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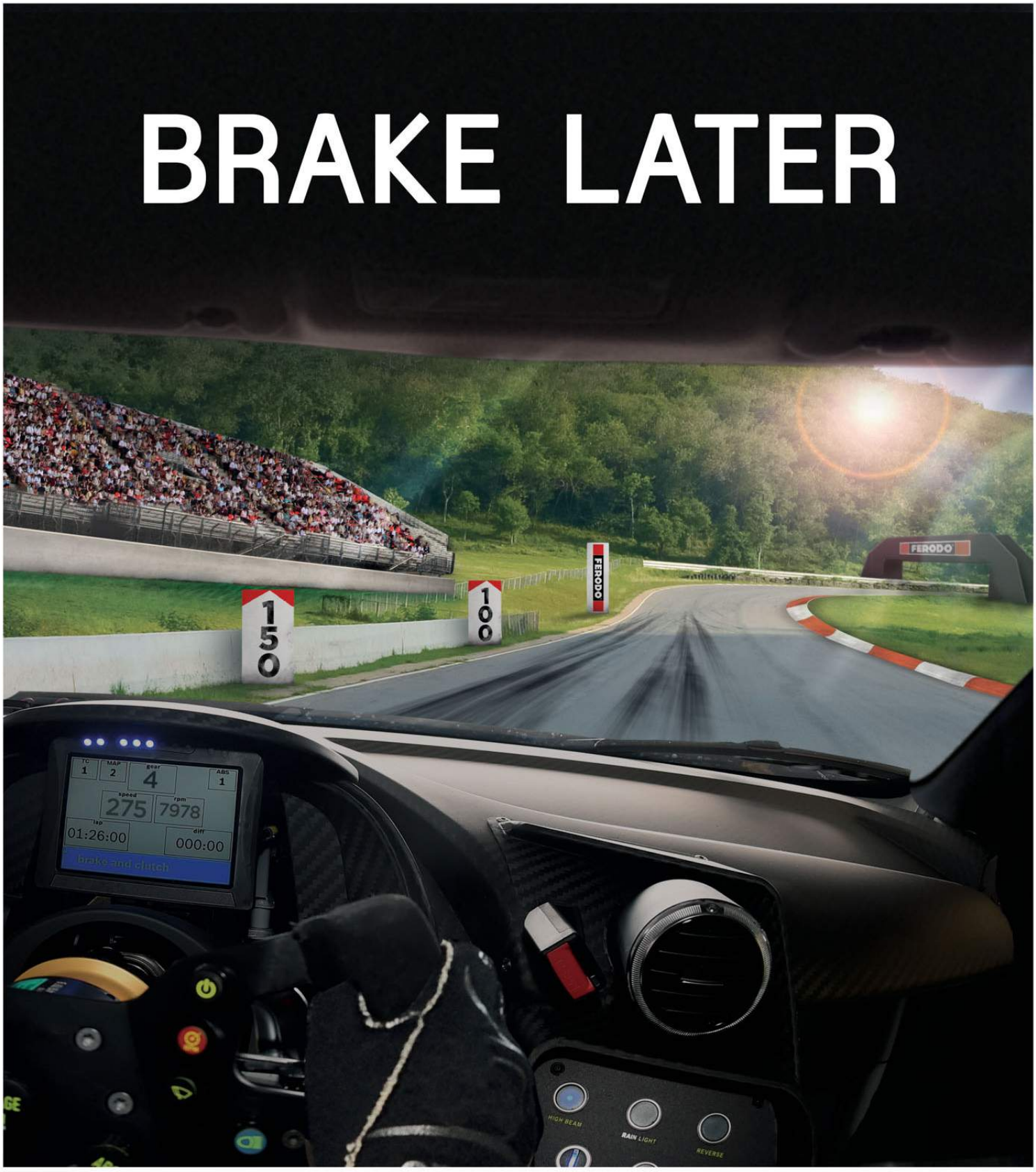

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Rally king's supercar ups ante in manufacturer fight for supremacy

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THE CHALLENGES OF MOTORSPORT

Alonso missing the Monaco Grand Prix to compete in the Indianapolis 500, McLaren said to be helping Honda overcome its Formula 1 engine woes and a dreadful accident to an up-and-coming 17 year old which has resulted in him losing both his legs. There is never a week goes by without something dramatic happening in the world of motorsport.

Referring to the accident first, it is an absolute tragedy that has befallen 17-year-old Billy Monger. We all know that motor racing is dangerous, even sometimes life threatening, but you just don't expect such things to happen in the lower echelons of the sport. As a result of the crash in a Formula 4 race at Donington Park, his right leg was amputated just below his knee, while his left leg was amputated further up his thigh. It is so serious that the Motor Sports Association has launched an investigation in partnership with the FIA. A crowdfunding campaign was instantly created with the target of £260,000 but within a few days had already made three times that figure, which is great although it will not compensate Billy for the loss of his legs. It's a message, though, that people care and are thinking about him and want to do something for him. Hopefully he will return to motor racing, as he has already stated he wishes to do, with technology allowing that possibility to happen.

The news that Fernando Alonso is to race in the Indy 500 is frankly astonishing. I know it is his long held ambition of winning the so-called Triple Crown – the Monaco GP, the Le Mans 24 Hours and the Indy 500 – which has only been achieved by Graham Hill, but to do so while still active in the Formula 1 championship is quite a statement, especially as by doing so he is missing the Monaco GP. The IndyCar execs have to be rubbing their hands with glee as Alonso's appearance is going to add massive global interest in a race that quite frankly has fallen off the radar of a lot of enthusiasts. Just how well he will do is going to be fascinating to see. Will he be a midfield runner, will he be challenging for the lead, how will the other drivers react? All these questions and many more will be answered on Sunday, 28 May.

Then we come to McLaren's engine partner Honda, which as we all know has really struggled on its return to Formula 1. It just cannot seem to get its act together and is always playing catch up. Now, though, although denied at the time of writing, it is said that Mercedes will be sending in some engineers to act as consultants. Soichiro Honda, the founder, must be turning in his grave.

It seems astonishing to me that a company as great as Honda undoubtedly is that it has had to call for external help, and no less than from its primary rival. I know that the modern Formula 1 hybrid engine is engineering at its very finest, but surely the Japanese company has enough resources at its disposal to work its way through the problems. Obviously not, though. From what I understand about the way Japanese automotive manufacturers work, it is altogether different to European or American ones. There is a hierarchy that tends to get bogged down in the decision-making process that doesn't lend itself to the rapid fire world of motor racing.

Nothing would please me more than to see Honda, and with it McLaren, return to challenging for race victories. It has been far too long for them to have been in the wildnerness and we need them to be revived for the good of the sport. It's not going to happen overnight, and it's going to be a long haul, but hopefully McLaren and Honda will one day return to their winning ways. RT

William Kimberley
EDITOR

ABOVE VW Motorsport is learning lessons from Skoda's R5 rally car experience, including how to support customer teams.

VW learns R5 lessons from Skoda

Hal Ridge

HANOVER, Germany: Work has begun on Volkswagen Motorsport's new Polo R5 rally car, one of the customer projects taking the place of the defunct factory World Rally Championship programme that was terminated last year. As part of its new direction for providing cars for customer use, the new R5 challenger is being developed at Volkswagen Motorsport's Hanover workshops.

Based on the next generation of VW's hatchback, it is set to be tested for the first time later this year, with homologation due to take place in 2018. "The summer is the target to begin testing," said Volkswagen Motorsport's technical director, Francois-Xavier Demaison. "The thing is we've used the new Polo as the platform and this will only be introduced in the beginning of the summer."

Volkswagen Motorsport joins its VW Group partner Skoda in producing an R5 rally car. Using a 280 hp 1.6-litre turbocharged engine, Skoda's R5 Fabia has achieved success with privateer drivers and as the firm's works team in WRC2.

While Volkswagen is not expected to run a works team with its cars, it can use knowledge gained from Skoda's experience of the R5 specification engine and chassis. "There's always been a strong cooperation between Skoda and Volkswagen so we will carry on like this. It was the case when we were in WRC and Skoda were R5, so there's no reason not to," said Demaison.

With the R5 regulations based on using a range of standardised components to control costs, he also confirmed that the Polo will share common components with the Fabia. "This is even easier because we can use the same components and sometimes bring the price down because of the higher quantities, so it's a win-win situation. The job's been done by Skoda so it would be stupid to do it again and get to the same conclusion."

Having only previously built cars for use in its own factory efforts, the R5 customer concept is a new way of working for the multiple WRC champion engineers. "For sure it's a big change for us. We have no customer department so building the best R5 possible is one thing, and having the best commercial and sales department is another big challenge for us. We want to have the best car, and best customer department. In the future we target having hundreds of customers. It's different, so far we've only worked with a few professional drivers, this will be different now so we have to take this change of the car being driven by amateur drivers into consideration."

Ekstrom – More power would make World RX more even

Hal Ridge

STOCKHOLM, Sweden: Reigning World Rallycross Champion Mattias Ekstrom thinks the FIA should change regulations to increase the power of the cars. Rallycross Supercars, which use 4-cylinder, 2-litre, turbocharged engines, currently produce in the region on 570 to 600 horsepower and 650 to 700 Nm torque. Airflow into the turbo is controlled by a regulation 45 mm restrictor.

With the ability to accelerate to 60 mph in around two seconds, the four-wheel drive cars are renowned for being some of the most powerful and exciting to drive in motor racing, but the latest developments in chassis geometry, suspension and transmissions has brought that power under control.

"I think power level is in general what makes everything difficult, and the more difficult you make things to drive, the more mistakes the drivers make and the variations in performance get bigger," said Ekstrom, whose EKS squad won the Teams' Championship last season and is now officially backed by Audi Sport.

"Details in setup, tyres, aerodynamics and everything is not so sensitive anymore when you have more power and the driver becomes more in the limelight. When you have a chassis that's too good, you need more power to make it a challenge again."

The double DTM champion made his rallycross debut in 2013, and says technology in the sport has advanced significantly since. He believes a modification as simple as implementing a more open restrictor would increase the driving challenge. "When I drove the Marklund Motorsport (VW) Polo for the first time that was a way different car from what I drive now. It's a big difference to have that feeling that it's a handful to drive, but that's how it should be. The cars today could easily live with 50 to 100 horsepower more. Me and my team will be pushing to get a bit bigger restrictor in a couple of years, that's one of the easiest ways to get more power." RT

ABOVE Make Rallycross Supercars more powerful says reigning World Rallycross Champion Mattias Ekstrom

Aero development gathers apace in World Rallycross

Hal Ridge

GOTENE, Sweden: Development of cars in the FIA World Rallycross Championship has intensified to a new level for 2017, with four manufacturer-backed teams and an unprecedented amount of pre-season testing. As part of that development, a number of squads have implemented aerodynamic evolutions, an area that hasn't been seriously addressed in rallycross since before the turn of the millennium when competitors utilised aerodynamic devises from other applications.

Team Peugeot-Hansen launched its 2017 specification Peugeot 208 WRX at the opening round of the series with more elaborate front wings and rear quarter panels than have previously been used on the Swedish/French cars. A fence similar to that employed on the Group B Metro 6R4 protrudes above the level of the arch at the outmost edge of the bodywork front and rear, to channel airflow over the car and down over the rear bumper, to increase downforce.

At the second round of the World RX series, the squad also introduced a new adjustable rear spoiler, with the lower element flowing out of the tailgate and the upper element adjustable in angle, maintaining the same height at the rear to comply with regulations.

"Everything is going more and more to the edge of what is possible in the regulations," said team principle, Kenneth Hansen. "Aerodynamics haven't been discussed so much before in rallycross, but you don't want to leave anything untouched now. If you can gain a little, then you try to do that. That's what we are seeing with manufacturer involvement, every point that it's possible to work on will be. I think in the next couple of years we will see that more and more. We worked a lot with the FIA to make the spoiler fit into the 'box' of the car."

ABOVE The devil is in the detail as more and more aero devices and tweaks are being fitted to rallycross cars

In a similar move to architecture introduced on the rear of Ford's Focus RS RX in 2016, the EKS Audi S1 sprouted new front wings for the second round of the series in Portugal, with a squared-off rear, housing louvres.

"As the rules are pretty free you can do updates through the year, I think this is the way to go for us," said World RX Champion, Mattias Ekstrom. "Everybody can see that they are aerodynamic devises. We're doing everything we can do to get more downforce and less drag. I think that's great for the sport that there are some small changes that the fans can see that's not hidden under the bonnet."

The EKS Audis have also changed to low drag wing mirrors. "I think this is also where the sport should be. I would still like to have a bit more freedom where our cars can look a more wild and crazy like the modern WRC, but I think still our cars are pretty cool." RT

BELOW The latest images of the proposed 2018 IndyCar bodywork, here in superspeedway configuration, reveal a much more traditional shape with a significant reduction in the individual aerodynamic elements of the current car

Shape of the 2018 IndyCar emerges

Andrew Charman

INDIANAPOLIS, IN: The Verizon IndyCar Series has released the latest graphics of its planned universal car bodywork for 2018. The new images add significantly more detail to the concept sketches released in January, but IndyCar emphasises they are likely to evolve further before testing of a car begins in mid-summer. Sources in the series suggest the design has already significantly moved on since the release of the images.

"While this remains a work in progress, we are encouraged with where the development of the 2018 car stands," IndyCar president of competition and operations Jay Frye said on the unveiling of the new views. "The look of the car is bold, the performance data from simulations is meeting targeted goals and safety enhancements built into the design will be substantial."

According to IndyCar director of aerodynamic development Tino Belli, the design has achieved its aim of a return to the look of past Indy Car machines, with from above the traditional Coke bottle shape particularly evident, as is the lower, more traditional engine cover design. The turbocharger inlets are now incorporated into the radiator ducts.

Belli said that the kit has been successfully reverse-designed to start with its desired appearance and build in functionality from there. "We've been working on the aerodynamics to suit the look, rather than the other way around."

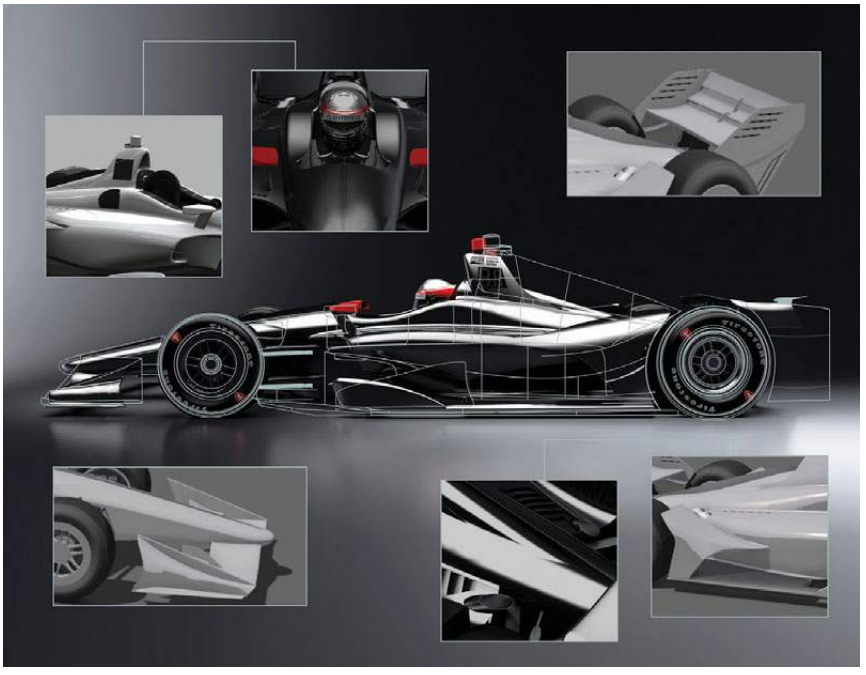
Technically the kit has been designed to generate the majority of its downforce from ground effect rather than atop the aero surfaces, IndyCar's technical team believing that a decrease in the turbulent wake generated by an over-wing format will improve racing and passing opportunities.

"We're working on creating more of the downforce from the underwing," Belli said. "The hole in the floor (of the undertray on this year's car) will be sealed for the road courses and short ovals, but will still be open for the superspeedways."

Safety improvements include additional side impact structures in the sidepods and repositioned radiators that will help absorb the severity of side impacts by crushing on impact.

Other visual differences include smaller wings – the rear wing in the road course/short oval configuration will be lower and wider, while the fins mounted on the leading edge of the sidepods of the current car will either be removed or at least minimised on the 2018 car.

Development will continue but Belli stated that "97 per cent" of the efficiency and visual goals set by IndyCar in creating the new bodywork have already been achieved. RT



ABOVE IndyCar has released an image of its proposed 2018 bodywork in superspeedway configuration, with an outline of the current car overlaid. The detail images suggest possible differences on the road course version of the 2018 car

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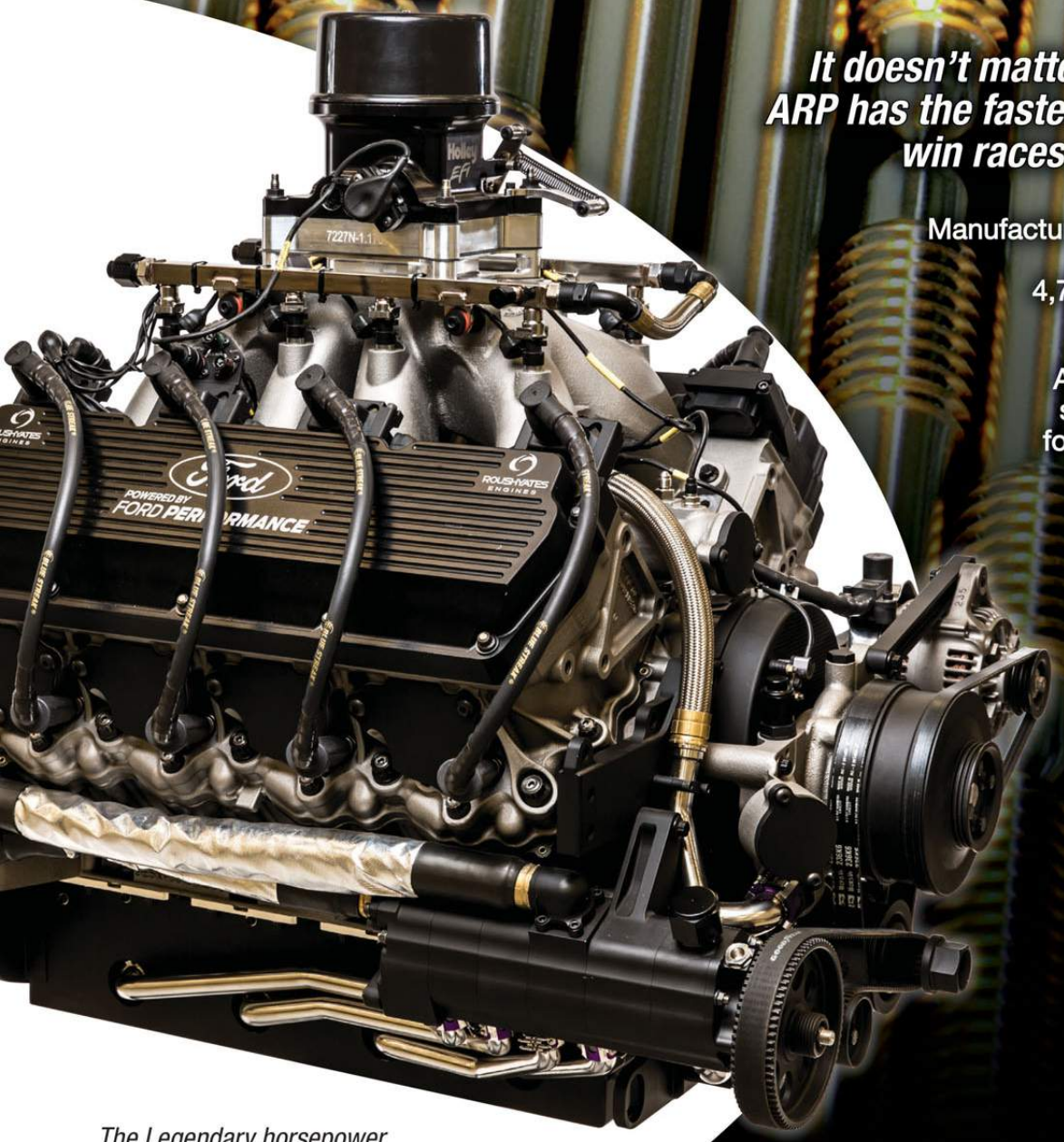

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NASCAR bids to keep cars on ground

Chris Graythen

ABOVE Staying down: Pop-up flaps help keep spun NASCAR cars on the ground such as here in the Xfinity Series race at Daytona on 25 February, but the sport feels more can be done

Andrew Charman

DAYTONA BEACH, FL: NASCAR used a Goodyear tyre test at Daytona International Speedway on 14 April to experiment with aerodynamic changes aimed at creating downforce – in reverse. The exercise, from which few details have been released, is part of a continuing programme trying to prevent cars becoming airborne, particularly at restrictor plate tracks such as Daytona.

A number of measures over the years, such as the roof flaps that deploy as soon as a car is turned backwards, have greatly cut the numbers of airborne incidents, however the fact remains that a car turned backwards against the airflow creates lift rather than downforce, and if it is then hit it is quite likely to take off into an airborne rollover.

Five cars took part in the test and according to Joey Logano, one of the drivers involved, a number of solutions were experimented with in a bid to replace the rearwards lift with downforce.

"It's easier said than done, we can probably do that pretty easily – but doing that and not affecting the racing and not adding a bunch of costs to the teams is the challenge," Logano told trackside media after the test.

Indy gets a restrictor plate

Andrew Charman

INDIANAPOLIS, IN: As predicted the Indianapolis Motor Speedway will become the third restrictor-plate track on the NASCAR schedule later this season, when competitors in the second division Xfinity Series race use the horsepower-cutting inlet restrictors.

NASCAR has announced a technical package for the race on 22 July that it states is aimed at improving competition at the speedway. While Indianapolis has become an iconic venue for NASCAR, races on the 2.5-mile track have consistently been among the least exciting of the season.

The Xfinity package will consist of a taller rear spoiler and splitter package, aero ducts added to the lower front bumper area of the cars and the use of the same 7/8th inch restrictor plate that is employed at NASCAR's two superspeedways of Daytona and Talladega. However, the four-inch static ride height of the cars will not be changed.

NASCAR developed the package using simulation at its Research & Development Centre and then tested the changes at Indianapolis on 12 October last year. Officials predict that the changes will not greatly affect speeds at the track, but may create small packs of five to six cars in which passing may be easier on straights.

NASCAR has not indicated whether the proposals could be extended to the headline Monster Energy Cup Series in future.

Logan Whitton/LAT Photo USA for Toyota Racing

BELOW Follow the leader: NASCAR races at Indianapolis have all too often turned into strung-out single-file affairs

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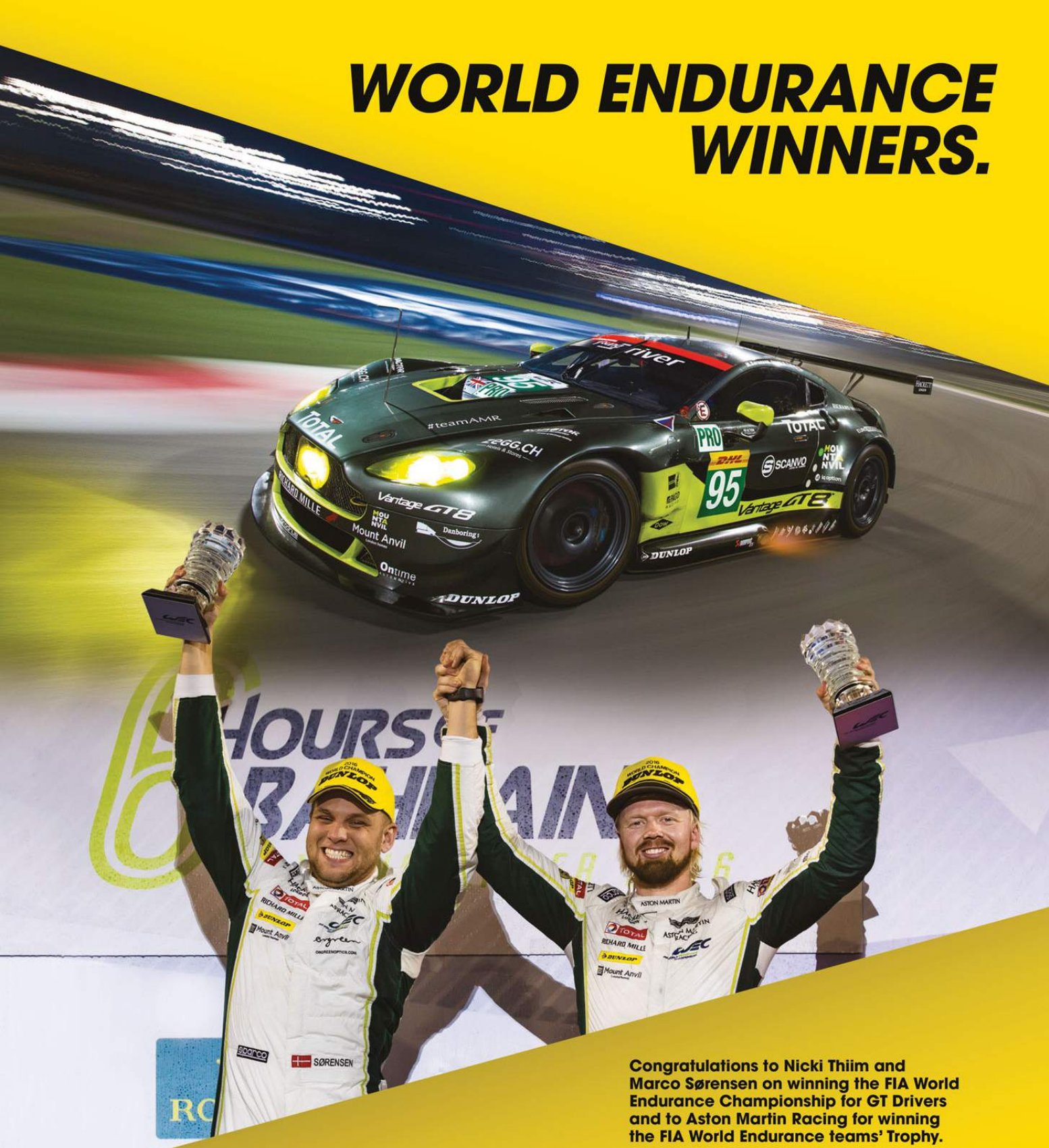

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FOREVER FORWARD

Tyre choices coming to NASCAR?

Andrew Charman

DAYTONA BEACH, FL: NASCAR is considering offering competitors the choice of two tyre compounds in its races. Currently all teams in the three lead categories use a single compound of tyre that is decided by supplier Goodyear prior to the event based on data from previous races at the venue and official tyre tests with teams. However, at the non-points Monster Energy all-Star race at Charlotte on 20 May, teams will be offered a softer compound option tyre that they will be able to select at any point during the four-stage race.


Matthew T. Thacker/LAT Images for NASCAR

ABOVE Compound interest: the number of tyres in NASCAR garages could be set to increase in the future

At Charlotte, the tyre is expected to be around 2.5 mph faster than the regular compound, up to four-tenths of a second per lap, but will also wear more quickly than the standard tyre.

Initially at least, the option tyre will be distinguished by its green Goodyear signwriting instead of the yellow of the standard tyre.

NASCAR vice president and chief racing development officer Steve O'Donnell has confirmed that a positive result from the tyre's use in the All-Star Race could lead to it being introduced to the regular season in 2018.

"This is something we will certainly look at for 2018 – we want to see how this plays out," he said after the All-Star Race announcement. "We're positive about what could happen, and it's something we would look at for sure." RT

DTM rings the changes

William Kimberley

HOCKENHEIM, Germany: Working to sustain fans' interests which is said to be falling away, ITR, owners of DTM, is working on different initiatives to revive them. One is to force teams to open up their garages so that fans can see more of the cars. Three garages, one per manufacturer, will be opened for the fans, thus providing the visitors a glance into the most important zone of the teams. In the Pit-View, the holders of a paddock ticket will be granted access to a garage that will allow him to watch the work in the two adjacent garages – and this also applies to most of the DTM sessions. Furthermore, the visitors also will have a clear view of the pit lane.

