just be machined and put together, saving two or three days' work."

Initially the engine will use port injection, but unlike the production-based rules, direct injection is permitted in the Custom regulations. MDS is understood to be working on a direct injection cylinder head for next year, which could provide a significant performance boost.

> ***"Customers will be able to switch bodyshells without investing in a new engine design"***

Godfrey expects the new engine to fall towards the revvier end of the spectrum. "I don't think it will have the torque of the [Cosworth] YB," he says. "It's something we're going to be working on, as I still believe torque is the best way to get round the circuit because it gives you the drive out the corners. It depends on the fuel, but with the P1 fuel used for the World Championship we're currently on about 570 bhp and 830 Nm of torque for the Citroen engine (with the YBs we're around 930 Nm)."

While the new engines will command an initial premium – maybe £10,000 to £15,000 in total – Godfrey expects them to be more reliable, and hence cheaper in the long run. He's targeting at least eight events in between rebuilds, compared to five or six for a typical production-based Citroen engine. It's hoped that the increased stiffness of the new block with its integrated main bearings will improve longevity.

With that in mind, the Custom formula sounds like a tempting proposition – even for those who have access to a viable production engine. And as Whittington is keen to emphasise, it's intended as an alternative option rather than a replacement. For those who prefer, the production-based engines will remain eligible and some designs could actually run under either category. Win-win sounds about right.

ABOVE Cars representing Citroën, VW and Audi fight it out at the front of the field. Custom engine regulations allow specialist tuners to offer an off-the-shelf motor that could be used in any make of car

FOCUSED ON THE FUTURE

The mere mention of his name might conjure memories of a golden era but Adrian Reynard is looking very much ahead. **William Kimberley** reports

FOR those old enough to remember, the name Reynard evokes a golden era – a time when single-seater racing in the US was thriving and when motor racing as a whole was vibrant and alive. You can almost date the decline of the sport from the day that Reynard Racing Cars went into receivership in March 2002. It was an indication that the heady days had gone and spec racing was on the rise to the detriment of the entire industry.

Adrian Reynard is a fighter, though, and totally belying his 64 years, is busy and active. Far from ruminating about the good old days, he is actively concerned with issues of the here and now and the future.

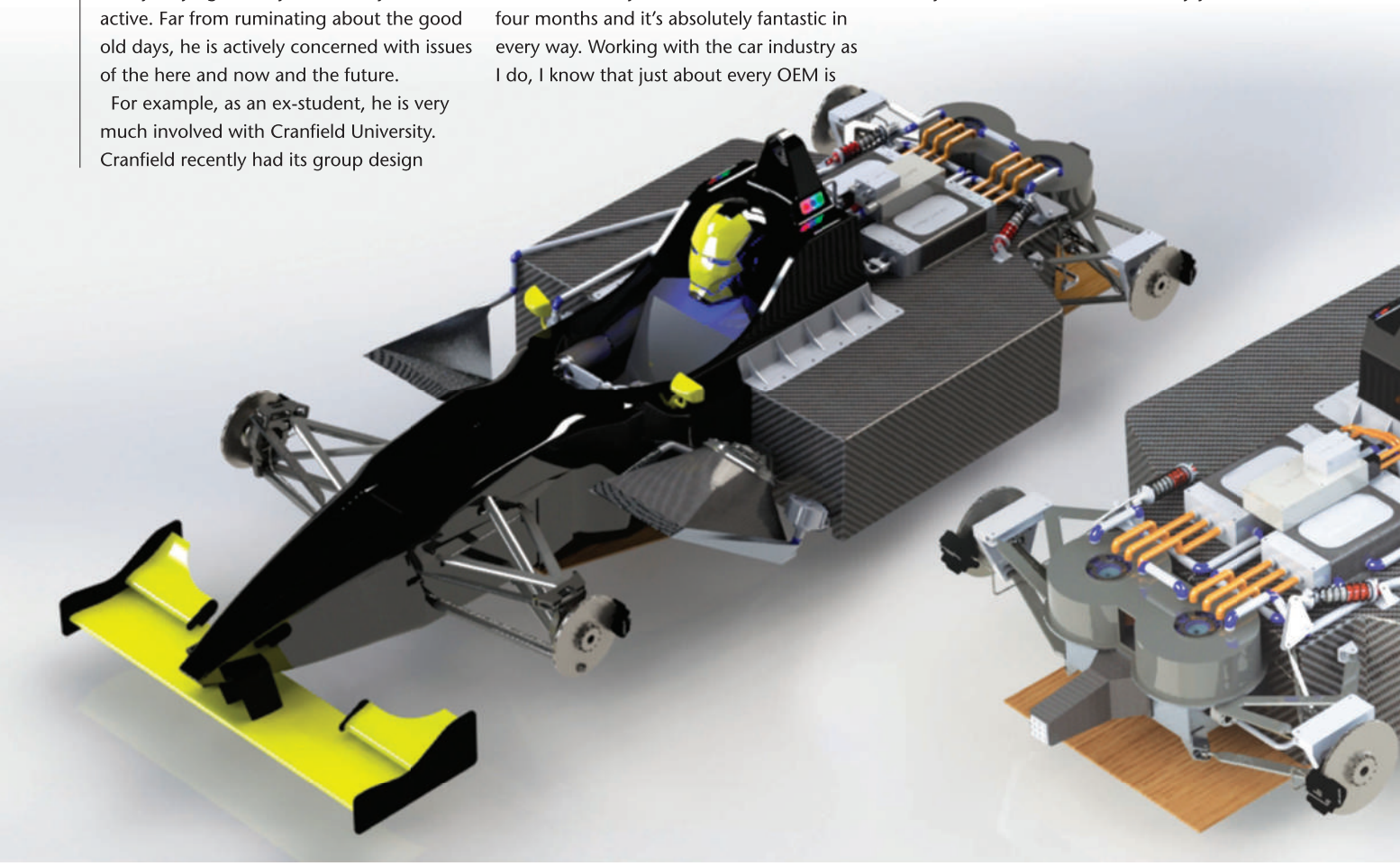
For example, as an ex-student, he is very much involved with Cranfield University. Cranfield recently had its group design project presentation day, to which end five teams of engineering students studying the Advanced Motorsport Engineering MSc had been set the task of solving thermal issues associated with electric racing cars. As chairman of the advisory panel, Reynard was instrumental in coming up with the topic.

However, his interest is not just academic because he sincerely believes that going electric is the future. He even owns a Tesla. "I'm a great admirer of this vehicle and in my view it's a game-changer," he says. "I've done nearly 7,000 miles in mine in four months and it's absolutely fantastic in every way. Working with the car industry as I do, I know that just about every OEM is now looking at a Tesla copy because this car company has got it right. The way that oil is becoming more scarce and electricity is the common denominator of power, I just think that it makes so much sense."

Reynard says that it was the Cranfield project that actually motivated him to buy the car. "I thought I've got to learn about battery-powered cars and there's no better way of experiencing electric power first hand than driving such a car all the time.

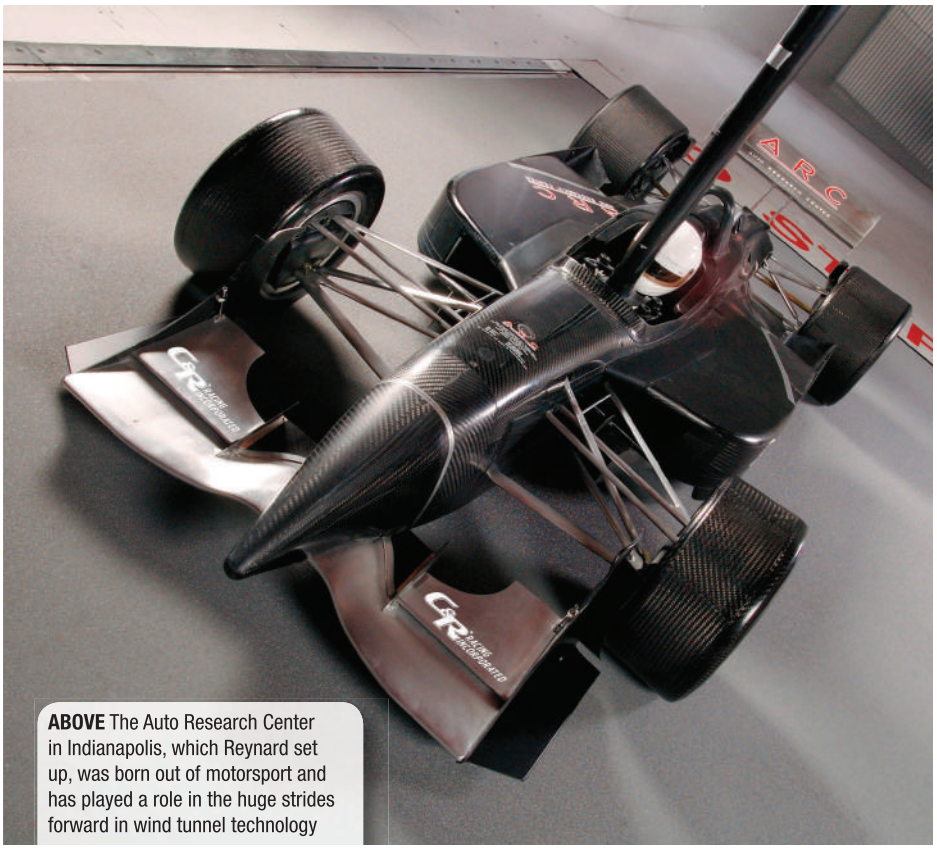
"Another reason for buying it is that I wanted to see for myself if I could improve its aero characteristics. While through my facility, the Auto Research Center in Indianapolis, we have contacts with many OEMs, we don't have one with Tesla so we haven't seen the car in our wind tunnel. The company also uses different software to ours, so I just wanted to see for myself how it performed."

While Reynard is coy about saying what he found and whether he could make any improvements, he was extremely complimentary about just how well developed it was. "However, there are always going to be things you can do," he says. "The more time and money you



> *He sincerely believes that going electric is the future"*

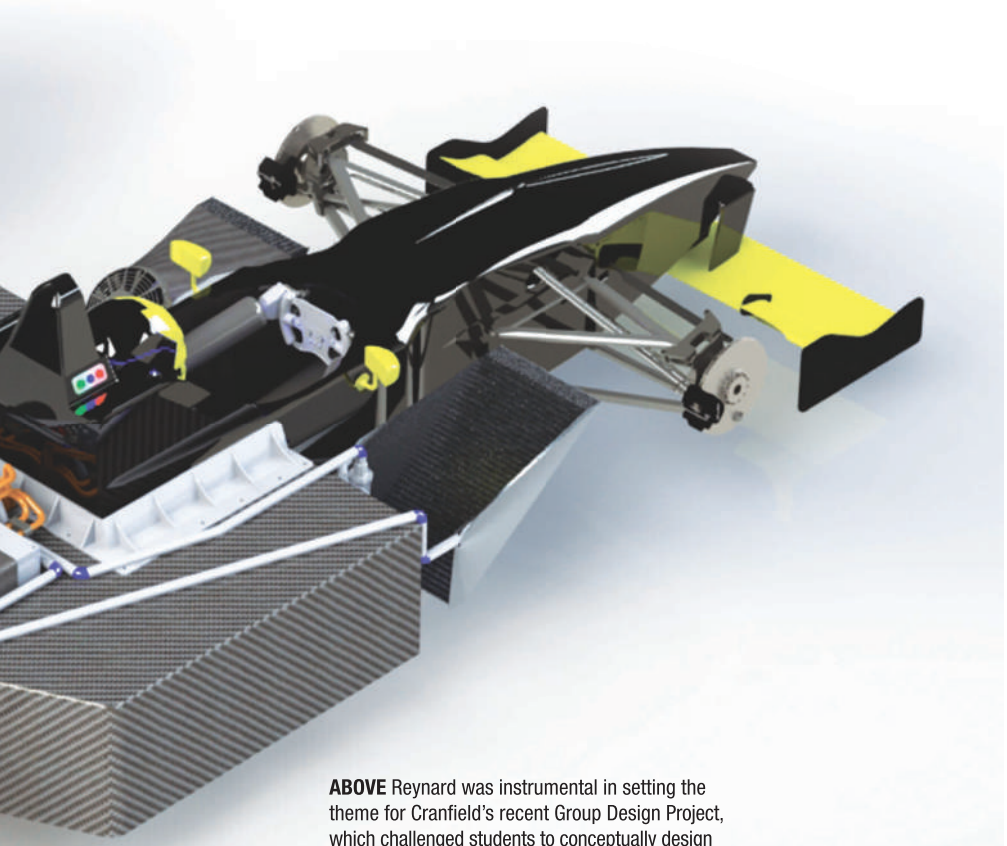
spend on aerodynamic development, you are always going to find improvements, and the techniques are far more refined these days. In the old days we just used to put a model in the wind tunnel or even go out on the road with it and experiment.



