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DAWN OF A NEW AGE

Is the 2012 Indy car the future of US open-wheel racing?

Car Of The Future
Australian V8 series cuts costs and searches for new blood

F1 under the spotlight
We analyse new Formula 1 technical regulations

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Simon McBeath's self-build racer one step closer to completion


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All eyes are firmly fixed on a cheaper, safer future for motorsport, and around the world new regulations are under discussion to achieve these goals.

We wrote about the new Indy car when it was first announced at the end of May and highlighted some of the issues that immediately sprung up around the new concept. Some have now been addressed, and more details have been released about the concept that carries the weight of being America's premier single-seat racing series.

In Australia, the tribal following that is enjoyed by Ford and Holden is legendary, but Mark Skaife has had to take a brave decision and move the technology forwards. With an eye on reducing costs, and attracting a new manufacturer, under the skin these V8 muscle cars will change substantially. The plans are evolving, and another decision has been taken, delaying the introduction of the new cars by a year. Our contributor Danny Nowlan runs through some of the reasons behind this.

The DTM is also Introducing new regulations for next year, with a view to taking its brand onto the global scene. Audi, BMW and Mercedes are hoping that a common set of regulations can be established between them, and series in Japan and America launched. A condition of BMW joining the series was that it could race in multiple series with the same machinery, but it remains to be seen whether or not the concept will be successful.

Formula 1's new regulations were discussed in last month's edition, but this month we take a closer look, and reveal some surprising results. We also talk to Alan Jenkins, who has his own opinions on spec formats, and feature the new multi-purpose Xtrac gearbox that suits the spec British and also the World Touring Car Championships.

With all of these cost-saving ideas, I will leave the last word to Stefan Johansson, who years ago said to me, 'If they were running lawn mowers in Formula 1, they would still spend the same money.' It remains to be seen how successful these new regulations will be in achieving their core objectives.

EDITOR
Andrew Cotton

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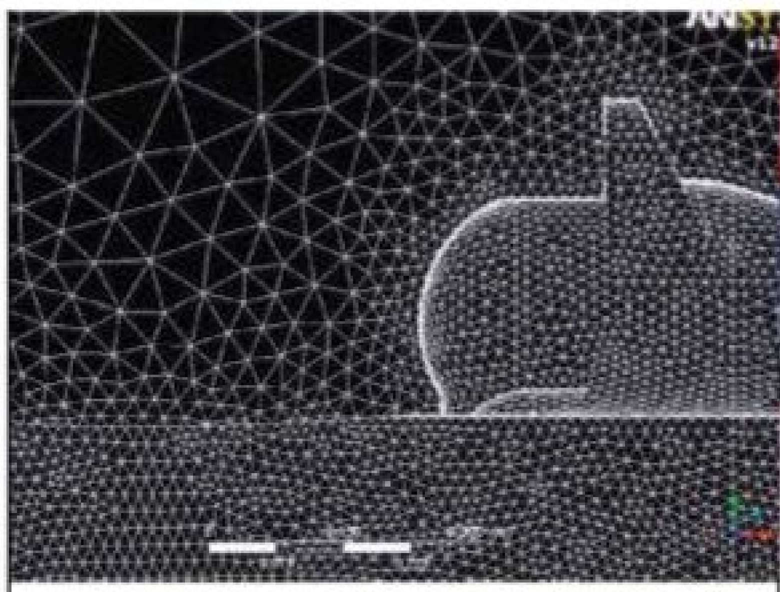
The future of American open-wheel racing has arrived, but is it any good?



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FORMULA 3

All-new 2012 F3 Dallara revealed

Italian company works hard to recover downforce lost through regulation

Dallara has released images of its all-new Formula 3 car, built to the 2012 technical regulations, while its F3 chief has told *Racecar Engineering* it has managed to regain much of the downforce it originally lost as a consequence of the new rules.

The completely new car, dubbed the F312, features a higher monocoque and lower nose section, F1-spec safety measures and front dampers and springs positioned inside the tub.

Jos Claes, who is part of the engineering and project management team at the company, and is responsible for its F3 programme, told *Racecar Engineering*: 'There is this new clean shape body regulation, which makes the body look, automatically, a little like Formula 1. This is because there are certain areas, volumes, around the car which cannot now have bodywork. So, no more little flaps and little tricky things. They don't exist any more because you cannot make them within these regulations.'

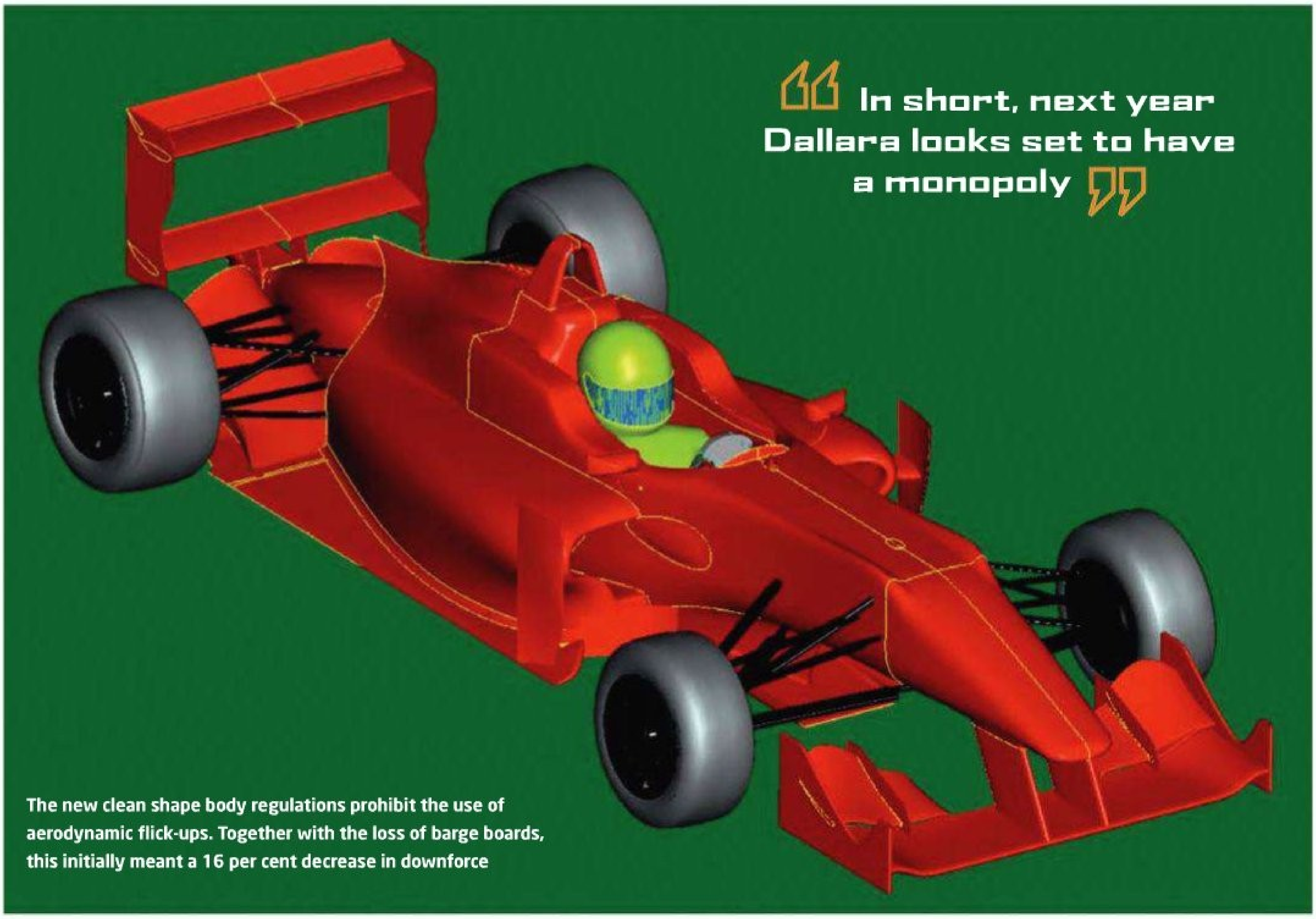
The loss of the barge boards and flick-ups meant a decrease in downforce, but that has been clawed back as a result of development of the car in Dallara's new wind tunnel, as Claes explained: 'We put our current car in our latest spec in the wind tunnel and we took the bits off we were no longer allowed to use on the car [in 2012] and lost about 16 per cent of the downforce. I will not reveal the amount of downforce we have recovered [with the new car] but it's quite a lot. We have had over 800 hours of wind tunnel development on this car, and that was enough to come to what we think is enough to beat the competition. But now I don't think there will be any other manufacturer racing with a car in 2012. Maybe afterwards someone comes, I don't know.'

There was talk that Mygale might be making a car for next year, but it's understood that is now unlikely, though it is known that both Lola and Dome are considering an F3 chassis for 2013. In short, next year Dallara looks set to have a monopoly.

The other major changes on the car include improved side protection, with 16 layers of Zylon, which has also actually helped stiffen the chassis, says Claes, while there are also homologated parts, such as the Hewland gearbox, in line with the new cost-cutting regulations - each make of new F3 car must now come with a specified 'box.

The front springs and dampers have been placed within the tub, rather than on top of it, for the first time, while Claes also tells us there has been a great deal of work carried out on the rear suspension. 'We made a lot of effort to stiffen the rear suspension, a lot of the parts still on the [current] car now, I have to tell you, they were parts that were originally on a 1999 car, which was doing 2.5g in the corners. Now we're regularly doing 3.5g in the corners. These parts were never questioned for their quality, but now we start selling them a lot more and, because they are overloaded, so people have to change parts.'

The first F312s will be delivered to customers in December, and Claes tells us it should not cost much more than the current car.



> "In short, next year Dallara looks set to have a monopoly"

The new clean shape body regulations prohibit the use of aerodynamic flick-ups. Together with the loss of barge boards, this initially meant a 16 per cent decrease in downforce

INDYCAR

IndyCar puts alternative aero kits on hold

IndyCar has decided to delay the introduction of the alternative aerodynamic kits for the new spec Dallara chassis until the car's second season of competition, after team owners expressed concerns over the costs involved.

The use of aero kits developed by a number of manufacturers was one of the key features of the new IndyCar formula, and was seen as a way of introducing variety – one of the aims of the ICONIC committee that eventually opted for the Dallara spec car.

But now IndyCar CEO, Randy Bernard, has said the idea is to be postponed until 2013, in the interests of cutting costs for the teams and ensuing grid numbers are kept up.

The car will now be raced with sidepods and engine covers, which will be universal for the diverse set of racetracks, while differing Dallara-designed and produced front and rear wings will be available for the ovals and road or street circuits.

'The most important thing we can do as a series is look at what is in the best interest of both our long and short term,' Bernard said. 'It is important that we maintain a high car count next year by ensuring we have cost containment for our teams. We must listen to our team owners and try to help. We don't want to see our car counts go from 26 and 27 down to 16 because of the aero kits. Both the manufacturers and the team owners have told us it's very expensive.'

Bernard added: 'No one is more disappointed than I that we're not going to do it, but I feel this is by far the best decision for our series. The 2012 season will be exciting with the debut of our new car as we focus on relevancy and technology through engine competition, turbochargers and direct injection.'

Andretti Autosport owner, Michael Andretti, agreed with the decision and confirmed that with the new car and different engines for 2012 it would not do too much damage to hold on until 2013 before introducing the alternative aero packages. 'We've got new engines and a new car for next year, so we can then have another new story for 2013,' he said.

So far Honda, Chevrolet and Lotus – the three new engine suppliers – have expressed an interest in producing aero kits.

Meanwhile, the prototype of the new car has made its test debut and IndyCar vice president of technology, Will Phillips, has reported: 'We are extremely pleased with the results of our first test of the new chassis. Everything performed as we expected in this initial shakedown.'

The three engine manufacturers, each of whom has a chassis ordered, are scheduled to begin testing their 2.2-litre turbocharged V6 engines in early October. Teams are then scheduled to receive their first chassis in December, while Dallara's US technology and manufacturing facility is now under construction on Main Street in Speedway, Indiana.

CAUGHT

NASCAR Nationwide Series crew chiefs, Mike Kelley (Roush Racing) and Gary Cogswell (TriStar Motorsports), have each been fined after it was found that lug nuts were less than the minimum specified thickness. The infractions were discovered during pre-qualifying inspection at Iowa Speedway.
FINE: $2500 (£1500)

Joe Shear, crew chief for ThorSport's NASCAR Truck Series team, was fined after the bed of the truck was found to be too high on the right rear following post-race inspection at the Iowa Speedway. Driver Johnny Sauter, and owner, Mike Curb, have each been penalised with the loss of six driver and owner championships points.
FINE: $5000 (£3000)
PENALTY: six points

Chad Kendrick, the crew chief at Joe Denette Motorsports in the NASCAR Truck Series, has been fined and placed on NASCAR probation until December 31 after an unapproved top mount was discovered on the fuel cell during opening day inspection at Indianapolis Raceway Park.
FINE: $2500 (£1500)

The Status Grand Prix GP3 car of Alexander Sims was excluded from the first of the category's races at the Hungarian Grand Prix weekend after it was discovered that the floor of the car was fractions of a millimetre too low at post-race scrutineering. The infringement was said to be the result of damage sustained to the car during the race.
PENALTY: excluded from results

BRIEFLY

Lola covers costs with coupé

Lola has announced it is to market a cost-capped LMP2 coupé for the 2012 season, becoming the first company to offer a Prototype with a roof for Sportscar racing's new budget-conscious category.

The B12/80 will be eligible for the FIA World Endurance Championship, the American Le Mans Series, Le Mans Series and the Le Mans 24 Hours, and Lola says its announcement shows the company aims for a long-term involvement in LMP2.

Managing director of Lola Cars, Robin Brundle, said: 'This is a significant announcement showcasing Lola's commitment for the future in this category. Our engineers are hard at work finalising the aerodynamics package for the B12/80. We invite all interested parties to consider what will be the most competitive, most reliable and most cost-effective racing package in global endurance racing next year.'

New Lola B12/80 customers are offered programmes in the Lola technical centre, all within the purchase price, which includes full aero maps, track-side spares supply in the LMS and Le Mans 24 Hours and free seven-post test rig time.

Racing Green

Swiss team, GreenGT, has announced it is to build its own LMP car in order to showcase its hydrogen technology. The team had originally planned to fit its powertrain – which is a hydrogen fuel cell that provides power to electric motors – to a commercially available LMP2 chassis, but has now decided to design its own car because of the complications of fitting the technology.

There is a possibility that the car, which will be longer and heavier than a conventional LMP2, will be allowed to take part in the test day for next year's Le Mans 24 Hours.

• MORE NEWS ONLINE AT WWW. RACECAR-ENGINEERING.COM

SET-UP EQUIPMENT

WIRELESS WEIGHT APP

Chassis set up specialist, Intercomp, has introduced a new 'App' for use in conjunction with its range of wireless scales. The iRaceWeigh App is a free download from the Apple iTunes store and offers numerous ways to view and process weight data. The App communicates directly with Intercomp's RFX wireless and cabled scales with RS232 outputs via the new iRaceWeigh module, which can be purchased online.

iRaceWeigh allows users to view live weights (or manually enter them), save weight data, export the information to a spreadsheet for future analysis, and email reports. Intercomp's RFX wireless weighing systems now has the flexibility to view weight data on three types of devices – the RFX wireless hand-held indicator (standard with most RF scales), an iPad, iPod or iPhone using the iRaceWeigh App and module, or a PC using the company's RaceWeigh Software and a USB radio.

For more information visit www.intercompracing.com

SENSORS

LOW PROFILE ROTARY SENSOR

Following the launch of its NRH280DP dual-output 'non contact' rotary position sensor in 2010, Penny and Giles, the high precision sensing technology manufacturer, has expanded its range with the introduction of a dual redundant output version. Operating from a 5Vdc supply, the NRH285DR has two independent power supplies and outputs that enable full redundancy, housed in a low-profile, 6.5mm thick casing, making it one of the thinnest currently on the market.

The IP69K-rated rotary position sensor provides numerous factory-programmable options and is designed for operation in extreme temperatures, from -40 to +140degC. It can also withstand temperatures up to +170degC for 72 hours. The NRH285DR offers OEMs numerous options, including a measurement range from 20-360 degrees (in one-degree increments) and clockwise or anti-clockwise output direction (including 1xCW and 1xACW). Outputs can also be factory-programmed to include non-linear laws, switch outputs, clamp voltages, different output phasing CH1/CH2, faster input / output delay and extended analogue range.

For more information visit www.pennyandgiles.com

HARDWARE

STAINLESS HOSE

UK hosing manufacturer, Viper Performance, has branched out from supplying silicone hoses and is now producing a range of stainless steel braided hose. This hose is suitable for oil, fuel, hydraulic fluid and water / coolant. The inner hose is NBR nitrile rubber, which is resistant to fuel, oil and other fluids, while the outer layers consist of two layers of braided stainless steel to protect the hose from damage and prevent the inner hose from expanding under pressure.

Viper Performance stock the hose in various sizes: AN -4 (5.56mm) through to AN -12 (17.47mm) and sell it by the half metre length.

For more information see www.viperperformance.co.uk

POWERTRAIN

DIE-CAST POWERGLIDE SUMP

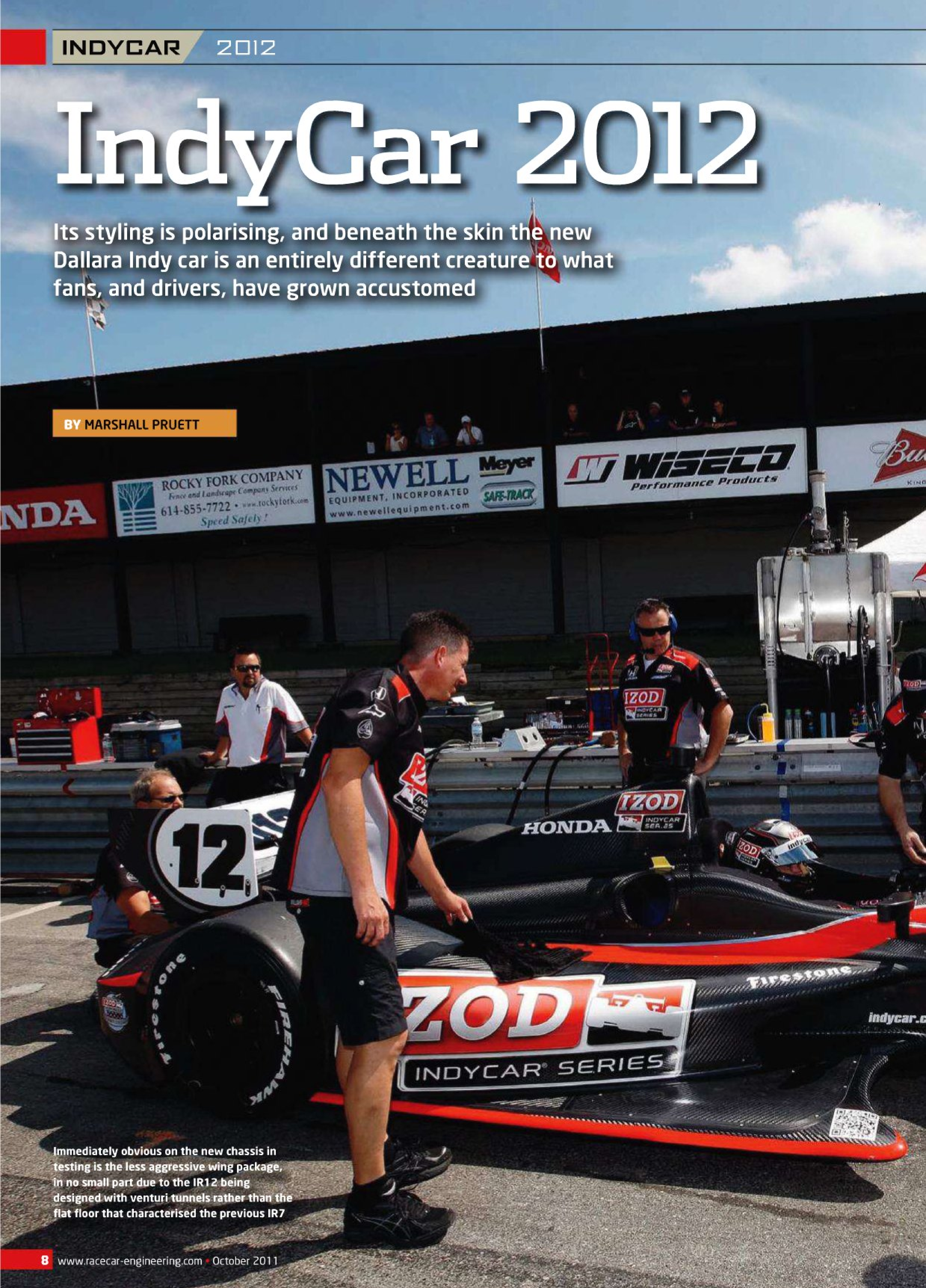
US-based transmission specialist, TCI Automotive, recently unveiled a new, die-cast deep oil sump for Powerglide transmissions, which it claims is the first of its kind on the market. The pan incorporates a thermal management design that draws heat toward the exterior of the pan where cooling fins transfer it into the under-vehicle airflow. The die-cast design is claimed to be at least 1.5lb (680g) lighter than competitors' sand-cast versions and holds two extra quarts of fluid.