ABOVE As the new chairman, former F1 driver Gerhard Berger is keen to revive DTM's popularity

At the same time Gerhard Berger, who was appointed as ITR's chairman in April, is keen to see the series grow, not by holding races in other continents. "We already have a series in Japan orientated towards the path the DTM wants to take, and it would be desirable if they would also implement it in America," he said at the DTM media day at Hockenheim in early April. "However, we are at home in Germany, and we will continue to focus here with additional visits in Europe, but I don't believe the DTM should race in South America or China, far from its fans."

Other format changes to the races in 2017 are two equal length races on Saturday and Sunday, with every race having a pit stop. The number of mechanics in tyre changes has been reduced, with only one wheel gun per side, and the pit window has been eliminated, so the pit stop can happen at any time during the race. RT

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BELOW Fondmetal, the Italian aero consulting company and wind tunnel facility, which came up with an electric single-seater design long before Formula E was a twinkle in the eye, has gone into voluntary liquidation

Blown away

William Kimberley

CASUMARO, Italy: Fondmetal Technologies, aka FondTech, the Italian aerodynamics consulting company, has gone into voluntary liquidation. It was established in Casumaro, Italy in 1993 by Jean-Claude Migeot, former Ferrari and Tyrrell F1 head of aerodynamics, to provide racing car aerodynamic consultancy and wind tunnel test services. After having built a second and higher performing wind tunnel in 2006, named FT2, FondTech had two wind tunnel facilities covering an area of about 10,600 square metres, including model-shop, technical and administrative offices.

"From 22 March 2017, our wind tunnels in Casumaro and Sant'Agata Bolognese will remain silent," said president Jean-Claude Migeot in making the announcement. "For over 24 years, FondTech has been involved in many motorsport programmes, including Formula 1, Le Mans, DTM, GT, NASCAR, Formula 3, IndyCar Series, World Rally Championship and MotoGP.

"As we are now heading our separate ways to start new adventures, I would like to thank our clients who, since 1993, have trusted us with wind tunnel developments and testing programmes for their prototypes. Together, we have shared our passion for motorsport, innovation and the permanent desire to go further, day after day. Thank you for all these technical and sporting challenges, which have delighted us!

"I would like to dedicate a special mention to Gabriele Rumi, Harvey Postlethwaite, Ken Tyrrell and Luca Birindelli. Sadly, they are no longer with us, but our story would have never started without them.

"Finally, from the bottom of my heart, thank you to all my colleagues who were part of this fantastic adventure. For some this was over a few years, for others it was from day one until the end. Our friendship is forever." RT

The next gen Nissan GT-R

William Kimberley

YOKOHAMA, Japan: NISMO has completed a shakedown of the newly-evolved Nissan GT-R Nismo GT3 that has been built in accordance with FIA GT3 regulations.

The first test for the new car took place on 11-12 April at Fuji International Speedway where development drivers Masataka Yanagida and Michael Krumm were joined by Mitsunori Takaboshi, who is competing in this season's Super GT GT300 class driving the current model Nissan GT-R Nismo GT3.

Additional tests will take place in both Japan and Europe to develop the new GT-R which will replace the current specification car which is competing in championships around the world in 2017 including the Super GT GT300 in Japan, the Blancpain GT Series Endurance Cup throughout Europe and the Pirelli World Challenge in the US.

"It was amazing how all the systems worked so well right from the beginning and the potential for making further improvements is very high," said Krumm. "As this car will be used worldwide by a variety of drivers with different styles, I want to work hard to ensure that it's possible to drive it safely at high speeds. I'm looking forward to the next tests." RT

BELOW The NISSAN GT-R Nismo GT3 is Nismo's new race car developed in line with FIA GT3 regulations

Audi extends racing portfolio

William Kimberley

AUDI premiered the GT4 version of the R8 LMS at the New York International Auto Show in April. It has directly been derived from the road-approved Audi R8 Coupé V10, delivers up to 364 kW (495 hp) depending on its rating, and offers a high level of safety. At the same time it is an affordable choice in terms of purchasing price and cost of ownership.

Making its racing debut in the Nürburgring 24 Hours from 25-28 May, it will be developed throughout the year before a final homologation level has been achieved and approval for racing is requested. During the second half of the year, the team of Chris Reinke, head of Audi Sport customer racing, will be preparing the production of the race car. Consequently, the first customers will be able to receive the new Audi R8 LMS GT4 before the end of the year. RT

BELOW Audi is developing a GT4 version of the R8 LMS

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IN BRIEF

NASCAR track Charlotte Motor Speedway has unveiled a 'Sun Deck' on the outside of Turn 4 as the latest of its spectator improvements. Aimed at both fans and corporate guests, the deck features 960 solar panels that will collect more than 375,000 kilowatt hours of energy annually, enough to power 416 homes for a month. Facilities range from luxury motorhome campsites to suites for small groups, plus a wide concourse with room for live entertainment, and refreshment facilities.

A proposal to schedule a small number of races in the NASCAR championship on midweek dates, an idea that first emerged some time ago, is unlikely to happen during the 2018 season, NASCAR sources have confirmed.

NASCAR venue Pocono Raceway has extended the SAFER (steel and foam energy resistant) barrier lining the 2.5-mile three-turn track by a further 5,197 feet. The section, lining the Start/Finish straight and between turns 2 and 3, is in addition to 6,000 ft of barrier added in 2016, and takes the total SAFER barrier length at the track to 23,640 feet.

Atlanta Motor Speedway has delayed plans to replace its surface until at least after its 2018 NASCAR meeting. Drivers at this year's meeting on the 1.5-mile speedway pleaded for the existing 20-year-old surface to be retained.

As the Verizon IndyCar Series looks forward to McLaren F1 driver Fernando Alonso racing in the Indianapolis 500 instead of the Monaco Grand Prix, McLaren shareholder Mansour Ojjeh has suggested that the Formula One team would consider a return to IndyCar racing in future. McLaren Technology Group, that includes the race team, is now headed by Zak Brown, an American and acknowledged supporter of IndyCar.

Prodrive Racing Australia, Ford's works team in the Australian Supercars championship, has refuted press claims by driver Mark Winterbottom that it will replace the current Ford Falcon with a Ford Mustang in 2018, running to the series new Car of Tomorrow regulations. Prodrive stated that it is still evaluating its options.

The City of Long Beach has signed a contract with KPMG Corporate Finance to evaluate bids to host a Formula 1 race. The Grand Prix of Long Beach's IndyCar contract with the city runs out after the 2018 race and so a change could take place in 2019. The Grand Prix of Long Beach organisation, which is owned by Aquarium Asset Management, a company that belongs to Kevin Kalkhoven, and the World Automobile Championship of California (WACC), which is run by Chris Pook, the man who created the Grand Prix, back in the 1970s, have made bids.

Paul Ricard will host the first two rounds of the inaugural Electric GT series on 25-26 November followed by races in Portugal, Italy, Germany, Belgium, The Netherlands, the UK and Spain which will host the final race in October. Currently no dates for these events have been announced. Each event will consist of a 60 minute qualifying session and two races that take place on just the one day.

The FIA and the Automobile Club de l'Ouest have extended their partnership to run the World Endurance Championship until the end of the 2020 season. RT

PERSONNEL

As of 1 March, **Rick Gorne** has once again teamed up with **Adrian Reynard** and has joined the Auto Research Center as its business development director. This dynamic combination grew Reynard Racing Cars into the world's largest race car constructor in the early 2000's. Since then, Gorne has spent the last 15 years as a racecar driver manager to some of the world's best drivers in the top echelons of racing. He will concentrate on bringing ARC's talents to future racing programmes around the globe. Concentrating additional efforts into the international racing arena will bring ARC back to its roots, IndyCar and F1 racing.

Team Penske crew chief **Paul Wolfe** was able to oversee the Ford of **Brad Keselowski** during the Monster Energy Cup Series round at Bristol Motor Speedway on 23 April after NASCAR deferred a final appeal by Penske on his three-race suspension until 25 April. The car was deemed to have a rear steer of more than 0.56 degrees following the Phoenix race on 19 March, but Penske argues it was allowed only one measurement on the scrutineering rig whereas other teams were permitted multiple passes. RT

Tribute to a brave racer

William Kimberley

DONINGTON PARK, UK: A crowdfunding site has been set up to raise funds for 17-year-old British F4 driver Billy Monger after his horrific accident at Donington Park which led to the amputation of both legs.

The Dunlop MSA British Touring Car Championship is showing its support for him with prominent #BillyWhizz signage set to adorn all 32 cars at Hampshire's Thruxton Circuit on 6-7 May while also setting up a fund.

Series director Alan Gow said: "In reality there is very little we can all do to help Billy other than to show our great support for him. So, this message of support on our cars will be seen by literally millions of viewers around the world and hopefully may even bring a little smile to his face. Everyone is right behind you Billy!"

Donations will be used to fund the care, treatments and therapies required by Billy in the immediate future and going forward, helping him to return to a full and active life. To make a donation please go to www.justgiving.com/crowdfunding/billymonger23 RT

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Ebrey/BTCC

BELOW Knock-out blow: centre-of-gravity changes to reflect the format of the Levorg's 'Boxer' engine have led to a difficult start to 2017 for the Subaru BTCC team

Subaru changes cause BTCC controversy

Andrew Charman

DONINGTON PARK, UK: Centre of gravity modifications aimed at equalising the performance of the Subaru Levorg GTs racing in the British Touring Car Championship (BTCC) have caused major controversy, with the team's lead driver Jason Plato claiming that the changes have "destroyed" the car's chassis.

The Subaru Levorg joined the BTCC at the start of the 2016 season, and was immediately dubbed a 'Frankenstein' car by rivals due to its compact, flat-four power unit making possible a low-down,well back, location in the engine bay and creating a lower centre of gravity as a result.

"It's a mid-engined racing car in a field of Touring Cars," Honda driver Matt Neal told *Race Tech* at the time.

The Subarus won six races during the 2016 season, and driver Colin Turkington was a title contender going into the final round at Brands Hatch.

Winter changes mandated by the BTCC's Design Group, which includes members of all the teams, sought to equalise the centre of gravity between the Subarus and the other rear-wheel drive cars in the series, principally the West Surrey Racing BMW 125i Sports that use an in-line four cylinder engine mounting — and on 29 March, four days before the initial 2017 BTCC meeting at Brands Hatch, further changes were mandated.

The four-car Subaru team struggled at the meeting, the best finish a 12th place for Plato in the first of the three races. Observers of the Levorgs on the track suggested they were suffering significant handling issues.

Described by Plato as "a curveball" that the team was trying to make work, the mandated changes sparked heavy criticism, particularly on social media and mainly directed at BTCC organisers TOCA.

In response, a clearly irritated series director Alan Gow made a detailed explanation to the championship's official fans forum of the rulings made, insisting there had been no fundamental or late changes.

"It's a calculation to even-out the centre of gravity (CoG) difference between the flat-four and inline-four engines when mounted in RWD cars," Gow stated. "The team have had the centre of gravity calculation since it was done by BTCC chassis technical supplier RML, agreed and issued on 20 January at the BTCC Design Group meeting — the team is a member of that Design Group."

The ruling, he explained, takes the form of a graph providing the team with a sliding scale combination of either weight added to the front bulkhead or an increase in the sprung-mass floor height of the car, but not the front aerodynamic ride height.

"Providing it meets the line on the graph then the team can decrease the weight on the bulkhead and increase the floor height, or vice-versa, to suit the balance of their car," Gow added.

The change made just before the Brands Hatch meeting, Gow insisted, was a minor re-calculation of only -2.5 kg, and it was to the benefit of the Subaru team. "Other than that, nothing has changed since it was issued on 20 January so I can only assume that any significant 'late changes' to the setup of the cars must have been ones that the team themselves decided upon," he added.

Observers noted that following the 20 January rulings, the BMR team had appeared to have undertaken limited testing with the new setup, not joining tests in Spain or Portugal attended by other leading BTCC teams.

In the championship's second meeting at Donington Park, Subaru driver Ashley Sutton appeared initially to have found an answer to the issues, taking pole position. However, he was then sent to the back of the grid after being found guilty of a turbo overboost. Sutton fought his way through to a third placed podium finish in the second and third races, the best finishes for the other three Subarus being a 16th spot for Plato in race 3.

Writing a blog for sponsor Adrian Flux, twice-champion Plato blamed the combination of the centre-of-gravity regulations and a lack of straight-line speed for the team's struggles.

"The centre of gravity regulation destroyed our chassis – the car's not working as well, or as balanced, as it used to. It's very frustrating," Plato wrote. "Our engines are not producing the power like the rest of them and we have no control over that. We're so slow in a straight line. It's clear to see with the boost level which has been given to us, our engine isn't producing the power it should be. I'd say we're 30 to 40 hp down on where we need to be. We just can't compete while we've got no engine power." RT

Wheel issues played down by BTCC

DONINGTON PARK, UK: A spate of loose wheels in the British Touring Car Championship has been played down by the series organisers.

Reports from winter testing suggested that several incidences of cars suffering lost wheels had occurred, with the finger of suspicion pointing at the nut and hub combination now manufactured by RML, which replaced GPRM as the championship's chassis supplier before the 2016 season.

Race Tech understands that modifications were made to the components and revised instructions issued to teams ahead of the opening rounds of the 2017 BTCC at Brands Hatch, but the meeting saw two more incidents.

Aidan Moffat, who had a wheel part from his Mercedes A-Class during free practice, called for more action, saying that the problems should not still be occurring.

However, speaking to *Race Tech* two weeks later during the second meeting at Donington Park, BTCC technical director Peter Riches said that not all teams had been following the torqueing instructions issued. He explained that the previous GPRM component had been fitted with a quite coarse thread that required a 400 Nm torqueing force, whereas the finer thread on the RML component required a 700 Nm torque. Some teams, Riches said, considered this figure unnecessarily high and had not been following it.

The issue appeared to have been solved by the time of the second meeting, with no loose wheels reported during the Donington weekend. While a wheel was seen to part company from Tom Chilton's Vauxhall Astra in the first race, this was as a result of a heavy collision. RT

TCR UK gathers pace

LONDON, UK: Prospects of the TCR category launching a UK championship are growing, with TCR Series promoter Marcello Lotti indicating at the opening round of the 2017 International championship that a UK-based sports marketing company is looking at promoting a series in 2018.

Lotti believes the category would flourish in the UK, not as an alternative to the British Touring Car Championship but a low-cost 'stepping stone' to the BTCC for drivers, engineers and teams.

His confidence has been bolstered by the success of TCR in Germany, with the national series announcing a 42-car grid in only its second season.

BTCC series director Alan Gow has emphasised that he would not be involved in any discussion about setting up a UK TCR series.

Meanwhile the top class in the FIA's European Touring Car Cup is expected to adopt TCR regulations this season. As *Race Tech* went to press the FIA and TCR were understood to be in discussions to agree the entry of the cars in the season-opening meeting at Monza on 30 April. *Race Tech* will report more fully on this next month. RT

IndyCar

BELOW Alonso's excitement, evident in his news conference at Barber Motorsports Park, has been mirrored by fans and media alike

A JOLT OF ENERGY

David Phillips, a veteran of the US press corps, looks ahead to the prospect of Fernando Alonso's Indy 500 baptism

AM I alone in reporting an unaccustomed spring in my step on the morning on April 12? That would be in the moments following the bombshell announcement of Fernando Alonso's decision to skip the Monaco Grand Prix to drive for Andretti Autosport in the 101st running of the Indianapolis 500.

And why not? In an increasingly beige motorsports landscape where the prospect of two (2) drivers from two (2) different teams contesting the World Drivers' Championship launches Formula 1 aficionados into rapture, NASCAR conjures ever more artificial rules in the hopes of recapturing its mojo, and incremental gains in television ratings are cause for celebration by IndyCar fans, competitors, and officials alike, the news that the best race driver with 'only' two world championships to his name plans to enter the Indy 500 is positively electrifying.

The backstory of Alonso's bid to follow in the footsteps of Jack Brabham, Jim Clark, Graham Hill and, more recently, Emerson Fittipaldi and Nigel Mansell is by now well-known. In a stroke of kismet, Alonso's ambition to do a racing triple (F1, the Le Mans 24 Hours and the Indianapolis 500), American Zak Brown's ascension to the executive director post at McLaren, the woeful McLaren MCL32/Honda, Honda's partnership with Andretti Autosport, and Stefan Wilson's gracious decision to step aside aligned to put the double world champion in a Dallara-Honda for the Month of May.

Make that what *used* to be called the Month of May. The Indianapolis 500 is no longer the month-long festival of speed it was in the days of Messrs Brabham, Clark and Hill. Instead, the whole affair is now shoehorned into a single week of practice and qualifying followed, after a week of pomp and circumstance, by the 500-mile race itself.

The compact schedule is both a blessing and a challenge. On the one hand, Alonso's Indy programme would likely have been a non-starter had he been forced to miss a second Formula 1 race – the Spanish Grand Prix in mid-May no less – in addition to Monaco. On the other hand, where other world champions had two weeks or more to get accustomed to the unique demands of the Brickyard, Alonso will have just five days of practice at average speeds of 225

mph, inches away from concrete walls in a "foreign" car before running four laps of qualifying to secure his place in the starting line-up. Throw in a day or two of rain and the challenge will be even more formidable.

The good news? In contrast to the days of yore, when 40, 50 and more drivers and cars vied for Indy's 33 starting positions, now virtually anyone who can lay claim to a Dallara DW12, negotiate an engine lease from Honda or Chevrolet, and keep the package in one piece during practice and qualifying is guaranteed a place in the field. And, in contrast to his forerunners, Alonso will have the luxury of logging hundreds of laps at the virtual Brickyard in a simulator before he sets foot in Indiana.

What's more, Alonso is driving for a team that has won two of the past three Indianapolis 500s and which, last year, coached/coaxed then lightly-regarded rookie Alexander Rossi to an upset victory over team-mate Carlos Muñoz. And just two years ago, NASCAR stalwart Kurt Busch was named Rookie of the Year in his own Indy 500 one-off with the same Andretti Autosport.

Rossi returns this year along with the very accomplished Ryan Hunter-Reay (winner of the 2015 Indy 500 and the 2012 IndyCar title), the underachieving Marco Andretti, and Formula 1 refugee Takuma Sato. The team also fields a sixth entry for rookie Jack Harvey in association with sports car veteran Michael Shank's group.

In addition to this catholic assemblage of talent, Alonso will be paired with race engineer Eric Bretzman, who moved to Andretti this year from Chip Ganassi Racing after helping Scott Dixon to an Indy 500 victory and three IndyCar titles. As well, Alonso will be able to call upon the considerable experience of team owner Michael Andretti, arguably the greatest IndyCar driver *not* to win the Indy 500 and the sage advice of the greatest IndyCar driver to win just one Indy 500 – 1978 World Champion Mario Andretti.

That said, it's a fact that some gifted grand prix drivers have struggled transitioning to Indianapolis. No less than Juan Manuel Fangio failed to get up to speed in 1958, while Nelson Piquet suffered grievous injuries during a practice session crash in 1992 but returned to qualify and race at Indianapolis the following year.

Few believe Alonso will have much difficulty qualifying at or near the front in his IndyCar debut. However, the race itself will present additional challenges, specifically running 200 laps of the 2.5-mile speedway in the aerodynamic eddies of slower (and faster) cars on a track notoriously sensitive to the slightest shifts in temperature, sun/shade and wind direction/velocity. Too, Alonso will be surrounded by 32 unfamiliar drivers, some of whose talent and experience, it must be said, pale in comparison to his own but who (in contrast to Formula 1 – it also must be said) will be driving substantially equal equipment.

Come to think of it, that will be a luxury for Alonso whose current lot brings to mind Jim Crawford's response to a query about his car's performance in traffic during practice for an IndyCar race at Phoenix International Raceway. "Traffic? I *am* the traffic," quipped the Scotsman.

Whether he wins or finishes dead last, Alonso has already accomplished much... for Honda, Andretti Autosport, McLaren, the Indianapolis 500, himself and motorsports as a whole. In a single bold stroke, he has injected racing with a desperately-needed jolt of energy, reminding us that, in a sport where technology always has the potential to overpower the human element, dynamic, risk-taking personalities can still stir the soul. RT

• David Phillips has written about motorsports (real and virtual) for more than three decades. His latest book is entitled *A Big Ask: The Story of Ford's Triumphant Return to Le Mans.*

Michael Peters/Peters Motorsports Designs

ABOVE iRacing's talented virtual community was quick off the mark with its take of Alonso and McLaren at Indy

IndyCar

ABOVE Alonso is no stranger to Indianapolis in an F1 car, but contesting oval racing's showpiece is a totally different proposition

THE WEC'S PHONEY WAR

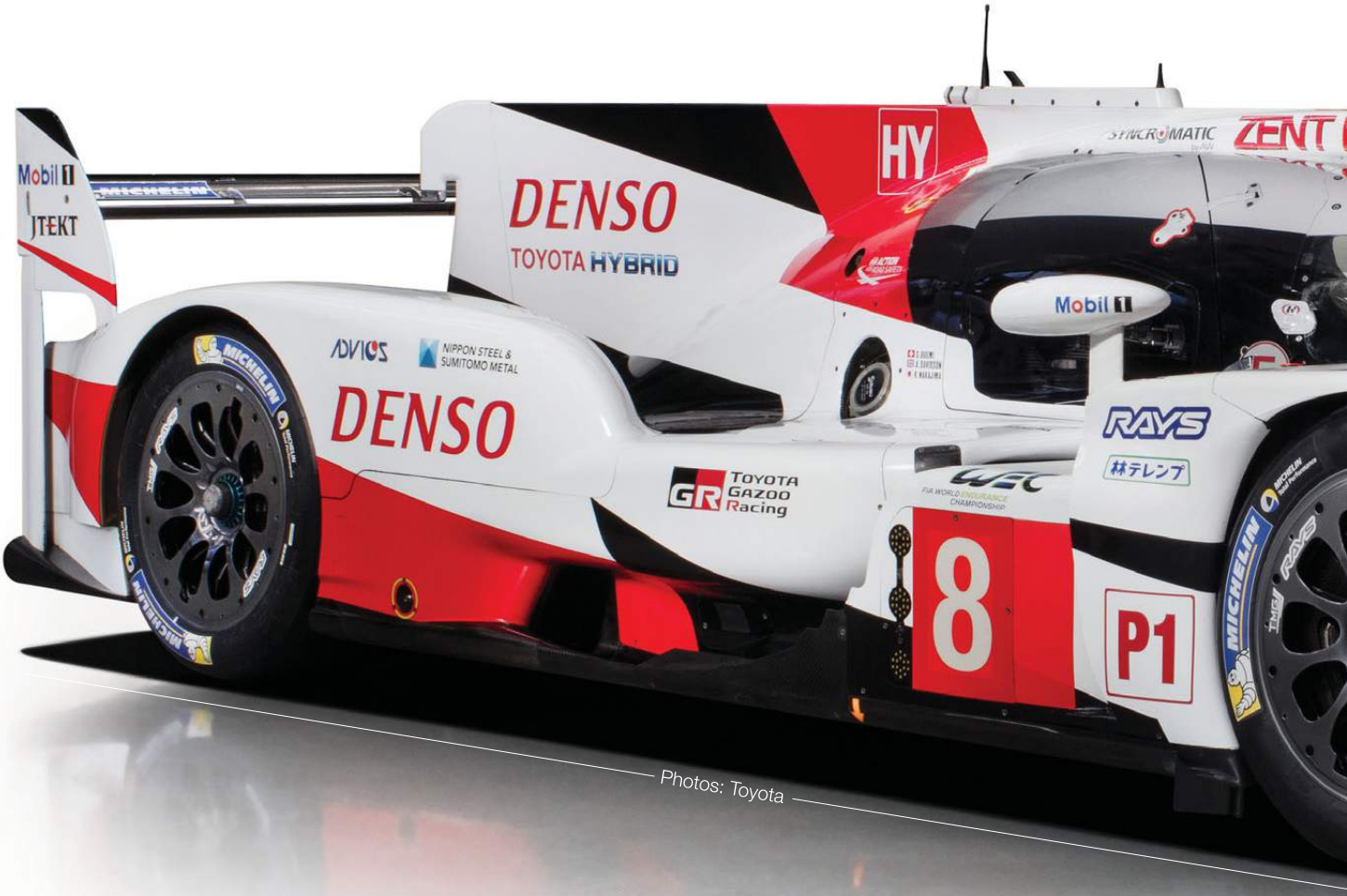
Toyota's TS050 HYBRID beat Porsche's 919 Hybrid in the opening race of the World Endurance Championship. But what, asks **Gary Watkins**, have we *really* learned from their early exchanges?

TOYOTA took the fight for the FIA World Endurance Championship down to the wire in Bahrain last November, but in reality it wasn't a serious contender for the end-of-season silverware. That's no contradiction because the Japanese manufacturer's new TS050 HYBRID was ultimately not a competitive proposition on all circuits, near miss at the Le Mans 24 Hours or no. The avowed aim of Toyota Gazoo Racing for 2017 is to change that state of affairs in its bid to prevent Porsche from taking a hat-trick of WEC titles.

The first version of the TS050 should by rights have won at Le Mans last year after prevailing in a thrilling battle with Porsche's 919 Hybrid through Sunday morning. Toyota was deprived of a first victory on the Circuit de la Sarthe in its 14th assault as a factory by a freak – and relatively minor – failure with approximately five minutes of the 24 hours remaining.

Yet the reasons why the Toyota had the narrowest of edges over Porsche around the 8.47-mile track ultimately compromised it on the Formula 1 circuits that make up the second, post-Le Mans leg of the WEC. The focus on shedding drag in a year when engine power had been cut by eight per cent – courtesy of the 10 megajoule reduction in the amount of energy permitted to factory LMP1 cars around Le Mans (and a percentage thereof at other tracks) – compromised its high-downforce car.

That explains why the most competitive



Photos: Toyota

showing by Toyota after Le Mans came at the Fuji Speedway, a circuit with an ultra-long straight that doesn't require high levels of downforce. It was truly in the hunt on home ground and some clever tactics that included short-fuelling and then double-stinting Kamui Kobayashi at the end of the six hours allowed the Japanese driver to seal the victory with Stephane Sarrazin and Mike Conway.

"All the development we were doing for Le Mans was really hurting the high-downforce version of the car," explains Toyota Motorsport GmbH technical director Pascal Vasselon. "As we are not able to put a lot of resources into a high-downforce package, we had to live with a baseline car that was conceived to shed drag."

Vasselon talks of a "resource limitation" that prevents TMG in Cologne from producing bespoke high and low-downforce bodykits. Porsche, he insists, "can do a Le Mans kit and a full high-downforce kit". New rules for this year designed to keep a cap on falling lap times by putting in new aerodynamic restrictions – raising the splitter by 15 mm and reducing the height of the diffuser by 50 mm and its width by 100 mm – have worked in Toyota's favour, he argues.

> *"The Le Mans development really hurt us elsewhere. We had to live with a baseline car that was conceived to shed drag"*

"The new regulations, I would say, better suit our resource limitations," continues Vasselon. "You will have more things in common between the two specs of car. Most of the aero work has been to recover downforce, and so the work is valid fully for both the Le Mans and the high-downforce package.

"The starting point of the regulations did not generate the gap [between the two configurations] we had last year. We do expect that our high-downforce aero package will be better suited to the [six-hour] WEC races, whereas last year we clearly had a deficit because our Le Mans development was quite extreme."

Also relevant to Vasselon's point about resource limitation is a second wave of cost-cutting measures introduced into the LMP1 rulebook for 2017. The manufacturers are now allowed only two rather than three bodykits per season, with the spec of each locked in once they are homologated ahead of their first race. At the same time the number of windtunnel hours allowed per calendar year has been cut from 1200 to 800.