ABOVE The Auto Research Center in Indianapolis, which Reynard set up, was born out of motorsport and has played a role in the huge strides forward in wind tunnel technology

FRACTIONS OF A PER CENT

"Today, though, you can look at different systems. For example, our wind tunnel at the moment is now using inflatable rubber tyres for better simulation than plastic or carbon fibre ones. All these tiny details help add up to more accurate results that can be validated. We're talking of fractions of a per cent improvement but as the challenges of the motor industry are in reaching their fuel consumption figures, especially in the US with the tough 2025 CAFE challenges, we're looking at ever smaller increments of improvement that are worth a lot of money."



ABOVE Reynard was instrumental in setting the theme for Cranfield's recent Group Design Project, which challenged students to conceptually design the thermal management system for an electric racecar. Volta Motorsport's work, pictured here, won the MSA prize for the best team presentation

Reynard says that even today there is still some low-hanging fruit in things like commercial vehicles. "We do a lot of work in this area. The vehicles are really big, there's lots of area and volume and mixed surfaces, so inevitably there are plenty of vortices and interesting air flow patterns to consider. Nor is there yet a standard tractor and trailer, meaning that the number of combinations is truly huge – and few have got a wind tunnel big enough to accommodate them."

Looking back to the time when he was active in motorsport – Reynard developed a reputation for winning its first race in whichever series it competed, the most famous being Michael Andretti's season-opening win at Surfers Paradise – Reynard says he was lucky to be involved in it during such a golden era. "I think I was in the sport when it was on the crest of a wave, on a rising tide and the economics were so positive," he says. "When we pulled out, things were coincidentally going downwards. However, I think the budgets are now finally coming back, as is the interest and confidence. But the technology in the meantime has moved ▶

onto another level, which means that certain things are less expensive. For example, you don't need to go testing, going round and round a track, burning up fuel and tyres, as simulation is a really great tool. It simply wasn't available 12 years ago."

As the owner of a wind tunnel, you would expect Reynard to have a firm view on any proposed ban or limitation on their use, as is the emerging trend. "When it comes to restricting wind tunnel usage in motorsport, I think you have to take into account the cost benefit analysis and, more importantly, the overall budget that's available," he insists. "Motorsport will survive based on the budget that's available. When teams have a budget in good economic times they will want to spend money developing their own vehicles, their drivers and their teams to perform better. That's what it's all about. None of that is free. It all costs money.

COMPLETE CAR DYNAMOMETERS

"I think that to a certain extent the teams should be allowed to use whatever technology or methods that they can. How can you ban a technology that is transferable by word or mouth for example? If Ferrari has its own test track, how can it not transfer that into results in Formula 1? Not everyone has its own test track.

"Looking to the near future, I'm sure that we'll be seeing teams developing complete car dynamometers soon where they can spend maybe $20m putting a car on a dyno and running it through every conceivable test, including transmission, climatic wind tunnel, cooling, stress, strain – why shouldn't they if it saves track time and saves money in other ways? If you didn't have a wind tunnel, then maybe they'd do more track testing, or they'd use it in other ways. A wind tunnel is a convenient, fast, accurate and cost-effective tool and because every Formula 1 team has one, then they might as well keep it. What else are they going to do with it?"

Bearing in mind Reynard's view of the future of electric-powered cars, it isn't surprising that he's a big fan of the current Formula 1 regulations. "I think the hybrid solution in Formula 1 is great because I believe in electric technology," he says. "Eventually it will probably develop into something like a BMW i3, a car that has an electric motor with an internal combustion engine range extender. I love all that."


IndyCar

ABOVE & BELOW Reynard was at the heart of IndyCar's halcyon days, with flourishing grids, big crowds and competition between different chassis and engines

> *"The powers-that-be have to decide whether it's technology they want or an entertaining event that people can watch"*

Having said that, he is also enthusiastic about the way that Americans market motorsport, less concerned with developing technology and more about putting on a good show. "I do think the Americans have got it right in that they say that motorsport is entertainment and needs to be ruled and possibly crafted to provide good entertainment," he suggests. "In NASCAR it's taken to the extreme where close racing is provided by all sorts of methods, including scrutineering – being sent to the back of the line on a technicality cuts a team's preparation time – other 'adjustments', penalties or whatever.

"Now the FIA – and I was a great believer in the European way – didn't want to introduce those sort of models, so we've ended up with a more pure sport where inevitably there are haves and have-nots. If you've got a 24-car grid, it doesn't make for good racing if they're all stretched out, nor does it make good entertainment. So I think the powers-that-be have to decide whether it's technology they want, and whether that technology is going to be shared between Ferrari, Mercedes and Renault, or whether it's an entertaining event that people can go and watch. If it's the latter, then they may need some more flexibility to allow the NASCAR-type penalties to even out the disparities." ▶

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Asked whether he thought a convergence of the Formula 1 and World Endurance Championship regulations might be a viable alternative, Reynard is less enthusiastic: "I think that it's great that F1 and the World Endurance Championship explore their own rules and develop in their own ways and learn from each other. So I wouldn't advocate their following the same hybridisation regulations because they're slightly different audiences; it's a different show and they should be free to go their own way. One thought about spicing things up is that while people do want to watch the race, you could have some sort of points system for qualifying."

It's IndyCar and Championship Auto Racing Teams (CART) with which Reynard will be forever linked. In 1995 his cars dominated the PPG IndyCar World Series by winning the Constructors' Championship, the Drivers' Championship, the Indianapolis 500, and Rookie of the Year. The success story continued in 1996, 1997, 1998, 1999, 2000 and 2001 with Reynard again dominating the FedEx Championship Series, winning the Constructors' Championship, the Drivers' Championship and Rookie of the Year titles, so his take on the current situation is therefore interesting to hear.

BUMS ON SEATS

"When it comes to improving IndyCar, it is all about getting bums on seats and getting sponsors to recognise the series," he muses. "I think one of the mistakes we made in my generation was to annually update the cars but that's what the market wanted. The teams all demanded faster cars and they wanted to pay for it; as a constructor it's very difficult to ignore that because it was very good business.

"However in the last few years I do think, taking into consideration the cost of change and the redundancy of the car, that it was a huge waste of money and resources. So, in lots of ways, having a chassis that's mandated to last many years is very good, but having said that, it kills it for manufacturers like Reynard. It's very good for Dallara over a period of time, and the more they're there, the more they dominate and the more obvious it is for them to continue, but it's really bad for the industry. Back in my day we had Lola, Eagle, Penske, March, Coyote – it was wonderful and I am privileged to have worked in that era."

Asked where he would see himself going today if he was a young engineer hoping to make a career in motorsport, Reynard replies: "I was always interested in performance and the criteria affecting performance does change. Simple physics like low weight, effective weight distribution and a low centre of gravity weren't fully recognised in the early days, while aerodynamics has always fascinated me and that is still my central interest.

"Now, though, if I had to start again, my focus would have to be powertrain, energy efficiency and harvesting energy. So if I wanted a strong career in motorsport now, I would definitely have to educate myself about the whole use of energy because performance is all about using energy efficiently." RT

Daimler

TOP & BELOW A fan of US motorsport's entertainment ethos, Reynard believes it's make your mind up time for F1: technology, or spectacle?

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Hands up if you said this was doomed!

The biggest thing in touring cars in 25 years? **Andrew Charman** finds out if the TCR formula is living up to its billing

IN *Race Tech* 172 we discussed prospects for an all-new touring car formula, TCR International, with its creator, Marcello Lotti. The fact that the man who created and successfully ran the World Touring Car Championship for several years was involved added kudos to the series, but while some dubbed TCR as potentially the biggest revolution in touring cars since the Super Touring formula of the 1990s, others remained highly sceptical of its prospects in an overcrowded market.

As this is written, TCR is in the middle of its 11-round inaugural championship. *Race Tech* travelled to round five, at Monza in Italy, to talk to those who invested in the series, and to discover if the excitement it is generating is well founded.

THE CONCEPT

The basic concept of TCR is simple: a pyramid system, with national championships at its base, moving through regional series to a headline international championship. Crucially all use the same car, so that drivers and teams can progress up the ladder, and cars can be sold on in an extensive and lucrative secondhand market.

Lotti is courting manufacturers for his series, but he has no intention of repeating history. In the mid-1990s Super Touring was considered extremely strong, 10 manufacturers battling in the British Touring Car Championship, but the formula then imploded in a very short period, as those manufacturers allowed budgets to balloon to several millions and then pulled the plug when they couldn't keep up with the spending.

Manufacturers entering TCR are obliged to build several examples of their chosen racecar – either through their own motorsport departments, as in the case of SEAT, or through a specialist constructor such as with Honda and JAS Motorsport – and then to sell these cars to entrants. This formula is about winning the market more

TCR International Series

ABOVE Track limits: TCR is providing all the action expected of a touring car championship

than winning the races.

For this concept to work Lotti needed an affordable technical package, and it already existed, in the regulations for the long-established SEAT Leon Eurocup. These heavily production-based regulations form the basis of TCR.

Speaking to *Race Tech* at Monza, Lotti probably has reason to feel satisfied with progress. In its first four meetings, two of which have supported Formula 1 grands prix, TCR International grids have averaged 14 to 17 cars. The racing has been entertaining, to traditional touring car all-out style, and produced seven different winners in eight races.

More importantly, however, interest in TCR is snowballing, both in terms of countries wanting to run national and regional race series and manufacturers wanting to build cars. The TCR Asia Series starts this month, while next year TCR will be represented in countries such as Thailand, China, Russia, Italy, the Benelux region, Germany, the Dominican Republic, Venezuela, even that nation where touring cars have traditionally struggled, the USA.

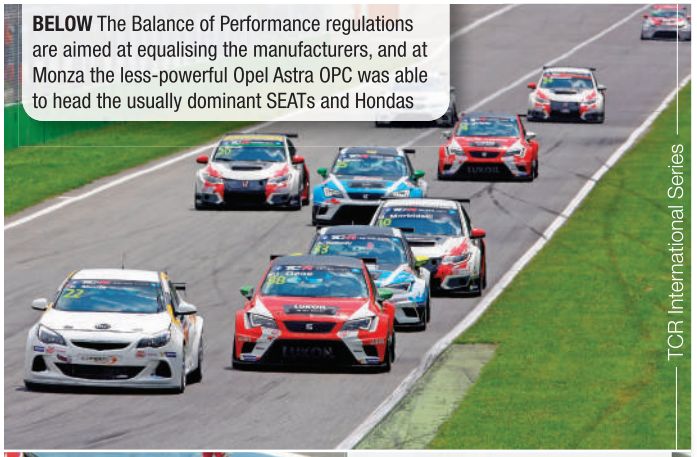
"We are seeing great interest in the US, a lot of VW group brands are in the market there," Lotti says. "Day by day more people are calling us with interest in organising a series. France for example – but I've suggested they wait one month as we are discussing a car entry with a French brand and if they confirm it will make it more easy to get support to organise a French series."