For more information visit www.tciauto.com

IndyCar 2012

Its styling is polarising, and beneath the skin the new Dallara Indy car is an entirely different creature to what fans, and drivers, have grown accustomed

BY MARSHALL PRUETT



Immediately obvious on the new chassis in testing is the less aggressive wing package, in no small part due to the IR12 being designed with venturi tunnels rather than the flat floor that characterised the previous IR7

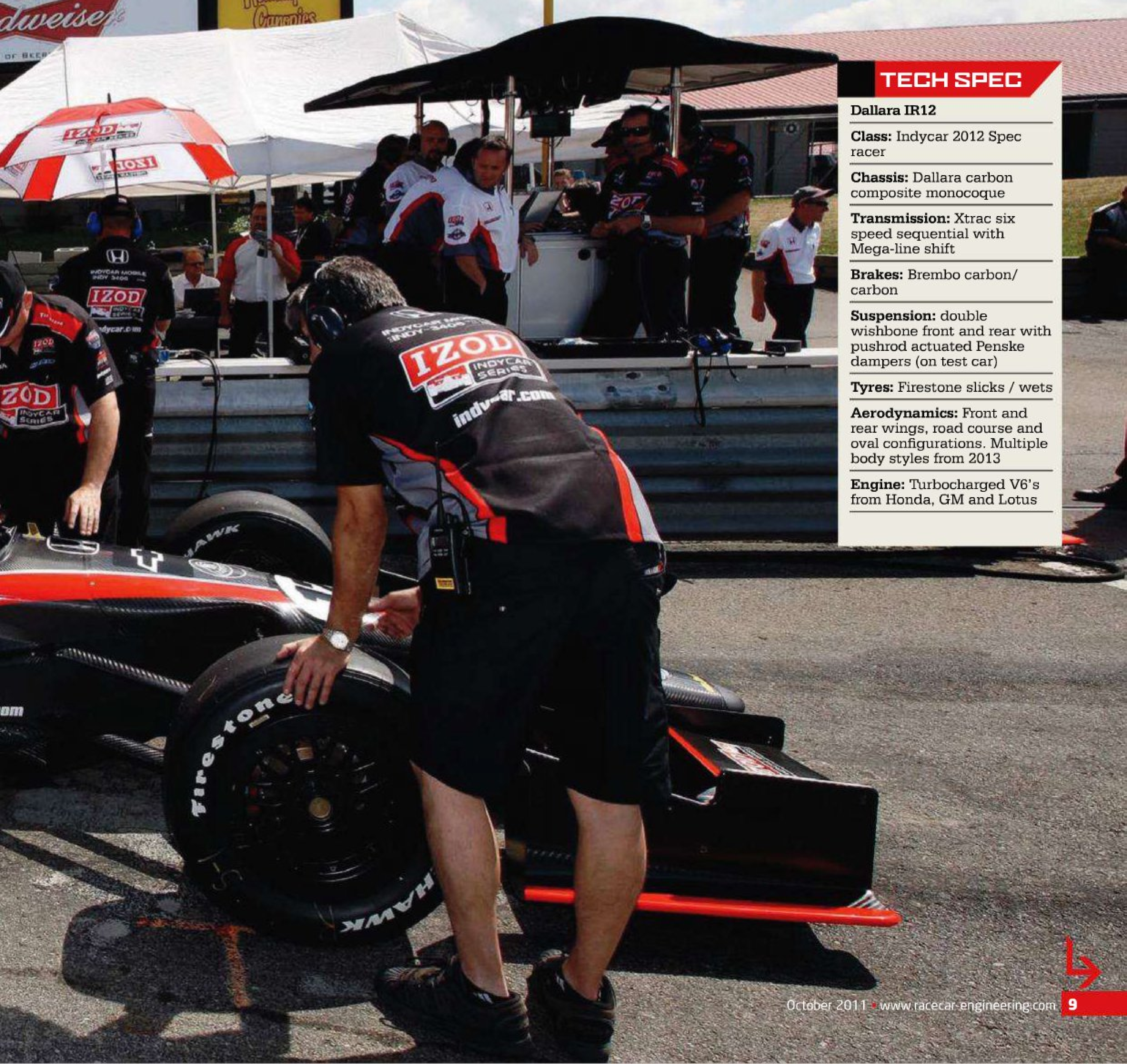
Born from the decisions made by the ICONIC IZOD IndyCar Series Advisory Committee in 2010, teams will compete next year with the first brand new design since the Indy Racing League (IRL) introduced its original formula for the 1997 season.

Utilising bespoke chassis from Dallara, GForce and Riley & Scott, and 4.0-litre, naturally-aspirated V8s from General Motors and Nissan, the first-generation IRL cars followed a design and cost philosophy that was fundamentally different to almost every aspect of the rival Championship Auto Racing Teams (CART) series.

At a time when seven and eight-figure annual budgets were the norm in the technology-friendly CART paddock (thanks primarily to multiple engine manufacturers, hi-tech turbocharged engines and a healthy sponsorship base) the IRL went in the opposite direction, opting for relatively simple spec cars, minimal technology and non-turbo, production-based engines. Fifteen years later, the second-generation IRL-turned-IndyCar series will deliver an interesting compromise between the open-wheel identities forged by CART and Champ Car, and the 1997-era IRL machines.

CHASSIS

From the outside, the IR07 and IR12 bear little resemblance, but dimensionally the two Italian Indy cars are very similar. Comparing the cars in road course trim, the IR07 runs with a wheelbase of roughly 122in (3099mm). Teams were once allowed to substantially vary wheelbase but, in recent years, 118-122in (2997-3099mm) has been the allowable



TECH SPEC

Dallara IR12

Class: Indycar 2012 Spec racer

Chassis: Dallara carbon composite monocoque

Transmission: Xtrac six speed sequential with Mega-line shift

Brakes: Brembo carbon/carbon

Suspension: double wishbone front and rear with pushrod actuated Penske dampers (on test car)

Tyres: Firestone slicks / wets

Aerodynamics: Front and rear wings, road course and oval configurations. Multiple body styles from 2013

Engine: Turbocharged V6's from Honda, GM and Lotus


Wide floor protruding beyond the bodywork and substantial front wing end plates are designed to prevent wheels interlocking during close racing

range. The IR12, however, will have a fixed wheelbase of 120in (3048mm).

At the behest of the series, Dallara designed the IR12's body to reduce the likelihood of wheels becoming interlocked, which can be seen in a few key areas. Looking at the car from the front, or overhead, one unique solution stands out, literally. While the IR07's track width must fall between 77.5-78.5in (1969-1994mm) and is wider than the bodywork, the IR12's track width is slightly narrower at 76in (1930mm), yet has bodywork - specifically, the floor - that measures 79in (2007mm) wide. That translates into a 1.5in (38mm) bodywork protrusion on the IR12. Drivers will be lucky to get away without damage if they hit the wall or another car flush on either side. With the narrower track, the front wheels are more protected by the front wings, and the front wing end plates have carbon pieces that extend out to block a portion of the front tyres. Behind them, the floor is used to prohibit wheel interlocking by filling some of the void between the tyre, chassis and sidepod.

The yet-to-be-named anti-interlocking structures behind the rear tyres form part of the IR12's new rear impact unit. A new rear crash attenuator is used and, at the bottom rear of the device, a robust beam is attached that extends outwards to both wheels. The anti-interlocking units bolt to each end with six fasteners apiece, forming a rigid assembly.

Some weight has been saved with the new chassis by integrating into the monocoque the anti-intrusion panels that were added to the exterior of the IR07 to protect drivers but, overall, the quest to ship the IR12 at the stated goal of 1380lb (626kg), a weight saving of 185lb (84kg) over the IR07, is an ongoing effort.

Members from IndyCar and Dallara confirmed that meeting the target weight will be a challenge and, due to having a number of prototype parts fitted to the IR12, they would not be drawn on weight distribution figures or an anticipated final kerb weight, but it seems that the first test car is heavier than they would like it to be.

> “meeting the target weight will be a challenge”

AERODYNAMICS

Dating back to the Dallara IR97, the design for its IRL chassis was only focussed on oval racing. The use of a flat bottom downforce configuration was chosen as a result, but when the IndyCar series added road and street courses to its calendar in 2005, the need for a higher downforce, venturi-based floor became immediately apparent.

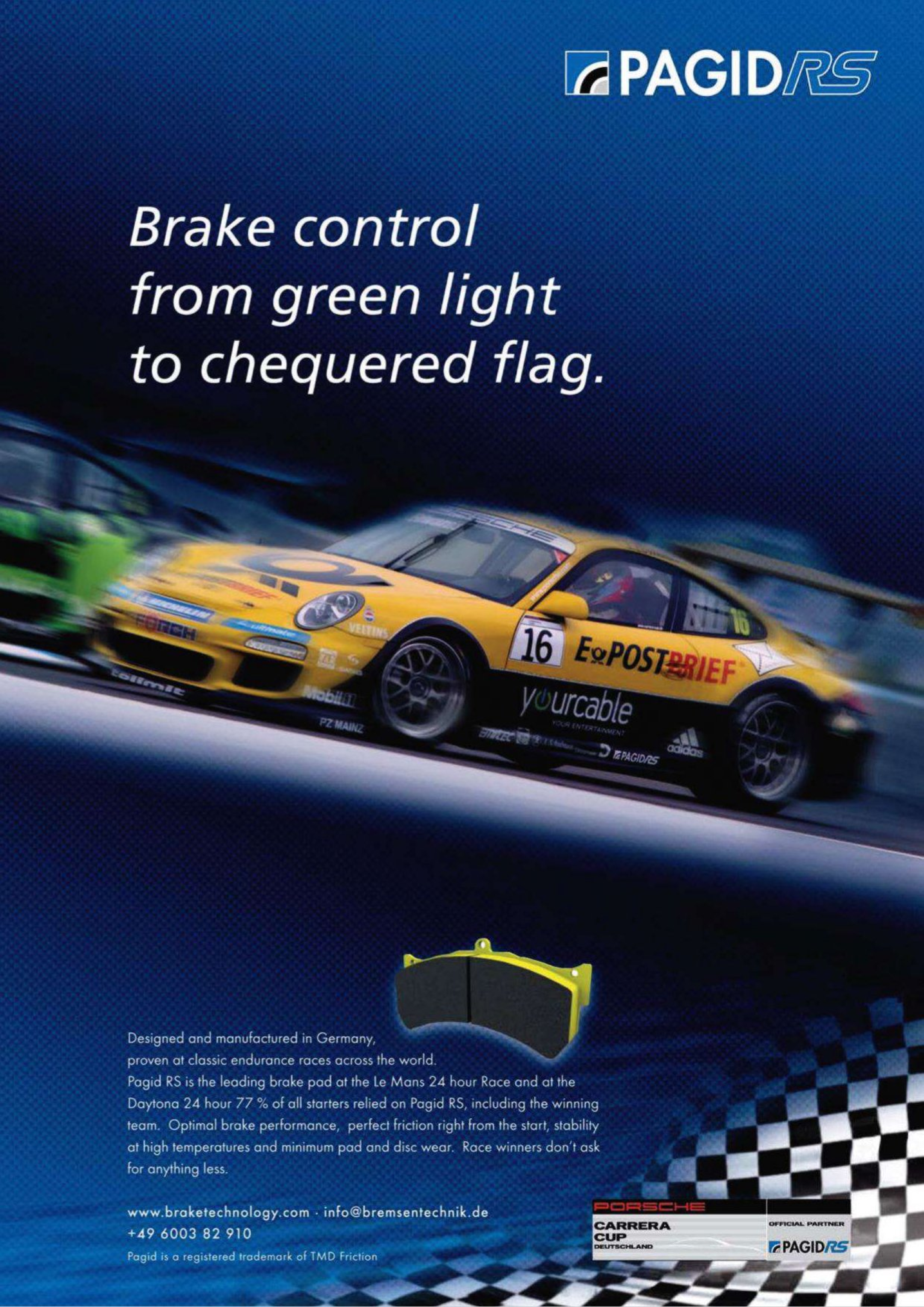
The lack of downforce produced from the flat bottom required Dallara, and the series, to adopt larger, multi-element wings run at incredible angles of attack to push the car down from the topside.

By designing the IR12 with venturi tunnels, Dallara has greatly reduced the drag penalty the IR07's road and street course wings provide, which is evidenced by the less aggressive wing package seen on the IR12 at Mid-Ohio. Two elements are affixed to the IR12's anhedral front main plane - one directly to the main element and one that stands on its own, similar to that seen in Formula 1 in recent years. The extreme drag-inducing attack angles are nowhere to be found.

The front wing end plates have a blunt leading edge, and sit higher off the ground than those used on the IR07 to reduce pitch sensitivity. At the rear, two elements, rather than three are used, with the upper element also run at a fairly shallow angle. Both elements are slightly curved. The rear wing end plates carry over a wide range of adjustability, and extend further back than their predecessors.

The oval wing package at the front of the IR12 will be completely different than the road and street course wings, while the main rear wing element will likely be used on all tracks. Beneath the car, the venturi tunnels feature a single strake but, as testing continues, the option to use more than one strake could become a possibility for 2012.

The effectiveness of the new underwing and the efforts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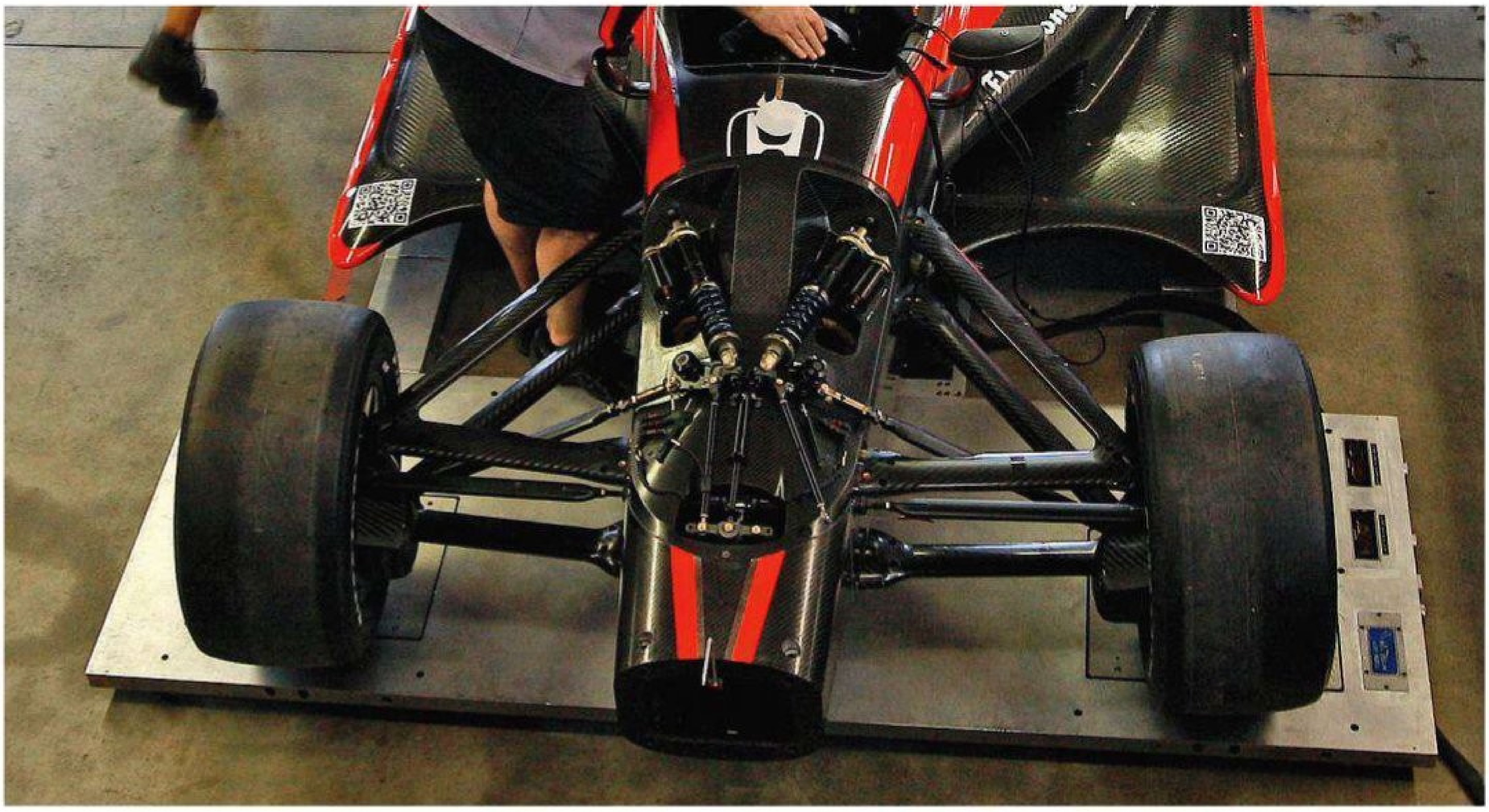

Front suspension has been changed from a pull-rod to a push-rod layout, with carbon fibre shrouds and twin dampers mounted on top of the nose. The entire front suspension is also now interchangeable side to side, greatly reducing the number of individual components needed in teams' inventories

to reduce drag has resulted in significant increases in downforce and major decreases in drag.

Most teams raced the IR07 at Mid-Ohio with approximately 4500lb (2,041kg) of downforce and, in similar trim, the IR12 has an extra 700lb (317kg) at the current level of 1500 - 1550lb (680kg - 700kg) of drag. In Speedway trim, and with downforce levels similar to the 2000lb (907kg) of downforce used today, the IR12 has shed a staggering 30lb (13.6kg) from the 775 - 825lb (351kg - 374kg) of drag generated by the IR07 at a similar speed. While it might not look impressive, such a loss of drag is a major part of what will allow a car with just 500bhp to run speeds above 220mph.

Dallara estimates 3000 hours of CFD and wind tunnel time has been spent on the creation of the IR12's standard aero kit, up from the 1000 hours of wind tunnel time the IR97 received.

After being rejected by team owners, the proposed 'Aero Kit' concept will not now be permitted until 2013 – a move that leaves Dallara as the sole vendor until another manufacturer chooses to enter the fray.

SUSPENSION

The IR12 has been designed to use as many universal components as possible. The suspension, for example, can be used on either side, and the uprights can also be swapped from left to right.

'There's been a big effort from Dallara to reduce the necessary inventory that teams have to carry,' Will Phillips, IndyCar's vice president of technology, explained, 'and to try to keep the cost controlled.'

The topic of suspensions was highly contentious last season, with teams pushing the boundaries in a few different areas. For 2012, teams will have most, if not all of the modern tools and systems they've sought at their disposal. The low nose and pull-rod suspension on the front of the IR07 has been replaced with a more conventional push-rod layout, with twin dampers resting atop the chassis.

> "significant increases in downforce and major decreases in drag"

Ride control is standard, and inerters will likely be permitted, provided the technology is part of the conventional coilover dampers employed by each team. 'As the two technologies have moved together, one has to go to re-define the regulations that provide that parity,' said Phillips. 'Certainly, for 2011 they're not allowed, but we are looking at going forward, allowing that to be used if it's incorporated into a damper.'

For those accustomed to the suspension layout used in Champ Car, or most modern single seaters, the IR12 features a ride control device and anti-roll bar mounted at the front of the chassis, and the front dampers attaching between the pushrod's rocker arms and the dash bulkhead.

The layout is inverted at the rear, with the dampers mounting between the rocker arms and the front of the bellhousing just behind the engine. The rear ride control device and anti-roll bar sit atop the gearbox at the back of the car.

Carbon fibre shrouds are mounted to the IR12's steel A-arms and push rods, giving the car a different look, while at the same time offering a first line of defence in minor impacts.

The bottom of the monocoque, directly below the driver, is raised and sculpted to help feed air to the underwing, which is a departure from the IR07's flat floor.

ENGINES

Compared to the relatively fixed chassis regulations for the IR12, final rules and figures for the new IndyCar engines will remain fluid until the ongoing track testing concludes. Honda, General Motors and Lotus have all built V6 engines, with Honda selecting single-turbo architecture, while GM and Lotus have chosen to go with twin turbos.

Until the engine regulations are finalised, IndyCar and its manufacturers are working from an initial understanding that calls for a rev limit of 12,000rpm, a minimum weight of 212lb (100kg) and an interval of 2000 miles between rebuilds.

The Cosworth XFE engine, as used in the spec Panoz DP01 Champ Car chassis, produced between 20-22psi of boost, while the new 2012 engines have been described by the series as 'low-boost powerplants'. Honda's current 3.5-litre IndyCar V8 engine, the HI11R, spins to 10,300rpm, produces approximately 650bhp and weighs roughly 275lb (125kg).

Like its rivals, Honda's 2012

The contentious overhead air intake remains, connecting to the cold side of the turbocharger(s). Single or dual turbos are allowed, with freedom in their placement

engine - tentatively dubbed the HI12R - is expected to produce between 550 and 700bhp, with the higher power figure used on road and street courses, and the lower figure on ovals.

'We'll be testing and going to each type of track that we're going to race on to be sure that the racing speed is safe,' said Phillips, describing the plans to set the final power levels for 2012. 'Our aim is to try and keep the excitement there.'

Borg-Warner, best known for the Indy 500 trophy it sponsors, was chosen as the sole turbocharger supplier through to 2016. Two sizes of turbos have been approved - a larger unit for single-turbo engines and a smaller unit for twin-turbo motors - and both features stainless steel housings, light titanium aluminide turbines and ceramic ball bearings.

Until more testing is carried out, maximum turbo boost values will remain undefined, but when they are worked out, all three manufacturers will have mass flow rates that are equalised across single and twin-turbo layouts. Variable-vane turbochargers and the use of anti-lag systems will not be permitted in 2012, but IndyCar 2012 project manager Tony Cotman says they are options for the future: 'I don't think we should write it off,' he warned. 'It's pretty common in the marketplace and it's quite relevant. Never say never, but it definitely won't be in 2012.'

Wastegates are open for each manufacturer to choose and implement, and measures to monitor and police boost pressures are currently being tested by the series. Performance balancing measures for the three engine manufacturers, according to Phillips, will be kept to a minimum: 'I would say that's still in process right now, but we're not intending to penalise someone for doing a good job. 'May the best man win' is part of competition. But there is going to be a means of trying to make sure we keep people involved and protect those that are involved. There also has to be recourse for getting back in the game if you're not in the game. The process is something we're still working on.'

> "a car with just 500bhp [that can] run speeds above 220mph"

Air is fed to the engine through an overhead air intake that connects to the cold side of each respective turbo. Rules permit the placement of turbos within the bellhousing (a familiar solution from CART / Champ Car) or outside of the bellhousing if insufficient space is available.

Despite the look of the overhead air intake receiving less than favourable reviews, the series does not expect to change its configuration. 'Yes, the airbox-looking thing is still there... I get asked that all the time,' said Cotman. 'We all think of turbo intakes at the back of the car and roll hoops you can see through with turbocharged [Indy] cars, but I understand the purpose of the airbox as it is and it provides a common solution for the different types of engines. It's the right thing to do.'

The three manufacturers will produce exhaust and turbo piping systems that fit their particular needs, but spec exhaust outlets - on top of the sidepods and in front of the upper A-arms - are positioned on both sides of the car.

Radiators, intercoolers and the rest of the external support systems for the 2.2-litre engines are spec, while the choice of ECU and ignition systems is left open. Honda, for example, will continue its relationship with McLaren Electronic Systems.

A new, compact, longitudinal, six-speed gearbox from Xtrac will come with the IR12. The vendor and style of differential teams will use is being kept private until it can be properly validated and agreed upon, though according to Phillips, the final version will allow for mechanical adjustment.

Some teams had hoped a seven-speed gearbox would be produced for the new car, but Phillips says cost control played a factor in deciding on the finished product: 'The more ratios you put in, the narrower they become, the more expensive they become. [And] selection mechanisms get more expensive as well.'

ELECTRONICS

Cosworth Electronics will provide data systems for the IR12. Some form of update is being considered for teams using the current generation of Cosworth Sigma data systems, but it is quite possible all-new systems will be mandated.

