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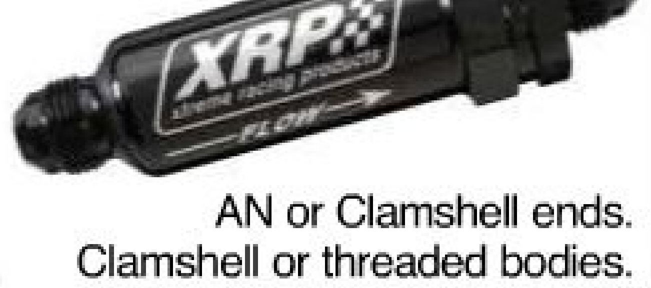
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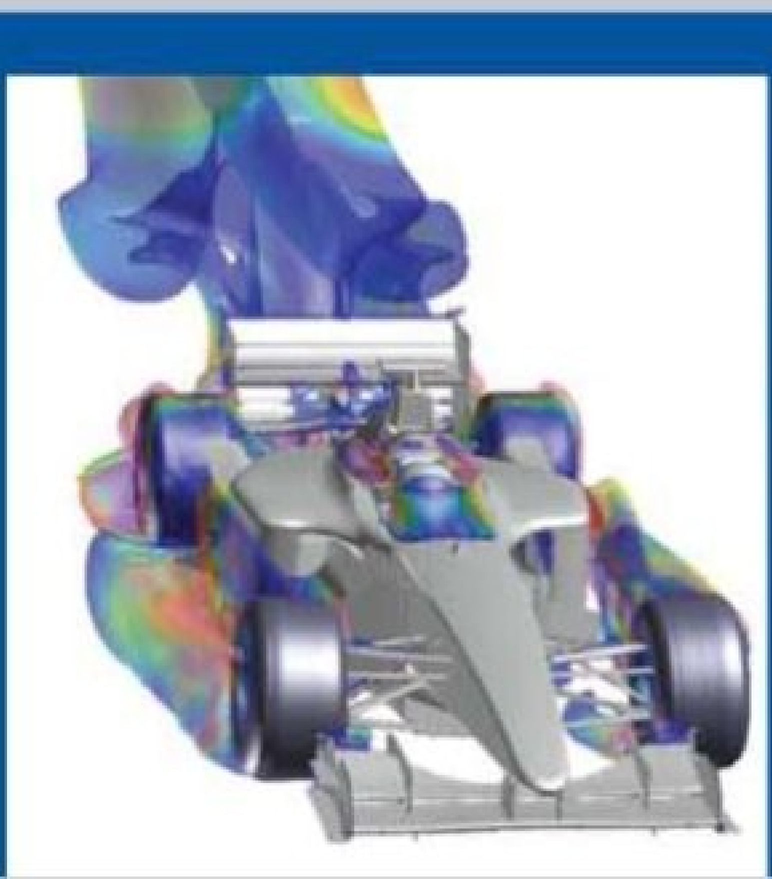
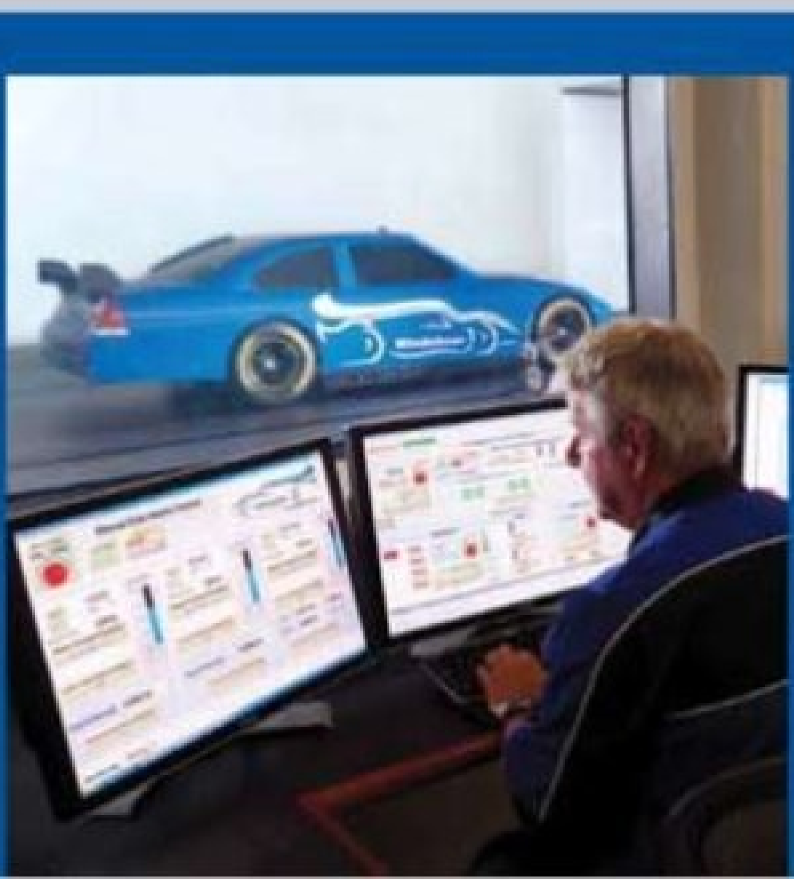




Rules is rules

But all should be examined to see if they pass the common sense test

Any sport is but a confrontation of individuals doing a less deadly version of combat. Initially, it was to the death, but the subsequent taming of mankind brought us to the substitution of enemy's heads with shiny cups. And, as the first rule was born (avoid killing your opponent), it then entrained a whole slew of others.

Let's just pause and see what we are afflicted with today, in Ye Holy FIA Book Of Rules. Said tome has slowly been adding girth (as most of us have with the passing years) and the shelf where they reside in my office lists decidedly to the right, as of course they are in yearly order, from 1969 to 2005. Luckily, for the shelves, from then on they're in electronic form.

That the use of rules be restrained to enforce safety is perfectly understandable, as most drivers would sit in an electric chair if it gave them a chance to set pole or win a race, but all other rules should be examined to see if they pass the common sense test.

Let's assume that we at least need some sort of restriction on the means and methods of getting from point A to point A (start line to finish line). History is littered with examples of the law of unintended consequences, not least in the fiscal horsepower used in European countries for taxation purposes, which skewed the entire automobile industry and had a series of corollaries we still live under.

Taking the devil's advocate position, the artificial rules encountered in the Japanese Super GT Championship, whereupon the winner of a race receives a weight handicap, has led to a strong, stable and competitive series, despite the engineers' obvious chagrin at being penalised for doing a good job. So pragmatism can work in a given environment.

On the other hand, many rules are invoked for laudable reasons, but end up being distorted as they, in turn, cause newer rules created to sort out the problem these earlier rules brought on, *ad infinitum*.

When wings first came into racing in the '60s (well, they came in earlier, but that's a subject for another column) we had them applying downforce directly onto the suspension. A series of structural failures brought that to an end, but the concept could not be un-invented, and the consequences of fixed aero then led us to ground effect cars with big tunnels, and that eventually led to a cascade effect in endurance racecars. But due to the rules restricting big tunnels in Sportscars, introduced to restrict cornering speeds and seen as dangerous because the size of the shunt obligingly respected mv^2, we ended up with flat bottoms. That, in turn, gave us cars with vestigial diffusers at the rear and a huge flat surface that, under some circumstances, offered to the wind flow a surface area equivalent to 7m^2. Add in the ability to travel at 300km/h and surprise! Cars took off.

"When the spirit of the regulation, rather than the wording, is the binding process, life can get a lot easier "

Rule books get thicker as race cars get quicker, says our man

So stage two of the rules introduced the dreaded plank, as a means of impeding the running of the car too low, and the raising of the sides, to avoid having a too effective flat bottom, led to increased cornering speeds and more aggressive diffusers, plus rear wings that have to work more to compensate for the loss of under-body downforce. Unfortunately, the raised edge of the body sides makes for a very good entry into what is now a vaguely aerofoil shape in yaw, which then produces lift again... At the same time, cars are running too quick, so reduce the power. Ah, now we have to reduce rear wing, reduce overall downforce, run the car as flat as possible, or even slightly nose up, to reduce drag again. So nose up, lift, take off again...

And so we go to stage three: introduce big holes into the bodywork to reduce the lift when car incidence goes to positive, at the same time increasing the drag and making cars look silly and making a mockery of most aerodynamic efficiency precepts.

I propose that somewhere here we should go back to first principles and say putting Band-Aids on gangrene will not solve the problem, but will only bring new ones in their wake. Aerodynamics of close to the ground bodies has advanced enough nowadays to give an opportunity to review our goals, and apply engineering to it. Why not have cars with ground effects via a tunnel? Why not have active aero with moving surfaces?

Perhaps following Mies van der Rohe's 'less is more' dictum here would help. After all, the only time I was involved with a NASCAR racecar I was surprised to see the thin epistle the rule book was, just 36 pages covering the entire technical regulations, and most of them concerning engines. The chassis and bodywork side had the particularity that every paragraph ended with the phrase, 'decision on the interpretation of this rule will be at the discretion of the NASCAR inspector, whose word is final.' No semantic wrangling of meaning there, no counting of angels on pinheads. When the spirit of the regulation, rather than the wording, is the binding process, life can get a lot easier.

The erstwhile chief scrutineer at Le Mans, Alain Bertaud, quickly put my F1 tainted view of rules into perspective when I first tried to argue some points of the Group C I was running at La Sarthe. 'I know what I mean by this rule. You know what I mean by this rule. Don't play the lawyer with me.'

Lest we think everything is easy, I will quote van der Rohe again, 'the devil is in the details'. Having now upset everybody, and not really proposed a suitable correction, I exit stage left, giggling.


SUPERTECH

Does F1 float?

Roll up! Roll up! It's that time again folks

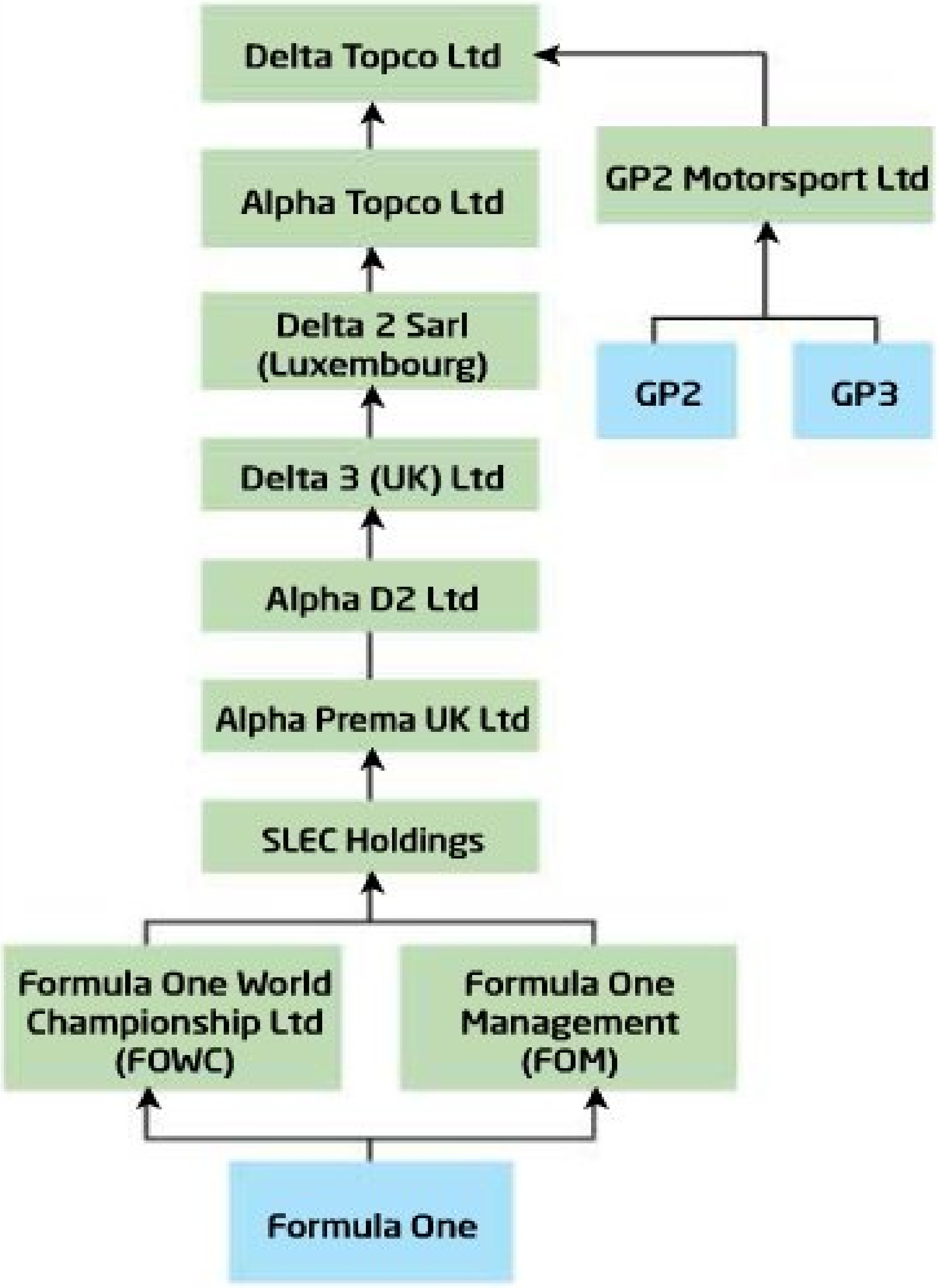
The previous 1997 attempt to float Formula One receded when backers got cold feet, partially due to team rebellions over the Concorde Agreement. To ensure history does not repeat, Ecclestone has sweetened the major teams sufficiently for them to agree to the new Concorde before the float. The agreement will run from 2013 until 2020 and provide extra payments to teams that have competed since 2000 without changing name, as well as to past championship winners like Ferrari, McLaren and Williams, and back-to-back champions like Red Bull.

Mercedes, though, will apparently not commit while it 'evaluates its options', including legal action under European Union competition laws. According to GP chief, Nick Fry, CVC 'need' to reach an agreement with his team before floatation can be successful. But is that really true?

Mercedes may have spent more than $1bn on grand prix racing in the past two decades, supplied engines to a number of teams and may even quit Formula 1 altogether if they don't get a seat on the floated company board, amid rumours that loss of their team could mean a 20 per cent drop in the floatation valuation. Mercedes motorsport boss, Norbert Haug, told *Auto Motor und Sport*: 'Floatation can mean many things. If you take to the market a minority share, does it change anything in ownership, give more liquidity to the owners, maybe more money to the sport?' Ecclestone was quoted countering with, 'Why should Mercedes have the same deal as the others? What have they done in Formula 1? They won a race and that is it.'

Board seats are reserved for those who make a major contribution to a company, and it is too early to tell whether Mercedes will make that contribution to the Delta TopCo commercial end of F1, as well as to the racing end. The two are not the same thing.

Delta TopCo heads the corporate pyramid that owns F1, GP2 and GP3. UK private equity firm, CVC Capital Partners Ltd, holds a 63.4 per cent majority stake, and a new stock market-friendly version of Delta TopCo would be publicly quoted, probably on the Singapore exchange.



There are many reasons for floatation. If banks have extended the maximum easily available credit then the market is the next resort to raise money. F1 has debts of $2.3bn, on which it is paying some $60m a year interest (2.6 per cent). That equates to quite a chunk (17.6 per cent) off its recent $340m annual profit, so paying down debt with floatation may be advantageous as longer term interest rates are on the increase. Another reason is to cash in the current investors' shares. CVC has held stock for six years and may feel it is time for a return. The next largest stockholder is LBI Group Inc, the rescue vehicle for the failed Lehman Brothers, and they have promised to sell their F1 shares within two years.

"Overall, F1 makes money, but it has vulnerabilities"

Flotation also creates an exit route for minor shareholders, such as Ecclestone's former wife, Slavica, who owns 8.5 per cent through family trust, Bambino Holdings Ltd. Ecclestone himself owns 5.3 per cent but says he has no plans to sell.

Perhaps 30 per cent may be floated? Less would be unattractive to the market, and more would lose CVC its control, so the block for sale may be about 15 per cent from CVC and 15 per cent from LBI.

Would one buy shares? CVC say it has annual sales of $1.54bn and employs 200 people. Total contracted income from future races is about $4.7bn, plus $1.4bn from television contracts, yielding an annual average of about $475m for the next 15 years. CVC still had $2bn outstanding debt due in 2014, but that has now been rolled forward to 2018 with the debt at $2.3bn. At least 50 per cent of earnings go to teams and rose from $545m to $660m, reducing annual profit from $420m to $340m. Team payments are likely to increase after 2013 so, overall, F1 makes money, but has vulnerabilities.

When Ecclestone can no longer herd the F1 cats, who will take over? And can they grow the sport as well as he has? Nestle chairman, Peter Brabeck-Letmathe, sits on the Delta TopCo board and is thought likely to head the new company, but will that lead to growth or 'steady as she goes' corporate milking? If the company knows its future is not rosy-cheeked growth but mere consolidation after it has already peaked, and investors want out while the going remains good, then why would anyone else want to buy into its sunset years? It may be good for current owners to cash in at, arguably, F1's peak, but the same logic dictates that buyers are going to buy at the top of the market. Some argue that F1 is already over the top as viewing figures were virtually static at 520m in 2009, increasing only slightly to 527m in 2010.

At 20, the 2012 season has the largest number of races so far, but 24 races are being discussed, which could bring another $150m a year race income, as well as increased TV revenue, so there is still room for growth, but it may never again reach the heady rate reached during the golden era when Ecclestone and Mosley wielded the iron fist within the iron glove.

F1 may float and then sink, so yer pays yer money – or not – and takes yer choice, but as always sport fans, *caveat emptor*...

State of the art

The 2012-generation of Le Mans Prototypes may look similar to their predecessors but, beneath their svelte aerodynamic lines, technology has moved on

BY SAM COLLINS

> "these openings unfortunately reduce the vehicle's stability on the straight because its c of g shifts forward"

On the face of it, there is little difference between the 2011 and 2012 Le Mans Prototypes. Most of the cars on the grid in the World Endurance Championship have been around for a long time with many, such as the Pescarolo, Lolas and Dome, dating back to 2007 and 2008. But a significant set of regulation changes has seen these designs substantially revised for the new season.

Immediately obvious are the bodywork revisions, many aimed at keeping the cars on the ground in yaw at high speed. The large dorsal fins appeared on some cars in 2011 but became mandatory for all LMPs in 2012. More significant from an aerodynamic standpoint are a set of holes above each of the wheels.

When the decision to carve holes in the bodywork was announced, Audi's Dr Martin Mühlmeier criticised the changes: 'I am always happy to see the safety of the vehicles being increased,' he said. 'But checks need to be carried out to determine how much safer they are, and whether there are actually any safety improvements at all. The fin dimensions are only being marginally changed, but the openings that now have to be above the wheels are a lot more serious. They are supposed to prevent a vehicle from losing contact with the ground on one side when the vehicle is at a large heading angle and therefore spinning. This is certainly the right idea in theory. But these openings unfortunately reduce the vehicle's stability on the straight because its c of g shifts forward, thereby increasing the likelihood that the driver will oversteer. In other words, the risk of the vehicle spinning out of control is actually increased.'

The FIA refers to these holes as air extractors in the technical regulations, and place a limit on their dimensions - each wheelarch must have a hole of between 7500mm^2 and 9500mm^2 at the front and between 1000mm^2 and 1200mm^2 at the rear, leaving only the tyre visible from above.

AEROBYTES

Racecar Engineering has already investigated the influence of these air extractors in some detail as part of the Aerobytes / MIRA wind tunnel programme, and found they do indeed move the car's balance rearward, as predicted by Mühlmeier. In our tests, they also increased drag by 2.6 per cent (see *RE* V22N5).

The way teams and manufacturers have dealt with this challenge is fascinating, and a wide variety of solutions are currently on display (see sidebar on p10).

'On the subject of the holes, there is not a design consensus at the moment, but I think in two or three years you will see the concepts converge, as that tends to be the way that motorsport goes,' explains Julian Sole, chief engineer at Lola. 'The regulation change for the holes came so late that it didn't really give us any time to develop. So, at the moment we are still experimenting, but you are always managing a loss to some extent, and are always trying to find a gain at the same time. By just opening up a hole, it will certainly be worse but you develop, until you get to the point where you are managing a gain. We have not made an overall gain yet but we have managed the losses.'

The impact of the holes can be felt significantly on other parts of the car too and, if a manufacturer should get the shape of the holes wrong, it could have a detrimental impact on the rear of the car, especially the rear wing. To mitigate this effect, some manufacturers, including Audi, Pescarolo (Oak) and ORECA, have added small ridges to the bodywork around the holes.

"On the holes, there is not a design consenus at the moment but it think in two or three years you will see the concepts converge"

'If you have the hole just cut into the body there is a lot of air coming out of them, damaging the overall efficiency of the car,' explains Christopher Reinke, technical project leader of Audi's LMP programme. 'There is also a huge drag factor, so you want to have as clean airflow as possible out of those holes by integrating them into the front wing (fender) in a way you can increase efficiency.

'The small strakes prevent the air from spilling out the side and interrupting critical flows in other areas. Note that there is quite a lot of airflow between the front wing and the main section of the monocoque. This is very important for the rear of the car and the wing. If the flow from the hole spills there, it destroys the airflow. The problem is that the flow from the holes is really messy and turbulent from the wheels and brakes. We need to look at the rear wing to stop these dirty flows messing up the flow onto the rear wing. If you let those flows interfere, you simply lose the outer edge of the rear wing.'

"It's a really interesting area of aerodynamic development"

UNINTENDED CONSEQUENCES

While the holes are a regulatory change, they have influenced many other parts of the car and some clear design trends are starting to emerge, especially at the front. Both the Pescarolo 01 and the Lola B08/60 have adopted convex front ends, part of a trend started by the use of wider front tyres. 'If you introduce any changes to the car, like the holes or the tyres, it involves a bit of development, but for the LMP1 we have really developed the bodywork around the holes. As a result, I think almost all of the bodywork surfaces have changed in some way or other,' Sole adds. 'The outboard corner is critical to the whole car and we are always working to improve it. Just looking at the front corner, you see a lot of variances because people are looking at managing the flow over the rest of the

1. Zytek retained some louvres on its air extractors, and added a split exit to smooth the flow 2. Dome ran with an interim solution at Spa similar to the Lola solution 3. The curved tail of the hole is likely to enourage the messy flow away from crucial areas like the rear wing 4. Oak Racing used a deep groove to channel air for the same purpose 5. ORECA use an interesting sculpted plate in the hole 6. HPD developed its holes in CFD

bodywork. Last year we changed to the big front tyre, so we did an update on that to fit into the arch, but there was more that we needed to do so we have developed that concept further. We ended up following this trend and are seeing some improvements from the shapes. It's a really interesting area of aerodynamic development. It has evolved twice from just being a bit convex to being really quite convex now.'

ENGINE CHANGES

Under the bodywork there have been some other major changes. This has seen the big engines of LMP1 up to 2011 outlawed, and smaller capacity units mandated for the 2012 season. The engine changes actually came in for the 2011 season, but teams were permitted to run under 2010 regulations for some time. Indeed, some teams were even granted dispensation to run the larger engines at Sebring in 2012. As most of these older cars were developed around engines such as the 5.5-litre Judd GV V10, many have had to be modified to accept smaller units like the 3.4-litre Judd DB V8. The Dome S102, for example, is typical, having a spacer plate installed to carry the smaller powerplant. But use of these smaller motors do give up some packaging opportunities for other systems.

ELECTRIC AVENUE

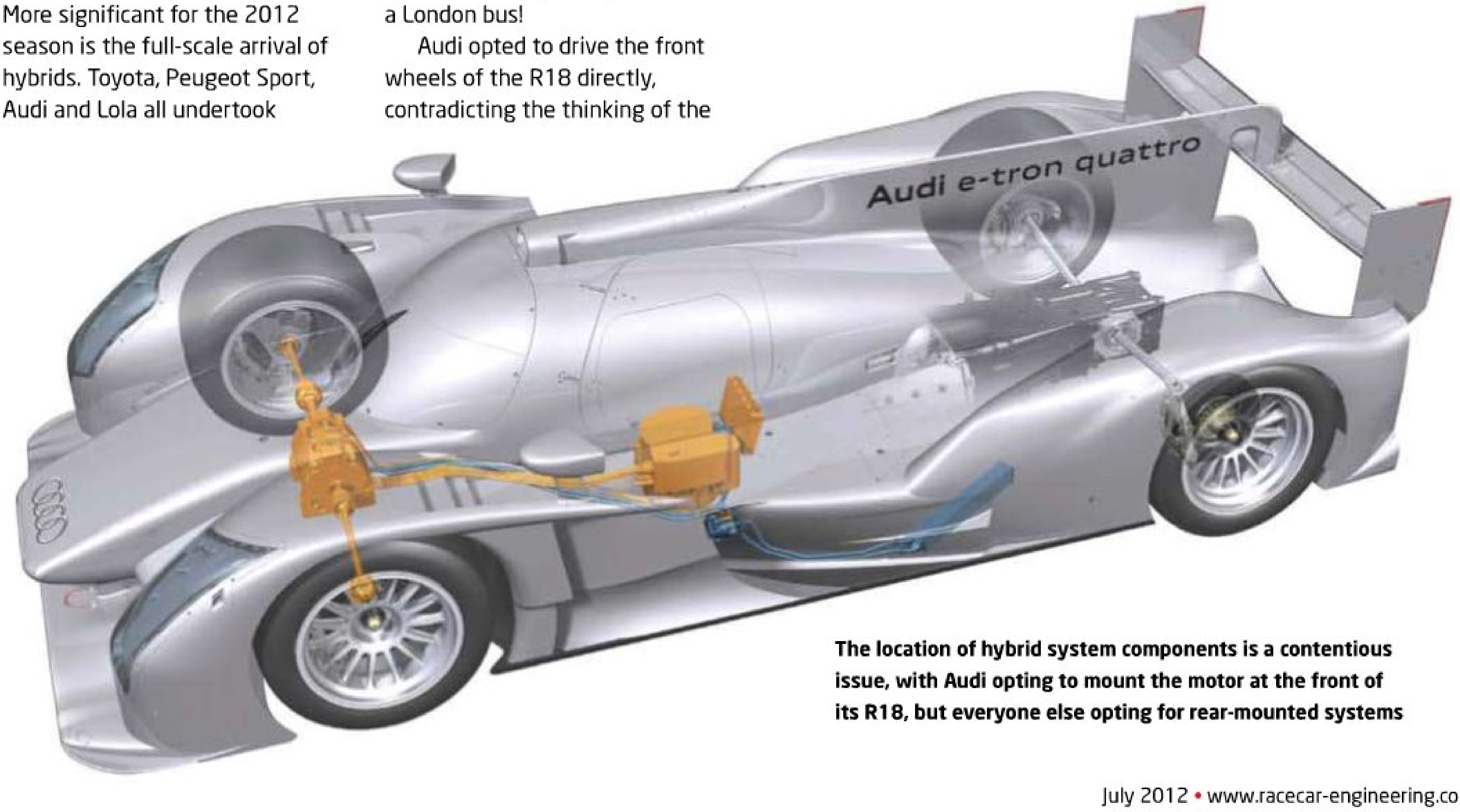
More significant for the 2012 season is the full-scale arrival of hybrids. Toyota, Peugeot Sport, Audi and Lola all undertook significant engineering exercises to install energy recovery systems into their cars and, interestingly, all opted for different solutions. The regulations allow for a fairly wide range of system layouts and teams have to decide on what they think is the best solution. Toyota, with its experience of production hybrids, finally opted for a rear-wheel drive layout using a Denso electric motor, after also testing a four-wheel drive layout with a different Aisin SW motor.

'We decided to run the motor generator unit in the gearbox, so we went for a rear-drive system because with a front [-drive] system you get a weight penalty and particularly an aerodynamic penalty,' explains Pascal Vasselon, technical director at TMG. 'You have to pay for a front system because you have to cool it, and also the driveshafts are running through a crucial aerodynamic area.'

Audi, meanwhile, took a different approach altogether, utilising the Williams Hybrid Power electro-magnetic flywheel system, first developed as a Formula 1 KERS, but then further developed for use in endurance racing with Porsche. Now an evolution of this has been developed for the R18 LMP1. It seems rather fitting that a diesel electro-magnetic hybrid racecar should have a direct link to a system currently being trialled on a London bus!

Audi opted to drive the front wheels of the R18 directly, contradicting the thinking of the Toyota and Peugeot's engineers. 'We had to make the car much lighter weight than the previous car because of the weight of the hybrid system, with a big saving coming at the rear with a carbon fibre gearbox casing,' contests Reinke. 'The weight distribution is right though, and that's why we went for a front axle-driven philosophy. Where we have put the motor at the front is exactly where we put the ballast anyway on the non-hybrid car. We are even using the same mounting points for the ballast as we do with the electric motor.'

Audi utilises lips both upsteam and downstream of the holes to prevent the dirty air from impacting other flow structures across the car



The location of hybrid system components is a contentious issue, with Audi opting to mount the motor at the front of its R18, but everyone else opting for rear-mounted systems

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But Vasselon disagrees with Audi's engineers, and claims the four-wheel drive system of the R18 is not better than the rear-drive system of the TS030. 'I heard Dr Ulrich saying that a four-wheel-drive car is inherently better, but I would not agree with that as the front motor cannot be used below 120km/h. This negates the main benefit of a four-wheel-drive car, and that benefit is traction. In principle, it's possible for us to go back to the front motor but I do not think we will.'

The four-wheel-drive layout also leaves a number of unanswered questions about the tyres. It would be logical to assume that the fronts would wear faster than on a rear-drive-only car, but this has not yet been tried or tested. 'We looked at the front tyres and we assume that tyre life will be shorter than on the non-hybrid car, but not everything has been calculated yet. Both Ultra (2WD) and Quattro (4WD) run the same tyres all round. To be honest, we do not really know what the results will be yet,' admits Reinke.

Lola too has investigated the use of KERS on its LMP1s and has changed the design to accommodate it. 'We have allowed on our designs a volume between the gearbox and the back of the engine where you can install a flywheel KERS system off the shelf,' reveals Sole. 'Having this volume has meant we have had to make some other structural changes. The suspension pick-ups have moved as a result, not for geometry reasons but for structural reasons around that volume. It then was a case of looking at how you put those loadings into the bellhousing and into the main case. We've worked closely with Flybrid to make sure it could all go together comparatively easily.'


The front wing shape of the Lola (pictured) and the Pescarolo 01 follow the same convex trend, and it seems likely others will follow

Le Mans Prototypes are certain to have a hybrid future. With gains in both fuel consumption and power output, it will not be long before the weight penalty of the systems is overcome. When that happens, hybrids will have a clear advantage. Right now, looking at Audi, which uses an identical chassis on its hybrid and pure ICE R18 (see p80), it has a slightly more aerodynamically efficient ICE car and a slightly more powerful hybrid. The net result is both are fairly evenly matched. Perhaps that is why few teams have taken up the option?

'At the moment nobody has signed up to take advantage of the capability our cars have to run as hybrids,' explains Sole, 'but it's there ready for them. To install KERS is an expensive thing to do and if your chassis is not ready for it then you have an even greater expense. Our customers at least have a chassis that is ready for it, which saves expense further down the line.'

Most of the cars will receive heavy updates ahead of the Le Mans 24 Hours and next month we will look at how those designs changed for the race, and how well those changes worked.

CUSTOMER SPORT

Le Mans Prototypes are unique in that they are purpose-built racecars that pitch customer teams against full works operations. This has a significant impact on the design of the cars. Whilst there are those designed purely as works cars – Toyota, Lola and Dome – there are also those that are purely for customer teams, notably Lola and ORECA. But there is also a sort of half-way house for cars that are not quite either, such as the Pescarolo and HPD.

'We are designing a car for customers to buy and win Le Mans with and that restricts what we can do to an extent,' admits Lola's Julian Sole. 'If you spend Audi or Toyota's budget on R and D, you cannot recoup that when you are selling cars, so it does not make sense to spend that much. We have to think about R and D from a business point of view, so our budget is restricted in terms of how many cars we can sell and what our customers can afford.

'In any customer car, or strict, budget-restricted formula, you have to focus on the areas that give the biggest gains. Working out where your money is better spent is critical.'

Nowhere is this more critical than in the LMP2 category, which is reserved for customer teams only and cost capped. Cars are allowed just one body kit for the season and one update for a low drag Le Mans package, costing no more than €10,000. How this figure is enforced remains to be seen. If a car wins Le Mans with the kit, it then follows that demand for the car and the associated aero kit will increase, thereby reducing the cost of the kit.

Also with Lola, HPD/ORECA and Pescarolo running identical chassis in both LMP1 and LMP2, what is to stop the LMP1 development programme influencing that of the LMP2?

'Some lessons and trends can be applied to both,' says Sole, 'but because of the tyres and the [different] power levels you are looking at, you simply have different targets. LMP2 is a cost-capped class, so your base car has to cover all track types, from a high-speed track like Le Mans to the twisty street circuits of the ALMS. The only thing in LMP2 you can change race to race is to remove the two front dive planes, so within those parts you need a very wide range. With LMP1 you can have a much bigger kit of parts, so that's the real difference between LMP1 and LMP2.'

Le Mans runners

Audi and Toyota have grabbed the headlines ahead of the 2012 Le Mans 24 Hours, but the other teams have been hard at work developing their cars, too. We take a look at their work

BY ANDREW COTTON

ZYTEK 07S

Although it has been through many names and a fair amount of development, the 2012-spec Zytek LMP1 and LMP2 designs retain the 2007 tub, which is built by British composites firm, EPM.

The chassis is only ever mated to Zytek's own in-house engine, including the Nissan LMP2 unit – a combination that won its class at Le Mans in 2011.

PESCAROLO 01

Oak Racing took on the development and manufacture of the 2007 Pescarolo some time ago, and has spent a great deal of time and money bringing it up to modern standards. The aerodynamic development has been undertaken at Ruag Aerospace and has resulted in one of the most interesting cars on the grid. Much attention has been paid to very small details, suggesting that a significant investment has been made. Pretty much every aspect of the car has been modified, with only the tub remaining unchanged. For 2012, the Judd/BMW-powered LMP2 version of the car has been re-named Morgan in a title sponsorship deal.

DELTAWING

The DeltaWing is not competing in any class, but is allowed to race as the ACO's Garage 56 entry for technical innovation. It weighs 475kg and is powered by a 300bhp 1.6-litre, four cylinder, turbocharged engine, designed and built by British engineering firm, RML. Backing and technical support comes from Nissan, which provided the base unit for the engine which, like the gearbox, is non-stressed. The cockpit comes from the Aston Martin AMR-One, which had already passed the necessary crash tests. Two front tyres are just 4in wide, rears are 15in. Drag co-efficient is 0.24. The differential features a variable torque steer / differential speed-controlled planetary final drive reduction layout.

LOLA B08/60 and B08/80 coupés

Lola's development follows that of the manufacturers, having shaved 40kg from last year's car in preparation for running a KERS system in the gearbox bellhousing. The c of g has been moved forward, and there is a new floor, new aerodynamics and a new front end to cope better with the 18in front wheels. The front and rear suspension and bodywork surfaces are new, and the geometry is optimised for the larger tyres. 'There was lots of FEA work on the body to take the weight out,' says chief engineer Julian Sole.

The Lola will be competing for honours against the petrol cars, but is hoping that a good result will encourage a buyer for the company, which went into voluntary administration at the end of May. The LMP2 version of the car has also received a significant upgrade, and two Judd-powered examples are running Lotus branding, one of which is contesting the full WEC.

ORECA 03

No fewer than eight ORECA 03s appear on the Le Mans entry list this year, but that is not surprising as it is based on the most produced Le Mans Prototype ever, the Courage LC70 / LC75. With the vast number of cars having been built, it allows ORECA to easily meet the LMP2 cost cap. Most of the 03s utilise the Nissan-branded Zytek engine, though a sole example runs with the Judd HK V8. A flywheel hybrid version of the car is also expected to re-appear in LMP1 at some WEC races later in the season.

HPD ARX 03/02 (below)

Powered by a Honda 3.4-litre V8 in LMP1 guise – built by HPD in its headquarters in Santa Clarita, USA – and a Honda V6 in the Starworks' LMP2 car. The cars run with Hewland six-speed sequential gearshift 'boxes, but not all have been converted to run on the larger front wheels, despite designer, Nick Wirth, being the first to experiment with 18in wheels front and back on the ARX-01 series cars. JRM will run with the smaller, 17in front wheels, which means the team will not benefit from the latest Michelin front rubber.

The teams are also working to improve the pitch sensitivity of the car, and so are running stiffer springs at Le Mans to compensate. That has led to further tyre issues. The LMP2 HPD is essentially an upgraded ORECA design, based on a Courage chassis, whilst the latest specification HPD has a slightly modified tub.

TOYOTA TS030

Toyota applied its Formula 1 development skills to its Sports Prototype, and has developed the car in record time. Not fast enough, however, to race at the Spa 6 Hours in May, following an accident with Nicolas Lapierre when the ECU intended solely for the dyno engines was inadvertently fitted to the racecar in wet conditions, causing the car to go into its fail safe mode at the fast first corner at Paul Ricard.

The TS030 will run with a capacitor system, which delivers large amounts of power for a relatively short period of time. 'We have a very clever system on braking and downshifting and we can control the motor, so it is a strong statement of our control technology,' says Hisatake Murata, hybrid project team leader at Toyota. The team developed the hybrid system over every other part of the car, believing that is where the greatest performance gains would come from. 'Performance of the rear system is the same since January. We ran a lot of simulation on how to use for the racing, chasing, pit lane limiter and so on, so we are now more clever. There are no big system changes since January,' says Murata.

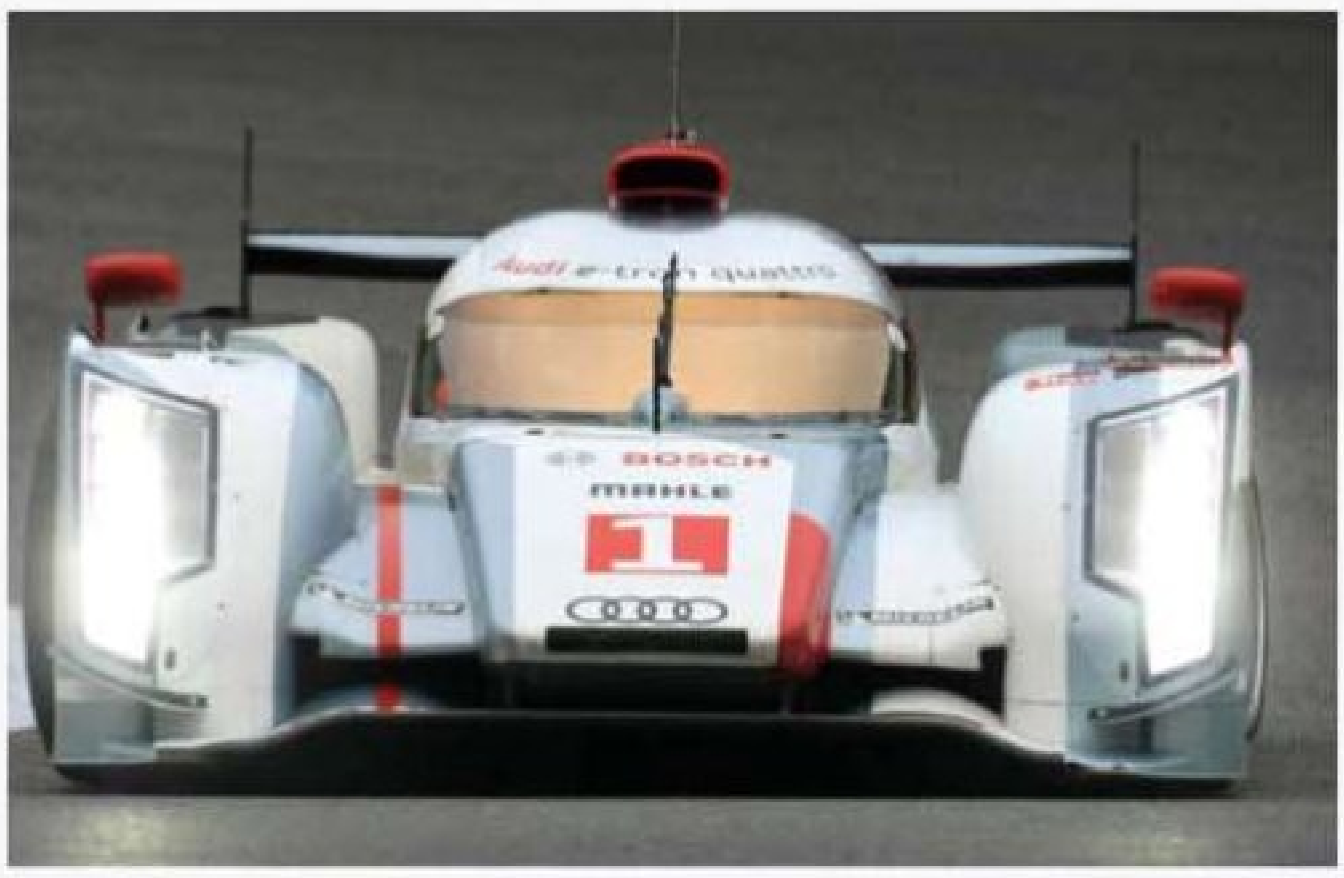
PESCAROLO 03

Henri Pescarolo's team faces a race against time to prepare its Judd-engined, Aston Martin-tubbed car for Le Mans. The car was due to make its debut at Spa but, according to the team, 'delayed payment deadlines from our major partner... blocked the delivery of some important elements from the suppliers in England.' Bodywork comes from the French aeronautic company, REXIAA.