"The good thing is that there is no chance of another update, which is also a question of resources," says John Litjens, LMP1 chief project leader at TMG. That comment hints at the advantage Porsche stole in 2015 with its all-dominating 'kit 5'. The car won on its debut at the Nürburgring after Le Mans and would remain unbeaten over the remainder of the season as Porsche swept first to the manufacturers' title and then the drivers' crown with Mark Webber, Timo Bernhard and Brendon Hartley. 'Kit 5', or rather the extent of Porsche's aerodynamic development at which its nomenclature hinted, can be viewed as the catalyst for the rules that limit the number of aerodynamic configurations.

NEW AERO LOOK

The changes mandated to the splitter and diffuser have resulted in similar aero treatments by the two remaining P1 manufacturers following Audi's withdrawal from the WEC for this season. Or at least the ▶

LEFT Continuing the high-nose philosophy of its predecessor, the latest TS050 has also been shaped by new aero rules, notably dictating its deeply scalloped sidepods

ABOVE & BELOW The TS050 prevailed at Silverstone but (below) not everything went to plan

treatments on the configuration of cars seen so far. Porsche won't be revealing its high-downforce kit until the Nürburgring round in mid-July, the result of its decision to focus resources on its Le Mans package over the first half of the season.

Litjens explains that the aerodynamics of the second iteration of the TS050 have been driven by a combination of the new aero rules and continued development of the high-nose set-up of last year's version. "We have lost so much downforce with the latest regulations that we have to find it back in other areas," he stresses. "The changes to the splitter and the diffuser have a big effect, but this year's car is also an evolution of the trends we saw last year. Audi went quite extreme [with the final 'cab-backward' R18 e-tron quattro], and for sure we looked at what was possible. We could not go as high as we might have done because we are using the same monocoque as last year."

The deeply scalloped sidepods behind the front wheels are a reaction to the revisions to the aero rules. "When such new rules come, you make the changes and study the flow patterns and try to work from there," explains Litjens. "That is where you see the undercut coming from on all the cars."

Litjens estimates that the majority of the downforce lost to the splitter and diffuser changes, put at 30 per cent by rulemakers the FIA and WEC promoter the Automobile Club de l'Ouest, has been regained. "I would say that we have gained back 90 per cent of the losses," he says.

The high and low-downforce TS050s look similar and Litjens confirms that the "concept is the same" on the two cars, as in previous years. He admits, however, that "you would see some of the shapes are different if you put the two cars side by side". For example, he says that the bodywork either side of the nose – a fixed part of the homologated crash structure – is a "bit higher" on the high-downforce version because more air is being taken through the car.

Litjens estimates that only 30 per cent of the bodywork is different between the high-downforce version that won this year's WEC opener at Silverstone and the Le Mans-spec car that took part in the official pre-season test or 'prologue' at Monza two weeks before.

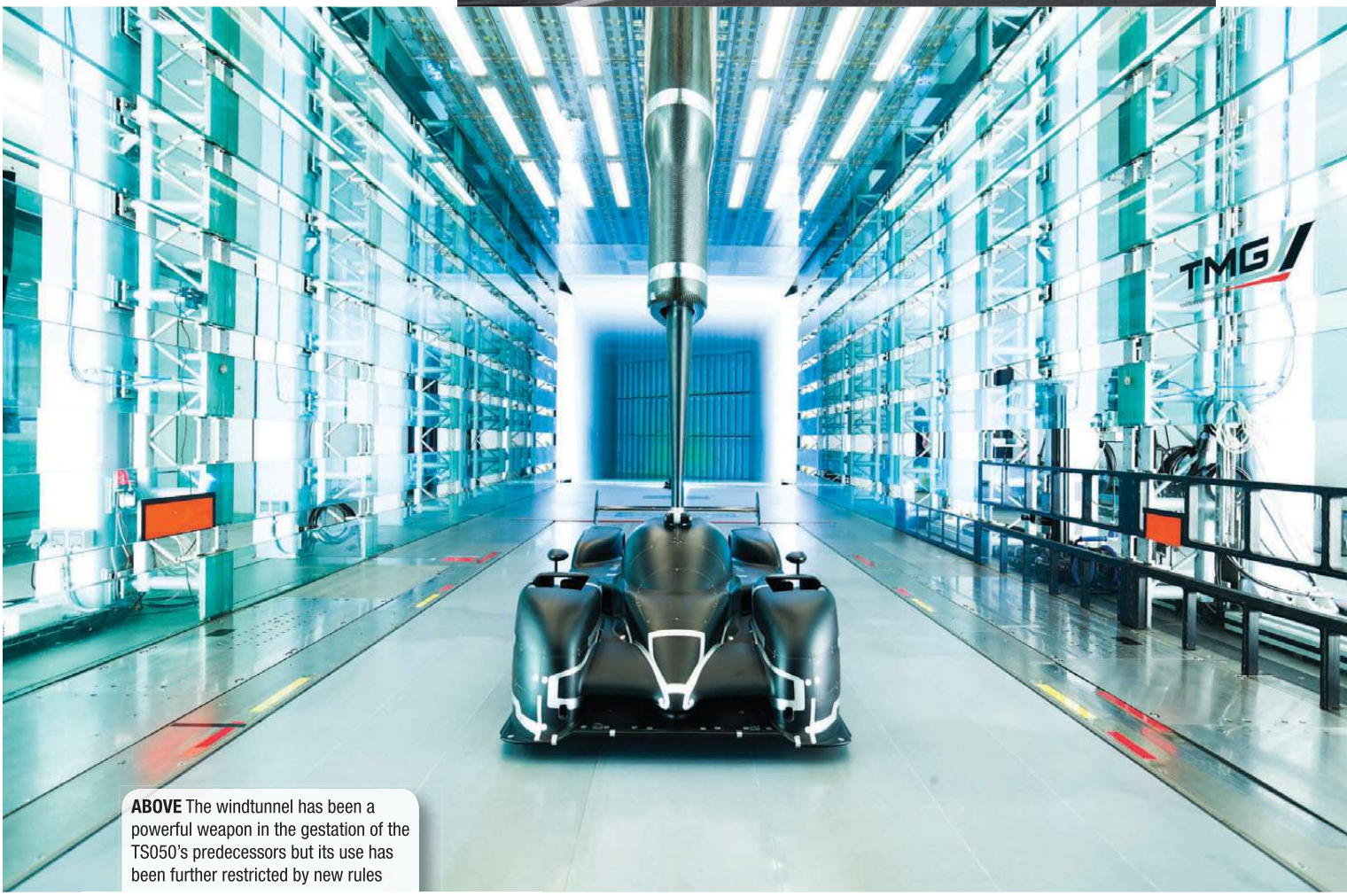
"A lot of the parts are common between the two cars, for example the main engine cover," he explains. "That is why we focus ▶

on the key drivers that make a difference, the parts of the car that are most sensitive. We have changed the rear section [of the tail] on the high-downforce car with a higher kick-up.

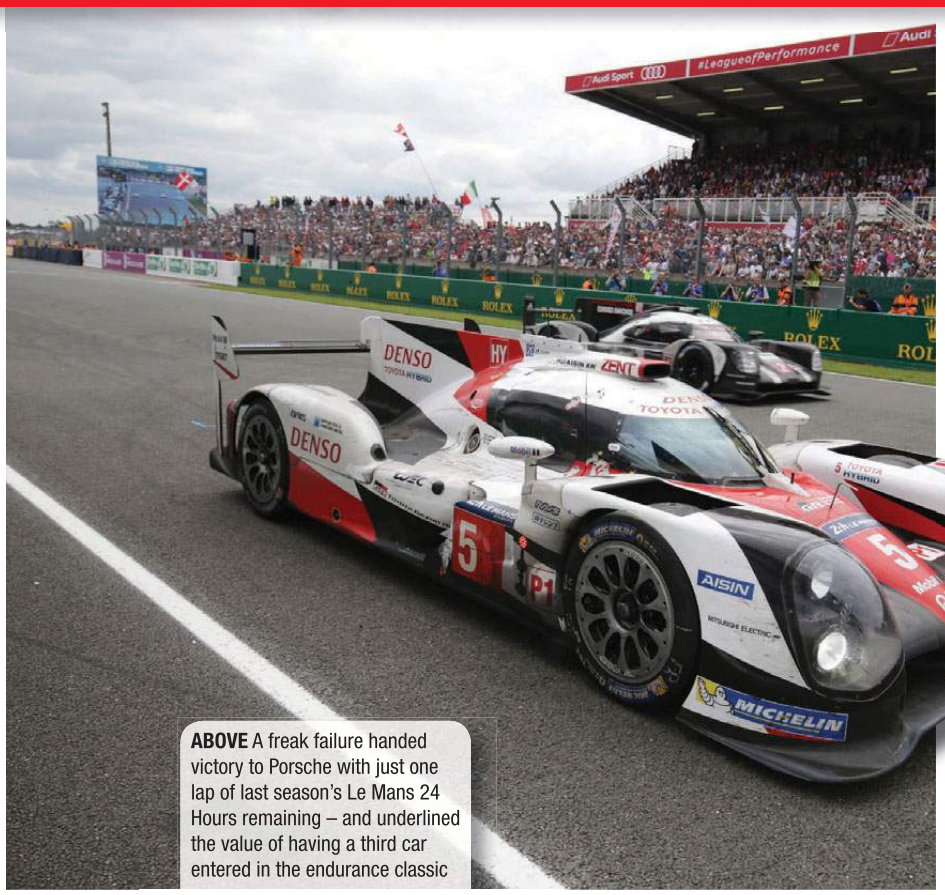
"We always start aero development with the Le Mans package. We don't forget about the high-downforce car, but we cannot follow through with all the concepts from a point of the wind-tunnel time available to us. There's also a question of parts. If you changed a big component like the engine cover, it would have a big impact on costs."

Litjens insists that another rules tweak for 2017 has had little effect on the aero thinking behind the revised TS050. The requirement for legality panes or fins to cover moving parts when the car is viewed from above has been removed because they created lift in a sideways moment. "It hasn't affected the aero too much or the base concept," he says. "In the past our aero people initially developed the car without them and then worked on profiles that met the regulations that didn't affect things too much." ▶

ABOVE & BELOW The Le Mans-spec car topped the times in the pre-season 'Prologue' at Monza (above). Its high-downforce sibling, triumphant at Silverstone (below), shares much of the same bodywork



ABOVE The windtunnel has been a powerful weapon in the gestation of the TS050's predecessors but its use has been further restricted by new rules



ABOVE A freak failure handed victory to Porsche with just one lap of last season's Le Mans 24 Hours remaining – and underlined the value of having a third car entered in the endurance classic

NEW ENGINE

Toyota always knew there were significant gains to be made with the 2.4-litre twin-turbo V6 internal-combustion engine that replaced the normally-aspirated V8 – first of 3.4 litres' capacity and then 3.7 – that it had used since its return to top-flight sportscar racing on the rebirth of the WEC in 2012.

The swap to a small-capacity turbo motor had originally been in the schedule for 2017, but a decision was made to bring the move forward by one season early in Toyota's annus horribilis in 2015, a year it was defending the WEC drivers' and manufacturers' crowns.

The final decision to move to a turbo for 2016 at the same time as it replaced its super-capacitor energy-storage system with a lithium-ion battery was taken just after Le Mans in 2015. Yet the first V6 LMP1 engine fired up on the bench at Toyota Higashi-Fuji technical centre in Japan as early as September that year. That explains why racing hybrid project leader Histake Murata says there were "several new ideas that we wanted to incorporate into the new engine". He reckons only "a few small bolts" are shared between the 2016 and '17 engines.

A particular emphasis has been placed on the combustion chamber, which includes an increase in the compression ratio. Both efficiency and power have been increased, according to Murata.

It is also worth remembering there was a structural problem to overcome. The two TS050s sustained engine failures in the Spa 6 Hours last May caused by the forces encountered in the compression at the bottom of the Eau Rouge big dipper.

The hybrid systems on the car have also been improved, including the front motor generator unit developed by Aisin AW in Japan. (The rear MGU is again the responsibility of Denso.)

"We have re-designed the battery and the front motor," explains Murata. "The front motor-generator unit is smaller and lighter and the main change on the battery is increasing the high-voltage limit. By increasing the voltage, you increase the power."

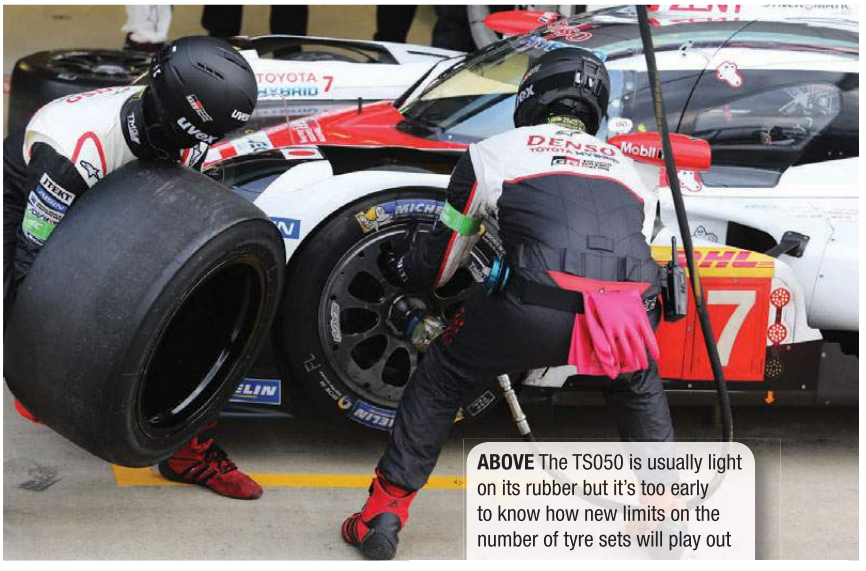
RESOURCES DIVERTED

Toyota has admitted that resources have been diverted from car development into the entry of a third car for Le Mans and, by way of preparation for the 24 Hours, the Spa WEC round in May. It is a strategy that it had previously opted against, but the events of Le Mans last year and in 2014 led it in a new direction for the present Toyota set-up. (Toyota previously ran three cars in 1998-99 during the GT-One programme masterminded by TMG and in 1992-93 when TOM'S GB looked after its campaigns in the 3.5-litre Group C era.)

"We have had to manage within our budget frame – we did not get more budget," he explains. "We have reduced some development items without hurting our performance target achievement and, at the same time, taking some financial risks.

Vasselon concedes that there is a risk involved with a budget he describes as "very optimistic". "If we have a couple of accidents, for example, we will be in financial trouble and we would have to make a drastic saving at some point," he reveals.

The decision to expand to three cars was a logical one despite previous reservations expressed by TMG, says Vasselon: "If you look at the past three years, two times we were in a position to win Le Mans and ▶



ABOVE The TS050 is usually light on its rubber but it's too early to know how new limits on the number of tyre sets will play out

CARTEK
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ABOVE Such is the pace of development at the WEC summit that most of the downforce lost to new rules has already been clawed back

two times we have had exactly the same scenario with one car having an accident and the second one having a one-off reliability issue. The same scenario twice in three years pushes you strongly towards having the third car."

For those who might have forgotten, a turbo pipe did for the leading Toyota in 2016. Two years before, the leading car was halted by a fault in the wiring loom caused by an FIA-mandated sensor.

STRATEGIC DECISIONS

Toyota opted to race its high-downforce car in the WEC opener at Silverstone because, says TMG race director Rob Leupen, "We have a commitment to the WEC". And by that commitment, he means trying to win it again. Vasselon says it would have been "too much of a compromise" to race the Le Mans car around the circuit that demands the most downforce of any on the WEC schedule. Porsche ultimately made that compromise or sacrifice. It has argued that it was not possible to develop two aero specs side by side and opted to take a similar course of action that has served it well in the past.

It will race the Le Mans-spec 919 in the first two races ahead of the 24 Hours and then bring out its high-downforce 919 for the 'Ring. Leaving what might be termed the sprint car in the windtunnel for a few extra months helped it to both WEC titles in 2015 and '16, though an option not available to it this time was starting out at Silverstone with an update of the previous year's high-downforce car.

COMPARISONS DIFFICULT

Trying to make predictions about the remainder of the WEC based on the events of Silverstone are nigh on impossible. Toyota claimed the victory, as quite rightly it should, but it was made to sing for its supper by Porsche's Le Mans car. The only reason that Sebastien Buemi had to come from behind in the final stint was that a big lead for the #8 car shared with Anthony Davidson and Kazuki Nakajima had been wiped out by a safety car in the fourth hour.

Decisive conclusions are unlikely to be reached after round two of the WEC at Spa on May 6 when three TS050s – two in high and one in low-downforce trim – go up against the pair of Le Mans 919s. Last year, the sprint-spec Toyota and low-downforce Porsche were evenly matched in Belgium, both marques claiming they should by rights have triumphed in a race ultimately won by Audi.

The two factory P1 teams ran in the same spec at Monza and Toyota came out fastest. Yet it placed emphasis on qualification simulations – one of its weaknesses last year – on the second day of the test, a time when Porsche was concentrating on long runs.

New tyre rules for 2017 limit each P1 car to four sets and two joker tyres for the aggregate qualifying session and the race. Again, the different specs of the factory P1 cars at Silverstone, combined with a short period of wet running and a safety car, mean there can be no definitive answers about who is dealing with the new rules the best.

Toyota P1 cars have traditionally been light on their tyres. But Vasselon isn't sure whether the new tyre rule will play into Toyota's hands, though he is happy to say that his team is "not afraid of it". Rather, it is "looking forward to the challenge".

Perhaps the only conclusion that can be reached so far is that the clever and industrious engineers in Cologne, as well at Weissach, have overcome the restrictions placed on them by the rule makers. Toyota and Porsche revealed before the season started that they were lapping close to 2016 lap times, in spite of the regulation changes. The pace at Silverstone suggested something a bit more.

Kobayashi's fastest lap of the meeting was a 1m 36.793s in qualifying, which compares with the 1m 39.655s weekend best of 2016 set by Porsche driver Brendon Hartley. It's not a fair comparison, because qualifying last year didn't take place in dry conditions.

Yet the fastest TS050 lap at the home of the British Grand Prix in 2016 was a 1m 41.148s, which means the men and women in Cologne and Higashi-Fuji have found the best part of four and a half seconds. Toyota didn't have a good Silverstone last year, but the jump backs up Vasselon's pre-season assessment that the Japanese manufacturer probably had more to gain than Porsche.

"We are definitely in a better position than last year because we are in better-known territory with scope for progress," he says, "possibly bigger scope for progress than Porsche because we are newer in technologies such as small-capacity-turbocharged engines."

That has to bode well for Toyota's challenge to the supremacy of a Porsche concept now in its fourth season. RT

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LIGHT AT THE END OF THE TUNNEL

Ginetta is developing a customer LMP1 car to fill the void in endurance racing. **William Kimberley** reports

ABOVE A team of world-class designers and supply partners have been lined up for Ginetta's LMP1 project

GINETTA is one of those car companies that tend to fly below the radar, yet it is a highly prolific racing car manufacturer that forms the cornerstone of accessible motorsport at every level. At the time of its LMP1-NH technical briefing at the opening round of the World Endurance Championship at Silverstone, there were more than 100 Ginettas competing at circuits around the UK over that weekend.

Since the company's acquisition by Lawrence Tomlinson in 2005, it has created a ladder from grassroots racing up to international competition with cars and race series around the world. Until now, the G57-P2 was the top of the pyramid, but it is about to be replaced by a car that will make the pyramid even taller. In what can only be classified as a bold move, but a rightful one for an entrepreneur like Tomlinson, he has spotted a vacuum in LMP1 and has moved in to fill it.

After the sudden exit of Audi from the World Endurance Championship that was announced at the end of last year, the senior class has looked vulnerable. It would only take a board decision by Toyota or Porsche, a sister company to Audi, to withdraw and the series would dissolve. While Rebellion did commission a bespoke LMP1 car from ORECA in 2015, it was more or less racing itself in the privateer class, apart from the occasional ByKolles Racing entry. This year, though, Rebellion has moved into LMP2, leaving ByKolles Racing as a lone entry with its rather old CLM P1/01.

The proposition being put forward by Tomlinson and Ginetta is for an affordable LMP1 car where the costs are contained. The price for the rolling chassis, including electronics, is £1,340,000 while the running costs for the V6 engine are £594,000 per season. That would include technical support from engine builder Mecachrome and Ginetta, which will have engineers on hand at all WEC events. Additional testing support will be made available by separate request and Ginetta expects spares to be within a range of no more than 30% above the equivalent LMP2 parts.

DEMYSTIFYING LMP1

"We are trying to simplify and demystify the cost of the LMP1 project," says Nick Portlock, Ginetta's newly-appointed commercial director. "The cost of the rolling chassis ready to race is £1.34 million. On top of that we are considering a groundbreaking way of looking at the engine leasing and the cost of the engine for three seasons that includes full technical support both in testing and all through the racing."


Ginetta

Tasked with pulling this programme together is Ewan Baldry, who has been Ginetta's technical director since 2014. Managing director of Juno Cars from 1999 for nearly 16 years, he was lured to join the Yorkshire company when it was developing its LMP3 car.

"That programme was so short that this LMP1 one seems a luxury in comparison," he says. "With the P3 we did it entirely ourselves, but we had never designed a carbon fibre car before or undertaken any kind of CFD study. Furthermore, I was at Silverstone for the TOCA round in late September and the rules were only finalised two weeks after that. It meant that we had from mid October until the Prologue in mid March to design, crash test, build and deliver five cars. No-one thought it was going to happen, but we did it."

The LMP1-NH project started to come to life in the summer of last year, with the green light given in September. Ginetta expects the first customer cars to be delivered in Q1 2018.

One of the most important things has been to build a team. While Baldry has a young and talented team at Ginetta, who already boast comprehensive experience in the development of prototype endurance cars, he needed significant additional resource and so started in a quest to find the right people, facilities and suppliers. He now has at his disposal a line-up of established names to help him in this venture.

Paolo Catone, a proven Le Mans winner with Peugeot and more recently the designer of the BR01 LMP2 car for SMP Racing, was among the first to be contacted.

> *"A groundbreaking way of looking at the engine leasing"*

"I was introduced to him by Advanced Reinforced Structures – ARS, the Italian composites company we use on our other cars as he was known to them for his work on the SMP car," says Baldry. "The thing that's great about him is that although he has been around the block and has so much knowledge, he's still very pragmatic and open. He will give his opinion but not be upset or dismissive if we decide to go another route.

"He is working with Peter Smith, our chief designer and race engineer, who is also an ex-Juno guy, who also worked for Progressive Motorsport which provided race engineering resource to Audi Sport. While it's not directly relevant, you can't unlearn what you've already learnt so he's been able to talk to Paolo about what he was doing at Audi, which has been useful."

Working alongside Smith as head of aero at Ginetta is Andy Lewis. Until he was recruited to the company in 2014, he had spent five years working at Williams Advanced Engineering, specifically on the hugely successful Porsche LMP1 project.

Another big-ticket name involved in the project is Adrian Reynard who has been drafted in to work on the CFD programme. "I have lived my whole life in Prototype Alley, building new cars and making old cars out of date, and that's what I love," he says. "I also learnt many things in the 30 years I was with Reynard Racing Cars, one being that you need the very best people, and I am proud to be part of the Ginetta team developing this car.

"Lawrence and I had been speaking for some time about such a project and I probably threw a bit of fuel on the fire by saying that it was a great opportunity, that there was a void, and if Ginetta could get a car out first then maybe there was an opportunity to sell more. You never know which major manufacturer might want to come in and test its engine in the car, so if Ginetta has got a ready-made chassis for 2018 then it might be a solution for them. ▶

ABOVE Ginetta's LMP1 vision is moving closer to becoming a reality

LAT

BELOW Ginetta enters the top tier having proven its sportscar expertise with the LMP3 chassis

There are also independent teams spending maybe £10 million a year and this is a lower cost car and perhaps a better option than developing their own car."

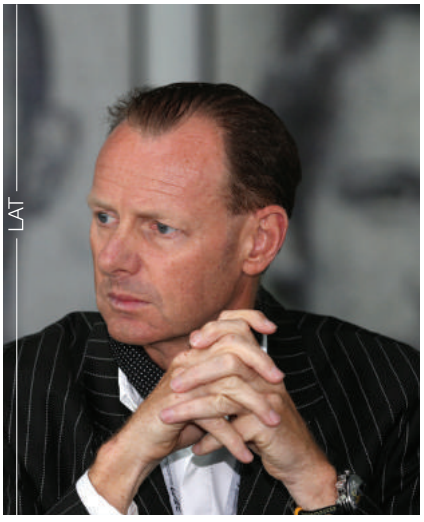
Reynard is particularly excited to be involved in the aero side of the project. "I've fallen in love with aerodynamics and how it can improve performance," he says. "CFD is an amazing science and that's my role in the Ginetta programme. We've already done about 20 runs and we're using some pretty advanced transient DES – detached eddy simulation."

The key aero route that has been taken is to run a relatively high footbox – 275 mm difference in between the driver's seat base and the height of the driver's heels – offering significant aero advantages.

"With the mandated crash structure, the wheelbase, the size and width and length of the wings, it does define a package, but there are some nuances within that where we believe we can derive some advantages," says Reynard. "I'm also really excited to get involved in a formula where there's the ability to continue development."

"We are also really conscious of driveability and driver visibility, a key complaint of cars like this being the roll-over structure and the thickness of the A-pillar creating a pillarbox visibility," says Baldry. "So we have been working with ARS for the production of chassis and crash structures to minimise that."

> *"The only way to ensure that LMP1 can survive is to offer an affordable system and give access to privateers"*



LAT

ABOVE Ginetta chairman Lawrence Tomlinson announces the project

The Italian company already has significant experience in the production of LMP1 and LMP2 chassis and crash structures. It is using its Ultra LEAD technology manufacturing process to hit the desired monocoque weight target of between 54 and 59 kg, which is in line with reducing the car's overall weight to well under the 835 kg minimum. "Our target is 750 kg, which gives us a significant amount of ballast we can use to tune the distribution and the dynamic behaviour of the car," says Baldry.

The CFD programme is well underway, while the first wind tunnel session at Williams Advanced Engineering is due in early June. "We took the decision to go with Williams Advanced Engineering for the wind tunnel work following its work on the LMP1 Porsche and saw it as a 'no-brainer' to take the opportunity to work with them," says Baldry.

The plan is to run a 50% scale model using pneumatic tyres in what is called Wind Tunnel 1. "It's slightly smaller than the current F1 tunnel, but it has all the advantages of moving ground plane and ▶

one that can do yaw as well and a model motion system that allows us to pitch, roll and yaw," he explains.

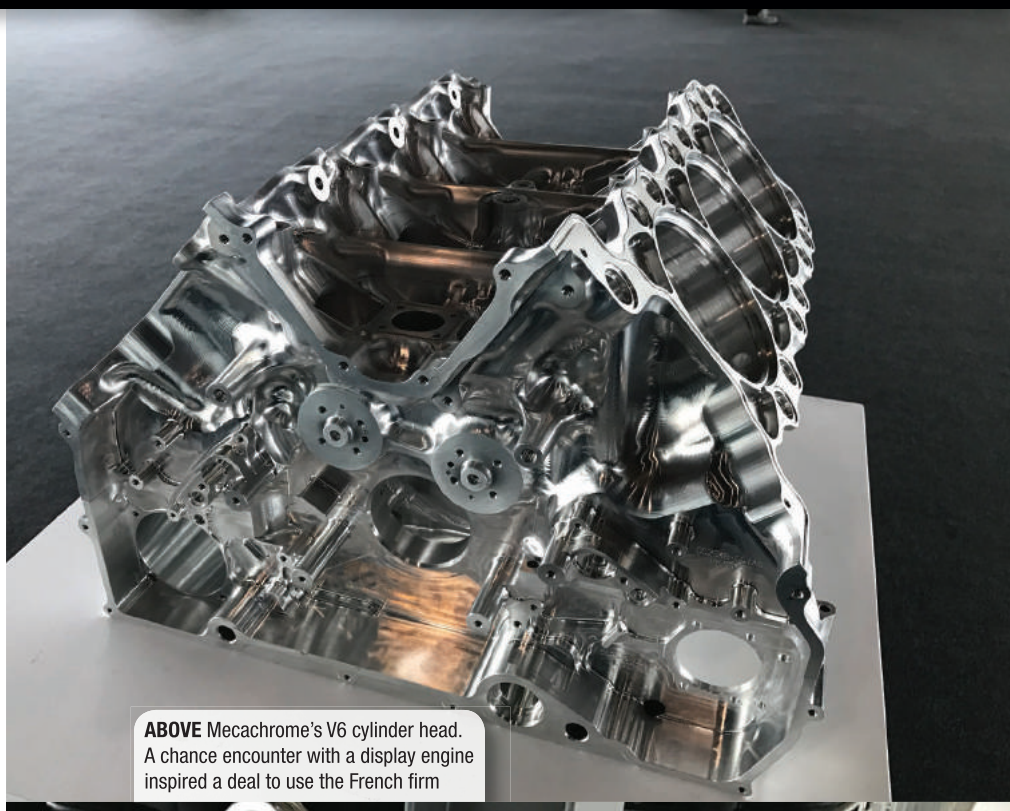
The car is being designed around the Mecachrome V6 turbo engine. Weighing 122 kg, it is very light with a single turbo located in the vee, similar to the current Formula 1 and LMP1 hybrid engines, to give mass distribution benefits. It also offers a further advantage in that it can run at high water temperatures – 120 deg C – offering aero efficiencies with respect to radiator sizing.