While Lotti won't say, that brand is widely rumoured to be Renault, which could adapt its well-established Trophy series to TCR rules, and this is indicative of the manufacturer interest in the concept. Just as *Race Tech* went to press the Volkswagen Motorsport-developed Golf made a winning debut at the A1-Ring round (see news). Italian squad Top Run Motorsport expects to debut its first Subaru WRX STI at Singapore in September, and has an agreement with Subaru to produce two cars a month from that point. And other manufacturers, notably Audi, are known to be close to confirming programmes.

Winged wonder

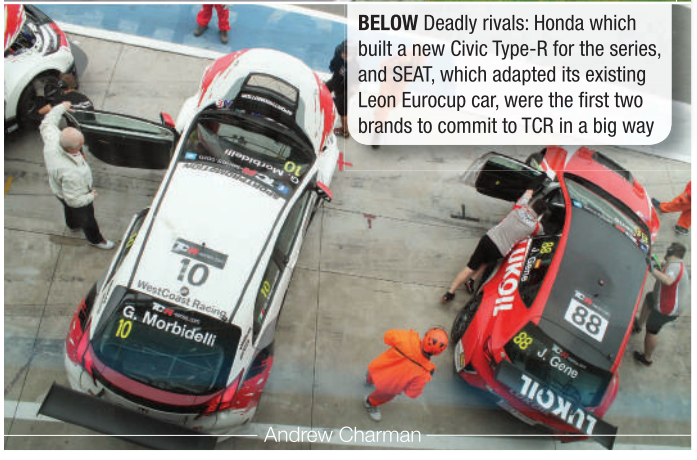
THE cars entered in the TCR International Series have displayed some novel methods of mounting their rear wings.

While the Hondas attach their vertical mounts from below in traditional fashion, other brands such as SEAT and Ford use mounts that stretch around the wing and bolt on from above. By far the most convoluted method is that fitted to the Opel Astra OPCs, a large device looking for all the world like a conventional wing that has been fitted upside down… RT



BELOW The Balance of Performance regulations are aimed at equalising the manufacturers, and at Monza the less-powerful Opel Astra OPC was able to head the usually dominant SEATs and Hondas

TCR International Series



BELOW Deadly rivals: Honda which built a new Civic Type-R for the series, and SEAT, which adapted its existing Leon Eurocup car, were the first two brands to commit to TCR in a big way

Andrew Charman

PROGRESS TO PLAN

So is Lotti happy with progress? "It's following our provisional plan," he says. "My personal plan was much better, to have all brands ready for the first event, but that doesn't happen in the real world, especially with a start-up. You have to lead day by day but it is not in my DNA to be patient!

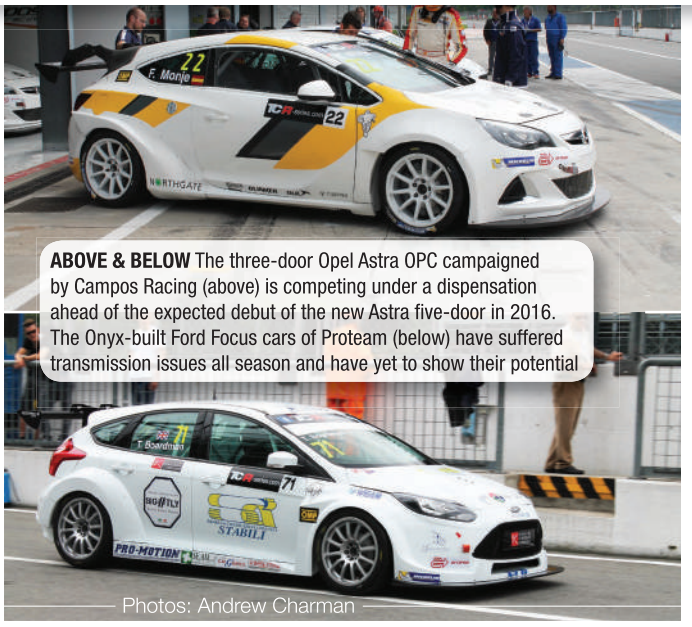
"We knew before we started that the development time for new models did not really suit our timing, but if you don't start you will never start. It was important to be out there, especially to help encourage potential customers of next year's national championships in such places as Russia, China, and Thailand. So we sped up the development time, to ensure that ▶

there will be cars ready for January next year and all the teams that will be running in national championships."

Lotti is pleased with the way the car builders and teams have responded to the challenge, though he does admit to disappointment at the performance so far of the Ford Focus cars built by Onyx in the UK. A decision to use a road gearbox to avoid the weight penalty that comes with a race unit has cost the Fords dearly, the plastic components of the road transmission apparently not strong enough for race demands, and current information suggests the team is working on a switch to a race 'box.

"I was expecting Ford to have provided more action, but they are still having gearbox problems," Lotti says. "Tom Boardman the test driver tells me that the car and the engine are okay, when they solve the problem we will see the car perform."

The technical package is correct, Lotti believes, and little likely to change going forward. He adds that the much-vaunted Balance ▶



ABOVE & BELOW The three-door Opel Astra OPC campaigned by Campos Racing (above) is competing under a dispensation ahead of the expected debut of the new Astra five-door in 2016. The Onyx-built Ford Focus cars of Proteam (below) have suffered transmission issues all season and have yet to show their potential

Photos: Andrew Charman

The driver's view

GIANNI Morbidelli should certainly be able to rate a touring car – his storied career includes spells in the Super Touring era of the BTCC with Volvo and in the World Touring Car Championship, even V8 Supercars. But for 2015 he signed with West Coast Racing, running JAS-built Honda Civic Type-R cars in TCR International, and he has quickly become a title contender.

Morbidelli believes that TCR has "incredible potential" and will become a significant part of touring car racing in the future. He points particularly to the fact that manufacturers are not permitted to enter the series with the aim of purely winning it by throwing huge budgets at a programme, without selling cars to customers.

"I was in the WTCC with Munich, a private team, we had a good budget but it was 10 per cent of what Citroën was spending," Morbidelli tells *Race Tech*.

"I had no chance of competing, we just made up the numbers. Here you buy the car and if you are a good driver, with a good engineer, you can compete at the same level.

"In the WTCC a car costs €500,000-€600,000, and then when you end your programme what can you do with that car? Nothing. Here the car costs much less to buy and there is a market to sell it on."

The Italian also contends that in terms of driver fulfilment the TCR car is not far removed from the more powerful machines of the WTCC. Perhaps not surprisingly TCR's only minus point for him is the one all racing drivers hate, Balance of Performance. "For the concept I have of racing Balance of Performance is wrong – for me the best must win," he contends. "If Rory McIlroy is the best golf player in the world you cannot penalise him with a heavier ball. Letting the best person win is the concept of sport.

"But I understand perfectly that the BoP is needed and we have to accept that. But we have to be very careful to do it in a proper way, so that you don't go direct from winning a race to fighting for 10th place at the next track."

He is also content that the TCR rules will ensure no manufacturer can win by spending money. "If a manufacturer comes in and spends €20 million, no BoP will make a difference to that, but here that is impossible. There must be a budget cap so everyone can be a part of the championship – if you say a car cannot cost more than €100,000, it is a good rule. Lotti has a good idea how to manage it."

He is highly confident about future prospects for TCR: "The concept is perfect. By the end of the year we will have more brands, we have already run two races alongside Formula 1 and will have another in Singapore, which is good if you want to sell the championship to sponsors.

"In January when we were talking about TCR many were saying it's rubbish, they will never do that. But it's here – I don't know how many people could set up a championship to this level in six months." RT

BELOW Morbidelli is convinced TCR has a strong future

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TCR International Series

ABOVE The series has already provided plenty of the panel-bending action that touring cars are renowned for

of Performance (BoP) regulations, used to equalise the various brands of car and provide competitive racing, have worked well, despite criticism.

The initial BoP was set during a pre-season test but the opening races have seen several adjustments, as Lotti always expected in the early days of the series. Notably the Hondas were given a 35-kilo penalty before the round in Valencia, for using a racing gearbox, while at the same time rivals were able to drop their ride height by 10 mm.

Such changes saw the Honda drivers complaining loudly, while by the time the series reached Monza the SEAT drivers were arguing for the straight-line speed of the Hondas to be reined in. But Lotti is unfazed.

"The balance of performance works very well," he says. "Honda and SEAT were the two brands ready for the start of the series. Honda built a car to the ▶

The constructor's view

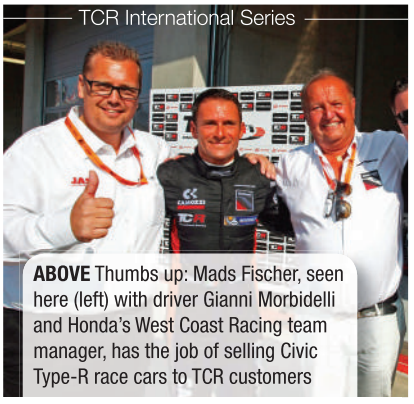
MADS Fischer is Development Business & Customer Service Manager for JAS Motorsport, a specialist constructor founded in Milan in 1995 and an official partner of Honda since 1998. Since then it has built cars for major touring car championships, including the BTCC and currently the WTCC.

JAS was one of the first constructors to commit to TCR and by March 2016 hopes to have built at least 23 examples of its Civic Type-R for customers. And according to Fischer, the build process is very different to that of a WTCC car.

"In this series the one major problem is cost constraint – you need to rethink everything you do, take care what you put in the car, what you spend on it," Fischer tells *Race Tech*. "We have built rally cars for cost-capped series but in touring cars we are used to having development projects with budgets."

The priorities in the TCR programme were to build a fast car that is reliable and looks the part. "We took the decision to make reliability point number one. We obviously want it to be fast but we also want to give the customer a nice product that he will be happy to look at, and to compare to other cars."

The other major difference is the need to set up a production line, as opposed to the bespoke handful of cars that would be built for a traditional programme such as in the WTCC, and this impacts the entire manner in which


TCR International Series

ABOVE Thumbs up: Mads Fischer, seen here (left) with driver Gianni Morbidelli and Honda's West Coast Racing team manager, has the job of selling Civic Type-R race cars to TCR customers

the company works. "You need to guarantee delivery times, to be flexible when you sell parts, to be good at managing your customers, and to not regard customers differently," he says. "Whether someone is buying one car or 10 cars they get treated the same way.

"Over the last 10 years in JAS we've turned the business into being more customer-related, which provides a strong base for the company. When you are running high-level programmes if they pull the plug on them you end up with a big hole in your income."

The build itself needs to be as efficient as possible: "You build the cars as kits – radiators, suspension for example, not one-offs but in blocks, several at a time. You need to carry a lot more spares, more stock, but this is the only way to make it feasible."

Fischer admits that from a sales point of view the cost cap is his least favourite aspect of the TCR formula, "but this is something you have to live with! Sometimes you have to compromise; you could make things a little better, but this would raise the price. I understand why they want to keep a €100,000 cost cap and this should be where they keep it."

JAS Motorsport's long-time technical partners have helped significantly with the TCR programme, Fischer adds. "We are lucky to have partners like Mugen – they have been with us for almost 10 years, and without them such a project would have been difficult. Partners such as Ole Buhl Racing have supported us in the initial build while one of our key suppliers is Sadev – they build gearboxes for our R3 rally programme and are also now helping us get this programme up and running."

He feels that brands such as Honda, which don't have DSG gearboxes in their production range, are compromised slightly compared to those such as the VW Group cars. "We didn't have a choice but to go with the gearbox that makes our car a little bit more expensive compared to other cars. It maybe has some disadvantages in terms of weight, but this is the championship, you have to live with it and we accept it."

He shares the confidence of others in the series going forward, saying: "It's a series where you can race all over the world but the cost is low. You will see a lot of second-hand cars changing hands. This is what has been missing in the sport."