Weight was saved on the new chassis through the use of an integrated chassis loom, replacing the add-on system currently in use and which features TV telemetry, TV video, track condition, voice and other looms tacked onto its base over the years. The decision was made to design a simple, modular

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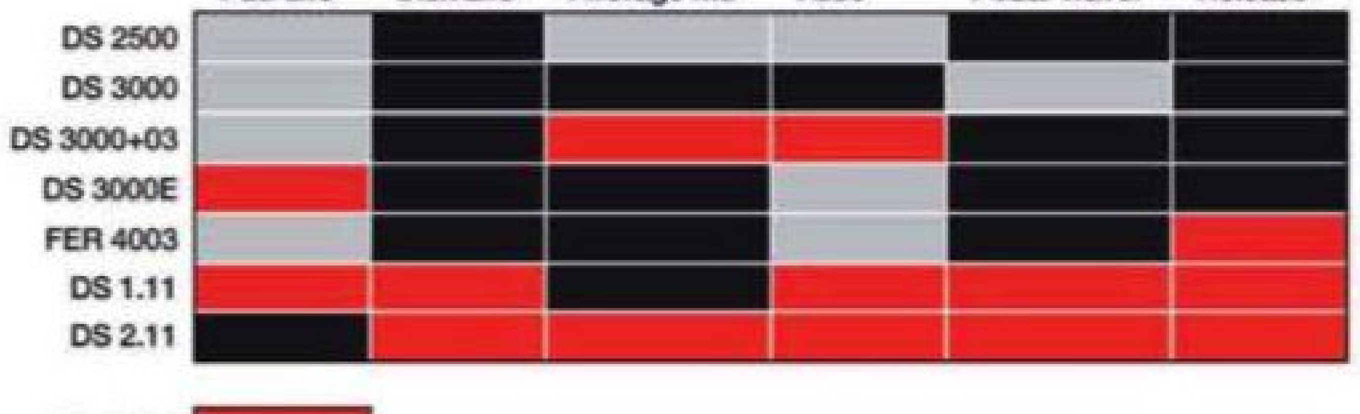

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DRIVING THE DALLARA IR12

As well as the rest of the chassis, the cockpit itself also received an extensive re-design, and IR12 test driver, Dan Wheldon, explained how it felt in comparison to the IR07. 'I think they've made huge gains from a safety standpoint,' he said. 'It's very different to the cockpit we have now. With the [IR07], the position you sit [in] is as low as it possibly can be, below the airbox. But when you sit that low your legs ride over the fire bottle, and then you go back down and kind of sit lower. It's just not very fluid and you're compacted a bit. The new seating position is very fluid. There's a lot more seat around you and the vision is very good. You just feel so much safer with all of the extra space, and you've got less stuff around you and around your feet, so it's really modern in that way.'

The cockpit of the IR12 is longer and wider than the IR07, with the driver moved further back between the axle centrelines, allowing for more legroom if needed. Elbow room is a comfort most IndyCar drivers have gone without for many years, but the IR12 addresses that issue as well, and can accommodate wider shoulders. According to Wheldon, ingress and egress is improved too, with the longer cockpit aperture: 'I slipped right into the car and it felt good immediately. You can pull your knees back and it doesn't have the sensation like the [IR07] has with the dash being close and the [cockpit] sides crowding in a bit.'

The use of an F1-style, steering wheel-mounted hand clutch system from AP Racing is standard on the IR12, eliminating the need for a clutch pedal. As Wheldon reports, learning to use his fingers to engage the clutch and pull away from pit lane was a joy: 'It's so cool,' he said. 'I feel I'm quite young now, but a lot of these kids today grow up playing racing games using a hand clutch, so for someone like me, it's totally different, but it was so easy to get used to. They are going to allow teams to cater the bite point to each driver, but you can get in it and the first time you use it, it's a piece of cake. It doesn't require too much [finger] pressure at all.'

Mega-Line continues to provide Dallara's paddle shifting solution, and the current gearbox control unit will be used on the IR12. The car does not have an on-board starter, but does come equipped with an ECU-controlled anti-stall system from AP Racing, with a pneumatic-to-hydraulic interface.

Most of the IndyCar Series drivers use their left foot for braking, and Wheldon believes the new two-pedal arrangement will make for a natural transition for right-foot braking: 'It's more comfortable. The car's set up for [left-foot braking]. I think for someone [tall] like Justin [Wilson], it will be a lot more comfortable. His legs won't have to go here, there and everywhere to fit. He can just sit in it and have his legs fit normally, and use some padding, too. And there's still right-foot brakers, and I know you can tailor the pedals to do that, too. It's not like F1 where it only works for left-foot brakers.'

> "they've made huge gains from a safety standpoint"

The throttle pedal does not use a mechanical linkage, but rather an electronic drive-by-wire system that will be a bespoke solution left to the engine manufacturers to implement.

Increased cockpit size is a bonus for bigger drivers, but steering wheel-mounted hand clutch is the biggest change

system for the IR12.

The long, snaking loom(s) found on the IR07 often needed to be removed and repaired in an accident, making the modular system on the IR12 easier to service or replace. With a few modifications, the current steering wheel / dash units are expected to be used on the IR12, and the rest of the data and telemetry systems will remain largely unchanged.

Boost monitoring will take place and power and torque figures are expected to be collected by the series, but the exact process whereby this will be done is still under discussion. The use of an overtake button, contrary to original reports, will not be permitted, and traction control is also illegal.

SUMMING UP…

The new car was briefly shaken down in Italy before being shipped to Mid-Ohio for its first proper test. 'There's no secret we had some teething problems,' admitted Cotman. 'A new chassis and new engine will always have some issues to work through, but overall, it was good. Was it perfect? No way. Was it a disaster? Absolutely not. Selecting Bryan Herta Autosport was the right thing to do. The effort they put in, and the professionalism they showed was just what we expected.

'I've been a very harsh critic of Dallara about their fit and finish. It's safe to say that when the two series merged, they pumped out a lot of extra stuff where the quality was lacking. If they continue with the quality that they have shown on this prototype, it will continue to be the best we've ever seen.'

Answering questions about handling and performance will have to wait for future tests. Mileage and lap times were not published, though useful feedback was given to the majority of the vendors involved, with the exception of Firestone, as the car was not pushed hard enough to generate meaningful tyre data. A lot more will be learned about the Dallara IR12 as testing continues, and the final engine specification will be decided later this year.

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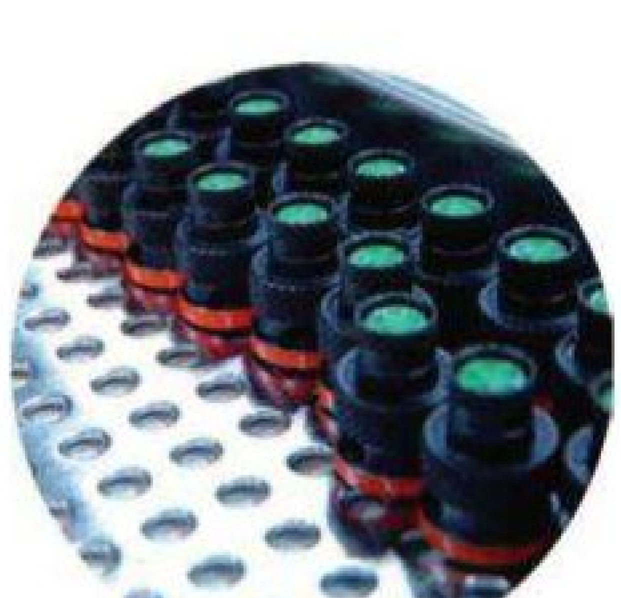

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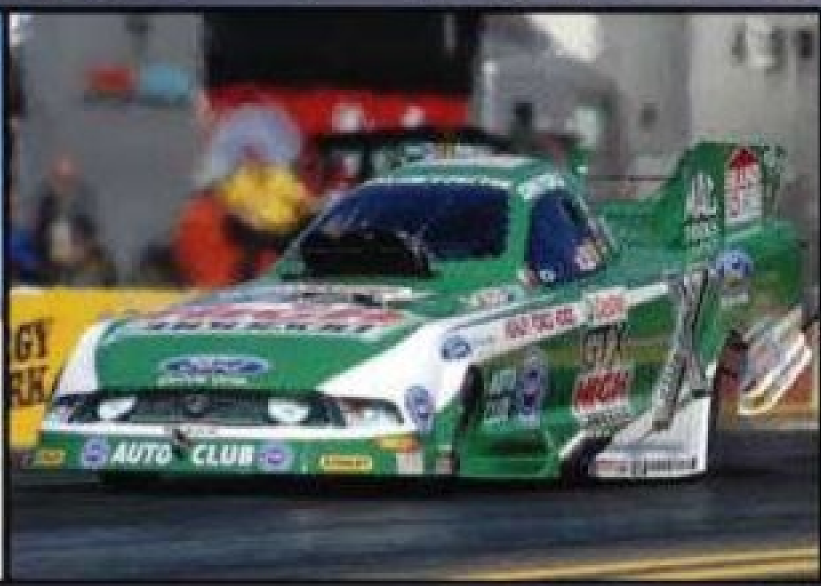




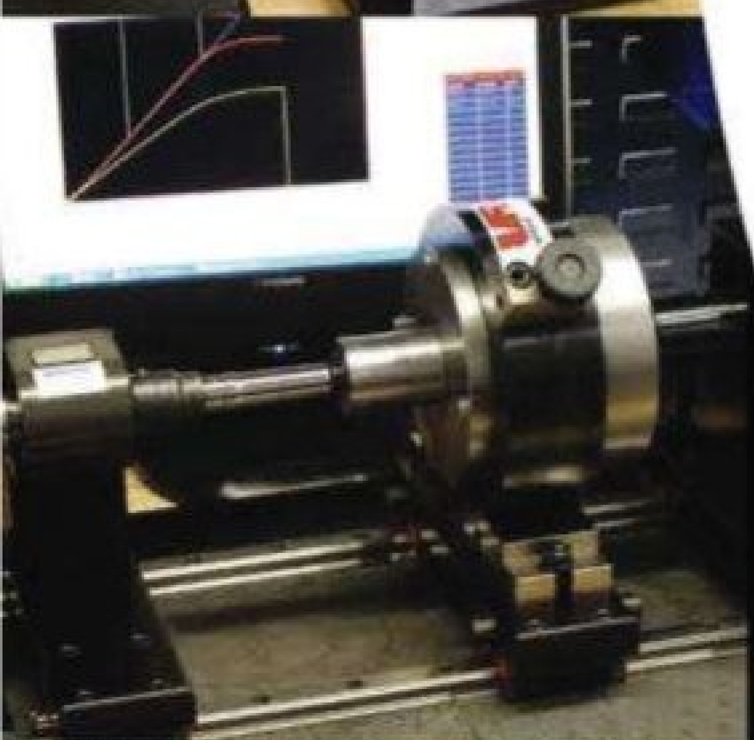


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Simon McBeath offers aerodynamic advisory services under his own brand of SM Aerotechniques – www.sm-aerotechniques.co.uk. In these pages he uses data from MIRA to discuss common aerodynamic issues faced by racecar engineers

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Yaw thoughts

Sports Racers demonstrate very different characteristics at small angles of attack

Continuing our investigations on the ADR3 twin-seat Sports Racer, this month we look at how the car's aerodynamics altered at small yaw angles.

A busy but ultimately successful session in the MIRA full-scale wind tunnel had produced an aerodynamic set up on the ADR3 that met initial targets. The front-to-rear downforce balance finished up very similar to the static weight distribution, and there was more total downforce, less drag and greater efficiency than at the outset. So, with a short period remaining at the end of the session, the car was set at a range of small yaw angles to see how the aerodynamics changed, and the results were interesting.

The range of yaw angles tested covered zero to six degrees in two-degree increments in both positive (clockwise, viewed from above) and negative directions. This range was considered akin to the typical tyre slip angle range when cornering. In other words, we were examining how the aerodynamics changed at a number of different steady state cornering angles compared to the straight ahead configuration in which all the other measurements were made. Table 1, below left, shows the baseline coefficients at zero degrees and all other data points, which are shown as changes relative to this baseline in counts, where a coefficient change of 0.100 = 100 counts.

A number of things happened to the measured parameters, so let's take a look at each data column in turn. In every case, as yaw angle was applied, drag seemed to reduce by a small amount – roughly one per cent – which we can think of as insignificant in this context at least. Total downforce also reduced at every yaw angle measured, and it reduced by more when the car was rotated anti-clockwise (negative angles), with the reductions greatest at the smallest yaw angle measured.

> "in every case, as yaw angle was applied, drag seemed to reduce by a small amount"

Table 1: The effects of small yaw angles on the ADR3's end-of-session coefficients

Yaw angle	CD	-CL	-CLfront	-CLrear	%front	-L/D
zero	0.511	0.962	0.459	0.503	47.71	1.883
+20°	-5	-44	-72	+28	-5.55abs*	-69
+40°	-4	-15	-91	+76	-8.91abs*	-15
+60°	-6	-18	-80	+61	-7.56abs*	-14
-20°	-4	-80	-113	+33	-8.48abs*	-143
-40°	-5	-73	-114	+41	-8.90abs*	-126
-60°	-4	-58	-112	+54	-9.33abs*	-100

** abs = absolute change in per cent front, not relative percentage change*

The ADR3 showed some interesting balance shifts when yaw angle was applied to the car in the wind tunnel

FRONT DOWNFORCE

Focussing now on front downforce, again this reduced at every yaw angle tested. It too reduced by more when the car was rotated anti-clockwise, but in either direction the reductions were similar at each angle, something that looks more obvious in the plot in figure 1. Also shown in figure 1, rear downforce increased at each yaw angle, and again the changes were asymmetric. Figure 2 reflects the front and rear downforce changes by plotting the aerodynamic balance as '% front' at each yaw angle. A quick glance at this plot simply shows that balance shifted significantly off the front as soon as the car was at any yaw angle at all, though on closer inspection the

Table 2: The effects of small yaw angles on the Radical SR10's coefficients

Yaw angle	CD	-CL	-CLfront	-CLrear	%front	-L/D
-2O°	+2	+26	+33	-8	+1.60abs	+40
-4O°	-1	+31	+53	-22	+2.87abs	+66
-6O°	-4	+30	+82	-52	+4.94abs	+80

The Radical SR10 LMP1 racecar showed the opposite pattern of downforce shift to the ADR3 when it was tested at small yaw angles

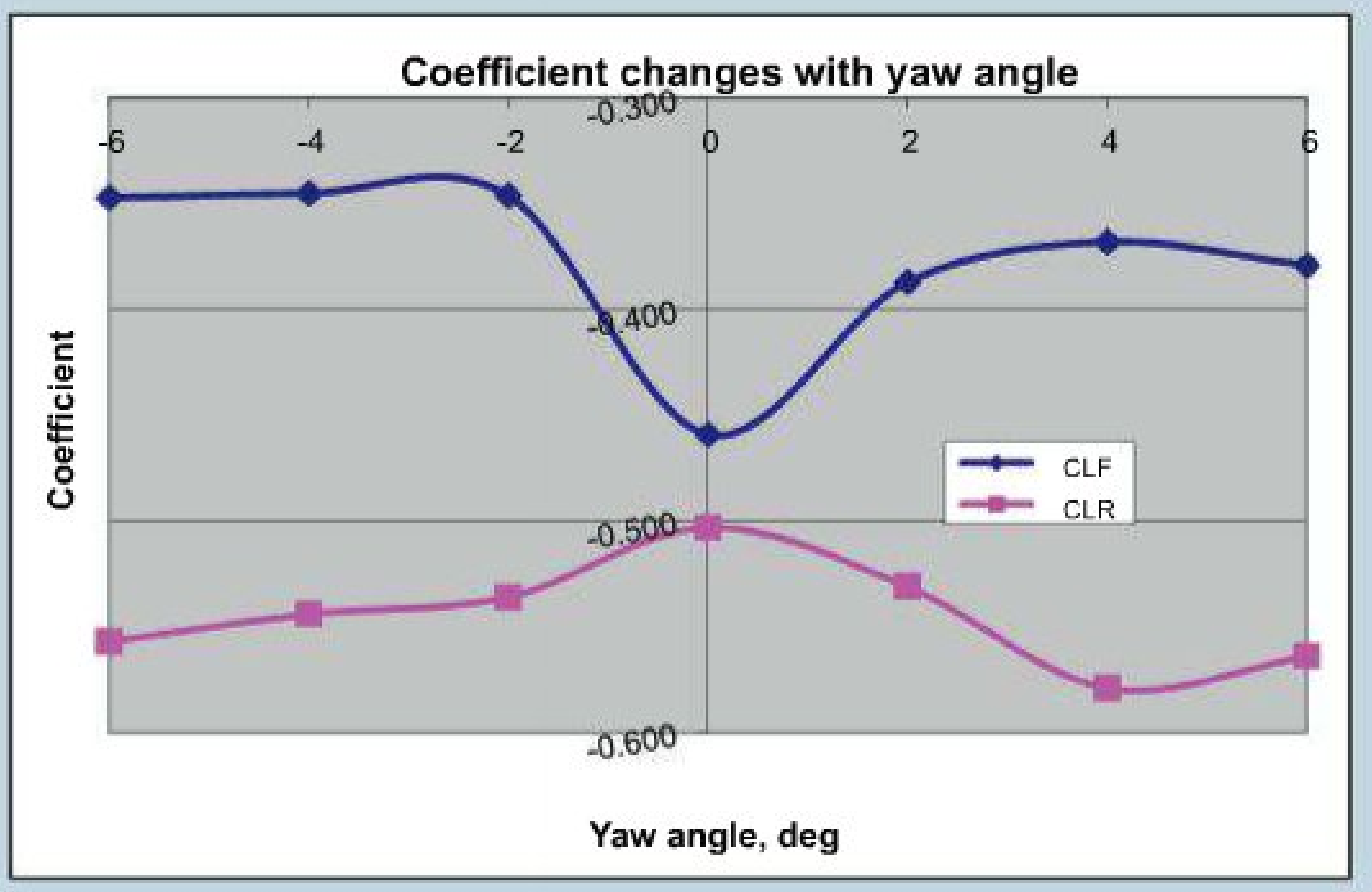


Figure 1: The ADR3 demonstrated a decrease in front downforce with yaw angle, whereas rear downforce increased

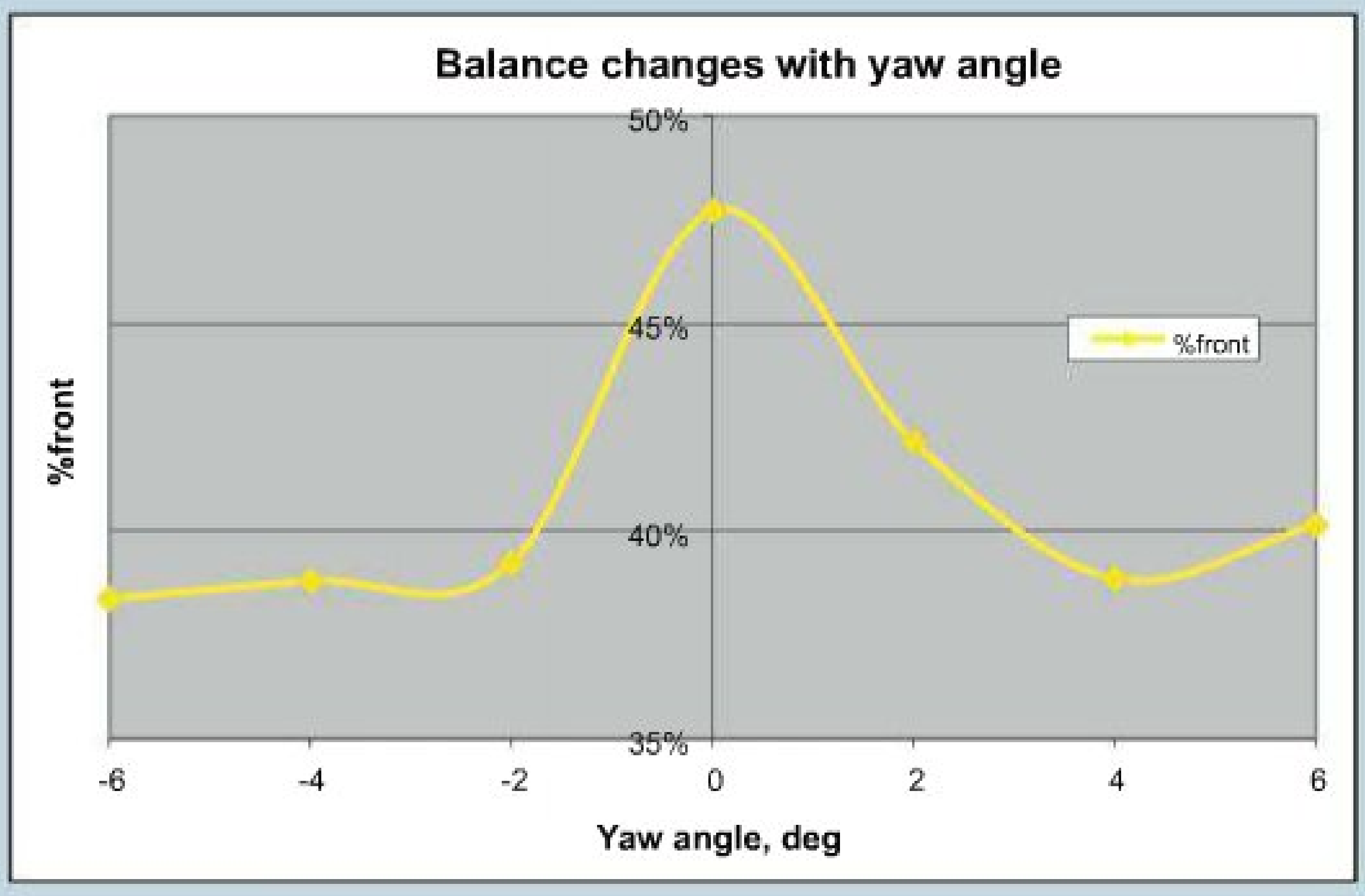


Figure 2: Figures for the Radical SR10 show aerodynamic balance shifted markedly to the front as yaw angle was applied

asymmetric nature of the results is again apparent. Efficiency (-L/D) also reduced at yaw, and again asymmetrically, though this parameter is likely to be of less import than the balance shift. The obvious questions arising from this data set are:

- **On a pragmatic level, what are the implications?**
- **On an academic level, how and why did these changes occur?**
- **Is the asymmetry in the changes significant, and why is it there?**

The implication of this data is that if the car is aerodynamically balanced in the straight ahead state, then once it is in a cornering state at a yaw angle within the likely slip angle range, as speed builds and downforce increases, it would gain more rear-end grip than front. The next obvious thought is that the car would appear to require a straight-ahead balance with still greater '%front' than was obtained during this session if it is to be balanced in steady-state cornering. However, MIRA's fixed floor wind tunnel underestimates downforce from ground proximity devices such as splitters, so front downforce is probably greater than the figures suggest. Fine tuning on track is the next step.