DOME S102.5

Dome's S102 chassis has been updated to the 2012 LMP1 regulations, complete with fin and holes in the wheelarches, but under the skin there has been plenty of modification. To meet the downsized engine regulations introduced in 2011, a Judd DB 3.4-litre V8 has been fitted in place of the 5.5-litre engine previously installed, producing around 520bhp, which at Spa was found to be lacking. A development of the engine saw piston failures, so the team has resorted to a previous spec. After Spa, the decision was taken to replace the wiring loom with that used in the Pescarolo 03, also run by Henri Pescarolo's team, and to change the wheel bearings from titanium to steel after losing time at each pit stop at Spa. The team also switched from a Zytek gearshift to Megaline late in the programme.

AUDI R18



Audi worked on its 2011-winning car and shaved an estimated 85kg from the base weight, including 30kg from the Honeywell-developed turbocharger, 10kg from the bodywork and went to a carbon case gearbox. 'Given the fact that we had a single turbocharger, it was not in our interest to make it lightweight because it was already risky with this VVT system,' said Audi's head of engine technology, Ulrich Baretzky. Weight has also been saved by using an all-new monocoque, which is both stiffer and lighter than that ued in the 2011 car, which performed so well in inpromptu crash testing by Allan McNish and Mike Rockenfeller. The reason for the extreme diet is that two of the four R18s will run as hybrid Quattros, using a flywheel system capable of delivering an extra 200bhp to the front wheels, though drivers question how much is *actually* delivered.

The weight saving measures will also benefit the two non-hybrid cars. At Spa, the non-hybrids, carrying two litres of fuel more by regulation, went a lap further than the hybrids, and mileage is tight between the two again at Le Mans. 'Consumption of the Ultra cars was higher than I expected from the values I saw on the telemetry, but then in the Quattro you have guys like Tom [Kristensen], who is our master in fuel conserving anyway,' said Audi's Ralf Juettner. '[With the Ultra] you can place ballast much better, so it is purely old fashioned motorsports – c of g and better weight distribution.'

NORMA MP200 (below)

The tiny French concern is back once again with its under-funded, Judd HK-engined LMP2 design, which dates to 2010. The ACO originally held this up as an example of a cost-capped LMP2, but the mass produced ORECA outclasses it on that front. At the Spa 6 Hours, the sole example of the car was heavily damaged, bringing its participation in the 24 Hours into doubt.


POWERED BY
NISSAN
MICHELIN
0
NISSAN

FERRARI F458 (above)

Weight: 1260kg
Air restrictor: 28.3mm
Gurney: 25mm
Fuel capacity: 90 litres
Height rear wing (from roof): -200mm

The Italian manufacturer raced the 458 in 2011 with tyres developed for the 430, and tyre development over the winter has improved the car. Front tyre size has increased, as with all the other GTE cars at Le Mans, and the front wheelarches, wings and splitters have all been enlarged to accommodate the bigger rubbers. Airflow over the bonnet directs hot air from the radiator to the rear wing, and designers, Michelotto, have changed to a single air restrictor deeper in the throat of the air ducts, improving torque from the 4.5-litre V8.

ASTON MARTIN VANTAGE

Weight: 1195kg
Air restrictor: 29.7mm
Gurney: N/A
Fuel capacity: 95 litres
Height rear wing (from roof): -100mm

Aston Martin's waiver-laden Vantage runs 50kg lighter than the 1245kg minimum limit. The air restrictor is 29.7mm, compared to 28.6 of the Ferrari, and the car will not run a Gurney flap on its raised rear wing at Le Mans. It also carries five litres more fuel than the others in class. The rear wishbones have been strengthened since Sebring in March, and the front uprights changed to be the same as the GT3 car. From front to back the aerodynamics have been improved, the biggest gain coming from a new rear wing.

CORVETTE CGR

Weight: 1260kg
Air restrictor: 29.2mm
Gurney: 25mm
Fuel capacity: 90 litres
Height rear wing (from roof): -125mm

Corvette's GTE underwent an extensive development programme over the winter. New aerodynamics to accommodate the larger front tyre led to a front that is two inches wider overall, while the rear wing is higher. The C6R has been handicapped by the same Porsche-inspired 15kg applied to Ferrari, but the American manufacturer has been given a 1.3 per cent larger air restrictor, up from 27.9mm to 29.2mm.

PORSCHE 997 GT3 RSR

Weight: 1210kg
Air restrictor: 28.9mm
Gurney: 25mm
Fuel capacity: 90 litres
Height rear wing (from roof): -200mm

Balance of Performance is keeping Porsche in the hunt for GTE honours in Europe, the US and at Le Mans. The latest change is to reduce the base weight of the 997 by 25kg, but the balance of the car relies on ballast carried in the nose, and so the ACO allowed Porsche to reduce the weight by 10kg, and put a 15kg penalty on the other cars. Porsche turned to its hybrid 997 for weight saving techniques, using its lightweight doors and fire extinguisher, and with other modifications including carbon switchgear, saved 8kg. The remaining 2kg came from the nose. Teams are also working on the pitch sensitivity of the car, although it is clearly quicker than its previous incarnation.

Cost-capped Formula 1

With a budget dwarfed by the front-running teams, is HRT an example of Formula 1 – how fast can you afford to go?

BY SAM COLLINS

Late in 2009, a new Formula 1 team was born, designed to run to a budget of just £40m, as designated by the FIA. Campos Grand Prix had partnered with Dallara to develop a new car, the F111, but changes in the team's ownership and management led to that car never being fully completed. Since that false start, the team has morphed into Hispania, and eventually HRT (Hispania Racing Team). Since its race debut, it has done little more than prop up the Formula 1 grid, but a recent re-structure is aimed at changing that.

The Hispania-Dallara F110 of 2010 wasn't ready for the first race of the season and raced for a season without any notable developments, beyond some new wing mirrors and a different make of fuel cell. The 2011 car, the F111, was late too, and the trend continued into 2012, although the F112 did manage a brief shakedown run at Barcelona ahead of the opening race meeting.

Toni Cuquerella was appointed technical director of the team in early 2012 – a position that had been vacant for some time – and what he inherited was a team in a state of disarray. 'The car was very late. The drawings only started in September of 2011, just after Geoff Willis had left the team,' he explains. 'The car was done with the people who were just remaining in the team, and Jacky Eeckelaert, who was leading it. There were different clusters of people all around Europe because we did not have a central facility. We did not have a drawing office or stress analysis or any of that stuff. So the design of the F112 was done by a number different companies – one did the monocoque, another the front wing and another the rear wing. Even when the groups are in the same country, they are nowhere near each other.

'It's fair to say the main cluster of these companies has been in Augsberg, Germany, around the Holzer Performance company, who were the suppliers of the design of the car. The chassis is manufactured by Carbo Tech of Austria, but it is not designed by them. That was done in England. The situation is really a big mess and it's difficult to understand as many people and companies were involved. I think we were lucky it was all assembled in a reasonable way… You'd expect things not to fit together but actually that wasn't really a problem.'

> **"Our biggest lack of performance is really aerodynamics"**

PROJECT TARGETS

The complex nature of the car's development left the car without any real direction on the face of it, but there were still project targets. 'The target was to be on time because everybody knew it was very tight to get a car done to be at the first race, as well as meet the regulations, but a big one was to be quicker in comparison to the rest of the field than the last car. Some of these things have clearly been achieved, but others we are still working on.'

The result is the HRT F112. It made it to the first race in Australia, but was clearly

less developed than most of its competitors and lacking in performance, so much so that both cars failed to qualify for the race. It is has since improved and both cars have made the cut at every race since, with a highest finish of 15th at Monaco. However, the team is still the least competitive in Formula 1.

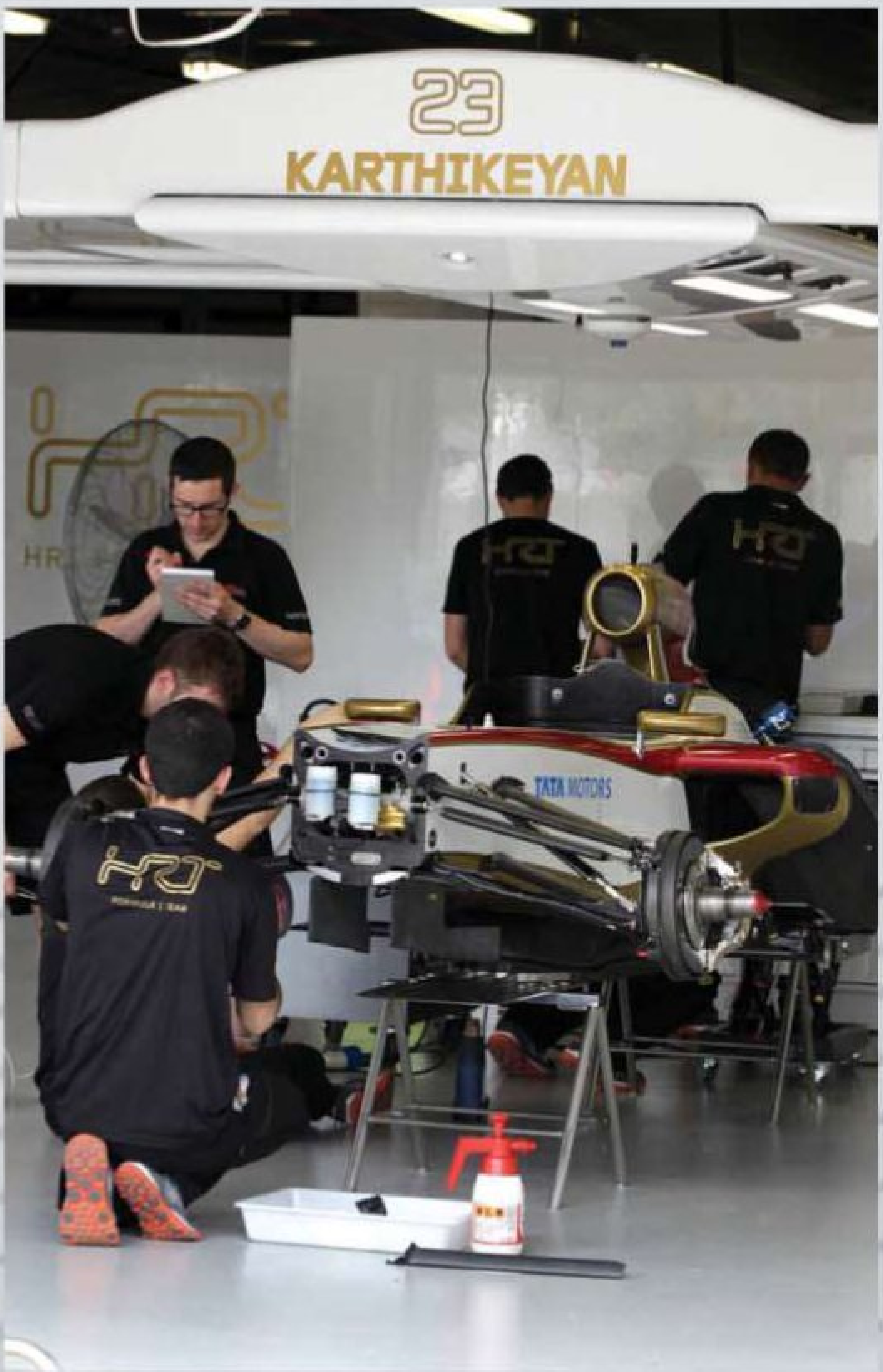
'Our biggest lack of performance is simply aerodynamics,' says Cuquerella. 'There are other things we may be missing compared to the top teams, but 90 per cent of the difference is on the aero side. Really that's the main task of development, because the car was built in such a short time. We have a group of aerodynamic engineers in Munich, Germany, and we use the second Mercedes wind tunnel at Brackley to test.

'You can see from looking at all of the cars on the grid, they are beginning to become very sophisticated aerodynamically. When these rules started, the cars were very simple, but now that has changed. This is the result of the stability of the regulations and the effort the teams have been putting into exploiting them. If you look at the front wing in 2009, for example, they were all very simple. Now they're very complicated again. We are in the process of getting there too, but we are so far behind. At the moment, in every session in the wind tunnel our car is very good and very productive because we've had so far to go forward. With the other teams, sometimes you can come back after a week in the tunnel without having found anything really useful. We were always finding something, but it is still not enough.'

ROLL OVER

The short gestation period of the car means that it carries over many concepts from the F111 and the Dallara F110. But it is actually quite a different car. 'When the aero people started in September, they did not have enough time to properly evaluate the car concept and come up with a new one, so they started with the baseline of something they knew from the 2011 car. That's why it looks very similar to the old car but, if we had started earlier, it would have been a lot different.'

One of the major aerodynamic developments of the F112 was to optimise the cooling, compared to the inefficient F111. 'That has changed completely. The radiator cores are much smaller, because the car last year was a bit too



After being behind schedule in 2010 and 2011, the principal aim of the re-vamped HRT was to be ready for the 2012 Australian GP

> **"a big [target] was to be quicker in comparison to the rest of the field than the last car"**

The real cost of running a competitive F1 team is in development, and HRT has to choose very carefully which areas of the cars to develop, balancing potential gain against cost at every point

safe on cooling. We are leaning them at 20-25 degrees and they are very long. You can see the influence of this from outside the car. The undercut is massive compared to last year and the intakes are much smaller as well.'

A pair of curious NACA ducts also appeared on the car next to the driver's headrest, though it turns out these are simply to cool some onboard electronics, as the team feel that at some of the hotter races they were too marginal on cooling.

QUICK SHIFTS

Mechanically, the car retains the Cosworth CA engine, and uses the same Williams gearbox found in the race-winning FW34. 'When you get to that certain level, the gearbox is not a performance differentiator between the cars. Everybody's got quick shifts so, from the best to the worst, is probably only a couple of tenths a lap. Williams give us a good product and it is reliable.'

One of the most notable things about the Williams 'box is its very low upper surface, which opens up a range of aerodynamic possibilities. 'In terms of volume, it is no smaller than a normal gearbox, but the top is much lower, though we are not yet taking advantage of that performance potential.

'With the engines there are simply not many options out there, but we don't have anything signed for next year.'

Using a bought-in gearbox gives some design restrictions at the rear of the car, notably around the rear wing mounting and suspension pick-ups, so the rear of the F112 is likely to be similar to the rear of the Williams.

'We don't use the Williams suspension geometry because that is not allowed according to the Concorde Agreement,' says Cuquerella. 'All of the components are our own, like the torsion bars, pullrods, wishbones and Penske dampers. We are limited by the inboard mounting points on the casing, but everything else is ours. We are probably not very far from what they have at the rear but, in reality, we don't know.'

Notably, the F112 is longer than the F111, for a number of reasons, but it's likely the HRT engineers found that a longer car gave more stability and gave the aero team bigger surfaces to work with. 'This car was designed to be able to accept KERS, the previous two cars were not. And that requires more space inside the car. But the car does not actually have KERS. When I started to make decisions in this project it was very late, but one of the decisions I made almost right away was to drop KERS. In our case, we can spend more effectively in other areas, like aerodynamics. If you're in the midfield, you need KERS to give you that extra bit but, in our position, we simply need more aero budget. We are so under developed that putting that money in other areas just makes more impact.'

> **"One of the decisions I made almost right away was to drop KERS"**

That is, of course, the real reason HRT finds itself at the back of the grid – it is very restricted on its budget. 'That's an understatement, it is a huge restriction!' exclaims Cuquerella. 'We are counterbalancing R and D against the benefit of what comes out. As engineers, we like tables, coefficients and factors like that. So we put on the table how much it costs to do a particular area of development and what we predict the lap time gain to be. Then the one at the top of the list gets done. We cannot do everything we want to do because we don't have the money for it. Sometimes we have to wait to manufacture the new parts until the differences are big enough to make it worthwhile. When you bring something new in, you have to scrap everything you had before, and that is expensive. It is not a problem for top teams to throw away brand new front wings, but it is for us.'

Despite what appears to be an incredibly tight budget – in F1 terms at least (HRT would not be drawn on numbers) – the team is still able to qualify for races and, with Formula 1 moving back towards some kind of budget restriction, in future HRT could start to move forward.

TECH SPEC

Engine: Cosworth CA2012 2.4-litre V8
Max rpm: 18,000
Engine weight: 95kg (minimum FIA regulation weight)

Chassis: carbon fibre and honeycomb composite monocoque

Suspension: carbon fibre double wishbone with pushrod operating torsion springs and anti-roll bar via rocker (front) and pullrod operating torsion springs and anti-roll bar via rocker (rear)

Dampers: Penske lineal hydraulic

Fuel tank: Kevlar reinforced rubber

Wheel: carbon fibre with integrated electronics and instrumentation

Steering system: HRT hydraulic, servo-assisted system

Gearbox: Williams seven speed with 'Quick-Shift' sequential semi-automatic shift

Clutch: carbon multi-plate

Brake material: carbon discs and pads

Brake calipers: six-piston all round

Cooling system: aluminium oil, water and gearbox cooler

Seat belt: six-point OMP

Cockpit: removable seat made of anatomically-formed carbon composite and HANS system

ECU and logging system: FIA standard ECU and FIA homologated electronic and electrical system

Battery: 12V

Wheels: magnesium alloy

Tyres: Pirelli P Zero

Dimensions:
Width: 1800mm
Height: 950mm
Front track: 1445mm
Rear track: 1420mm

Weight: 640kg (FIA minimum)

The power of dreams

How one English F1 enthusiast set out to do the impossible – to build a complete, running, driving F1 car in his garden shed

Building a Formula 1 car is not a simple task. It requires significant outlay on staff, facilities and the fabrication of thousands of bespoke parts. Even preparing a historic car for a series like Boss GP, which caters for high performance unlimited cars – often modified grand prix machines from the late 1990s – is a significant undertaking. It's not the sort of thing you do in your garden shed… So to find a 2001 BAR003 under construction in the back garden of a very normal house in a very normal street in a small town near Brighton, England, is something of a surprise.

None of the above seems to have put off one English Formula 1 enthusiast, who is attempting to do exactly what everyone says is impossible, in a shed at the end of his garden. Kevin Thomas is a keen collector of motorsport memorabilia, especially car parts, though you would not know it if you paid a visit to his house.

'It probably started 20-odd years ago when, in the late '80s, I was a quite a big Formula 1 fan. I went to the racing car show at Earls Court. One of the stands had some odd bits of old cars for sale, so I bought a Formula 1 car spark plug and a brake pedal. What was apparent was that it was all considered rubbish, nobody really wanted this stuff. You could buy a Tag McLaren engine for about £300 at the time,' he explains. 'With the internet, more and more parts appeared on more websites, and I started to collect things like tyres and bodywork.'

BY SAM COLLINS

There the hobby would have stayed, a typical memorabilia collection, and barely worth a passing mention in these pages, but Thomas chose to take things a step further.

'A couple of years ago there was a Formula 1 car on display in a Renault showroom near Brighton. I went along to see it and thought to myself, "I would love one of these." A short while later, a company called Memento Exclusives, run by an ex-BAR mechanic, put a chassis on eBay. The listing ended and nobody had bid on it, so I sent the guy an email and he replied telling me he actually had three in stock. So I did a deal with him and, a little while later, he turned up on my doorstep with a Reynard BAR-001 and a BAR003. I paid him cash for the pair.'

No high-tech workshop, no engineer, just a man and his shed

Thomas had no background in engineering, no connection with the motorsport industry and no specific knowledge of modern competition car construction. But he decided there and then to undertake a substantial project – he wanted to be able to drive one of his newly acquired chassis on the tracks he saw on television every other weekend, despite only having the tub.

'I decided to sell the older of the two tubs to a company called FMCG who sell a lot of parts for Force India. The 2001 car had a chassis plate so it was easy to identify, but the 1999 car did not. At the time teams would routinely remove chassis plates at the end of the year when the cars left their custodianship.'

TRACK PROVENANCE

His tub, BAR-003/2, never actually raced in a grand prix, but was used as a T-Car at five rounds, so has some track provenance. As the project developed in Thomas' mind, and his garage, it became obvious that there simply was not enough space to house the car. So he did what all Englishmen do when getting serious about a hobby – he built a new shed.

'I slowly started to plan out what I could do with the car, and it quickly became clear that it was very difficult, or even impossible, to get the right parts. So I have to use what I can get. For example, the inboard suspension mounts on the car at the moment are from a Benetton. Other parts I have not got I will have to be very patient and wait for, but if they do not come up for sale I will have to adapt something else.'

Looking around the shed, this approach is clearly evident. A 2007 Spyker nosecone leans up against a Honda RA107 gearbox main case, and all around are an assortment of Formula 1 car components. Some are just parts of Thomas' ever-growing collection, but others will be adapted to fit the car. Parts from the collection are traded with other collectors to obtain more suitable parts. For example, the floor from a Spyker was tried and found not to fit, so some trading with a memorabilia dealer turned up a BAR-004 floor, which did fit.

'One of the things you have to think about is that there's no owner's manual for this car. I don't have the CAD files, or even an exploded view, so when you buy something like a cockpit leg protector you have to work out

how it fits into the car. That's all part of the challenge. Part of the fun is working out what I'm going to do when I can't get the right bit. The sidepods were an example. It was just impossible to get the right ones, so I got a slightly damaged engine cover and sidepods from a later Williams-BMW and cut it up, modifying the sidepods to fit with the correct engine cover I already had. I have also taught myself how to do basic fabrication with carbon fibre – the wet stuff, which is resin based to help do things like this.'

The £30 ATL F1 fuel tank was one of the best deals of the whole project

VALUED ACQUISITIONS

This approach has yielded some alarmingly good value acquisitions. Thomas is especially proud of the fuel cell – a genuine ATL F1 unit – that had been repaired by the tank specialists in Milton Keynes on behalf of BAR who then never fitted it to a car. In principal it's worth thousands of pounds, but Thomas purchased it for just £30. 'I don't just buy things from eBay. There's a whole group of memorabilia sites and dealers around the UK, but also you start to build a network of contacts and they know you are looking for particular types of car parts. Then, when stuff turns up, they let me know. I get one or two emails a week from people saying, "do you need a spare floor?" Things like that. Also I check eBay religiously every morning. It's really immaterial what it costs as the people on there do not necessarily realise the value it has to you. They think it's just a worthless old control box from a Honda.'

KNOW YOUR LIMITATIONS

If this all sounds a bit too good to be true, Thomas is aware of the fact that he cannot seriously build every element of the car up himself, and that to get a car like this running is near impossible if all of the parts are F1-derived. He also knows all too well that running 3.0-litre V10 F1 engines are not cheap, and very hard to source, and that their complex hydraulics and air valve systems are really beyond the scope of the amateur builder.

'I have got it to the point now where I can pretty much get it rolling, but you could not drive it. The wishbones would probably snap on the first bend. In the next year or two, when I can find more of the correct parts, and some spares, I will get it properly rolling. At that point I will take it to someone to have it plumbed

Williams BMW engine cover and sidepods were cut up to make the sidepods

Thomas has amassed a number of suspension components, and plans to use a set of wishbones from a Honda RA107, along with a Hewland FTR gearbox

Where some have gnomes at the bottom of their garden, Thomas has an F1 chassis floor, or two...

Though a full set of carbon /carbon brakes have been sourced, driver ability dictates the use of steel

in, get the fuel cell installed and have the wiring loom made up.'

Sourcing, or fabricating, the bodywork and ancillaries is one thing, the mechanical components are quite a different challenge altogether but, like the rest of the car, have been sourced from far and wide. A 2002 BAR steering column, for example, might end up being mated to a 1998 Benetton steering rack, but the really big money will need to be spent on the powertrain. 'I can't afford to buy or run a proper V10, so I'll probably go for a Formula Renault 3.5-litre engine. That will be plenty fast enough to scare the living daylights out of me,' he enthuses. 'With the gearbox casings I have, even if I found the right gears and shafts, I couldn't maintain that transmission or the hydraulics it needs. So for this car I'll probably use a bog standard Hewland FTR, or similar, but as that impacts the rear suspension and wing mounting, I'll probably have to work around it and adapt those. It means I won't get to use the correct rear suspension, but that's all part of the beauty of it – I don't how it's going to work but I'm going to be able to make it work somehow. I don't have £10m to fabricate proper BAR-Honda rear suspension, but I have a set of wishbones from a Honda RA107. Using those, I will be able to adapt something though.'

> **"I don't how it's going to work but I'm going to be able to make it work somehow"**

The eventual result will not be for historic racing or any serious competition, just for the thrill of driving an F1 car he has built himself. He has only done a few laps in a 2.0-litre Formula Renault at a Thruxton track day in the past and is fully aware that his skill level will be below what the car is cabable of, so the car is being built with that in mind. For example, despite having a full carbon / carbon brake set up he will use more conventional steel brakes instead. 'I'm going to use quite a lot of parts from the less technologically advanced cars so they're not so difficult to install, and make it literally arrive and drive. It will *look* like an F1 car because it *is* an F1 car, it's just that it will be made up of three or more different types of F1 car. It won't be within the performance bracket it was built and designed for originally, but it was designed to be driven by expert drivers, and none of us can drive like that, myself included. But even then, it should still wipe the floor with most other cars on the circuit, but still only be 70 per cent of what it could be. The beauty of having your own Formula 1 car is that you can just build up at your own pace, go to tracks you want to go to, and do your own thing.'

Ultimately, the build is going to be a long and complex process, so you might wonder why he did not just save up the £650,000 needed to buy a Lotus T125 – purpose designed for people just like him. Or even choose the more cost-effective route and buy an old F1 car in running condition for around £100,000?

His supportive wife explains: 'He could just go online and do that, but that's not what he wants to do. He wants to build it himself... Not a lot of people I know genuinely have real interests or hobbies. Most people's hobby is to go out and socialise, whereas my husband doesn't do things like that so much, instead he has a real hobby. I've managed to contain it in that it's in his office upstairs and it's in the garden.'

Clearly, it's not just his wife who has been supportive. Members of the F1Technical.net forum he participates in help him in any way they can, and even established F1 people have taken time to pass on advice. 'I have been speaking to people who worked on the car in its era, like Andrew Green from Force India. I have spoken at length about the project and he has helped a lot. I tried a few times to contact the Mercedes team, but they didn't even reply to my emails.'

Thomas hopes to have the car complete in around three years time, but admits he has already started thinking about the next project, so if he gives *you* a call looking for some advice, do try to help him out!

BUDGET SO FAR...

Tub	£3200
Wheels and tyres	£700
Engine cover	£300
Floor	£300
Rear wing	£300
Barge boards	£60
Fuel cell	£30
Sidepods, after butchering	£300
Axles and hubs	£400
Shed	£1500
Total so far (including many small ancillary components, such as wheel nuts and uprights)	**approx £8000**

The tablet revolution

Tablet PCs are rapidly replacing laptops, and the software being developed for them is revolutionising the way things are done in the pits and paddock

'When people come to us they are pretty great guys. To actually get a job at the top of motorsport in a company like this, they have to be very bright and committed individuals,' enthuses Pio Szyjanowicz of Cosworth. In recent times, many of these new, bright, young engineers came bearing a new piece of consumer electronics, namely a tablet computer, such as the Apple iPad or Samsung Galaxy. The arrival of this new breed of engineer and the new application of existing technology started to change the way things are done in the pits and paddocks of the motorsport world.

'Eventually I think everything we do will go to tablets, and we have already started thinking that way,' explains Szyjanowicz. 'Some of our older software was very Windows-centric in the way it was designed, especially with its interface, which absolutely needed a laptop, a keyboard and a track pad. With Toolset we have thought about that and the type of devices it will be used on. We can see the day when the laptop at the racetrack is replaced with a tablet PC at the racetrack, and that day is not very far away.

'That is one of the things that we as a company have to invest in. You can't just open a piece of software on a tablet and expect it to work properly. A lot depends on how you design it in


The Mobile Demand xt T7000 tablet, as used in NASCAR and by Pirelli in F1

the first place. Things like screen size resolution and information like that we get through our relationship with Microsoft. It is all about having the right code and the right people in the right place. We also have an iPhone and iPad app developer in house, though I can't tell you what he is working on yet!'

But Cosworth is not the first to look at tablet computing for trackside use. This new piece of electronic technology has been tried and tested in the least likely place, NASCAR. In 2010, the now defunct Red Bull Racing NASCAR Cup team (RBR) was looking for a competitive advantage and chose to adopt the newest digital technology. The team was renowned in Stock Car racing for its implementation of cutting-edge technology and wanted to automate the collection and distribution of critical car performance and equipment data in real time to speed up decision making at the track. Working with real-time data would let the team make quicker decisions that could change the outcome of each race – when to call for a pit stop, how much fuel is put in the tank, how the tyres are wearing. Previously, this had all been carried out using a pen and notepad.

ROBUST HARDWARE

Motor racing is a harsh environment for electronics, with a wide temperature range, precipitation, and all manner of other challenges. The huge amount of travel undertaken by the teams is also relevant, as is the robustness of the hardware itself, as the vibrations caused by a Formula 1 engine running in a garage, for example, could easily damage a spinning disk hard drive.

Previously, the Red Bull team's use of pencil, three-part paper forms and dry erase boards would mean that information took at least 15 minutes to be available to all the other team members. As a result, in Cup races where strategy is critical, the team would not receive the data in time to make strategic decisions before the next pit stop. Consequently, they felt they needed a better method of data sharing, so looked for a technological solution.

Pirelli, too, was looking for a system of tyre management when it arrived in Formula 1 at the start of 2011, especially as the outgoing supplier declined to sell their system to the Italian firm. Interestingly, both Red Bull and Pirelli opted for the same rugged, military-spec tablets from Iowa-based firm, Mobile Demand. The xt Tablet T7000 runs Windows 7 and is powered by the Intel Atom processor found in many netbook-style PCs. But additional to that basic functionality, the tablet offered extensive communication capabilities, allowing teams to set up their own secure wireless network with built-in WiFi, as well as integrate their mobile 'phone receivers.

For both Red Bull and Pirelli, tyres were at the core, and a critical component of the tablet was a barcode scanner. This was used by both to track tyres through their life, especially when in use at the track. For Red Bull, what started out as a search for a product to replace a standalone barcode scanner produced a single, rugged PC

Barcode scanning is an integral part of the tablet revolution in motorsport engineering

with barcode scanning capability, which could automate time consuming routine tasks. For Pirelli, it was simply a case of upgrading the systems already used in other championships.

At Red Bull, the tablets were being used by the spotter, tyre specialist and the refuelling mechanic to record and compute data. The barcode scanners assisted the tyre specialist in organising the race tyres throughout the weekend, while timing and scoring provides the spotter with information to assist the driver during sessions. The refueller provided fuel data to the race engineer in real time.

'You would not believe the interest we had from the other guys [NASCAR teams] wondering what we have, what we do with it,' said Chris Lambert, who worked as a spotter at RBR. 'NASCAR itself looked at it with us. There was no keeping this a secret around the track.'

'We sped up the data flow probably more than a hundred fold,' explained John Probst, who was technical director at RBR. 'The tyre guys said the first weekend we had the tablets at the track, it saved them 90 minutes just sorting tyres.'

For Pirelli, the tablet forms part of what it calls the racing tyre system, or RTS – the integrated computer system it uses to collect data during tests and races.

This platform, designed by Pirelli's Information Technology division in Milan, allows engineers to monitor the performance, wear and evolution of each tyre when it is on track. In particular, Pirelli's RTS tracks details of the electronic 'passport' that belongs to each tyre and updates it in real time, from construction to recycling.

The tablet is considered an extension of a laptop, and gives each engineer the ability to track each tyre in each session and feed information to the servers in Milan. The tablet feeds directly to a server in the Pirelli truck, wirelessly. That is then beamed back to Milan for further study. Even post-processing can be done on the tablet, but is more commonly done on the laptop.

The server is updated with information about every one of the company's competition tyres (made in Izmit, Turkey) during each test session and race. The central server also stores information about the production process and quality control of every tyre at the factory, certifying its identity and providing relevant data about its characteristics. Once the tyre has reached the circuit and is mounted on a wheel, the RTS collects all the information about the fitting phase and optimal tyre pressure range from when the tyre is first fitted to a rim. Other information stored includes the weight needed for balancing the tyre, as well as the dimensions and weight of the tyre when first fitted. When out on track, the car sends telemetry data relating to tyre pressure, temperature, wear and degradation. This information is recorded on the tablets of the Pirelli engineers after the teams correlate it with the car set up, and other telemetry, and sent to the central server.

"We sped up the data flow probably more than a hundred fold"

The accumulated data is available for Pirelli's engineers to consult in real time from the track. At the same time, the R and D division in Milan can also make full use of the information to provide analysis and future projections that are sent on to the teams.

Formula One Management (FOM), which helps the system to run by providing precise lap times for every driver, also receives data in real time from Pirelli, such as which compounds are fitted to which car. Formula One Management then sends this information out in live TV broadcasts for the public at home. With only three minutes between the tyres being fitted to the car and the start of the warm-up lap, it would be impossible to do this the old pencil and paper way.

For 2012, Pirelli rolled out an updated version of the system that will enable tyre analysis over a single sector and prescribed split times, in order to provide a complete picture of the performance of a tyre during each phase of the lap.

LATEST EVOLUTION

The latest evolution of the RTS will also make it possible to compile and send final reports to each team in real time, as well as to Pirelli's R and D division. Finally, for 2012, each tyre's temperature will be measured at the end of every session by a pyrometer that can send instant readings to the engineers' tablets and the central server via Bluetooth. However, the Pirelli crew still carry a pen and paper just in case!

The Mobile Demand tablet has a camera built in to it but, for both Red Bull and Pirelli, it is largely redundant as it is only a 2 megapixel unit. Pirelli therefore equips its engineers with an 8 megapixel Fujifilm point and shoot camera so they can photograph and analyse any failures and send the images, via the tablet, back to base. At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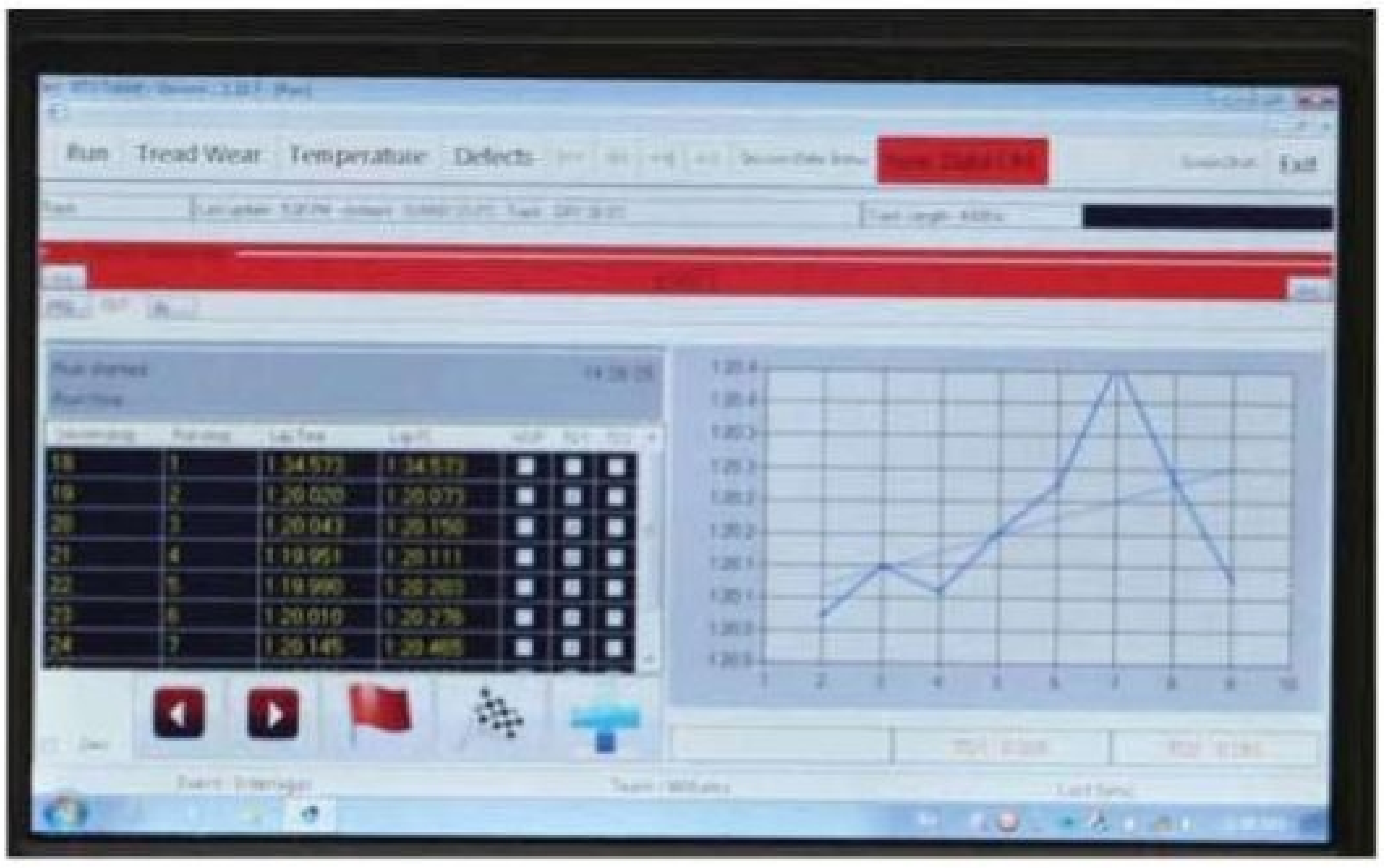
Even drivers can benefit from the use of tablets, which give them real-time information about lap times and tyre wear

the end of each day, the data is backed up and synchronised with the servers in Milan.

'It is a very solid bit of kit,' explains a Pirelli engineer, 'made for outdoor use. We have had no failures. An iPad is too fragile. It's fashionable, but not strong enough. What we have is best for robustness and performance.'

Battery life is also a possible limitation with tablets, but Pirelli claim it is good for a whole Formula 1 race, though for longer events like Grand-Am races they rely solely on a laptop instead. As such, the Pirelli engineers consider the tablet an extension of their laptops, rather than the other way round. Curiously, though, the Red Bull team never reported any battery life issues using the same system in 500 and 600-mile races.

"a critical component of the tablet was a barcode scanner"



A data screen from Pirelli on a tablet, from the 2011 Brazilian Grand Prix

INTO THE MATRIX

But tablet computing and the concepts around it can be taken further into the world of production and onto the parts room. Mazak's Mazatrol Matrix system hugely enhances the capability of its machine tools, and even helps users make decisions based on what it tells them in a conversational process (more on this in a future issue). The Mazatrol Matrix is now standard equipment on all Mazak models, such the new Integrex IV series, Integrex e-series, Variaxis II series, Nexus series, Vortex five-axis machining centres and Cybertech Turn machines.

Once a part has been made using such technology it ends up on the parts shelf and eventually on a competition car, and this is where the software of Kinetic Racing Technologies comes in. It tracks parts throughout their life, using a barcode scanner – just like the ones found in tablet computers.

'In lifing a part, each item needs to have a unique reference number, and there are different ways to do that,' explains Scott Jasamund, the company's founder and the man behind the software. 'A lot just use an engraving pencil, or have the number stamped on, but some of the more forward thinking teams wanted other options, so we use a barcode system.'

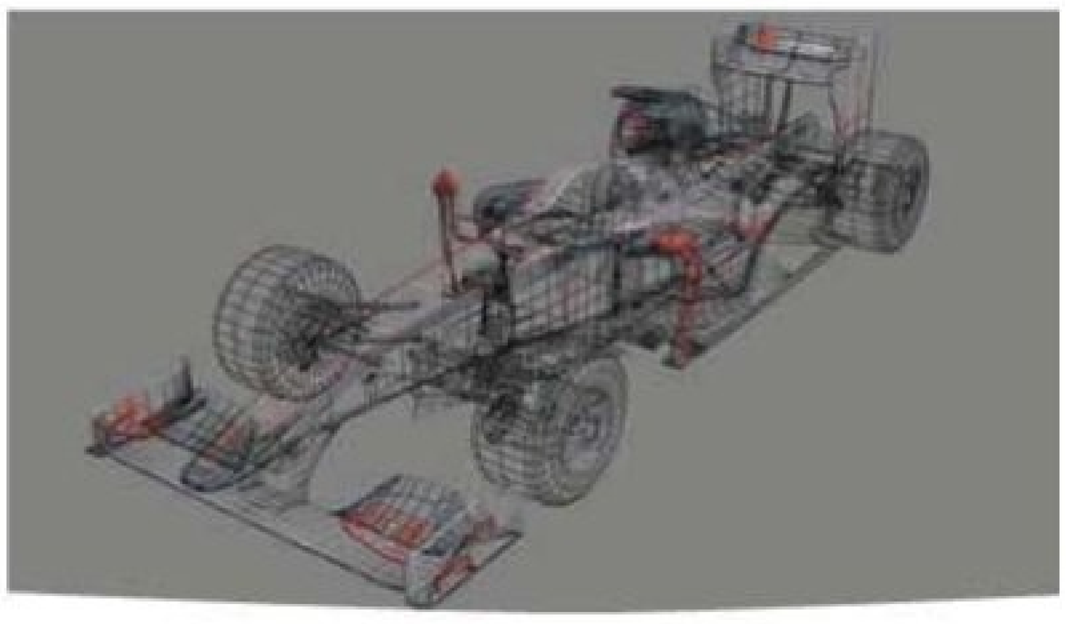
Some components in the past have actually failed due to etched part numbers and very detailed papers on this can be purchased from the SAE. However, affixing a barcode in such a harsh environment could be incredibly tough. But Jasamund says his company has solved this: 'We came up with this 2D adhesive barcode. It is very resistant to heat, chemicals and wear, and being 2D, it has a lot of redundancy in it, so up 60 per cent of it can be worn away and it's still fine. We have completed a 24-hour race with these on brake pads and calipers, and they are fine. The only things we can't put them on is exhaust manifolds as they are just that bit too hot. But you can also use a laser to direct etch a barcode onto individual parts, especially those [that will be used] inside an engine or gearbox.'