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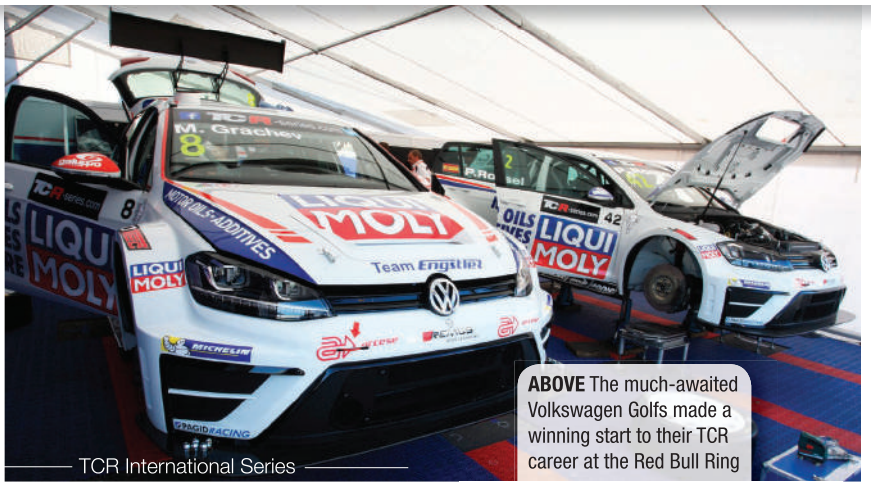


TCR International Series

ABOVE The much-awaited Volkswagen Golfs made a winning start to their TCR career at the Red Bull Ring

TCR regulations, the SEAT was an existing car adapted to TCR.

"Some circuits favour the Honda, some favour the SEAT, which is basically production and manages its temperatures better between hot and cold places. The Honda is more racing-focused but cannot manage the changes in temperature so well.

"After the Valencia race when the cars were in parc ferme we booked a dyno without telling the teams. We put the four brands, the Honda, SEAT, Opel and the Audi TT, on and gained horsepower and a torque graphic from all of them. It was what we expected, within 5-6 horsepower, the Opel a little less than 300 horsepower but with better torque."

TCR allowing Engstler Motorsport to campaign two Audi TT coupes, after the team's planned VW Golfs were not ready in time for the start of the season, raised eyebrows, but it was regarded as an information-gathering exercise for a potential Audi entry. And it is indicative of Lotti's determination to get the series right that following Audi TT driver Nicki Thiim's win at Portimao, the exemption ended, Lotti deciding enough information had been gathered despite the potential drawbacks of removing two cars from his then not over-populated grid.

"They helped to start the series with a nice brand but they departed with enough info," Lotti says. "To continue would be unfair on other competitors."

So going forward, where does he expect to be at the start of 2016? "Marcello's plan would be to change the track rules to allow more cars on the grid! But realistically, I expect a 24-car full field in TCR International with at least six brands represented."

Such a grid will without doubt produce a very exciting second season for TCR, just as the national and regional series get up and running. No one is sceptical any more. TCR is here to stay and in 2016 will be a significant global force in the touring car arena. RT

The manufacturer's view

SEAT Sport Director Jeimi Puig has reason to attend each TCR round with an expression of satisfaction. The TCR rules are based closely on those of SEAT's own Eurocup series, successful over many years, and it is no surprise that currently the most numerous cars on the grids are SEAT Leons.

"We are now on our third generation Eurocup car, and we have always started on the same basis," Puig tells *Race Tech*. "We take our standard highest performance road car, the Cupra, and we make a car that is good for racing.

"We've seen over the years many using these cars in national, in endurance championships. Now for the first time a promoter will create a pyramid with national championships, regional and international. For us it's like we won the lottery!

"Someone has believed in our idea and followed it, but it's an idea all manufacturers can follow, it's not just related to SEAT. Many manufacturers have 2-litre turbocharged cars in their road range, and it is important to use as many standard parts in the racecar as possible."

In SEAT's case, according to Puig, that means a road-derived engine, gearbox, differential, steering and body. "We are lucky to be part of a big manufacturer group where many parts are available, but it is not easy – the engineer has to do a lot of work to make the racecar competitive.

"It's very easy to build a performance car to win a championship, but a performance car that has to cost less than €100,000, that's difficult. An engineer designing a racecar never thinks that he has to use a standard part, he always wants to design a motorsport piece. To give one example, our front and rear sub-assemblies come from the production line, but they have motorsport bushes fitted."

Puig is happy with the TCR technical package, but believes it is important to closely monitor how it is interpreted by new brands coming into the series. So what if a manufacturer entered with the intention of simply winning it, without basing a programme around selling customer cars? "If the TCR organisers say we have a new manufacturer but they will not sell cars for two years I will say no problem, 300 kilos extra weight for them!" he laughs.

Puig supports the current rules but appreciates the arguments over gearboxes. "Everyone is asking us about sequential gearboxes – we have one developed and it is faster but it would add €20,000 to the costs. We are lucky in the VW group that we have a very good DSG gearbox in the road range. I understand some other teams cannot use the standard gearbox, that's why we opened the rules to allow not only the standard gearbox." RT

Andrew Charman

ABOVE The SEAT Leon Eurocup car needed minimal modification to make it suitable for TCR competition

DOUBLE DUTCH

Immediately following the British Grand Prix at Silverstone, the circuit hosted an event that is as important in its own way as the flagship F1 race. **William Kimberley** was there to see 135 universities from around the world compete with their self-built cars

THERE is something electric about Formula Student. Not in the way that the only way to win this event, ironically organised by the Institution of Mechanical Engineers, is with an electric car, but in the atmosphere generated.

The thought of up to 3,000 students milling around is enough to put some people off, but this event represents the future, many of those working on their cars here will be seen plying their trade and skills in all forms of motorsport, including Formula 1, in future years. On hand were a number of F1 luminaries including Ross Brawn, Willem Toet, Paddy Lowe and Andy Cowell, all of whom are very supportive of the event.

From the well-funded European teams, many of which benefit from tax breaks in their country that encourage businesses to invest in them, to the less well-funded ones from elsewhere, there was a sense of camaraderie. The 'we're all in it together' feeling persists, despite the fierce competition to be best British team, the best combustion-powered one or whatever.

As usual, there was a baffling array of machinery to look at, ranging from the beautifully turned out cars to the rather more careworn versions. Whatever they were, though, they were the lovechildren of their respective teams.

One of the best turned out cars in the paddock this year was the Revolve NTNU's one from Trondheim, Norway, the attention to detail earning the car a deserved third place in the Design event behind ETH Zurich and Oxford Brookes. As explained by chief engineer Kurt Erik Nesje, a real focus of their attention had been developing the aero kit, many hours being spent by team members in simulation.

The car had been ready for testing in April but was constantly beset by problems that held it back. It was the finished product, though, that caught the eye, the attention to detail the reason for it doing so well in Design. As explained by Nesje, the team has worked with Kongsberg Automotive from the start, the tier-one supplier allowing a handful of students to work there on their car to produce the various composite components required such as the monocoque, the wing package and the wheel rims. Sadly, the gremlins that affected the car so badly in testing continued into the event. It was unable

ABOVE Willem Toet is given a briefing about the TU Delft car

ABOVE Ross Brawn may have walked away from Formula 1 but he is still a keen supporter of Formula Student and remains its Patron

ABOVE & BELOW It may not have won the event but the attention to detail of the Norwegian University of Science and Technology's car was of the highest standards. Unfortunately for the team the car let them down in the dynamic events

to score any points in acceleration, and only minimal points in endurance, which knocked it way down the rankings come the final totting up of the scores.

At the other end of the scale was the TU Delft team from the Netherlands, last year's winners. The DU15, as the number implies, is its 15th car, but its fifth electric car and fourth all-wheel drive one, so it is extremely experienced in producing such machines. With 60 students divided into six different categories and a management team of four, it is also extremely professional in its approach and everything about the team and the car showed this. Perhaps it *piece de resistance* was its own 14.5" tyres that had been developed over the winter.

The car topped the Business Presentations category and came second in Acceleration and Endurance. For all that, though, Lady Luck smiled on the team: it was having a head-to-head fight with the ETH Zurich squad which just had the edge until it fell down badly in the Endurance event, scoring no points. As a result, it finished up in 17th place overall.

"All the hard work over the past year has paid off and the whole team has gained invaluable hands-on experience on what is involved in developing a car from start to finish," said Stijn Pennings, team leader for Formula Student Team Delft "I think the key to our win is the extremely light and agile nature of our car. This year we trimmed the weight of the drivetrain and also had a one-piece monocoque. We worked well as a team and I am incredibly proud and happy with our win, particularly winning by such a big margin."

RAIN DANCE

Another team to capitalise on its good fortune was the University of Bath. Not only did it come fourth overall but in winning the Endurance event, a first for a British team, it really made a point. It was fortunate that as it finished its run in this event the heavens opened and the course was red flagged, meaning that the much more fancied teams that followed had to run on wets and therefore stood no chance of equalling Team Bath Racing's time.

However, to put the overall result down to luck would be unjust: the team won every Class 2 category – Design, Business presentation and Cost. As it turned out, this was something that the Class 1 team found difficult to emulate, finishing 12th in Design, 22nd in Business and 54th in Cost.

Things had looked gloomy for Team Bath Racing during the mandatory Brake test when a wishbone failed, leading to the whole front left section of the car facing the wrong direction. Where many would have ▶

ABOVE The TU Delft car won Formula Student for the second consecutive year

called it a day, such was the team's character that it installed a new, lighter set made from carbon tubes, rushed back through scrutineering to participate once again and finally passed on the third attempt.

"We had a bit of luck," admitted Dr Geraint Owen, one of the University of Bath's faculty advisers, "especially after a mixed weekend. We were disappointing in our Class 1 presentations, dropping a number of points, while the dynamic events were okay but not outstanding, but our car was particularly good in endurance. We beat our big UK rivals Oxford Brookes by two and a half minutes on that event before the rain came, and we were quite happy with that. Unfortunately the points we scored on it weren't quite enough to make us the best internal combustion engine finisher, Stuttgart winning that plaudit. I don't count the electric cars that came first and second because personally I think they're cheating. In every other Formula SAE/Student event around the world, they're in a separate class.

"From an educational point of view we know we could make a faster car if it was electric but we keep to a combustion one because it's all about learning and automotive graduates need to have an understanding of things like valve events, plenum sizes, boost levels, turbocharger maps, those sort of things, rather than high-tech motors and spending a lot of money on batteries.

"This year we were running a single cylinder 550 cc KTM with a turbocharger as we had given up on the Aprilia V-twin which was just so unreliable. That was a really positive move for us although we are not there yet and there's still plenty of scope for more development. ▶

ABOVE Scrutineers Michael Royce (left) and Howard Ash (right) inspect another car in what proved to be a very rigorous scrutineering process

The design brief conflict: an expert's view

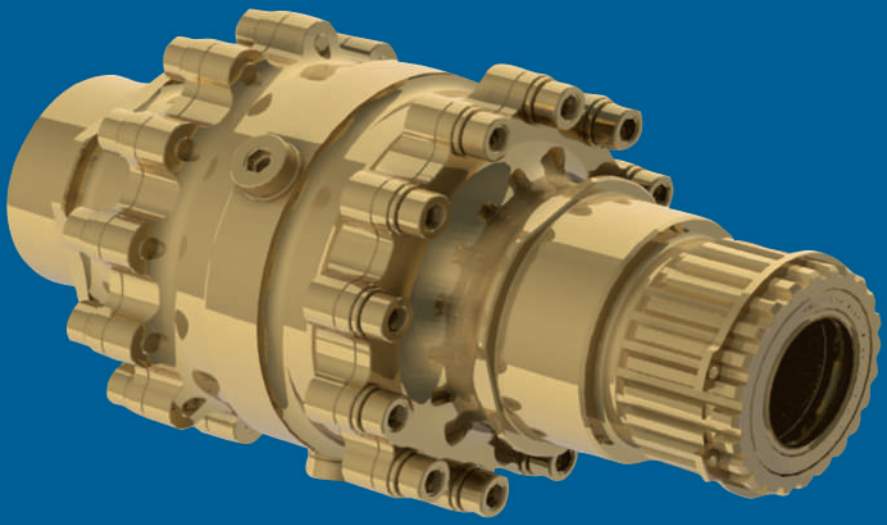
JOHN McCrory is one of the individuals in motorsport who seems to be everywhere on behalf of his company, Aurora Bearings. An avid supporter of Formula SAE in the US, his company historically offering special rate discounts to Formula SAE/Student teams, the Formula Student at Silverstone has become an annual pilgrimage for him. His view on this year's offering makes interesting reading.