THE REASONS WHY

As to why the car lost front downforce and gained rear downforce when at yaw, possible contributory reasons would include increased front upper surface lift or decreased splitter and / or front diffuser effectiveness. The apparent rear downforce gains may just have been the mechanical leverage effect of the decreases at the front, although the differences between the front and rear changes depending on the direction of yaw rotation may suggest there were also genuine aerodynamic changes at the rear. And possibly contributing to the overall shift might be differences in flow to the rear wing affecting the extraction of air from the diffuser and underbody.

Given the offset position of the driver, we shouldn't be surprised to see asymmetry in the aerodynamic results arising from yaw changes. However, it is apparently quite possible for supposedly symmetrical vehicles to generate asymmetric aerodynamic data! Other factors that may have contributed to these asymmetric results include minor differences in cooling ducting side to side (these were of temporary cardboard construction) or minor ride height differences across the car.

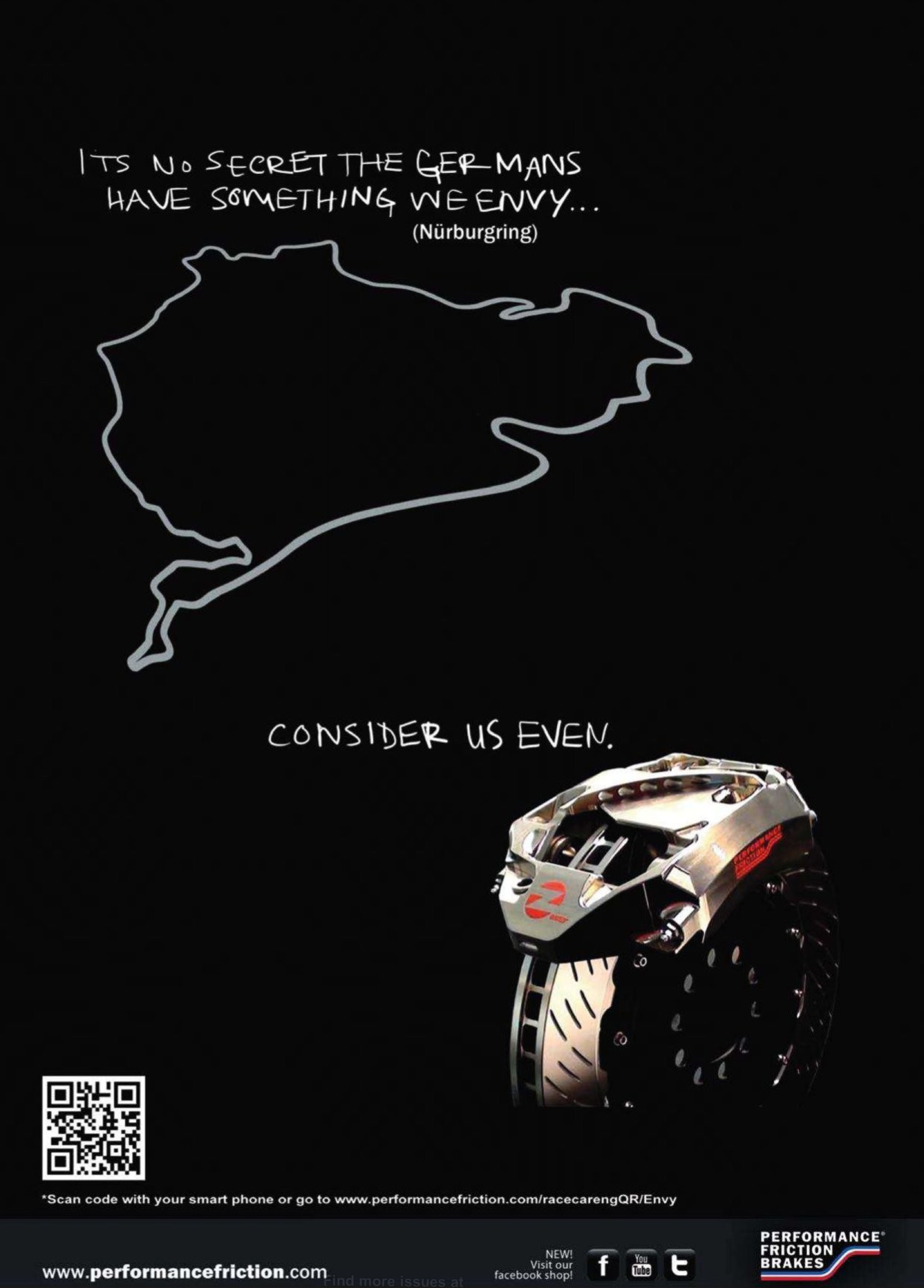
But lest we begin to think that all Sports Racers exhibit similar effects, let's compare to some data derived at similar small negative yaw angles on the Radical SR10 LMP1 car in 2008.

> **balance shifted significantly off the front as soon as the car was at any yaw angle at all**

Looking at the results in table 2, we can see that drag remained similar to the straight ahead case but, rather than there being a loss of front downforce, there was in fact an increasing *gain* with yaw angle which, combined with increasing losses of rear downforce, saw a reasonably significant shift of balance onto the front of the Radical as yaw angle was increased. This is the complete opposite of what we saw on the ADR3. So while the two cars might be thought of as superficially similar in type, once again we are reminded that what applies to the aerodynamics of one car does not necessarily apply to another.

Next month we'll look at two very different racecars that we compared in a single session in the MIRA full-scale wind tunnel.

Racecar Engineering's thanks to ADR Engineering, Carbon Weezel and Simon Marsh.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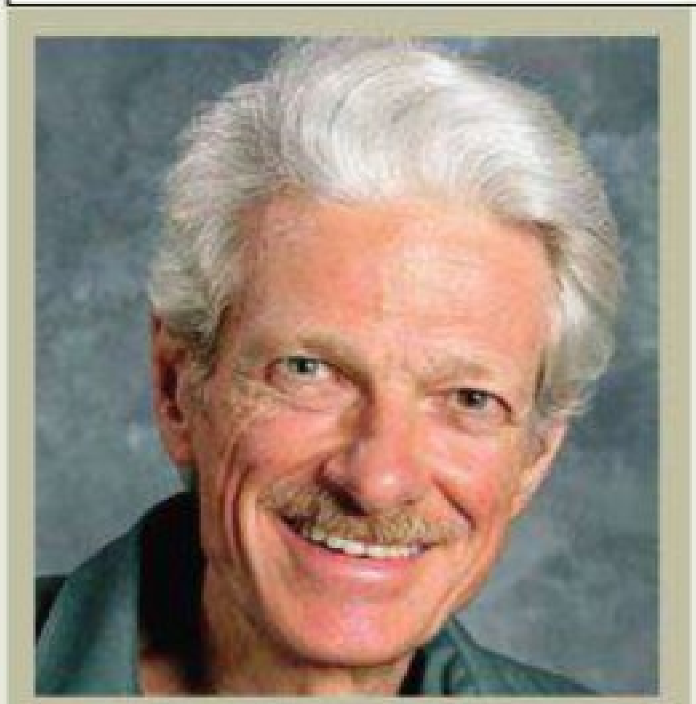

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A low rear roll centre allows for greater elastic rear roll stiffness and minimises torque wedge

Mumford's the word

THIS MONTH:

Q1 **How does the Mumford link work, and why is it not as popular as other forms of axle location?**

A1 It is less commonly used because of its complexity, but allows for a very low rear roll centre on a live axle car

Q **I would like to find more information on the Mumford link, as it seems to be a potentially useful modification for my Bugeye Sprite. Can you point me to any sources of information on how it works? Is it not as popular as a Watts linkage or a Panhard rod because of the complexity and difficulty in determining link sizes, pivot locations etc?**

The Mumford link, or linkage (since it is a linkage – a system for motion control containing more than one link, together with other elements), is actually a family of possible layouts, commonly used for lateral location of beam axles. This family has at least four possible members: the better known Watts linkage consists of a central rocker, and two links attaching to the ends of a centrally pivoted rocker, extending in opposite directions from the rocker. The WOB linkage has a rocker with its pivot at one end, and two links different distances from the pivot, extending in the same direction from the rocker. The Mumford linkage, on the other hand, uses two rockers and three links. All three systems can give very nearly straight-line axle location in ride, while allowing roll about a reasonably well defined point, which serves as the roll centre, or as one end of an axle axis of rotation whose axle plane intercept defines the roll centre.

> **The Mumford linkage is able to provide a roll centre below any part of the hardware**

The Mumford linkage is, as you correctly surmise, a more complex means of accomplishing a simple task than its rivals, so can only be justified if it either provides better packaging or load paths in a particular situation, or if it permits geometrical properties unobtainable otherwise.

The usual appeal of the Mumford linkage is that it is able to provide a roll centre below any part of the hardware. Indeed, the roll centre can be lower than the ground clearance of the car, or lower than a smooth floorpan under the rear axle, running smoothly into a diffuser.

Now, why would we want an unusually low roll centre with a rear beam axle? Not to prevent jacking. Maybe to minimise lateral scrub on one-wheel bumps, particularly with stiff tyre sidewalls. But more commonly, we want a low rear roll centre with a live rear axle so we can have a lot of elastic rear roll stiffness, via springs and / or anti-roll bars, relative to the front elastic roll resistance. The advantage of this, for a road racer, is that it minimises torque wedge – the change in diagonal percentage due to inherent driveshaft torque.

With appropriate design, there are better ways to minimise torque wedge. But these may or may not be understood by the designer, and may or may not be allowed by the rules.

TERMINOLOGY

There isn't any standard nomenclature for the parts of a Mumford linkage, so I am inventing some. The mechanism has two rockers, each with two link attachment points and one pivot. One link from each rocker connects to the axle (if the rockers are attached to the frame or sprung structure) or the frame (if the rockers are on the axle). I will call these the side links. The third link connects the two rockers to each other, and constrains their movement so they can only pivot equal amounts, in opposite directions. I will call this the centre link.

There are four basic configurations. The rockers can be near the centre of the vehicle, with the side links extending outward from them, and a short centre link, or they can be out toward the sides of the vehicle, with the side links extending inboard from them, and a long centre link. Additionally, the rockers can be on the frame or on the axle. We will refer to these as such:

- **Rockers unsprung (on axle), inboard (RUI)**
- **Rockers unsprung, outboard (RUO)**
- **Rockers sprung (on frame or sprung structure), inboard (RSI)**
- **Rockers sprung, outboard (RSO)**

All of these options can give a roll centre below any point on the linkage, but differ with respect to what I call the Mitchell index ie how the roll centre height varies as the suspension moves in ride. When the rockers are unsprung, the roll centre only moves a little with ride, relative to ground. It moves oppositely to the sprung mass so has a Mitchell index that is negative, with a small absolute value. When the rockers are sprung, the roll centre moves with the sprung mass in ride, a bit more than the sprung mass so has a Mitchell index a bit greater than one.

If the system is paired with an independent suspension at the front, the front suspension will in most cases have a Mitchell index of one or greater. It is difficult to get a Mitchell index near or less than zero with independent suspension.

It is desirable to have similar Mitchell indices at the front and rear of the car. This way, the roll axis inclination will not change drastically as the car negotiates humps and dips while cornering – that is the relationship of front geometric anti-roll to rear geometric anti-roll will not vary a great deal with heave displacement. The car's oversteer / understeer balance should therefore be more constant, particularly in undulating sweepers. However, many cars race fair effectively disregarding this. It is not the end of the world if the front and rear Mitchell indices are dissimilar.

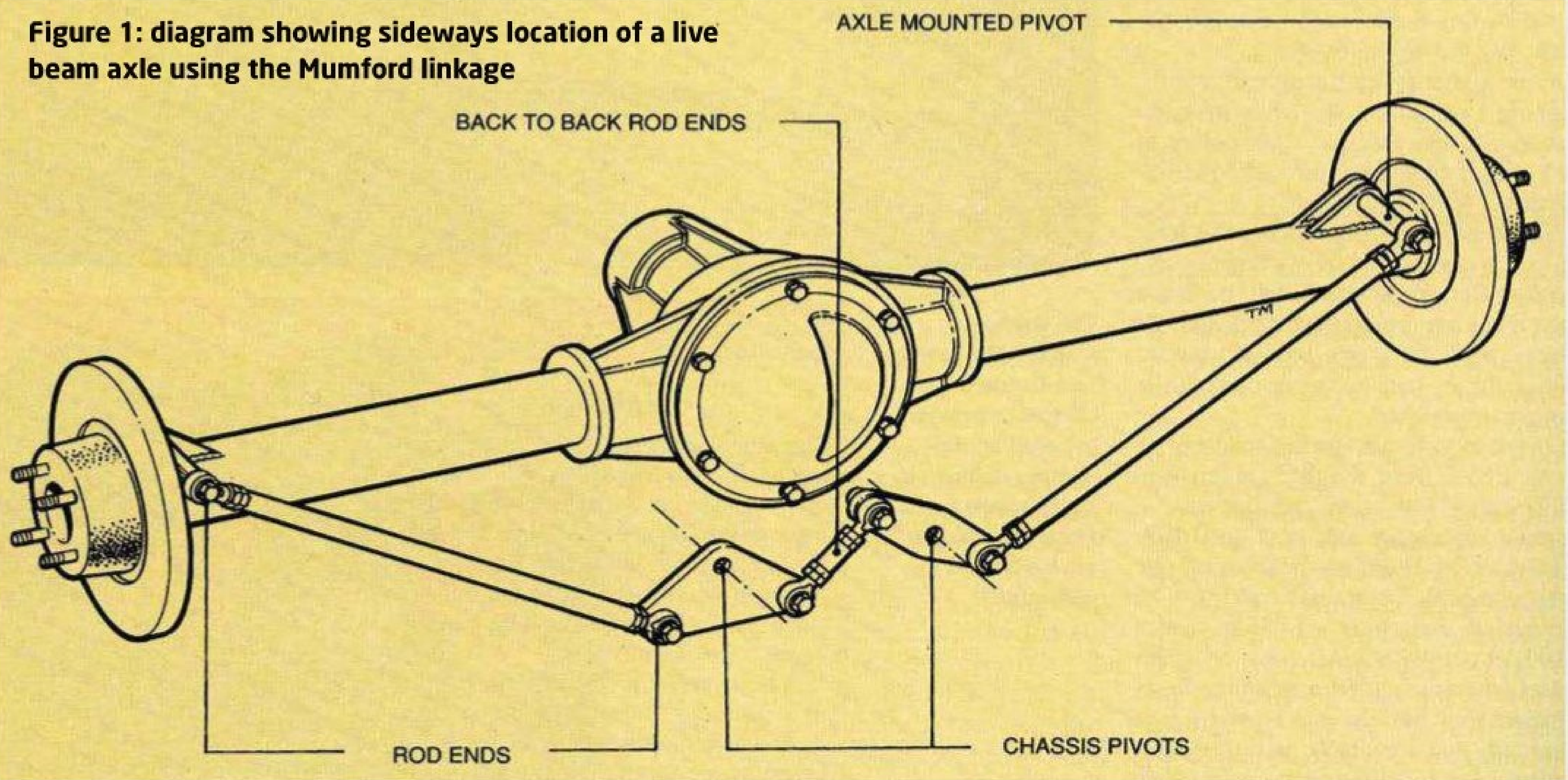
The questioner is interested in applying the system to a Mk1, or Bugeye, Sprite. The stock suspension on that car consists of trailing quarter-elliptical leaf springs a bit below axle centre, and rubber-bushed trailing links above those. The springs provide lateral location. There is no additional mechanism for lateral location. The roll centre is then at spring height, and the system appears to be fairly compliant laterally.

American production sports car rules (eg SCCA) would require that the leaf springs be retained, but would allow addition of lateral locating devices, and also allow changing bushing design. If the objective is merely to take lateral compliance out of the system, probably the best approach would be a diagonal Panhard bar running approximately from where one of the leaf springs connects to the unibody to where the opposite spring connects to the axle. This would work with stock bushings, or with upper links having rod ends and adjustable length. It would not lower the roll centre. The bar might need to have a bend, and pass over or under the driveshaft.

If a lower roll centre is desired, the attachment of the springs to the axle has to be modified so that the springs no longer locate the axle laterally. Or, rules permitting, the springs might be eliminated entirely and replaced with heim-jointed links. In any case, the axle must be free to move laterally with respect to the springs, or the system will bind in roll.

If the roll centre is lowered, the car will need more rear spring or anti-roll bar for similar steady-state cornering behaviour. The main advantage to going this way will be that the car will put power down a bit better exiting right turns.

Figure 1: diagram showing sideways location of a live beam axle using the Mumford linkage

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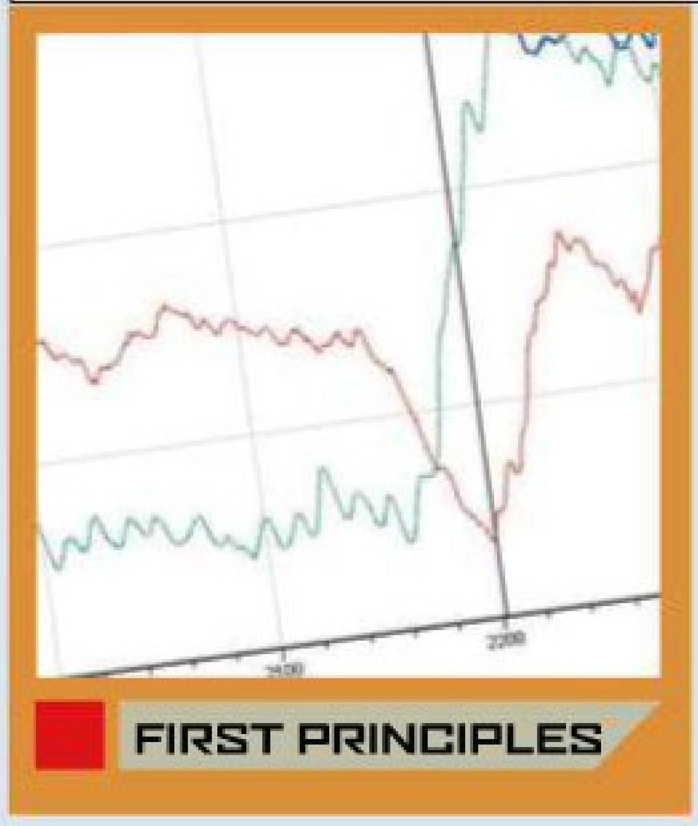


Challenge Cosworth

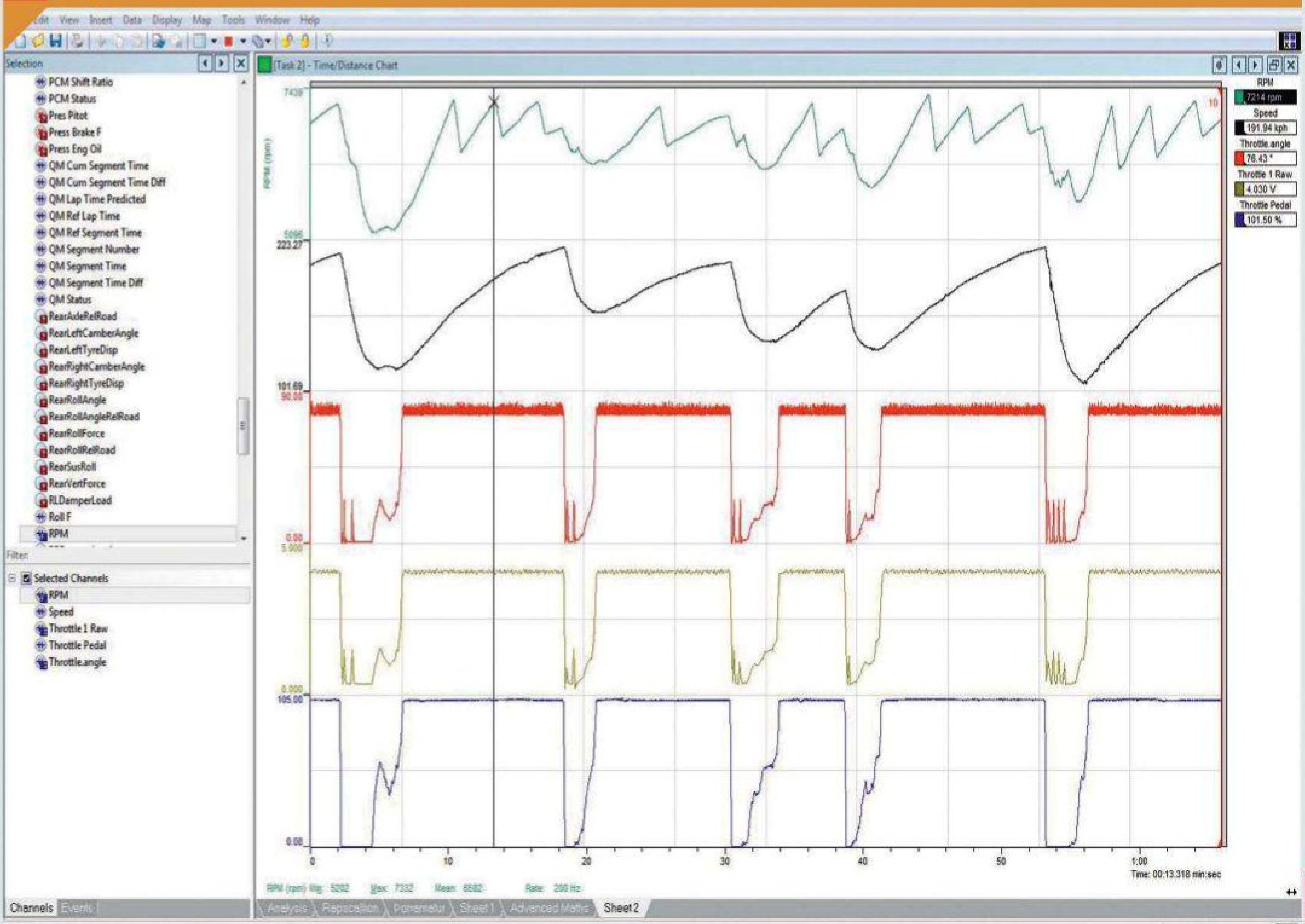
Test your data analysis skills with this series of questions set by the data engineers at Cosworth

Databytes is a little bit different this month as we have launched a new section on the *Racecar Engineering* website dedicated to the ever-popular challenges. Each week we will upload a new challenge and invite you to discuss the answers. We will also be offering a range of great prizes for some of the challenges so remember to keep checking back. But for now, test your analysis skills with these three challenges set by our partner, Cosworth Electronics. The answers will be posted online at www.racecar-engineering.com/databytes. Databytes will be back as normal next month.