Once the barcode is affixed, the part can be tracked by anyone working on the car, and makes the process of component lifing an integral part of running the racecar. The Windows-based software runs on all tablet PCs and has already found a home in many top racing teams in North America. Jasamund stresses that whilst there is other lifing software out there few, if any, programmes are designed specifically for motorsport. His, he argues, is different, and the name he has given it is a dead giveaway. It is called Racecar Preventative Maintenance Pro, or RPM for short.

It has been developed using Jasamund's experience as a data engineer working in both Stock Car and Sportscar racing. 'Teams have different ways of working and this software had to be able to handle that. As a result, it is very versatile. On the Porsche RS Spyder, for example, they would have 1000 parts, of which they have two or three of each. With a NASCAR team they have perhaps 100 parts, but have 1000 or so of each of them. It's a totally different scale. The software was primarily designed for a racing team to use for part lifing. Some teams fall into the trap of using an accounting-based system for part lifing, but it never really works out. Probably because accountants don't understand racing, and racers don't understand accounting.'

To handle the broad scope of customers, Jasamund offers two versions of its software, one of which was developed specifically for the racing departments of major car manufacturers.

'One of the thing we have done is do two versions – team and manufacturer versions. We developed a version with Porsche Cars North America and they define all of their own parts cruden



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The already rugged tablet has a strap on the back so it can attached and not dropped, though in reality it has survived the rigours of motorsport use

Data can be downloaded directly from the racecar and immediately sent to the servers in the race transporters, and to component manufacturers

and the triggers for inspection and replacement. They enter all of that, it is encrypted and uploaded, then the teams can download the part data and details, but the one thing they cannot do is adjust the details. The manufacturers can then follow how the teams are using that part. It can record every session it ran in and can follow all of the teams without any direct interaction. They just upload the data and download any updates from the manufacturer. They will then get failure data for all teams, which helps them balance things and track any batch issues.'

Whilst, ideally, every single individual component is tracked on the car, larger sub-assemblies can also be tracked. 'All of the parts inside are part of that, so if you change a 'box, for example, then all of the parts associated with it go with it. But if you just change a ratio, then it tracks that, too. If that ratio then gets re-used in another 'box, for whatever reason, it is tracked throughout with its life,' explains Jasmund. 'The system then automatically highlights any component that is reaching the end of its life and tells the car chief whether it needs inspection or replacement, even running off a job sheet for the mechanics. It's quite intelligent. If the data is entered incorrectly, it can highlight that too, so if the team enters two right rear brake discs and one right front disc for a single car it will highlight it and raise a query. Most often it's just poor data entry, but it has prevented cars running with the wrong parts fitted before.'

Whilst accountants may not understand racing, racing parts software does need to have an accountancy element, not least because amateur drivers tend to crash a lot. 'You can add in extra details too, like where the part is [stored] in the shop, what shelf it is on etc. Also there is a costing element to this. Nothing too complex, but the reason it's there is for crash damage reports, so if you have rental drivers and they go out and smash up the car, you can do an itemised invoice automatically using the system.'

Jasmund, like the crews at Pirelli, Mazak and Cosworth, are looking forward to the future. While software and tablet computing may not on the surface seem to lead directly to an on-track advantage in the way a new wing or engine update does, it can still lead to improved lap times.

'I'd like to integrate this more closely with the data acquisition system, where this runs seamlessly with a data logger and outputs onto a tablet. Let the software go through the lap outings and highlight any abnormal loads, and suggest parts to inspect. If a sensor is giving a strange signal, it should highlight it. For example, if there was something wrong with the damper velocities, it would highlight it. A lot of my time as a data engineer is just spent making sure the car is healthy, checking things after every session are okay, checking to see if everything is within parameters, to see if there is anything untoward going on. That can sometimes leave very little time before the next session to look at performance.'

> **"It's quite intelligent. If the data is entered incorrectly, it can highlight that, too"**

That extra time that could be freed up for the engineers to focus on making the car go faster, rather than just making it go at all, is now becoming a reality. Indeed, it may not be too long before engineers find themselves making their way down to RadioShack rather than the performance parts store to buy a completely different piece of new technology.

TECH SPEC

xt Tablet T7000

Dimensions: 225mm x 145mm x 39.8mm

Display: 178mm diagonal widescreen

Weight: 1.1kg (base configuration)

Operating temp: -4degF to +122degF (-20degC to +50degC)
Storage temp: -22degF to +140degF (-30degC to +60degC)

Humidity: 5-95 per cent, non-condensing

Processor: Intel Atom Z530P, 1.6GHz, US15W Chipset; 512KB L2 Cache; FSB 533MHz system memory; 2GB DDR2 RAM

Hard drive: solid state drive, 32GB, 64GB, 80GB, 128GB+ shock mounted; 1.8in hard disk, 120GB

Operating system: Windows 7 Professional; Windows XP Tablet PC Edition; Linux 'Ready'

Display: 1024 x 600mm (WSVGA); Color TFT (supports 1024 x 768 mode XGA) touch screen standard, digitiser optional xView sunlight readable option, 500nit

System expansion: SD card slot; Express card slot (standard); surface contact docking connector RJ-45 10BaseT 10/100 Ethernet, USB 2.0; serial port optional (9-pin D-SUB); I/O board Con_g standard; USB (2); Ethernet; audio

Battery system: hot swappable dual battery packs

Std capacity: lithium polymer

Total: 5160mAh, 7.4V, 38Wh

Battery: 3-5hrs estimated; lithium ION

Total: 10400mAh, 7.4V, 77Wh

Battery operation: 6-8hrs (est)

Communication: 802.11b/g/n 2.4 GHz; Bluetooth v2.1 + EDR (class II) open slot WWAN Express Card slot open for various service provider wireless cards; protective cover maintains seal / ruggedness; GPS (optional)

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DS 3000+03	▨	⬛	🟥	🟥	⬛	⬛
DS 3000E	🟥	⬛	⬛	▨	⬛	⬛
FER 4003	▨	⬛	⬛	▨	⬛	🟥
DS 1.11	🟥	🟥	⬛	🟥	🟥	🟥
DS 2.11	⬛	🟥	🟥	🟥	🟥	🟥

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Moderate	▨

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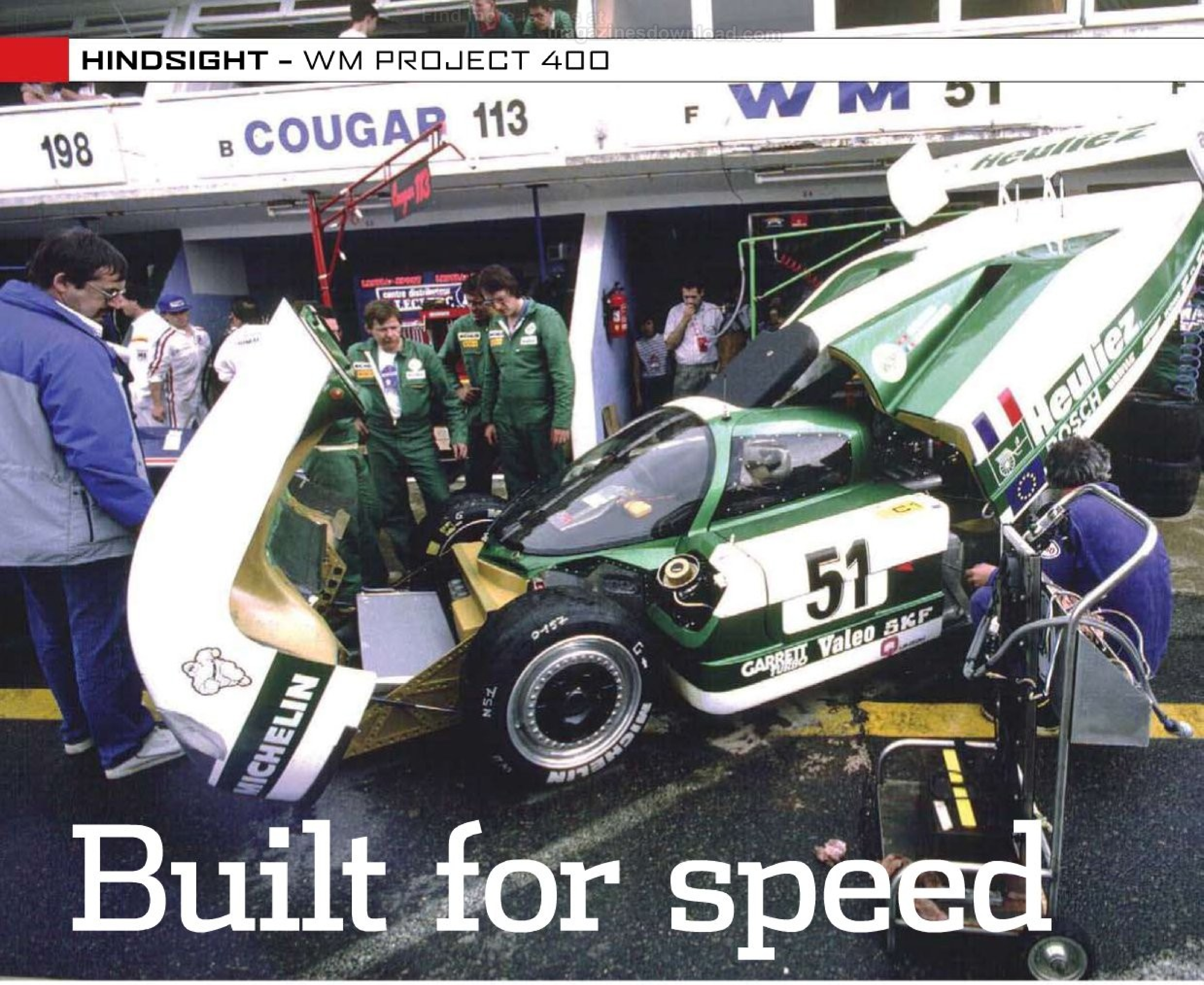


Built for speed

In the days when privateers could still win at Le Mans, a dedicated group of engineers set a record that will never be broken

BY ALAN LIS

At the 1988 Le Mans 24 Hours, a French garage owner, driving a car built in a workshop at the bottom of its creator's garden and run by a team with no full time members, set a record that is likely to stand for all time. Shortly after 8.46pm on Saturday June 11, Roger Dorchy, driving a WM P88 chassis powered by a twin turbocharged Peugeot PRV V6 engine rocketed through the speed trap on the ligne droite des Hunaudières (the Mulsanne Straight to English speakers) at 407kph (253mph) – the first time (officially) that the 250mph barrier had been broken on that famous three-and-a-half-mile stretch of Route Nationale 138.

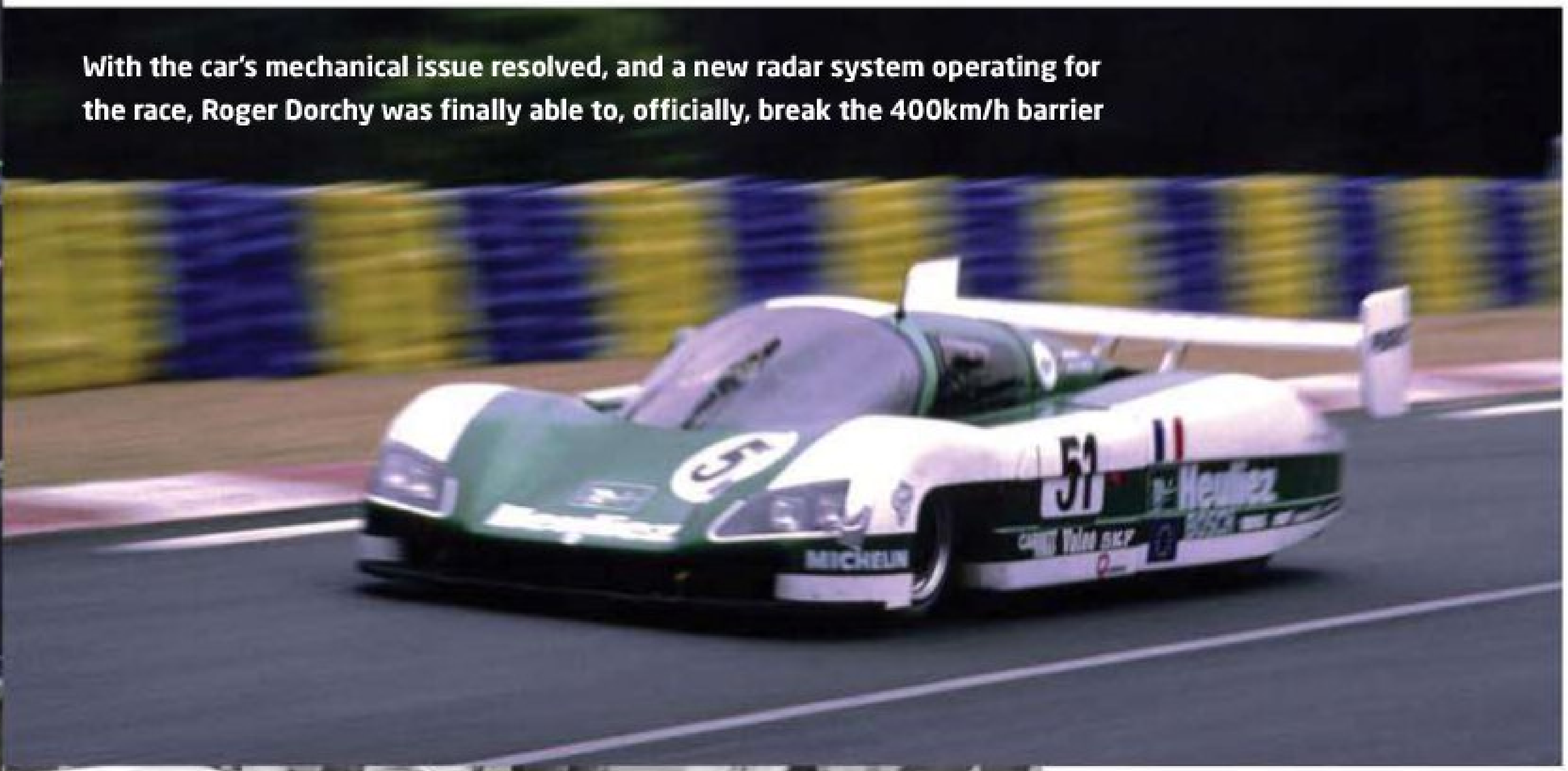
Peugeot employees, Gerard Welter and Michel Meunier, had formed WM in 1967 to pursue their motorsport ambitions, and their first efforts were concentrated on the race preparation of Peugeot 204 saloon cars. For 1969, they produced a 1.3-litre, front-engined sports coupé based on the running gear of the 204, which gave the team its first taste of international competition by taking part in the Paris 1000 kilometres at Montlhéry. The following year WM unveiled a 1.3-litre transverse mid-engined coupé that took part in the 1970 Tour de France Auto. In 1971, it was entered for a three-hour race at the 1971 Le Mans test weekend, but did not start due to a clutch failure. Five years later, a WM raced at Le Mans for the first time with a new chassis conforming to the ACO's newly introduced GTP rules (the forerunner to the FIA's Group C class) and powered by a race-prepared version of the 2.7-litre PRV V6 engine.

Chassis and engine performance improved year on year so that by the early 1980s the narrow track, slippery-bodied WMs were regularly among the fastest Group C cars to run at Le Mans. In 1984, WM briefly grabbed the limelight when, live on French TV, Roger Dorchy took the lead of the race on the opening lap and held it until a brake balance problem half spun him out at Mulsanne Corner. Despite recovering to re-take the lead, a recurrence of the brake problem pitched the WM into the barriers at the same corner two laps later.

By the mid-'80s, Group C competition had intensified to the level where a team such as WM, staffed by crew members working in their spare time and holidays, were no longer able to challenge the high budget, manufacturer-backed teams for outright honours. Realising this, shortly after the 1986 Le Mans 24 Hours, the WM team embarked on Project 400, which aimed to capture the Mulsanne speed record.

The car that would be used

Despite completing just 59 laps at the 1988 Le Mans 24-hour race with the number 51, the WM team met its Project 400 target



With the car's mechanical issue resolved, and a new radar system operating for the race, Roger Dorchy was finally able to, officially, break the 400km/h barrier

With the front bodywork 70mm wider than the front track, the WM's steered wheels were able to turn inside the overhanging body

for Project 400 was based on the WM team's hard-won experience and would incorporate a combination of new and existing hardware, along with some clever and innovative thinking. The first Project 400 car, the WM P87, used an existing P86 sheet aluminium monocoque, which derived much of its strength from a central backbone structure. A new nose box and sidepods were grafted onto the P86 tub to cater for revised cooling arrangements on the newer car.

> **"the cost of technology in Group C was increasing greatly and we couldn't keep up"**

LOW DRAG APPROACH

Like the previous P86 model, the P87 was equipped with a front-mounted water radiator. This was laid horizontally, fed by an upward duct and vented into a channel running around the base of the windscreen. WM's low drag approach for the P400 cars dictated a novel arrangement for the turbocharger intercoolers. Air was taken in through a frontal opening above the splitter and fed into the ducts beneath the front suspension and into the side pods running down the flanks of the car. After passing through the intercoolers, further ducting turned the airflow inwards and directed it upwards within the engine cover through a forward-facing tube on the roof of the car and into a lateral slot in the low pressure area behind the apex of the cockpit canopy, where the heated air vented to the atmosphere. 'The cooling system on the Project 400 was very original, and with very good reasons,' explains WM engineer, Vincent Soulignac. 'At the end of the air ducts that went from the front of the car between the front wheels and into the side structures under the doors we still had the same air pressure as when the air first entered above the splitter, so we had a very high flow rate. The heat exchangers we used also had very low permeability, which made them very efficient and meant we had high pressure air at the entry to the turbocharger.'

The P87 was clothed in body panels developed in a series of Peugeot-financed tests in the fixed floor St Cyr wind tunnel in Paris that took place each Sunday over a four-month period during the winter of 1986 / '87. A 10 per cent scale datum model was used for the tests and up to 25 iterations were evaluated on each tunnel visit.

The bulbous shape of the P87 gave the impression it had been built on a wider track chassis. Not so, says Soulignac: 'At 1850mm wide, the P86 was narrower than the maximum permitted width by 150mm. When we designed the Project 400 car we decided that the best way to have a very low drag car was to have the wheels covered by the bodywork as much as possible. The track width of the Project 400 car was almost the same as the P86, but the body was wider by 70mm so that it completely covered the rear wheels. The bodywork also partially covered the front wheels, but there were cut outs to allow air to escape from the front wheelarches. The increased body width also allowed the front wheels to turn inside the body.'

FLAT FLOOR

The FIA Group C technical regulations at the time stated that the floor of the car had to be flat for a minimum of 1000mm behind the vertical plane of the front wheels, limiting the length of the Venturi tunnels, which were exhaust energised, and there was also a limit on their height. 'The floor of the P400 car was also flat between the front wheels and there was a small deformation under the front splitter, so small – just 30mm – that you could not really call it a diffuser. Otherwise, the splitter was at the same level as the flat floor.

'The drag co-efficient for the P400 cars was between 0.25-0.26 and the lift-to-drag ratio was 2.0. So it had exactly what we wanted – very low drag and not very high downforce. I don't

The Le Mans scrutineering hoist reveals the WM's exhaust blown, low drag, low downforce underwing

recall the precise figures but, with larger tunnels and a shorter flat floor than the LMP cars have today, the P400 cars had much better aerodynamic stability, especially over bumps.'

AERO ADJUSTMENTS

There were two main aero adjustments that could be made at the front of the car. Firstly, different length nose splitter panels could be fitted. Secondly, the team could also adjust the extraction of the air from inside the front wheelarches. 'This was very sensitive,' says Soulignac. 'It was quite similar in principle to what the LMP cars have today in that area. On our car the bodywork covered the forward part of the front wheels, but they were open at the rear and adjusting the extraction of the air in this area had a high influence on front downforce. To make adjustments, we had different lengths of small deflectors that were mounted on the inside rear wall of the wheelarch.'

As low drag was a priority for the Project 400 car, it might be assumed that the rear wing was used as a trimming device, rather than an important provider of downforce. 'The car could probably have run without a rear wing,' says Soulignac, 'but we found it was necessary to achieve a good front-to-rear aerodynamic balance.'

The wheelbase of the P87 was 150mm longer than the P86, the difference between the two being accounted for by the fact that the P87 had the oil reservoir positioned in front of the engine, which added 70mm. A new bellhousing between the engine and gearbox added the other 80mm.

WM engineer, Vincent Soulignac: 'I'm sure it wouldn't have been a problem to have gone 420km/h'

EXPENSIVE STEPS

At the test weekend for the 1987 Le Mans 24 Hours, the WM P87 was plagued with engine management issues and could rarely complete more than one or two successive laps. 'The P87 was the first WM with electronic fuel management,' explains Soulignac. 'It was a very expensive step for our small team and, to be honest, we didn't have enough money to make it work properly. Engine management was a big problem for us throughout the P400 project. It wasn't the quality of the parts, it was the cost, and we didn't have enough funding. When you are a team of unpaid volunteers, the cost of parts is the main expenditure. At that time, the cost of technology in Group C was increasing greatly and we couldn't keep up.'

Despite the engine problems, on one of his few flying laps, Dorchy passed through the Mulsanne speed trap at 356kmh (221mph), some way short of the target, but heading in the right direction – a feeling further reinforced by the fact that the P87 subsequently completed a total of more than 1000kms of trouble-free testing on the short Le Mans Bugatti circuit and at Michelin's Clermont-Ferrand test track, the latter of which included a 1km straight.

> **"a team supporter offered to let the team siphon 30 litres from the tank of his Renault 5"**

On June 4, nine days before the 1987 Le Mans race, the speed potential of the P87 was tested again when WM team manager, Gerard Clabeaux, arranged an attempt on a public road speed record. The car was trailered to a new, and as-yet unopened, stretch of the St Quentin – Rheims autoroute, near the town of Laon. The record attempt would be covered by the French TV station, TF1, with one camera on the car and another above in a helicopter.

As they prepared the car, the team realised they had left the fuel behind and, with no service stations on the new road, there was no nearby supply. Fortunately, a team supporter offered to let the team siphon 30 litres from the tank of his Renault 5. Then Roger Dorchy, the intended driver for the record attempt, was delayed in traffic and so, with the weather looking threatening, Clabeaux turned to François Migault, who had come along to watch. He was strapped in to the P87 and on the first run, intended merely as a warm up, passed through the police radar speed trap at 416kmh (258mph) and the record was broken. Although Dorchy did finally arrive a short time later, rain prevented any further running.

On the second practice day for the 1987 Le Mans race, the WM team's own speed radar clocked Dorchy in the P87 at 407kmh (253mph), but the ACO system only credited the car with 381kmh (236mph), though that was still enough to establish a new record. Dorchy's vow to officially break the 400kmh barrier in the race was scuppered by engine failure. The low quality of the ACO's central fuel supply, which affected a number of cars during that year's race, killed the P87's PRV V6 engine after just 13 laps.

When the WM team returned for the 1988 race, it had two Project 400 cars, including a new P88 version that featured improvements to its chassis, suspension and aerodynamics. The P88 rear suspension changes were also incorporated into the P87, allowing the use of wider Venturi tunnels. Both cars were equipped with 3.0-litre displacement engines developing over 900bhp at full boost as the team again set their sights on the 400kmh barrier...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THE 1988 LE MANS 24 HOURS

The 1988 Le Mans race was memorable for the fierce battle between the works Jaguar and Porsche teams, but will also forever be recalled as the year the 400kmh / 250mph speed barrier was broken.

In practice, both WMs suffered turbocharger problems, but the team was convinced it had broken the 400kmh barrier with its new car. Again though, the ACO speed radar denied them. In the race itself, the P87 came to a premature halt with a transmission failure and was officially retired from the race with 13 laps completed. Dorchy's P88 was also an early caller at the pits. Engine management and bodywork issues kept the car motionless for the best part of three and a half hours but, when the P88 eventually rejoined the race and showed itself to be running cleanly, Dorchy received a radio message from Soulignac asking him to increase turbo boost pressure. He was then unleashed on a series of laps aimed at officially breaking the 400kmh barrier on the Mulsanne straight.

'During practice, according to the ACO radar, we never reached a speed higher than 387kmh,' recalls Soulignac. 'The ACO radar system was from Metstar, a French company that supplied police radar systems. The model used in practice was the Metstar 206, which was sold as being able to measure speeds of up to 420kmh, but we found out that it was badly affected by the vibrations caused by the high noise levels of racecars. During the two practice days we had discussions with Metstar about this and, as a result, they told us that for the race they would bring a new type of radar system - the Metstar 208 - which was a prototype that could measure even higher speeds and was less prone to the noise problem.

'So the new system was in place when the race started, but of course we had our engine management problem early on. A little time after we finally got the car running, someone from Metstar came to see me in the pits and said, "We don't understand. Your car keeps passing the radar point at 397 or 398kmh (247-248mph). You only need 2-3kmh to obtain your record." We knew the car was capable of setting the record, so I called Roger on the radio and told him to increase the turbo boost pressure by 100mbars. Then he did three or four laps in which he passed the radar point at 400-407kmh. As 1988 was the year the Peugeot 405 Turbo was introduced, we decided to declare the top speed as 405kmh. In fact, 407kmh was Roger's best run.'

> **"407kmh was Roger's best run"**

Some reports of the 1988 Le Mans race claim the P88 was equipped with special narrow Michelin tyres, and that for its record laps, ducts in the bodywork were strategically taped over. However, according to Soulignac, the only difference in the configuration was the increase in turbocharger boost pressure, which pushed peak power to 910bhp. The exertions of setting the record cost the P88 dearly, as afterwards it spent a total of 3hr 20mins in the pits as the team tried to rectify turbocharger, cooling and electrical issues before the car was retired shortly before 2am.

Could the car have gone even faster? Soulignac thinks so: 'In practice for the 1988 race, we ran the car with longer gear ratios and I'm certain it did over 410kmh (254mph), but the radar system didn't register it. We worked out our road speed from the engine speed and gear ratios and were sure we'd made it, but there was no one to verify it.

'In 1987, with lower downforce, the P87 reached close to 417kmh (259mph) on the motorway run. I'm certain the car ran over 400kmh in the '87 race and I'm sure it wouldn't have been a problem to have gone 420kmh (260mph) in the 1988 race...'

Dorchy's achievement withstood a challenge from the Sauber-Mercedes team in 1989, when one of the Silver Arrows passed through the speed trap at 400kph in practice, before the record was effectively 'sealed in amber' when two chicanes were added to the Mulsanne Straight ahead of the 1990 race, preventing such speeds from ever being reached again.

The 1988 Le Mans 24 Hours. While Porsche and Jaguar fought a tense battle for overall victory, WM set the all-time Mulsanne speed record

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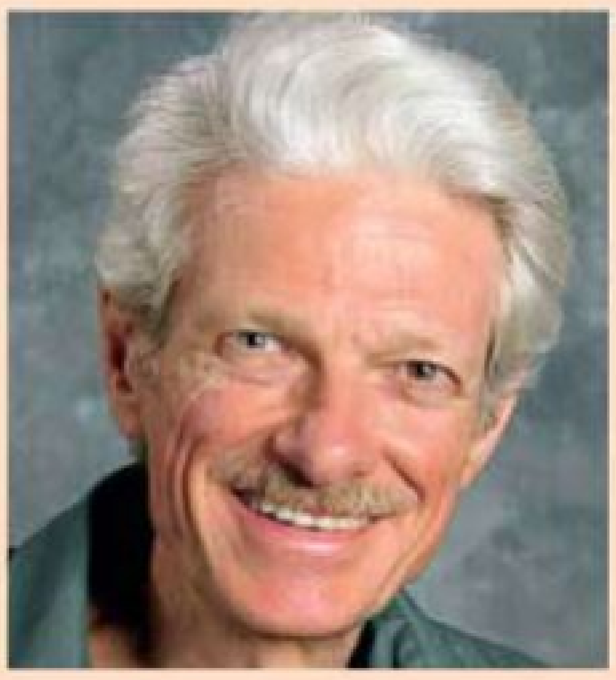

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A question of dive

Turns out current F1 cars do have anti-dive after all

Q I was reading your article in the April issue of *Racecar Engineering* entitled 'Questioning the rule makers'. In it you stated, "Most current F1 cars have little or no anti-dive or pro-dive."

I had intended to write to you last year regarding something I observed in a late season F1 race. I noticed that from a roll hoop-mounted camera it was evident that the car's nose was rising under braking, which would imply greater than 100% anti-dive. I don't recall which constructor it was, but it was more than one of them. How is this possible? And what would be the benefit?

I was wrong. Until recently, my statement would have been accurate, but it appears F1 has suddenly re-discovered anti-dive, and there is a massive 'trick of the week' effect going on, with designers going to the opposite extreme and using outrageous amounts of it. In fact, this may have a lot to do with the 'prominent nose bridge' (or maybe brow ridge?) noses that have appeared. The front inboard pick-up points of the upper control arm are being raised to create anti-dive, and simply having a higher or more convex top surface on the nose may be undesirable for reasons of sight lines, side view area and lift.

And it may well be that some cars do now have more than 100 per cent anti-dive, so that the front actually rises under braking. But why might that be?

I do not think it is desirable to have the car pitch rearward under braking. However, if the rear lifts under braking, it may be aerodynamically preferable to have the front lift similarly, so that pitch remains minimal, even though the ride height increases. It is entirely possible to have 100 per cent anti-lift at the rear as well. That would mean we could have zero pitch without the front lifting.

My consulting clients are mainly hobby racers. But very occasionally, I get calls from top-level NASCAR engineers. I get absolutely no F1 work. Consequently, I have no idea how well F1 engineers actually understand vehicle dynamics. With the money and prestige the series has, one would think

"It appears F1 has suddenly re-discovered anti-dive"

they'd be the best, but I don't have the visibility to confirm or dispute that.

I do know that there is lots of incorrect information published about anti-dive and related effects. I've seen one graphic recently that apparently has circulated quite a bit that purportedly shows geometry for 100 per cent anti-dive. It shows the control arm pivot axes in side view – the axes defined by the control arm attachment points to the tub – meeting at the sprung mass c of g in side view. This replicates illustrations that appear in a number of old chassis books, but it is incorrect in at least two ways.

First, the side view geometric properties depend on the actual side view projected control arms. These are the lines where the control arm planes intercept the wheel plane, not the control arm pivot axes as seen in side view.

Second, we do not have 100 per cent anti-dive when the side-view projected control arms intersect at the c of g. We have 100 per cent anti-dive when the side view force line intercepts the side view resolution line at sprung mass c of g height. The side view force line is the line from the contact patch centre through the side view instant centre. The side view resolution line is a vertical line located rearward from the front axle line by a percentage of the wheelbase equal to the percentage of ground plane retardation force exerted by the front wheel pair when braking. This will generally be a greater percentage than the static front weight percentage, so the resolution line will generally be aft of the c of g.

"It is possible that a designer could deliberately make the front end lift in braking"

If the front suspension meets this criterion, the front suspension will neither compress nor extend in braking, as the questioner correctly understands. If the front end is lifting in braking, that implies that the anti-dive is more than 100 per cent and that the force line slope and jacking coefficient are greater than described earlier.

But it is important to note that sprung mass pitch, and front wing height, also depend on what the rear suspension does. 100 per cent anti-dive only results in zero pitch if the rear suspension has 100 per cent anti-lift. It is quite possible to provide that. There are many production cars that have more than 100 per cent anti-lift. Almost any car with trailing arm or semi-trailing arm rear suspension jacks the rear suspension down in braking. This potentially results in wheel hop but, in practice, as long as either ABS or the brake bias keeps the rear wheels from approaching lock up, such cars brake just fine.

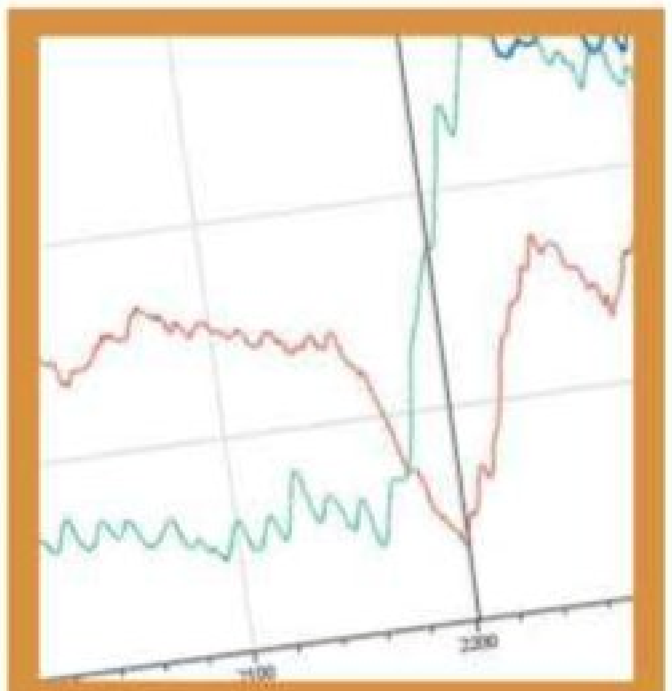
With SLA or double wishbone rear suspension, 100 per cent anti-lift requires a lot of inclination of the side view projected control arms – more than is needed for 100 per cent anti-dive at the front. The need for extreme-looking geometry results from the fact that the ground plane force we have to work with is smaller at the rear than at the front.

So it is possible that a designer could deliberately make the front end lift in braking because the rear lifts, or it is possible that even an F1 designer might have read the wrong literature...

Is there a penalty in the car's ability to absorb bumps while braking when there is that much anti-dive? Yes. However, when the track is very smooth, that may not matter so much. And when the alternative is to use stiffer springing instead, some anti-dive may be deemed preferable to that.

My own default recommendation regarding anti-dive lies somewhere between the recent former practice of using little or none, and the current fashion of using a huge amount. I generally suggest that the side view force line should have a slope at static of around four degrees, and no more than eight degrees in any condition. Depending on brake bias, wheelbase, and sprung mass c of g height, this will generally result in somewhere between 25 and 60 per cent anti-dive.

Some Formula 1 cars raise the nose under braking, but 100 per cent anti dive only results in zero pitch if there is also 100 per cent anti lift at the rear



Databytes gives insights to help you improve your data analysis skills each month as Cosworth's electronics engineers share tips and tweaks learned from years of experience with data systems. Plus we test your skills with a teaser each month

To allow you to view the images at a larger size they can now be found at www.racecar-engineering.com/databytes

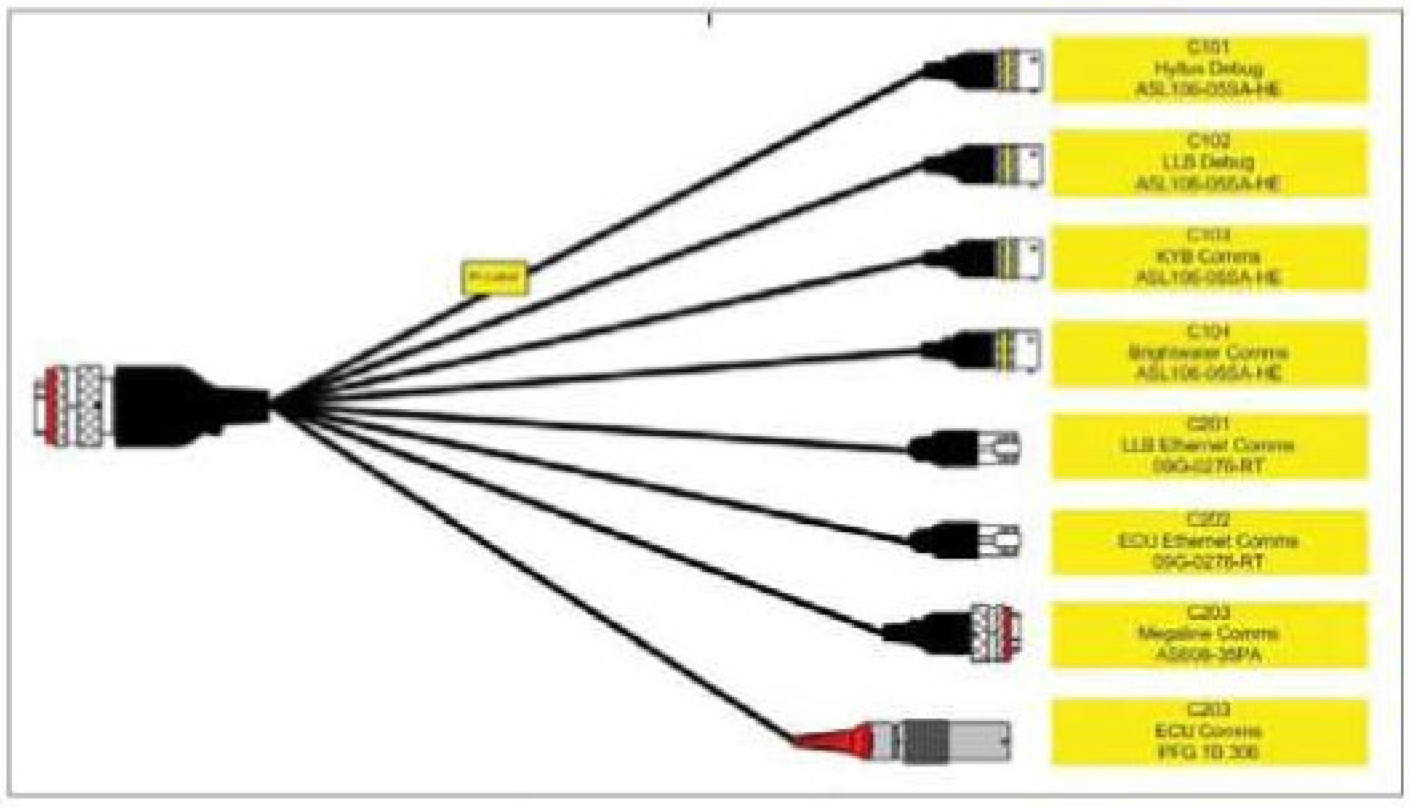
Calling all cars

Data stations and garage networks

Computers have become an integral part of running almost any type of racecar these days and it is more than likely that you will find a laptop close to one, even at the local drag strip or sprint track. As you progress up the ladder, in whichever series you compete, the cars generally become more complex and the engineering starts to get more involved. This inevitably means more data and even more computer involvement. At the top levels of racing, you will find teams will be running some form of data station for each of their cars and that a dedicated engineer is looking after this data station at all times.

These form an integral part of a garage network that centres around running the racecar. The data station will often have two monitors, one connected to a server on a garage network, which will hold data, video and set-up information for the team's vehicles. A second screen could then be connected to a laptop as a monitor for the data engineer or race engineer. There are, of course, different variations of data station available, depending on how teams prefer to run their systems. There could, for example, be one large main screen with telemetry information for all vehicles, along with a TV feed. In most cases, the bulk of the work done at the data station will be carried out using laptops as they allow engineers to carry their work around with them.

↳



The 'umbilical cord' is the lifeline between the racecar and the engineers in the garage, connecting all the systems on the racecar with a single harness

[Data] - Fuel

Channel	Value	Units
Air Temp	24	°C
Collector Level	7.20	ltr
Fuel Pressure	4.45	bar
Fuel Temp	33	°C
FuelUsed	82.57	ltr
TankFuel	62.18	ltr
TCS Position	2	Position

[Data] - Engine

Channel	Value	Units
Engine RPM	8761	rpm
Gear Selected	5	
Coolant Temp	79	°C
Coolant Pressure	5.64	psi
Oil Temp	106	°C
Oil Pressure	81	psi
Gearbox Oil Temp	111	°C

[Data] - Channel Di...

Channel	Value
Gear Selected	5
Collector Level	7.20
Battery Volts	13.9
Press Tyre FL	1.95
Press Tyre FR	1.98
Press Tyre RL	2.03
Press Tyre RR	2.04

Last lap: 122

Lap time (min:sec): 03:51.180

Collector Level 7.20 ltr

Figure 1: typical view of a live telemetry window. Tyre data is shown as raw numbers and bitfields indicate if there is a problem. Trends are then monitored using live graphs and summary tables

The data station and garage network will generally have three ways of communicating with the on-board systems on the racecar.

There will be the standard download to a laptop using a direct cable connection between a laptop and the car. In some cases, the download lead will have the ability to connect to a number of different systems on the car as it may be necessary to communicate with more than just the data logger.

The next connection is the 'umbilical cord', which is connected to the car while it is sat in the garage. This allows the car to become an integral part of the garage network and, in turn, allows the engineers to make changes to the onboard control systems and data loggers from the data stations without actually going near the car (in many cases, the area where the data stations are located is some distance away from the car, perhaps even in a separate office). The umbilical cord allows the engineers to work on the car's systems without being in the way of any mechanical work being done.

The third connection is probably one of the most important ones – the data telemetry connection. Where permitted, teams can run a radio link to the car systems to allow them to view live various parameters on the car. These can include engine and drivetrain parameters, as well as tyre temperature and pressure information. Having this link allows the data engineers to remotely monitor the health of the car, leaving the driver free to focus on navigating around the circuit and other drivers.

The data station really comes into its own when the car is out on track during an endurance event, as it allows the engineers to have current data streaming live to the data station on one screen, while on another screen there can be older data from the same track, or from an earlier part of the race, which enables the team to easily monitor any trends or discrepancies. On a third screen, it is then possible to have a spreadsheet open to note any values of interest – maximums and minimums for example. It is, of course, possible to set the analysis software up to do this automatically if preferred.