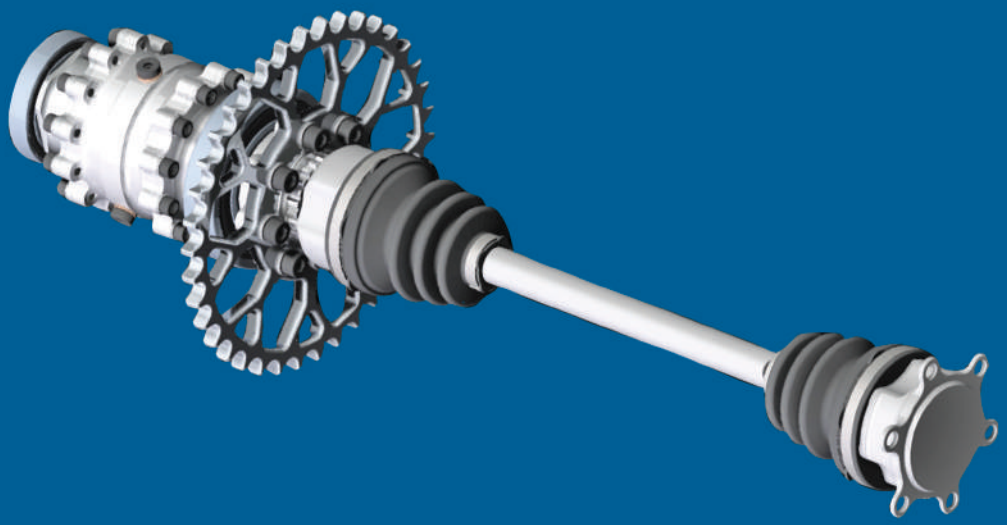
"I have been involved with Formula SAE since I joined the company 25 years ago and I'm here at Silverstone to make contact with the people and teams that are using our products, to build relationships and frankly get a temperature of what the future of the industry is going to be," he says.

"This year the level of engineering is amazing. However, there has been a debate within this competition that's gone on for quite some time and that is the brief of the car that is supposed to be built, which is an autocross car that I can myself campaign, versus the concept of stretching young minds and developing young engineers and increasing their breadth of knowledge. The two are in conflict. As the late, great Carroll Smith once said, the perfect car in terms of a car for sale is a mid-'80s Formula Ford, but the cars that are going to win the competition are every bit as sophisticated as a Formula 1 car. So there's the dichotomy.

"Also, with the number of Formula SAE/Student events happening around the world now, it's possible to use one event as a test session prior to going to one that they really want to win. Not many schools have those resources but that's the way to run the system and you can still do that with a petrol car but now also with an electric one." RT

Formula Student





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BELOW The University of Bath excelled itself this year even if it was the fortunate beneficiary of the variable weather conditions, but winning the Endurance event is no mean feat regardless of that

"However, the real area where we have made a superb step forward with the car is in 3D printing steel components. Our wheels, for example, are down 800 grams, a 60 per cent weight saving on last year's, due to the our utilisation of 3D printing technology, in this case producing a steel insert in the wheel to reinforce the carbon. It has real advantages so that the wheel nuts can fall down on steel rather than on carbon. We also 3D printed all the steel uprights.

"We are now talking to people about 3D printing Inconel parts, alloys of lithium and aluminium that are massively strong and also very light. So we are hoping to have a series of projects on the car in the forthcoming year."

Finally, Formula Student would not be what it is without those teams that come from the far flung parts of the world, for whom just by being present is an achievement in itself. One such was the Jordan University of Science and Technology. It brought a car and team of 15 that had to overcome serious financing issues, a lack of parts and support back home, and yet still arrived at the circuit to compete.

"It's been a superb experience to participate in this event," said JUST Racing team leader Malek Abu Sultaneh. "We have met many people from the UK and other countries who have been very supportive in what we do, and they have also become friends. What's also so great is that you learn so much more by being hands-on and the pressure of working on a car to meet deadlines, like getting it through scrutineering, rather than just by studying books. I hope that this event will continue to be supported not just by my university but by others in Jordan and the Middle East as it's a once-in-a-lifetime experience." RT

"Automotive graduates need to have an understanding of things like valve events, plenum sizes, boost levels, turbocharger maps etc, rather than high-tech motors and spending a lot of money on batteries"

Aero evolution

ONE area of design that is constantly evolving and becoming more complex in Formula Student is the aerodynamics, writes *Scotty Whitelaw*. This year changes in the regulations were made to further challenge the competitors.

The most notable changes in aero design were to the wings, with the front ones having to sit higher off the ground and the rear's width becoming narrower, the outside edge of the tyres being the boundary. To regain the consequent loss of downforce, some innovative designs were introduced, the most noteworthy being the addition of a front cascade to the rear wing and the rear tyre wings.

Adding a cascade increases the rear wing's working section to throw the airflow onto the rear elements without stalling the air or causing severe turbulence. However, some teams did not look to run this due to the problems it presents if designed incorrectly – it could result in an increase in drag if the rear elements do not have access to the required airflow.

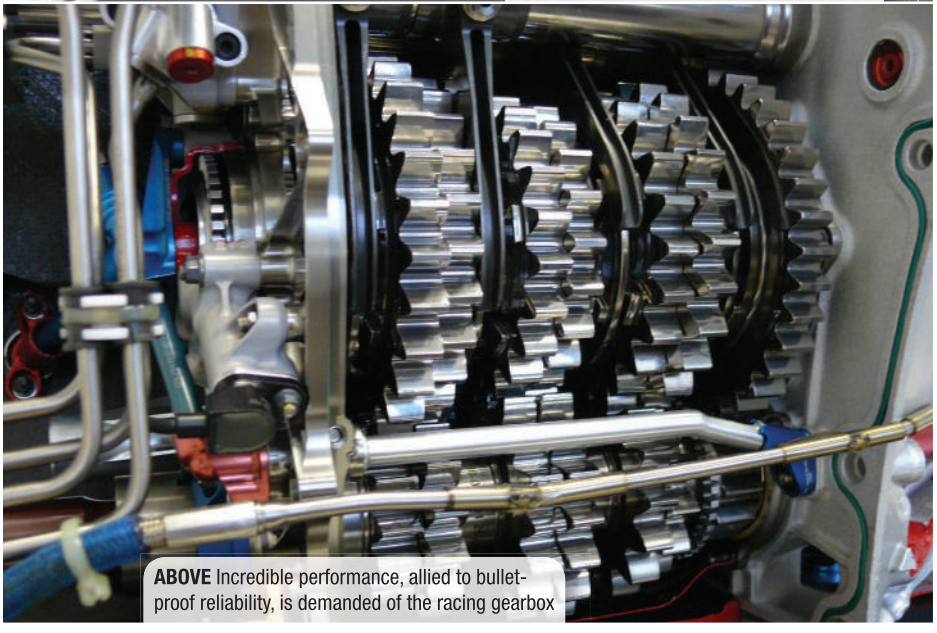
The aero designs on offer on this clutch of Formula Student cars were varied although in a few cases questionably ineffective even if they did look spectacular. RT

WHEN EVERY MILLISECOND COUNTS...

"It does what it says on the tin" is not something top motorsport teams accept without question when it comes to transmission lubricants, as ***Race Tech*** discovered when visiting the Toyota Motorsport GmbH (TMG) facility in Cologne, Germany

Staley/LAT

ABOVE Anti-clockwise circuits like Interlagos inflict different demands on lubricants



ABOVE Incredible performance, allied to bullet-proof reliability, is demanded of the racing gearbox

WITH margins incredibly tight in Formula 1, every millisecond of performance counts. That means the search for improvement never stops, although the pressure to maintain bullet-proof reliability is ever-present.

At Toyota Motorsport GmbH (TMG), which ran the Toyota F1 operation from 2001 to 2009 and counts several F1 teams amongst its current client list, the solution was a dedicated testing area which put a particular focus on lubricant analysis.

The lubrication rig, which evaluates lubricant performance, is the first step in a lubricant's journey from potential candidate to actual race usage. Data recorded from the car on any given circuit is converted to two-dimensional angular displacement, which allows the rig to simulate lubrication flow. Accuracy is validated by cross-referencing pressure in/out data from rig and track.

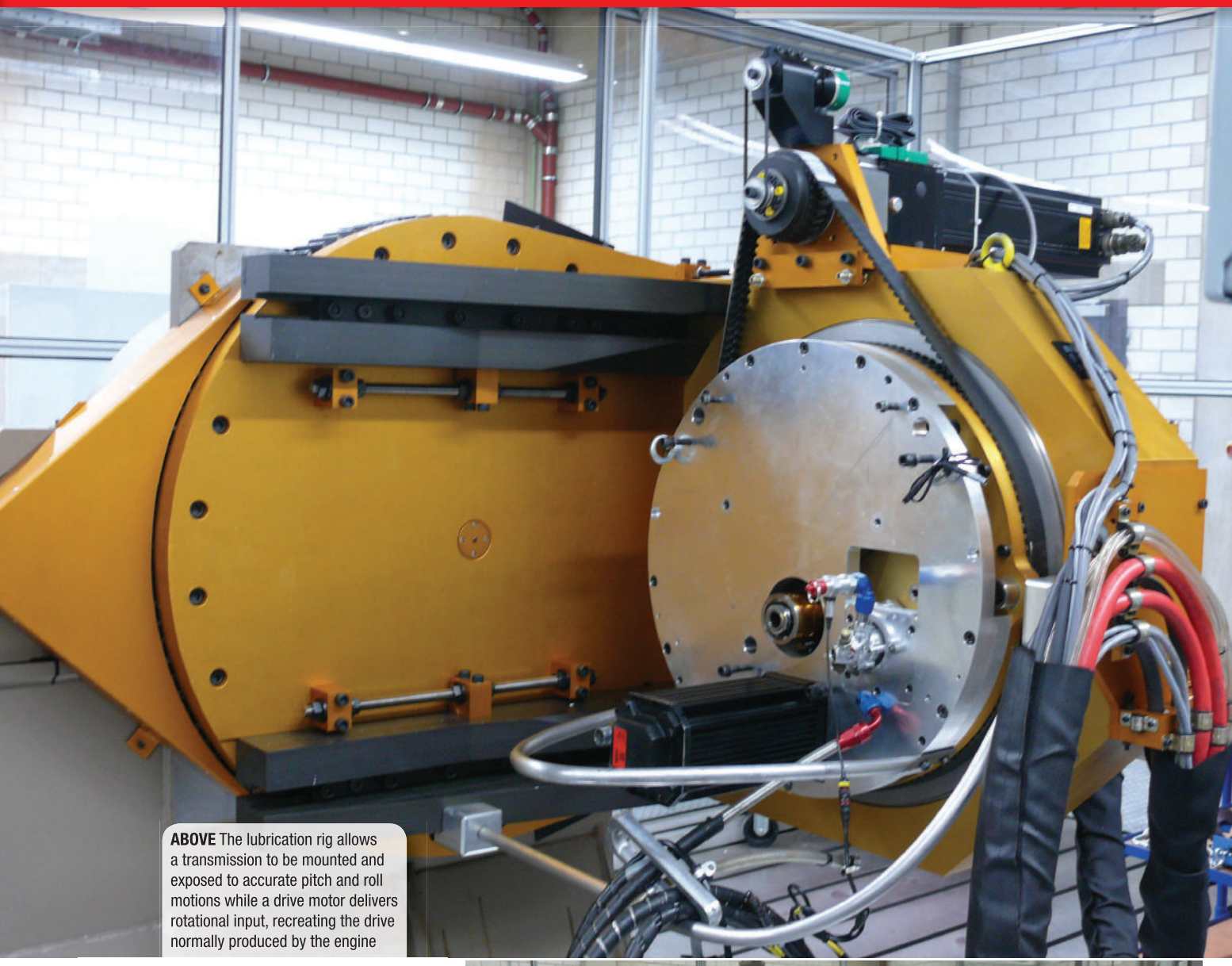
Marco Gehlen, manager of vehicle and component testing at TMG, explains: "Two main performance factors are analysed: gearbox in/out pressure and energy

> *"Pressure drops can be alleviated by increasing the amount of lubricant, but more oil means more weight and increased internal losses"*

consumption; that means how much power is lost during a dedicated test cycle. In F1 or any level of motorsport, you never want to lose any power before it reaches the wheels so we focused a lot on that area during our F1 times."