DIRECT INJECTION

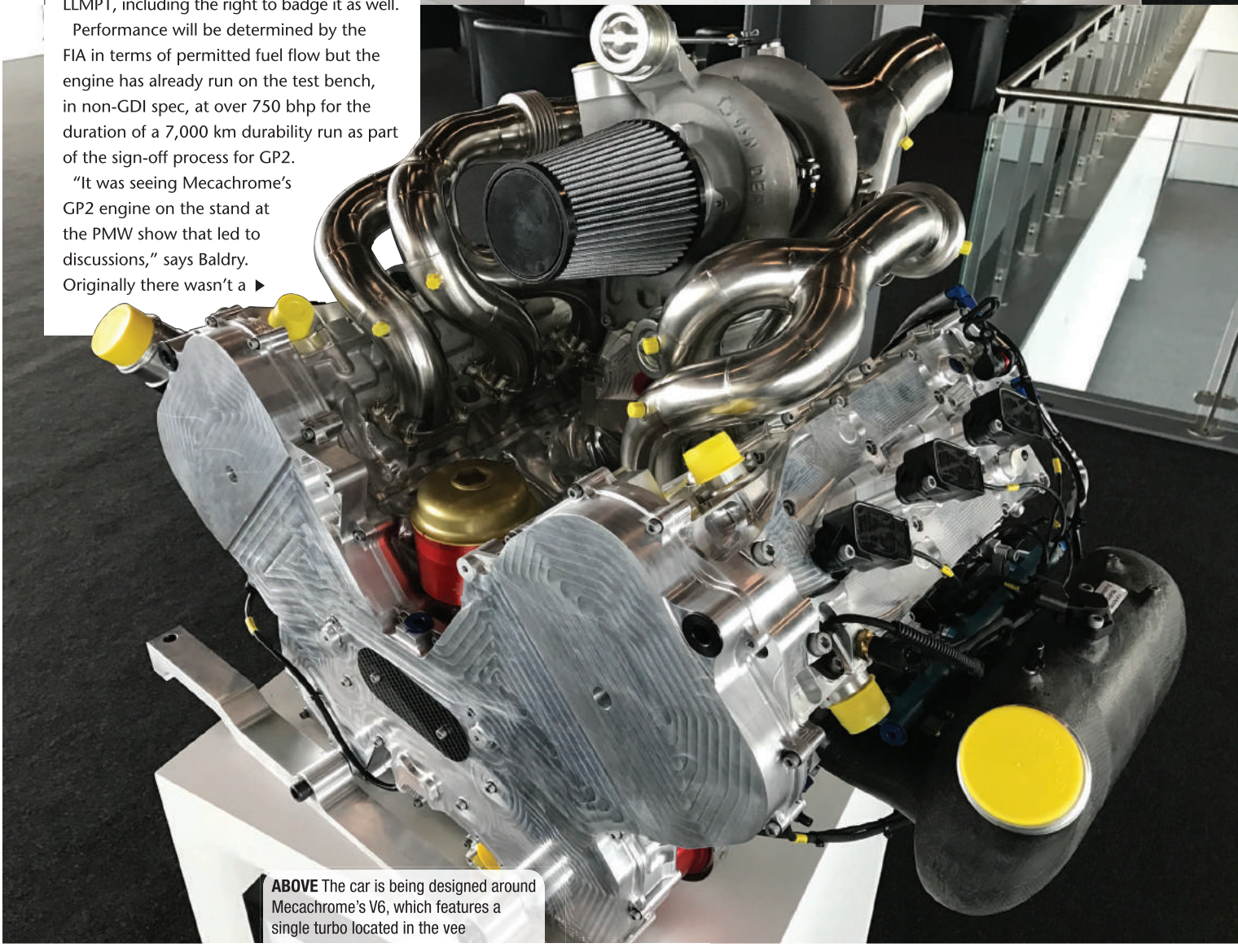
It was originally developed for GP3 and then GP2, but from the start there was the option of making it suitable for LMP1, particularly with the addition of direct injection and a bigger turbo in accordance with the fuel flow regulations. It is exclusive to the Ginetta LLMP1, including the right to badge it as well.

Performance will be determined by the FIA in terms of permitted fuel flow but the engine has already run on the test bench, in non-GDI spec, at over 750 bhp for the duration of a 7,000 km durability run as part of the sign-off process for GP2.

"It was seeing Mecachrome's GP2 engine on the stand at the PMW show that led to discussions," says Baldry. Originally there wasn't a ▶



ABOVE Mecachrome's V6 cylinder head. A chance encounter with a display engine inspired a deal to use the French firm



ABOVE The car is being designed around Mecachrome's V6, which features a single turbo located in the vee

meeting of minds but the persistence of Bruno Engelric, Mecachrome's motorsport manager, paid off when he visited the car company in Leeds.

"He understood what we were trying to achieve, which was an affordable but competitive engine for the car. With this one being used in GP2 and 3 with the same block, sump, crank, rods and pistons, the economies of scale could come into play," says Baldry.

"I would say the fact that we have developed this engine with the GP3 and GP2 programmes in mind has really helped because both series demand superior efficiency," says Engelric. "Any time that you blow up an engine due to your fault, you more or less burn the margin for a full year. That means that there's no place for any mistakes. From the start this has been a reliable engine. We have covered the whole GP3 series in one year with 24 cars without any problems, at least from our point of view.

"We have spent a great deal of time on simulation. That's probably the result of developing the last diesel race engine for Peugeot which was really challenging at the time, but it was beautiful. What we have here is in the spirit of this design and is why we have a very reliable package today and why we feel very comfortable about this LMP1 programme. For sure it's challenging, because it's not a single spec series and we will have competitors, but we are ready to compete."

ENGINE SIMULATION

"While the full GDI engine is unlikely to be available until late October, we do have the ability to run one in a simulated format with a GP2 engine that can already make the numbers," says Baldry. "The plan is to run Bosch for the ECU and so it's likely we will go with Bosch for the chassis logging as well, although a final decision has yet to be reached."

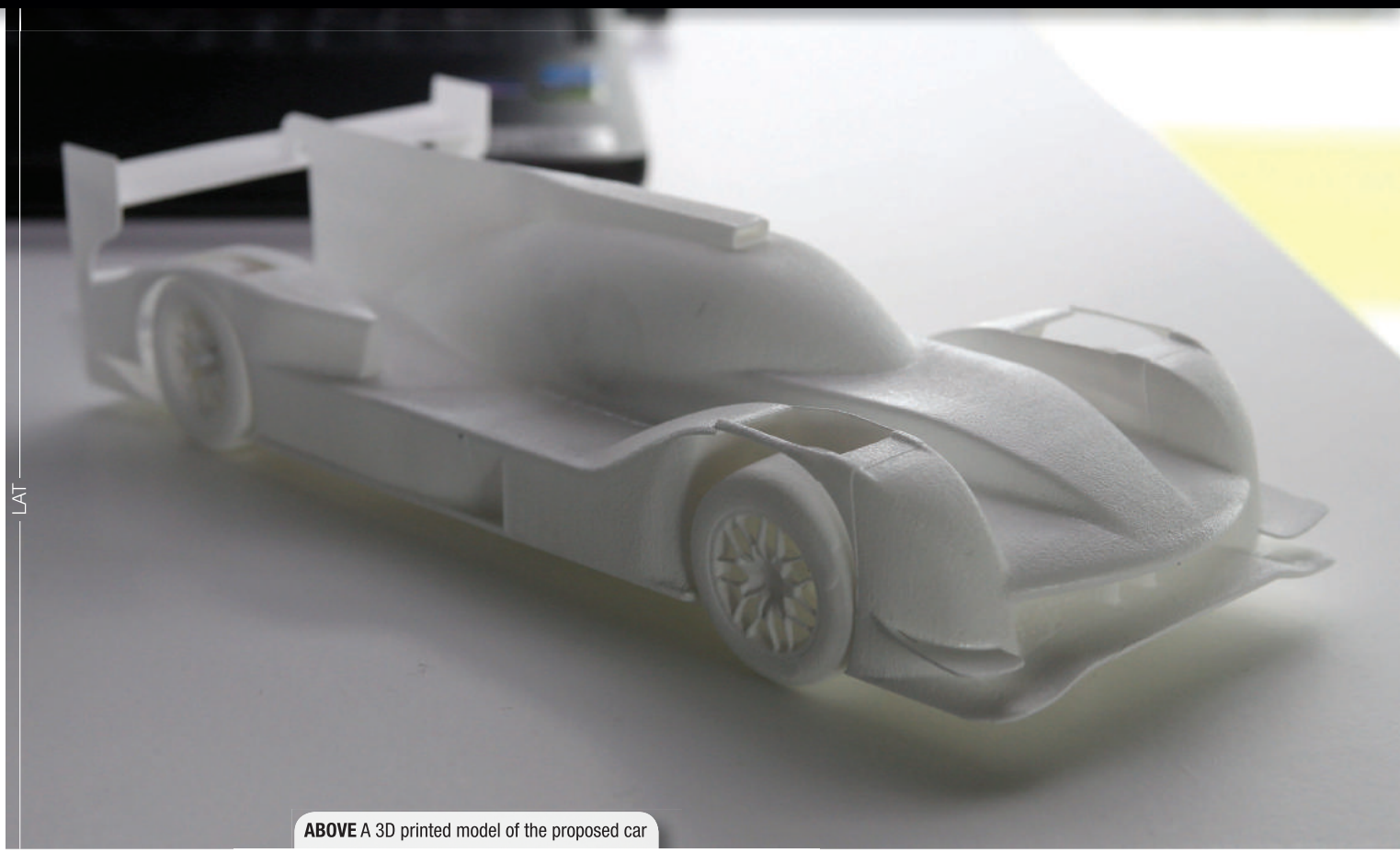
Mated to it will be Xtrac's 7-speed 1159 transverse gearbox. Launched a couple of years ago, it has already proven itself in both LMP1 and LMP2. To meet Ginetta's criteria, though, it has been slightly modified to become the 1159H.

"The great thing is that the internals are all proven and it has been raced at Le Mans many times," says Baldry. "All we are doing is twisting a little bit, to get the centre of gravity lower and further forward, and putting in a main case that bolts straight to the back of the engine so there's no bellhousing or that extra complexity. Having said that, we don't want to lose out on a customer who might have an engine deal elsewhere so we're making sure we package protect so that any other engine can be used."

Baldry and his team are working with both tyre companies in endurance racing on the project. "The key thing with a car like this is enabling the front tyres to be switched on," he notes. "There isn't the hybrid drive at the front end, so we have to make sure we can work the tyre and so focus on the mass distribution, especially at the front.

"We've therefore had quite intensive conversations with both Dunlop and Michelin. The thing that's surprised me is that both are telling me that it's an important programme for them. It's not a question of simply a 'one size fits all' tyre. It ▶

ABOVE Xtrac's gearbox internals have already been proven at Le Mans



ABOVE A 3D printed model of the proposed car

means we are sharing kinematic information and we won't be getting the hand-me-down tyres that have been developed for the nose-heavy LMP1-Hs. However, as it's a customer car, it will be up to the teams which tyres they use. Our target is to have something that's good with both."

The brake system will be supplied by AP Racing and will include 6-piston Monobloc callipers and carbon spline driven disc/bell arrangement. Brake actuation will be by a sliding pedal box.

"NO-BRAINERS"

"As it's our first LMP car we wanted as many 'no-brainers' as possible, which is why we've opted for AP Racing as the brake supplier," says Baldry. "Obviously last year we followed the dramas with the Brembo heat issues and know that AP Racing is on the majority of Formula 1 cars and has an offering for LMP1."

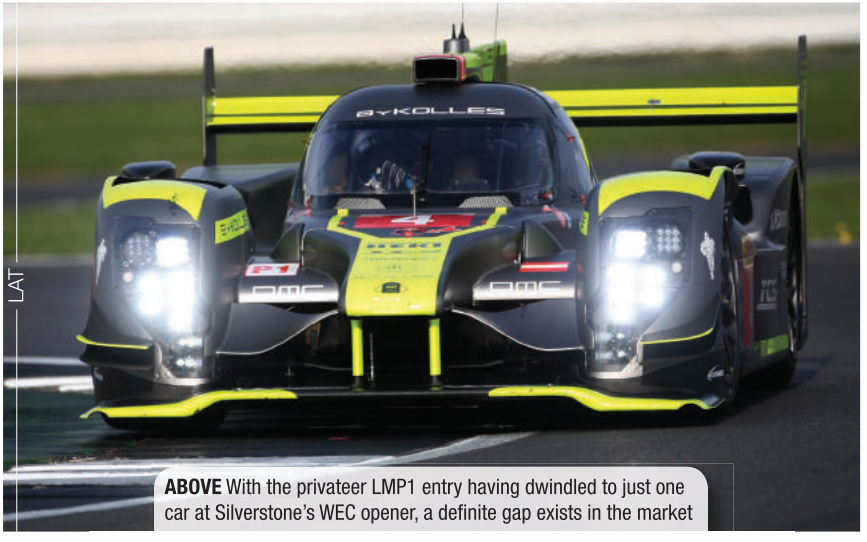
The front and rear suspension systems will be a relatively conventional layout with torsion bar springing, third element for heave control and adjustable anti-roll bar. Öhlins is providing the 5-way adjustable dampers.

Extensive testing is planned, recognising that performance and reliability gains will come from time invested in endurance testing on track, both in the UK and southern Europe. Ginetta will conduct a 30-hour test of the car to validate its reliability for Le Mans. It intends to engage with teams from the point of sign up and their development input will be actively encouraged.

"We want to rent circuits and invite our customers along to be involved in the experience in the early stages of the programme," says Baldry. "We want to work with teams and they are very much part of this development programme."

The rules have been fixed for a five-year period, until the end of 2022, but Baldry is designing the monocoque to future-proof it. "One of the things about LMP1 is the ability to continually improve it, although it goes with the danger of spiralling costs," he says. "The only way to ensure that LMP1 can survive is to offer an affordable system and give access to privateers and not just rely on the big manufacturers.

"We have to maintain a high level of competition for privateers and we have to guarantee that the price we ask covers our expenses but is not so extreme that nobody can afford it. It is our responsibility, along with the ACO, to ensure that it remains sustainable." RT



ABOVE With the privateer LMP1 entry having dwindled to just one car at Silverstone's WEC opener, a definite gap exists in the market

THE REAL-LIFE CRASH TEST DUMMIES

Chris Pickering discovers how motorsport is helping save lives on the road

WHAT has motorsport ever done for us? Much like Monty Python's misunderstood Romans, this loud, brash and unquestionably expensive sport can actually claim to have made a very positive impact on society over the years. And nowhere are its altruistic achievements more important than in the pursuit of safety.

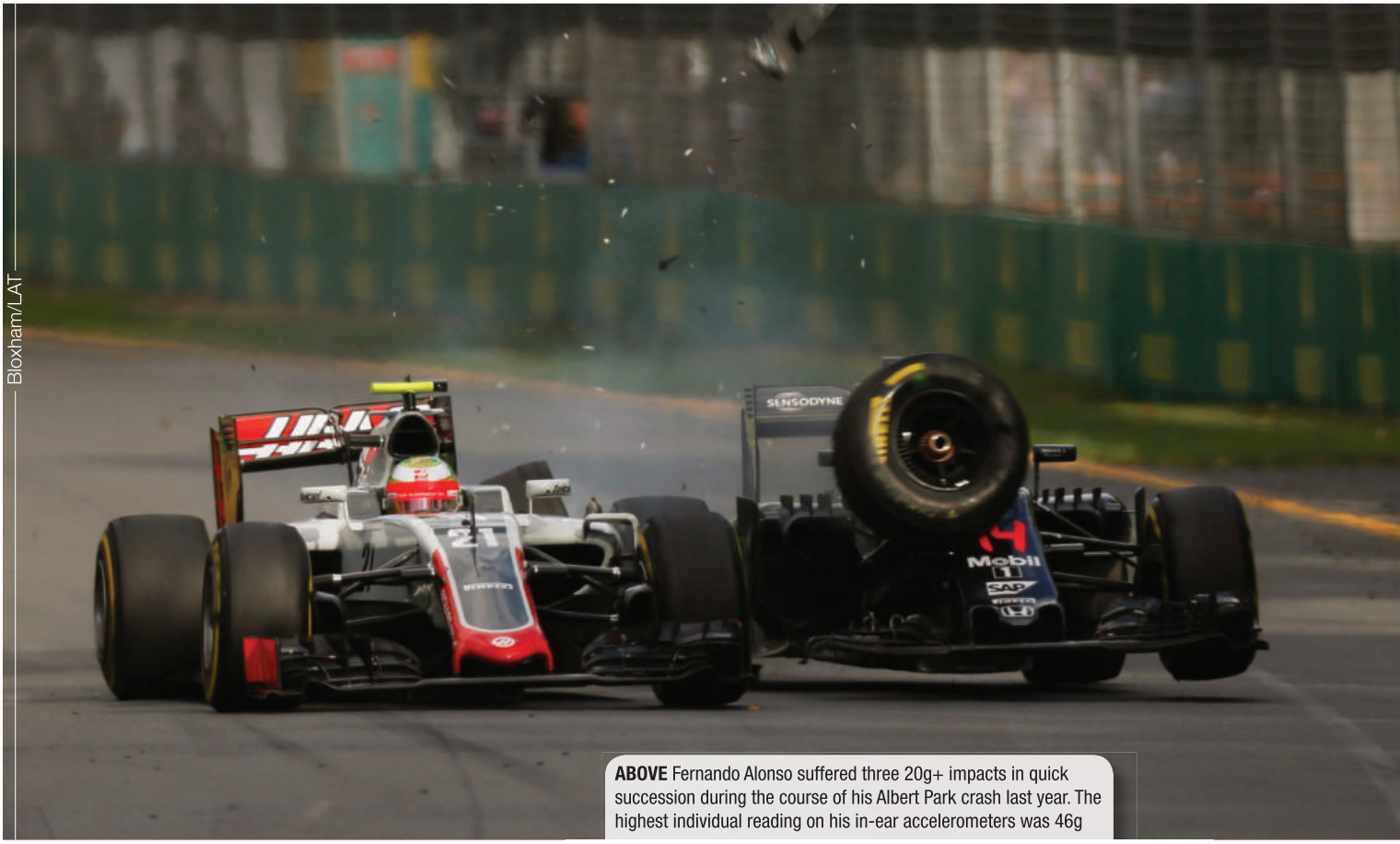
Historically, racing has been responsible for bringing features like disc brakes, composite structures and even the rear view mirror into the automotive industry. There's no doubt that direct technology transfer like that is rare these days, but motorsport is still helping to save lives on the road.

"Motorsport and road cars have diverged quite a bit, but the knowledge we've gained on how injuries occur in the car and how to protect drivers is extremely valuable," comments Peter Wright, technical consultant to the Global Institute for Motorsport Safety (GIMS) and president of the FIA Safety Commission.

It was once generally held amongst aircraft designers that the limit of human survival in an accident was around 18g. Consequently cockpits were only designed to withstand that sort of level of deceleration, on the assumption that there would be no survivors if the impact was significantly heavier. Opinions started to change in the late 1940s, however, when a US Army physician named John Stapp volunteered to strap himself into a rocket sled and put it to the test. On one occasion he clocked more than 46g with no significant injuries, but that's nothing compared to the peak figures that have been recorded in motorsport.

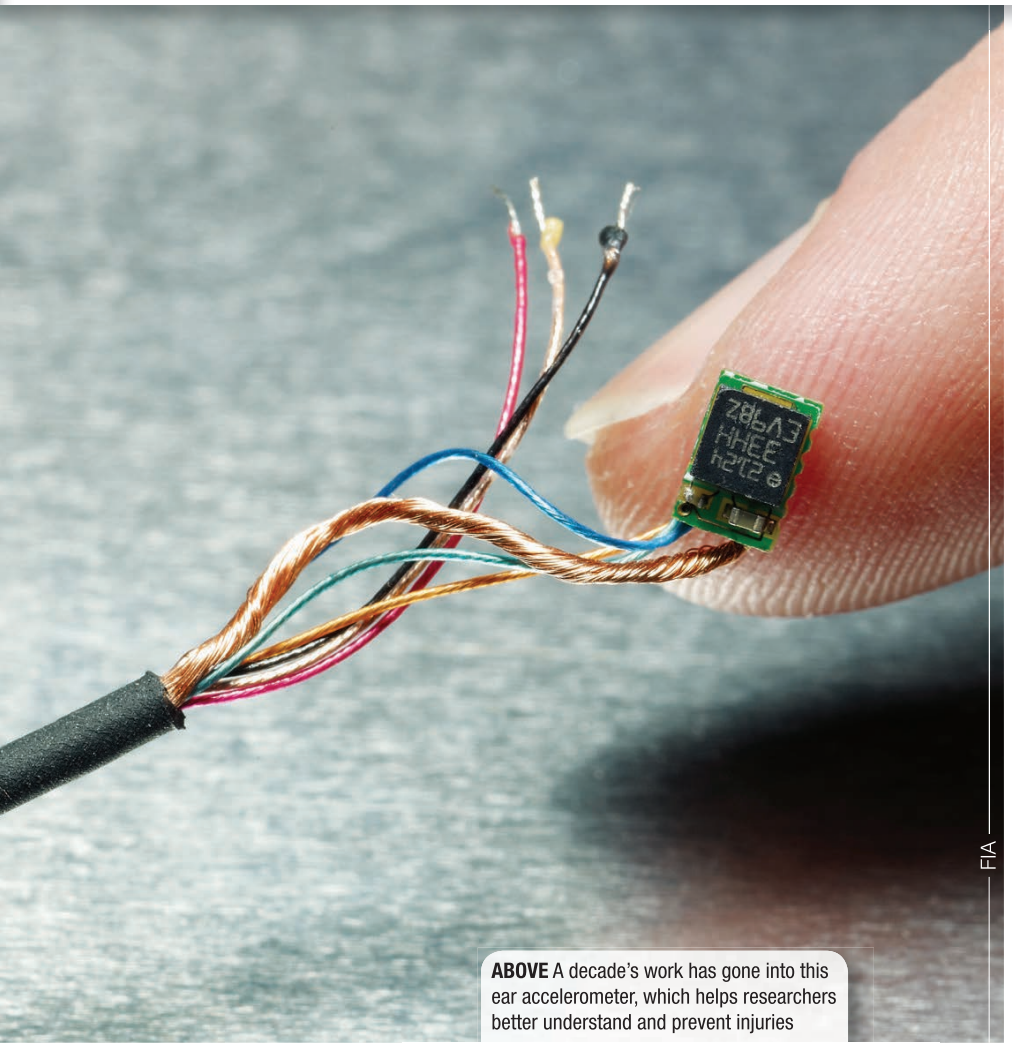
"Typically, in a road car, the aim of the structural design is to limit the impact g to the high 30s," says Wright. "In racing, however, the FIA's standard test for equipment is 70g. The expectation is that the driver will survive an impact of that sort of magnitude and hopefully walk away."

In 2003 IndyCar racer Kenny Bräck was doing 220 mph round the banking of Texas Motor Speedway when he locked wheels with another car, sending him spinning into a metal post. The onboard data logger recorded an instantaneous spike of 214g. And no, that's not a misprint. Although injured, Bräck survived and came back 18 months



Bloxham/LAT

ABOVE Fernando Alonso suffered three 20g+ impacts in quick succession during the course of his Albert Park crash last year. The highest individual reading on his in-ear accelerometers was 46g



ABOVE A decade's work has gone into this ear accelerometer, which helps researchers better understand and prevent injuries

> *"The onboard data logger recorded an instantaneous spike of 214g"*

later to set the fastest qualifying time at the 2005 Indy 500.

Admittedly, these figures are somewhat misleading. The effects of g-force depend greatly on the exposure, so a sustained 20g may prove fatal where a momentary 200g does not. Nonetheless, motorsport demonstrates just what the human body can endure.

"The wonderful thing about motor racing is that we have real-life crash test dummies who volunteer to take part," says Wright. "We have a lot of instrumentation these days, both on the car and on the drivers themselves. Formula 1 drivers, for instance, have a three-axis accelerometer in each earpiece. The cars now have very high speed cameras looking back at the driver, which capture the head and torso motion in an accident. It gives us lots of knowledge that you could otherwise only get in the laboratory with a mechanical dummy."

The rear-facing cameras on Formula 1 cars are visible as a ridge just in front of the cockpit. Supplied by Italian automotive giant Magneti Marelli, they record at up to 400 frames per second and send the video direct to the car's accident data recorder. The earpieces, meanwhile, use tiny accelerometers developed by ST Microelectronics, embedded in a silicon gel moulding that's designed to sit in a driver's ear canal. They're able to measure acceleration up to 400g very precisely, again sending the data direct to the accident data logger.

"As the costs come down I think we'll see impact measurements deployed into more and more categories," notes Wright. But already, some branches of motorsport have gone one step further with real-time biometric data. Formula 1 and Formula E have both experimented with biometrics systems that can log data such as heart rate, respiration and even perspiration. The aim here is principally to prepare doctors for what to expect when they attend an accident, but it all helps to build a more comprehensive picture of how the human body responds to trauma.

This data is allowing researchers to build up some very sophisticated finite element models of the human body. Toyota's Total Human Model for Safety (THUMS) represents state of the art. It can measure all the forces and accelerations on any part of the body in immense detail.

FUTURE OF RESEARCH

"We're doing research with Toyota on spinal injuries in motorsport," comments Wright. "That has definite contribution to road cars, because it develops the analysis techniques and improves understanding of the injuries. That's probably the biggest benefit – because we crash real-life people, we can take the results of those accidents and compare them to the simulations to improve the models. That's the future of vehicle safety research."

One issue that's a hot topic across a lot of sports currently is concussion. The problem is that there's very little known about the condition. It's very difficult to diagnose; the long-term effects of multiple concussions are not fully understood and neither are the forces involved in triggering concussion. Unfortunately – at least for them – racing drivers continue to be a useful source of data. Dario Franchitti, for instance, points to the cumulative effects of multiple concussions for prompting his decision to retire from racing in 2013.

It's not just impact safety that's benefitting from work carried out in motorsport, either. Things like electrical isolation and thermal management are highly relevant to drivers and engineers working in series like Formula E.

"When it comes to electrification, motorsport initially learnt quite a bit from the road car industry. Some of the findings have since fed back in to the road car industry, though," says Wright. "That's one of the reasons the major OEMs particularly like to be involved in electrified programmes like LMP1, Formula E and Formula 1; they do learn from them."

Ultimately, the most important thing to come from motorsport is knowledge; whether that's how to build a more efficient combustion system or how to feed 70g loads into a human being without injury. And that relationship looks set to continue, no matter how far the two industries diverge. RT

ABOVE Nightmare scenario: Helio Castroneves's flip was the first of three such incidents in the run up to the 2015 Indy 500. Behind the scenes, work was already underway to dramatically reduce the chances of cars flying

AP

A BUZZ IN THE AIR – NOT CARS!