> **"The data station really comes into its own when the car is out on track in an endurance event"**

Currently, data stations are mostly used to monitor data at relatively low rates as standard radio telemetry systems do not have enough bandwidth to supply a great deal of information at high rates. But, with recent advances in communications technology, it is likely that in the near future the data station will serve as a much more involved tool in the analysis of racecar data, as bandwidth increases allow, for example, analysis of suspension movement at high frequency rates live, and even receiving video signal from several sources onboard the racecar at the same time.

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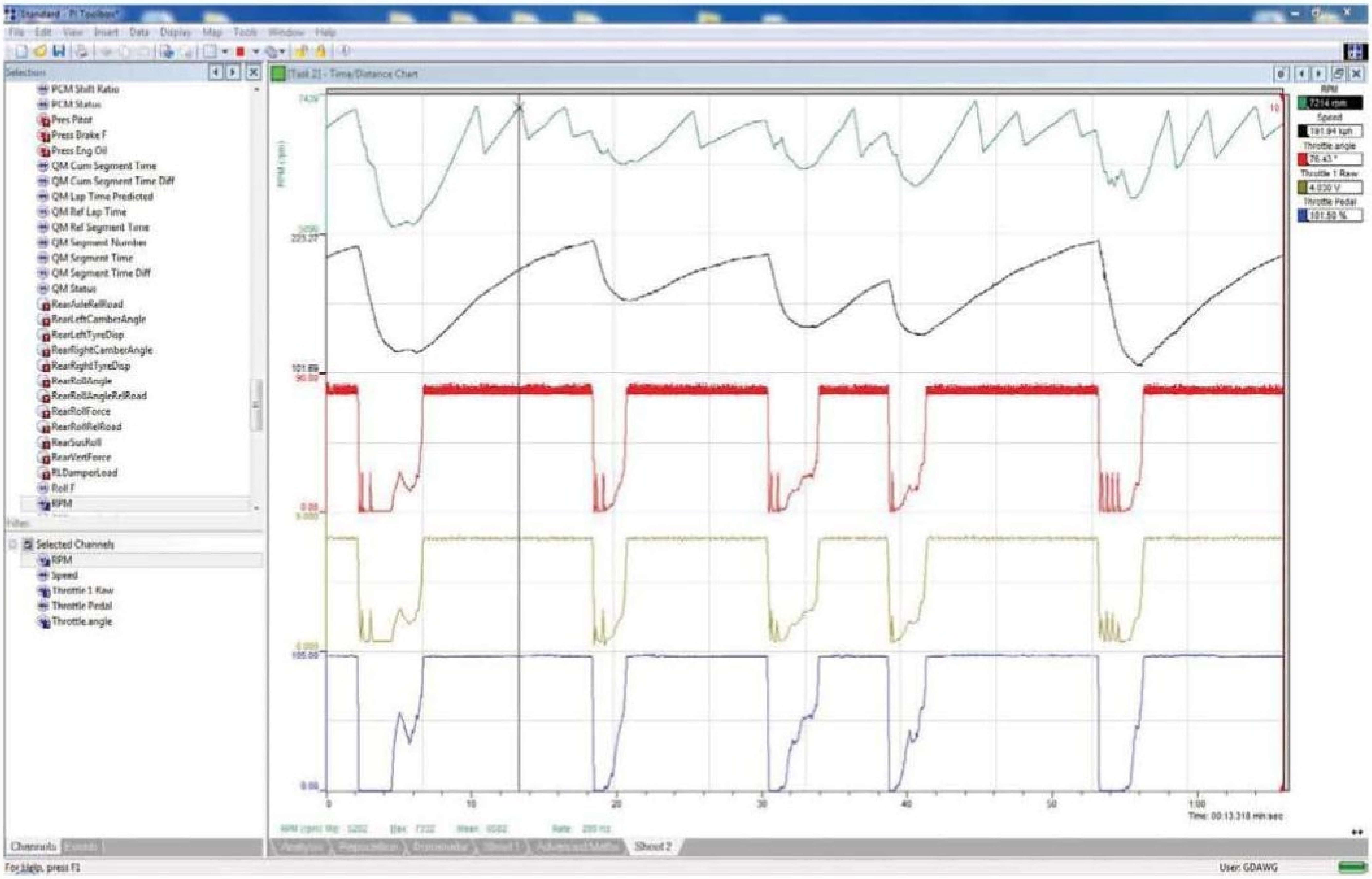
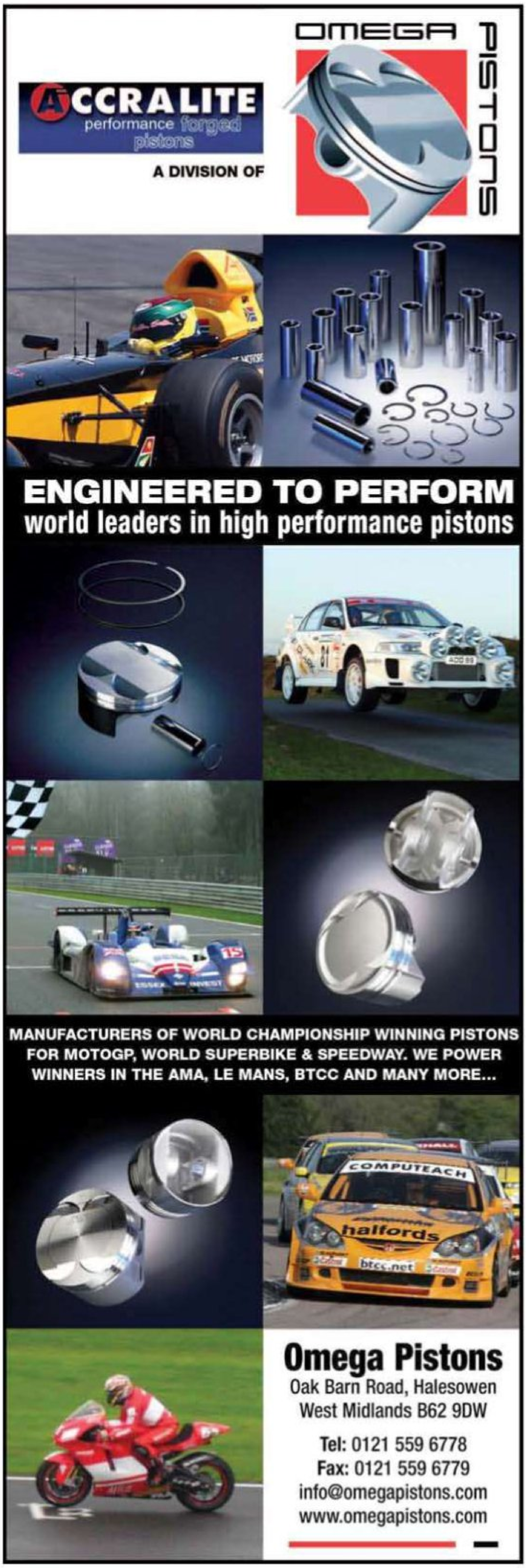
CHALLENGE

This car was struggling with a lack of straight-line speed and was notably down on other competitors in the speed traps. What could have caused the issue?





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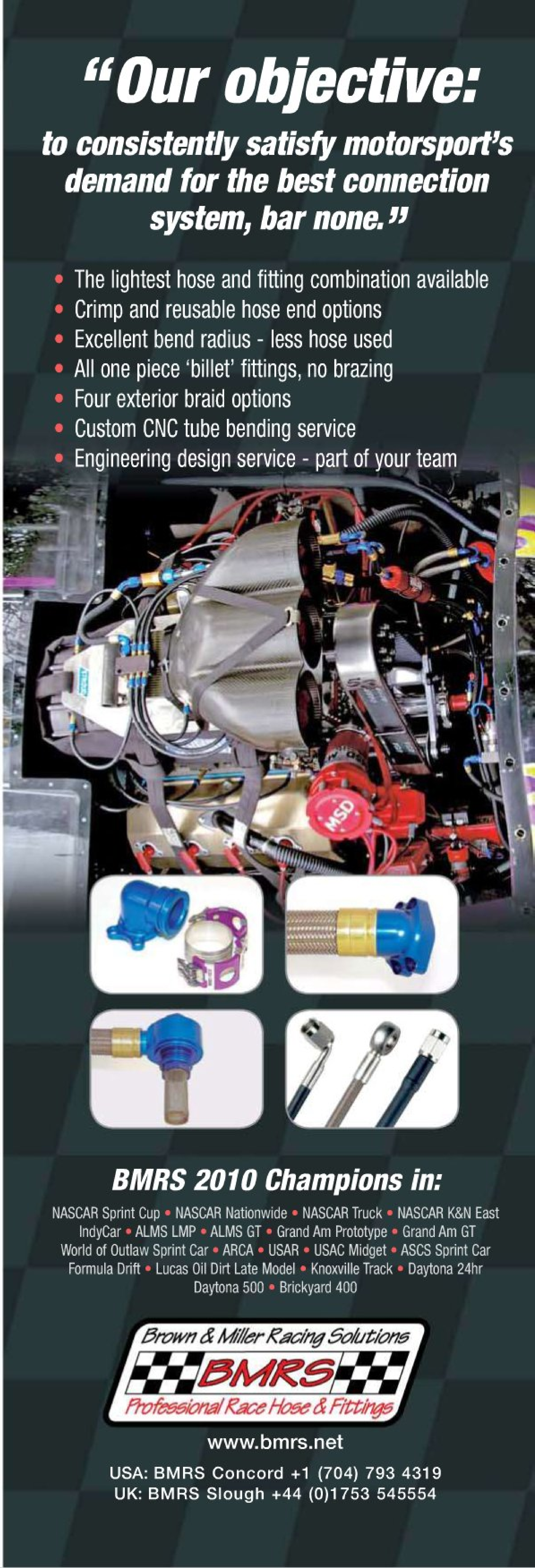

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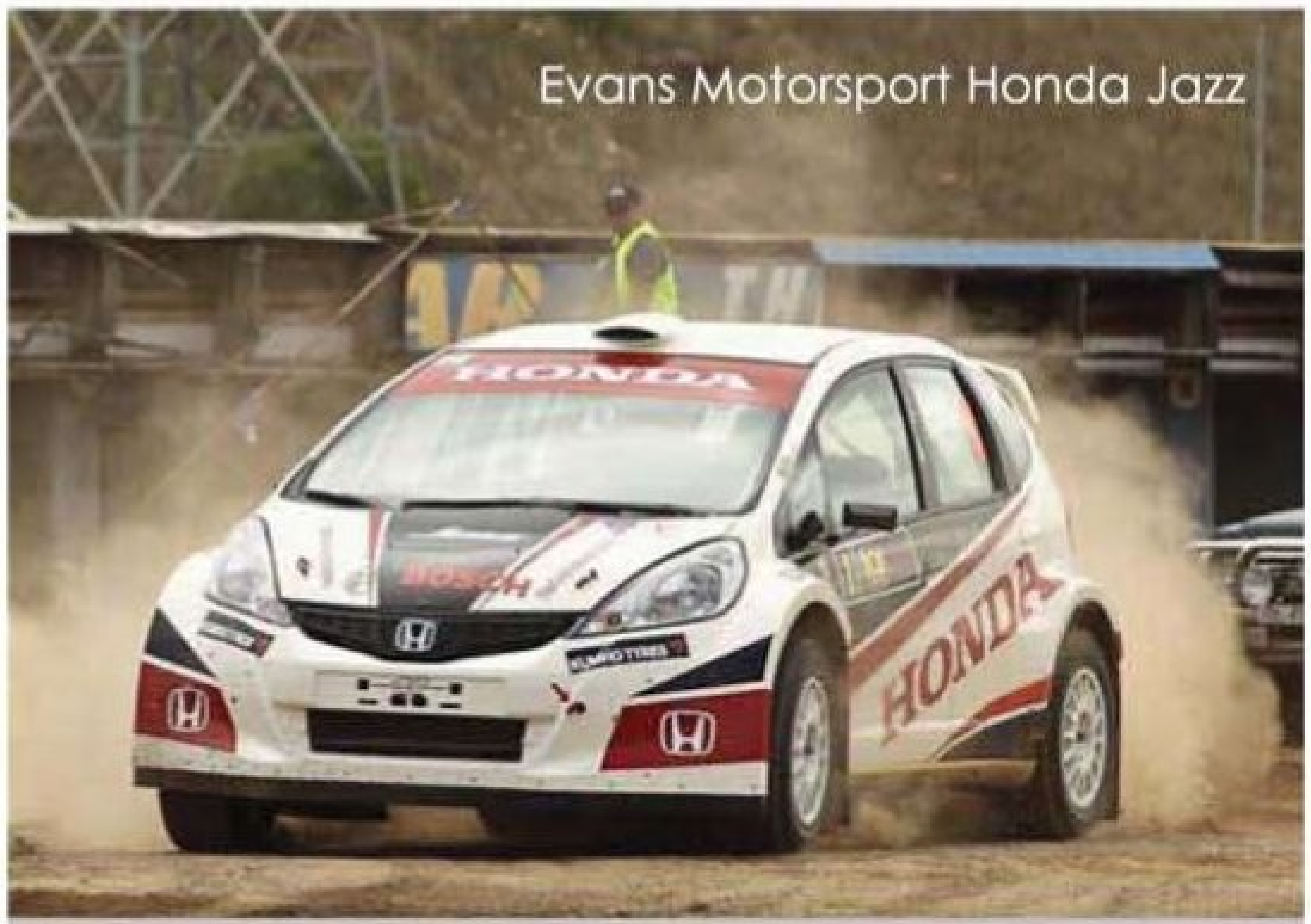

Simon McBeath offers aerodynamic advisory services under his own brand of SM Aerotechniques – www.sm-aerotechniques.co.uk. In these pages he uses data from MIRA to discuss common aerodynamic issues faced by racecar engineers

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New vs old

The brand new Dallara F312 comes under the wind tunnel spotlight, with the old F308 for comparison

We start another new project this month, again on a current specification racecar from a leading international formula - the Fortec Motorsport Formula 3 Dallara F312. For comprison, Fortec also brought along a 2011-specification F308.

Our feature in last month's *Racecar Engineering* described the F312 in full but, in short, the F312 featured cleaner bodywork with less aerodynamic paraphernalia, a higher nose, a larger front wing and a sharply terminated engine cover with a gearbox top shroud below.

We knew, with the F3 car's ultra-low front ground clearance (typically 10mm to the front splitter under the driver), that MIRA's fixed floor would not enable fully realistic data to be generated, especially on downforce from the floor, and to a lesser extent from the front wing. But we would still be able to compare the 2011 and 2012 cars and examine the relative effects of configuration changes. We have used aerodynamic coefficients throughout, calculated at a nominal frontal area value to preserve some semblance of confidentiality. So the coefficients here should not be taken as absolute.

Both cars were brought to the wind tunnel with maximum front and rear wing settings. And during the cars' set up, each was fitted with 'trip strips' on the tyres to better simulate rotating wheels, these angled aluminium strips cause flow separation on the tyres closer to where it would naturally occur if the wheels were rotating (the flow stays attached further around a stationary wheel and creates a different flow field downstream). The baseline aerodynamic data on the two cars is shown below in table 1. The differences (Δ values) between the two cars are given in 'counts' where 100 counts = a coefficient difference of 0.100.

So, with maximum wing angles and the same chassis rakes, both cars generated much the same drag level, but the new car generated 111 counts (7.5 per cent) more overall downforce, with 140 counts more on the front end. Given that exactly the same adjustment ranges were provided on the wings of both cars, the new front wing is clearly a more potent device. According to Andi Scott, Fortec's chief race engineer, the static weight split of the old car of around 41-42 per cent on the front meant it was always hard to generate enough front-end downforce to obtain an aerodynamic balance. It would appear that the F312 will not have this problem.

Table 1: the baseline aerodynamic data on the 2011 and 2012 Dallara F3 cars, with maximum permitted wing angle front and rear

	CD	-CL	-CLf	-CLr	%front	-L/D
2011 car	0.637	1.480	0.571	0.909	38.6	2.323
2012 car	0.630	1.591	0.711	0.880	44.7	2.525
Δ (Delta)	-7	+111	+140	-29	+6.1	+202
Δ (%)	-1.1%	+7.5%	+24.5%	-3.2%	-	+8.7%

Table 2: aerodynamic data on the 2011 and 2012 Dallara F3 cars with similar aerodynamic balance

	CD	-CL	-CLf	-CLr	%front	-L/D
2011 car	0.637	1.480	0.571	0.909	38.6	2.323
2012 car	0.614	1.479	0.577	0.902	39.0	2.408
Δ (Delta)	-23	-1	+6	-7	+0.4	+85
Δ (%)	-3.6%	-0.1%	+1.1%	-0.8%	-	+3.7%

The 2012 Dallara F312

The 2011 Dallara F308

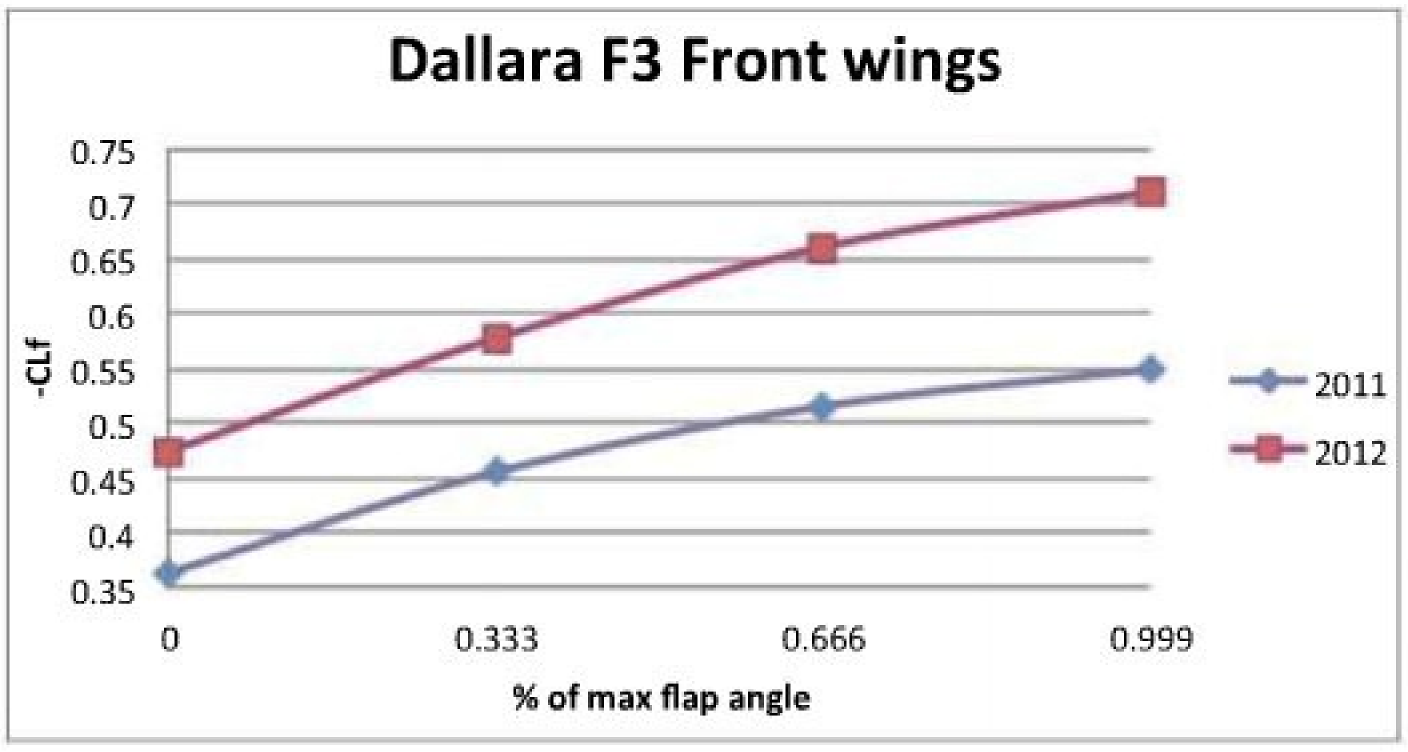


Figure 1: the Dallara F3 front lift coefficients plotted against four flap positions covering the available adjustment range

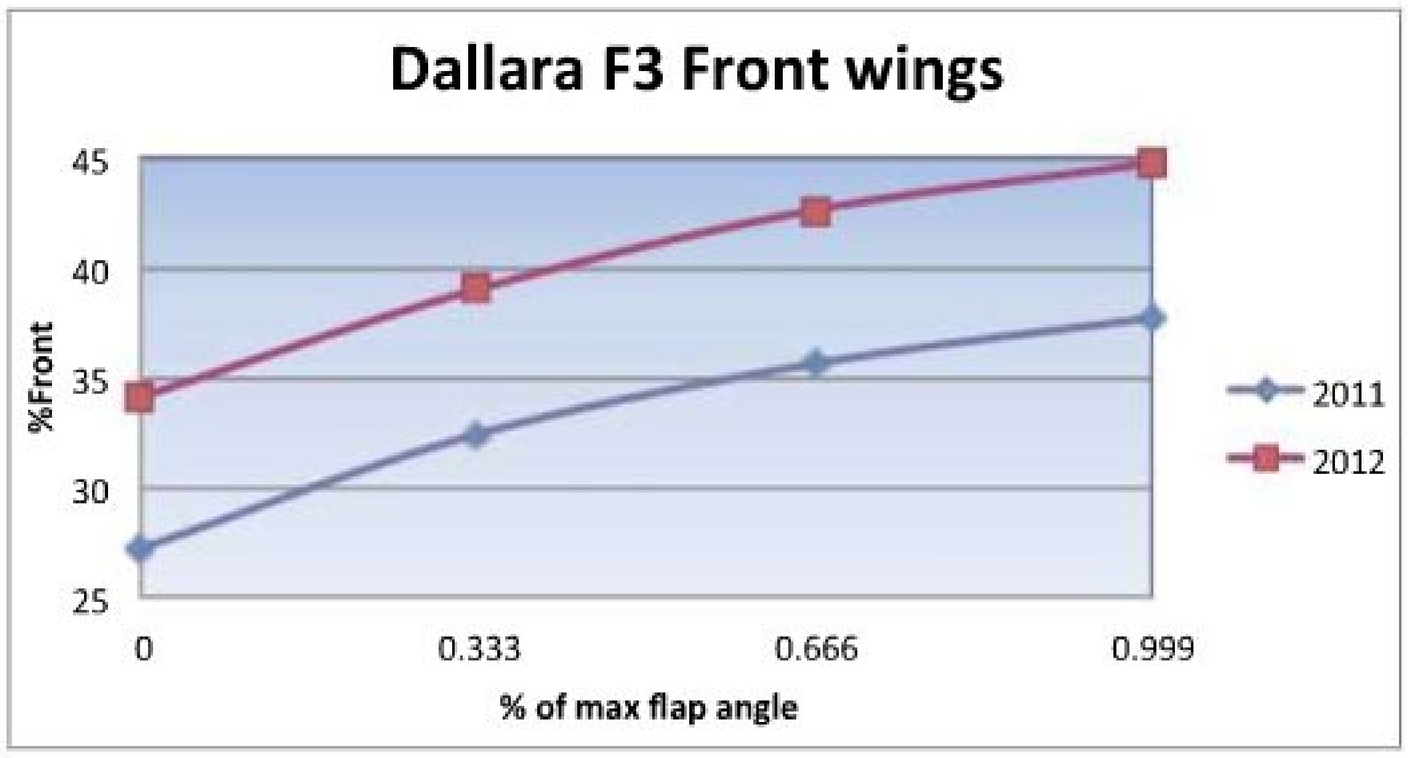


Figure 2: the Dallara F3 '%front' plotted against four flap positions covering the available adjustment range

The F312's front wing features a larger main element chord and larger flap area than the previous car's

The F308 wing dates back several years, although some teams did add additional flaps inboard and 'bridge' flaps

Table 3: the 2011 F308's aerodynamic data over the range of front wing flap adjustment

Flap posn	CD	-CL	-CLf	-CLr	%front	-L/D
Maximum	0.636	1.455	0.549	0.906	37.7	2.288
2/3	0.631	1.445	0.515	0.930	35.6	2.290
1/3	0.624	1.403	0.455	0.948	32.4	2.248
Minimum	0.620	1.333	0.363	0.970	27.2	2.150
Total Δ	-16	-122	-186	+64	-10.5	-139

Table 4: the 2012 F312's aerodynamic data over the range of front wing flap adjustment

Flap posn	CD	-CL	-CLf	-CLr	%front	-L/D
Maximum	0.630	1.591	0.711	0.880	44.7	2.525
2/3	0.623	1.550	0.660	0.890	42.6	2.488
1/3	0.614	1.479	0.577	0.902	39.0	2.409
Minimum	0.606	1.391	0.474	0.918	34.1	2.295
Total Δ	-24	-200	-237	+38	-10.7	-230

But, with its more potent front wing, the F312 was not aerodynamically balanced with the wings at maximum angle at both ends of the car, with over 44 per cent of total downforce being exerted on the front axle, compared to a weight split of around 40-41 per cent. Table 2 shows a comparison of the 2011 car in the same configuration as above with the 2012 car with a reduced front wing angle that gave approximately the same aerodynamic percentage on the front axle.

In these configurations, the two cars had not only roughly equal balance but also very similar total downforce. And at this comparable level of downforce, the 2012 car generated 3.6 per cent less drag, which calculated to an efficiency (-L/D) value 3.7 per cent higher than the 2011 car. So, despite the loss of all except one of the various bargeboards and turning vanes, Dallara seems not only to have more than recovered the lost downforce these devices would have helped generate, but have also added greater capacity for front downforce generation and improved overall efficiency.

The F312 front wing is different in a number of respects from the previous car's, but with the same range of available adjustment on its larger and more complex flap. Figure 1 illustrates how it performed relative to the previous car's front wing, which had changed little over the years.

Clearly, the 2012 car shows greater front downforce across the range of front flap adjustment. It also shows greater linearity to the two thirds full flap point. That is, it tails off more slowly, which suggests its front wing was further from its stall angle in the wind tunnel at this setting than was the F308's wing. And, because the F312's is a more potent front wing, the changes in downforce between the same adjustment increments were somewhat larger.

Fortunately, Dallara provides a wide range of adjustments in between the settings illustrated here, and no Gurneys were available at test time, which would provide further fine tuning. Figure 2 illustrates the effect on aerodynamic balance (%front) of adjusting the front wings.

Tables 3 and 4 show full sets of data obtained at the four front flap angles tested on each car at maximum rear wing angle, and give a clearer idea of how the cars compared over the front wing adjustment range. Most of the trends are as expected, but one of the more interesting ones is that the increase in -CLr with decreasing front wing flap angle was considerably less on the 2012 car, despite the front wing being more potent and further ahead of the front axle on that car. This suggests the F312's front wing also has less adverse aerodynamic effect on its rear wing and / or other rear downforce-generating devices than was the case with the F308.

Note too, as has been previously highlighted in this column, that front wing adjustments do not make large changes to the overall drag value.

Racecar Engineering's thanks to Fortec Motorsport

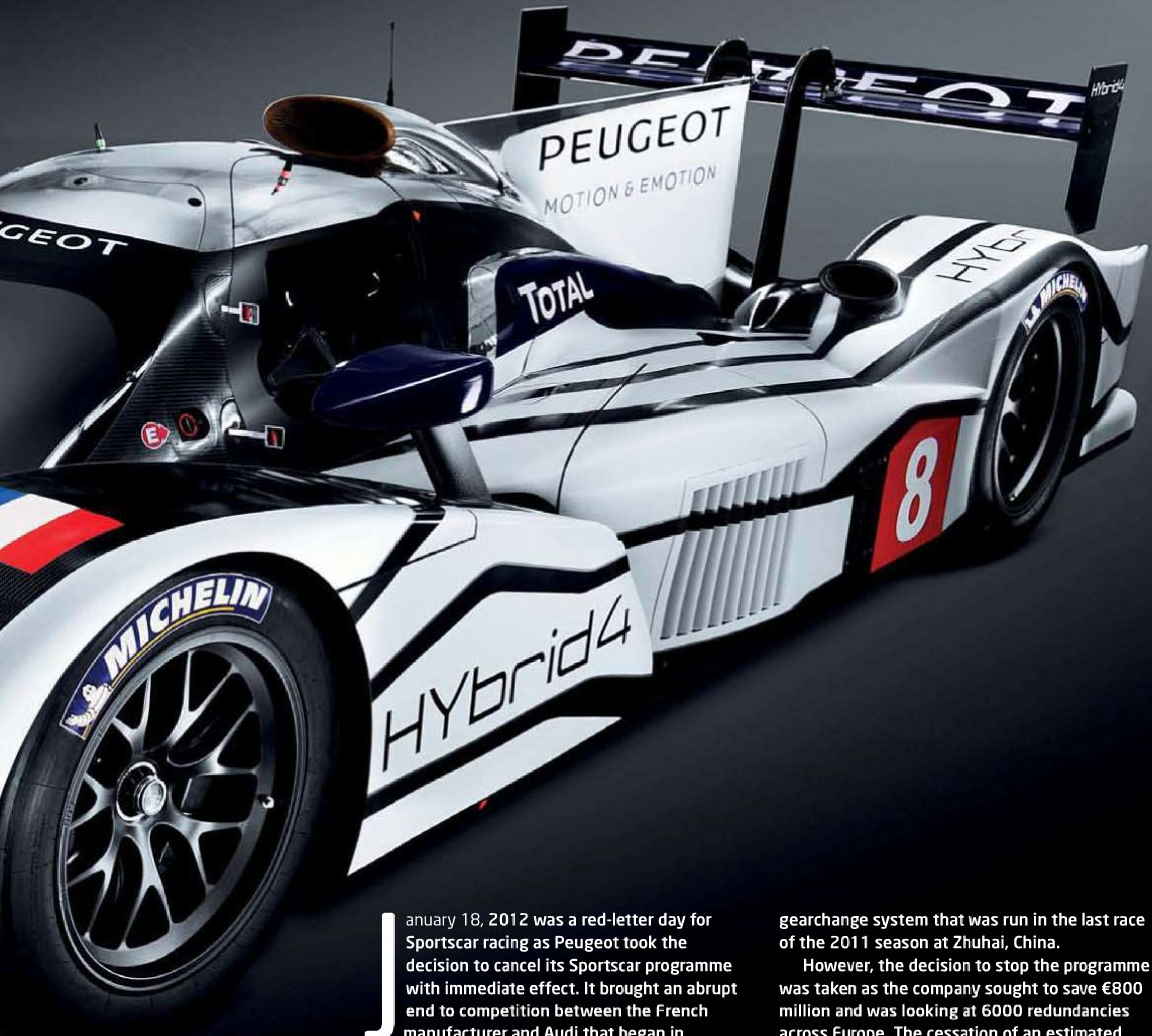
The caged lion

Peugeot Sport agreed to take the covers off its 2012 Le Mans challenger, the 908 HYbrid4, and explain the secrets behind a car that will never race

BY ANDREW COTTON

> **"We thought that 1MJ was too much, and we fought to get it reduced for economic reasons"**

“In the last months, 80 per cent of the team was working on the hybrid system. It was our main development for 2012”



January 18, 2012 was a red-letter day for Sportscar racing as Peugeot took the decision to cancel its Sportscar programme with immediate effect. It brought an abrupt end to competition between the French manufacturer and Audi that began in 2007, which pushed the development of diesel technology and was about to do the same for hybrid technology on track.

The decision to stop came as a shock to everyone, particularly as the majority of development work was already completed for Peugeot’s latest Le Mans challenger. The 908 HYbrid4 had a hybrid system integrated into the chassis, beneath the fuel tank and just behind the driver, and the team was confident it could deliver 500kJ of energy six times around a lap of Le Mans over the full 24-hour distance.

Other development work was already designed and raced, including the variable turbine geometry (VTG) turbo and a quick shift gearchange system that was run in the last race of the 2011 season at Zhuhai, China.

However, the decision to stop the programme was taken as the company sought to save €800 million and was looking at 6000 redundancies across Europe. The cessation of an estimated €50m Le Mans programme was a step that the board of management felt necessary, bringing to an end a programme that saw the French manufacturer win two ILMC titles, and the Le Mans 24 Hours in 2009.

FIRST STEPS

In 2008, Peugeot introduced its 908 HDi FAP, fitted with a rudimentary hybrid system. Frenchman Nicolas Minassian demonstrated the V12 powered car, fitted with a 60KW electric motor, at Silverstone, but the project was an experiment and was never intended to race. Simply put, the packaging for the weighty V12 did not give enough room for the system to be

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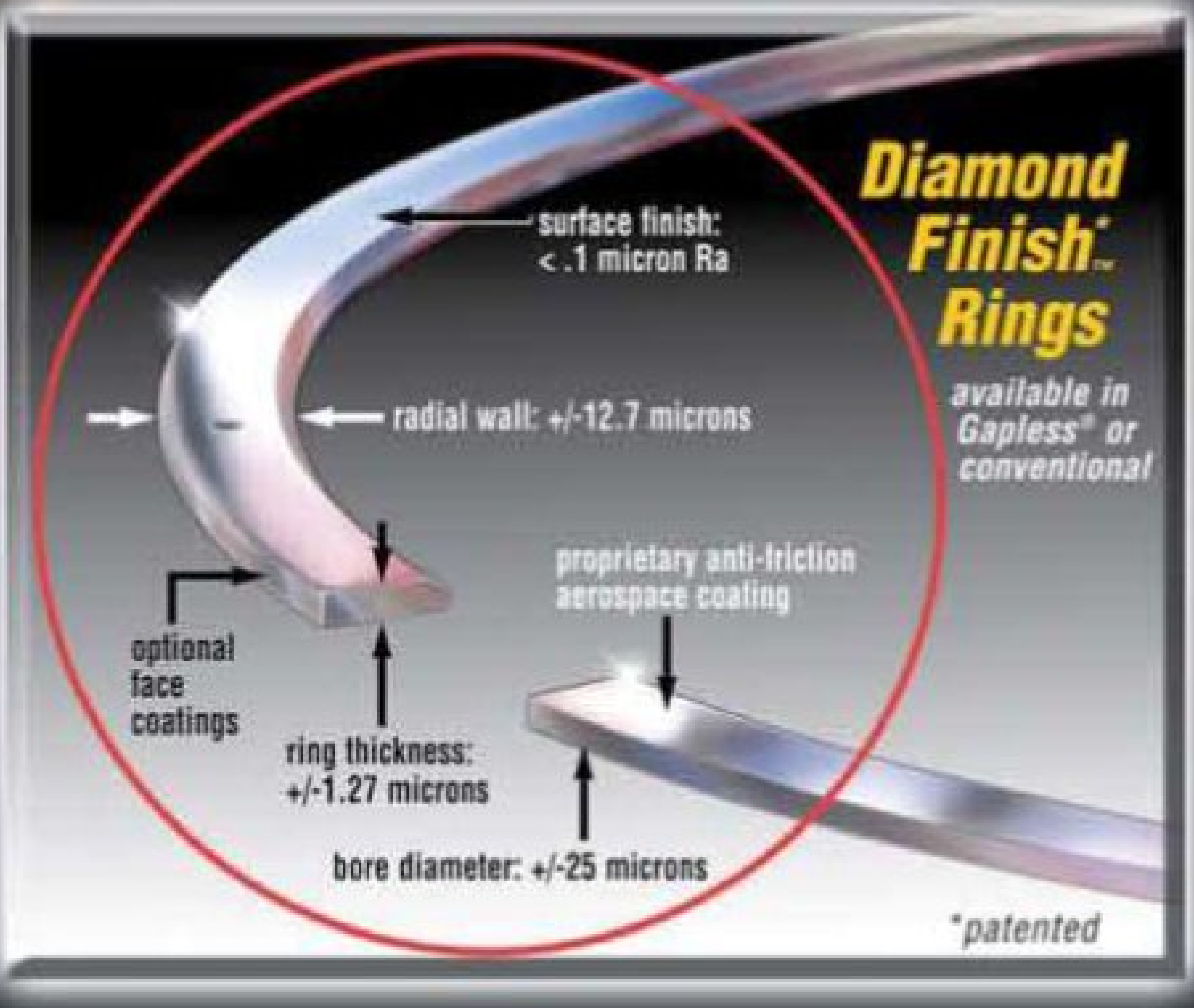

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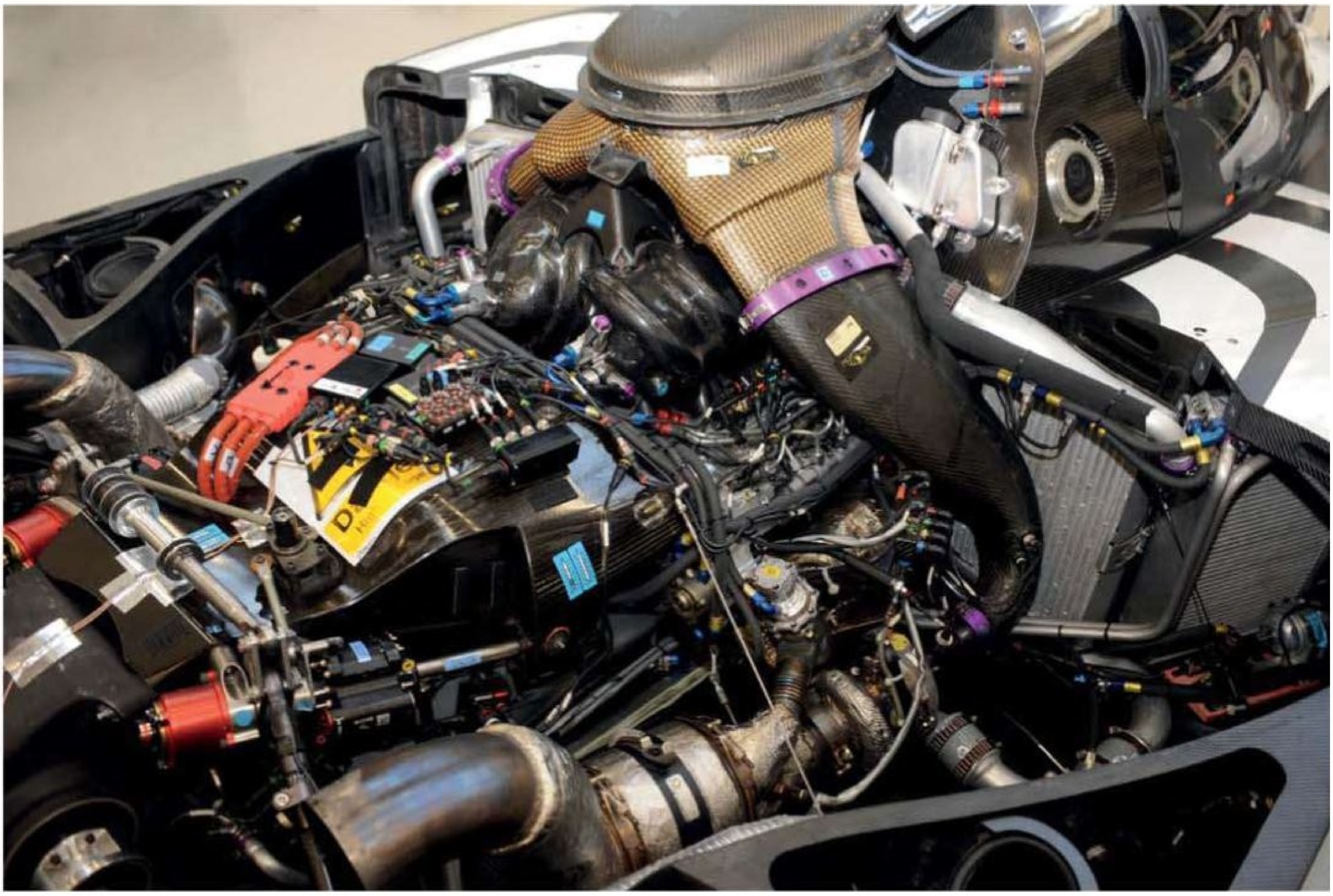

Test mule. Peugeot's 908 HYbrid4 was in the latter stages of development when the programme was abruptly stopped in January. The carbon fibre bell housing was initially built to accommodate the hybrid system, but at the last minute due to reliability issues, the battery pack was put into the tub

integrated and be suitable for racing, and so while the project provided useful knowledge for the team, it was mothballed until the 908 HDi FAP's successor was signed off.

'The problem was that the old 908, the V12, was not designed for the system,' said Peugeot's technical director, Bruno Famin. 'Pierre [Calippe, head of electronics] was in charge of the project at the time, and we wanted to go quickly to see how this system would work. We had no other option than to just put the system in the car, but it was not at all optimised. It was functional, and it was good to learn, but not to race because it was not safe, and not reliable enough. The complete system, the suppliers and the teams learned a lot about the system, particularly in Formula 1 in 2009. Even the technical rules and the safety rules, everyone learned a lot from it.'

It took until the end of the 2009 season before the Peugeot board agreed to fund the development of a full hybrid, and the successor to the V12, also called the 908, was given the green light. The new car featured a 3.7-litre V8 and required considerably smaller ancillary devices, which allowed more space to fit a system, and options for where to put the heavy battery. 'By the end of 2009, we got the final rule for 2011,' said Famin. 'We designed the new 908 chassis to have the possibility for the hybrid.'

Discussions between the ACO and the manufacturers saw the amount of useable energy reduced from 1MJ to the 500kJ that the cars will use at Le Mans this year. 'We thought that 1MJ was too much, and fought to get it reduced, for economic reasons, and we had good compromise with the level of power and storage level to use the rule as it is,' continued Famin. 'We were working with the ACO and FIA to adjust the rule because we were discovering new things together. One of the questions was that the technical rules say you can deliver the 500kJ between two braking areas. But what is a braking area, and how many are there in the Le Mans track?'