Question 1

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

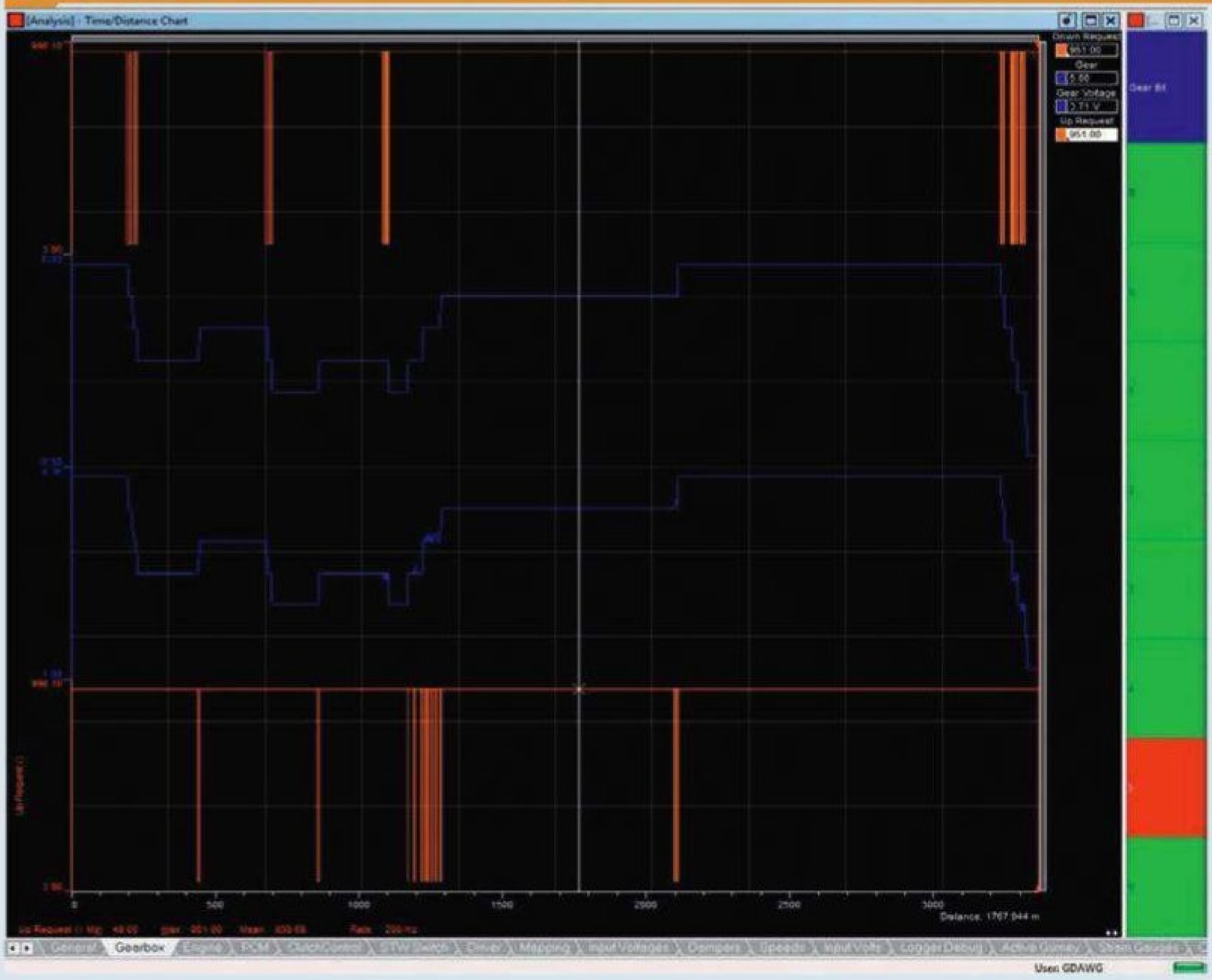
CHALLENGE 1



CHALLENGE 2

Question 2 The team are having trouble comparing data from two different laps. What could be the cause of this, and how could it be fixed so the data is comparable?

CHALLENGE 3



Question 3

Any good data system will have the means of showing a trace of what gear is used at what time, whether it is directly recorded from the gearbox or by way of calculation. But what if we want to count how many gear changes are made in a lap? Surely there must be a better way to do this than counting it manually. How could this be accomplished?

Aussie rules

The latest in a line of saloon racecars to undergo a 21st century transformation, V8 Supercars unveil its Car Of The Future

BY STEFAN BARTHOLOMAEUS

Having emerged as one of the world's most competitive and professional forms of motorsport over the last decade, Australia's V8 Supercars championship is currently shaping its future. Targeting a reduction in costs and an end to the current Holden / Ford duopoly, former five-time series champion Mark Skaife introduced the Car Of The Future (COTF) project into the public domain in March of 2010.

Underlining the decrease in Ford and Holden's share of Australia's new car market since the basis of the current regulations were introduced in 1993, Skaife has spearheaded an immensely thorough market research programme designed to maintain the category's success over the next 10 years.

While particularly bullish on V8 Supercars' ability to entice more manufacturers into the championship, Skaife is quick to emphasise that the COTF is about evolution, not revolution. 'We know what the fans like about our cars and our product, and we certainly don't want to deviate away from the core ingredients that have made it successful,' he says. 'But we would be derelict if we didn't recognise the changes in the automotive market and engage with other manufacturers.'

CHASSIS AND BUILD

With a rolling chassis cost target of AU$250,000 (£159,500 / US$260,150) – approximately AU$100,000 below current levels – V8 Supercars commissioned Queensland-based Pace Innovations to design and build two COTF prototypes to illustrate both the popular Ford (Falcon FG) and Holden (Commodore VE) body styles.

Owned and operated by former Schnitzer BMW engineer, Paul Ceprnich, Pace currently supplies rollcage and floor structures to a large portion of the field, so was a logical choice for the new car.

Consistent with the evolution theme, the layout of the COTF chassis is essentially the same as the 2011-specification cars, with two centre chassis rails, two

Though initial testing has been undertaken with a Ford, and a Holden variant is imminent, one of the aims of the COTF programme is to attract other manufacturers into the series

outer rails and a common floor welded to a chromoly rollcage.

While the shotgun rails, front firewall and transmission tunnel currently retain elements of the Ford and Holden road cars, the entire COTF chassis (save for the body side inner and the rear parcel shelf) is a bespoke V8 Supercars design, to which custom-made body panels representing the new manufacturers' cars can be added relatively easily.

In the name of cost saving, the rollcage is now a simpler, standard specification across all teams, halting the search for incremental stiffness gains and weight saving. 'The new cars certainly won't be as stiff as the ones currently out there, because the teams have developed a lot of complex tubing around the front and rear in the search for performance,' explains Ceprnich. 'But they will still be a lot stiffer than what is common in saloon car racing around the world, as well as being cheaper, easier to build and safer than the current V8 Supercars.'

With V8 Supercars being part-owned by the competing teams (local private equity firm, Archer Capital, recently took a majority shareholding), Ceprnich has been required to work closely with the V8 Supercars board and recently introduced Commission, while an additional three-man panel consisting of Ludo Lacroix (Triple Eight), Doug Skinner (Walkinshaw Racing) and Jim Stone (Stone Brothers Racing) was formed to provide input to the project.

“a rolling chassis cost target of AU$250,000”

'All teams have had access to V8 Supercars in terms of the rollout of this car – that's the way the business works,' says Skaife. 'Having teams on the board, for instance, has given the teams input at every level to ensure we end up with well thought out regulations that fit the evolution not revolution criteria.'

Construction of both cars commenced in September of last year, but was delayed by a decision to move from the traditional Holinger RD6S front-mounted gearbox to a transaxle unit, which subsequently allowed the engine to be moved back 100mm. This resulted in the planned racing debut being pushed back one year to 2013, and a decision made to concentrate on finishing the Falcon prototype first.

The car received its maiden track outing at Queensland Raceway in July, and had completed over 2300kms testing as this issue went to print. The debut of the Holden version is imminent.

The test team is a joint effort between the V8 Supercars' technical department, headed by former Subaru World Rally Team engineer, Vincent Dumarski, and Fujitsu V8 Supercars Series (the second tier) squad, Matt Stone Racing. 'We are focussed on reliability, but we have done a bit of 'outside the box' testing as well, simulating starts and just putting the car through normal racing scenarios,' explains Dumarski of the initial testing, which has seen Fujitsu Series drivers, Scott McLaughlin and Jack Perkins, drive the car on the existing 17-inch wheel and tyre package, prior to the new 18-inch examples being ready. 'We want to put at least 5000kms on the rear suspension, fuel system and drivetrain before signing anything off.'

“cheaper, easier to build and safer than the current [racecars]”

SAFETY

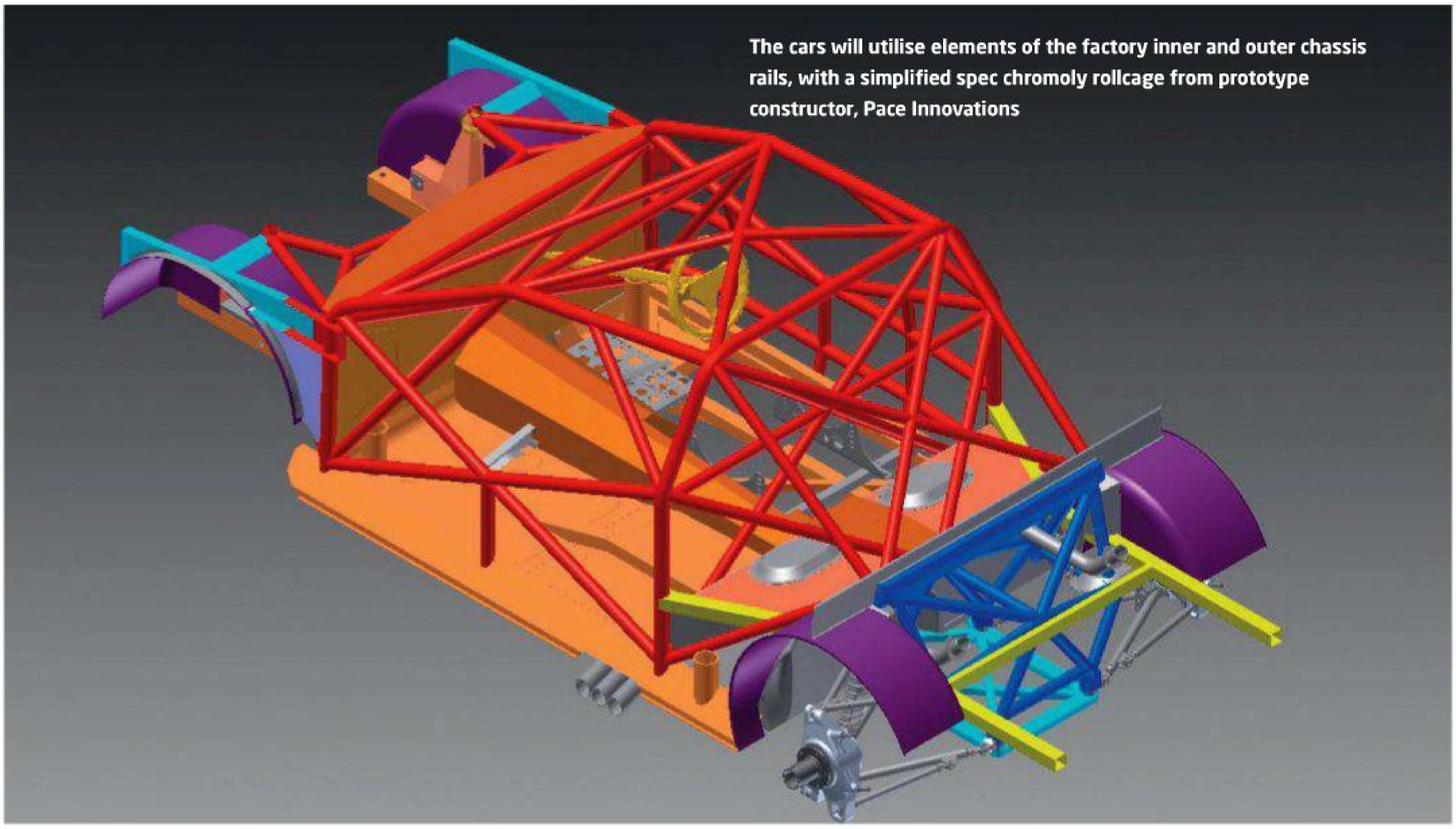
V8 Supercars continues to work closely with the FIA Institute in England on the COTF's safety features, and has already tested four new side impact crash structure designs. The work in England follows the shipment of a retired V8 Supercar to Germany late last year, where a frontal impact into a load cell provided valuable data.

The benefits of moving the fuel tank from the boot area to inside the cabin for the COTF were underlined earlier in this year's championship when two drivers were lucky to walk away from a start-line accident that saw the fuel tank of a stalled car punch through its rear firewall, engulfing both cars in flames.

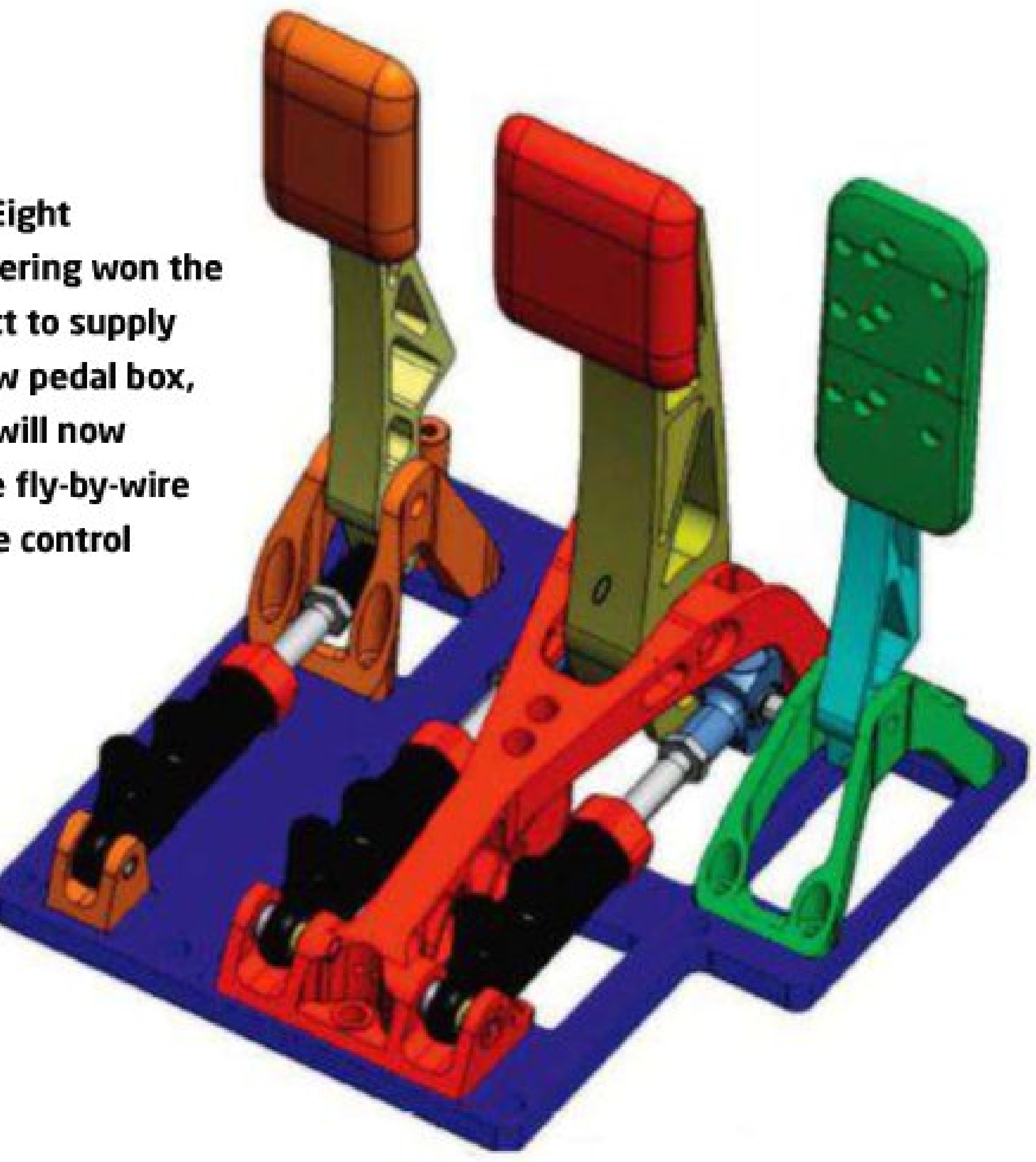
Also in the name of safety, the COTF sees the introduction of polycarbonate windscreens, while a NASCAR-style Woodward collapsible steering column has also been adopted.

SUSPENSION

Moving from a four-link live rear end to independent rear suspension is perhaps the clearest indication of V8 Supercars' intention to increase the market relevance of the cars. Triple Eight Race Engineering won the tender to develop the new units, complete with rear uprights, which see the wishbones bolt directly to the chassis rather than a rear subframe.



The cars will utilise elements of the factory inner and outer chassis rails, with a simplified spec chromoly rollcage from prototype constructor, Pace Innovations



Triple Eight Engineering won the contract to supply the new pedal box, which will now feature fly-by-wire throttle control

Although the final designs are yet to be locked in, the new rear uprights are expected to be a slightly larger evolution of those used with the current rear end, while the rear anti-roll bar will remain an avenue for differentiation, despite initially been tabled as a control item.

The decision to carry over the current double wishbone front suspension remains a subject of debate, with freedom allowed in the design and layout of the detachable front crossmember, uprights, anti-roll bars, control arms and pick-up points potentially leading to a spending spree as teams adapt their current solutions around the new car.

'There will be a lot of design work for the teams to do in the front of the cars,' says Ford Performance Racing technical director, Campbell Little. 'For the engineers, the rear end will just be about tweaking roll centres and anti-squat, but at the front everybody has their own way of making front uprights and steering racks that'll need further development in the new car.

'There's no doubt the COTF will greatly reduce build costs and be a big step forward for the category, but right now we're champing at the bit to get the final designs to see where we need to focus our attention.'

According to Dumarski, modifications to both the front suspension and steering systems can be largely controlled by requiring the cars to pass scrutineering fitted with the old 17-inch wheel (after the brake assembly is removed), while elements of the current steering packages, which vary between front steer and rear steer, may go through a homologation process. 'Redundancy is a big topic at the moment with the series, because the inventory is going to change quite a lot, but we will carry over as many front suspension and steering components as possible.'

> “well thought out regulations that fit the evolution not revolution criteria”

GEARBOX

The six-speed sequential transaxle unit, sourced from Australian company Albins, has been one of the major talking points of the COTF, and not just because of the delays associated with its adoption.

Albins specialises in the design and manufacture of racing transaxles. It is well known for its range of top level off-road racing teams, but is not a regular sight in international circuit racing classes.

Drivers such as Todd Kelly (who is also a co-owner of Jack Daniel's Racing) are looking forward to the weight distribution benefits of the transaxle, which will combine with a targeted reduction in overall vehicle mass of around 100kg (220lb) to 1250kg (2756lb). 'Everyone has had an open mind right from the beginning of the design phase with this car, and moving to a transaxle is absolutely the right move for improving the way the cars handle,' says Kelly.

'With the weight changes, on top of moving to a bigger wheel and a smaller sidewall [control Dunlop] tyre, it should make the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The entire COTF chassis, save for the aforementioned rails and body side inner and rear parcel shelf, is a bespoke design, to which custom-made body panels representing the new manufacturers' cars can be added easily

The current carbon / Kevlar front splitters and adjustable rear wings which be retained for the time being, keeping downforce and drag levels at a similar level to the current cars, and the aero balance the same at around 53 per cent

things really trick to drive.'

Despite the move to a transaxle, the clutch remains located in the back of the engine, while the use of a full spool in the differential continues.

Gear shift is via a rod attached to the gear lever within the cabin. Gear position is detected by a rotary potentiometer on the gearbox and displayed on the dash for the driver.

There are a set of gears at the front of the transmission that can be easily changed to achieve different overall transmission ratios for individual circuits, leaving all of the other gears, including the final drive fixed. The incorporation of this feature means a reduction in the amount of spare components the teams require, as well as the reduced labour in changing the gears. Other features incorporated into the design include inspection ports that are located throughout the gearbox. Removing the plugs and fittings from these ports will enable the teams to inspect the condition of the final drive, gears and engagement dogs between events (or races) to give greater confidence of the condition of the components without the need for full disassembly.

> **"moving to a transaxle is absolutely the right move for improving the way the cars handle"**

ENGINE

The engine regulations have remained largely unchanged since their introduction in 1993, save for a stream of cost-saving initiatives surrounding minimum weights and control items (notably the ECU and camshaft), and the substitution of blocks and cylinder heads for availability reasons. And having originally tabled an AU$50,000 (£32,000 / US$52,500) target for a COTF powerplant, details of V8 Supercars' new engine programme have been kept largely under wraps at the present time.

The current 5.0-litre pushrod Ford Boss 302 and Chevrolet Aurora motors feature cast iron blocks, aluminium cylinder heads and produce around 640bhp with a 10.1:1 compression ratio and 7500rpm rev limit. The approximated cost for a complete unit is AU$80,000-AU$120,000 (£51,000-£76,500 / US$83,500-US$121,000).

With avoiding large scale inventory changes a key consideration, the two existing motors are set to continue on in a slightly de-tuned specification (potentially losing 50-80bhp), and be joined by a V8 Supercars-branded 'common engine'. Currently being developed by experienced V8 Supercars engine builder, Craig Haysted, the new engine will provide a cost-effective option for a new manufacturer that wishes to slot into the class, as well as catering for existing teams without manufacturer support.

It is likely to feature similar specifications to the existing units, while V8 Supercars is also working hard on an engine equalisation programme to allow new manufacturers to enter with their own V8s. 'It's important that a new manufacturer can bring in their own engine and adapt it to our rules without hurting the balance between the current competitors,' says Dumarski.

Currently running MoTeC's M800 as a control ECU, the COTF features the Australian electronics firm's newer and more powerful M190 model, as well as its power distribution module and ADL3 data logger / driver display.