Additionally, a lubricant's tendency to foam, as a result of its composition or the design of spray bars, is studied. Foam and cavitation – when small air bubbles implode under pressure, potentially damaging components – are enemies of effective lubrication.

Gehlen adds: "We can see any evidence of cavitation on the oil pump. We take this risk very seriously because parts can be blasted into pieces in extreme circumstances. As well as cavitation, foam is a problem by its very nature; when air enters the cooling systems



ABOVE The lubrication rig allows a transmission to be mounted and exposed to accurate pitch and roll motions while a drive motor delivers rotational input, recreating the drive normally produced by the engine

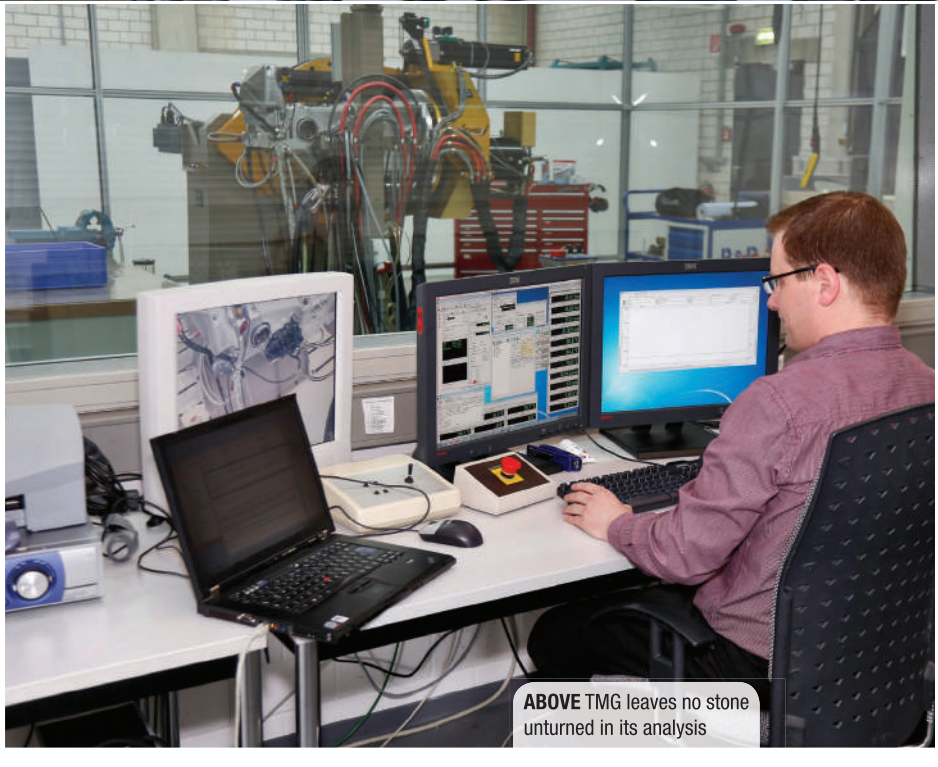
it reduces the quantity of viscous lubricant, which in turn reduces the cooling effect and this can have serious consequences."

It is not only ultimate lubricant performance which is analysed. Different circuits bring different demands on lubricant flow, particularly anti-clockwise circuits as F1 cars are generally engineered for the majority of tracks which run clockwise.

SPRAY BAR LOCATION

Via replayed track data, the lubrication rig highlights any pressure drop and this data can be used to revise the location of spray bars or pick-up points. Naturally, such pressure drops can be alleviated by increasing the amount of lubricant in the system, but more oil means not only more weight but also increased internal losses – when every millisecond counts, that is not an appealing option.

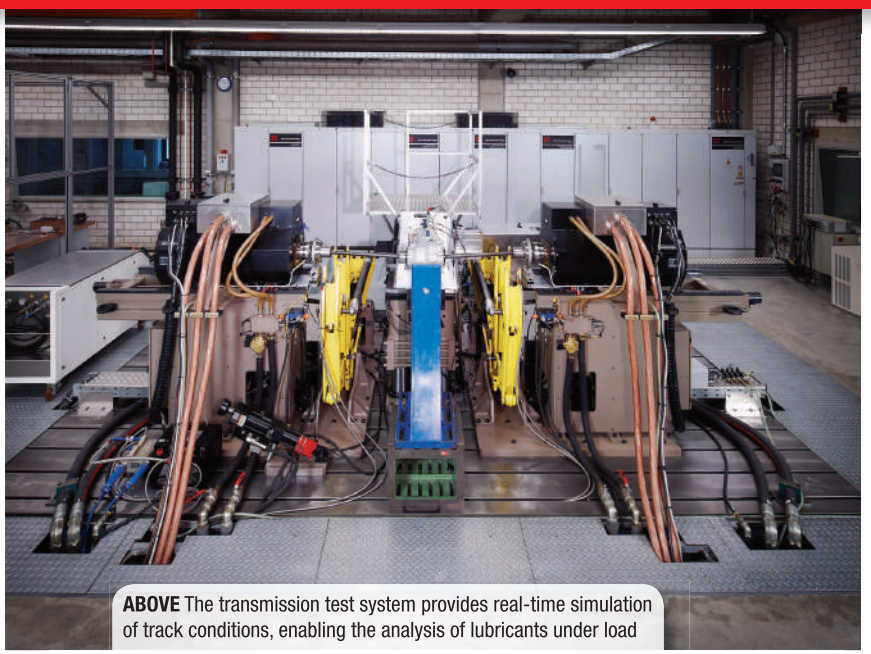
In the search for performance, no stone is left unturned, as Gehlen reveals: "During our ▶



ABOVE TMG leaves no stone unturned in its analysis

time in F1, we employed two engineers who were dedicated to studying lubricant pressure, spray bar locations and so on. Modifications were made to gearbox layout on a regular basis to get the maximum performance without resorting to over-filling."

After performance has been analysed, a successful lubricant faces the final test before it is deemed worthy of gracing an F1 transmission. The transmission test system (TTS) analyses lubricants under load, exposing the gearbox to all forces and moments experienced on the racetrack, delivering realistic operating conditions.



ABOVE The transmission test system provides real-time simulation of track conditions, enabling the analysis of lubricants under load

LOADED EFFICIENCY

Loaded efficiency, with the realistic pressure distribution and the friction generated on bearings and gear teeth, can be different to the unloaded efficiency seen on the lubrication rig, when the transmission spins freely.

As part of a hardware-in-the-loop system, the TTS takes dynamic simulated inputs from the other main elements of the car and exposes a gearbox to a realistic driving environment to test durability and reliability. This follows tried-and-tested fatigue test methodology; after a pre-defined running time, components such as dog rings and gear teeth are subjected to a detailed material analysis for any signs of fatigue or failure.

As well as lubricant reliability, this also allows the optimisation of shift and control strategies in the era of seamless shift F1 transmissions. Again this potentially saves vital milliseconds, whilst simultaneously confirming durability over a specified distance.

"A big advantage of the TTS is to fully test a gearbox before a car even exists," adds Gehlen. "The hardware in the loop environment means we can pick up any reliability problems on the rig, before we waste any track testing time. And that applies to lubricant testing in the same way as to gearbox component testing."

Transmission lubrication may be only a small part of a bigger jigsaw to extract maximum performance from a racecar, but small details count in F1. The top teams leave nothing to chance. RT

BELOW Toyota focused considerable attention on transmission efficiency during its time in F1

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ABOVE A double haul of points amid the mayhem in Hungary ended McLaren-Honda's first half of the season on a high

THE START OF SOMETHING BIG?

Bruce Crawley, ExxonMobil's motorsport technology manager, explains to **William Kimberley** the role that his company has played in the development of Honda's Formula 1 power unit

BRUCE Crawley is ExxonMobil's motorsport ambassador and trouble-shooter. Whether it's NASCAR Cup, US sprint cars, Le Mans or Formula 1, he can be found on hand on behalf of the company. However, his present task as the technical partner to the ailing McLaren-Honda team is perhaps his most challenging yet.

Challenging it may be, he concedes, but there are so many more positives, he asserts. "Right now is one of the most interesting times in my tenure in this job because we have been lucky enough to start this relationship with Honda when it was a clean sheet of paper," he says. "It means that we have been able to sit down right from the start and really share lots of ideas from all sides of the relationship. McLaren has had an input, as have we, to influence the design of the engine, so we are on this journey right now, albeit a very challenging one."

While fuels and lubes are essential in making any engine run, being involved in the design is surely a new concept, but not so says Crawley. "On the fuel side, you look at the challenges in terms of combustion. When it was the naturally aspirated V8 there were occasional knock limitations but, as we moved the engine rpm above 20,000 and then back down again, knock was generally not an issue.

"With the direct injection turbo 1.6-litre V6, we've got an interesting trade-off and challenge which is to get as much energy as we possibly can into the fuel composition and convert that energy, that heat, to work against a background of the engine wanting to knock during combustion. In order to trade that off from an engineering point of view you would very simply say that we'll just retard the ignition timing – but that means losing performance.

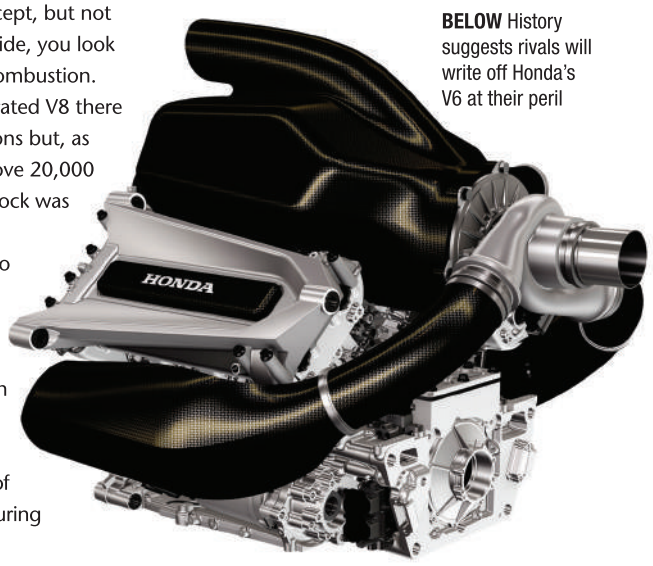
"So in terms of influencing the design, it means you are looking at the optimal compression ratio, allowing a little bit of head room for the fuel composition to do its work as well, pushing the envelope in terms of compression ratio and the whole issue of injection and timing and speed of combustion. So it means the design of the combustion chamber, and how the engine is operated in conjunction with the fuel compositions, is the interface that we are working on."