"You could perhaps get 4MJ for one lap, maybe more, but you will not be able to do it for 400 laps, that is for sure"

Other details had to be sorted out to ensure the 908 would be competitive against Audi's energy recovery system that delivers power back to the front wheels, creating a four-wheel drive, or Quattro, system.

'We had to decide with the main manufacturers, the ACO and the FIA. And we had a big fight about the 120kmh rule, to reduce the advantage of a four-wheel drive car,' said Famin. 'At least it was something! We were definitely against the four-wheel drive system at Le Mans, and the ACO and the FIA agreed, and tried to reduce the obvious advantage given to Audi.'

Even at 500kJ, the Peugeot system was approaching its limit per lap, although the system was in its early stages of development. 'We think the system should do 3MJ per lap,' said Oliver Jansonnie, head of chassis R and D. 'It is a temperature limit for the system. You could perhaps get 4MJ for one lap, maybe more, but you will not be able to do it for 400 laps, that is for sure.

'It is not only a matter of the cooling. You have to extract the heat from the components, so you need to have a big radiator. You cannot extract the heat because you can't have the flow, even with a big radiator. To increase the size of the radiator would not solve this.'

The duty cycle was the

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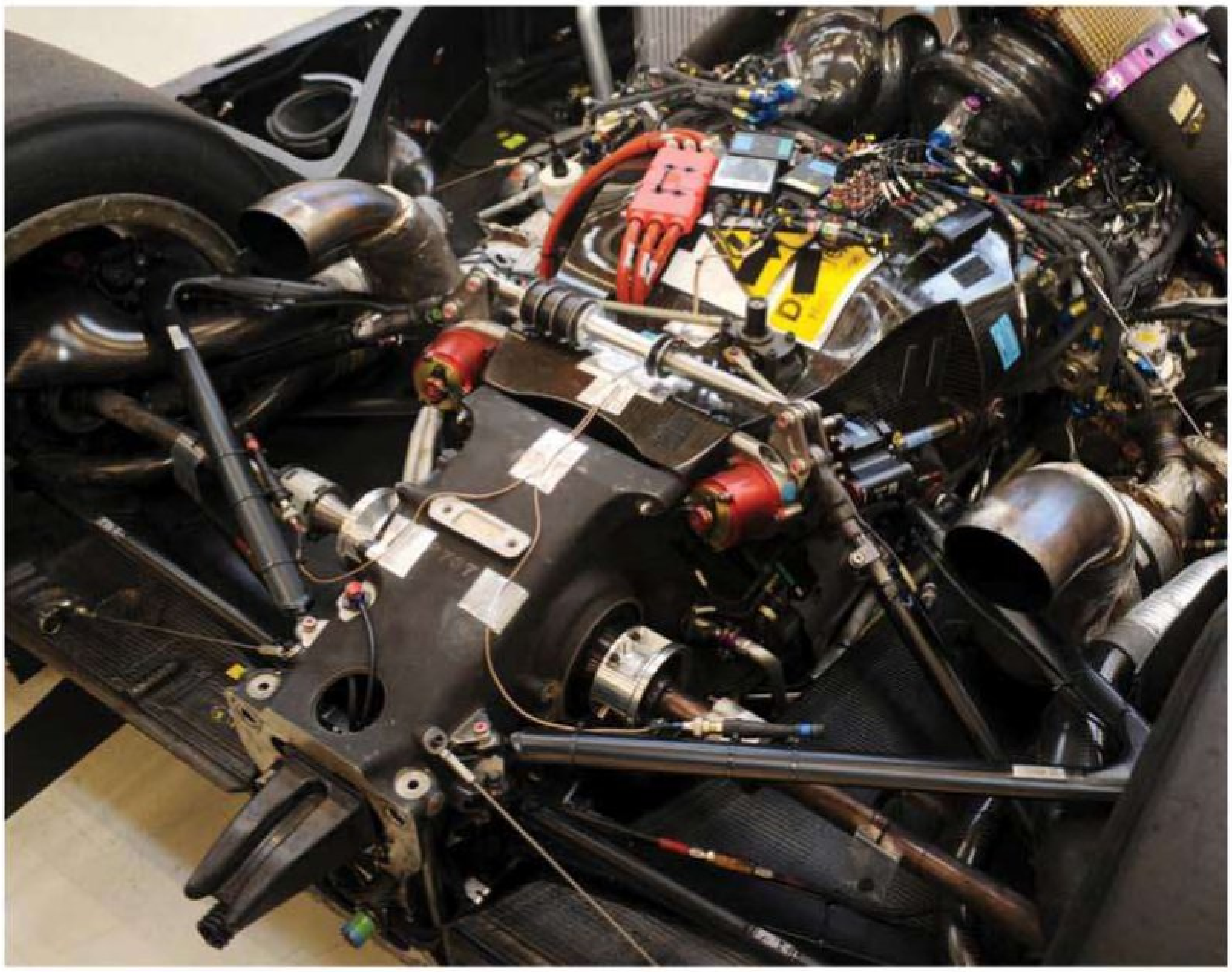
critical factor limiting the performance of the system and, in this first year, Peugeot reckons it could have 40 per cent duty cycle from the system before running into temperature problems. 'To increase the duty cycle would be to increase the rotor temperatures, and the rotors would not sustain such temperature,' said Jansonnie. 'We were still in the development phase, so it means we could have done more on this – change the bearings, the motors and pushed the limits further.

'There were two systems. One for the KCU (the inverter) and the MGU (the motor-generator), and one for the battery pack. The electric motor was water cooled, and the battery pack was oil cooled with its own circuit, and its cooling came from the bottom of the radiator.'

One advantage of a battery system is that it is relatively lightweight. Peugeot's system weighed in at a total of 52kg, and its entire extra mass was 40kg as the team was able to remove the starter motor, alternator and the 12V battery. The hybrid car weighed 870kg though, and would need an extra 30kg of ballast to bring it up to weight.

'We wanted to remove the alternator, 12V battery and starter motor, and to do that, you have to have enough energy stored,' said Calippe. 'A capacitor or flywheel may not provide the energy when you need it to start the diesel engine, so you certainly need a battery. Looking at the level of energy and power this year, the battery system is extremely competitive compared to a capacitor or flywheel [system]. But for higher power, I would not say that. We could change our mind for 2014, but for 2012, this is very competitive.'



The low driveshafts were already an ideal design to accommodate the hybrid system

Peugeot may have been pushing the limits, but perhaps with its 2010 Le Mans experience in mind, it was also playing it safe with its engines. 'On the engine, the timing was reinforced from day one,' said Jansonnie. 'The installation of the gearbox in the chassis was probably not the lightest you could get because we knew this layout was integrating with the hybrid system. There are two components that are very different – the tub to integrate the battery pack, which was mandatory because of the fuel reduction 2011 and 2012, and the bellhousing for the gearbox so we could get the [hybrid] components inside. We knew from day one with this gearbox casing, with the shafts very low down, that it was quite good for putting in some electronics.'

QUICK CHANGE AT LE MANS

The team was evaluating whether or not to run a hybrid at the Le Mans test day in 2011. From the outside, it made logical

ROAD CAR APPLICATION

The development of the hybrid system should have fitted in perfectly with Peugeot's planned launches for production cars in 2012, with the 908 HYbrid4 sharing similar nomenclature with the 308 HYbrid4 and the 508 HYbrid4. From a marketing perspective, it was a perfect relationship, better even than racing a diesel at Le Mans.

'There was never going to be crossover parts from the racing 908 to the production cars, but there was more to the relationship than just the name,' says Oliver Jansonnie, head of chassis R and D. 'But the know how of the battery management and electrical technologies was always going to improve the complete know how of the group. At the very beginning of the diesel engine, we didn't know anything about it and we had a lot of contact with [the production team]. We learned and from time to time and in an informal way we exchanged information with them.

'The parts will always be different because they are so much more expensive, but with bits like cooling the rotors of the electric engine, I am sure you would have the same issues in the road car with an extended duty cycle as you do with the racecar. So you can apply the same solutions to the road car, even if the parts are different.

'It is a technology Peugeot wants to develop. We won in all areas. We were improving our know how, the know how of the PSA Group, and it was obvious. We considered that we were getting more knowledge on the hybrid technologies. On the standard car, the compromises are more difficult to make, whereas in the Sportscar there are no compromises, just pure performance.'

One of the big advances came with the decision to make the electrical systems in house, after initial work by Bosch. 'You need to manage a diesel engine and an electric engine, and you need to combine the torque,' says Pierre Calippe, head of electronics, who switched over from production to racing at the beginning of the hybrid programme. 'If you don't do the software yourself, it takes five times longer to understand what you need, or even what you want. For the 2011 car, we developed the software here, with three people. That was really key when we have to develop the strategies. We could test on the dyno the day after, and on the track a week later.'

sense that a fourth car should be run to generate comparable data to the three cars that would race. However, Peugeot announced that, if it were to run a hybrid at the test, it would be one of the three cars entered for the race.

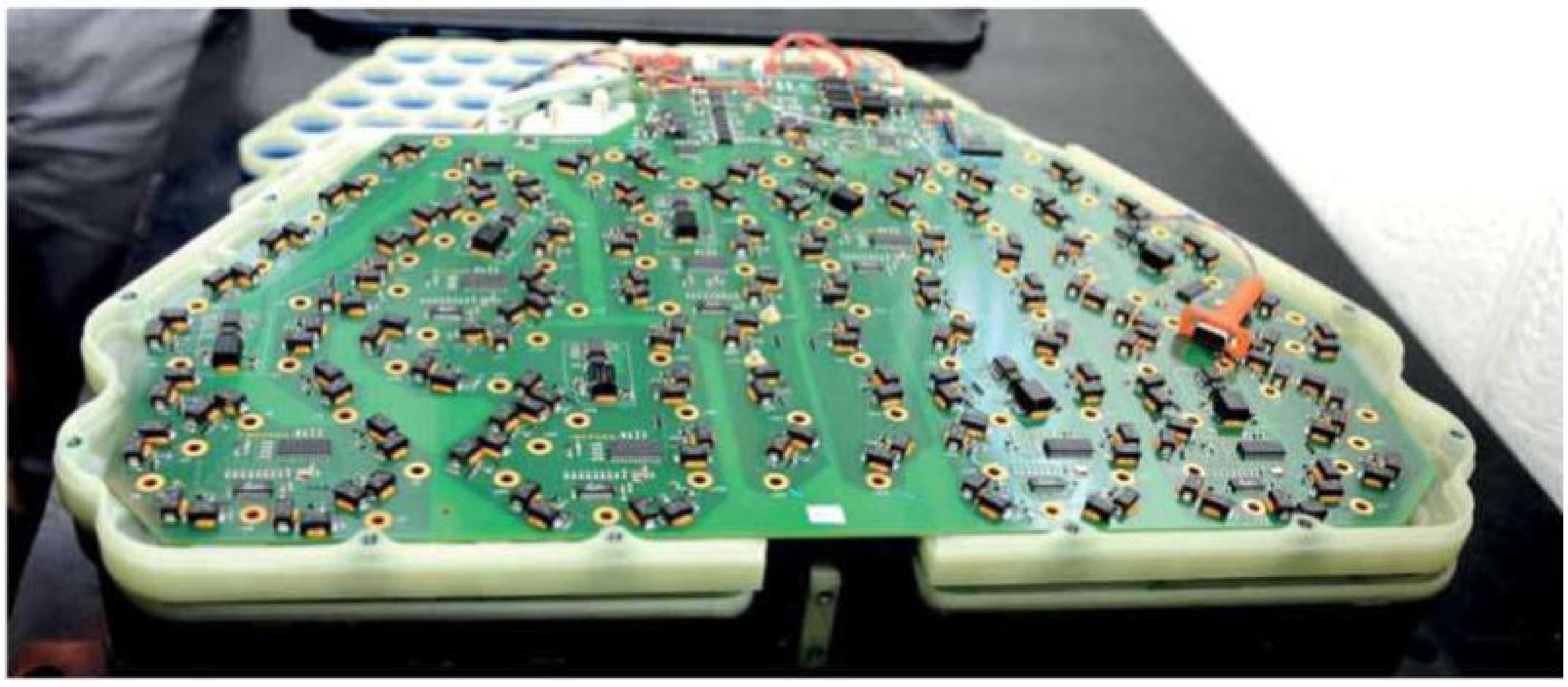
At the time it made no sense but, by running the hybrid system in the gearbox bellhousing, they could convert a car from hybrid in the morning to a standard car in the afternoon. The carbon bellhousing, designed by Peugeot Sport and built by Ricardo, was adapted specifically for the job, but the team was struggling with reliability, so ultimately elected not to run the system at the test day as it suffered a leak in the cooling system.

'Our initial idea was to put the battery pack in the bellhousing,' explained Jansonnie. 'Finally, though, we considered it too difficult. It was possible, but there was a lot of risk. The volume was not enough.

'At the last moment, when we could still make big changes on the 2012 tub, we made the decision to change.'

The first two generations of gearbox-housed batteries were water cooled, but the team experienced problems in two tests, and switched to the more traditional oil-cooled method for the third generation, with the battery pack in the tub.

'The water-cooled battery



The 26kg battery was designed and built by Peugeot Sport. The first versions were water cooled.

BUILDING A BATTERY

Peugeot took the decision to build its own batteries under the guidance of Pierre Calippe, head of electronics, and was taking no chances. Away from the workshop and hidden away in the storage and spare parts unit, an unassuming room was built specifically for the job, and contained all the safety features Peugeot Sport felt necessary.

The hybrid system included a 120kW motor and a small gearbox to adapt the ratio of the motor to the diesel engine. 'Without the gearbox, the motor is approximately 7kg,' says Calippe. 'The power inverter connects to the motor and this is 3kg. Because we don't have an alternator, we have a 2kg DC/DC converter that converts the high voltage battery to the 14V for the car. These are the principal components.

'All the cells in the main battery are oil cooled, with an oil flow. All the monitoring of the battery is done by a large board that was developed internally. It measures temperature, voltage and also controls all the relays and makes it completely safe.

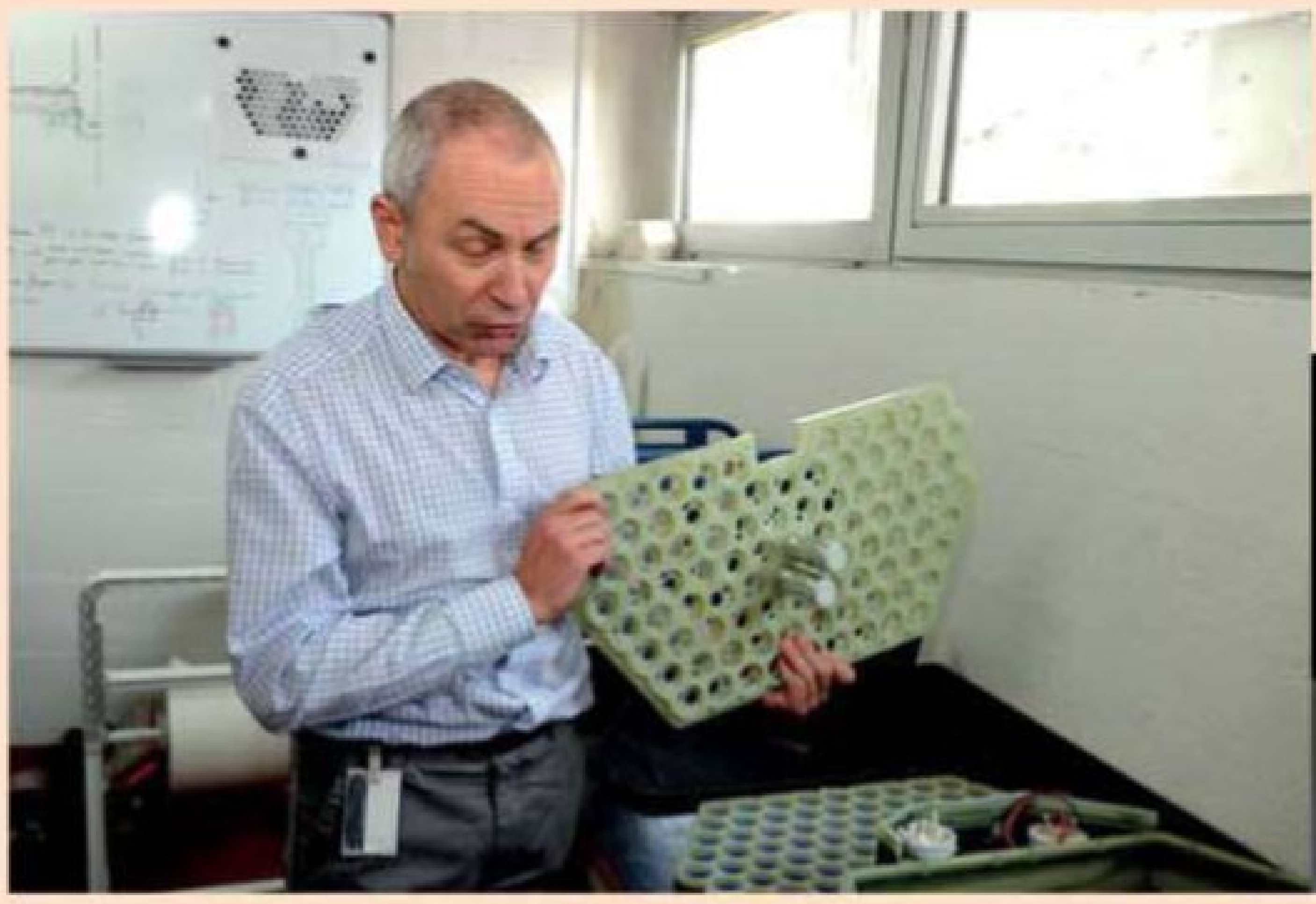
'There are different layers, into which you can fit the cells – 90 in total – and they are connected in series by the aluminium bars. The concept is simple, so it can be built quickly. 'The time taken to build one was one week, but we were able to disassemble and re-assemble in one long day. This board fits on top of the box with no wires, for reliability issues.'

The triangular battery, which weighed 26kg empty, and an extra 4kg when full of oil, was designed specifically to fit inside the Peugeot-designed, Capricorn-built chassis, as low as possible, yet still accessible in case of a problem.

'We have a mechanical switch that you can move inside the car, so if you need to work on the car, even if you cannot see what the state of the car is, you can disable it and the car is safe. It also works in case of an accident. This was going to be standard. The rule says you should have something to disconnect, and that at a specific place there is a switch that controls the relay, but not necessarily the mechanical system.

Battery power was 350V, so not tremendously high, and there was a system to split the voltage in the event of an accident. However, one of the main worries for the team was how to recognise when there was a fault, and so Peugeot designed an ingenious system to alert the team in the pits, or marshals out on track, in case of an accident, whether or not the car was live, and safe. 'The regulation says that whenever you switch on the high voltage power, you have a red light switched on, but we have added more,' says Calippe. 'There is a small red circle, and a green ring. If the green ring is on, the car is safe. It doesn't tell you if there is high voltage or not, just that the car is safe and that you can touch it without risk. The red tells you there is power.

'If the car comes to the pit and the red is on, but not the green light, you put on the gloves. We discussed this with the FIA and they said this is what they want. They said the main switch should also control the high voltage. In the car, you have the hybrid master switch, which has a green LED for the driver. If the green is not on, it usually means it is not dangerous, just that there is an insulation problem, something not going well.'



The 90 individual cells in the 350V battery are contained within different layers with aluminium bars connecting them. Peugeot developed a warning light system that informs whether the car is live and / or safe to touch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was not reliable enough, and we had some leaks,' admitted Calippe. 'When you have water leaks in batteries, it can be very dangerous. The battery is functional, but it becomes dangerous, so we moved to oil-cooled batteries using oil from a high voltage transformer. Then, if ever you have a small leak somewhere, it is not dangerous at all. That was a major change between generation two and three.' However, fate dictated that the Le Mans test day would have been the only public outing for the 908 HYbrid4.

DEVELOPMENT CYCLE

As the 2011 season progressed, so did testing on the hybrid system. The majority of the development concerned cooling, increasing the duty cycle of the system and optimising the system usage to improve lap time. 'In the last months, 80 per cent of the team was working on the hybrid system. It was our main development for 2012,' said Jansonnie. 'Even though it was expensive and time consuming, it was worth it for the gain in performance. It was the promotion, but the technical side was good, too. We knew the cost of the system would be worth the expense.'

The team was confident that, by the time Le Mans rolled around in June, it would have been competitive against the flywheel system in the Audi R18 Quattros, the lightweight design of the R18 ultras and the capacitors housed in the Toyota TS030. Given that Peugeot was consistently competitive throughout the five-year programme, the 908 HYbrid4s could well have added an extra spark to the 2012 event.

Sitting in the workshop, the 908 HYbrid4 featured the latest VGT development and quick-shift gear system

Technical director Bruno Famin led the Peugeot endurance racing programme to two ILMC titles, at victory at the Le Mans 24 hours in 2009

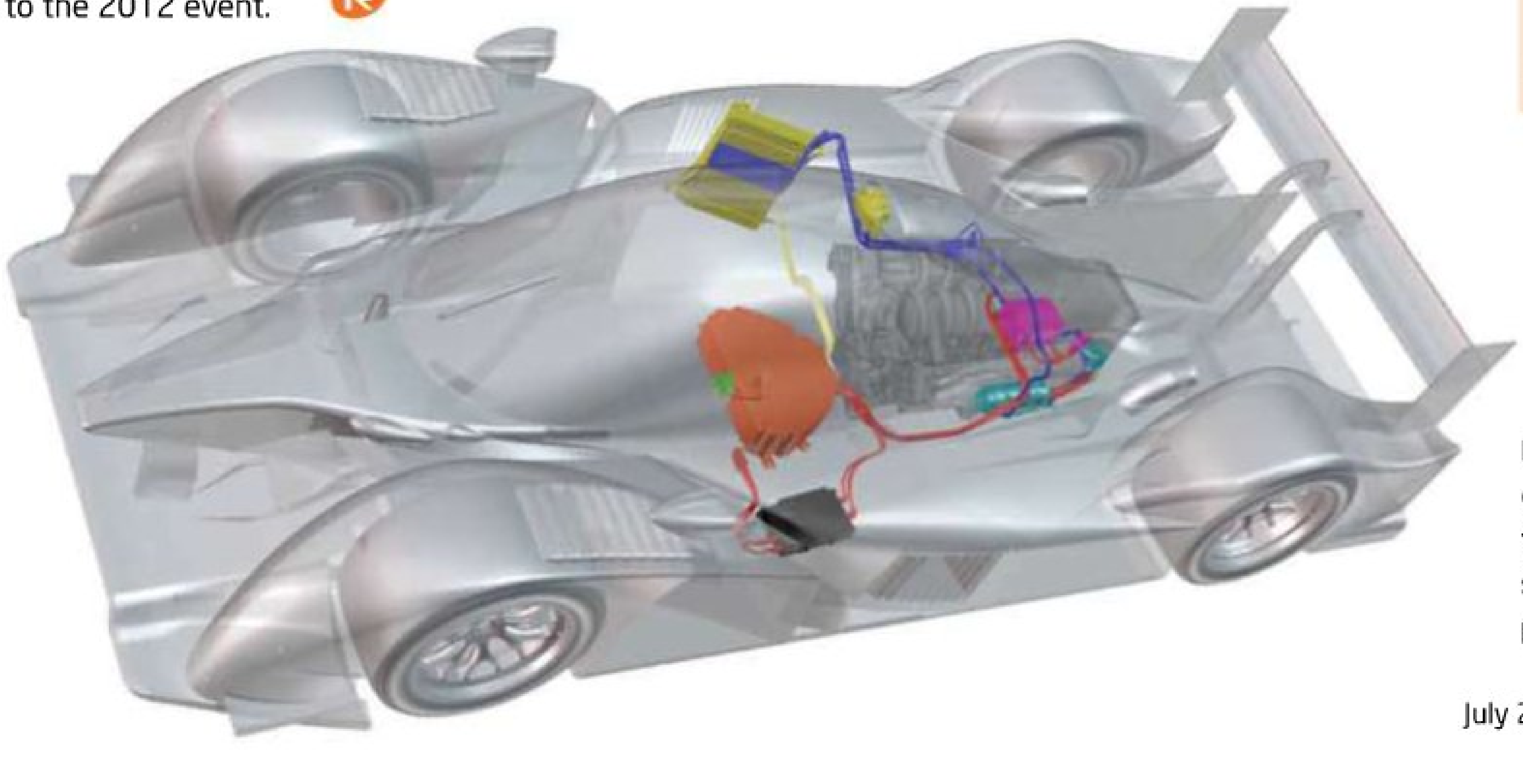
The carbon tub was built by Capricorn to Peugeot's specific design, and here housed the triangular battery

TECH SPEC

Engine: HDi 90° V8
Location: Mid, longitudinally mounted
Construction: aluminium block and head
Displacement: 3.7 liter / 225.8 cu in
Valvetrain: 4 valves / cylinder, DOHC
Fuel feed: Direct Fuel Injection
Aspiration: Turbo
Power: 550 bhp / 410 KW
BHP/Liter: 149 bhp / liter

Electric Engine: Electric Motor
Location: Mid, longitudinally mounted
Power: 160 bhp / 120 KW

Body: carbon-fibre composite panels
Chassis: carbon fibre monocoque with fully-stressed engine
Suspension: double wishbone, push-rod actuated torsion bars and dampers
Steering: rack-and-pinion, power assisted
Brakes: carbon ceramic discs, all-round
Gearbox: 6 speed Semi-Automatic
Drive: Rear wheel drive
Weight: 900kg / 1984.2 lbs
Length / Width / Height: 4640 mm (182.7 in) / 2000 mm (78.7 in) / 1030 mm (40.6 in)
Wheelbase: 2950 mm (116.1 in)
Combined Power: 710 bhp / 530 KW



Peugeot's hybrid system was considerably better packaged than in 2008, when an interim system was squeezed into the V12 powered 908 HDI FAP

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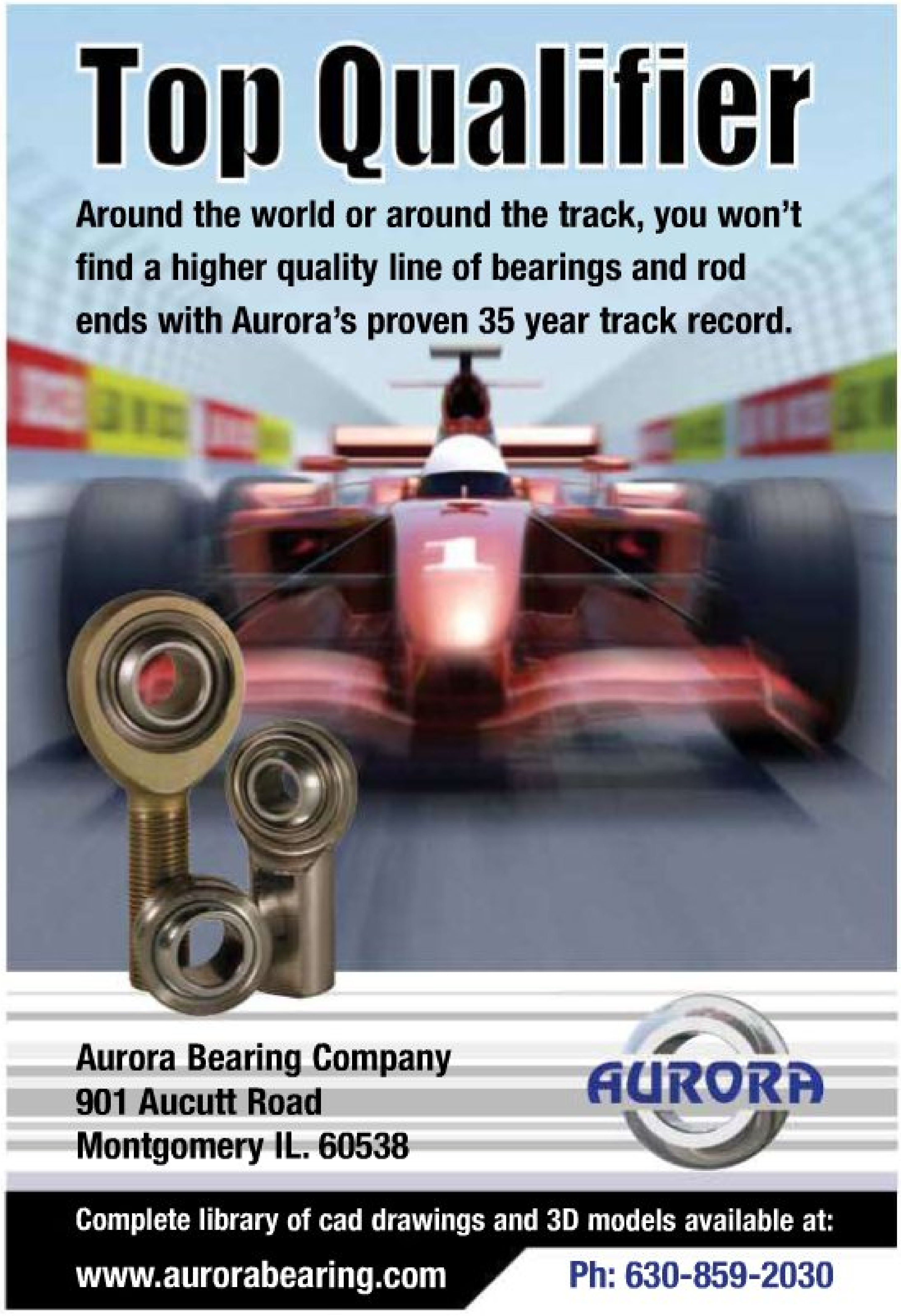

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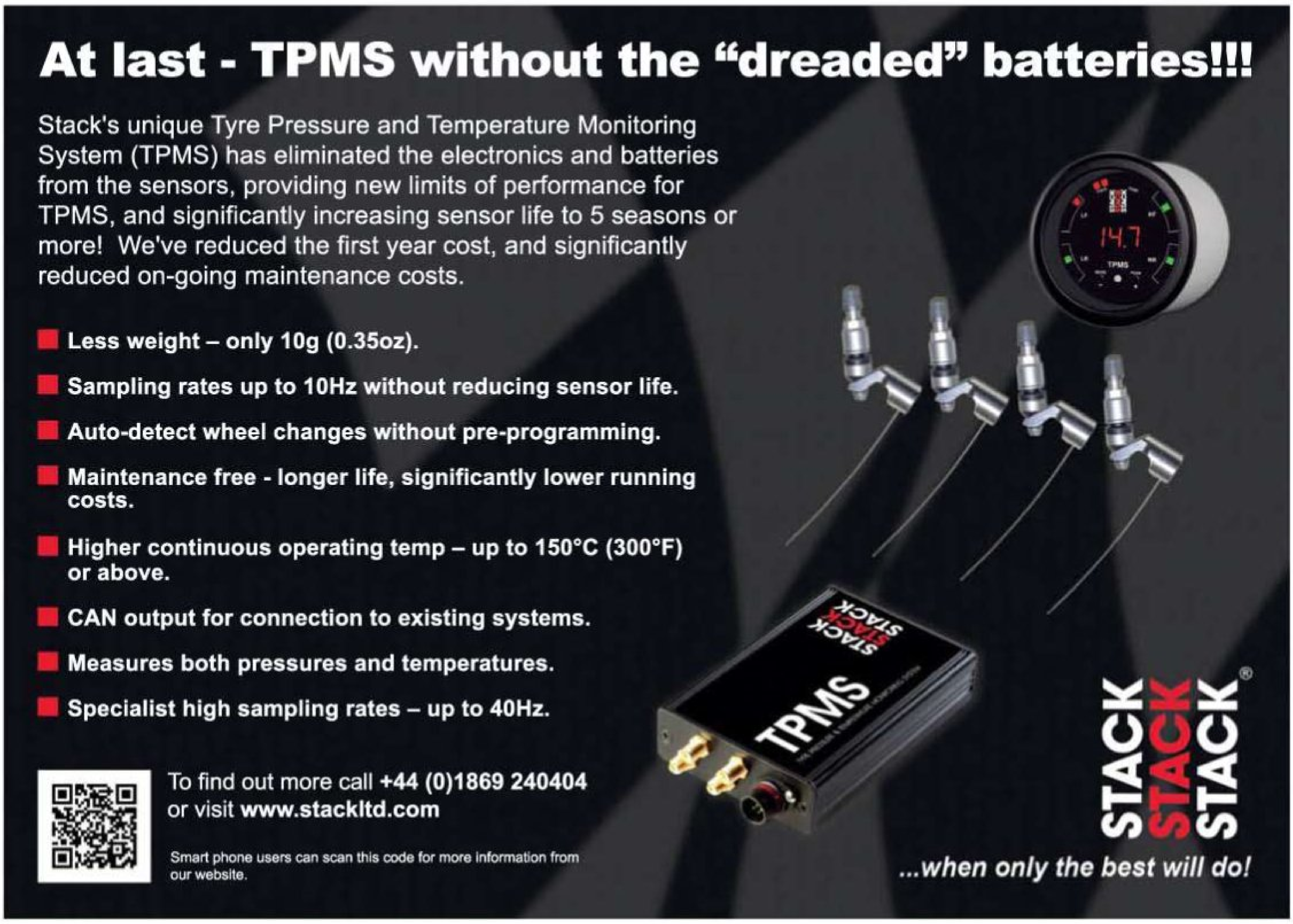

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Better all round

Lighter, and with improved suspension, brakes, steering and balance, Peugeot's new 208 rally car looks to be a worthy replacement for the outgoing 207

BY SAM COLLINS

Peugeot's new R2 rally car rolled out in France in late May. Squarely aimed at customer teams, the car is the first of a new range of rally cars. Two other motorsport derivatives of the 208 road car will see the light of day before the end of 2012 – a racing version with a specification similar to that of the R2 and a higher performance variant built to the FIA's R5 regulations, which will take over from the current 207 Super 2000 rally car.

> **"These features combine to provide the 208 R2 with outstanding roadholding"**

Though the 208's bodyshell is approximately 40kg lighter than that of the 207, its overall volume is one of the R2's chief strengths. 'Weight-saving work has enabled us to bring down the c of g further, optimise where the weight is located and reduce the intrinsically low inertia of this car with its short overhangs,' explains Yann Goraguer, the 208 project leader. 'These features combine to provide the 208 R2 with outstanding roadholding.'

To comply with the regulations, Peugeot Sport has developed for the 208 R2 a brand new, naturally aspirated, 1.6-litre engine based on the 1.6 VTi road car unit. 'For the competition version of this engine, we started from a clean sheet of paper and achieved the 185bhp specified in the brief,' continues Goraguer. 'At the same time, we succeeded in maintaining the low fuel consumption and CO^2 emission figures of the original engine.

'Group R regulations specify that the valves must be of the same size as those of the standard engine... so we worked closely with Sodemo to make our new engine driver friendly by focussing on flexibility rather than on peak power, which often goes unused in rallying. We achieved this thanks to the use of variable valve technology. The 208 R2 kits will be sold with the engine built, run in and checked on the dyno.'

The gearbox, too, is new, and features an innovative cooling solution using an air duct at the front of the car that channels cooling air to fins built into the front part of the casing. The 208 R2 is equipped with a five-speed sequential gearbox, with a gearshift system similar to that of the 207 S2000, but with a much shorter gear lever now positioned on the steering column, in line with the gearbox, instead of on the floor, making shifts more direct and precise.

Goraguer: 'We have carried over the proven three-way adjustable dampers, plus a new, bespoke, adjustable, hydraulic bump stop, developed specially in association with our supplier, Öhlins. The R2 also features a specific wishbone arrangement that increases suspension travel. This, in turn, improves traction and is positive for the car's overall performance.'

'The 208 R2's steering is specific, too. We have switched from the standard car's electric power steering to a hydraulic system, combined with a higher ratio hydraulic rack for greater precision and enhanced comfort. The use of a hydraulic system also permits more accurate feedback of information, notably on loose surfaces.'

Lastly, the brake package has also been improved, with an eye on cost and reliability. 'To simplify the ordering and management of parts, and to facilitate the [easy] conversion from gravel to asphalt-spec, we have opted for a single Alcon caliper plus standard, re-machined discs. Thanks to the floating caliper arrangement, the conversion between specs only requires the caliper mount to be changed.'

With all this in mind, the new 208-based rally car has surely to be an improvement over the outgoing 207. Time will tell.

208 R2 will use a 185bhp, naturally-aspirated, 1.6-litre, VVT engine

TECH SPEC

Engine

Type: EP6C – special pistons, con rods, camshafts (chain driven DOHC with VVT intake and exhaust timing); indirect (Magneti-Marelli) fuel injection; motorised single throttle valve

Cubic capacity: 1598cc

Bore x stroke: 77mm x 85.8mm

Maximum power: 185bhp at 7800rpm

Maximum torque: 19m.daN at 6300rpm

Specific power: 116bhp/litre

Fuel tank: 60 litres

Gearbox

Five speed, sequential gearbox with three homologated final drive ratios

Differential: pre-loaded limited slip differential

Clutch: hydraulically-operated 184mm cerametallic single plate clutch

Brakes / steering

Front brakes: floating, radial-mount, four-piston calipers and ventilated discs

Asphalt: 310mm x 30mm

Gravel: 285mm x 26mm

Rear brakes: solid discs: 290mm x 8mm with radial-mount, two-piston calipers

Handbrake: hydraulic

Power steering: hydraulic

Suspension

Front: MacPherson type with uniball-jointed wishbones; interchangeable front anti-roll bar (three stiffness choices) with plain bearings; cast aluminium struts (camber adjustment at pivot)

Rear: strengthened H-beam modified to accommodate an interchangeable, three-position, anti-roll bar

Front / rear dampers: three-way Öhlins dampers with adjustable hydraulic bump stops

Chassis

Bodyshell reinforced by welded, multi-point, FIA-approved steel rollcage; underbody shielding

Weight: minimum 1030kg (unladen) / 1180kg (with crew)

Front / rear distribution: 64 / 36 per cent

Dimensions

Length: 3962mm

Width: 1739mm

Wheelbase: 2538mm

Track: 1475mm / 1470mm (f / r)

Wheels / tyres

Asphalt: 6.5 x 16 wheels with Michelin 17/60-16 tyres

Gravel: 6 x 15 wheels with Michelin 16/64-15 tyres

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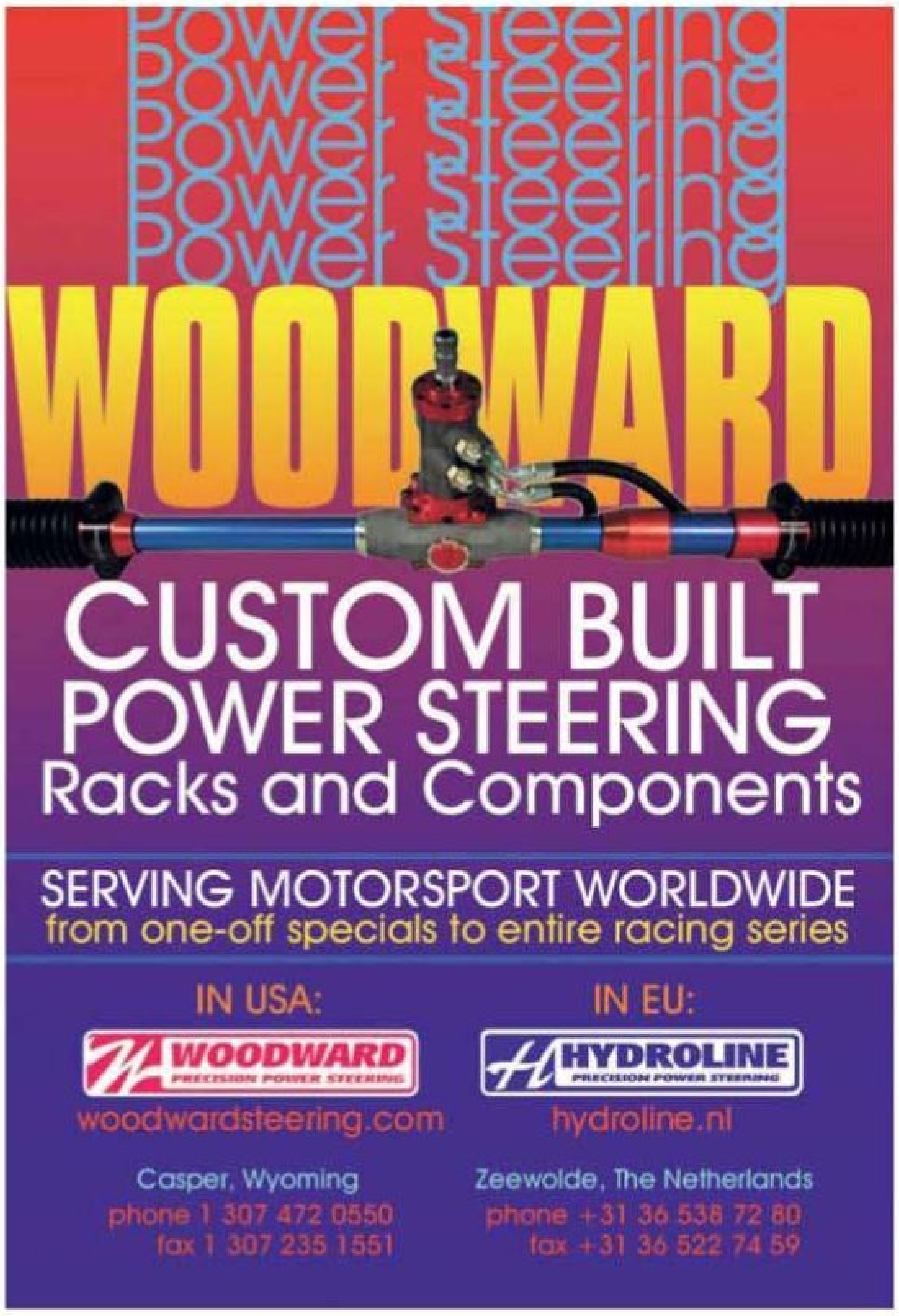
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A load of hot air?