As preparations ramp up for this year's eagerly-awaited Indy 500, **Simon Marshall** examines the lengthy process to add a life-saving part to the Indycar – and get it right first time

THE super-speedway car has been evolving over the last 20-odd years with some bodywork surfaces limited or removed by regulation, and others added or enhanced by the car constructors. Unfortunately, this eternal battle between the sport's gamekeepers and poachers also resulted in a car that was more susceptible to aerodynamic instability in a spin.

The same problem had afflicted NASCAR – which responded by adding top surface flaps to the cars – and sports cars. The WEC fin, domed skid and wheel arch top holes are all designed to help the lift-off problem. When I worked on the DeltaWing Garage 56 project for Le Mans, the FIA was so nervous about the stability in any direction that we had to prove, by CFD, that the car was safe.

At the Indy 500 an Indycar will weigh in at 1884 lb (854 kg including fuel and driver) and boast around 675 hp. The evolution of the species has resulted in ever increasing amounts of downforce to keep the car glued to the track at 200+ mph cornering speeds: currently about 2000 lb downforce and 700 lb drag at 200 mph.

Unfortunately, three car flips during practice and the race at Indianapolis in 2015 ensured that as IndyCar approached last season's showpiece 100th running of the Indy 500, safety was right at the top of its agenda. The proposed solution, conceived between GM (Pratt and Miller, PME), Dallara and IndyCar, was a pop-up flap devised to sit on the rear beam – the sturdy lower wing member mounted on the rear crash attenuator between the wheel guards – to keep the rear end of the car down while travelling backwards at high speeds.

The rear beam is normally quite invisible aerodynamically, even though it acts as an extension of the diffuser. It's really for the rigid mounting of the rear wheel guards but now the plan was for it to have a greater purpose. The trouble was, the governing body faced a race against time and knew that it had to get the answer right first time.

An important number for the safety study was the 'aerodynamic lift-off speed', with simulations of the car conducted in a specified range of attitudes during a spin. A few even included some provocation, with the nose or tail held a few degrees up.

For the 2015 season, using the Dallara DW12 surfaces as a baseline, Honda and Chevrolet designed their own aero kits using CFD, with well-defined goals for these minimum lift-off speeds. At IndyCar's behest, Chevy, Honda and Dallara had all undertaken CFD studies of the cars at all attitudes.

CFD can produce accurate results when the conditions are understood and can be verified with some common sense. Some validation was required. The matter of pure sideways lift-off was dealt with separately with the mandated reintroduction of the domed skid, its accompanying increased ride height, and the central spine gurney. The rearward and sideways cases are very separate at 180 deg and 90 deg, but at angles in between, there is a complex mixture of effects from all the added devices: the rear beam flap, domed skid, top surface centreline gurney, blanked off rear wheel guards and forward underbody holes.

ABOVE & BELOW The 'down-wind' rear beam flap upright, above, as the car rotates past 90 deg in Mikhail Aleshin's crash at the 100th Indy 500. The LH flap is hidden from the wind behind the LH rear wheel pod at this instant. Below, both rear beam flaps upright as the car continues to rotate

TEST #1: CFD

Since there was really no way to accurately duplicate these stability scenarios in any wind tunnel, virtually all the development for this device was done with CFD.

The homologation rules concerning the stability of the 2015 cars were set as a % delta to the 2014 baseline Dallara geometry. Dallara, Honda and Chevy each used diverse CFD code and methods, so everyone arrived at different results even for the common baseline case. Because of this, IndyCar specified that each should quantify changes from 2014 to 2015 as % delta to their own baselines.

You'll see from Figure 1 that the deployed flap creates very high pressure on the top surface of the beam wing, and a strong stabilizing moment. One issue with the deployed flap is that it also creates an increase in high pressure on the lower surface of the upper rear wing – which is one reason why a hinged upper wing could potentially help things – but, even so, the benefits outweigh the negatives.

Rearwards stability was not a criterion for homologation in 2015, so aero kit constructors just had to match the DW12 baseline. For 2016, they had to improve on the baseline for homologation: 15% for backwards flat condition, and 10% for backwards 3.5 deg tail up condition (without the beam flap).

Although work was ongoing throughout 2015, the whole issue was thrown into ▶

FIGURE 1 Cp (Pressure coefficient) as a fraction of the dynamic pressure. The first set of images are without the lower hinged flap. The second are with the flap deployed at 90 degrees

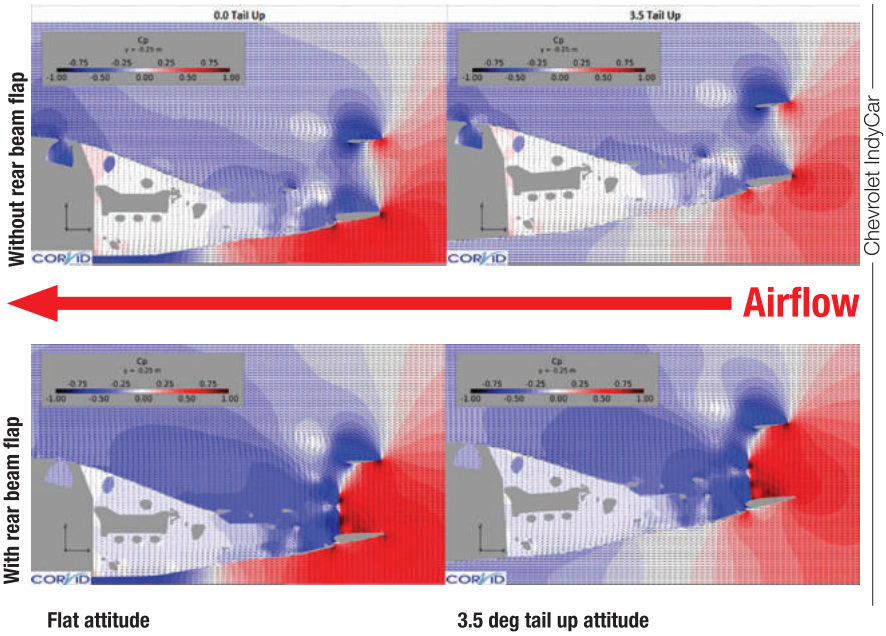


FIGURE 2 A critical speed summary for a few cases, based on PME CFD work

Description	Critical (take off) speeds (mph)			
	-180 deg/0 deg tail up	Delta to baseline	-180 deg/3.5 deg tail up	Delta to baseline
DW12 Baseline	178.4	-	196.4	-
I15 Indy Spec	179.3	0.9	200.7	4.3
I15 with closed rear wheel guards	203.9	25.5	232.7	36.3
I16 with lower rear wing flap deployed	214.6	36.2	279.4	83

sharper focus by a torrid run up to the 2015 Indy 500. Papers were trumpeting a 'crash crisis' after James Hinchcliffe ended up in intensive care after a bad crash. His was the fourth accident in a number of days after the Chevrolets of Helio Castroneves, Josef Newgarden and Ed Carpenter all got airborne following collisions. IndyCar's reaction was swift, with closed rear wheel guards implemented for the 2015 Texas race and beyond.

TEST #2

In September 2015, carbon versions of the rear beam flap were tested on a Chevy car at the GM Aero-Lab full-size tunnel in Detroit, with a 360 deg yaw turntable and 110 mph wind speed. It was quite a useful combination for this scenario.

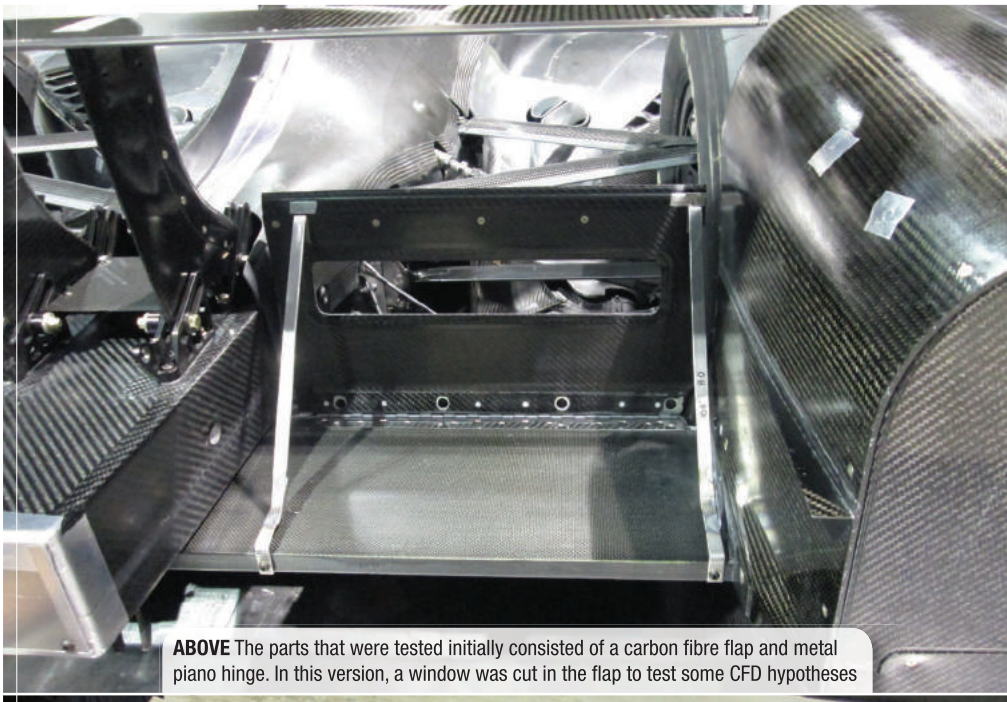
The straps limiting and restraining the flap position were fixed at pre-determined angles and tested at various (and continually adjustable) spin angles in the tunnel at 110 mph. This tunnel has a fixed floor but the stability cases generated in CFD with either fixed or moving ground created a high degree of discrepancy. The wind tunnel forces were cut by as much as 50% (with the car running forwards or backwards) compared to the CFD and racetrack measured results.

The improvement, or otherwise, of the de-stabilizing forces shown in either CFD or wind tunnel would, however, lead the development of beam flap deployment.

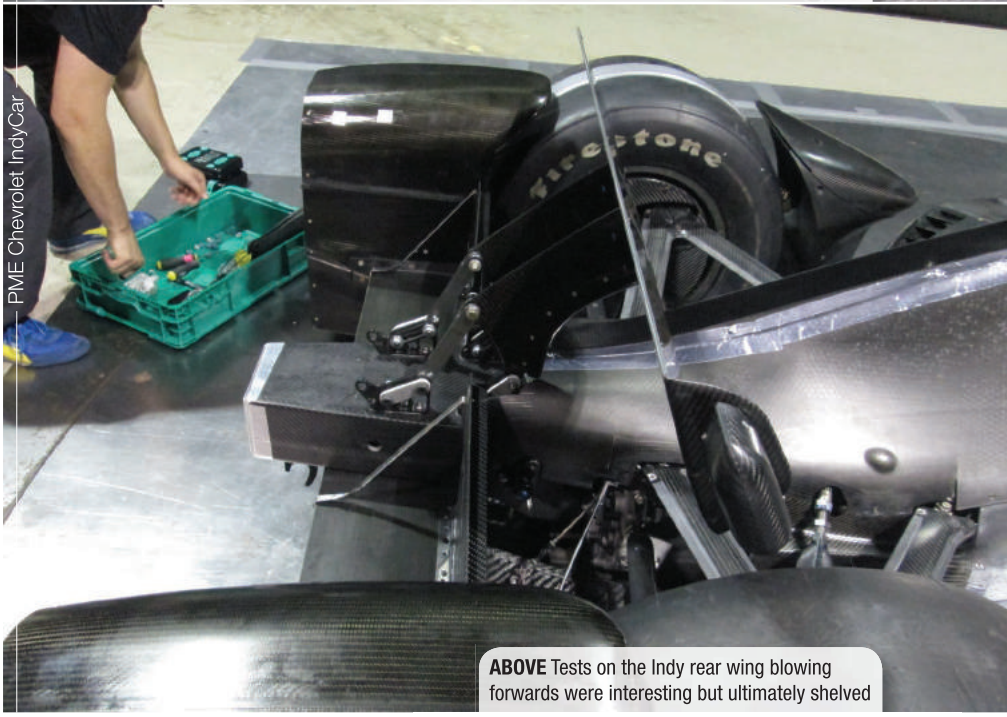
Both the wind tunnel and CFD assumed that there was no friction at the tyre contact patches (from a skidding tyre), which further clouded the issue. A car running backwards on track with the brakes on (or tyres locked) is less likely to take off. The moment of the tyre friction about the centre of mass opposes the aerodynamic moment trying to lift the back end off the track. The actual 'real world' take-off speeds are therefore likely to be higher than the simpler calculations assume. This actuality errs on the side of safety though.

The fixed angles tested were 60, 90 and 100 deg. All deployed angles showed improvement over the baseline lift-off speeds but the 90 deg case was marginally the best. The windowed flap shown in the pictures was slightly better for the minimum rear wing angle case, but not generally for any wing angle.

A further, more extreme, test involved the Indy rear wing blowing forwards to give the

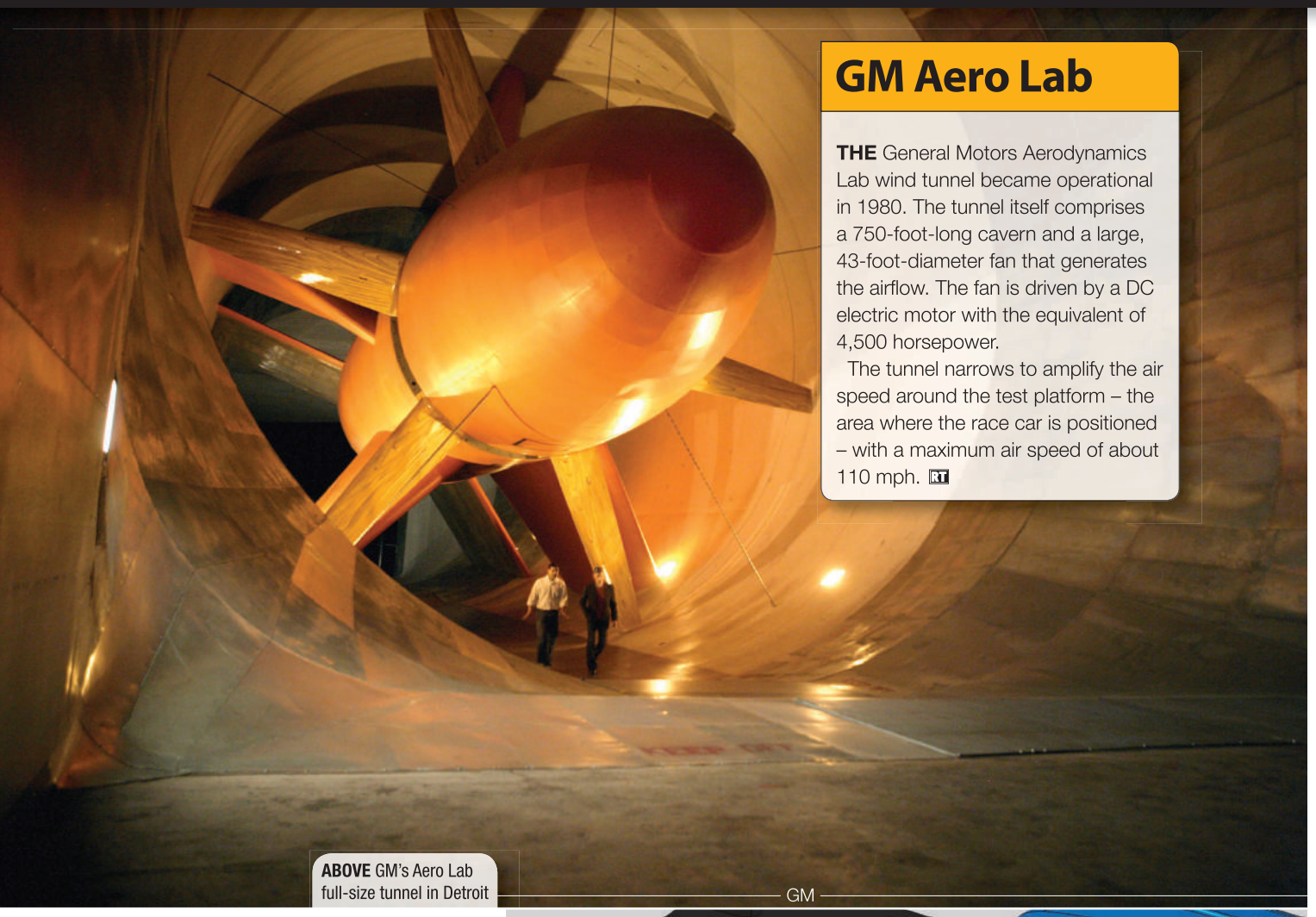


ABOVE The parts that were tested initially consisted of a carbon fibre flap and metal piano hinge. In this version, a window was cut in the flap to test some CFD hypotheses



PME Chevrolet IndyCar

ABOVE Tests on the Indy rear wing blowing forwards were interesting but ultimately shelved



GM Aero Lab

THE General Motors Aerodynamics Lab wind tunnel became operational in 1980. The tunnel itself comprises a 750-foot-long cavern and a large, 43-foot-diameter fan that generates the airflow. The fan is driven by a DC electric motor with the equivalent of 4,500 horsepower.

The tunnel narrows to amplify the air speed around the test platform – the area where the race car is positioned – with a maximum air speed of about 110 mph. RT

ABOVE GM's Aero Lab full-size tunnel in Detroit

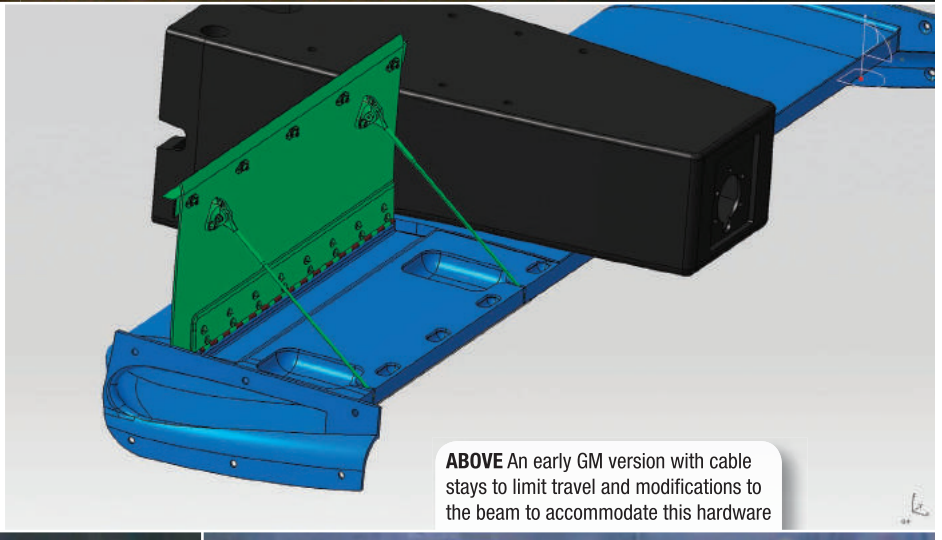
GM

same effect as the flap. It wasn't particularly good on its own, but did enhance the effect when the flaps were also deployed. The trick didn't seem to work with the larger Dallara speedway wing, and installation would be complicated, so the idea was shelved. An interesting concept though…

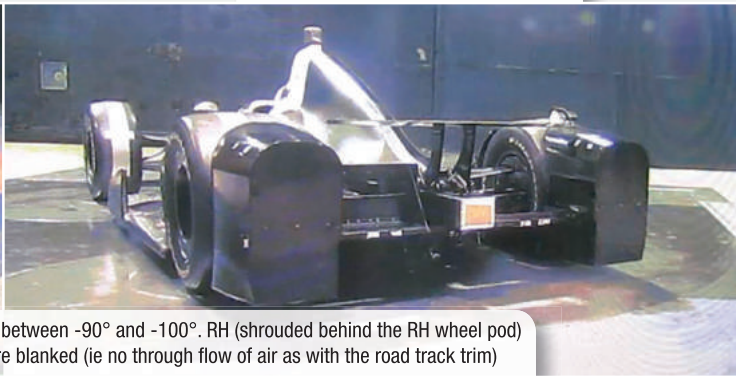
TEST #3

A full-size dynamic test was undertaken at GMAL, with cable restraints, in September 2015.

The fixed flap stays were replaced with cables, of varying lengths, in order to test both the car rotation and flap deployment dynamically. The wind velocity was set to ▶



ABOVE An early GM version with cable stays to limit travel and modifications to the beam to accommodate this hardware



LEFT & RIGHT Dynamic rear beam flap activation. LH side opens between -90° and -100°. RH (shrouded behind the RH wheel pod) opens between -130° and -165° yaw. The rear wheel guards were blanked (ie no through flow of air as with the road track trim)

110 mph, and the car was rotated.

Short cables were used to limit the angle of deployment and therefore the load on the flap while determining the activation speed and characteristics. Long cables were then used to achieve the full 90 degrees when deployed.

The cables actually interfered with the free deployment of the flaps due to their stiffness, some hardware binding and difficult packaging. A new limiting restraint would have to be developed.

Closing the rear face of the wheel guards had a big effect but it was not mandatory that they remain closed in 2016, as long as stability targets were met. Nevertheless, both manufacturers decided to keep them closed in some fashion to help with take-off stability. Honda closed front and rear surfaces; Chevy closed the front only, although this is effectively the same thing.

Like almost everything aerodynamic, there was a trade-off. The blanking reduced Indy lap speeds by about 2 mph but, as both aero kit constructors were taking the responsible path, IndyCar could always turn up the turbo boost to tune lap speeds!

TEST #4

In October 2015, a full-size rear wing assembly (only) test was conducted at the Texas A&M tunnel with the speed range planned from 0 to 230 mph. Tethers limited the travel, but they were still difficult to package and inconsistent in deployment.

The lowest speed that the flaps would 'flip up' was a mere 15 mph and they would drop back down at 9 mph. This was illustrated at Pocono later in the 2016 season, where gusts of wind would raise the flaps with the cars stationary in the pit lane!

The entire rear wheel guards were incorporated in this test, but they proved to shake quite badly. The mountings on the rear beam are quite capable when the full car is travelling forwards, but the backwards-facing bluff body created a lot of turbulence, that may or may not be properly replicated by CFD. The blockage of the tunnel was also severe in this bluff condition and the wind was not able to reach the 230 mph goal.

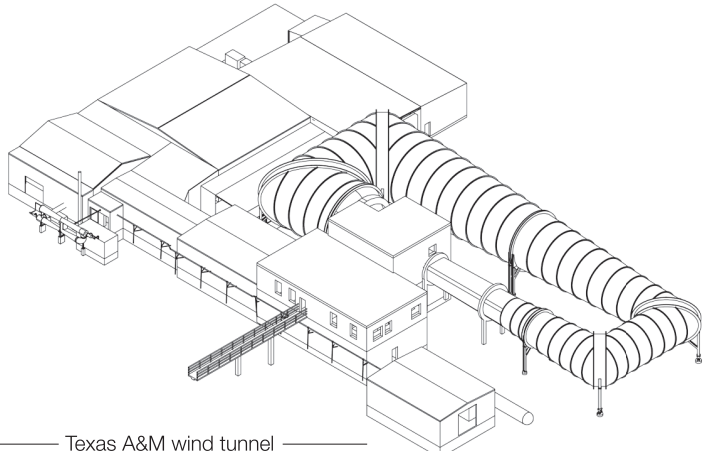
The flaps were allowed to flip up freely with high wind speed and the air flow was introduced gently as the assembly rotated, so the parts weren't subjected to the most extreme conditions imaginable. ▶

ABOVE & BELOW The rear assembly was rotated about the Z axis while the wind was 'on'. Some damage can be seen to the LH flap, below, leading to stronger parts and restraints for the next test

Oran W Nicks tunnel

TEXAS A&M University's Oran W Nicks low-speed wind tunnel is a fixed ground tunnel, with boundary layer suction. The working section is 7 ft tall, 10 ft wide and 16 ft long. Wind speeds are up to 230 mph.

It was built in the 1940s as an open loop (closed section) tunnel, and converted into a closed loop in the '60s. The tunnel reportedly gives high accuracy and repeatability, plus a very high wind speed and good value for money! RT



Texas A&M wind tunnel

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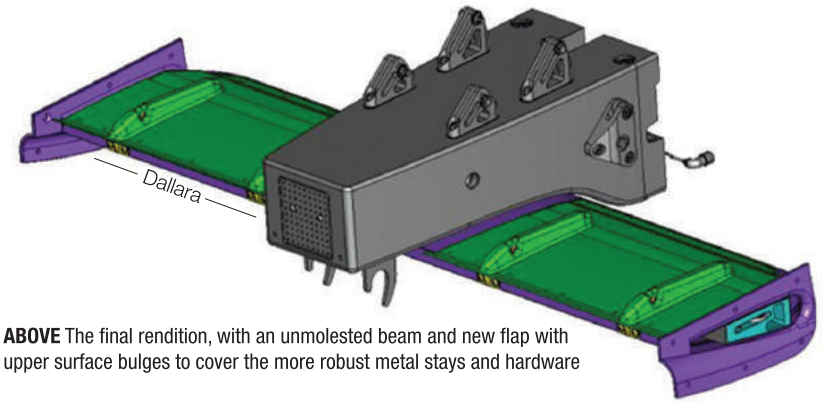


ABOVE The final rendition, with an unmolested beam and new flap with upper surface bulges to cover the more robust metal stays and hardware

TEST #5

Test five took place at the Texas A&M final test on Jan 5 2016.

In January 2016 the full-size full-speed (230 mph) 'slam' test was conducted in the Texas A&M tunnel, to confirm that the device would do its job on the race car at full speed. Only a 180-degree attitude was tested for this final sign-off.

At this time, the flaps had a Dallara-developed fabric and rubber hinge replacing the piano hinge, as an improvement to their robustness. Dallara also added the more precise scissor stay and top surface stay pods to the design, also improving some composite details to increase strength.

The full rear wheel guards were replaced with only the inner wall of that part, to cure the tunnel blockage and turbulent shaking problems of the previous test.

From the outset, the trailing edge of the flap extended past the beam element, with an upturned lip to help trigger the raising of the flap. However, the trailing edge did increase the drag of the car by about one point (nominally around 1 mph at Indy).

The parts were deployed at successively higher speeds, to 'creep up' on the ultimate full-speed test. Some damage was sustained during the repeated testing, but as there was nothing to lose, and plenty to learn, the tests continued, come what may. It's brave of the Texas A&M staff to allow a potentially destructive test in the wind tunnel!

It's unlikely that the car would still be travelling at 230 mph in a spin past 90 degrees when the flaps start to deploy but it is a good worst case scenario.