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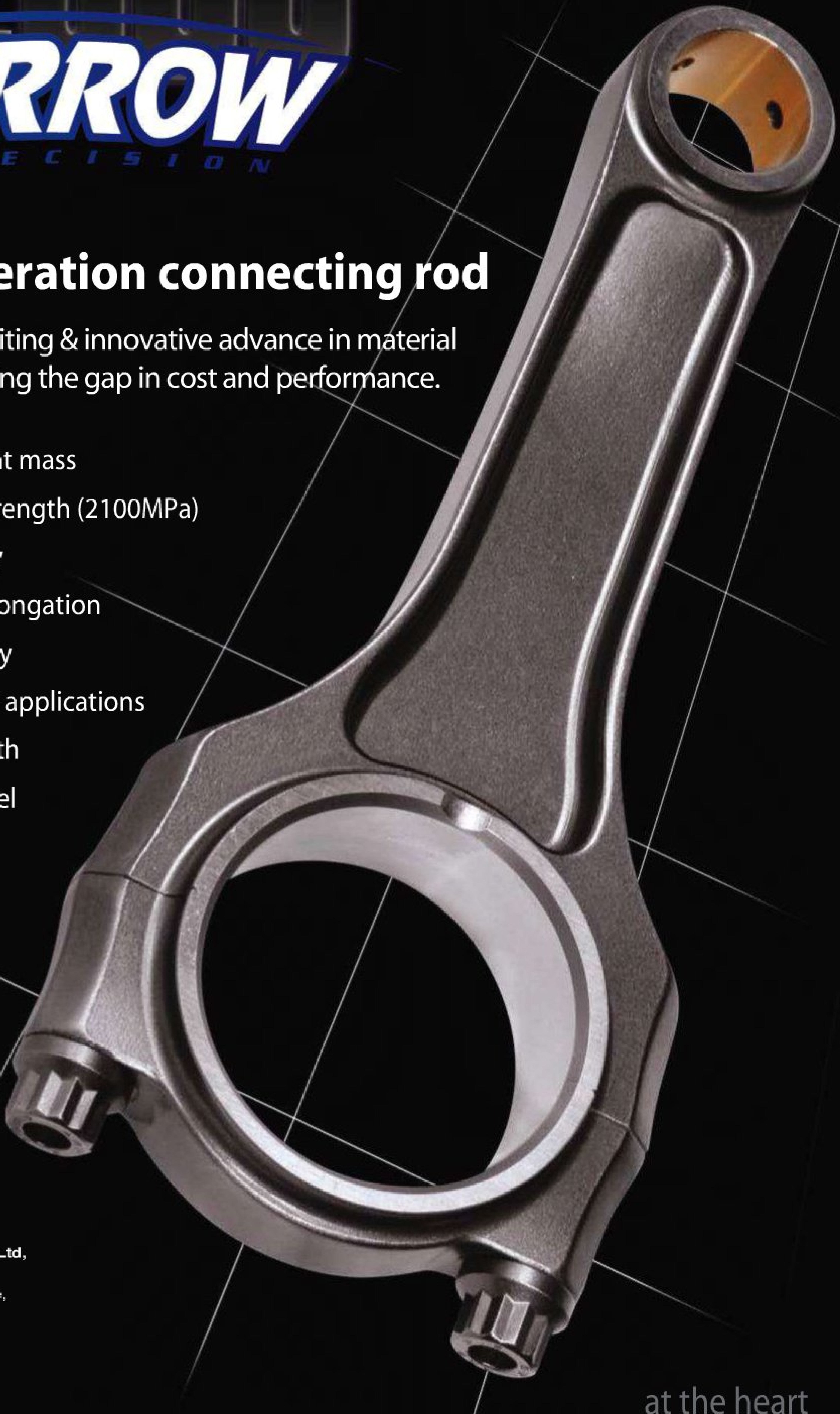

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With no high-end wind tunnels in Australia, the COTF will undergo open-air testing, with comparisons of the different body styles pencilled in for early 2012

The major electrical changes include a move to fly-by-wire throttle and coil ignition systems, while several new features are currently being programmed into the ECU, including a 'push-to-pass' mode that, whilst looking unlikely to be rolled out in the short term, may become a feature of the series in the longer term.

A central data system similar to that currently seen in Formula 1 is also in the process of being developed for the series.

BRAKES

The COTF's revised racing debut coincides with the end of the current brake package contract, which sees cast iron Alcon discs matched with Alcon calipers and a choice of five different pads (two front, three rear).

While a move to carbon-ceramic discs is being considered in order to improve overtaking potential in traffic, the final brake specification is unlikely to be determined until after the thermal capacity of the cast-iron set up is assessed while running inside the 18-inch wheel.

Triple Eight Engineering won the contract to supply the pedal box. While it is a complete re-design over that of the current cars, the Alcon master cylinders and balance bars are carry-overs. As Triple Eight is producing large quantities, machining time savings and the size of the raw materials order translate to cost savings that are passed onto the teams with the price of the COTF pedal box a lot less than the current spec arrangements. The move to fly-by-wire throttle control makes the use of mechanical linkages between the throttle and the engine obsolete.

AERODYNAMICS

While mid-season tweaks to splitter lengths and Gurney flaps were commonplace in the first decade of V8 Supercars, aerodynamic parity arguments have largely evaporated in recent years, due to the increasingly thorough nature of the homologation process.

Downforce is likely to be kept at today's levels, with the combination of carbon / Kevlar blend front splitters and the adjustable rear wings currently generating 380kgf of total downforce and 290kgf of drag at 240km/h, with an aero balance of 53 per cent.

As Australia does not possess the high-end wind tunnel technology seen elsewhere in the world, V8 Supercars will continue to use open-air tests for the COTF, and has pencilled in an initial comparison of the new Falcon and Commodore body shapes for early 2012.

With teams itching to receive design specifications in order to start building the new cars, and fans eagerly awaiting the announcement of the sport's newest manufacturer, Skaife is confident that the COTF programme will help propel V8 Supercars even further into the international spotlight over the years to come. 'In the history of this sport we've never applied as much effort as what we have on the Car of the Future,' says Skaife. 'We want to be as good as, if not the best, Touring Car product in the world, and this car absolutely suits that objective.'

Racecar would like to thank Speedcafe for its help

> “We want to be as good as, if not the best, Touring Car product in the world”

TECH SPEC

V8 Supercar Of The Future

Class: V8 Supercars 2013

Chassis: tubular steel frame by Pace Innovations with chromoly rollcage

Transmission: Albins six-speed sequential transaxle

Electronics: MoTeC M190 ECU with ADL3 data system

Suspension: double wishbone (front), double wishbone independent (rear)

Engine: Ford and Holden V8; details TBC

Price: target AU$250,000

Kiwi connection

Essentially a cut-price version of the V8 Supercar, the V8SuperTourer uses many off-the-shelf components, including a Chevy LS7 V8 and a 9-inch axle

Visual similarities to the V8 Supercar are obvious, though the target price of AU$140,000 is over AU$100,000 lower than that of the Australian version

V8 Supercars' Car of the Future isn't the only 'next generation' Touring Car set to make its mark on the Australasian motor racing landscape. New Zealand is also currently bracing itself for the arrival of a new category, dubbed V8SuperTourers, which, like the V8 Supercars, will feature a Pace Innovations-designed control chassis that is able to be fitted with a variety of body panels.

The vision of three team owners from the country's existing NZV8 Championship – Mark Petch, Wayne Anderson and Garry Pedersen – the V8SuperTourer is effectively a cut-price version of the new V8 Supercar, with a control 7.0-litre Chevrolet LS7 engine the biggest point of difference. A Holden Commodore VE-bodied prototype is currently being used for development testing prior to the start of the class' inaugural seven-round series next March.

'The New Zealand car has been a very different project to the V8 Supercar,' says Paul Ceprnich, owner of Pace Innovations. 'The V8SuperTourer is a different car for a different market. It's a much simpler car that uses a lot of off-the-shelf equipment in order to keep the costs as low as possible.'

The all-alloy, fuel-injected motors will arrive in New Zealand direct from the GM Performance Build Center in Michigan, USA, and produce an estimated 575bhp. The organisers of the series claim the engines will cost approximately AU$13,500 (£8550 / $14,130) each, helping to keep the total outlay for a complete (but unbuilt) car down to the AU$140,000 (£88,750 / $146,500) target.

A conventionally mounted Quaife (QBE69G) six-speed sequential gearbox will deliver the power to a nine-inch axle, which features a Torsen-style limited slip differential.

The car's suspension consists of a control double wishbone set up attached to an integral (rather than bolt-on, as is the case with the COTF) front subframe, matched with a three-link live rear end. The fuel tank is mounted behind the rear axle centreline, as in the current V8 Supercars, while a G4 Xtreme from Link Engine Management Systems has been chosen over the more expensive MoTeC unit.

According to Mark Skaife, sharing technical regulations between the Australian and New Zealand cars was not possible. 'I would have liked them to be on board with our plan, and at various levels we had discussed this because it makes sense from a practical and overall industry point of view... For two countries to be so close and not have linked regulations has been something that's been difficult to understand, but from where they were, getting to our level was a very big jump for them.'

Sixteen cars will take part in the inaugural V8SuperTourer series, with V8 Supercars' star, Greg Murphy, set to join a field of mainly ex-NZV8 racers.

TECH SPEC

V8SuperTourer

- **Class:** V8 Super Touring Cars
- **Chassis:** tubular steel frame by Pace Innovations with chromoly rollcage
- **Transmission:** Quaife six-speed sequential
- **Electronics:** Link EMS G4 Xtreme ECU
- **Suspension:** double wishbone (front), three link nine-inch live axle (rear)
- **Engine:** GM Performance 7.0-litre, all alloy LS7 V8; 575bhp at 6200rpm
- **Price:** target AU$140,000

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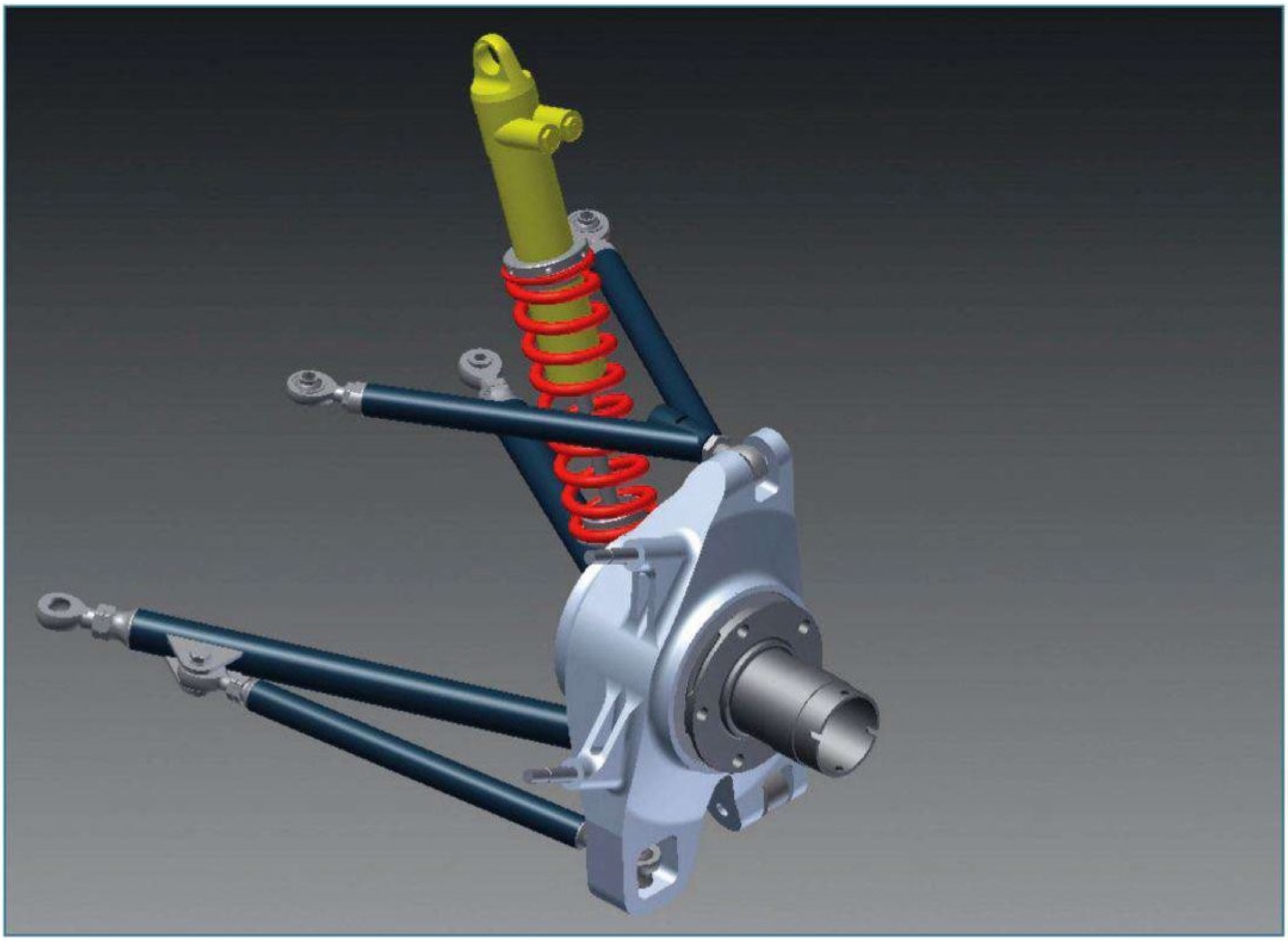
Greg Murphy gets his first taste of the New Zealand Car of Tomorrow, based on the Australian Car of the Future, but cheaper.



A brave new world

There's trouble brewing for the engineers in Australian V8 Supercars...

BY DANNY NOWLAN

It's not often I get to comment on what's going in my own backyard but I can tell you right now there are some rumblings in Australian motorsport. After over a decade of relative technical stability, the V8 Supercar formula is about to undergo the most radical technical transformation in its history. The introduction of the Car Of The Future is going to pose some serious technical challenges to all the teams, and it's going to be very interesting to see how the teams respond. The biggest change of all is the elimination of the live axle rear end, and its replacement with an independent, transaxle rear end. Make no mistake, this will really throw the proverbial cat amongst the pigeons.

Let me just state in advance that in this article I'm taking the role of Devil's advocate. I actually think V8 Supercars progressing to an independent rear end is an exciting change to the formula, but it's a change about which I think everyone involved is now starting to appreciate the ramifications. To understand why this is so much of a change, we need to understand the rear suspension geometry of a V8 Supercar. Currently, the teams are using a live axle, supported longitudinally by two semi-parallel links and laterally by a Watt's link. To illustrate this, consider the schematic, figure 1.

The disadvantage of a live axle is that both wheels are connected together, so grip is degraded as the car goes over bumps. And Australia has some very bumpy circuits! I'm perhaps in a unique position to quantify this because I've done road surface profiles for circuits over three continents, and can state categorically that Australian circuits are definitely the bumpiest.

The big thing that the current V8 Supercar rear end has going for it is that the roll and pitch properties are disconnected and easy to adjust. This pops out in two seconds flat when you do a free body diagram analysis of what the suspension is doing, both laterally and longitudinally. I actually wrote about this at length in one of my earlier articles for *Racecar Engineering* where I discussed how you could use the location of the longitudinal arms of a V8 Supercar to tune understeer and oversteer. To briefly re-cap, to adjust the lateral properties you simply move the Watt's link up and down, while to change the pitch centre you move the longitudinal arms up and down – a very straightforward job for a skilled mechanic.

You, the reader, might be thinking, 'well, so what?' I can tell you right now this ability to tune the car is vital. The reason is because, in its current form, a V8 Supercar is a very odd racecar, for the following reasons:

- **The car is heavy (1500kg / 3307lb), with a high c of g (about 0.45m)**
- **The horsepower is in the**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What all this translates to is a racecar with wheel rates that are lower than some high performance road cars (we are talking 50-80N/mm) and roll centres typically between 80-120mm at the front and 200-270mm at the rear.

The implication of all this is that while the live axle rear end is not technically ideal, it is easy to tune. What's more, you can make some pretty big changes during the middle of a session and achieve a great deal, allowing a race engineer to quickly arrive at a good, fast set up.

In contrast, the proposed independent rear end is nowhere near as user friendly. To understand this, let's consider a double wishbone rear end, as illustrated in figure 2.

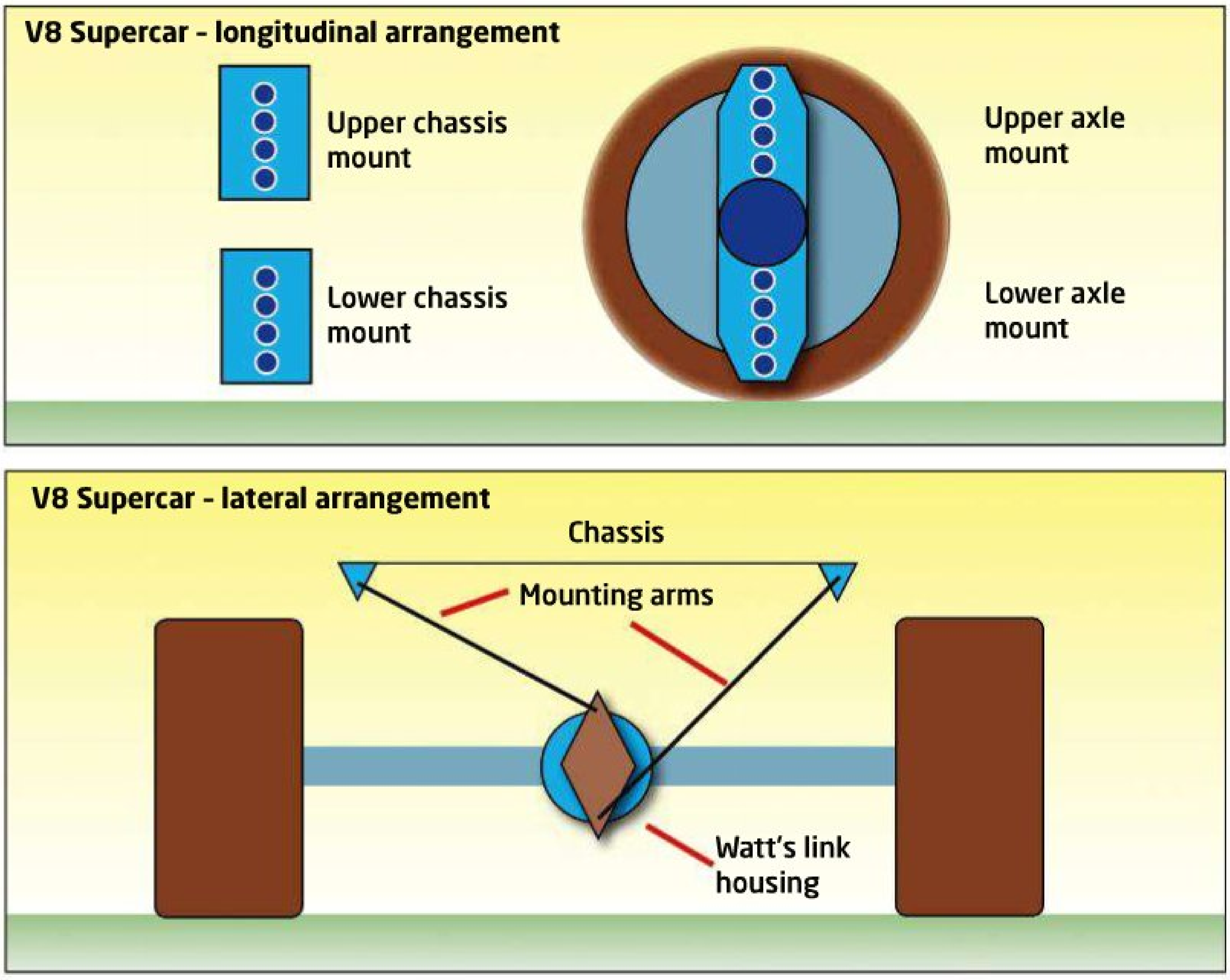

Figure 1: schematic of the rear end of a current V8 Supercar

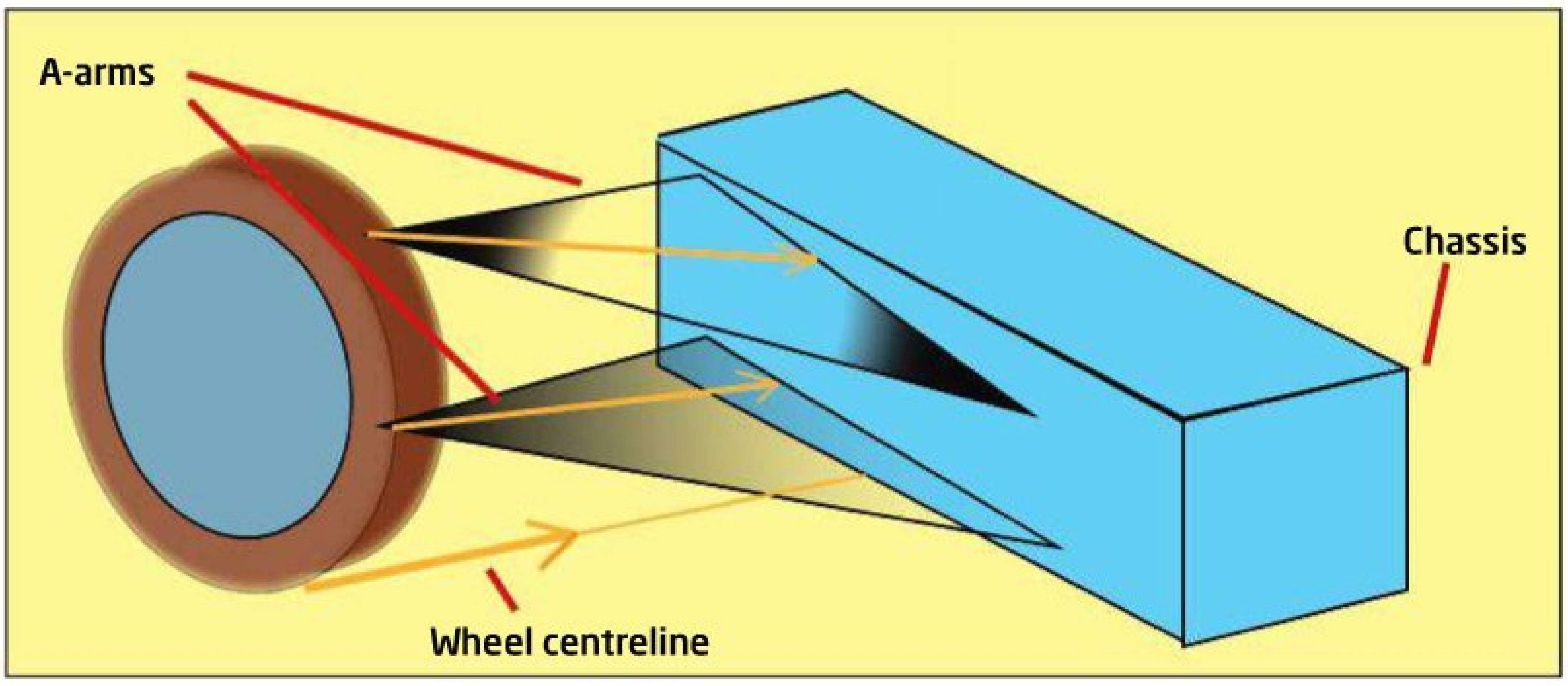

Figure 2: the proposed double wishbone rear end

INDEPENDENT THINKING

As with the live axle, the parameters of a double wishbone suspension are adjustable, but in practice it is nowhere near as user friendly. For example, if you want to make a roll centre change on a double wishbone suspension you have two options. The first is to put spacers on the hub, but that doesn't offer the range of adjustment that the current Watt's link roll centre arrangement offers. And, while this might be okay in practice, you can forget about doing this in a pit stop during a race. The other option is to change the inner pick-up points, but again there is no way you can do that during a session. These are the only ways you can adjust the pitch centre properties. What all this means is that it is going to take significantly longer to sort out the set up, and I for one feel there will be much heartache in the meantime.