Formula 1's blown diffuser theory was topical in 2011. While designers are still trying to master it in 2012, one student applied the theory to a Pilbeam Sportscar

BY SAM COLLINS

In 2010 and 2011 there was one major area of discussion surrounding Formula 1 aerodynamics. With the banning of the multi-level diffusers pioneered by Brawn, Toyota and Williams, Red Bull had found a new way to boost the performance of its car's underbody – it had placed its exhaust exits lower than was then conventional, so the gas from the pipes blew into an area around the rear wheels.

Using exhaust gases for aerodynamic gain was not new. Various Formula 1 cars over the years have featured 'exhaust-driven diffusers', many of them designed by Adrian Newey, notable as the designer of the current breed of Red Bulls. Key to this is using the gases expelled by the exhausts to energise the flow around critical components such as wing elements or, more importantly, the diffuser.

The concept is not only limited to open wheelers and has also made an appearance in Sportscar racing, with the Allard J2X of 1992. While that car is largely forgotten, it housed its exhaust tailpipes in a through-car tunnel, in theory increasing downforce. The concept had dropped out of fashion of late, possibly because the tools required to fully understand what is going on with the airflow were not well developed. Even then, it was the preserve of high-end cars such as the highly advanced Allard.

"Using exhaust gases for aerodynamic gain was not new"

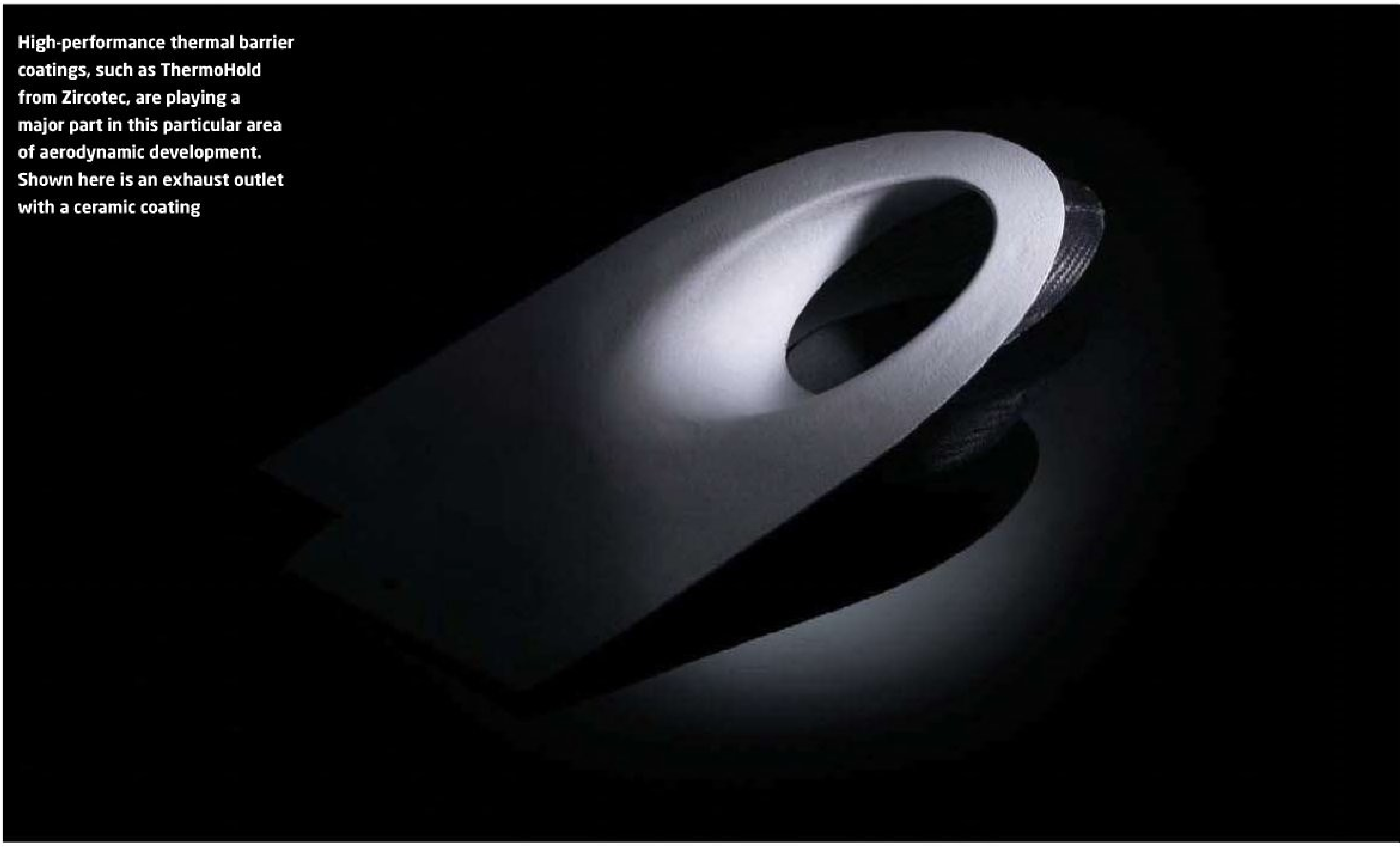
HOLLAND CALLING

It was a subject that fascinated Dutch graduate, Thijs van Rees, who was working on a Phd at Cranfield University. He decided to make the concept the subject of his thesis, but not on the traditional top-end open wheeler. Instead, he picked out a mid-range, full-bodied car as the model for his study.

'I used the Pilbeam MP98 CN regulations Sportscar [shown in lead pic, above]. It was developed purely in CFD and later tested on track, which is fairly unique in that category,' explains the Dutchman, who now works in Formula 1 with Williams. 'The regulations for that class of car stipulate that exhausts must be mounted in a specific area and must point either rearward or sideways, which gave me an interesting challenge. But they do not prevent you locating them in an area that can bring aerodynamic gains.'

To study the implementation of such a layout on a mid-range car (turnkey CN machines retail for around £80,000-£100,000 ($125,575-$157,000) makes this an unusual piece of work, and the results of the research are substantial. Van Rees was heavily influenced by Red Bull's recent designs, which appear to be all about the flow structure around the rear wheel.

'Their concept was to manage the wheel wake at the rear of the car, and that was to improve the flow through the diffuser,' he explains. 'Tyres are



High-performance thermal barrier coatings, such as ThermoHold from Zircotec, are playing a major part in this particular area of aerodynamic development. Shown here is an exhaust outlet with a ceramic coating

very strange things. The radius and the contact patch changes continuously, and this is a very important aspect in terms of aerodynamics, especially in open-wheel cars. At the base of the tyre there is a vortex created and, if this gets into the diffuser, it reduces its effectiveness. Using the mass flow from the exhaust to drive this vortex away from the diffuser and other critical areas effectively makes the diffuser larger and more efficient.'

COMPUTER SAYS 'NO'

But to fully understand these flows is a complex challenge, only really made possible by recent technological advances. Indeed, when van Rees attempted to run his first simulations he discovered it required more computing power than the clusters at Cranfield could supply, so he was forced to simplify his model.

'One of the important things to remember is that the exhaust is a very high temperature gas flow, and you have to manage that in the simulation,' explains van Rees. 'To do it fully, you have to understand the changes of the properties of the gases. The velocity, density and the thermal conductivity are all influenced so, for me, CFD was really the only way to survey all these factors.'

Van Rees' simulation was basic by current F1 standards, but nonetheless highly revealing, and he found substantial gains to the aerodynamic performance of the Pilbeam. 'Just using a very rudimentary design, the MP98's downforce increased by 11 per cent, and more detailed studies could almost certainly bring greater gains. The drag level also increased but, even so, there was an overall gain.'

With the widely reported change in Formula 1's exhaust regulations often called a ban on blown diffusers, many of the innovative layouts, such as those used by Red Bull, were outlawed. However, blown diffusers are not banned *per se*, and the teams are still actively trying to optimise their exhaust plumes. 'It is still important, but when you have changes in performance of the order of magnitude that we are seeing with the tyres and getting the tyres to work, it's not our higher priority,' explains Ross Brawn of Mercedes. 'Last year it was one of the predominant performance factors, but this year it is nothing like as significant as it was. I think the cars that came first and second at the Spanish Grand Prix had very conventional exhausts so, unlike last year, the cars with innovative positions are not pulling away from those who are conservative. The range of performance between the solutions is much smaller now. But we still do a lot of work on it, both in CFD and tunnel testing. You can't do everything in a wind tunnel and, obviously, you cannot generate hot gas. It's a combination of both that gives the best results.'

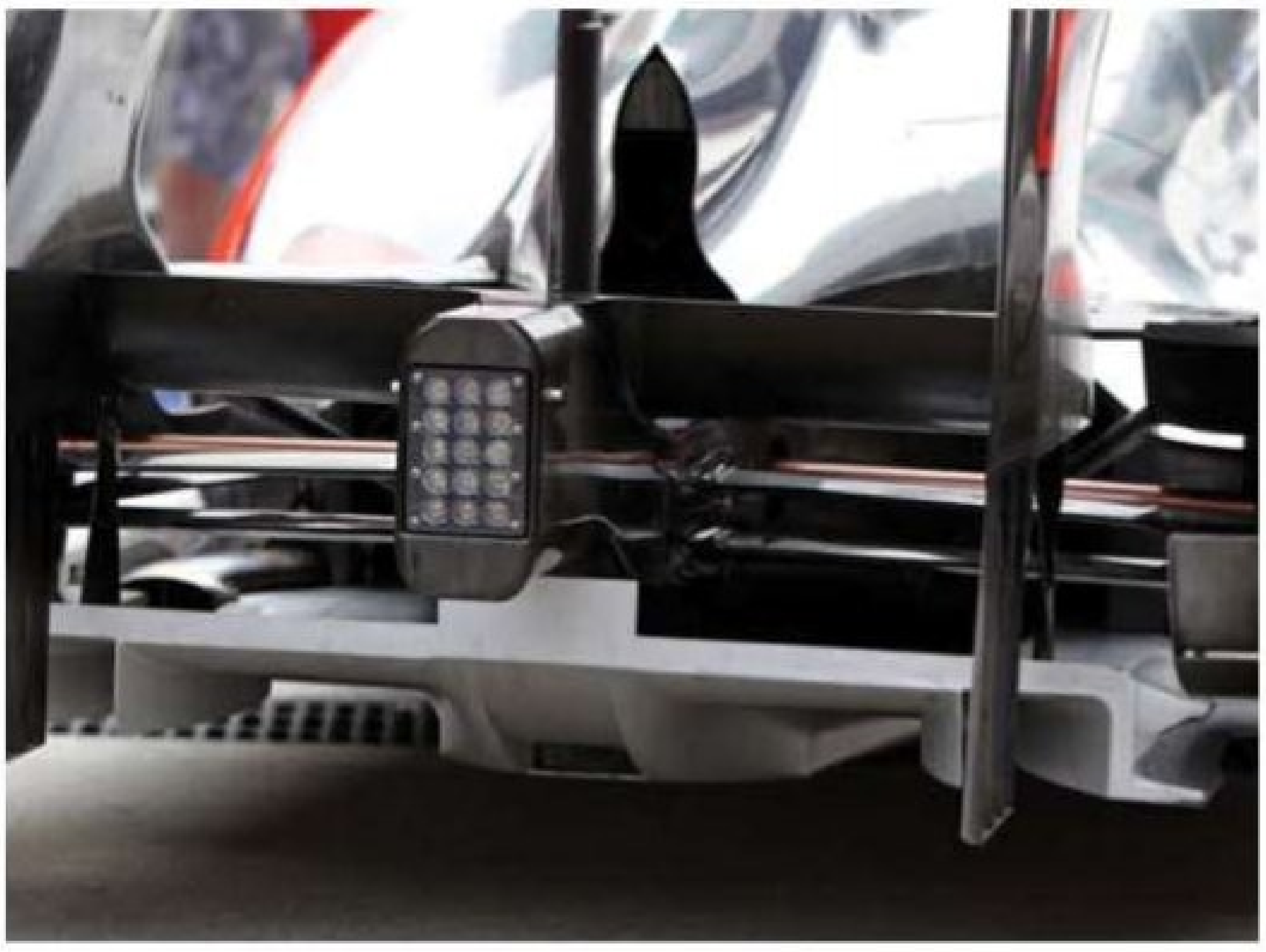
Indeed, most modern F1 teams are now working on simulating exhaust flows in the wind tunnel, but it is notoriously difficult to do, as Giorgio Ascanelli, technical director at Toro Rosso, admitted in pre-season testing: 'Our simulation capacity is limited in this respect. It depends on the pulse, the speed of exhaust flow compared to the speed of the airflow, the expansion rate, the temperature, ride height, cornering speed and we cannot simulate all of these things with sufficient certainty.'

THE TMG CONNECTION

However, some wind tunnels are more advanced in this respect, and Toyota Motorsport GmbH (TMG) in Cologne is a popular destination for Formula 1 teams chasing aerodynamic gains, partly because both of its wind tunnels are capable of simulating exhaust gases, as engineer, Chris Herbert, explains. 'We have two systems at TMG. In wind tunnel one, we use an air amplifier inside the model connected to a compressed air line. In wind tunnel two, as part of the wind tunnel assembly,

> **"exhaust is a very high temperature gas flow, and you have to manage that in the simulation"**

This close-up of the Red Bull exhaust outlet shows how the floor is being blown directly ahead of the rear wheel with the exhaust pointing to the inside edge of the rear tyre to stop the vortex interfering with the flow through the diffuser. Note the cut out just ahead of the wheel where the flow will go down



Shown in white at the bottom of the picture, the McLaren diffuser covered with a ceramic thermal barrier coating

A further iteration of the exhaust blown floor, as seen on the Mercedes, showing the attachments to channel airflow through the diffuser

we have a large accumulator for the storage of compressed air and this is fed directly into the strut, then into the model.

In both wind tunnels, the compressed air lines are fed down the main strut and into the model via the cockpit. In wind tunnel one, the air lines terminate at the air amplifiers, which are located in the engine region. The air amplifiers use the compressed air to entrain additional flow, which is drawn from the roll hoop and then fed into the tailpipes. In wind tunnel two, the supply is simpler, with the compressed air lines being directly connected to the tailpipes.'

However, it is not really possible to replicate the gas temperatures in the wind tunnel. 'Doing the temperatures is very difficult,' admits Lola's Julian Sole. 'We have a cooler in our tunnel but, once you start pumping hot gases in, you are working it overtime. I'm not sure anyone in F1 is doing that.'

Herbert elaborates: 'It is not possible to heat the model scale tailpipe flow. We cannot simultaneously replicate a scale equivalent of both the speed and mass flow of the full-size car in the wind tunnels. Therefore, based on our experience, as well as a lot of testing and configuring, we know the appropriate level to set the wind tunnel tailpipe velocity to replicate actual exhaust gas behaviour.'

"We cannot replicate a scale equivalent of both the speed and mass flow of the full-size car in the wind tunnels"

It would seem, then, that van Rees was right in that the only real way to get a full simulation of the heated gases is to either run the car on a track and see what happens – which is not simulation at all – or to use CFD.

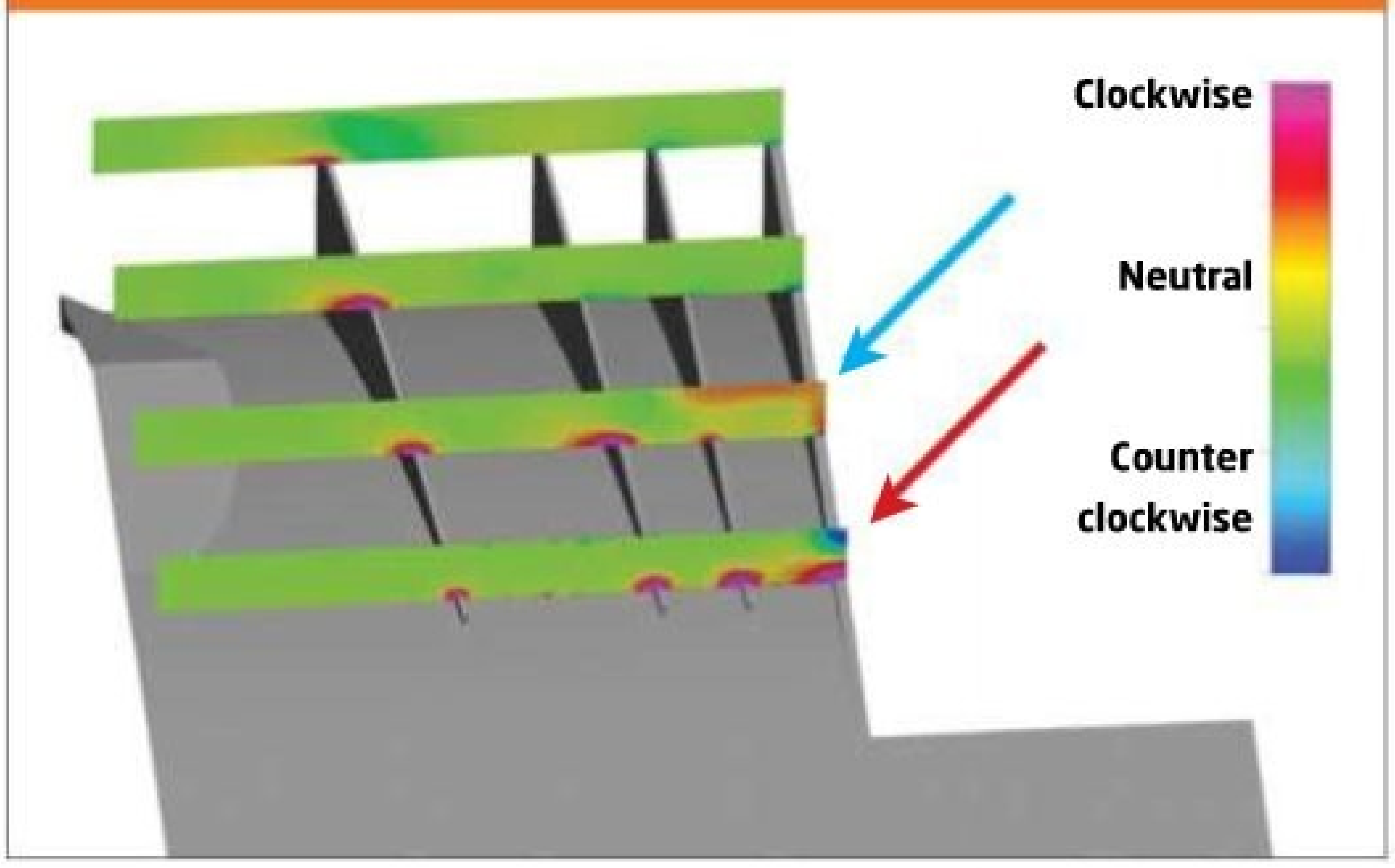
'We use CFD to visualise the flows,' continues Herbert, 'and we use our PIV (Particle Image Velocimetry) technology to ensure a good correlation between tunnel results and CFD modelling, in the same way we use PIV to enhance the accuracy of our CFD for other aerodynamic work. CFD can also be used to assess whether the plume impinges on the tyre surface and, if necessary, to simulate the thermal effects on the air around the tyre.'

THERMAL MANAGEMENT

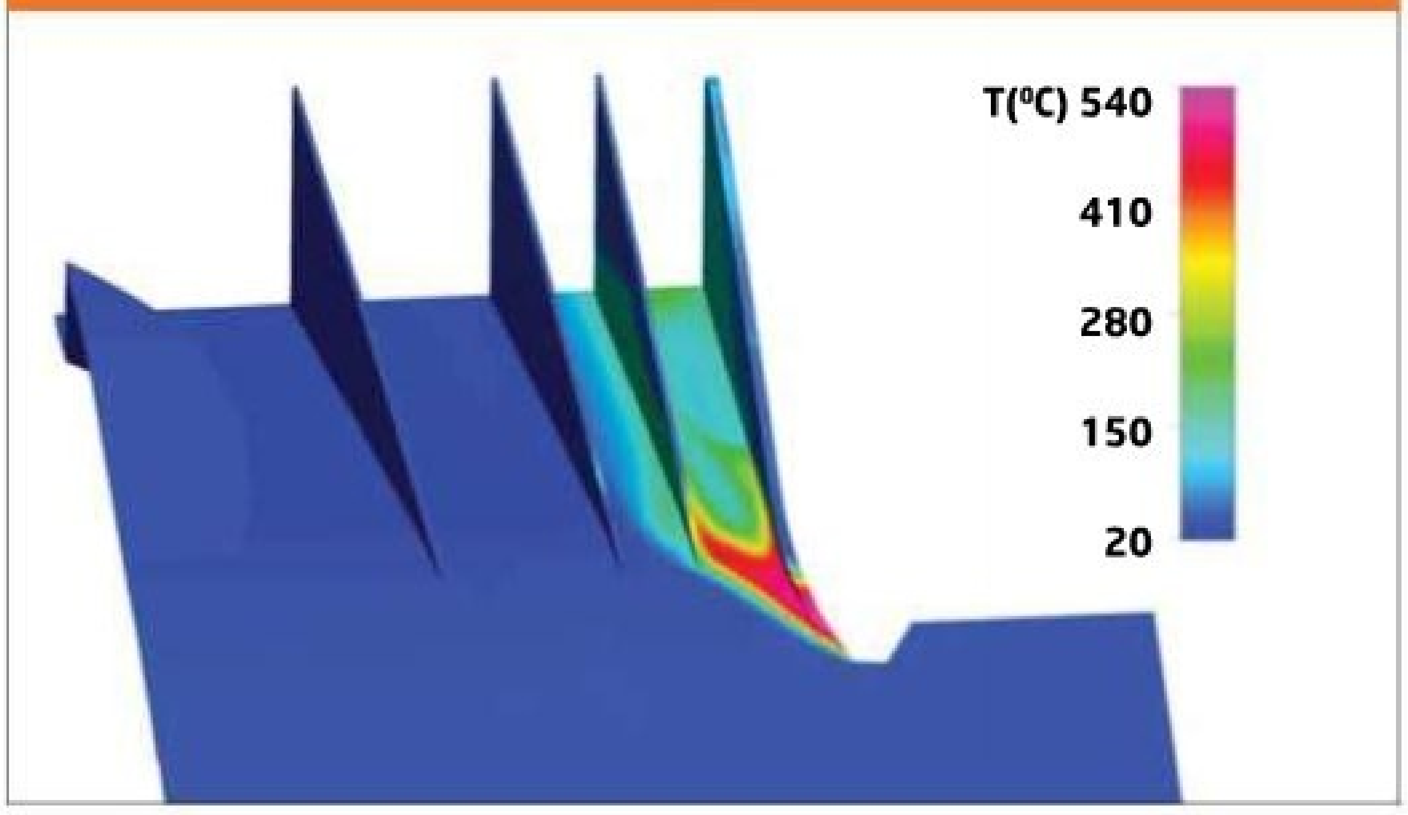
As Herbert hints, the temperature of the gas has more than an influence on the dynamic properties of the exhaust plume. It also has significant implications for the materials and structures of the car itself. Exhaust temperatures of 650-1000degC are commonplace and any team contemplating a blown diffuser has to take this into account.

There are several different solutions available to help cope with this, including gold foil wrapping or thickening of carbon fibre structures, but ceramic coatings such as those offered by the Oxfordshire-based firm, Zircotec, are now an essential

DIFFUSER VORTICITY



DIFFUSER TEMPERATURE



Top: the vortex from the rear wheel of the Pilbeam with an unblown floor can be seen to reduce the overall efficiency of the diffuser
Bottom: the blown version of the floor, showing the temperature of the exhaust gases into the diffuser (both images from Thijs van Rees' thesis)

ingredient. Its zirconia-based product, ThermoHold, has a thermal conductivity of less than 1.7W/mK, compared with 4W/mK for alumina. Its origins are in the nuclear industry and Zircotec was previously part of the UK's Atomic Energy Authority. The firm uses gas plasma spraying to load molten ceramic powder onto composite parts, building up layers until a thickness of somewhere between 250-400microns is achieved.

'Our coating reduces surface temperatures by 125degC and enables hot exhaust gases to pass over delicate carbon parts like diffuser strakes, protecting them from delamination. Not having to do complete re-designs helped teams reduce the introduction time for the blown floors,' says Peter Whyman, Zircotec's sales director. The influence of CFD-generated simulations of the heat distribution are clearly crucial.

'We are now seeing engineers incorporating the coating into the design, rather than merely solving heat issues after they find them. Our first coating applications provided a safe solution. With reliability proven, teams are now seeking performance gains by maintaining high gas speeds. Our ability to finely adjust the surface finish means we can offer a smooth finish with no impact on thermal protection.'

> **"teams are now seeking performance gains by maintaining high gas speeds"**

So, with the simulation of the gases on the MP98 modelled and understood by van Rees, why has the Lincolnshire-based constructor not yet implemented the concept on its car? Well, as always seems to be the case in engineering, the reality is more complex than the theory. 'There is a slight problem in that the regulations in that category state we must use in-line, four-cylinder engines, and so we would need to have split the exhaust system somehow without losing performance, or only have it blowing on one side, giving an imbalance,' explains Pilbeam.

THROTTLE DEPENDENT

John Iley, now Caterham F1 performance director, was instrumental in the design of the Allard J2X, but says he was not a fan of the system: 'As a rule, I am not a supporter of such a system as it makes the car's performance too throttle dependent, which does not provide the basis for a stable platform,' he told Mike Fuller of mulsannescorner.com. 'However, the location on the J2X Allard was far enough rearward that its effect was greatly reduced. The main drive to route the exhausts this way on J2X was to achieve an incredibly low and tidy rear deck for the lower rear wing, not to utilise a blown diffuser principle.'

Van Rees elaborates on the instability Iley mentions: 'Obviously, these designs rely on exhaust mass flow, and that relies, of course, on the driver's foot being on the throttle. It means a driver can get on the throttle earlier because the mass flow massively increases downforce, and therefore traction.'

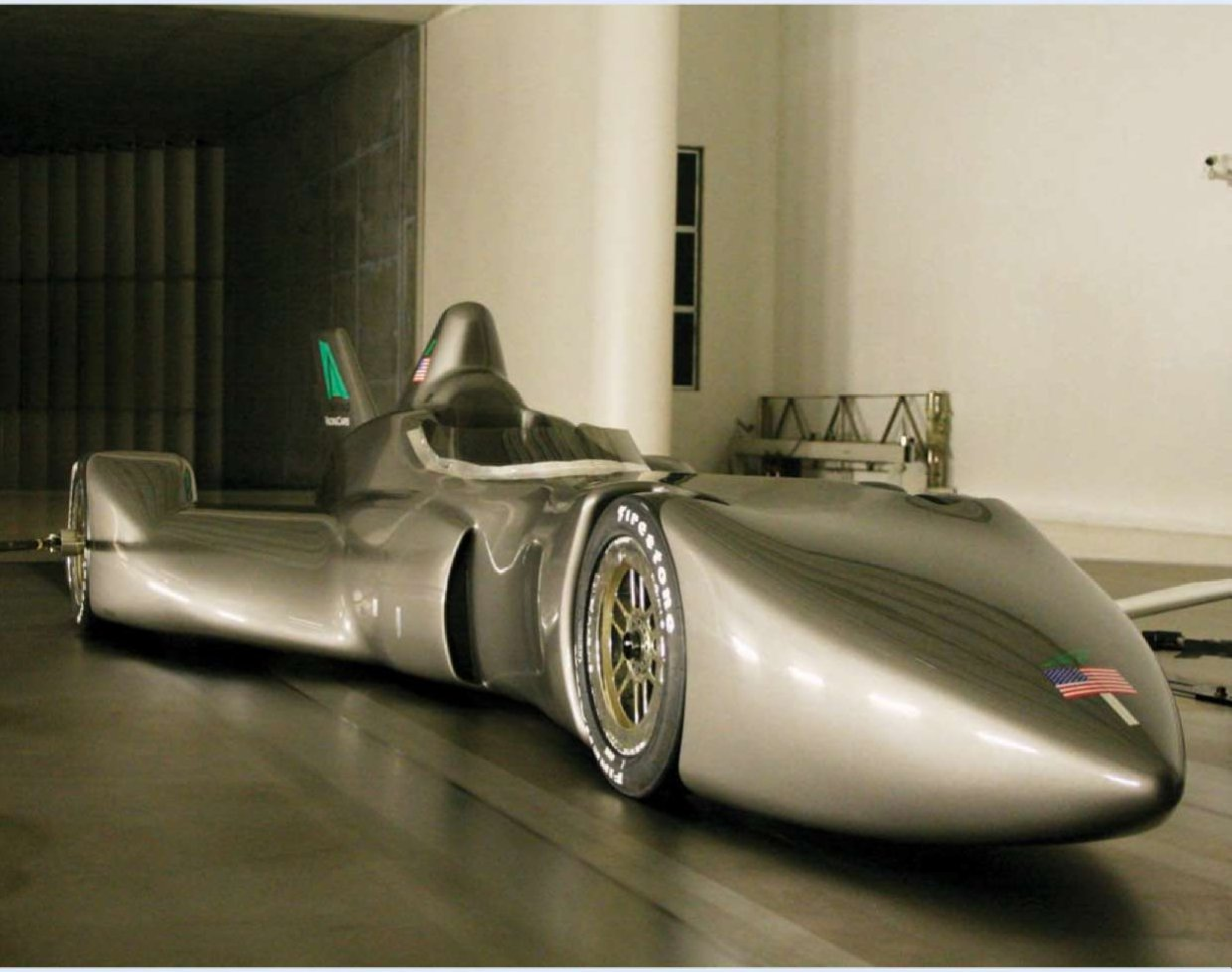
But in a section of corners where the driver is balancing the throttle, the mass flow from the exhaust is constantly changing, as is the downforce level. This makes cars with a so-called 'cold-blown' diffuser (where the exhaust mass flow is purely dependent on the driver's right foot) somewhat unpredictable, as Iley mentions, though van Rees suggests there are ways of making it a bit easier: 'You could do things like keeping the brake pedal on the car as you go through the corner and drive through on the throttle, all the time keeping the mass flow rate going through the system,' he suggests.

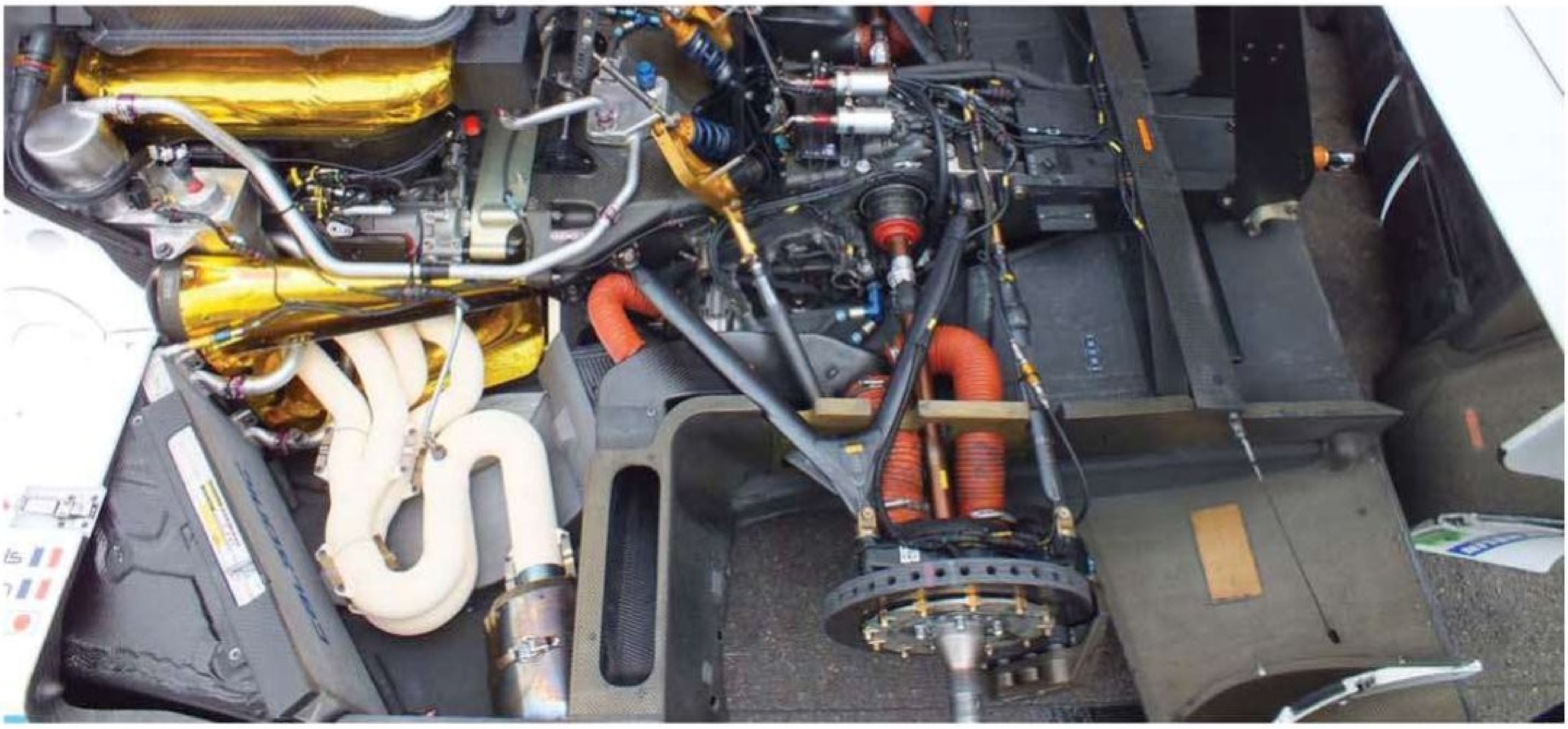
In 2010 and, particularly, in 2011, Formula 1 teams used a more advanced solution to this problem. A 'hot-blown' diffuser is used to maintain a constant stream of gas through the diffuser to keep downforce levels consistent. When a driver goes off throttle with a hot-blown diffuser, the engine throttles are kept open, fuel keeps being injected (and is ignited through careful mapping), maintaining the necessary gas flow. Naturally, this approach has a detrimental impact on fuel consumption but, put simply, the more fuel burned, the more exhaust gas is produced, and potentially the more downforce created.

The Renault RS27 Formula 1 engines fitted to the two cars that took the greatest advantage of hot-blown diffusers – the Renault R31 and Red Bull RB7 – burned 10 per cent more fuel than normal during the Australian Grand Prix that year, simply because the throttle stayed open when the driver was off the accelerator pedal.

'In general, our goal is to optimise the overall performance of the car [for that read: race results]. For many purposes, this can be simplified to optimising the lap time,' explains Rob White, deputy managing director (technical) at Renault Sport F1. 'One of the performance trade-offs within this optimisation is the extent to which exhaust gas energy is deployed to gain aerodynamic performance vs engine performance degradation (eg power loss, fuel consumption penalty, driveability penalty, durability or reliability risk).

'With off-throttle blowing, this is typically achieved by some combination of exhaust design to increase gas velocity, such as smaller tailpipe diameter, or nozzle, exhaust design to deliver exhaust gas to where it can influence aero (longer tailpipe), and throttle position – more open equals more air. Also things like cylinder cutting with no fuel or spark reduces torque to compensate for open throttles. Ignition retardation by later





The aerodynamically efficient Dome S102. Current ACO regulations state the floor must be continuous but it does leave scope for exhausts to be exited into the wheelarch, which could increase downforce, even in a cold-blown situation

spark timing increases exhaust temperature, and reducing torque compensates for open throttles. Finally, you also need to look at post-combustion – fuel burning in the exhaust after the combustion chamber.'

WIDER APPLICATION

Why are blown floors not being used more widely elsewhere? According to Audi Sport, a turbocharged engine does not produce enough mass flow to be able to take advantage of the concept, ruling out the current generation of diesel-engined Sports Prototypes, Indy cars and the forthcoming new generation of Formula 1 cars from 2014 onwards. But what about normally aspirated racecars, such as the Dome S102.5 or Toyota TS030?

It is clear to White that the concept has applications across many areas of motorsport, at least where regulations allow, and hints that those who say that blowing a floor with a turbocharged engine does not really work may be incorrect: 'All of the above is generic and equally true of any high-end race engine with electronic engine control, fly-by-wire throttle and unrestricted control of individual cylinder ignition and fuel injection. Note that a turbocharged engine would have additional scope, relative to a normally aspirated engine.'

Sole, of Lola, feels the reason the concept has not yet been taken further is not so much technical as commercial: 'We had blown floors in F3000, so we have some experience of that. Doing it on a Le Mans Prototype is difficult, but not impossible as the regulations say you must have continuous surfaces. Also you can hit budget limitations, not least through burnt bodywork as you develop. Moving the exhaust position around is expensive, with the cost of new pipes and bodywork, as well as the R and D.' However, his conclusion is enigmatic: 'There are other ways to take advantage of the aerodynamic impact of the exhaust, other than working the diffuser...'

"increased fuel consumption is not the only downside of running a hot-blown diffuser"

But, as White is keen to stress, increased fuel consumption is not the only downside of running a hot-blown diffuser: 'There are things to consider, like engine power being compromised by increased back pressure and acoustic compromise. Driveability, too. Cylinder cutting is a blunt tool, so managing torque transitions is challenging, and can cost lap time, and there may be second-order effects from vibrations associated with cylinder cuts, though this is typically marginal. Increased temperatures are also more difficult for engine and car components – notably, exhaust valves and exhaust components.'

So, despite the effective ban on hot-blown floors in Formula 1, they are not banned in many other categories and F1 teams are instead finding ways of using cold-blown diffusers inside the current regulations, engineering the cars' bodywork to have a similar influence.

Hot blown floors are outlawed in F1 but attempts to utilise cold blowing continue, as seen here on the Red Bull RB8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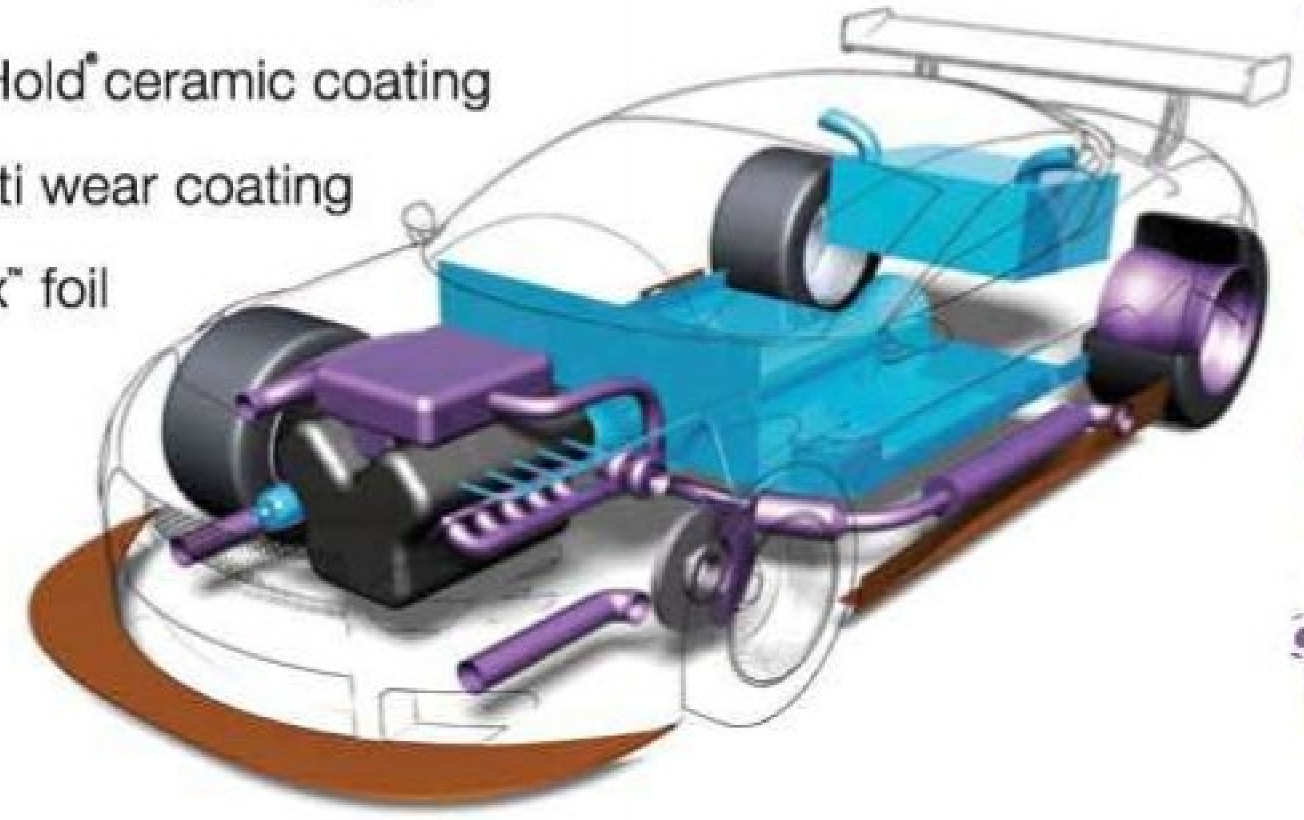

Is it really worth it?

Investigating the case for all-wheel drive in a Sports Prototype

BY DANNY NOWLAN

The 2012 running of the Le Mans 24 Hours promises to be one of the most technically fascinating in recent memory. We are going to see diesel, petrol and diesel hybrids, the DeltaWing and all the usual LMP2 and GT suspects. But what is of particular interest here is the fact that you'll have hybrids that can switch between rear-wheel drive and all-wheel drive.