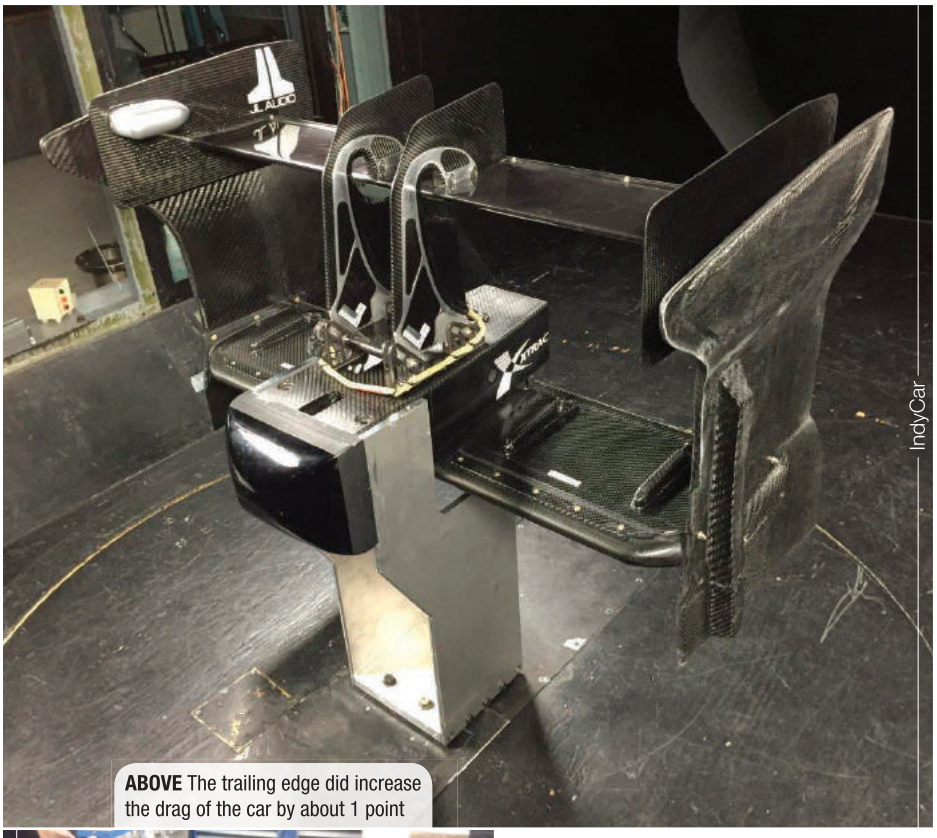
The final tunnel test was planned to gauge how the parts would react dynamically at full speed. The force on the flap at 90 degrees (180 deg 'car' rotation) at 206 mph can be easily deduced from the live wind tunnel data.

The result is that the lift of the (backwards) wing was reversed and the assembly made significant downforce, and the drag was increased by 328 lb. As this is a remote test, the effects on the full car can't be appreciated.

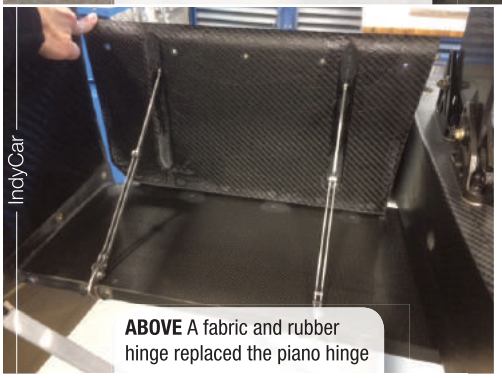
This wind tunnel balance is very accurate, but is heavily damped, so the peaks of downforce and drag data coincide with a reduced wind speed, as the fan was shut off immediately after deployment.

In actual fact, the effect on the full car is more like adding 500 lb extra rear downforce, and the 328 lb drag addition was more like 650 lb drag at 230 mph through extrapolation of the CFD data.

Each flap is subjected to 186 lb of drag force. The severity of statically restraining the flap at 230 mph had caused some problems in the previous test, so the dynamic problem would be more severe.


IndyCar

ABOVE The trailing edge did increase the drag of the car by about 1 point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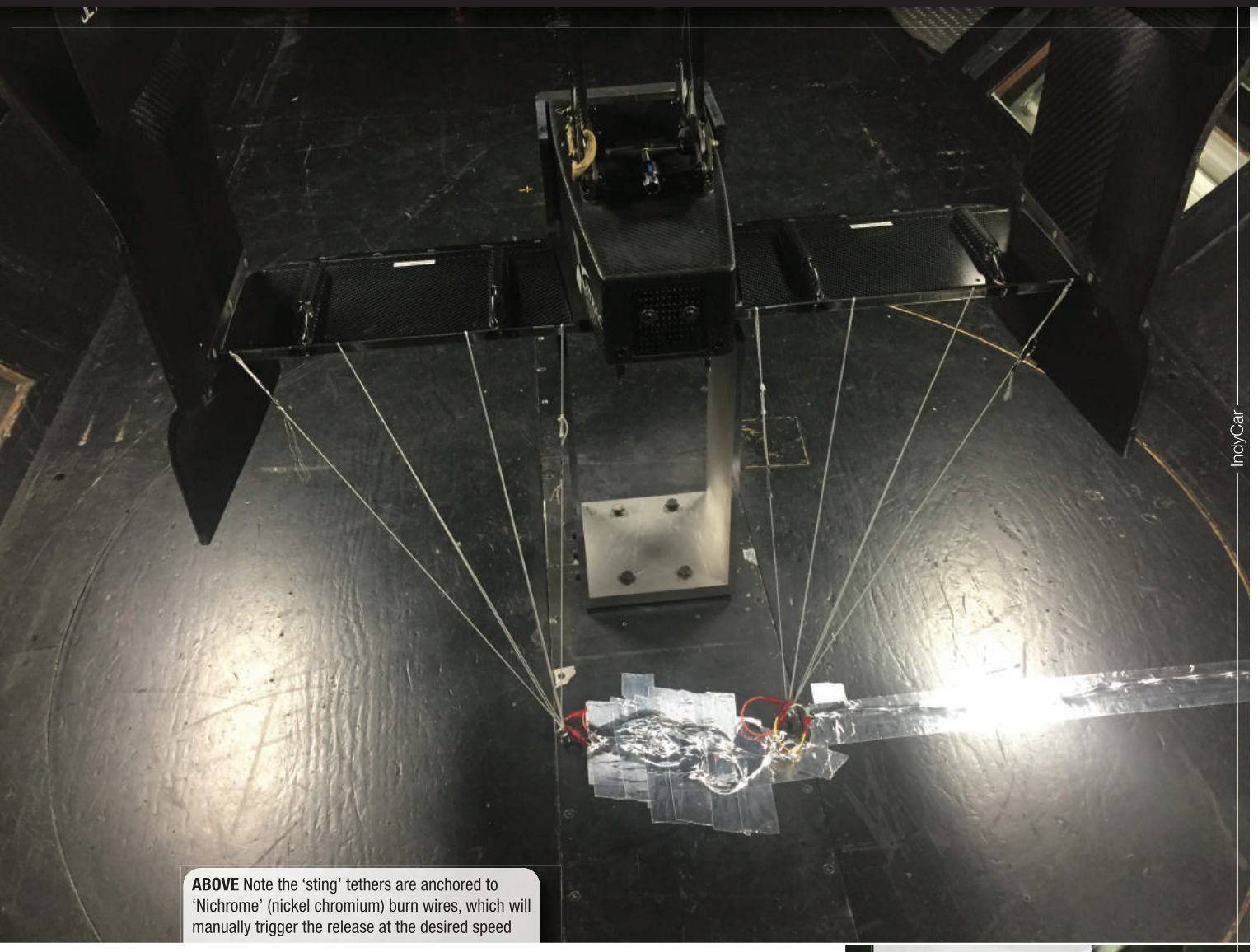
ABOVE A fabric and rubber hinge replaced the piano hinge

FIGURE 3 Live wind tunnel data

SPEED MPH	206 mph before deployment	231 mph just before deployment	206 mph after deployment	Delta
LIFT or downforce lbf	-53 lift	-94 lift	273 downforce	+367 lb DF
DRAG lbf	156	200	528	+328 lb drag



IndyCar

ABOVE Note the 'sting' tethers are anchored to 'Nichrome' (nickel chromium) burn wires, which will manually trigger the release at the desired speed

> *"The addition of the rear beam flap raised the calculated 180 deg lift-off speed from 204 mph to 215 mph"*

MISSION ACCOMPLISHED

Thus a lengthy, deliberate process that began in mid-2015 was finally ready for action in time for the 100th running of the Indy 500 in May 2016. The extensive testing was complete but, under the glare of the media spotlight, would the beam flaps deploy when it really mattered on the racetrack?

As events transpired, the answer was an emphatic 'yes': they popped up, as designed, for incidents involving Spencer Pigot in practice, Pippa Mann in Qualifying,, Alex Tagliani in Q2 and for Juan Montoya on lap 63 of the race.

Without this new device, the rearward (rotated 180 degrees) lift-off speed was, by CFD calculation, approximately 204 mph in 2015 Indy trim with closed rear wheel guards. Also notable is the 135-degree rotation attitude (past 90 deg, on the way to fully rearwards) which has an even stronger tendency to lift off. This was shown by CFD, tunnel testing and on-track experience.

The addition of the rear beam flap raised the calculated 180 deg lift-off speed to 215 mph.

Interestingly, CFD runs indicated that the car has a stronger tendency to lift off at the rear with the car flat on the ground, than with the rear of the car lifted up by 3.5 deg. This may seem counter-intuitive but it does illustrate the complexity of the full car aerodynamic model.

BELOW View from rear at max speed before flap deployment

BELOW View from rear at flap deployed: max drag condition

NEW GAME OF THRONES FOR THE STAGE KINGS

Having conquered the World Rally Championship, Volkswagen Motorsport's engineers have followed their counterparts at Peugeot, Ford and Audi into World RX. **Hal Ridge** quizzes the manufacturer's technical director about the transition

THE future for Volkswagen Motorsport's Hannover-based engineers didn't look bright last November, when the German marque made the shock announcement that it would withdraw from its hugely successful four-year World Rally Championship programme with immediate effect.

The news got worse still when efforts to run privateer 2017-spec Polos in the WRC for customers were blocked.

But then, a ray of light emerged in the shape of a deal to build a pair of Volkswagen Polo GTi Supercars for double-champion Petter Solberg and new PSRX Volkswagen World RX Team Sweden team-mate Johan Kristoffersson to campaign in the FIA World Rallycross Championship.

Time was tight, but the dominant force of the WRC in recent years had something to focus on again. In only three months the Polo GTi Supercar was tested and developed to take on a competitive field in World RX, which in 2017 includes four manufacturer-supported teams, Volkswagen joining Audi, Peugeot and Ford.

To say that VW Motorsport built a totally new car in that period isn't true, but they themselves are not suggesting that. The car that rolled out for round one of World RX in Barcelona is not only a creation based on existing know-how from the multiple-title winning stable, but an idea that has been floated in secret in Northern Germany for some time.

"World RX is a growing FIA championship, so it's a good way to bounce back after what happened last year for us. A new series is always interesting; there are new things to discover. We like the challenges and in some ways there is more freedom (in World RX) than in the WRC, so it's nice to engineer," explains Volkswagen Motorsport technical director, Francois-Xavier Demaison, known as FX. "This project was a very big help to

ABOVE Hot property: The Polo GTi Supercar, developed from the platform of VW's 2014 double title-winning rally machine, has already laid down a marker with its early pace

keep most of our engineers. Our designers were busy for the last three months on this project, which shows them that there is a future for us. Even if we stopped in the WRC, this is an interesting project and most of them are still with us. Don't get me wrong, of course we did not put all of the WRC team on the WRX project."

Well versed in the World Rally rule book, like many engineers and designers that have entered the land of rallycross in recent years, Volkswagen Motorsport is exploring the relatively open nature of the regulations. While cars have to be fully homologated for the WRC, with a few jokers (three engine and three chassis) allowed to be played to make changes, rallycross regulations are significantly less restrictive, in both architectural design and the frequency that those designs can be changed.

In any aspect of life, it sometimes takes an outsider's view to spot things that may have been overlooked by those immersed in a subject. Volkswagen is the new kid on the block in rallycross, and is approaching the challenge from a fresh angle.

Traditionally, rallycross Supercars have the cooling package moved from the front to the rear for a number of reasons, including being able to fit a larger intercooler in the front of the car, make the radiator less vulnerable from inevitable racing contact and flying stones, and to affect the weight distribution of the chassis. In the Polo however, the cooling package remains in the front.

With fresh eyes on the subject, Volkswagen Motorsport hasn't seen the need to follow that tradition. "It's much more simple," says Demaison, when quizzed about the reasoning behind that decision. "There is all the water, the pipes, the extra ducts [with running the cooling package in the rear]. We will have both options – that is the nice part of WRX, you don't have a homologated car [so] you can adapt to the conditions and there are different solutions."

> *"Maybe I did not read the rules properly or maybe it's interpretation"*

When images of VW's first test with the rallycross Polo broke, from Loheac in France, in January, the car outwardly resembled a WRC machine, without any of the usual rear-radiator ducting in the bodywork. Low quality images from further tests showed the development mule with ducts in the rear quarters. But, in reality, a rear cooling package is yet to be tested.

BUCKING THE TREND

"No," says the French engineer, who previously worked with Solberg in the Subaru World Rally team and the Norwegian's own private WRC effort, when asked if Volkswagen has even tired mounting the radiator in the rear yet. "Probably we made a mistake, we put it in the wrong place… whoops!" he laughs, attributing the stickers on the rear quarters of the car in testing to a mechanic: "That was bit of fun; it was a mechanic's initiative."

Although the German outfit would like to maintain the front-mounted cooling package, such is the nature of the regulations that, should it need to, the team could swap between a front- and rear-mounted setup depending on the ambient temperatures or characteristics of an individual event or the construction of the unsealed surfaces (big gravel/sand or fine stones etc). One of the biggest problems ▶

FIAWorldRallycross.com

ABOVE The Polo GTi impressed on its World RX debut at Barcelona

with the race environment rather than rally is the potential for flying objects hitting the radiator, or overheating from following another car closely.

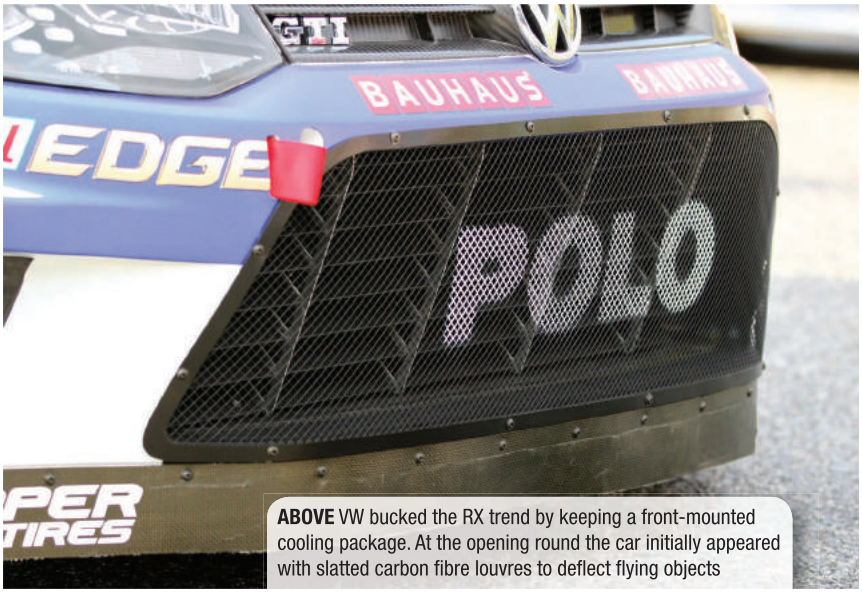
Asked if the newly-formed team has used Solberg's title-winning Citroen DS3 for helping with the development of the Polo GTi, and if it has simulated races with the car to reproduce following in a car's wake, Demaison replies: "Yes, we tested with that car [the DS3] as well. It would have been stupid to not [simulate a race]."

The Polo did indeed work with its existing setup in the opening round of World RX in Barcelona. Initially the large grille in the front bumper was fitted with slatted carbon fibre louvres, to deflect potential flying objects, but the louvre arrangement was removed during the event, presumably to allow for increased airflow. "We will see [about trying a rear-mounted radiator], it depends how it goes," he concedes. "If we don't need to, then no. When it's cold like this (in Barcelona), I don't think it's an issue. Later in the season when it's a bit warmer, we will see."

In the 1.6-litre WRC Polo, the radiator and intercooler are arranged in a side-by-side configuration, but in World RX, one sits in front of the other. "The dimensions are free in WRX, so we went to the biggest possible," explains Demaison.

Behind the cooling package sits the transversally-mounted, four-cylinder turbocharged engine, liberated from the American-based Global Rallycross Championship Volkswagen Beetle Supercar. Built by Volkswagen Motorsport for Andretti Autosport to run in the series, the Beetle has claimed the GRC title in 2015 and 2016 with ex-Formula 1 driver, Scott Speed.

Initially launched with a 1.6 TSI engine in 2014, Volkswagen Motorsport switched the Beetle's engine to a 2.0-litre TSI unit for 2015 and it's that motor that has been used in the Polo GTi. In specifications released by Volkswagen, the engines used in the two cars differ slightly, but with World RX starting earlier than GRC in the year, both may run the same evolution. The Polo boasts 570 horsepower with 650 nm of torque, with the bore and stroke at 86 mm. FIA World ▶



ABOVE VW bucked the RX trend by keeping a front-mounted cooling package. At the opening round the car initially appeared with slatted carbon fibre louvres to deflect flying objects

Rallycross regulations stipulate that a 45 mm air restrictor in the turbo must be used.

"We have great experience with this type of engine in the US with our Beetle GRC, so we used it here also," says Demaison, who although won't commit to any updates to the engine for 2017, says it's an ongoing development. "For sure, year after year we do some changes, that's normal."

One significant difference to date between GRC regulations and the FIA-sanctioned World RX series has been the implementation of homologated ECUs and software in World RX (featured in RT186), to prohibit any potential use of traction control systems. For this reason, Volkswagen has switched to a different Bosch engine management system for the Polo GTi: "We have a different ECU here, yes. We actually use the ECU from the 2017 WRC car." As per current World RX regulations, the Polo will also run a fly-by-wire throttle.

Aside from the engine and cooling package, the majority of the Polo GTi is heavily based on the 2014-specification WRC-winning Polo, chosen because that was the last year in which the WRC didn't authorise paddleshift transmission. "We had to modify the transmission because going from 320 horsepower to 570 for sure means you can't use the same, so we reinforced it," says Demaison, who won't commit to specific details about the gearbox and multi-plate limited-slip differentials used in the Polo.

RALLY ROOTS

In the history of rallycross, many teams and drivers have employed the use of adapted rally cars. Notably, Group B machinery outlawed from the stages in 1986 found a home in the mixed-surface sport, doused with even more power. More recently the Peugeot-Hansen team first used an R5 208 chassis for its Supercar base and a number of teams have used a similar R5 Fiesta to form the basis of their World RX challengers. Those teams generally use that knowledge as a platform to build more bespoke rallycross machinery from.

Some outfits using rally equipment have struggled with breaking components, such as steering arms, designed for turning the wheels under specific loads on a rally stage and not for inevitable wheel-to-wheel contact in rallycross, as the MJP Racing Team Austria outfit found with its Fiesta. Demaison doesn't think there is currently a requirement to strengthen the WRC-spec suspension or steering on the Polo. "The chassis is exactly the same," he says. "It's purely WRC, the ▶

Polo GTi Supercar spec list

Bodyshell	VW Motorsport
Engine	VW Motorsport
Engine management	Bosch
Brakes	Alcon
Dampers	ZF
Wheels	OZ Racing
Seat	OMP
Steering wheel	OMP
Harness	Schroth Racing
Fuel	P1*
Tyres	Cooper*

*World RX control fuel/tyres

Hal Ridge

ABOVE In the World RX car the intercooler and radiator are arranged one in front of the other, where in WRC guise they sat side-by-side

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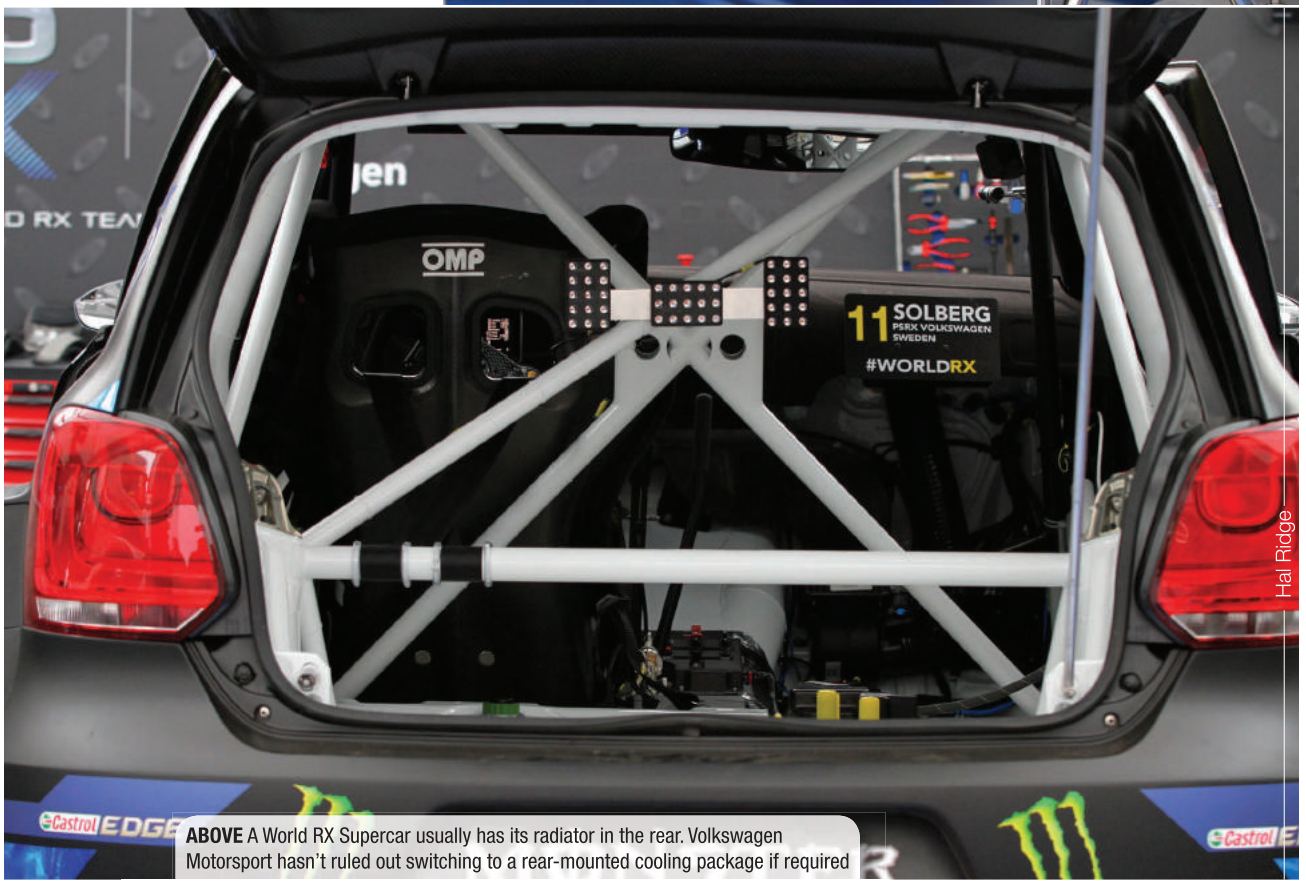
kinematic and suspension. The dampers, uprights, wishbones, steering arms are all WRC, everything. Fingers crossed [that it will survive the rigours of rallycross].”

With its 2017 WRC cars banished to its Hannover workshops, for the time being at least, those cars have offered some parts to the rallycross project. But Demaison says the knowledge gained from developing the latest rally challenger hasn’t been particularly transferable to the new venture.

“We cannibalised our ‘17 cars in the workshop a bit to do this [rallycross car],” he says. “In terms of aerodynamics the ‘17 WRC car is much more free than in World RX, and the track width is completely different because the rules are different. In WRC it’s a fixed width (previously 1820 mm now 1875 mm); in World RX you start from the standard car and add 140 mm. By chance I think we ended up with 1820 front and 1817 mm at the back so we are very close to the WRC width. We just modified the bodywork to fit the [17” OZ Racing] wheels.”

In rally trim, the Polo had approximately 180 mm of suspension travel for tarmac events and 275 mm on gravel. As rallycross is a combination of the two surfaces, the amount of travel is roughly in the middle. The GRC Beetle has 240 mm. “I ▶

ABOVE & BELOW The WRC brakes are swapped for Alcon’s lightweight rallycross setup. A future bespoke World RX car might move away from the Polo’s MacPherson suspension



ABOVE A World RX Supercar usually has its radiator in the rear. Volkswagen Motorsport hasn’t ruled out switching to a rear-mounted cooling package if required

Hal Ridge

From monster Beetles to American dream: VW in rallycross

WHILE PSRX Volkswagen Sweden's 2017 programnme is Volkswagen's biggest involvement yet in the World Rallycross Championship, cars from the German marque have been winning at international level since the inception of the European Rallycross Championship in 1973.

Indeed, Franz Wurz, father of double Le Mans winner Alexander, finished third in the first ever European Championship (although not FIA sanctioned) in a 2.2-litre Beetle 1302. He claimed the title himself a year later, with an additional 200 cc extracted from the engine.

With a Porsche Carrera engine in a Beetle 1303, Dutchman Cees Teurlings then won the Euro title in 1975.

German Jochi Kleint raced a Volkswagen Motorsport Mkl Golf 1.6 GTi to glory in the German Rallycross Championship in 1978 and finished 11th in the European series.

The late John Button (father of Jenson) raced a 2.1-litre Beetle before switching to a Mkl Golf, while Peter Harrold competed for several years in a similar car (featured on the cover of HRT8) which also achieved national-level success in four-wheel drive trim, fitted with a Subaru-based engine. The same car is still used today by his nephew, James. Swede Mikael Nordstrom was also a Beetle stalwart and raced several times in the Rallycross Grand Prix at Brands Hatch with a four-wheel drive car producing over 500 horsepower from its turbocharged engine.

Norwegian Egil Stenshagen claimed back-to-back Division 1 titles in 1982 and '83 in a Golf GTi, while Belgian Ronny Scheveneels won the Group N title in a Mk3 Golf in 2001.

The 1.6 16v Polo starred in the Division 2a category in 2002 when Czech driver Ales Zazvorka headed an overall podium lockout for the car. Polish driver Krzysztof Groblewski won the Super1600 title in a similar car using a more developed version of the 1600 cc unit in 2006.

Marklund Motorsport introduced a Polo Supercar to the European Championship for 2013 with a longitudinally-orientated engine and transmission and a Gunnarsson Motorsport chassis with double-wishbone suspension. Anton Marklund first raced the car, while Swede Mattias Ekstrom claimed its first podium on his European Rallycross debut at his home event, Holjes, the same year.

World RX wins came in 2014 courtesy of Tanner Foust (who drives the Beetle in GRC today) and Toomas Heikkinen while versatile racer Tommy Rustad claimed the European title with the car in 2015.

Kristoffersson Motorsport introduced MacPherson suspension-based cars – Johan Kristoffersson claiming the first win for that version in Portugal 2015. Both of the Swedish Polos were fitted with Trollspeed-built 2.0-litre 16v engines.

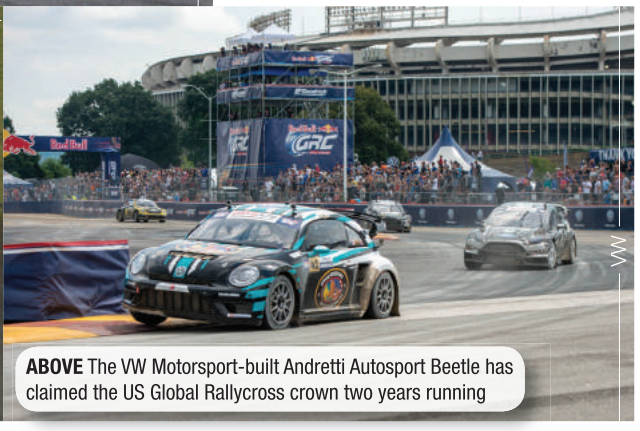
Rally and rallycross legend Per Eklund, who had raced the ex-Kleint Golf in 1980, built a new-shape Beetle Supercar at his Arvika-base in Sweden in 2014. Unlike the Andretti Autosport-run Volkswagen Motorsport-built version of the car introduced just before Eklund's for the American-based GRC series, his version of the car features a longitudinally-mounted 'Custom Engine', a Sellholm transmission and Reiger suspension. Andretti's Beetle, built by Volkswagen Motorsport, has claimed back-to-back GRC titles in the hands of ex-Formula 1 driver, Scott Speed.