FRICTION REDUCTION

From a lubricants point of view, the focus is still very much on friction reduction, says Crawley, so the initial design has been put together with a certain specific lubricant performance in mind. "That initial design was set in order fundamentally to get the reliability right from day one, so what we are working on in the lubricants area right now is predominantly friction reduction, although we are looking at other things.

"If you look at the design criteria from an engineering design and lubricants point of view, that was set reasonably conservatively to ensure mechanical reliability. Although it would not appear so from race performances, the base engine performance reliability has been pretty decent."

In replying to the question as to whether any lessons had been learnt from working on the Mercedes power unit that McLaren had been using in 2014, Crawley replies: "The Honda's a relatively clean sheet because experience shows that very rarely are two ▶



BELOW History suggests rivals will write off Honda's V6 at their peril

racing engines going to require the same appetite for engine lubrication or for fuel, so I can say that the requirements are quite different, which is to be expected.

"Lessons learnt, though? Yes, definitely. You are always building your experience base up and maybe something might not be immediately applicable but I bank 10 years' worth of knowledge and whenever I have an opportunity to exploit something that I may have learnt previously, I will do that. That for me is beneficial for most of our technology partners because we might have learnt something in NASCAR five years ago which because of a regulation change or a design change in another formula actually becomes applicable, so that piece of information or knowledge gets transferred – base knowledge we call it – across and applied.

"If you look at last season and what we did on the Mercedes engine, I think that you could say that some of the base knowledge understanding was certainly useful, as you might expect. The engines are all 1.6-litre direct injection, turbocharged V6s so you might suspect that there's going to be some similarities. However, the appetite of the Honda engine compared to a Mercedes one is quite different."

While there is little glory to be reaped in Formula 1 for ExxonMobil right now, this year's Le Mans 24 Hours was a different

McLaren

ABOVE & BELOW Jenson Button's points at Monaco provided welcome relief in what has been a difficult development campaign for both drivers

Coates/LAT

Porsche AG

ABOVE ExxonMobil played a role in Porsche's Le Mans success

matter, Mobil being the lubricants of choice for both the winning Porsche LMP1-H and the Corvette team in GTE. Asked whether there is much technology crossover between the two series, Crawley is cautious.

"Comparing Formula 1 and the World Endurance Championship from a lubricants point of view, the challenges are pretty similar so we are talking about efficiency gains, but there aren't otherwise too many similarities. At a high level we're pushing for efficiency but once you get down to the micro and get into the detail of what you need to do to get the gains, they are actually different and that just comes down to the engineering design and philosophy and where the Achilles Heel fits.

"Because of the engine longevity in WEC and the greater emphasis on wear protection and deposit reduction than there is in a Formula 1 power unit, the emphasis on design philosophy is different. However, the outcome in terms of some of the lubricant properties isn't too different. It really comes down to exactly how you end up designing the engine with the lubricant properties." RT

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BLAZING A TRAIL IN ROUGHHOUSE RALLYCROSS

William Kimberley looks at a company causing something of a stir in the ranks of the racing fuel industry

AS a young company P1 Racing Fuels is quickly making a name for itself, especially in the rally and rallycross worlds where it is the accredited fuel supplier to both the FIA World and European Rallycross Championships.

That it remains a little known name to the public at large is partially by choice of founding director Martin Popilka. He says that his concentration has been upon carving out a good niche for his company as a technical partner to carmakers, teams and series organisers rather than selling low-priced consumer goods. In fact, he is quite open in saying that price isn't the key driver for him because what his company is providing is high-end bespoke fuels where a few pence a litre more can be justified by his customers for performance gains.

"Realising that the products we need to make aren't being produced, or are being produced in quality levels that don't cut it, we decided to set up P1 Racing Fuels to address this," he says. "It meant that our initial focus wasn't to produce generic fuels but ones that are engineered for specific applications."

CONSISTENCY

The one word that Popilka himself constantly uses, as does commercial director Daniel Coxall, is consistency, almost to the point of it being a mantra. "There are component fuels out there that are more traditional but they don't have the levels of consistency that you would expect and need when it comes to forced induction, very high specific output per litre and very high stresses," notes Popilka.

"Where those engines have been tuned into soft knock for maximum performance, for example, any change in the consistency (as with pump fuels and their high manufacturing tolerances) could be damaging to the engine. So what we wanted to do was ensure that we offered a range of very high purity component fuels, any one of which, whether bought today or in 12 months' time, would be exactly the same. Why? Because that meant the engine wouldn't need to be recalibrated for any change in fuel." This is something which in the FIA WRC, for example, costs manufacturers hundreds of thousands each season.

"By taking a Blue Sky approach, it means that rather than start with a feedstock or generic formula we're instead able to look at the engine's design, application and operating environment in detail and from there we search for chemical components, whether liquid or solid, organic or synthetic, that have the unique characteristics we're looking for to tailor the fuel to the desired characteristics and optimum performance for that engine type," he says. "This applies to our newest P1 product for example, SR5, many of the components for which have never been used in fuel production before but have instead come from other industries. This access to a wider range of building blocks than used in conventional fuel formulation means that we have been able to develop a race fuel that outperforms everything else currently on the market for restricted engines."

P1 Racing Fuels was the first to develop an FIA Appendix J (2014) compliant fuel, the 102 RX that has since become the spec fuel for the FIA World Rallycross Championship. "102 RX came about as a result of that regulation change and is the specified fuel for the term of the FIA World Rallycross Championship," says Coxall, "but subsequent to that we have developed a number of other 2014 Appendix J compliant fuels that either offer superior performance or alternatively are more cost-

ABOVE & BELOW P1 Racing Fuels has created a bespoke component fuel for rallycross

effective. Either way, the ethos that always carries through is the consistency and the quality and the level of service."

Apart from being the fuel supplier to the FIA rallycross championships, P1 Racing Fuels has also developed very close relationships with a number of manufacturers both publicly – such as JRM with its Group N and new NR4 cars, and Renault Sport with its Clio R3T – but also privately, such as the one with Škoda Motorsport. "We can reveal that we have a technical partnership with the team and have produced a fuel that is tailored to its rally Fabia R5 engine," says Popilka. "We work very closely with the engineers there who provide us with all the data and information on how it performs in a range of conditions so that we can then formulate a suitable fuel for them.

"This can be a one-off process or an ongoing one where the fuel is constantly being developed to further improve performance, or durability or whichever parameter a manufacturer wishes us to target. It's a loop that allows us to stay ahead of the competition."

As he points out, "There's a really big gap between people who understand fuel, how the chemistry works etc, and the engineering side, and this is where we are attracting a great deal of interest. Add that to the fact that we not only design and manufacture the fuels but also offer on-event servicing and analysis (as in the FIA World Rallycross Championship) and we think we're onto a winning formula."

There is no doubt that P1 Racing Fuels is causing something of a stir in the ranks of the racing fuel industry. It has global ambitions and is on course to increase its footprint into many parts of the world with local tie-ups and partnerships. While it may never be a familiar name to the man in the street, it may well become so to the man on the track. RT

ABOVE Working closely with Škoda's engineers has enabled P1 Racing Fuels to produce a bespoke fuel for the engine of the Fabia R5 rally car

Keeping well-oiled

Fuchs Lubricants (UK) manufactures Fuchs Titan Race, a range of race-ready engine and gear oils to provide optimum performance and reliability throughout the lubrication process

FUCHS Titan Race Pro R 15W-50 is a race-proven 4-stroke engine oil with a high synthetic content. Utilising advanced wear-reducing chemistry, ester synthetic base materials and technology derived from aircraft turbojet engine lubrication, it exhibits load-carrying and film strength properties significantly in excess of those achieved with conventional mineral or synthetic hydrocarbon lubrications (PAOs).

Fuchs Lubricants (UK) claims that it also provides outstanding protection for highly stressed engines and is recommended for use in all high output engines where a specification SL, SJ is required. The manufacturer also says that Titan Race Pro R 15w-50 gives excellent performance in competition cars, offering very high film strength and stable multigrade characteristics to give optimum protection.

Additionally, it is said to provide superior gearchange characteristics that ensure reliability and long component life with race-proven increases in power output. All high-performance power units running on lead-free, low-lead or racing gasolines can benefit from its extra protection.

Also part of the range is the Fuchs Titan Race Syn 5, a high quality friction modified PAO/Ester-based synthetic gear oil for high-performance vehicles operating in race/arduous applications. It has been developed for use in manual transmissions and final drives where an SAE 75W-90, API GL-5 gear oil is recommended.

It utilises the latest and most advanced additive technology along with selected fully synthetic base stocks to provide thermal stability and excellent corrosion protection. The modern additive technology also provides outstanding load carrying and anti-wear performance and Fuchs Lubricants UK says that it will protect driveline components under the most demanding operating conditions.

Providing optimum lubrication and protection over a very wide operating temperature range, Fuchs Titan Race Syn 5 eliminates low-temperature gear selection problems, as well as providing excellent protection to highly stressed components at high operating temperatures. With outstanding EP load carrying and anti-wear performance, this ester based synthetic gear oil can help extend component life, keeping all internal components clean for efficient operation. It gives true 'stay in grade' performance for the entire drain period whilst allowing optimum power transfer across the entire temperature range.

These highly developed products were used throughout the 2014/2015 race season by the Staffordshire-based race team Classic Racing Cars. Its Fuchs Titan Race-branded AC Cobra performed flawlessly throughout the gruelling five-day Tour Auto in France, finishing fifth in a field of 200 drivers before the team won the GT class at Spa-Francorchamps with its Fuchs Titan Race-branded Ford GT40. Subsequent exceptional results furnished the team with a premium reputation. RT

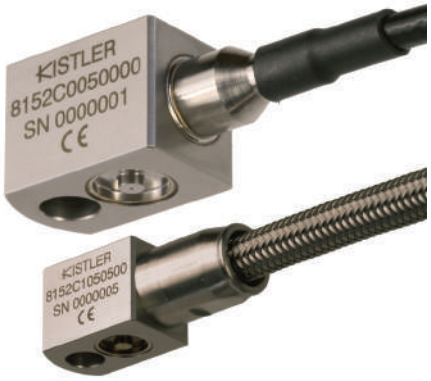
Sensors for different environments

KISTLER has launched three new products – an acoustic emission sensor, a high sensitivity miniature pressure sensor, and a signal amplifier for both piezoelectric and voltage output sensors.

The Kistler acoustic emission sensor has an integral impedance converter for measuring acoustic emission (AE) above 50 kHz in bearing based machining structures, high pressure vessels, compressors and valves. Its small size makes it easy to mount the AE sensor near to the source of emission to optimally capture the signal using just one bolt. Available in both intrinsically and non-intrinsically safe versions, the AE sensor is very rugged with a welded housing giving IP65 protection and wide operating temperature range from -54°C to 165°C.

The new Type 601C miniature pressure sensor, available in both charge output and voltage output types, is especially suited to a wide variety of applications where very small pressure pulses need to be measured. The high sensitivity of the unique PiezoStar crystal developed by Kistler, much higher than that possible with quartz, allows small pressure fluctuations which are superimposed on static pressures to be measured with exceptional resolution. In addition to the high sensitivity and small size, the new charge output sensor has an extremely wide operating temperature range from -196°C to + 350°C at pressures up to 250 bar. Typical applications include pressure pulsation on pumps and compressors and dynamic measurements on pyrotechnic devices.

The new Kistler LabAmp Type 5165A, especially suited for use with the new Type 601C pressure sensor, is designed specifically to combine impressive flexibility with convenient usability for the measurement of dynamic signals from a wide range of piezoelectric, Piezotron (IEPE) and voltage output.