The purpose of this article is to investigate the impact of all-wheel drive on the performance of an LMP1 car. We all know the effect this had on rallying. The Audi Quattro is the stuff of legend, and all-wheel drive and World Rallying took a little known Japanese car brand by the name of Subaru and turned into one of the most identifiable car brands in the world. However, are we dealing with the same potential performance differential for an LMP1 car as a World Rally Car?

To kick things off, it would be very instructional to look at a current representative LMP1 set up and investigate its implications. Some typical Sports Prototype variables are presented overleaf in **table 1**.

Please note, for obvious reasons, the numbers are approximate. I should also add most Sports Prototypes also have significant bump rubber rates incorporated in the main springs, which will add considerably to the wheel rates, particularly at the front. What all this translates into is that in the mid-corner condition, the outside front tyre is dealing with the bulk of the manoeuvring load for the front axle. For example, in a low-speed corner, when the car is pulling, say, about 1.8*g* we might expect this as representative tyre loads. This is shown in **table 2**. Again, these numbers are approximate but they are in the ball park.

The reason the fronts are so heavily loaded is due to a combination of aero and mechanical considerations. First things first: the aeromaps on these cars are very ride height sensitive. Also, as a rule of thumb, there is a very narrow window of front ride height at which you get optimum downforce. Consequently, you have to be stiff at the front. The other reason is that modern Sports Prototype tyres are very temperature sensitive. Given the front tyre is spending the bulk of its time down the straight doing very little, when we turn in we need to drive temperature into it.

What these numbers tell us is at the mid-corner, the outside front tyre is having to support the front axle. So, given the front outside tyre is under significant load, is it worth considering an all-wheel drive system? Similarly, as most Sports Prototypes tend

"Are we dealing with the same potential performance differential?"

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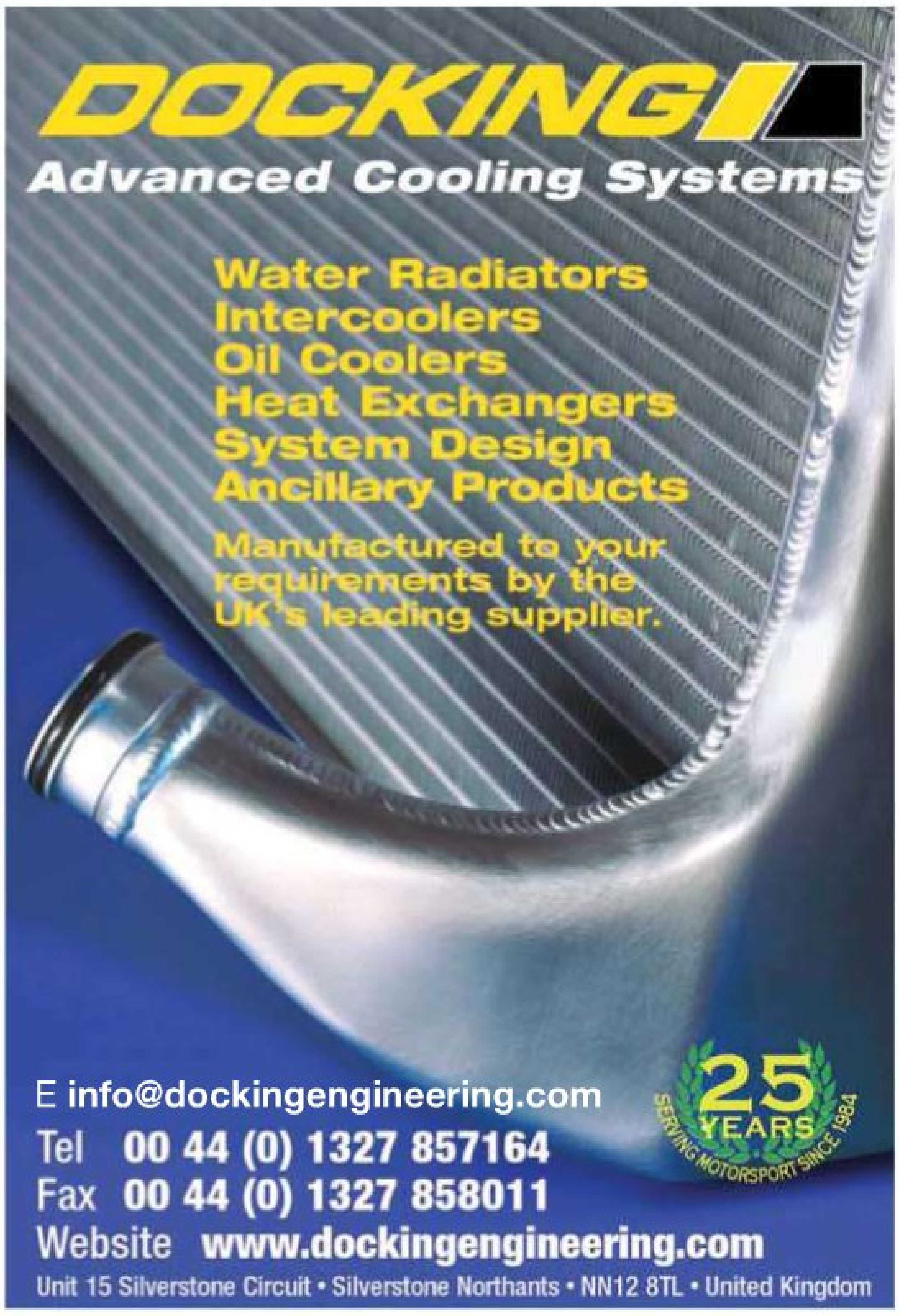

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to understeer in the mid-corner condition, particularly in low-speed corners, we have to ask the same question, considering the front outside tyre is only just able to turn the car.

To resolve this, we are going to do some simulations around the Le Mans circuit. We are going to use constant all-wheel drive for our simulations, holding the torque split constant between the front and rear axles as active all-wheel drive is banned in most racing formulas. We'll sweep through rear-wheel drive, 15 per cent on the front axle and 50 per cent on the front axle.

Let me also note at this point that the all-wheel drive system used by Audi will be something that can be controlled by driver or computer. However, the point of this article is to explore whether or not all-wheel drive is worthwhile. Therefore, we are going to use some simplifying assumptions to get us going.

Table 1: set up parameters for a typical Sportscar

Set up parameter	Value
Front wheel rate	140-210N/mm
Rear wheel rate	140-210N/mm
Front bar wheel rate	300-1000N/mm
Rear bar wheel rate	0-50N/mm
Front roll centre	20-40mm
Rear roll centre	30-60mm

Table 2: Sportscar tyre loads in a low-speed turn

Tyre	Load
Front left	300kg
Front right	100kg
Rear left	450kg
Rear right	300kg

Table 3: results of simulations for rear-wheel drive vs all-wheel drive simulation

Set up	Lap time
Rear-wheel drive	3:45.46s
Torque split: 15% front / 85% rear	3:46.9s
Torque split: 25% front / 75% rear	3:47.9s
Torque split: 45% front / 55% rear	3:50.9s

The simulation sweeps turned up an interesting spread of results, the results of which are summarised in **Table 3**.

You might now be thinking, looking at these results, why would you bother considering all-wheel drive? In the 45 per cent / 55 per cent case, you would be justified. To consider this, look at the overlay in **figure 1**, which shows a comparison of the car through the Porsche Curves.

The coloured plot is rear-wheel drive, the black is where the torque split is 45 per cent on the front and 55 per cent on the rear. As can be seen, we suffer everywhere. The speeds are on average 5-10km/h down at the mid-corner. Also, in the third and fifth that shows throttle and accelerations, the rear-wheel drive is getting the speed down much more effectively, whereas in the first corner the 45 / 55 case simply cannot get on the power as effectively. The throttle difference is in the order of 20-30 per cent!

The reason for this is due to the tyre loads. While the rears are reasonably loaded, the outside fronts are doing the bulk of the work, as illustrated by **figure 2**.

As we can see, the inside front tyre is getting down in the order of 50-90kg. Consequently, we are asking the outside front to both turn the car and play a significant role in accelerating it. In short, we are going to be on the back foot with this option.

> **"I would be throwing it in as a tweak at the end, rather than building a car around it"**

However, the 15 per cent / 85 per cent torque split presented a different story. While the overall lap time was slower, there were glimmers that the all-wheel drive option is worthy of further investigation. To illustrate, let's consider this plot through one of the Porsche Curves, as seen in **figure 3**.

As per figure 1, the coloured plot is the rear-wheel drive option and the black plot is the 15 per cent / 85 per cent torque split option. As can be seen in the mid-corner, we have a 3km/h advantage and a little bit of an advantage under traction. Given the nature of this change, this is a genuine advantage and something that is worth pursuing. A similar picture was seen in a couple of the low-speed corners.

What the 15 per cent / 85 per cent case shows us is that there

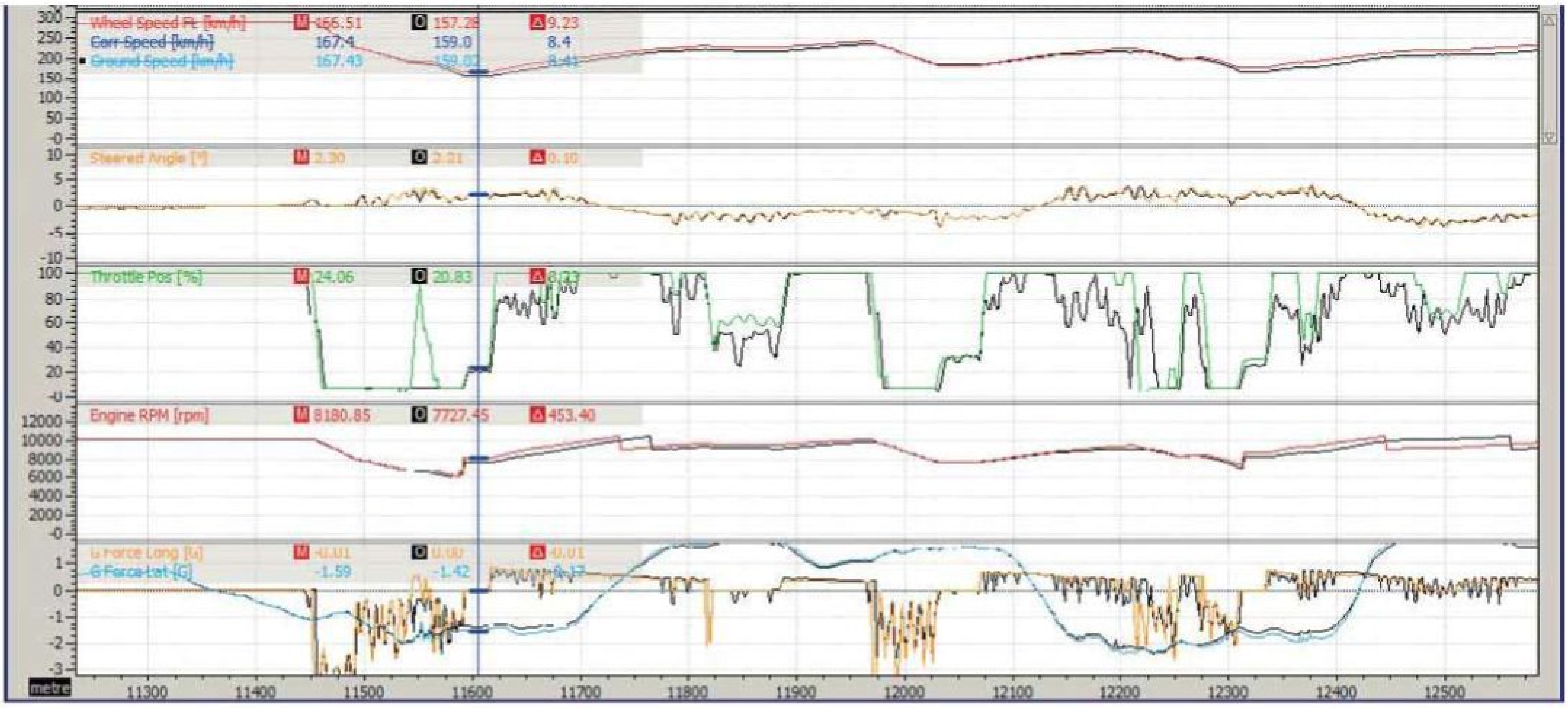

Figure 1: comparison of rear-wheel drive vs 45 / 55 per cent torque split

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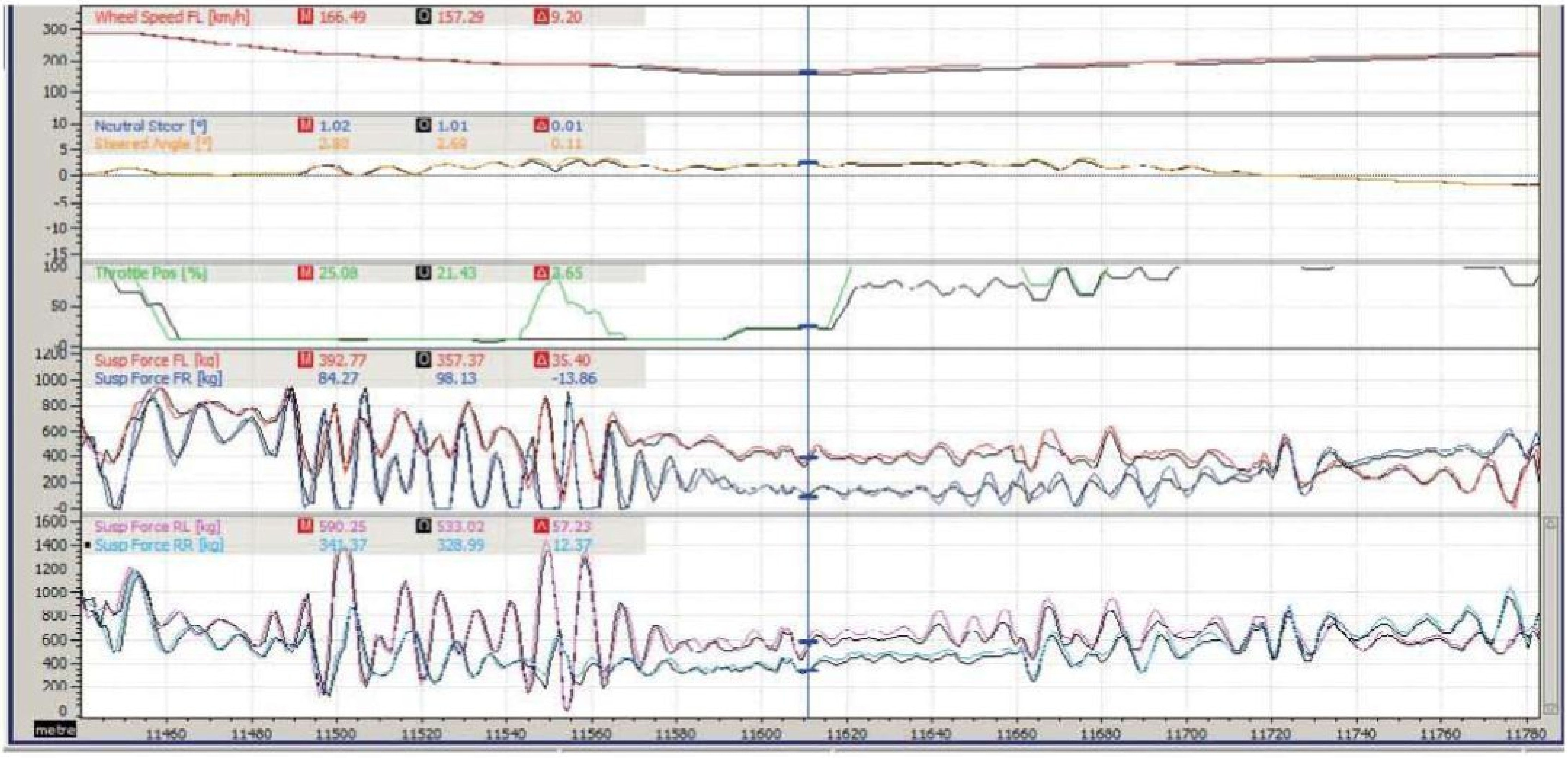

Figure 2: investigation of tyre loads

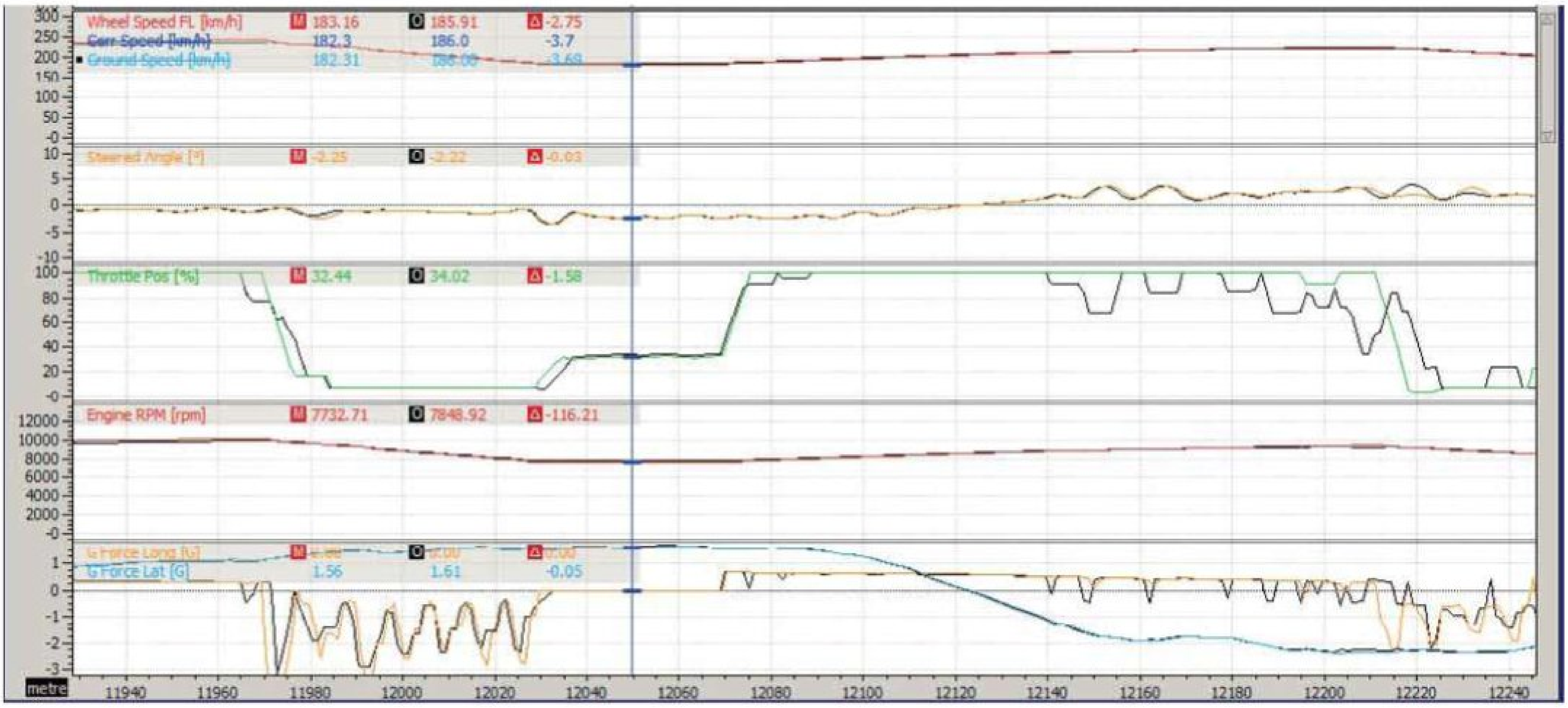

Figure 3: comparison of rear-wheel drive vs 15 / 85 per cent torque split front to rear

could be a genuine advantage in actively splitting the torques between the front and rear axles. While the gains in the simulation on these respective corners were in the order of 0.02-0.05 secs, we must remember at Le Mans there are approximately 20 corners, so this could add up to 0.6-1 second a lap.

PACKAGING ISSUES

The other question to consider is whether this is worth the undeniably difficult packaging issues in a Sports Prototype? I for one am fascinated to see how Audi approach this.

If you were a lower budget LMP1 or LMP2 team, I wouldn't be losing any sleep over other cars running with four-wheel drive. Yes, active all-wheel drive offers a potential advantage that shouldn't be sneezed at, but I have always maintained that if a race team does its job properly, it's amazing what you can do when you pay attention to details. For example, that 0.6s-1second per lap we could pick in all-wheel drive could just as easily be made up through damper adjustments.

My personal opinion is that while all-wheel drive is worthy of consideration, it is something I would be throwing in as a tweak at the end, rather than building a car around it.

Don't get me wrong. Obviously, in the car's initial design you have to make room for it but, in terms of race engineering the car, this is something you add as an enhancement at the end once you had everything else sorted. As we have just outlined, it's not a big enough change to be your first go to adjustment.

The biggest drawback to all-wheel-drive is understeer. Audi's system will not be active below 120km/h by regulation. Consequently, as the understeer washes off, the system can be activated. This is something that we haven't explored in this article but, from what we have seen, there is certainly merit.

I should also add that what we have done here is only a preliminary analysis. To complete the picture, I'd code up something in ChassisSim to actively optimise splitting torque between the front and rear axles and then we could get a truly accurate picture of what we are dealing with. I presume this is what our friends at Audi have done, and clearly they have concluded it's worth their while pursuing this avenue of engineering further.


Audi R18 e-tron Quattro


The hybrid R18 (lower image) has slightly higher cooling demands at the front compared to the ICE-only R18 (upper image)


A dimple in the R18's roof is the result of a regulatory change and allows for cleaner airflow to the plenum chamber

Audi vs Toyota

A closer look at the two hybrid Prototypes that will battle it out at Le Mans this year

BY SAM COLLINS

Two Le Mans Prototypes will be grabbing the headlines at Le Mans this year, and both have undergone substantial updates ahead of the race. Audi's R18 has been substantially altered over the winter, not least with an all-new monocoque, whilst the definitive version of the as-yet-unraced Toyota TS030 was seen for the first time at a photoshoot ahead of the Spa 6 Hours.

The changes to the German-built Japanese car were immediately apparent, with an entirely different front end on display, compared to the car's rollout. Toyota technical director, Pascal Vasselon, explains the updates: 'The car we had at the rollout was really just a generic LMP design, to start running the car to see if the hybrid system worked, the engine, the gearbox etc. Now we have a proper racing package on the car. We have gone away from the classic LMP-style splitter and adopted a more F1-style nose with the front essentially acting as a wing. We have reduced drag and increased downforce and the car is simply more developed now.'

Toyota's Le Mans programme was initially only meant to consist of a single car, but Peugeot's withdrawal from the

Toyota TS030

Both Audi (above) and Toyota mount the energy storage systems in the passenger seat area of the cockpit

Toyota has heavily revised the front of its TS030, with an F1-inspired nose. LED headlights have also been added to increase brightness

World Championship saw the team double up its effort for the 24 Hours. However, a major crash in testing put that in jeopardy. It also means Toyota will arrive at Le Mans having never raced the TS030. Despite this fairly major setback, it allowed the TMG engineers to run a rear-mounted hybrid system, instead of a front-mounted system. Whilst some may think this would call for a complete new chassis, in fact this is not the case.

'It was impossible to re-develop the monocoque we had. There was absolutely no time to do that as we had to rush the manufacture of the third tub as it was. It is touch and go if we will make it to the test day with both cars,' admits Vasselon.

Mounting the hybrid system at the rear of the Toyota does create another challenge, as Vasselon explains: 'The rear brakes are interesting because when we are running the hybrid system it takes a lot of energy from the rear, so brake cooling at that end is blanked out. But if there was a system failure, or similar, the brakes will be hotter because of the normal load going through them. We would then have to open up the cooling ducts on the bodywork so they do not overheat.'

TOUGH OPPOSITION

Toyota has set itself the target of being the fastest hybrid at Le Mans, and that will mean that it will have to see off some tough opposition from the new Audi R18 e-tron Quattro. Despite being based heavily on the 2011 Le Mans-winning Audi R18, the 2012 car is in fact a new car. The German marque had to substantially reduce the base weight of the R18 to accommodate an electro-mechanical hybrid system, which has a motor mounted in the front, along with the flywheel storage in the cockpit alongside the driver. With this system fitted, the car is known as the R18 e-tron Quattro, though two of its four cars will race at Le Mans without a hybrid system installed and will be known as R18 Ultras. Essentially, though, there is no difference between the two base cars. 'The chassis on the R18 Quattro and Ultra are exactly the same. We can run the same chassis as an R18 Quattro one day and as an Ultra the next,' explains Christopher Reinke, technical project leader

Weight saving was a critical part of the new R18's design, which went as far as a new lighter and stiffer monocoque than in 2011

Carbon fibre gearbox casing is another crucial weight saving

of Audi's LMP programme. 'The difference is just stickers, and we have someone in the back of the pits ready to change any spare bodywork to the right colours. Both the Ultra and Quattro chassis have holes in the front for the driveshaft from the hybrid system, but on the Ultra cars that hole is covered by a blanking plate on the same mounting as the universal joint would be.'

Comparing the 2012 R18 to the 2011 car, you find a number of changes, one in particular Reinke is keen to highlight: 'The air intake on the R18 is very different than the shape used in 2011. It is larger and wider and a regulation change is the reason. The change allowed us to have an undercut beneath it, so there is a sort of dent in the roof to do that. The reason for that is that in 2011 there was air there that was coming up from the front of the car over the windscreen that we didn't want to get into the engine intake. So we had a design to get some of it out again. But now we have adapted the tub, which gives us much cleaner airflow into the plenum. The flow over the windscreen stays attached to the bodywork and so goes under that intake.'

Lola goes into administration

Lola Group, one of the last top level racecar manufacturers in the UK and a lynchpin of the British motorsport industry, has gone into administration.

The Huntington, Cambridgeshire-based concern broke the news in late May, stating that it had fallen foul of recent changes in the UK Government's R and D tax credit scheme. But the company has been struggling over the past few years in the wake of a high profile failure to secure a place on the F1 grid and the loss of the IndyCar contract to rival Dallara.

Both Lola Cars International and Lola Composites – which serves the defence, aerospace, communications, automotive, renewable energy and motorsport industries – will now be placed in administration while a buyer for the group is sought.

A Lola statement said: 'The latest economic downturn and the decision of HMRC not to pay ongoing R and D tax credits has caused a serious cashflow problem for the businesses. It is with enormous regret that a decision has been taken to issue notices of intention to appoint an administrator to Lola Cars International Limited and Lola Composites Limited. This step allows the board to continue its discussions with possible investors and prospective purchasers with a view to securing the best outcome for the staff, creditors and customers of both businesses.'

The issue with the HMRC revolves around a recent amendment to tax relief for companies involved in research and development. On the whole, these changes have been well received by industry, but one criticism has been that they only apply to large companies, and not small and medium-sized enterprises (SMEs).

Lola, while certainly a big operator in the world of motorsport, is classed as an SME. The criteria as to whether a company is judged to be an SME includes whether it has fewer than 250 employees (Lola employs 172) and if it has an annual turnover not exceeding €50m, or an annual balance sheet total not exceeding €43m.

Lola Group Holdings' last filed accounts, dated 31 March 2011, shows it to have made a small profit of £200,000 on a turnover of £12.8m, which was a marked improvement on the 2010 loss of £1.3m. This was largely down to the Lola Cars International side of the business, the Lola Composites arm making a loss of £1,339,000.

The company put the losses in its composites division down to the recession and delays with a number of the contracts won by the company. As for the car side, Lola stated that although sales were down by 17 per cent, it had experienced growth in its 'more traditional Le Mans business'.

In 2009 Lola announced it planned to file a Formula 1 entry, but withdrew after it failed to make the shortlist. It also lost out to Dallara in the competition to supply the latest generation of IndyCar in 2010.

Should Lola not find a buyer, its possible demise will leave Radical as the last large-scale producer of racecars in the UK.

The future of 172 Lola employees hangs in the balance if a buyer is not found

Formula 1 set for highly profitable future

Formula 1 is on course to make a whopping $325.7m profit this year, according to a respected industry monitor, while that figure could balloon to double the amount within the next five years.

Formula Money, a business research organisation that specialises in F1, has stated in its annual industry report that it has estimated the Formula One Group's profits are expected to amount to around $325.7m in 2012. This is from a total revenue of around $2bn, giving the sport an estimated net profit margin of 16 per cent. This will be the first time the profit has exceeded the $300m mark.

Formula 1 will make its money from race sanction fees ($710m), sale of TV rights ($550m), sale of advertising at the circuits – it controls this for all the tracks other than Monaco – ($300m), sponsorship ($150m), the Paddock Club ($190m), plus a further $116m on other combined sources of revenue. Total costs are around $1.7bn.

Long term, the future of F1 seems even rosier, according to Formula Money, with an increase in profits of over 50 per cent expected in 2016 – an estimated revenue of $3.3bn and net profit of $882.3m.

Meanwhile, the flotation of Formula 1 is expected to go ahead some time this summer (see Straight Talk, p7), and it's believed it has now been approved by the board of Delta Topco – F1's parent company. Indeed, Delta Topco board member, Peter Brabeck-Letmathe, has gone on record as saying: 'We intend to float in Singapore soon.'

Brabeck-Letmathe, the chairman of Nestlé and its former CEO, looks likely to become chairman of the floated F1 Group, while three teams are expected to have seats on the board: Ferrari, McLaren and Red Bull. However, it is beginning to look as if Mercedes might also secure a seat on the board, too.

Mercedes has been resisting signing the new Concorde Agreement (the charter that governs Formula 1) but it's now believed a deal may be done whereby it becomes the fourth team with a representative on the board, in return for signing the Agreement.

CAUGHT

Penske Racing's NASCAR Nationwide crew chiefs, Jeremy Bullins (no 22 car) and Chad Walter (no 12), have each been fined and placed on probation until the end of the year after their cars were found to be running with unapproved parts and aerodynamic modifications at the Talladega round of NASCAR's second tier championship. The car chiefs for the offending teams – Thomas Clavette (no 22) and Raymond Fox (no 12) – were also placed on probation until December 31.

FINE: $10,000 each

Criminal gangs target motorsport

An expert in vehicle crime says that motorsport has become a target for criminal gangs, while teams are also facing increasing difficulties when it comes to retrieving stolen racecars or parts, due to problems with proof of ownership.

Ken German, a retired head of the Metropolitan Police stolen vehicle squad and a former president of the International Association of Auto Theft Investigators, told *Racecar Engineering* that he is convinced that racecar and motorsport parts theft is a growing problem: 'Racecars and parts are clearly expensive items, a fact that organised criminal gangs are well aware of,' he said. 'Quite a few competition cars have been stolen in the past 12 months and certainly many parts, too.'

German said that many stolen racecars are being sent abroad: 'Race vehicles are being sucked in like a sponge from the [former] Eastern Bloc countries, that's where the money is. It's becoming rife and, without the expertise in the police service – no vehicle squads left, no training, etc – things will undoubtedly get worse.'

A former racer himself, having competed in cars and bikes, German says part of the problem is that there is no way of a buyer knowing whether a racecar has been stolen, and he believes it would be useful if there was a way of logging all thefts. 'If they had a central database where police and custom officers could find out if a racecar had been stolen, that might help.'

Yet German warns that even if someone is caught with the stolen item, the main problem facing a victim of a theft is proof of ownership: 'The problem is that old cherry of identification, or lack of it. Police haven't got the resources, and you won't get it back at court because the judge or the magistrate will say: "I'm sorry, I believe it might be yours, but this man says it's his and he bought it in good faith and we can't prove otherwise. You can't have it back because there's a chance that there might be two of them in the world." If there is that chance, you've lost it.'

German, who now acts as a consultant, warns that chassis plates are easily removed or changed, and advises that teams and competitors invest in technology to make sure they can identify retrieved racecars or parts: 'You can mark parts in any way you like. There are microchips – if you think it's worth it and if you can hide them – and you can use the new DNA liquids, which are inexpensive.'

As to just how big the problem of racecar theft actually is around the world, German says it's impossible to say for sure because there are currently no central records in existence.

RACECAR STOLEN?

In an effort to get an idea of the actual size of this problem, it's been suggested *Racecar Engineering* asks its readers if any have had a racecar or spares and equipment stolen within the last year. Send details to Mike Breslin at bresmedia@hotmail.com

SEEN: MITSUBISHI I-MIEV EVOLUTION

This is Mitsubishi's new entry in the Electric Class at the Pikes Peak hillclimb. The car uses the same motor, drive battery and other major components as the production i-MiEV, all fitted into a tube-frame chassis with a carbon fibre cowl.

The four-wheel drive hill racer has a single motor driving the front wheels and two motors driving the rear wheels, producing a combined total of 240kW of power – 80kW from each motor.

BRIEFLY

Green teams

McLaren has picked up a prestigious Edison Award (named after Thomas Edison, the father of incandescent electric lighting) for being the first carbon neutral F1 team last year. The British team were only beaten into second place by the VW Group of America.

Meanwhile, Sauber has announced that it is also now operating at 'greenhouse gas neutral', as the result of a new promotional partnership with Carbon Neutral Investments (CNI), one of the world's leading companies in carbon offset schemes.

Show numbers

This year's Autosport International show attracted 28,500 visitors, 5100 of them from outside of the UK, according to surveys carried out by its organiser. Over £800m worth of business is said to have been generated at the show, with over 40 per cent of trade visitors being either chairman, director or owner of the companies they represented.

Ninety-two per cent of visitors questioned said their main objective at the show was to network with contacts and suppliers.

Chevy opts for SS

The Chevrolet Super Sport (SS) is to be the base model for General Motors' NASCAR Sprint Cup assault in 2013. The Chevy road car featuring the SS badge will be a V8-powered, rear-wheel drive sedan, the first on offer from the company in the US in 17 years. New bodies will be introduced in the Cup next year as manufacturers have moved to try to make their racecars look more like their road cars. The SS will go head to head with Ford's Fusion, Toyota's Camry and the Dodge Charger in the Sprint Cup in 2013.

CAUGHT

Six NASCAR Nationwide Series crew chiefs were fined during the Richmond International Raceway event. Crew chiefs Luke Lambert (no 2 car), Danny Stockman (no 3), Trent Owens (no 30), Jimmy Elledge (no 31), Ernie Cope (no 33), and Mike Shiplett (no 38) have all also been placed on probation until December 31, as have the above teams' car chiefs - Phil Gould, Robert Strmiska, Shannon Rursch, Ronald Hornaday III, Paul Balmer and Christopher Meyers.

The transgressions were specifically the use of unapproved front bumper covers that were discovered at opening day inspection.

FINE: $10,000 each

The Tech 1 Racing Formula Renault 3.5 car driven by Jules Bianchi in the formula's season opener at Aragon was disqualified from the race - and a second place finish - after it was found to be running with elasticated washers in its differential stack, as opposed to the 'plain' items mandated by Renault Sport Technologies. The team will appeal the decision.

PENALTY: exclusion

Drayson Racing plugged in to FIA Formula E

Lord Drayson has told *Racecar Engineering* that his team is committed to racing in the all-new FIA Formula E Championship for electrically-powered racecars.

Drayson, who has been a champion of the electric car racing cause for some time and was to compete in the stalled EV Cup series, says the Formula E championship is now the most viable chance to kick start electric car racing.

'The status of Formula E is that the FIA is strategically committed to it. It's recognised that there is a need for this kind of racing. It has set up a commission to establish Formula E and the target is to have the first race at the end of next year,' Drayson said.

He also said the Formula E regulations will allow for engineering innovation: 'There's very much an open rule book to encourage innovation. It's going to be an open series with a limitation on the battery cells - they can only have 300kg cells - but there's freedom on aerodynamics and drivetrain, and they will be very high performance cars. They will have a top speed of around an F1 car, but with not as much downforce, so lap times should be around, or slightly better, than an F3 car, with short races - 15, 20 minutes - on street circuits.'

Drayson says the fact that these quieter cars will be ideal for street racing might be one of the new formula's major selling points: 'Not many cities want to hold a motor race with all the noise and pollution-type issues, and that's where electric really scores. So the discussions that have taken place with a number of cities, which include London, New York and Monaco, have all been very positive.'

Drayson Racing is currently testing much of the technology for its Formula E car in its Lola B12/69 EV LMP.

US company clutches UK base

American motorsport parts company, Competition Clutch, is opening a dedicated UK sales office and logistics centre.

Competition Clutch has teamed up with industry leading logistics provider, Universal Automotive, and will set up shop at the latter's Kidderminster, Worcestershire base - a state-of-the-art, 40,000sq.ft, computer-controlled facility.

Dan McCarny, sales manager for Competition Clutch, said: 'We are delighted to be able to offer our UK customers a dedicated call centre and customer service team, as well as the fact that by working with Universal, we can increase our inventory of parts and improve our speed of delivery. This is a great partnership for us that will allow us to build on the success and hard work of our existing UK dealer network.'

The Competition Clutch range includes motorsport and fast road clutch kits, discs and flywheels. The range has already found favour in the UK, being the first choice of many drag racers and drifters, as well as being specified as a control part for one-make racing series.

Universal Automotive are also the logistics partners for well-known names such as Denso, Brembo and Monroe.

PEELING BACK THE STICKERS NO 3: CHELSEA

What could a Champion's League-winning football club get out of backing a Formula 1 team? It's the question that's been taxing race and footie fans alike since the inking of the deal between Chelsea and Sauber in April. 'Sponsorship has been way beyond space on the car for a long time,' says motorsport sponsorship guru, Brian Sims. 'Say a race team's season starts in March, then runs through to October. A sponsor can only really get their mileage in that period and not in the off season. So what Sauber and Chelsea have done does not surprise me, and the potential is there for them to do an awful lot with branding and all sorts of things... Instead of twice the amount of publicity they probably get three times the amount, so the two combined offer a huge opportunity.'

As to whether any money has changed hands, neither Sauber nor Chelsea would say, but it's worth noting that the soccer club is getting around £40m's worth for the prime spots on the car - while Sauber has pointed out the Chelsea brand will be seen in territories most Premiership teams simply cannot reach: 'The football club benefits from F1's television reach which, compared with the Premier League, is much higher and more international, particularly in the Asian and Latin American markets.'

Then again, Roman Abramovich has a few pounds to spend and Sauber is rumoured to be up for sale. Pure speculation, of course.


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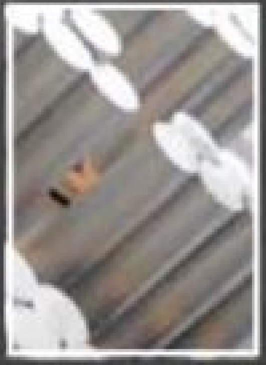
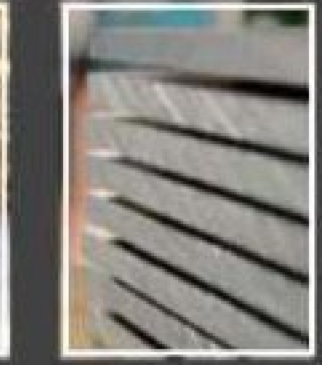




Unique UK motorsport complex up for sale

The owner of one of the UK's lesser-known motorsport venues hopes that a buyer can be found to make sure the site will not be lost to the sport.

Manby Motorplex, which is near Louth in Lincolnshire, has been put on the market for offers over £3.5m. The 440-acre site currently operates as a motorsport, driver experience and training centre and boasts five miles of rally special stage, a 2.5-mile perimeter circuit and its own airstrip. It has also had planning permission for use as a performance driving centre and showground since 1990.

The facility was developed from farmland by its MD, James Tointon, and has been used for motorsport since the 1980s, hosting rallies, 4x4 trials, competition safaris, hill rallies, Rallycross, Supermoto, Motocross, motorcycle enduros, grasstrack and quad racing.

On top of this, the venue can offer a skid pan, schools facilities for rally, off road and HGV training, as well as space for activities such as tank driving.

There is also potential planning permission for motorsport-related industrial estate units, a clubhouse and further roads. Manby also boasts an old RAF control tower, spacious workshops and storage, and an operations centre – currently being used as a base for the driving school and motorsport business activities.

Tointon, who has been forced to sell up to due to personal reasons, said: 'It's incredibly sad to be selling Manby Motorplex. It has a high agricultural value, but we have split the site into lots, so the motorsport side could be purchased separately. I'd be very happy to see it run as a motorsport venue, having worked so hard to keep it as a motorsport and motoring venue for all these years.

'In an ideal world, I'd like to see someone buy the site, develop its massive potential and keep running the popular events, school activities and all we already do here, and keep on the excellent staff. It's a truly unique place and it would be a shame to see a great motorsport venue lost to be developed as housing or turned back to all agriculture, after years of hard work and investment.'

Manby Motorplex is for sale for offers over £3.5m via Brown & Co (www.brown-co.com).

440 acres of motorsport heaven, with planning to expand – yours for £3.5m

SPONSORSHIP DEALS DONE

The Mercedes F1 team has signed a partnership deal with American company **Starwood Hotels and Resorts**. As part of the deal, Mercedes personnel will use Starwood hotels around the world during grand prix weekends. Mercedes has also signed a sponsorship deal with luxury watch maker, **IWC Schaffhausen**.

American Express is to enter the **Global Rallycross Championship** through its **Serve** brand in a sponsorship deal with the **Best Buy Ford Fiesta Mk7**, peddled by British driver David Binks. Serve is a re-loadable, pre-paid account that allows customers to receive and send money through the mediums of email, text and Facebook.