FIAWorldRallycross.com

ABOVE A synchronised flying display from the Polos in 2015

Tim Whittington/RallycrossWorld.com

ABOVE Mikael Nordstrom's turbo Beetle, with four-wheel drive and over 500 bhp on tap, leads the way at Brands Hatch in 1985



VW

ABOVE The VW Motorsport-built Andretti Autosport Beetle has claimed the US Global Rallycross crown two years running

FIAWorldRallycross.com

don't think we need as much as WRC and travel is weight, so on the WRX car we are somewhere between the Beetle and WRC," says Demaison. The MacPherson suspension with lower control arms (made by ZF) is also from the rally car.

TYRE MANAGEMENT

An integral part of any competition car's setup is the tyres, as the contact patches with the road. In rallycross, Cooper Tire-manufactured crossply rubber is mandatory, as opposed to the radial rubber used in rallying. With eight tyres assigned to each car for an event, tyre management is becoming critical in achieving success in World RX. "All the tests we did were in the winter so we have a pretty good idea in cold conditions, but we have still a lot to learn," cautions Demaison. "We're still testing and learning, the cars, the tyres and World RX. Give us a few races and we will be stronger."

The WRC brakes are swapped for a more rallycross-suitable package, Solberg's link with Alcon in developing its lightweight rallycross setup continuing into the Polo GTi. Four-pot aluminium callipers and 325 mm vented discs are used front and rear. "We don't need such big brakes as in WRC," says Demaison. "They are big in diameter but there is no real heat problem in rallycross, so we have smaller callipers. Alcon have a very good lightweight package."

Other changes to the car have included a smaller (25-litre) fuel tank, which sits under the floor behind the driver. As the Polo is up there with the most developed and successful rally cars of all-time, such minor changes don't affect the balance of the chassis, now with a 1300 kg minimum weight in World RX. "We always have things we can move around to compensate," confirms Demaison. "Motorsport is the World Championship of ballast. I read that Mercedes has to find weight on their (F1) car because they can't carry enough ballast. It's the same problem for all of the racing engineers, they want to put the ballast where they want."

The Polo GTi impressed on its debut in World RX, where Kristoffersson set the fastest time in its first ever Free Practice session, and the first qualifying race. Both drivers made the final and the squad left the opening round of the year leading the

VW

ABOVE The shelved 2017 WRC car has been cannibalised for the World RX project

LEFT & ABOVE The car's pace in round 2, in Portugal, where its fastest time beat all rivals, further underlined the threat VW poses to the established World RX order

FIAWorldRallycross.com

> *"There is no miracle in motorsport. We need time to be at 100%"*

Teams' Championship. In Portugal for round two, the Polo GTis set the pace. Had it not been for a missed joker lap by Kristoffersson in Q3 and a puncture for Solberg in the final, the eventual third place finish (and the squad's first podium) for Kristofferson could well have been a dominant one-two. Regardless, the squad extended its Teams' Championship margin.

But, despite the obvious pace of the car, Volkswagen Motorsport has only just begun its World RX development process. "We hope that we can put some engineers to really try and define the best concept to use the rules. It's planned in the next months to try to do this, to really optimise the rallycross car," says Demaison, who confirms that in a more bespoke rallycross concept, the German firm may move away from a MacPherson suspension setup and even the current Polo chassis.

"For sure if we have to develop a proper car, I mean a car according to the World RX rules, we will consider double-wishbone and optimise the engine position. That is not optimised on this car, it's for the WRC where the rules are completely different. Today it's (inclined) 25 degrees, when we could go 35 degrees in World RX. We haven't had the time or budget; we do this car for Volkswagen Sweden, so they have a limit on their budget."

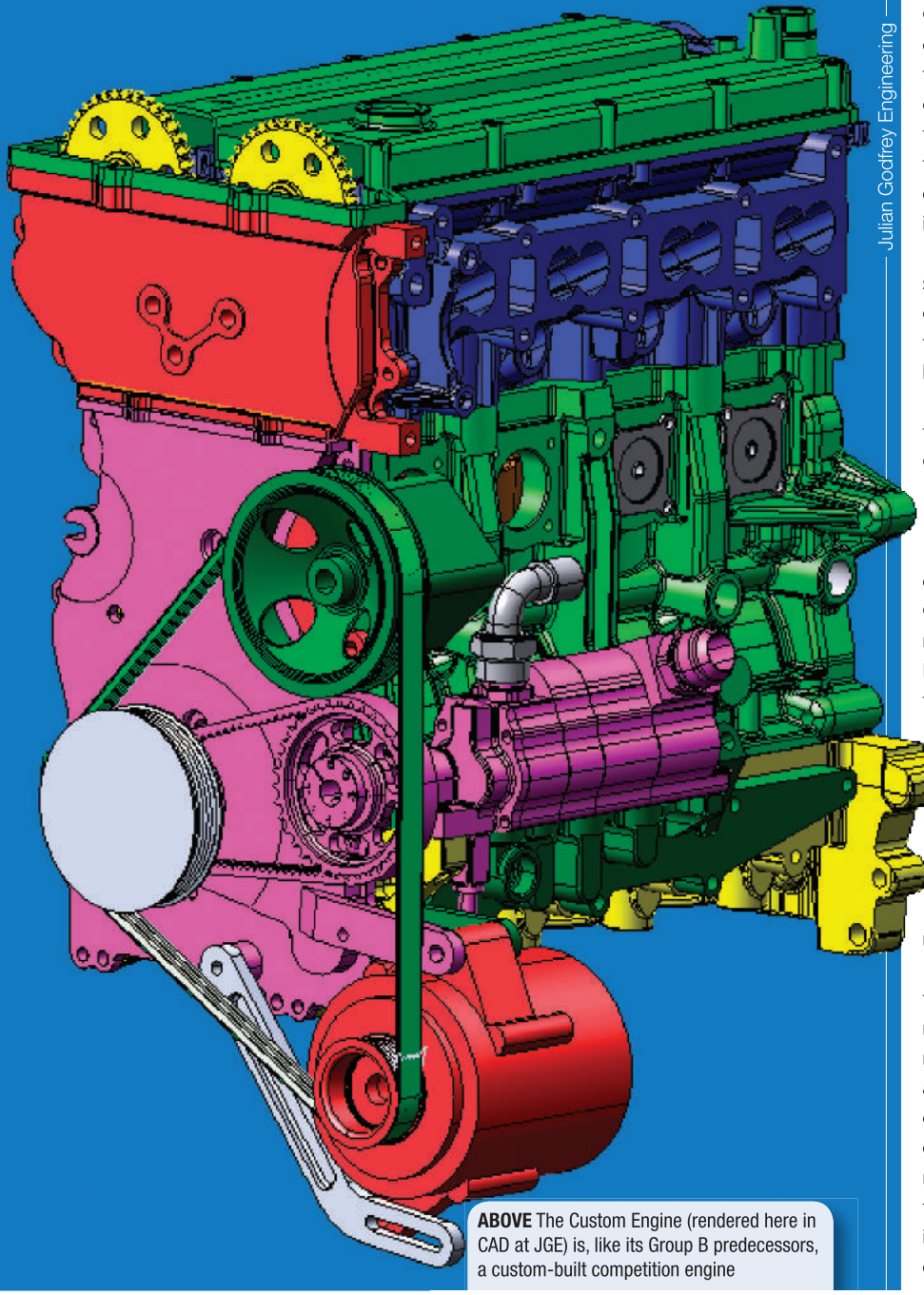
Working behind closed doors over the winter, with an unprecedented amount of pre-season testing for most teams, the first round of the championship in Spain gave the first opportunity to see the opposition up close. As newcomers to the sport, that process was particularly interesting for Volkswagen Motorsport. "I think I need to read again the rules because there are many things that I did not see like this in the rule books," quips Demaison, with a smirk that suggests he thinks other teams are pushing the regulation boundaries. "Maybe I did not read properly or maybe it's interpretation."

For the time being at least, the team will work on what it has. "It would be nice if we could concentrate already on doing a new car, but I don't think it will be like that, we will have to work on this one," he says. "We need to learn the series to be stronger in the future. There is no miracle in motorsport, you can't invent and design a car which will win without learning and it's all new for us. Petter's team has experience but the level is increasing every year also, so we need a bit of time to be at 100%."

The development race in World RX has become just as intense as the door-to-door action on track over the last three years. With the stakes increasing, that is only set to intensify further still. If Volkswagen's current effort is by its own admission a work in progress, rivals can be forgiven for being apprehensive about what's to come out of Hannover in the future. RT

THE APPEAL OF BRUTE

With cars required to run for only a few minutes at a time, **Chris Pickering** discovers that rallycross offers engine designers a remarkable degree of freedom



Julian Godfrey Engineering

ABOVE The Custom Engine (rendered here in CAD at JGE) is, like its Group B predecessors, a custom-built competition engine

AS much as we might like to suggest it's about sophistication and finesse, the iconic eras of motorsport all tend to have one thing in common: power.

Obviously, a reasonable degree of motive force is a given in any form of motorsport, but it's *power in excess* that really seems to capture the imagination. From the Silver Arrows of the 1930s to 1.5-litre turbo grand prix cars of the mid-eighties, there's something about these over-endowed behemoths that guarantees them instant legend status.

Perhaps the most fearsome of all were the flame-spitting Group B cars. Famously deemed too fast for the World Rally Championship that they were designed to conquer, they were said to give the drivers tunnel vision, because their eyes simply couldn't adjust focus quickly enough between the corners. The Group B cars lived on after their much-publicised WRC demise, however, evolving into something even more dramatic, in the hands of privateer rallycross teams.

It's now 25 years since the last international season of Group B rallycross. The sport's current Supercars may be less powerful than their iconic forebears, but are they really any less spectacular?

To find out how rallycross has evolved over the years, we've come to speak to Julian Godfrey. He's the quiet, unassuming engineer behind some of the most successful rallycross engines of recent times. What's more, his company, Julian Godfrey Engineering (JGE), can trace its roots back to the glory days of Group B. Having set up shop in 1989, the first rallycross engine he worked on was the MG Metro 6R4 unit of Brodie Branch, followed by the Ford RS200 of Pat Doran.

"The Group B regulations were fairly open – you could do more or less anything you liked," he comments. "What made them special was the fact they were purpose-built competition engines, covering a broad range of configurations, from highly turbocharged four-cylinders to large, naturally aspirated V6s."

Unusually, even by the standards of the time, there was no limit on capacity, no intake restrictor and no cap on turbo boost. All that really governed the cars' performance was a sliding weight limit that went up with the capacity. Under this system, the displacement of cars running forced induction was multiplied by 1.4 – as had previously been the case in Formula 1 – but in other respects it was a straight fight between a variety of different engine options.

> *"They were more of an animal to drive than the current cars"*

None of these cars were cheap to maintain in factory-spec, so homebrew modifications were common. Fortunately, the only real constraint was that the engines had to retain the same number of cylinders as the original homologated 'road car'. (The phrase was clearly used in its loosest possible sense in reference to vehicles like the mid-engined Metro 6R4 Clubman, but allegedly at least 200 examples of every Group B car were sold for use on the streets.)

With the engines only required to run for minutes at a time, the boost figures were soon ratcheted up. While Group B engines had peaked at around 590 bhp in WRC form, the rallycross machines went on to well over 800 bhp.

"Virtually all the Group B cars were turbocharged – the Metro was really the only naturally aspirated car to make any impact," comments Godfrey. "It was certainly easier to drive and the lap times weren't actually that different to the more powerful turbocharged cars. The real area where you noticed it, though, was off the start line. They just didn't have the same grunt – even in 3.8-litre form the Metros only had around 400 bhp and maybe 350 lbft of torque, whereas even the most basic 2-litre turbo Group B engines were producing 600 bhp and getting on for 600 lbft."

Nonetheless, the 6R4 engine is a classic example of the free-thinking Group B era. The cylinder block for the prototype actually started life as a Rover V8, which had two cylinders lopped off to create a 2.9-litre V6. From there, it differed substantially, though. In place of the Rover's archaic pushrod-operated two valves per cylinder layout, the Williams-designed evolution featured double overhead camshafts with four valves per cylinder.

It started off with a 92 mm bore and 75 mm stroke, but subsequent long-stroke rallycross specials took the capacity out to 3.5 and even 3.8 litres, albeit with an additional weight penalty. These remained naturally aspirated, ▶

Photos: Hal Ridge

ABOVE & BELOW Group B rallycross engines like the RS200 E2's 2.1-litre turbo were surprisingly unfettered by legislation. The sport enjoyed a hedonistic period when the cars were outlawed from rallying

Tim Whittington/RallycrossWorld.com

Tom Banks

ABOVE & BELOW The engine for the Citroën DS3s of a battling Petter Solberg and Liam Doran started with a cast iron cylinder block from PSA's diesel range

but there were also turbocharged variants, de-stroked down to 2.5 litres to compete under the same weight limit. Reducing the crank throw had the added benefit of improving the rev capacity and increasing reliability, so it's arguably in this incarnation – producing over 700 bhp – that the 6R4 proved most successful.

In 1992 FISA (the forerunner of the FIA) increased the multiplication factor for turbocharged cars to 1.7, which led to a corresponding weight penalty. However, the naturally aspirated cars continued to struggle against the turbocharged monsters. It also did little to deter the turbo teams, some of whom simply switched to higher revving, short-stroke engines, which made the same sort of power at a lower weight limit.

"The turbo engines were more reliable, because you had to really rev the naturally aspirated engines to get the power out of them," recalls Godfrey. "That said, we did see quite a few turbocharger failures to begin with, and that's been one of the main areas of improvement right up to the present day. The turbos are now vastly improved, as is the boost control on modern ECUs."

Engine management systems were pretty primitive in the Group B era. A lot of them used the Bosch Motronic, which was a good system for its time, but it was a road car ECU designed in the 1980s. "You just had basic boost control and no anti-lag on most of the Group B cars," notes Godfrey. "With the big turbos, the throttle was like a switch: there was nothing and then it all arrived at once. They were more of an animal to drive than the current cars, with lots of horsepower, but less finesse in the handling and the engine drivability."

GROUP A GIANTS

At the end of the 1992 season, six years after it was outlawed in stage rallying, Group B was discontinued in rallycross as well. Its replacement in the top tier of the sport was loosely based on the Group A regulations that had been adopted by the WRC.

While the Group A rally cars are generally seen as tamer than their Group B predecessors, that's not really the case in rallycross, Godfrey points out. They were still producing prodigious amounts of power with plenty of freedom for the engine developers to work their magic.

"In stage rallying, the Group A cars ran a 34 mm restrictor and all the parts had to be homologated – you had to run the stock valve sizes, for examples," he says. "On the rallycross side, the engine was more or less free apart from the homologated block; if you wanted to use titanium rods and things like that, you could. The two were very different beasts – 320 bhp compared to 800 bhp for the rallycross cars."

The engines pumping out these figures were still typically turbocharged 2-litre four-cylinders. That's 400 bhp/litre out of what is – at least loosely speaking – a production-based engine.

Although there was still considerable freedom to modify the engine, the rules stated that the cylinder block had to be taken ▶


Hal Ridge

ABOVE Julian Godfrey has been responsible for a long line of impressive engine creations

from the same manufacturer as the car's shell. As a result, the most important thing was to find a strong base engine, Godfrey explains: "We'd see over 200 bar cylinder pressures, so it was really important to achieve and maintain a reliable gasket seal without distortion. The density of the materials and the deck strength were vital. In most cases, the internals were swapped completely, so you could engineer round any other weaknesses, but cylinder block distortion could wreck all your hard work."

The situation is much the same under the current Production category rules. These are essentially a mild evolution of the Group A regulations; they still require the cylinder block castings to be taken from a production car, hence the same philosophy applies. When Godfrey produced the engine for Liam Doran's Citroën DS3, for example, he started with the cast iron cylinder block from one of PSA's diesel engines. This was designed for a high-compression engine, so it was a lot stronger than the aluminium block on the equivalent petrol model.

FREE REIN

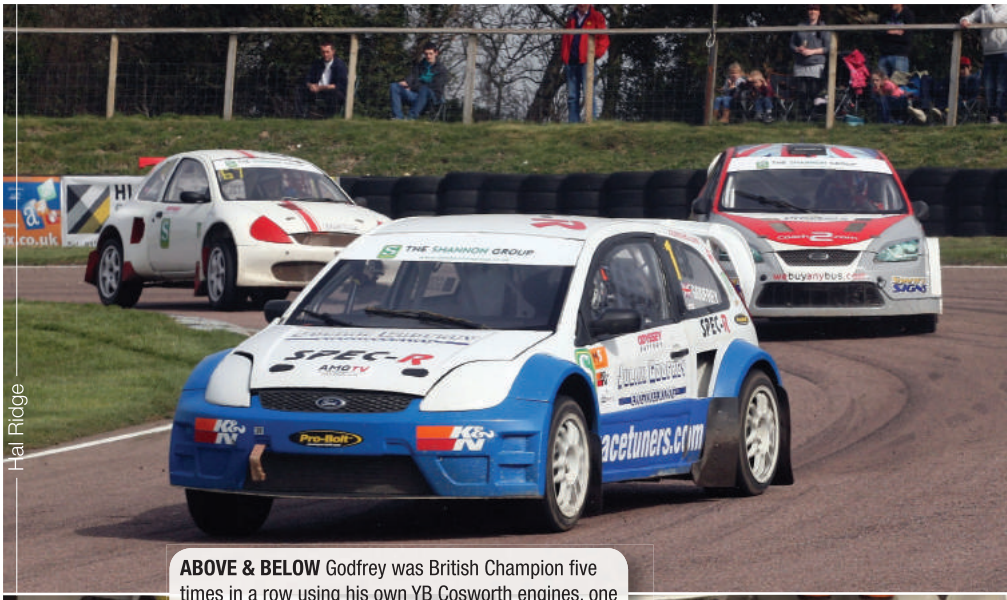
"Using the diesel crank as a dummy, we experimented with compression heights, pin diameters and rod lengths until we found a combination that we were happy with," he recalls. "The rules gave us free rein on the cylinder head, so we could have created our own billet item if we'd wanted, but that would have been an expensive option. We considered a WRC head, but that would have needed a thorough re-design due to the substantially different restrictor sizes (45 mm plays 34 mm). So instead we used a production head, but heat treated it to improve its stiffness."

One of the biggest changes to rallycross engines since the demise of Group B was the introduction of a 45 mm intake restrictor in 1997. In other respects the rules were – and to a large extent, remain – little changed, but it had a significant knock-on effect. Most obviously, the power output dropped to around 550 bhp, but its repercussions stretched right through the engine.

"Limiting the airflow with a restrictor effectively caps the power at the top end and forces you to focus on the torque lower down. And it's torque that generally breaks turbo engines," Godfrey explains. "The cylinder pressures are higher and the load on the components is sustained for longer at low rpm. After the introduction of the restrictor we found we were cracking bores where we hadn't had any issues before."

In 1997 JGE converted its Cosworth YB blocks to Nikasil-coated steel dry liners, in an attempt to solve this issue. It worked, but as successive generations of turbochargers provided ever greater boost at low engine speeds, the problems moved elsewhere.

"The liners were being forced down in the block every time the engine fired, which would blow the head gasket," says Godfrey. "After that we moved to wet liners with long-studs. We were constantly ▶


Hal Ridge


Tony Bardy Motorsport

ABOVE & BELOW Godfrey was British Champion five times in a row using his own YB Cosworth engines, one of which is seen below in Ollie O'Donovan's Ford Fiesta

> *"Inspiration from ideas tried at the end of Formula 1's turbo era"*

developing the engine and we switched to an aluminium billet with integral main bearing housings to prevent it from pushing the crank out the bottom."

This sort of thing proved to be common across the board. Deck plates and billet sumps became virtually standard as engine builders sought to make their powerplants stronger. It meant that not only was the performance of the Group A engines a lot closer to their fire-breathing predecessors than you might expect, but so too was the cost.

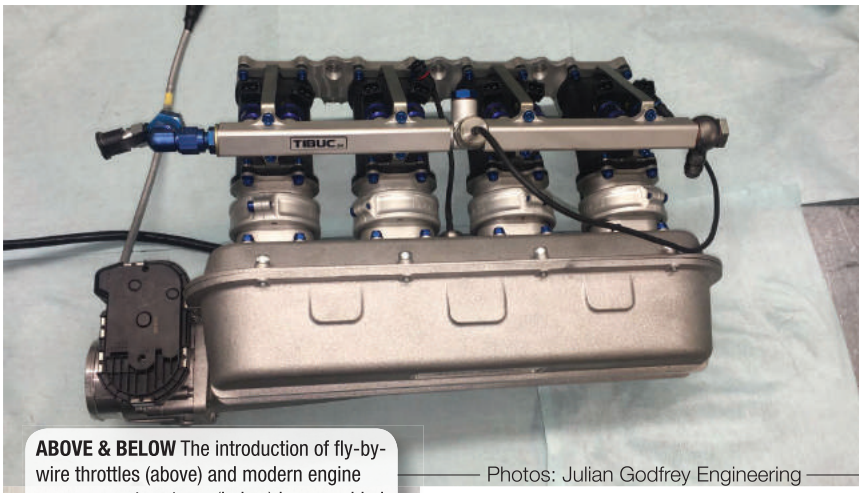
"Off-the-shelf components for Group B engines could be expensive and hard to find. Ford only made about 20 cylinder blocks for the RS200, for instance. Major castings for the Group A engines were obviously a lot cheaper, but you spent more money getting them to hold together," Godfrey points out. "Overall, I wouldn't actually say there was much difference."

BANG BANG NOT DEAD

Aside from the structural implications, the other issue with running very high levels of boost was traditionally turbo lag. Although Audi ran an anti-lag system (ALS) on some of the works rally Quattros, true anti-lag systems were rare in rallycross during the Group B era.

"Anti-lag only really appeared at the end of 1992," says Godfrey. "When I was working with Pat [Doran] on the RS200 we tried various things to achieve a similar effect, like placing a butterfly valve in front of the turbo to create a vacuum that would draw air through and keep it spinning. That was inspired by some of the ideas that were tried at the very end of the 1500 cc turbo era in Formula 1. We never got very far, though. It wasn't really until Group A returned in 1993 that we really had proper anti-lag systems."

Modern rallycross ALS systems use what's known as a fresh air feed. When the driver steps off the throttle this opens up a valve that controls flow from the intercooler into the exhaust manifold, just upstream of the turbocharger. At the same time, the throttle butterflies are held open slightly and fuel continues to be injected into the engine, but the ignition timing is retarded so most



ABOVE & BELOW The introduction of fly-by-wire throttles (above) and modern engine management systems (below) have enabled unprecedented control of boost and anti-lag

Photos: Julian Godfrey Engineering

of the mixture reaches the exhaust manifold unburnt. There it meets the additional oxygen from the fresh air system, which combined with elevated temperatures in the exhaust, helps it to ignite. This keeps the turbine blades spinning in the turbocharger.

In more recent years, the effectiveness of ALS has been boosted by improved engine management systems and the introduction of fly-by-wire throttles. These allow the system to be controlled more precisely, Godfrey explains: "ECUs started to move forwards about 10 years ago with new designs from the likes of Cosworth and Bosch. It's the ability to control the boost and the anti-lag more effectively that really helps."

The rallycross regulations still prohibit the teams from running things like gear position and wheel speed sensors, in order to prevent anyone using traction control. Modern rallycross cars do have launch control, but it's an open loop system, which effectively just limits the rpm and sets the desired boost for a fast getaway. It's activated by a button on the steering wheel, monitored by the FIA scrutineering logger, which the driver must release once they're moving.

CUSTOM ENGINES

In 2015 the option of running a so-called Custom engine was introduced. These are built to a similar set of rules to the traditional (Group A-derived) Production engines, but there are a few subtle variations: notably, there is no rev limit specified for Production engines, while Custom engines are capped at 9,500 rpm; the maximum capacity for Custom engines is also slightly smaller at 2 litres (as opposed to 2,058 cc); and the category introduces a minimum engine weight of 82 kg.

On the flip side, Custom engines are allowed to use direct injection (DI), while the Production engines must be port-injected. And, most importantly, engine builders are allowed to use their own bespoke engine blocks under the Custom regulations, albeit subject to a number of dimensional constraints. The idea is largely to offer non-branded alternatives to the Production engines, so teams aren't compelled to change their powerplant every time they move to a new bodyshell.

At the moment the two sets of engine regulations operate alongside each other. Many had assumed the Custom engines would simply displace the Production units, and there are signs that they may yet do so, but the shift hasn't been as dramatic as expected.

JGE caters for both camps. It continues to ▶

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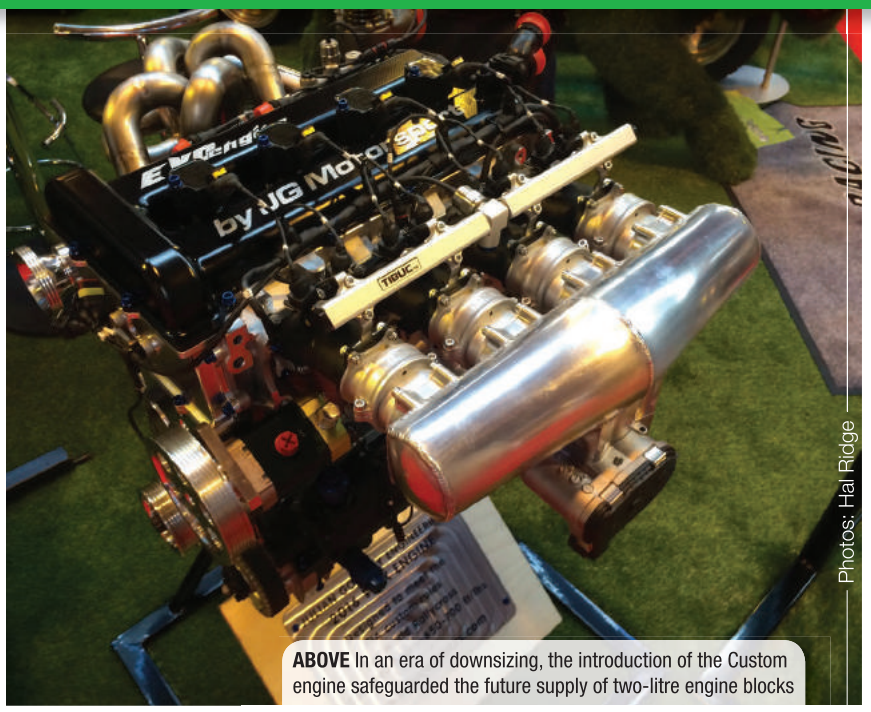


Photos: Hal Ridge

ABOVE In an era of downsizing, the introduction of the Custom engine safeguarded the future supply of two-litre engine blocks

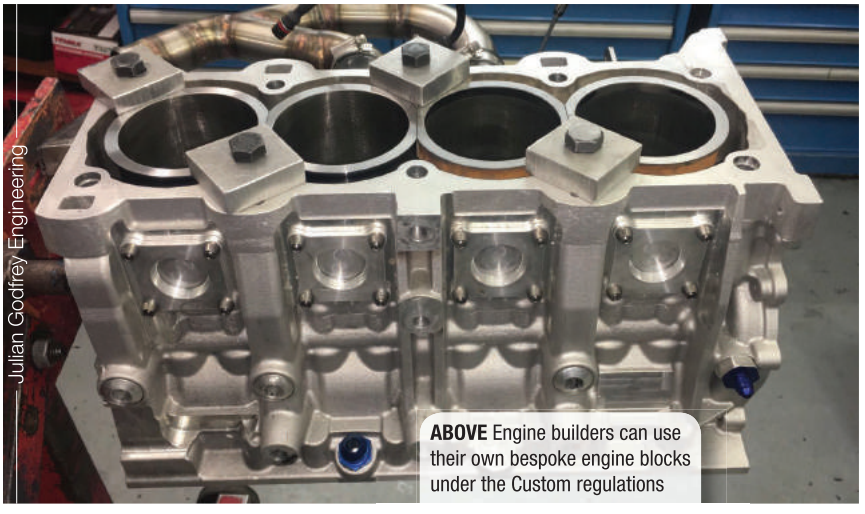
prepare the Cosworth YB engine (once found in Ford's Sierra and Escort Cosworth road cars) for the Production regulations, but it was also one of the earliest adopters of the Custom rules.