ABOVE The Kistler acoustic emission sensor

ABOVE The new Type 601C miniature pressure sensor

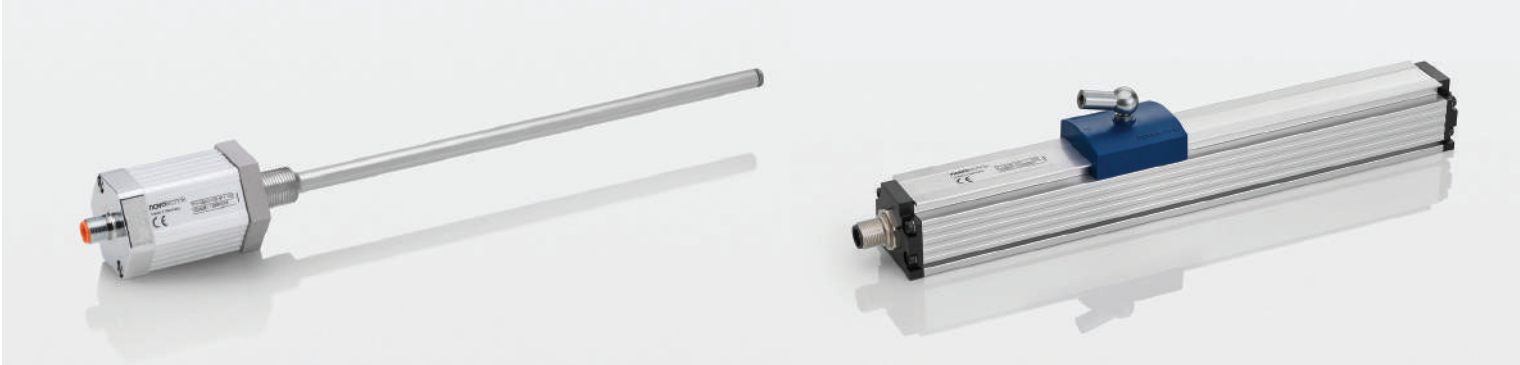
ABOVE The new Kistler LabAmp Type 5165A

A robust alternative

RECENTLY announced by the German sensor specialist Novotechnilk, and available from Variohm EuroSensor, its exclusive UK distributor, the long-range TP1 and TH1 absolute linear sensors now have a CANopen interfacing option. Both of these models feature Novotechnik's magnetostrictive technology which provides touchless and wear-free linear position measurement with up to 1 micron resolution over the entire travel range up to 4250 mm. As a more robust alternative for long range optical encoders, the TP1 has an enclosed housing and touchless position detector that can be either fixed or floating, whilst the TH1 comprises separate rod and ring-shaped position marker components that allow integration into fluid power cylinders or mobile machinery.

The CANopen fieldbus option complies with CiA DS-301 V4.2.0 and device profile DS-406 V3.2, and includes position and speed signals for one or two sensors. The industry standard profile provides a dependable, robust and standardised option for data transfer with high immunity to interference and straightforward set-up and installation. The combination of CANopen and the extremely high durability of the touchless technology, which is insensitive to shock and vibration, brings new levels of reliability to demanding industrial machinery and automation applications.

Both models offer IP67/68 protection as standard and an integrated teach-in function provides a calibration tool that, without external equipment, can be built into the customer's machine set-up. Throughout the TP1 and TH1 series, a wide choice of electrical and mechanical interfacing options are available and custom options are available on request.



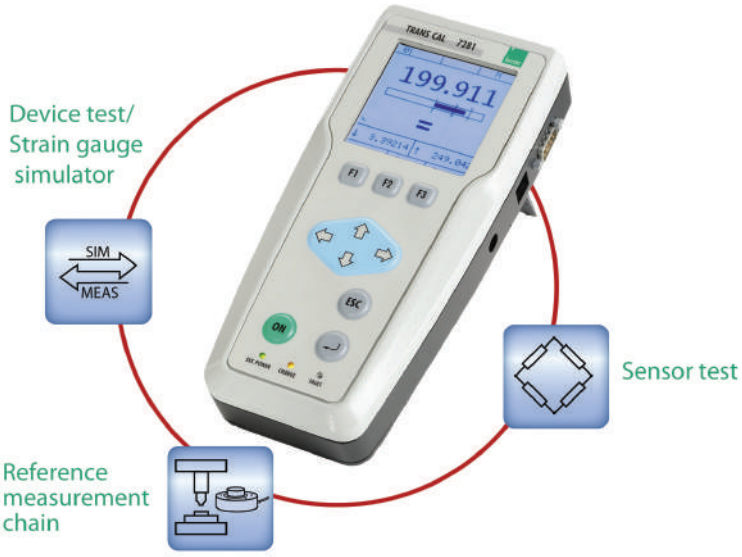
Hand-held portable test and calibration tool

NOW available in the UK from Ixthus Instrumentation, Burster's new TRANS CAL 7281 is a high precision hand-held portable test and calibration tool for sensor components used on equipment such as hydraulic presses, torque tools, high precision measuring devices and pressure-regulating systems on assembly lines. The battery or mains powered instrument supports strain gauge/ normalized signal ± 5 V, ± 10 V, and potentiometric sensors; and includes a strain gauge simulator up to 50 mV/V. Combined with a reference sensor the device provides a high-precision reference measurement chain for force or torque.

The compact instrument can also be used for routine testing to measure and record isolation resistances and input/output resistances, and as a fault-finding tool for service engineers. An optional factory calibration certificate and/or German accredited DAkkS calibration certificate is available when the measurement device needs to be used as a reference.

The TRANS CAL 7281 can store up to 16 programs and has a data logging capacity of 30,000 measurements which can be shared and transferred to a PC with Burster's DigiCal configuration and data-acquisition software for display and reporting functions which also includes test certificates compilation. Furthermore Burster's TEDS software can be used to automatically load measuring chain values.

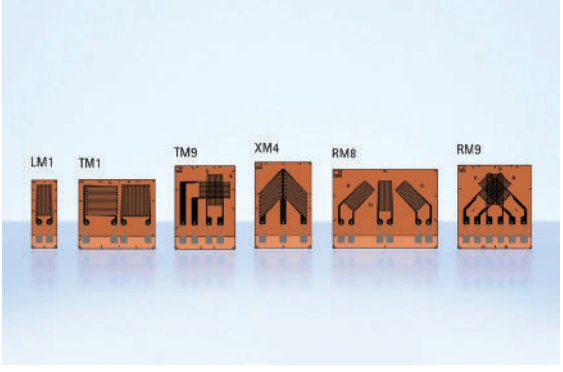
A dedicated version for reference measuring chain of compression load from 20 N to 100 kN with DKD/DAkkS calibration certificate is also available. The 72-REF-EN version uses the full featured 7281 for the calibration of press-fit force measuring equipment and is typically used with Burster's high precision 8527 series sensor and is supplied all connection cabling and DigiCAL PC software.



New challenges for measurement technology

NOW available from HBM is the new range of M Series strain gauges, specifically developed to meet the demanding requirements of measuring strain in fibre composites. New materials offering high strength, such as fibre composites, pose a major challenge for strain gauges used in measurement purposes, particularly when pushing components to their mechanical limit of performance. An example of this would be when a strain gauge, subjected to alternating loads at increased load levels, is weakened and fails earlier than the component under the test. In response to this problem, HBM has added the latest M series of strain gauges to its existing range.

The new range of strain gauges from HBM has been specifically developed for high resistance to alternating loads, at increased strain levels and high temperatures – up to 300°C – and is available with various geometries, measuring grid lengths and temperature response matching.



BEI's new Hall Effect rotary position sensor suits extreme environments

THE recently launched 9970 series Hall Effect rotary position sensor from BEI Sensors builds on a wide range of non-contacting sensors that are designed to provide long-life and high reliability in harsh and challenging environments.

Available in the UK from Variohm EuroSensor, the 6 mm shaft-driven sensor features a choice of 0 - 5 V ratiometric or 4…20 mA output with 2-bit resolution and electrical angle ranges from 30^0 (+/- 15^0) up to 360^0 (+/- 180^0) in 30 degree increments. Full endless rotation is included for maximum installation versatility. Accuracy is specified at +/- 0.6% of active electrical angle. Input voltage is 5V DC +/- 5% for ratiometric, or 9 - 30V DC for current output.

With 2-hole mounting on 50 mm centres and an integral Amp Superseal three-terminal connector, the compact sensor is a drop-in replacement for existing installations or a great choice for new steering angle and pedal position applications on construction and agricultural vehicles as well as positon feedback for mining, marine and industrial equipment or for valve positioning in process control.

The sensor is housed in tough glass-filled PBT and includes IP67 and IP69K sealing. Non-contacting Hall Effect technology makes the 9970 particularly robust against shock and vibration; a life factor of more than 35 million cycles, high resilience to salts, oils and frequent washdown, and an operating temperature range of -40° to 125°C in addition to protection for overvoltage, reverse polarity and short circuit provides fit-and-forget reliability.

BELOW How could the FIA get things so right with the WEC and yet so wrong with F1?

Le Mans vs F1? No contest!

Sergio Rinland, an engineer whose career spans legendary outfits like Williams, Brabham, Benetton and All American Racers, says F1 needs a change of direction

WHEN I was at a WEC race a few months ago some people who have been around for many years asked me the question: 'What do you think about F1?' I follow F1 as well as Le Mans and have to say, just as when I was a teenager in the '70s, Le Mans cars are more exciting than F1 – from the technical point of view, there is no doubt, but also from the show side now.

How could F1, the pinnacle of our beloved sport, get in such a mess? And here I'm not talking about the Mercedes-Benz domination. We've always had domination from one team or another throughout the history of Formula 1: Mercedes-Benz in the '50s; Lotus in the '70s; McLaren in the '80s; Williams in the '90s; Ferrari in the 2000s; and Red Bull just two years ago. So, no change there, then.

What is different now is that the way the rules have evolved over the last few years, for reasons of cost and show, unsuccessfully, has put F1 in a situation where once a team does better, it takes ages for the others to catch up. This is because testing is not allowed now and because powertrains, even in a period of infant technology, are frozen.

In contrast, we have LMP1, with the best set of rules since Can-Am, with enough freedom to make it really exciting for engineers to innovate. The ACO and FIA have done a fantastic job of balancing such diverse technologies as diesel and petrol, naturally aspirated and turbo, with no limitations on anything but energy consumed. At Silverstone, after six hours, three different cars with diverse technologies were separated by 14 seconds and with no lack of drama.

What this is telling us – and I am surprised that the same FIA which got it so right with the LMP1 rules (not without a little help from the ACO) is getting it so wrong with F1 – is that the F1 rules need changing. That revamp needs to be a major one if we don't want to lose it as the top motorsport series.

Formula 1, as well as LMP1, is dependent on the automotive industry's major players for its survival. If they are not satisfied with the return on their huge investment, not only in marketing but also in R&D, they will leave, creating havoc.

The solution, in my opinion, is to end the 'control' philosophy and embrace freedom. In politics and the economy, Communism did not work. If control after control did not work there, what makes us think that it will work in motorsport?

All that we need to control is ultimate performance being in tune with the available venues and safety. The major contributors to performance are power and downforce, so all we need to do is limit those two aspects while leaving free efficiency of power deployment and downforce generation. Not by 'Go-Not Go' gauges as now, but by using current sensor and scanning technology.

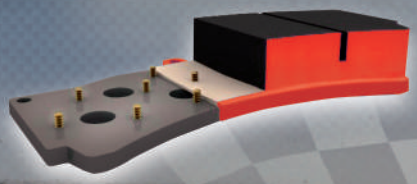
We do have the technology today to achieve that, as demonstrated by LMP1 following a recipe I first advocated in these pages back in 2010 (for the World Motorsport Symposium). We already control fuel flow and consumption; the next aspect to limit is power itself. The increased efficiency this will encourage may not give us the ultimate lap time but it will make a difference in the race. Control of downforce is probably more complex, but the technology is there to limit it and allow engineers to concentrate on reducing drag.

This will give us cars with different areas where they will perform but, again as shown with LMP1, at the end of the race we will still have battles. Diversity will improve the show without artificial mechanisms and the public will be drawn to watch the cars.

Will we have domination of a particular car and team? Surely we will, but with freedom for development and testing, it will not last for long. RT

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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