The other thing that really throws the joker in the pack is that live axles and independent rear ends transfer their loads in different ways. To illustrate this, consider a live axle with a Watt's link, as shown in figure 3.

When a lateral force is applied, due to the nature of the Watt's link, the load effects due to suspension geometry will be equal and opposite. This becomes immediately obvious when you do a free body diagram. In contrast, an independent rear end transfers its weight in a fundamentally different way. To illustrate this, consider the diagram of force application points for an independent rear end, as shown in figure 4.

As you can see, as the lateral load transfer goes up, the load transfer due to suspension geometry effects will not be equal and opposite. Due to the nature of force application points, it gets pinned on the outside rear tyre, which has massive implications for tyre loading / heating and your eventual set up.

My personal take is that, given the nature of these cars, the teams will eventually have to move to various versions of multi-link arrangements. This will become particularly apparent if they carry on with a locked rear differential. There's an old adage in motorsport that says once something has been learnt it can't be un-learnt and many teams will, I'm sure, be left pining for the adjustments they used to have. I would also anticipate that, if the rear suspension geometry is free, the direction most teams may move is to have radius rods that act either purely laterally or purely longitudinally. Structurally, the longitudinal radius rods should be easy to implement but a lateral radius rods and hub design could take a lot of work. And we haven't even talked about possible implications for the transmission housings etc.

This all being said, I have heard multiple rumours that a double wishbone rear end has been mandated with a low rear roll centre. The other rumour I have heard is that there is

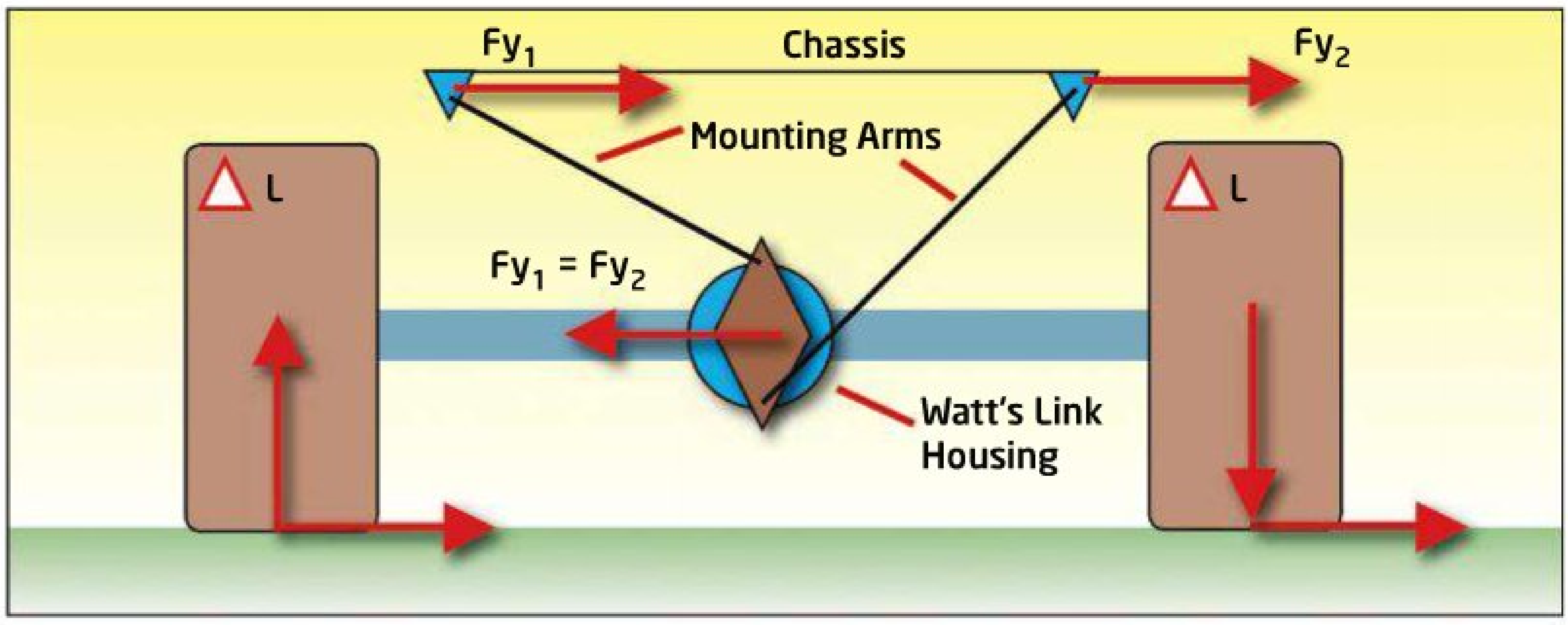

Figure 3: roll centre in the Watt's link live axle

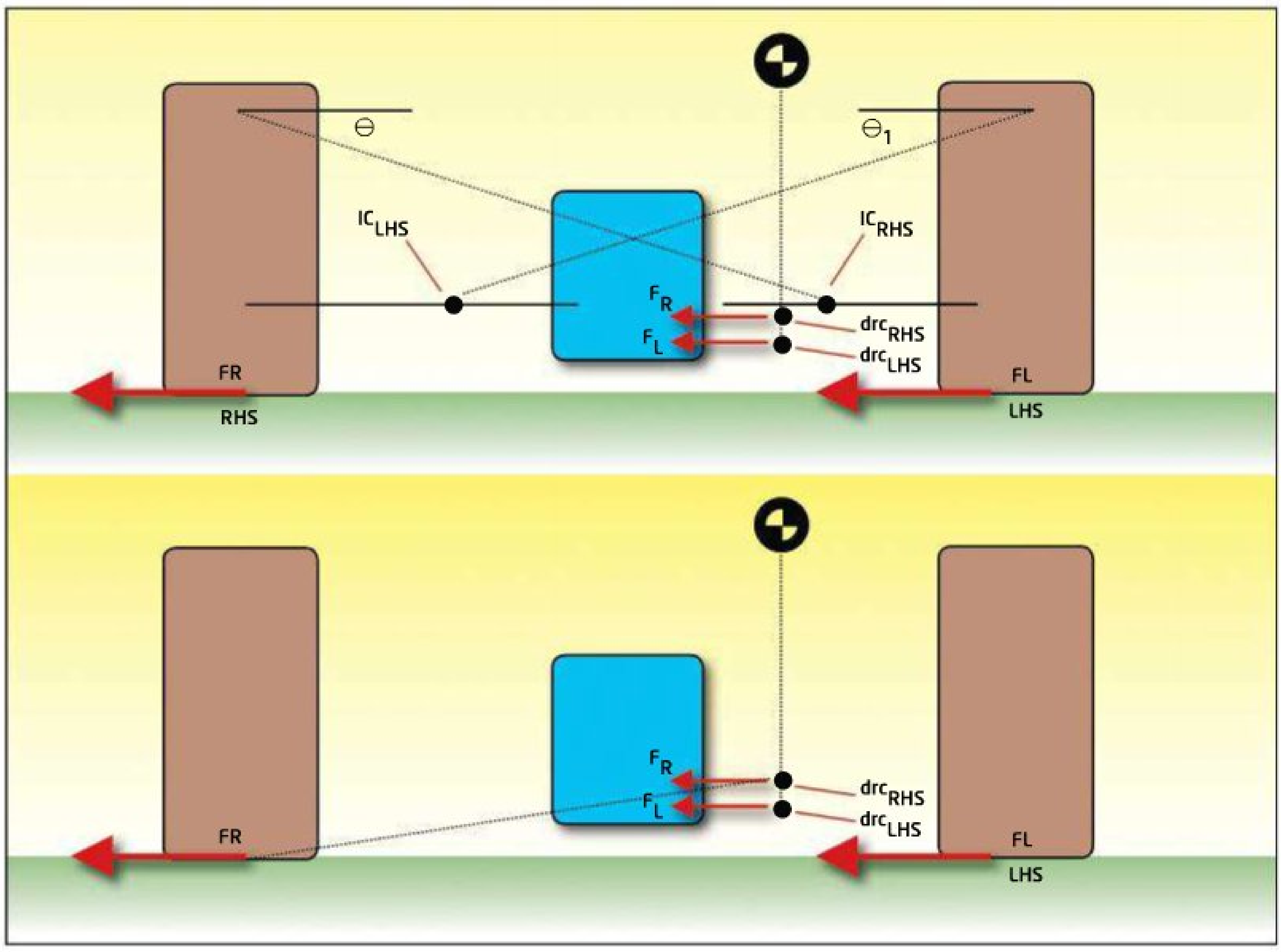

Figure 4: load transfer in an independent rear end

Table 1: typical V8 Supercar set up

Parameter	Value
Front roll centre	100mm
Rear roll centre	240mm
Front wheel rate	60N/mm
Rear wheel rate	60N/mm
Front bar wheel rate	40N/mm
Rear bar wheel rate	10N/mm
Front track / rear track	1.6m / 1.6m
Front tyre spring rate	305/mm
Rear tyre spring rate	305/mm
c of g height	0.45m

significant adjustability. If the relevant people reading this could clarify that I would welcome them to do so. Nevertheless, I think it is worth the exercise to walk through the implications of dropping the rear roll centre significantly, so let's consider a typical V8 Supercar set up, as shown in table 1.

A CASE IN POINT

To keep the discussion simple, I've made the tracks equal, so calculating the lateral load transfer at the front we come up with a figure of 48.3 per cent. I realise this borders on being a Mickey Mouse example, but bear with me. Let's just say for the sake of the argument that the rear roll centre on the new arrangement is 140mm, and that we are going to recover that with rear bar. So, to keep our lateral load transfer at 48.3 per cent, the rear bar rate is going to need to be approximately 50N/mm.

If the compound of the tyre isn't changed significantly, this is going to pose a major handling problem. In its current configuration, when a V8 Supercar is going over a bump, the wheel rate the tyre sees is the sum of the bar rate and the spring rate. Currently, this is in the order of 70N/mm. With our proposed rear end with a roll centre of 140mm, as we traverse bumps the effective wheel rate will be in the order of 110N/mm. I can tell you from practical experience that this is a really bad idea with a contemporary V8 Supercar, as with the current tyres these wheel rates simply won't work. I'm not trying to be a naysayer here, just that if the compound isn't changed significantly then life is about to get very interesting for V8 Supercar engineers / drivers.

My personal take is if the compound is the same and they have the ability to tune for high roll centres then I would expect (in terms of rough numbers) the roll centre to drop about 40mm from where they are now. I haven't done any serious numbers yet but, given the differences in how independent and live axle suspensions work, this is where I feel the numbers will work out to, though I could be wrong.

In conclusion, I want to state that if you're designing a racecar from a blank sheet of paper, an independent rear end is a *fait accompli*. However, what I'm presenting is the worst case analysis of what the teams can expect as they move from something they know well to something that is new to them.

In summing up, we are about to see a massive change to the V8 Supercar formula. And given everything we have discussed here, this is a change that the Supercar community is only just starting to appreciate. What's sure is that we are going to be in for a fascinating season, and I for one am looking forward to seeing how the teams respond to it. We live in interesting times.

> **"teams will eventually have to move to multi-link arrangements"**


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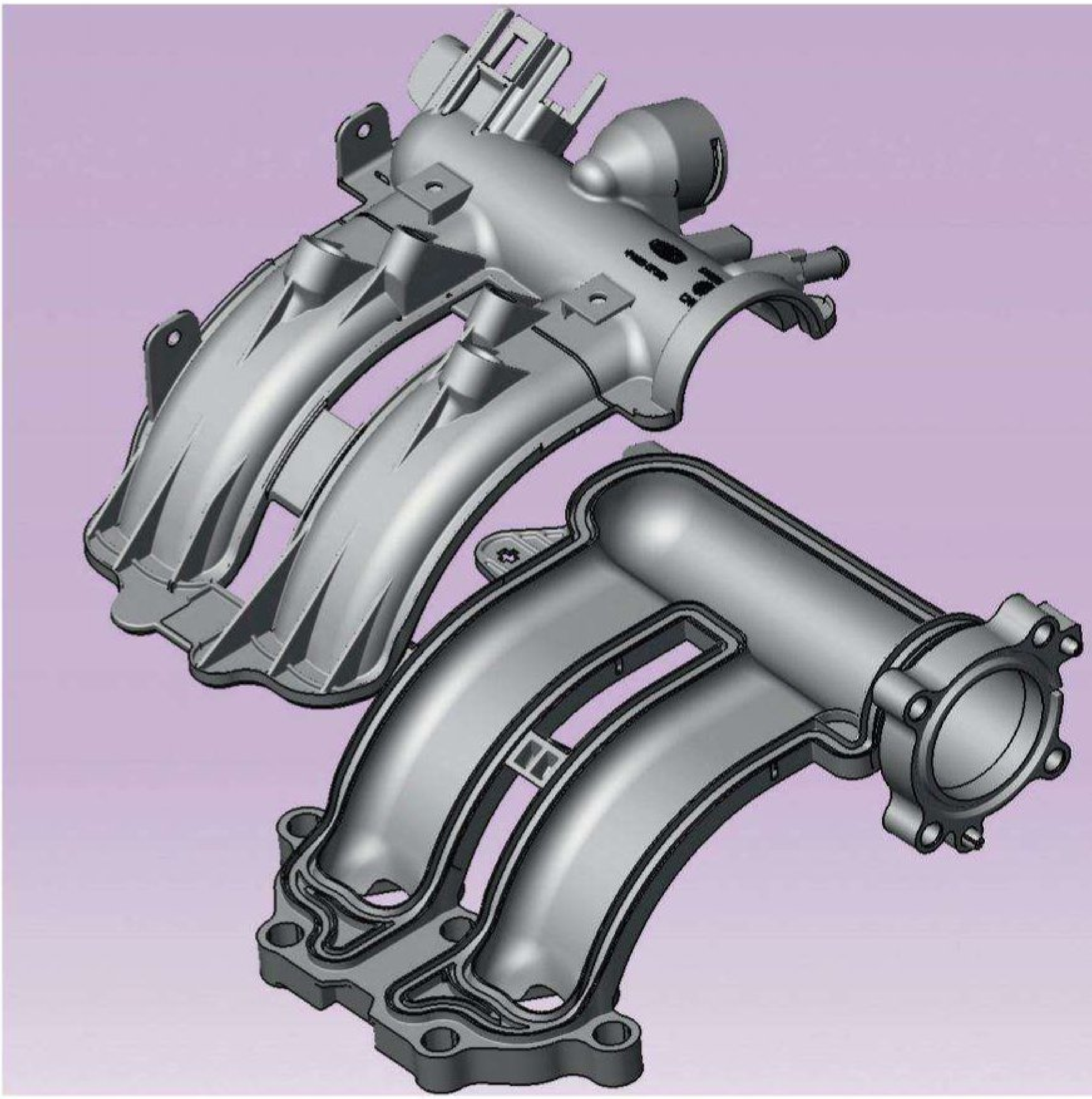
Leakdown testing

Using modern technology to improve the production process

This is the first in a new occasional series following the development of a single component from concept to production.

Best known for its work in Formula 1 rapid manufacturing, CRP Technology has partnered with Magneti Marelli on the development of a new manifold for the latest generation of two cylinder competition engines.

The prototype manifold was composed of two single injection moulded parts made of glass-reinforced nylon (PA66-GF35), joined by vibration welding. Extensive testing of the component was undertaken and some issues were found, including during pressure testing a potential weld quality issue that only made itself known at a higher test pressure than was required by the customer. Examination of failed manifolds showed an uneven weld seam that would have created potential reliability issues. This conclusion is based on the years of experience at Magneti Marelli in the field of plastic air induction manifolds, and their high standard of production quality.



The subject of our investigation: a Magneti Marelli glass-reinforced nylon air induction manifold

TEST OF STRENGTH

As a result, it was decided to first do a comparative test of the strength of different weld seam areas. This was done in accordance with the standard Magneti Marelli procedures. It was decided that the tensile strength would be tested at 14 points along the weld seam to determine if there was a specific area, or areas, contributing to the issue.

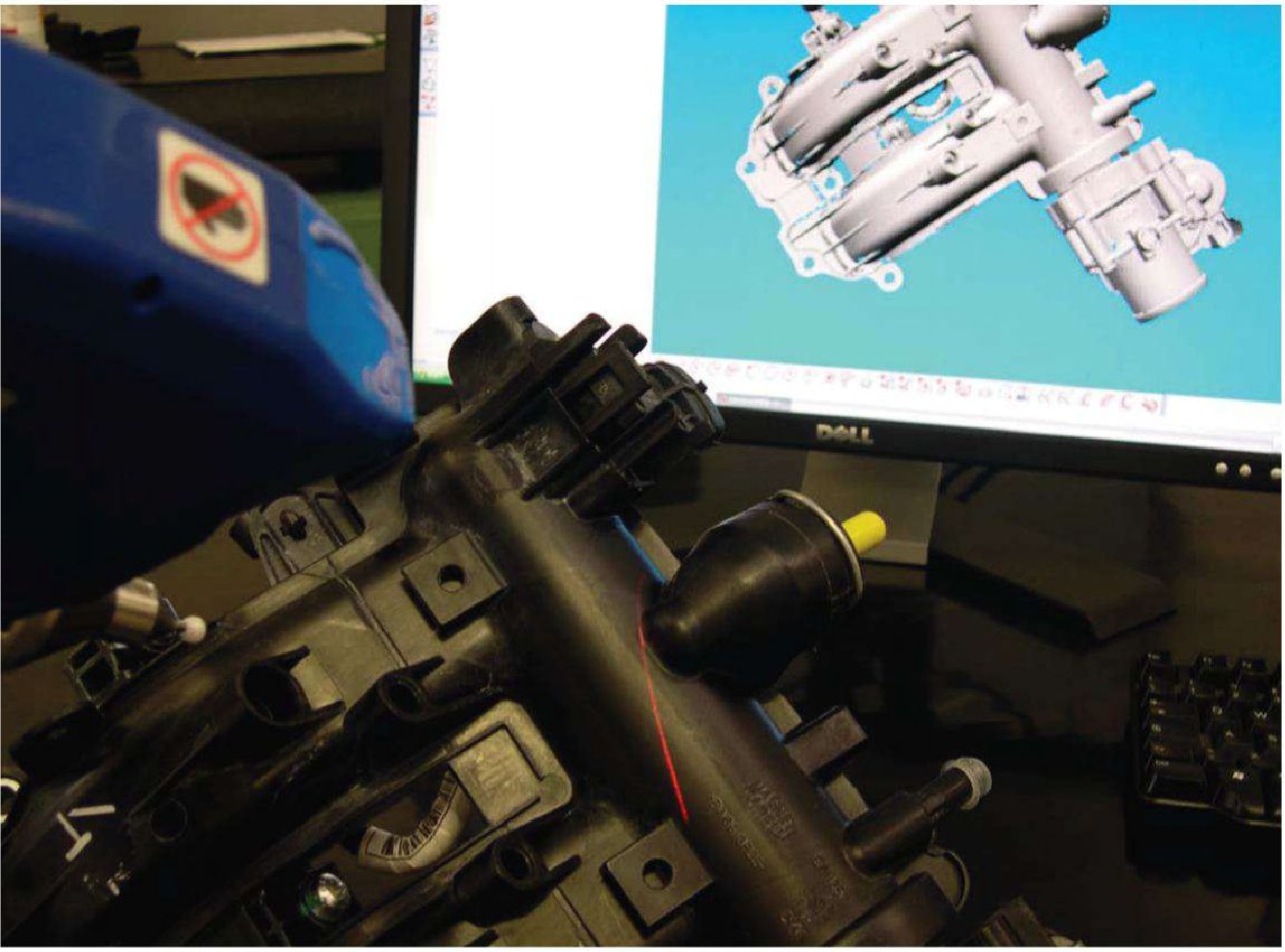
It was discovered that both manifolds appeared to have the same issue, which was put down to part warpage. The failure to create a homogeneous weld and the presence of excessive stress in some areas of the welded seam reduced the strength of the product. The result was the part would perform under normal operating pressure, but tests indicated the weld strength was below the engineered values expected, and that the warping in some areas directly affected the strength of the welding seam.

The 3D models were reverse engineered with assistance provided by CRP Technology. This allowed the surfaces of the parts to be measured and compared with the original CAD model. A comparison report was then generated that showed the differences in dimensions due to the production process.

This procedure was utilised because the dimensional shrinkage and warpage that can be generated in the moulded part during the cooling phase are difficult to measure with standard manual measurement equipment.

Two parts were digitalised using an optical scanning system mounted on a seven-axis measuring machine. The combined use of this machine and a laser scanning system allowed optical scanning to take place simultaneously inside the same reference system.

The scan consisted of seven million points (a traditional coordinate measuring machine is able to detect a few hundred points on an object). These are often located on different sections than those previously chosen. These 3D point locations may lack enough data to allow all surfaces to be accurately represented. A perfect example being the kind of surface



With the problem traced to the vibration welding process, a new methodology and production process was put into place to solve it

distortion seen here, which may not be easily found utilising a limited point system to describe the geometry. Only through a more complete scanning method utilising laser technology can a true representation of the surface be generated.

COORDINATE ALIGNMENT

Once the scan is complete, the data must be aligned in the coordinate system of the original CAD models, which can be done via the following optional procedures:

1. Best fit: this method allows the comparison of the two files while leaving the coordinate systems unconstrained on the file being checked. The software can overlap the surfaces of the part file and those of the CAD model. This algorithm of alignment is useful to check the general correspondence of the original CAD part.