Ironically, the cylinder block for the company's Custom engine is actually loosely based on the Ford Duratec production engine. It was designed by Swedish company MDS, while the blocks are produced by Grainger & Worrall, using a pressure casting process and a high end aluminium alloy, which results in a very dense structure.

It uses a similar design philosophy to the company's Production engines, with through-bolts and a structural sump, which carries the bottom half of the main bearings. Inside, there is a set of Nikasil-coated steel wet liners from Capricorn, plus Omega pistons and an Arrow Precision crankshaft. Swedish firm Auto Verdi produces the connecting rods, along with the oil pump for the dry sump system.

Although direct injection is now creeping in via the new Custom regulations, most rallycross cars use port injection with two injectors per cylinder. This is a legacy that stretches right back to the Group B days, when a single large injector would have struggled to provide the required blend of flow rate and control. JGE still uses this setup, although it has switched to a fly-by-wire throttle system, instead of the traditional mechanical linkage. The actuator and butterfly valve is actually taken from a Bosch road car system, but it's Cosworth's Pectel SQ6 management system that forms the brains of the operation.

"Under the Custom regulations, you can only use a single throttle butterfly if you run a fly-by-wire throttle system (as opposed to one per cylinder with a mechanical linkage). But you gain so much more on the anti-lag side with an electronic throttle," says Godfrey. "Originally there was some resistance to the introduction of fly-by-wire, but one of the OEMs wanted it to tie-in with its production engines. Initially it was going to be capped to a 1:1 ratio between the throttle pedal and the butterfly, but that was changed before the regulations were finalised so you can now do much more with it."



Julian Godfrey Engineering

ABOVE Engine builders can use their own bespoke engine blocks under the Custom regulations

The Duratec production cylinder head will actually bolt straight on, Godfrey explains, but instead a custom design is used. It features bespoke valves from Italian specialist Zanzi, with camshafts from Kent Cams and a set of off-the-shelf high-performance injectors from ASNU.

The final piece of the puzzle is the induction system. "You're allowed to do anything you like with the turbocharger, providing it's a single turbo setup," says Godfrey. "Boost levels are unregulated, but the restrictor limits that to a certain extent – at 4,000 rpm you can get 3 bar of boost, but at 7,000 rpm you're down to about 1.4 bar. We've gone for a twin entry EFR design from Borg Warner. Single entry turbos tend to be lighter and they can be better at higher engine speeds, but we find that twin entry gives more torque."

THE FUTURE

For the time being, the Custom regulations look like they're here to stay. Smaller 1.6-litre engines were allowed into the sport after the WRC adopted this capacity, but the preferential weight limit they enjoyed was withdrawn in 2016 and they have since virtually died out.

"At one point there was talk of rallycross engines going down to 1.6 litres, but it now looks like they will stay at 2 litres," says Godfrey. "There's a general consensus that the WRC has got better to watch since they increased the power output at the beginning of this season (and I think that's demonstrated that smaller engines in rallycross would be a bad idea). I'd expect them to stay with the Custom regulations for some time."

The regulations have actually remained remarkably stable, he points out, right from the end of the Group B era to the introduction of the Custom engines: "What defined the Group B engines was the fact they were purpose-built competition units. In a way, we've come full circle with the Custom engines."

It seems to be working. With around 600 bhp, 900 Nm (650 lbft) of torque and four-wheel drive, the current crop of rallycross cars are quicker off the mark than a Formula 1 car. Good to see that excess is alive and well.

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Image: Jakob Ebrey Photography

BELOW The Mirage's first test at a rallycross venue, Lydden Hill

WHY PLAN FOR GLORY REALLY *IS* A MIRAGE

Hal Ridge reveals how a new rallycross project aims to carry Mitsubishi back to the big-time

JAPANESE marques are synonymous with rallying. In the 1990s, they ruled the world. For a time, the World Rally Championship was dominated by Subaru, Toyota and Mitsubishi. But, despite glory on the stages, cars from those brands never achieved the same success at the highest levels in rallycross.

Mitsubishis have experienced glory in national level top-flight rallycross in recent decades, but now a new Swedish-built, Welsh-run Mitsubishi Mirage Supercar is part of a long-term plan to take the name to the highest echelons of the dual-surface sport. Former rally driver James Grint has formed a partnership with Swedish firm Mpart AB (responsible for producing the Mitsubishi R5) and Welsh rally team Spencer Sport to build and develop a new Mirage RX for 2017.

Based on the R5 platform, the new car has been adapted specifically for rallycross at Mpart's base in Orebro, Sweden. That process includes the rotation of the engine and transmission through 90 degrees, which are now orientated longitudinally in the chassis. "Mounting the engine longitudinally was a major task in this bodyshell, made more difficult by the type of gearbox that we've chosen," says Spencer Sport owner, Charlie Jukes. "The gearbox sits in the middle of the car and as the car is actually very narrow, you would certainly struggle to get a passenger seat in there."

The Mirage's transversely-mounted five-speed sequential transmission from Swedish firm Unic is similar to that previously used by double World Rallycross champion Petter Solberg in his title-winning Citroen DS3. There is much debate in rallycross about which engine and transmission orientation is most effective. A transverse layout provides more weight over the front axle for traction, while a longitudinally-mounted unit potentially offers a more even weight distribution.

Unic's transmission takes things a little further. Instead of having a shallow bellhousing to locate the transmission behind the engine but in front of the driver, an aluminium torque tube of around 600 mm moves the gearbox further back in the chassis. Between the torque tube and engine block, the clutch housing (within which is a triple-plate rallycross-specification Alcon clutch) is also home to the starter motor, meaning a further four kilograms are moved 200 mm towards the centre of the car. The five-speed gearbox has two options of ratios, and five variables of drop gears.

TOMORROW THE WORLD

On the new Mirage, the limited slip differentials (with a hydraulic system to adjust preload), driveshafts and CVs are courtesy of Unic too. "This is a car built to World RX specification, so we can move up and progress when we are ready," says Jukes, referring to the squad's 2017 plans to develop the car in the British Championship.

Grint has only previously competed in Supercars with transversely-mounted engines, but thinks the benefits with the Mirage's setup are significant. "There's a bit of a debate about which is best, but we believe that longitudinal is more favourable," says Grint. "You have a better weight distribution, ▶

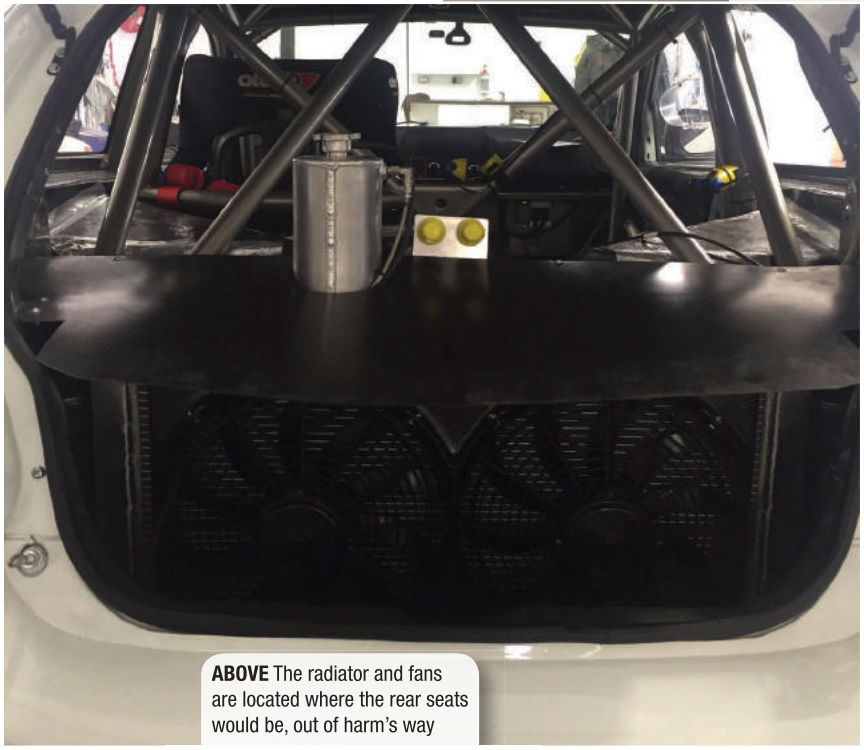
which for sure helps with the launches too. The car will be well balanced and the transmission is cutting-edge."

Attached to the transmission is a Julian Godfrey Engineering-built two-litre, turbocharged, 16-valve, dry-sump engine. With the regulation 45 mm restrictor, this produces in the region of 600 horsepower and 650 lf/ft torque, running Pectel MQ12 management – homologated with the FIA to be used in World RX events. Jukes won't be drawn on specifics of the engine, but says multiple-European Champion engine supplier Godfrey was chosen for his experience: "For us, it's sensible to go with a known quantity in suppliers. Julian's got a very good reputation and we're really pleased to be working with him."

As with most Supercars (aside from Volkswagen Motorsport's new Polo GTi, featured elsewhere in this magazine), the cooling package in the left-hand drive Mirage has been relocated to the rear. This prevents potential damage from contact and allows for as large an aluminium intercooler as possible to be housed in the front. "The intercooler [made from a PWR core with bespoke tanks] is only really constrained by the size of the space in the front of the car," says Jukes.

He adds that the Mirage's bodywork, which features a recently introduced facelift to the R5 rally car, has also been adapted to suit the cooling package. "There is very little difference in the bodywork to the rally car, apart from the larger rear spoiler and that we've changed it from a four-door to two-door," he says. "The rear doors have been replaced by composite panels and the ducts for the rear cooling are mounted in there."

ABOVE Mounting the engine longitudinally was a major task



ABOVE The radiator and fans are located where the rear seats would be, out of harm's way

Located in the original home of the rear seats in the standard car, the radiator and fans sit close to the composite boot, with vents to expel unwanted warm air. "The chassis has almost no overhang; the wheels are very much at the corners of the car," explains Grint. "It's a really neat package, and that includes how the radiator is mounted." Underneath the car sits the 20-litre ATL fuel tank.

The suspension geometry of the Supercar remains close to that of its R5 brother, using a MacPherson strut and lower A-arm design at each corner, attached to bespoke tubular subframes. Swedish firm Öhlins has been involved with Mpart's R5 project since it was conceived in 2013, but the firm also has solid knowledge of rallycross, working with World RX outfits such as current champions EKS, ▶

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ABOVE The car features Alcon's bespoke rallycross brakes and Öhlins dampers

OlsbergsMSE and Team Peugeot-Hansen.

For the Mirage, Öhlins provides multi-way adjustable remote-reservoir dampers. "The geometry is very similar to the rally car," says Jukes. "There are some small changes, like the position of the [rack and pinion] steering rack, but not huge amounts."

Attached to the suspension, housed inside 17" Speedline Corse wheels, are Alcon's bespoke rallycross brakes (featured in RT189). These include 355 mm vented discs front, 315 mm rear and lightweight four-pot callipers.

Although built to a much less restricted set of regulations than the R5 Mirage, experience gained from running the rally version since 2013 has influenced the Supercar build. Jukes believes the concept is tough enough to survive the rough and tumble of rallycross, despite rally cars not initially being designed to deal with the inevitable contact of racing. "We know what we have in the suspension and steering is very strong, so we're fairly confident that it's going to be okay for rallycross, but only time will tell really," he says.

FORCE TO BE RECKONED WITH

The Mirage's first test at a rallycross venue, Lydden Hill, was cut short by head gasket problems just days before the car's intended debut. Following further inspection by JGE, the squad elected to miss the event to completely resolve the issues. "This is a brand new car with a brand new engine and issues are bound to come to light so early in the development process," says a philosophical Jukes. "But from what we've seen so far in testing, we know that the Mirage is going to be a force to be reckoned with."

There's a lot to learn for the new team to crack rallycross with its new car. But, the two-month gap between the second and third rounds of the British RX series will give it time to further prepare the car for use in competition. The amalgamation of rallying knowledge and well proven components will stand it in good stead.

As Grint explains, this project is about taking a Mitsubishi back to the big-time, using some of the most current technology to do so. "I think we've got a very strong package, from the engine to transmission, braking and suspension. This is a lot of the latest technology available," he says.

The Mirage, like many World RX machines, is fitted with a video-logger and performance meter system from VBOX. The package aids drivers and engineers in reviewing and dissecting how both driver and car are working on track.

"The end goal is to have a competitive car in the European championship and beyond. This is a development year," he stresses. "The ideal plan is to run more cars in the future, to have a two-car assault on the European Championship and to be racing in World RX events too." RT

Mirage RX Supercar Spec List

Bodyshell	Mpart AB
Engine	Prepared by JGE
Engine management	Pectel
Dash	Cosworth
Clutch	Alcon
Intercooler	PWR core with bespoke tanks
Pedal box	Alcon
Brakes	Alcon
Dampers	Öhlins
Fuel tank	ATL
Braided hoses	Goodridge
Seat	Atech Racing
Steering wheel	Sparco
Harness	Sparco
Fire extinguisher	Lifeline
Video-logger	Racelogic VBOX
Wheels	Speedline Corse
Fuel	Carless*
Tyres	Cooper

*British RX control fuel

FORMULA 1 2015/2016 Technical Analysis

Giorgio Piola

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AS with previous years, 2015 was one in which Mercedes-Benz dominated both the drivers' and constructors' championships. The German manufacturer confirmed the technical advantage it had derived from the introduction of the revolutionary power unit, which first appeared in 2014. In place of Red Bull, which fell into disgrace after a media conflict with engine supplier Renault, it was Ferrari that attempted to stand up to the Silver Arrows. Side issues were the stories of a Williams wanting to come back and battle for the title; McLaren with a new but not very effective Honda engine, which touched the lowest point in the Japanese manufacturer's long history in F1; and the other leading teams of a season that ended with the official announcement of Renault's return, having acquired Lotus.

Offering a precise analysis of this latest F1 championship, especially from the technical point of view, there is once again Giorgio Piola. A hundred or so all-colour illustrations document the development of the various cars throughout the Formula 1 World Championship, and offer - as always - a wealth of information anticipating the 2016 season.

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ABOVE Mixed surfaces make suspension a compromise. Here Petter Solberg leads the way from loose to asphalt in Portugal

CONTROL FREAKS

The unique mix of surfaces in rallycross makes suspension evolution a key battleground. **Hal Ridge** talks to one of the experts

THERE'S arguably no other motor racing discipline with a more self-explanatory name. Rallycross is, as the name suggests, a cross between the loose surfaces and Tarmac stages of rallying and the wheel-to-wheel action of circuit racing.

Not only is rallycross a combination of the two disciplines, but rallycross circuits – generally around a mile in length – also combine the various different surfaces that rally drivers would usually only encounter in totally separate events.

A single lap of a rallycross circuit can include super-smooth asphalt, rough and loose gravel, high kerbs and big jumps. As a result, it's nearly impossible to achieve the perfect setup on a rallycross car and the word compromise is bandied about freely when talking about achieving the optimum lap time. Make a four-wheel drive rallycross Supercar too suited to the Tarmac that makes up 60% of a lap and it simply won't work on the gravel; but an ideal car for the unsealed loose surfaces can haemorrhage performance on the smooth stuff.

Aside from the tyres, which are a controlled single-make rubber of crossply construction in the FIA World Rallycross Championship, the suspension is the next point of contact with mother earth. Suppliers are therefore tasked with making the 600 horsepower Supercars work as well as possible, in all conditions.

"You're always looking for the best compromise for the track conditions. Of course you can make a car better in one corner, but you lose in another, so you just need to find the best compromise for the conditions," explains Sander Haverkamp, Reiger Suspension's rallycross customer support engineer.

To add further complications to the setup variables, each rallycross circuit offers sealed and unsealed surfaces. "The condition of the Tarmac is the main thing. From there you can define the setup usually," notes Haverkamp. "Some drivers just survive on the gravel, but there are others who like to set the car up for it. If you take the French drivers for instance (used to racing on smooth, sandy circuits), they like to gain the time on the Tarmac, whereas people like [double World RX Champion] Petter Solberg want to make the time on the gravel."

Track conditions and individual drivers'

unique driving styles aside, rallycross presents kinematic design challenges in that the FIA regulations remain relatively open. Unlike in rallying, where cars have to be homologated to a particular specification, in rallycross suspension is reasonably free. As a result, race-winning teams use a variety of solutions. Some employ a MacPherson strut with a lower A-arm all-round, others opt for double-wishbone and there are even those that have gone for a combination of the two (MacPherson front and double-wishbone rear). For the 2016 season, Solberg switched from double-wishbone to MacPherson on his title-winning Citroen DS3, while M-Sport's Ford Focus RS RX was designed with double-wishbone, moving away from the Fiesta WRC with a MacPherson orientation. Last year, in America, the OlsbergsMSE team even built an inboard suspension system into its new Honda Civic Coupe Supercar.

"If every car was the same then there's no challenge. It's interesting that there are many different options," says Haverkamp, who reiterates that there are pros and cons to the different options: "Double-wishbone is very good because you can make so many adjustments, but it's difficult to get the measurements right and you can get lost in the adjustments if you're not careful. As a privateer, it's easier to use a MacPherson strut design."

Reiger's rallycross dampers are designed specifically for the sport, having been involved at the highest level for seven years, and been successful in a range of championships. "For the MacPherson design we have two different variants, but the most used in World RX is a triple-tube damper," he explains. "That's a strut body with a tube inside which takes the side-load of the wheel. Inside the strut is a separate damper, which is the damping for the bumps. With the coilover dampers for double-wishbone, all the side loads are in the chassis and all the damping is in the damper."

ABOVE Mounting the external reservoir low down, as on this STARD R5 chassis, keeps the weight low

> *"'Roll Control' allows the damper to sense the severity of each corner"*

The Reiger suspension used in rallycross is generally three-way adjustable, for high and low speed compression – low speed for the slower movements of the damper and high speed for the bigger impacts, like jumps – and for rebound. "If you go from full dry to full wet you might make five to seven clicks of adjustment, but if the conditions are consistent you might make just one or two clicks to refine the setup," explains Haverkamp.

Once a base setup is defined, teams using Reiger suspension change springs infrequently, aside from weather changes (to soften the car in the wet), but Haverkamp won't be drawn on lengths or poundages. "We can make what we want, depending on the car and requirements," he says.

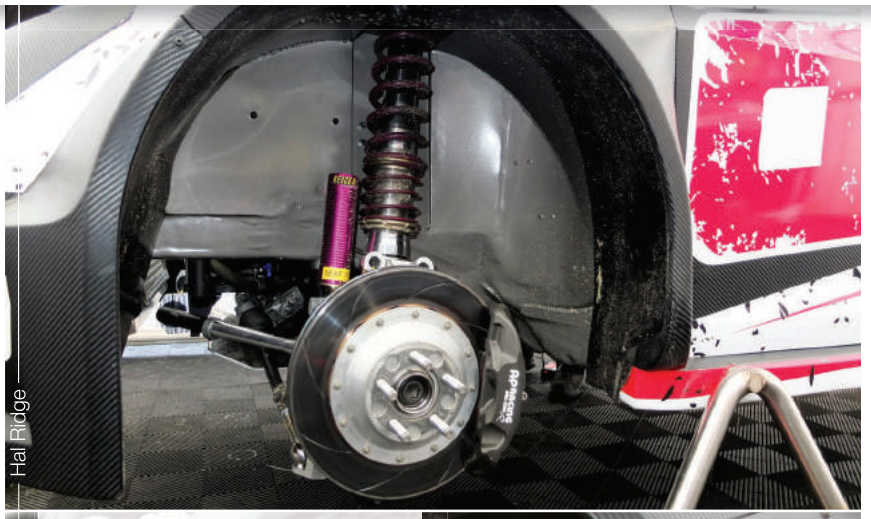
ABOVE One of Reiger's latest rallycross shock absorbers, the fully aluminium triple tube damper used on several Peugeot 208s

ROLL CONTROL

Uniquely, Reiger's dampers also include a dynamic variable referred to as 'roll control'. Active suspension is banned in rallycross, but this solution, which Haverkamp remains secretive about, allows the damper to sense the severity of each corner.

"It works on centre of gravity and feels when you are taking a corner," he concedes. "As soon as there is movement, it makes an adjustment, to make the outside damper stiffer to control the roll of the chassis. When the driver counter-steers, it goes away. It works internally, but is a passive system."

The 'roll control' system – known internally as 'CCV' (Corner Control Valve) – allows a car to have different damping for straights and cornering: potentially softer on the straights to increase weight transfer under acceleration or deceleration, harder in the corners to decrease body roll. ▶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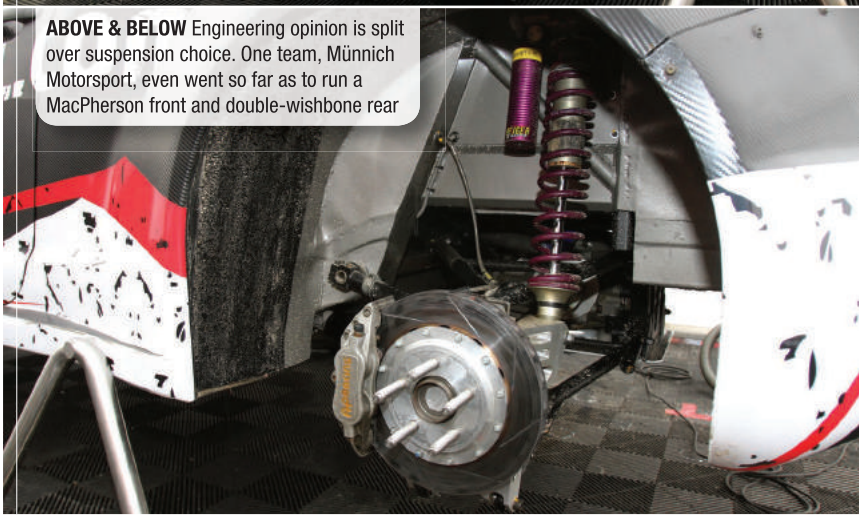

ABOVE & BELOW Engineering opinion is split over suspension choice. One team, Münnich Motorsport, even went so far as to run a MacPherson front and double-wishbone rear

> *"Some drivers just survive on the gravel, whereas people like Solberg want to make time on it"*

The external oil reservoirs are mounted to the base of the dampers to keep the weight low, avoid potential fires from oil leaks under the bonnet and to receive cooling from the driving wind created by the movement of the car. Overheating the damper fluids isn't an issue in rallycross, races lasting between four and six laps, far less mileage than most rally stages.

Some World RX teams use an adapted version of M-Sport's Fiesta R5 rally chassis and Haverkamp confirms that the damper construction differs for the required environment. "The hardware is similar, but the length of travel is different – you don't need as much travel in rallycross," he says. "It's a bit of an intermediate setup between a Tarmac and gravel rally car because we use different tyres (radial in rallying, crossply in rallycross) and there's a different usage time as well. In rallycross you can make compromises to save weight; on a rally car the durability is more important."

The sport of rallycross is growing globally at a rapid pace and with manufacturer involvement for existing teams, the stakes are becoming higher than ever. "We supply the dampers and our customers design their cars, but we do end up being a bit more involved than that. We get asked for our opinion at the design stage, but it's up to them how they design things, how the differentials affect the chassis and how the roll centres are," says Haverkamp.

"We make dampers as good as possible for each car. When people come with a new car there are high expectations and targets, and that's more than ever now. At the start of last year, we made a number of changes to the dampers on some of the top cars in World RX in the first few races, but by the end of the season the dampers were staying pretty much the same. There is a lot of work everywhere."

Haverkamp believes that the implementation of cars designed by engineers on computer, rather than 'home-built' versions, has brought the sport on significantly as the desire to succeed pushes for more frequent developments and changes: "If you take the chassis, there have been big changes. The current cars are properly designed, so things like wheel position and bump steer are correct. The thing with the construction of the (crossply) tyres is that they are very forgiving. In the past if you had bump steer, for instance, you wouldn't notice so much compared to a rally car, but that has all changed, 100% in a positive way."

The saying goes, 'Power is nothing without control'. Rallycross Supercars are renowned for their large power outputs and 'faster than Formula 1' acceleration, but modern developments in suspension technology mean that rallycross drivers now have more control than ever. RT

FIAWorldRallycross.com

ABOVE A rallycross Supercar's suspension travel is around 240 mm. Jumps are among the extremes that the setup has to cater for

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Coates/LAT

ABOVE Yes, it's harder for the new cars to follow each other. But it does mean any overtaking we have witnessed has had an authentic feel to it

BLOWING AWAY F1'S OVERTAKING MYTH

Could the halcyon days of endless overtaking many yearn for in F1 be a myth? And if so, asks **Sergio Rinland**, is that really a problem?

THE 17th century Spanish novelist Juan Ruiz de Alarcón wrote in his masterpiece *The Suspicious Truth* the famous phrase, 'Those you claim to be dead are in perfectly good health'. That is what the F1 fraternity seems to be saying today to those who were reading the sport the last rites at the end of last year.

I have to admit that I was critical of the new rules, not so much for being bad, but in my opinion for not addressing the problem as I think it should be. Nevertheless, the opening races of the year showed a much improved F1. The cars were not only more exhilarating for the drivers, but they look more exciting to watch. Partly because they are faster in the corners and partly due to the fact that the divers can really work them hard and attack instead of always tiptoeing around to look after the tyres. (This last improvement has more to do with the new tyres than the actual rules themselves).

One thing is for sure: as we suggested a few months ago, these cars are a lot harder to overtake. Before, this fact was ignored, but now everybody is admitting that.

So, the races are more exciting and we have less overtaking? Is overtaking a problem then? If we look historically at F1 and other series, I would argue that overtaking is not the core of the issue.

It was the creation of the 'Overtaking Working Group', a few years ago, that highlighted the concern and resulted in the multi-layer front wings and the DRS. Can you imagine setting up a 'Goal-Scoring Working Group' in football if there are fewer goals one season? People watch football for the game itself; the goals are the coronation of a team's efforts. Just like winning races.

LAT

ABOVE Dijon-Prenois, 1979. Gilles Villeneuve (Ferrari 312T4) leads Rene Arnoux (Renault RE10) across the line after a duel we still remember today

Even today, we look back once in a while and watch (in awe) the famous Dijon 1979 duel between Villeneuve and Arnoux. Why is that? Because that kind of overtaking was rare even then. So, perhaps we have the proof that endless overtaking is actually a myth, something people thought was missing when what was really missing was to see the drivers fighting the cars, pushing hard and having fun doing it.

We don't have overtaking in rallying. People go mad on the side of the road to see the cars being driven on the edge, literally, that's all. On the other hand, we have enormous amounts of overtaking in WEC because, in that category, four or five types of cars compete with distinct performance differences, hence the overtaking. Also, the cars competing within the same class are different, performing better in some areas than others, such as the fight at Silverstone between Porsche and Toyota, two cars with completely different setups and drivetrains.

Going back to F1, where the difference between the cars is a tenth of a second, expecting much overtaking is a chimera – a thing which is hoped for but is illusory or impossible to achieve. I would make one change to make it more exciting: do you want to keep the DRS? Leave it free then, allow drivers to defend. That may reduce the overtaking, but it will not deter them from tying, which is what people want to see – the fight, the drama, the emotion.

That is the real difference in today's F1: we don't have drivers driving 'carefully' – looking after the car (tyres!), not really pushing; not taking risks for the sake of doing an extra lap on those tyres. Before, they knew they could get any overtaking done with the DRS in the middle of the straight, rather than in the braking zones, where you see the brave trying. Now that the DRS is not that effective, due to the new rules, it becomes a bit redundant, don't you think?

Even the business is sending the right vibes and there is excitement in the paddock, so: 'Those you claim to be dead are in perfectly good health' (*Los muertos que vos matais gozan de buena salud*). RT

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Team NMA - Lotus Evora GTE
2nd Place in GTO - GT Cup 2016

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- If you want to top-up your existing Engineering Qualification to a full Degree

Degrees awarded by our academic partner Staffordshire University

STAFFORDSHIRE UNIVERSITY IN PARTNERSHIP

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