HRT announced a number of new partnerships at the Spanish Grand Prix, its home event. **Kyocera Document Solutions** is now its official supplier for office products, while Spanish windscreen repair and replacement company, **Cristalbox**, has also become a sponsor.

Red Bull Racing has joined forces with the **Michael Pachleitner Group** to create a Red Bull Racing eyewear collection. Based in Graz, Austria, the Michael Pachleitner Group has been involved with the design, production, sales and international distribution of eyewear for more than 50 years.

The Williams F1 Team has inked an all-new sponsorship agreement with Finnish business, **Wihuru**, a global industry and trade conglomerate. Williams has also announced a new sponsorship deal with another Finnish organisation, welding company **Kemppi**.

Toro Rosso has signed a deal with lighting company **Trilux**, which is now a technology supplier to the team. As part of the deal, Trilux will supply lighting at Toro Rosso's Faenza factory and in the pit garages at the races. The German company is well known for its innovative LED lighting systems.

The Caterham F1 team has signed partnership deals with **Rockwell Collins Aviation Technology** and **Russian Helicopters**. New York-based Rockwell Collins is involved in the development and deployment of communication and aviation electronic solutions, while Moscow-based Russian Helicopters is one of the global leaders in helicopter production.

Russian GP subject to delay

Preparations for the inaugural Formula 1 Russian Grand Prix in 2014 could be subject to "serious delays" due to the local political situation, according to a spokesman for the Russian Automobile Federation.

Igor Yermilin told RIA Novosti (the state news agency) that potential problems could be caused by personnel changes in the regional government of Krasnodar, where the new venue is under construction in the Winter Olympics Park, near the southern coastal city of Sochi.

Yermilin added that little work had been carried out on the facility since March, but emphasized that he did not believe the project was at risk of collapse, and hopes the race will go ahead as scheduled in 2014.

Among local politicians to lose their seats in recent elections was Mikhail Kapirulin, the principal of Omega, a company created to act as the event promoter. Kapirulin's signature is on a six-year contract with Formula One that runs from 2014 through 2020.

INTERVIEW – LORD PAUL DRAYSON

Formerly a successful businessman and politician, Lord Drayson has turned his attention to running his Drayson Racing team in recent years, and has been particularly active in promoting racing with alternative power sources.

Q. Where exactly are we with electric cars in motorsport?
We are still in the very early stages. There have been a very small number of races, but really, up to now, there just haven't been any proper electric championships. I think that's really a pity and anomalous, because if you think about how motorsport has been at the heart of a lot of innovation in the car industry, going back to when cars were first on the road, then the fact that there is no opportunity to race electric cars – when electric cars and the challenges of electric drive technology are one of the biggest priorities for the industry – means this is a massive opportunity the motorsport industry is missing. I think there's an urgent need for motorsport to provide a means for electric cars to go racing.

Q. Is Drayson Racing looking at competing in Formula E?
If and when Formula E happens, then Drayson Racing will be there, we're committed to it. We're working on it [see news story on p85].

Q. How is the development of the B12/69 EV electric racecar progressing, and what is its purpose?
Great. We will be doing the final testing of the car prior to its running in the next few weeks. It's a technology demonstrator really. It is for us to learn about the technology, although it's a proper racecar in that it has 850bhp in just over 1000kg. Its purpose is for testing all the systems, the software, the drivetrain and offering us the experience to prove the technology.

Q. What will its range be?
15-20 minutes at full power. With electric cars it very much depends on the level of power and the size of the batteries. The bigger the batteries, the more weight, so there's a sort of sweet spot around 15-20 minutes, where it's long enough to have a good run and a race, but not so long that you're carrying around half a tonne of batteries.

Q. What have been the main difficulties in developing the B12/69 EV?
There's a lot of knowledge being developed around the electric drivetrain for road cars, but very little work has been done for very high performance cars. So when you reach the level of power that we're operating at, you get a lot of heat management issues. For example, you have to deal with a lot of waste heat generated from the motors. And you're dealing with much higher voltages in the car, so there's a lot of safety systems and so forth. And of course there's no differential and no gearbox, so therefore the differential is software, and that's all very safety critical. A lot of development work goes into making sure it all works.

Q. What is the biggest technological advance that needs to happen for electric racing to become successful?
The adoption of dynamic wireless charging – being able to have the cars being charged as they race so they can run for an infinite amount of time. This would make the biggest difference. We're working on a development of wireless charging, and that's where they have coils embedded in the track, which the car goes over and is charged by induction.

Q. How will this be environmentally friendly if the electricity is taken from a national grid?
The national grid has got to be de-carbonised itself. The UK has committed to legally binding targets to dramatically reduce CO² emissions from electrical generation. Also, say for example we held a Formula E race in the Olympic park after the Olympics. We've built in the Olympic Park these biomass power stations that produce electricity from biomass in a renewable form, so that's clean, and that can be used for electric racing.

Q. What do you find the most frustrating aspect of modern motorsport?
Sometimes I think there's too much emphasis on looking backwards, on the history, and not enough emphasis on looking forward and the future. I love historic motor racing, and racing an historic Lotus on the streets of Monaco [at the GP Historique] was an absolutely sublime experience. There is a place for racing these old cars, but what motorsport has got to do is continually reinvent itself to be part of the future. People want to go and watch racing because it's exciting and entertaining, but also because you see things

F1 teams rally round Williams' pit fire

31 members of the Formula 1 community were taken to the Barcelona circuit medical centre following a blaze in the Williams pit garage after the Spanish Grand Prix.

Team members from the Williams team, plus some from the neighbouring Caterham and Force India teams, valiantly put out the fire, which is believed to have started when a fuel rig caught alight, though the ultimate cause is the subject of an ongoing investigation by Spanish authorities and the FIA.

Though the blaze was swiftly brought under control, there were casualties

Most of those caught up in the incident were relatively lightly injured, but one Williams team member was badly burnt and is now receiving treatment in the UK after spending two days in hospital in Barcelona. At the time of writing, he was said to be in a stable condition. Most of the other people affected by the fire were treated for smoke inhalation.

The fire came at the end of a memorable day for the Grove-based team, which had just taken its first win since 2004.

Wheelchair-bound team boss, Frank Williams, was actually in the garage when the fire that you can't see on the roads. Unless racing continues to innovate, continues to be a leader and continues to break through with new technologies and new ideas, motorsport will become irrelevant to the rest of the world.

So one thing that frustrates me slightly is putting too much emphasis on how electric cars are not like V8s. Well, obviously they're not like a V8, they're completely different. We're about pushing the boundaries of technology in competition, so when the technology changes we have to use it.

Q. What's the future for Drayson Racing?
We would like to be the leader in the next generation of electric and hybrid motorsport technology. That's what we want to focus on. So, in terms of a race team and an R and D operation that works on understanding the challenges of new technology coming into racing, that's our focus. When Formula E happens, we want to participate in that as a race team. It's a combination really of racing experience and technology development, that's what we have. My background is in R and D, and what I'm aiming to do with Drayson Racing is to create a business focussed on bringing together the two disciplines of technology development and racing.

broke out, having just posed for the victory photograph with other team members. He said: 'Everyone at Williams F1 is extremely relieved that this event was contained as quickly as it was and the damage which occurred was, relatively speaking, limited in its nature. While the incident was unexpected and definitely most undesirable, it has demonstrated the genuine cohesiveness, camaraderie and spirit of co-operation that exists within the Formula 1 paddock. The astonishing response from the teams and other paddock personnel was immediate, unconditional and overwhelming.'

Kaltenborn handed a one third share of Sauber

Monisha Kaltenborn, who is widely tipped to become Formula 1's first female team principal, has been given a one third stake in the Sauber Group.

She was given the stake by the Swiss outfit's founder, team principal and president of the board, Peter Sauber, who is to keep the remaining two portions of the company himself.

Kaltenborn was appointed chief executive officer of Sauber in 2010, after the team's former owner, BMW, pulled out of Formula 1. 'When BMW pulled out of Formula 1 in 2009, Monisha was instrumental in the team's survival and, since then, she has been doing outstanding work in her capacity as CEO. Transferring one third of the stake to her represents an important step for me in providing continuity,' Sauber said recently.

'My desire is to ensure that the company continues to be led as I would want over the long term. Monisha Kaltenborn and my son, Alex, who joined the company as marketing director in 2010 and has since also been a member of the board of management, both embrace this aim. It means we can offer our employees a positive outlook for the future.'

In response, Kaltenborn commented: 'For me this step is a mark of the greatest possible trust, which I will do everything in my power to justify.'

Forty one year-old Kaltenborn was born in India, but the family moved to Vienna when she was a child. She qualified as a lawyer, taking a number of jobs with law firms before working for the Kaiser Group, which at the time was the co-owner of Sauber. She became head of the team's legal department in 2000 and has been on its management board since 2001.

RACE MOVES

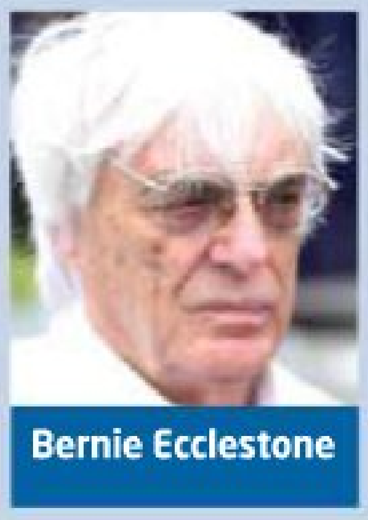
Former rally driver and Peugeot WRC team manager, **Jean-Pierre Nicolas**, is now the manager of the Intercontinental Rally Challenge. Nicolas, who joined IRC promoter, Eurosport Events, in 2007, steps up from his previous position as IRC motorsport development manager.

Richard Petty Motorsports has taken on **Mike Ford** as crew chief for the no 43 car in the NASCAR Sprint Cup. Ford has spent the past six years successfully tending Denny Hamlin's Joe Gibbs Racing car, winning some 17 Cup races and qualifying for the Chase every time the car has completed a full season. Ford replaces **Greg Erwin**, who has been a crew chief at RPM since mid-season last year.


Mike Ford
LAT

The five-member board of the ITR, the body that organises and overseas the DTM, has been re-elected for a further two years. The board comprises **Hans Werner Aufrect** (chairman), **Dr Thomas Betzler** (deputy chairman), **Walter Mertes** (executive board member for marketing and sponsorship) **Jurgen Pippig** (public relations), and **Hans-Jurgen Abt** (sport and special assignments). The three advisory board members are **Norbert Haug** (Mercedes), **Dr Wolfgang Ullrich** (Audi) and **Jens Marqaurdt** (BMW).

Bernie Ecclestone is to marry his girlfriend of two years, **Fabiana Flosi**, a lawyer who is 45 years younger than the 81-year old Formula 1 boss. Ecclestone has told the British press that the couple are now officially engaged and, although a wedding date has yet to be fixed, it will be sooner rather than later.


Bernie Ecclestone
LAT

NASCAR Digital Media has hired veteran media executive, **Colin Smith**, as it gears up to launch its new NASCAR.com 'digital experience', scheduled to come on stream at the beginning of next year. Smith, who was previously vice president at Raycom Sport (new media and distribution) now takes on the post of managing director, digital platform, for NASCAR. He will report to **Marc Jenkins**, vice president of NASCAR Digital Media.

NASCAR Digital Media (see above) has also announced that **John Martin** – who joined NASCAR Media Group in 2007 and has worked with NASCAR's media division in some capacity since 2000 – is to lead the operations group of the NASCAR Digital Platform as managing director of digital operations. Martin will continue to report to vice president of NASCAR Digital Media, **Marc Jenkins**, and will be responsible for the technology systems and development group.

Daniel Whittemore is now sales manager for the Silverstone Wing, the circuit's stunning exhibition and event facility. Whittemore has been manager of the track's corporate sales team for the past six years, but will now be responsible for creating a new conference and banqueting team, identifying potential customer partnerships, developing mutually beneficial supplier relationships and managing customer relations for the Silverstone Wing.

NASCAR has reinstated crew member, **Ryan Sebek**, upon his successful completion of its 'Road to Recovery Program'. Sebek had been indefinitely suspended from all the US Stock Car racing governing body's championships since April 13 2010 for violating its substance abuse policy.

Akio Toyoda, the 56-year old president and CEO of Toyota Motor Corporation, has driven the company's latest rally car. Toyoda requested the outing in the rear-wheel drive GT 86, which has been built alongside Subaru for an All Japan Rally Championship assault. The test took place at Toyota's private test facility in Japan.

Mark Taylor, the manager of the MSA British Rally Championship, is on the judging panel for the Silverstone Motorsport UK event's Sprit of Motorsport Awards. He joins veteran racer and journalist, **Mark Hales** and **Carolynn Hoy**, and show organiser, **Martin Capenhurst**, on the panel. Applicants from the world of racing, rallying and karting will be judged on their performance, approach to motorsport and ability to overcome adversity.

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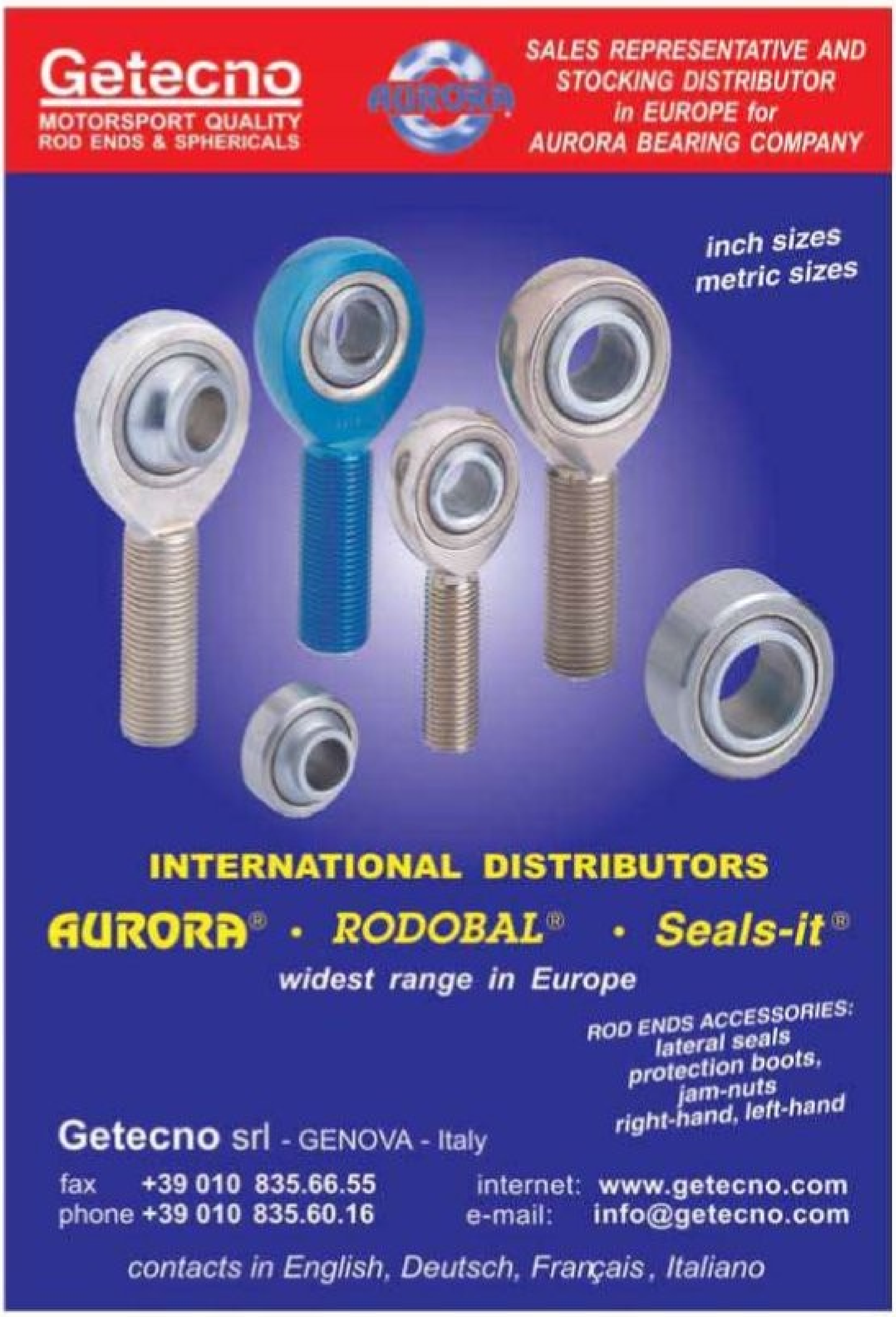

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OBITUARY – CARROLL SHELBY

The man behind one of motor racing's most exciting and iconic cars, the Shelby Cobra, has died at the age of 89.

Carroll Shelby first became acquainted with high-performance machines during the Second World War, as a pilot in the US Army Air Force. He started racing in an MG TC in 1952, before going on to enjoy a very successful career as a racing driver throughout the 1950s. While he did race in Formula 1 – in eight grands prix with a best result of fourth place, albeit in a shared car – it's in Sportscars that he was most successful, winning at Le Mans in 1959 in an Aston Martin he shared with Roy Salvadori.

His driving career was cut short due to health reasons, but it was when he switched to designing racecars that he really made an impact, and it's for the cars that bore his name that he will surely be best remembered.

Shelby at Aintree, 1959

The Shelby Cobra was the result of a transatlantic liaison between British car manufacturer, AC, and Ford, with Shelby shoehorning a Ford V8 into a suitably modified AC Ace. The result was a Le Mans GT win in 1964, and the birth of a legend.

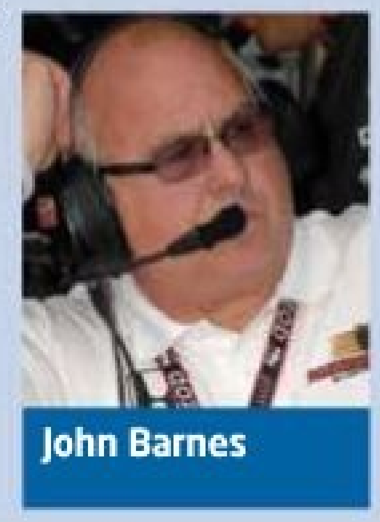
Shelby's association with Ford continued throughout the '60s with the creation of the Shelby Mustang and then when his company ran the GT40s to Le Mans victory in 1965 and '66. No surprise, then, that he's remembered fondly at the Blue Oval: 'In the history of our company, there are a handful of men who have stamped their imprint on the heart and soul of what we do at Ford Racing and Carroll Shelby is definitely one of them,' Ford Racing director, James Allison, said in a tribute to Shelby.

More recently, Shelby managed his Shelby American companies, which include a hugely successful parts business. Yet it was not all cars for Shelby, he was also a philanthropist and successful entrepreneur, and even ran a hunting company in Africa for a decade.

Carroll Shelby 1923 – 2012

RACE MOVES

IndyCar has fined Panther Racing boss, **John Barnes**, $25,000 and placed him on probation. The punishment is for remarks he made on Twitter, specifically criticisms of the way the turbo-parity issue has been handled. IndyCar deemed the comments to be damaging to the sport.



John Barnes

LAT

Heat management company, Zircotec, has expanded its sales support operations for its motorsport business. **Karen Ilsley** has joined the company, while **Linda Dowdell** has been promoted to sales manager.

Chelsea AutoLegends, the London-based automotive and motorsport show, has taken on Prova PR to help raise the profile of the September 2 event. **Max Wakefield**, director of Chelsea AutoLegends, said: 'We're delighted to have Prova alongside us this year, helping us to deliver a unique automotive social event in one of the most breathtaking urban surroundings in the world.'

Anatole 'Tony' Lapine, the former chief designer at Porsche, has died at the age of 81. Latvian-born Lapine will be remembered as one of the greatest car designers of all time, with the Porsche 924, 944 and 928 on his CV. Before joining the German firm he also teamed up with **Larry Shinoda** to pen the iconic 1963 Chevrolet Corvette Stingray.

Sponsorship expert, **Brian Sims**, tells us he's interested in running bespoke courses on finding backing for race teams. Sims has recently run a series of courses for drivers looking for sponsors, which were backed by the MSA. One of his courses has also been validated by Oxford Brookes University, which has made it a module for its Motorsport MBA programme.

Former 1950's F3 ace **Les Leston** – a man who went on to become a major player in the race safety business and the aftermarket industry after he retired from driving – has died at the age of 91. Leston won 500cc F3 races driving his own Leston Special and in Coopers during the 1950s, and also started two grands prix.

Dr Nandan Khokar, R and D manager and co-founder of composite fabric weaving company, Oxeon, has been made Professor of Textile Technology for Composite Materials at the Swedish School of Textiles, University of Boras.

Brian Sims

LAT

Neil Semple is the new head of automotive at the UK Trade and Industry Advanced Manufacturing Directorate in the Strategic Trade Group, replacing Ian Lockhart in the position. Lockhart is moving to China to become head of Advanced Engineering and Transport at UKTI in Beijing.

Oxford Brookes University motorsport engineering graduates, **Laura Shelley** and **Will Hannis**, have joined **Steve Durrant** at his RPD Motorsport BARC Formula Renault outfit. The team was set up in 2007 as a privateer effort, but has been transformed into a full time professional team recently thanks to investment from Arcadius Sports.

■ Moving to a great new job in motorsport and want the world to know about it? Or has your motorsport company recently taken on an exciting new prospect? Then send an email with all the relevant information to Mike Breslin at bresmedia@hotmail.com

Motorsport money men rank high in UK Rich List

Motorsport personalities and businessmen featured prominently on this year's *Sunday Times* Rich List, which is billed as the definitive guide to wealth in the United Kingdom and Ireland.

Unsurprisingly, a certain Bernie Ecclestone was the top motorsport earner, coming in at number 23 out of 1000 with an estimated wealth of £2.5bn, which is attributed to motor racing (interesting note; the £740m wealth of his ex-wife, Slavica, (ranked 106 and above all the other motorsport entries) is attributed to 'divorce').

Other motorsport people to feature include Paddy McNally, the former boss of F1 trackside advertising business, Allsport, with £515m, which is down by £105m on last year, putting him 161st on the list.

Team bosses have also done well. Frank Williams is listed at 182 with £110m, while Mercedes boss, Ross Brawn, is at 751 with the £100m fortune he pocketed from selling Brawn GP to the German car manufacturer and the Abu Dhabi wealth fund. Other Rich Listers with motor racing connections include Martin Sorrel, the advertising mogul who is one of the non-executive directors of F1 Group parent company Delta Topco, listed at 438 with £174m. Former F1 driver, Eddie Irvine, also makes the List (908, £80m, 'motor racing and property'), as does Lola boss – at the time the list was compiled – Martin Birrane (956, £77m, also 'motor racing and property').

Meanwhile, in the sister publication to the Rich List, the Sport Rich List, motorsport accounts for 12 of the top 100 richest sportsmen and women. On a more sobering note, *The Sunday Times* Giving List, which ranks those who have made philanthropic contributions, does not contain one name from the world of motorsport.

CONSUMABLES

Pagid RBF brake fluid

Braking specialist, Pagid, has recently released a new high performance brake fluid specially formulated for racing applications. It has a typical dry boiling point of 328degC (622degF) and is for motorsport use only. In addition to guarding against vapour lock, the fluid maintains its viscosity, lubricity and compressibility performance at extreme temperatures, helping to maintain braking system reliability and repeatability.

See www.pagid.de for more information

PIT EQUIPMENT

Mac fast air / impact ratchet

Mac Tools claims its new 500rpm AR38RP air impact ratchet is the fastest air ratchet on the market, and is designed with safety in mind. The tool generates an impressive 74.5Nm (55ft.lbs) of torque and is optimised to prevent shock being transmitted during use, especially when fasteners tighten down and the torque suddenly increases.

The AR38RP 3/8in air impact ratchet combines an impact wrench with an air ratchet, and incorporates an impact assembly with a single dog clutch ahead of the ratchet assembly, which allows the high output torque of this model to be applied safely and easily.

An air regulator and throttle lever are included, both of which are housed in the comfort-grip handle, all designed to make operation as smooth and as comfortable as possible.

See www.mactools.com for more information

PIT EQUIPMENT

Autotel racing radios

Communication and radio specialist, Autotel, has recently released its new Pit-Lite headset system. Designed as a lightweight alternative to box-type headphone and mic systems used by pit crews and mechanics, the Pit-Lite is compact enough to fit under a helmet (now a requirement in many series, including the WEC). The units feature custom fit, clip-on twin earpieces and a dynamic microphone with high noise-cancelling performance, mounted on a flexible boom. Two button, belt-mountable control packs are also available to coordinate pit-to-car communications.

See www.digitalracingradios.com for more information

WORKSHOP TOOLS

Eco-Jet water jet pump

Water jet cutting specialist, Jet Edge, has recently introduced the Eco-Jet water jet pump, a new environmentally and budget-friendly unit. Producing 55KSI from a 30bhp motor, the Eco-Jet features an efficient direct drive pump design that consumes up to 40 per cent less electricity than a regular 50bhp pump, but has the same pressure output. The Eco-Jet produces up to 1gpm of ultra-high pressure (UHP) water for precision cutting, cleaning and surface preparation applications. It runs a .015in orifice and can power most common water jet cutting systems and water jet tools.

See www.jetedge.com for more information

HARDWARE

Ballistic battery

Cambridge Motorsport Parts has announced a new, high power, lithium race battery, called the Ballistic EVO2. The battery is one of the smallest performance batteries on the market, measuring 11.2cm high and 11.4cm wide and deep. Despite its tiny size, the power pack turns out 28AH and has a cranking power of 500CCA. It also features interchangeable terminals to facilitate ease of fitment in different applications.

See www.cambridgemotorsport.com for more information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SOFTWARE

Creaform C-Link

Creaform, a leading manufacturer of portable 3D measurement technologies has introduced the latest improvement to its inspection systems – C-Link functionality. Through C-Link, it is possible to network up to four C-Track probes and operate them simultaneously with a HandyPROBE portable CMM or a MetraSCAN 3D optical CMM scanner. This functionality allows for rapid inspection of large and complex parts, such as a vehicle body. The C-Link system incorporates the company's TRUaccuracy technology, said to generate guaranteed high accuracy results, no matter the measurement environment or operator skill. **See www.creaform3d.com for more information**

HARDWARE

Titan air temperature sensor

Florida-based Titan Motorsports has just released a universal air temperature sensor (AIT) that provides intake air temperature information to ECU and data logging units. The Titan Motorsports' AIT is made to OEM specifications and uses a weatherproof wiring connector. The sensor is an ideal and budget-friendly option for standalone ECUs and includes a male / female plug and wiring pigtail for simple installation. **See www.titanmotorsports.com for more information**

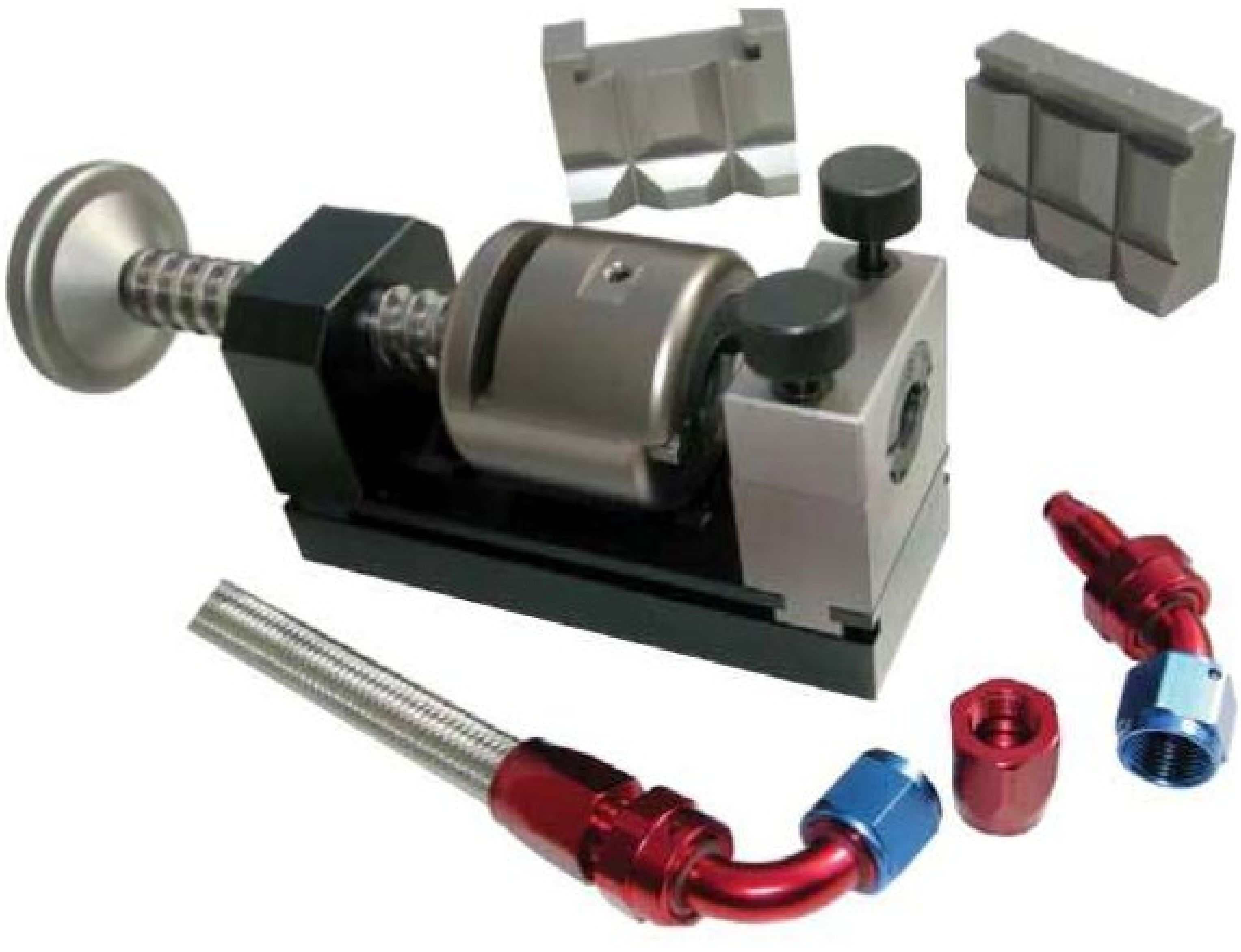
HARDWARE

Jenvey throttle bodies

If you are using a crate engine or a modern transplant engine in a racecar, chances are it will have been designed to use electronic fly-by-wire throttle bodies. These can be complex to incorporate into non-standard applications and the solution is to use a replacement mechanical throttle body. UK injection specialist, Jenvey, now offers 90mm and 102mm throttle bodies that are ideal for this purpose. The units are designed to offer good progression and are suitable for applications up to 700bhp. **See www.jenvey.com for more information**

GARAGE TOOLS

Viper braided hose tool kit



Plumbing specialist, Viper Performance, is now offering a tool kit to enable easy assembly of braided -AN hose fittings. Without a specialised tool, securely attaching ends to braided hose can be tricky and time consuming, but this precision-made tool will crimp -AN-style hose ends by hand with ease. The tool can be bench mounted or used portably and comes with everything needed to fit all sizes of braided hose ends to a professional standard. **See www.viper-performance.co.uk for more information**

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A championship of style

McLaren didn't have much to write home about following the Monaco Grand Prix but, on that same weekend, as Dario Franchitti was celebrating victory at the Indy 500, a little known French driver, Frédéric Makowiecki, was setting the world alight in Spain on the Navarra circuit in the FIA GT1 World Championship in his McLaren MP4-12C.

Now, some of you will know that this championship is close to my heart, and I will admit that it is not a headline act in the same way as Monaco or Indianapolis. It is an FIA World Championship, but one that is probably more under threat than the World Rally or Touring Car championships. Even organiser, Stéphane Ratel, has succumbed to the adage, 'if you want to make a small fortune in motor racing, start with a big one' and, if the Frenchman sticks to his word this year, the championship will not continue in 2013.

Ratel, by his own admission, needs the calendar to be fixed by the end of July and for his teams to commit by the end of August to give him a chance to sell the championship to television companies this autumn. He made the same request last year, didn't receive the support that was promised, and so put his hand in his own pocket to fund multiple teams to ensure he didn't let down those who had already committed.

> **"With professional drivers... the car could not be the defining factor"**

Ironically, just as the championship looks rocky, this is the year he has the formula completely right – a world championship with GT3 cars, a new balance of performance (BoP) system and a move to smaller tracks that rapidly fill with spectators to provide a good atmosphere. Unfortunately, it is five years too late. For too long Ratel pursued his GT1 dream with Aston Martins, Nissans and Maseratis. While these cars were wonderful to watch, they were run by private teams, had little development, were expensive to run, and the configuration of the Maserati MC12 gave it an inherent advantage over the course of the season. It therefore won multiple titles.

Ratel always said that GT1 cars, properly engineered in the first place, could be performance balanced to within half a second, but that GT3 was another matter. These cars were taken from spec championships, and balanced to within 1.5secs as the level of the drivers was so varied there was no need to make them closer. With professional drivers, argued Ratel, the car could not be the defining factor and so Peter Wright's system worked perfectly in GT3 and GT1, at least once the standard ECU from Magneti Marelli had been made to work with the various engine configurations.

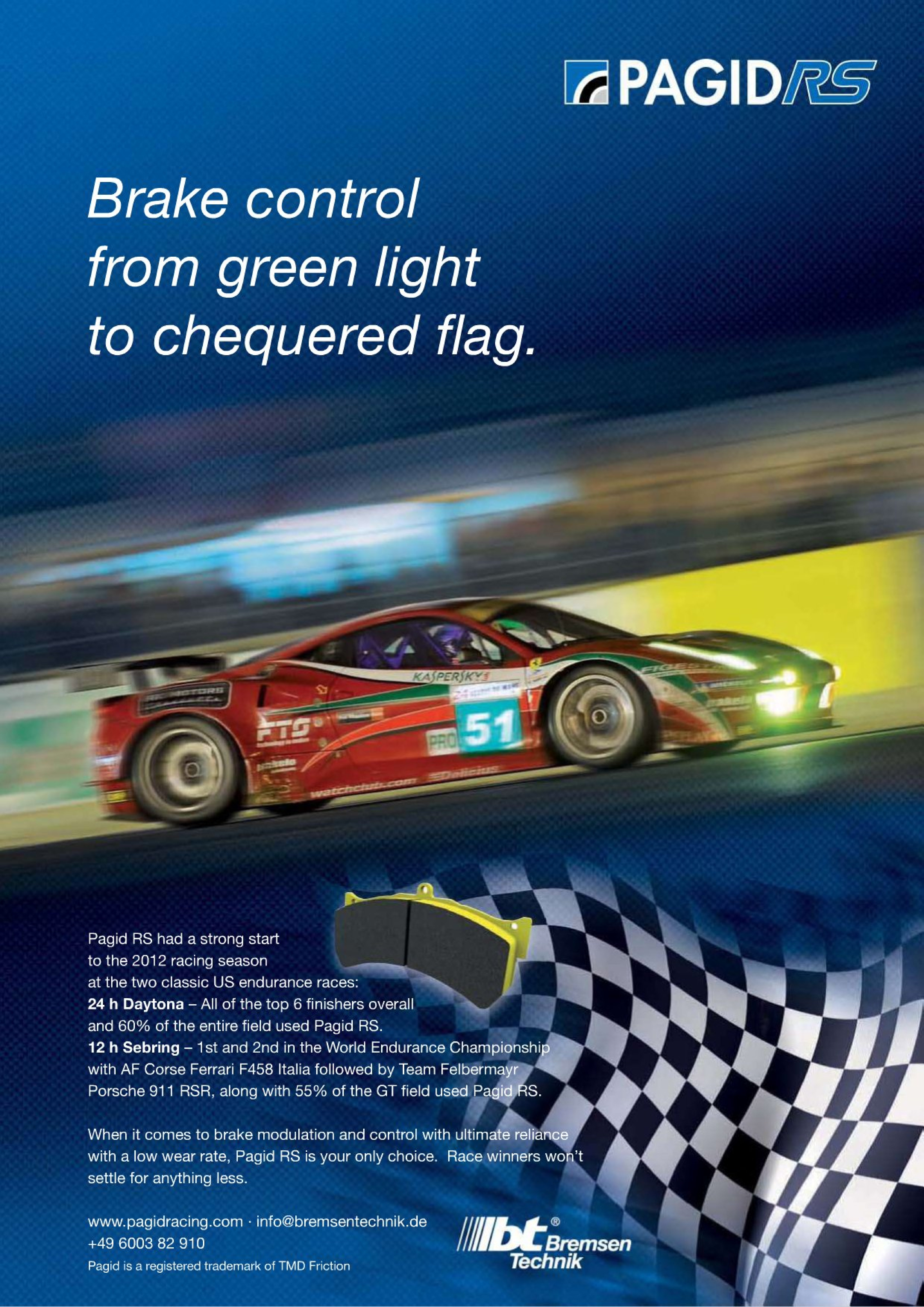
So, when time was called on the GT1 cars at the end of 2011, Ratel bowed to the inevitable, and turned his championship into GT3 only. That gave the likes of Porsche a chance at a world title years before it joined the WEC. Ferrari could come too, as could McLaren, Lamborghini and Aston Martin, giving him the brands he wanted and racing at a price the teams could afford.

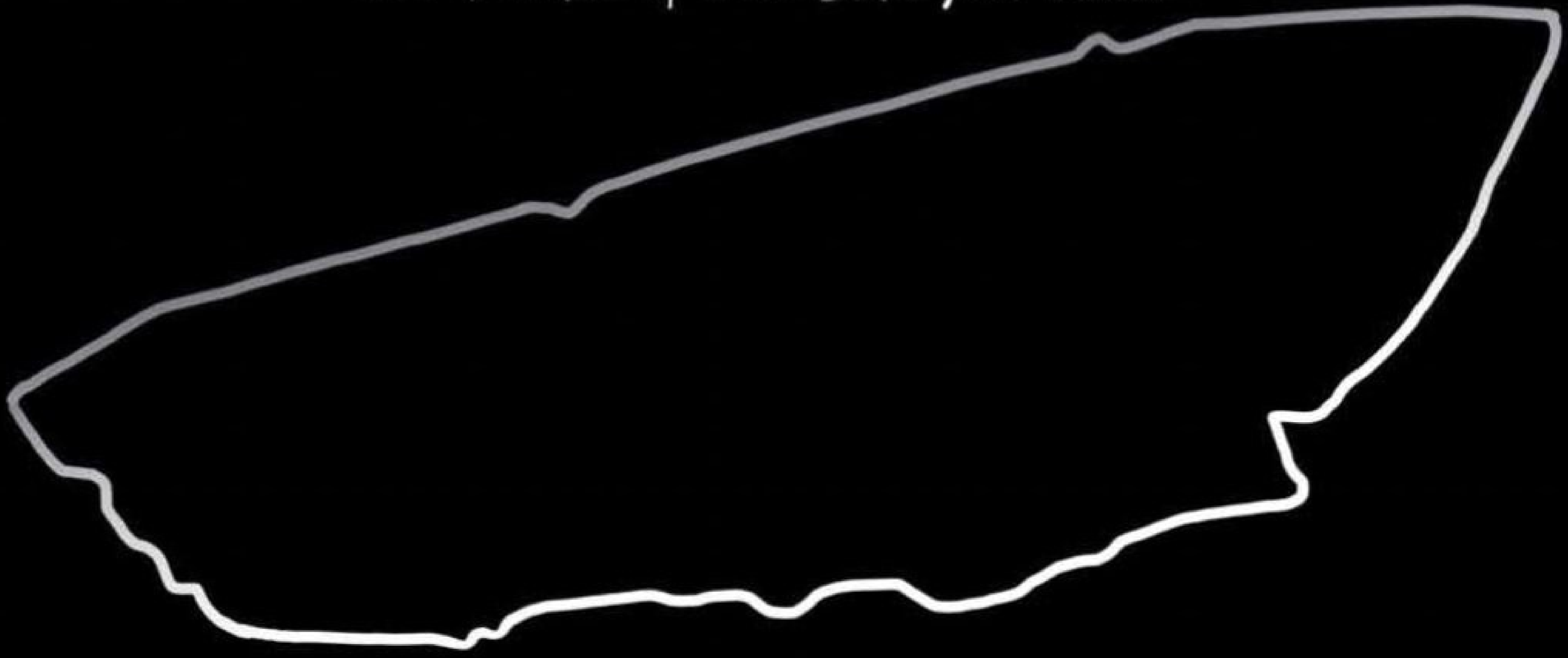
The new balance of performance system is still being tinkered with and, unfortunately, as Makowiecki was blazing through the field, it became apparent that the McLaren MP4-12C (featured in *REV*21N11) needed to be carefully studied against the data accumulated by the FIA at the start of the season. The car started from the back of the grid and went on to win by 21 seconds from the third placed BMW of Michael Bartels, which itself started from the pit lane.

The FIA has balanced the cars over the course of the season, and so will not react with a knee jerk, despite the general arm waving from rival team managers. However, Oliver Jarvis, who drove the Audi R8 LMS, commented that his rivals appeared to hit the mushroom featured in Super Mario a quarter way down the main straight, and pulled away from him. He even lost his sense of humour for a while, pulling out the top speed charts from the race, which showed the R8 achieved 234km/h on the straight, the McLaren 245km/h. The best optimal lap time for the winning McLaren in the same race was 1m39.388secs, for the Audi, 1m40.588secs. For drivers who would likely be facing each other this year in LMP1 at Le Mans – Jarvis in the Audi R18 Ultra and Makowiecki in the Peugeot 908 HYbrid – this is a big gap.

Obviously, the BoP needs to be carefully looked at, but the championship also needs solid support from the teams and promoters. By August we will know whether or not there will be a 2013 championship. If it fails, I for one would lament its loss.

EDITOR
Andrew Cotton



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