2. Datum system: this method is defined in two files (data file and reference file) with the same reference information (plains, axes, centres) that are considered fundamental for the mounting or the functioning of the part. The component is aligned according to the CAD model.

For this project, a best fit alignment method was chosen by the Magneti Marelli engineers and the 3D testing phase results provided an explanation for the initial pressure test findings. The two moulded parts were pushed together on the welding machine and the resultant deformation of the moulded parts created a gap, which in turn caused an incomplete weld. Examining all aspects of the moulded parts in a virtual environment makes is possible to concentrate the analysis in the areas of interest, resulting in a substantial time saving.

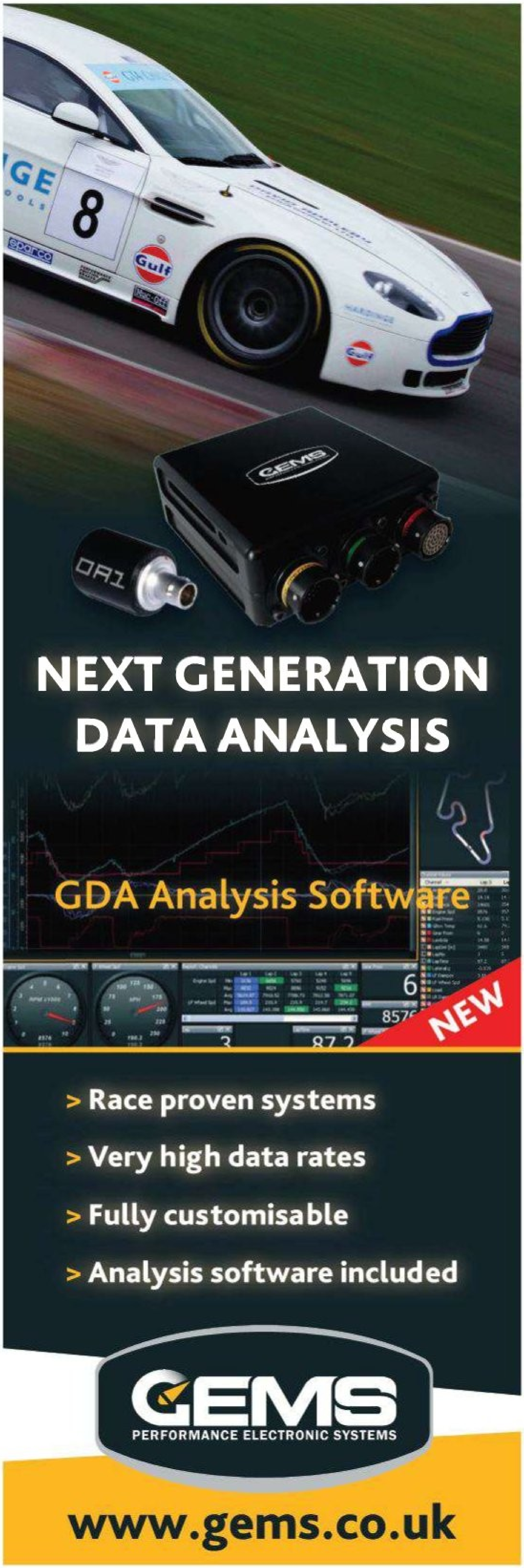
Once the 3D testing phase was given to CRP Technology, the deformation values of the moulded plastic pieces discovered by Magneti Marelli in the simulation were used to calibrate the model's reaction to adjustments in moulding parameters. The new simulation suggested improvements related to the process parameters and some operations on the mould.

RESOLVING THE ISSUE

New injection moulded parts were produced according to the adjustments suggested by the simulation results and the tests were all run again. With the new data obtained with the help of CRP, the issues were solved. The multi-disciplinary activity was an experience that allowed Magneti Marelli to introduce a new quality control methodology for the evaluation of weld lines and how to control potential part warpage in the future. In the past, the sole parameter of reference was the data generated from pressure testing, along with reference data provided by the customer.

With the welding process issues solved, the two manifold shells were given to CRP Technology for system testing, which included the manifold and the corresponding accessories (tubing, injectors and sensors). The aim of this secondary activity was to measure the part and check for possible mounting interferences inside the engine compartment. This check was carried out in a virtual (digital mock-up) environment.

Reverse engineering completes the CAD / CAE / CAM technologies and the design loop. The process is represented by the development of the concept, the design phase, engineering and production.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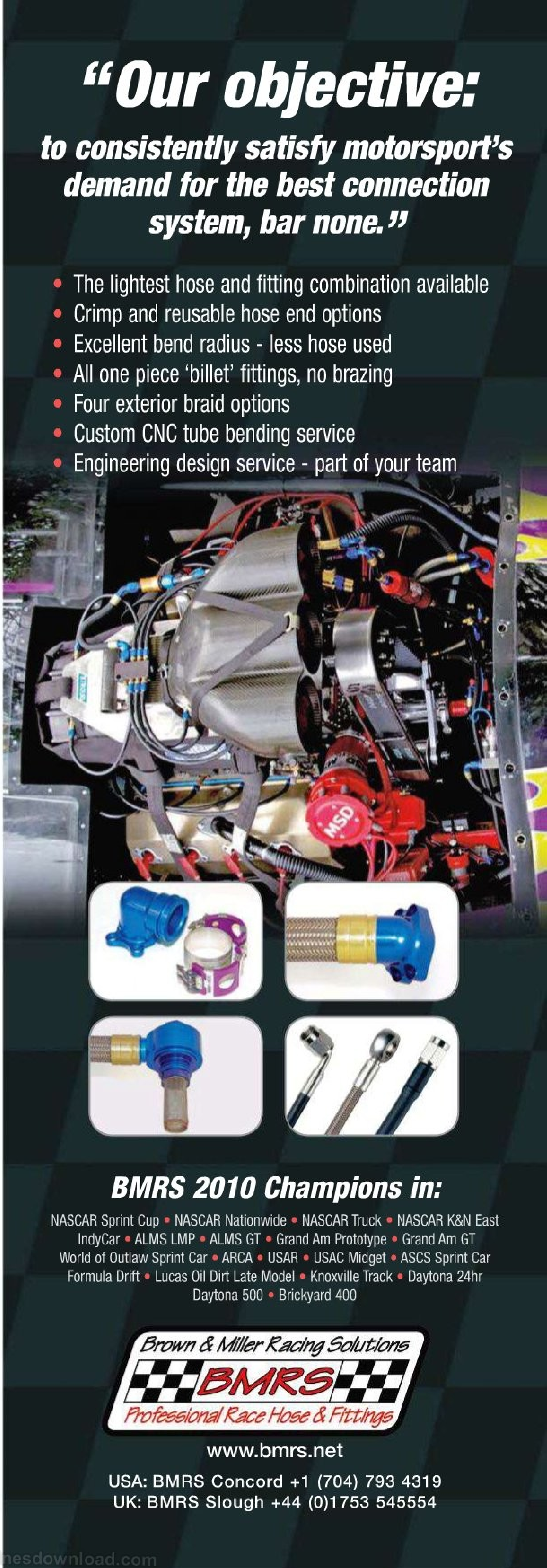
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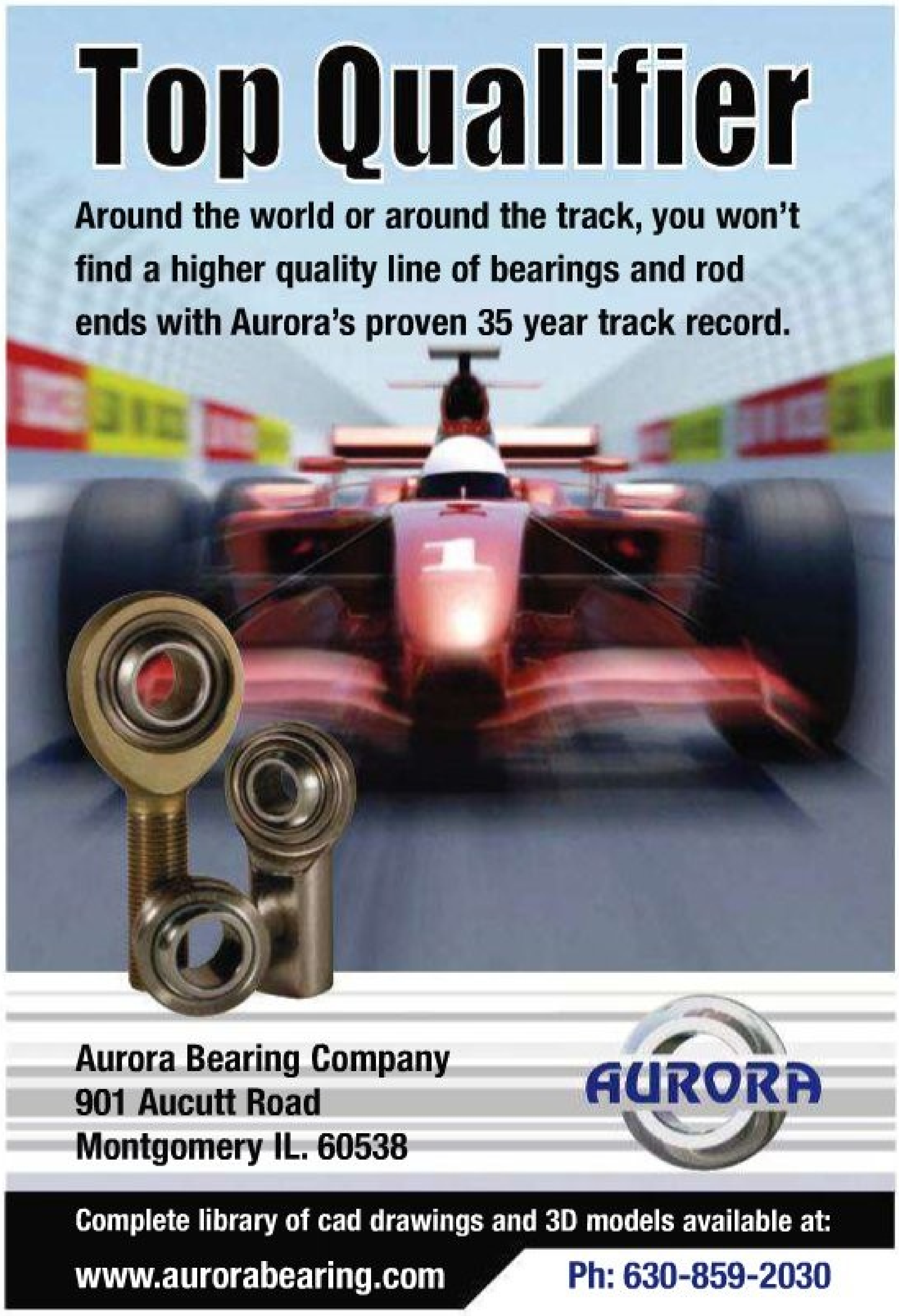
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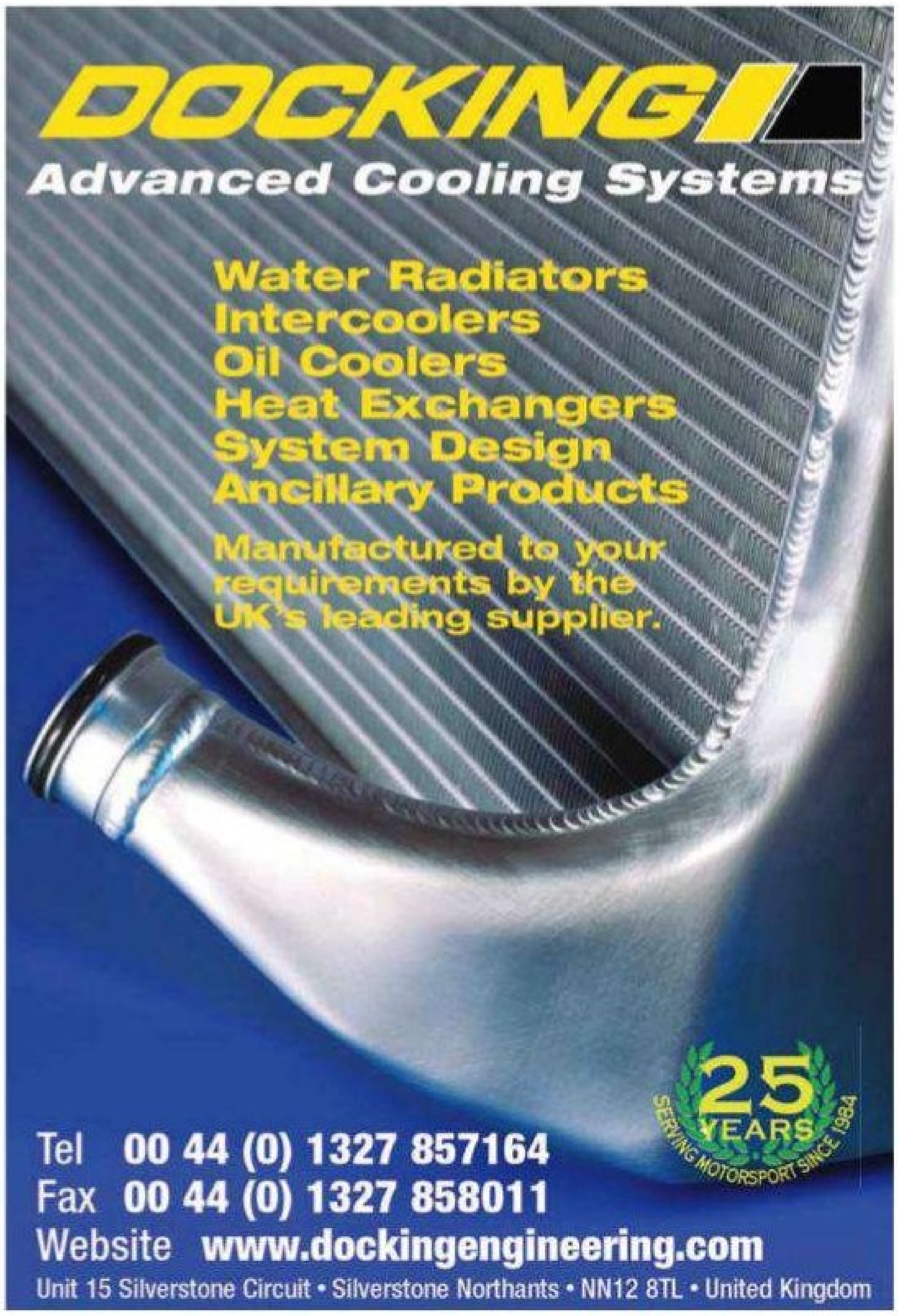
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Deal maker

Spec components are often accused of driving down the quality and value of parts. Xtrac believes its new Touring Car gearbox disproves the case

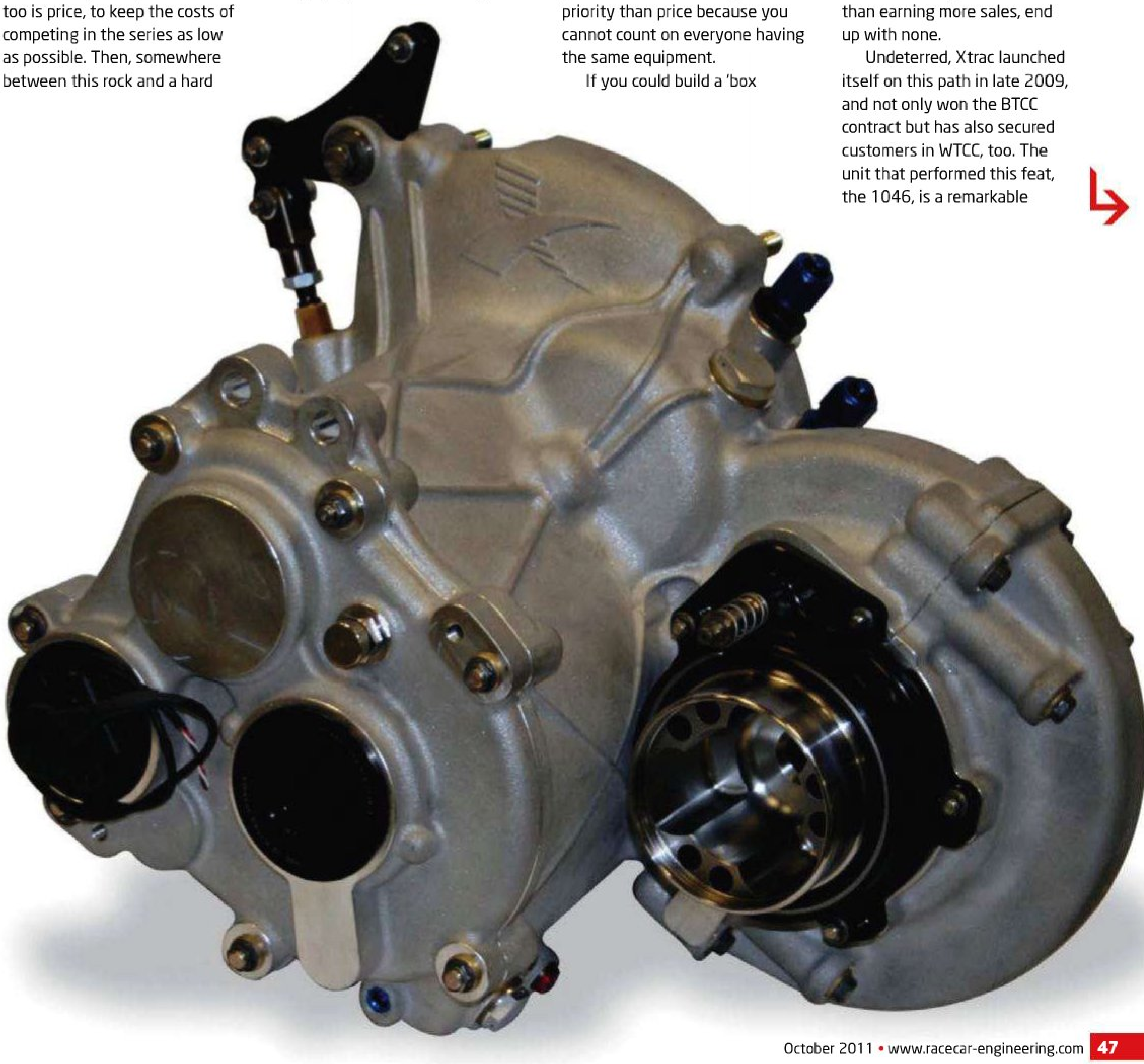
BY CHARLES ARMSTRONG-WILSON

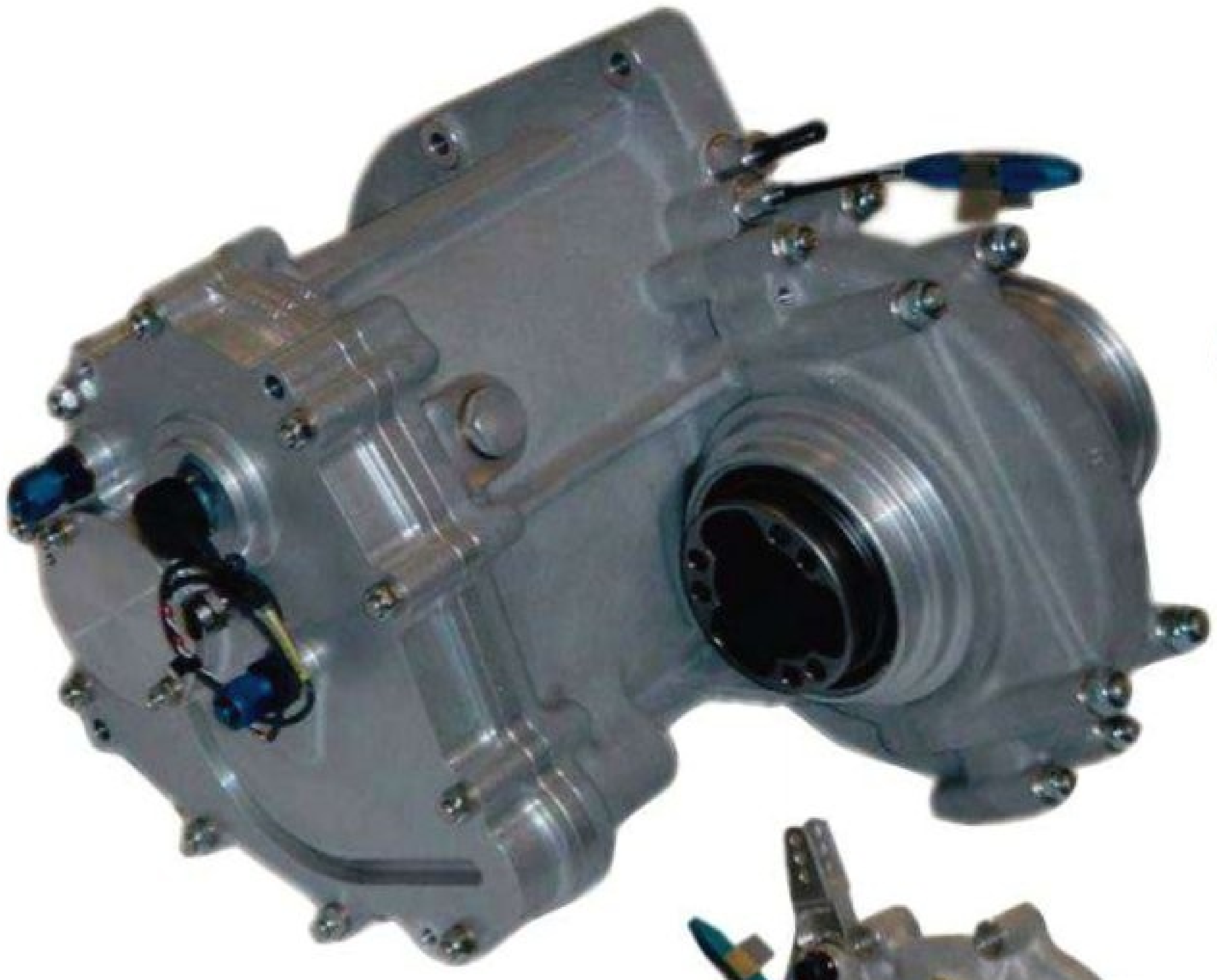
Mandated parts for race series always present a challenge to suppliers. When tendering for the contract, their proposal is always under pressure from three directions. Obviously, the product needs to be attractive to the organisers, so build quality and functionality is important. But so too is price, to keep the costs of competing in the series as low as possible. Then, somewhere between this rock and a hard place, the supplier needs to squeeze a profit margin or they could end up paying for the privilege of supplying the series.

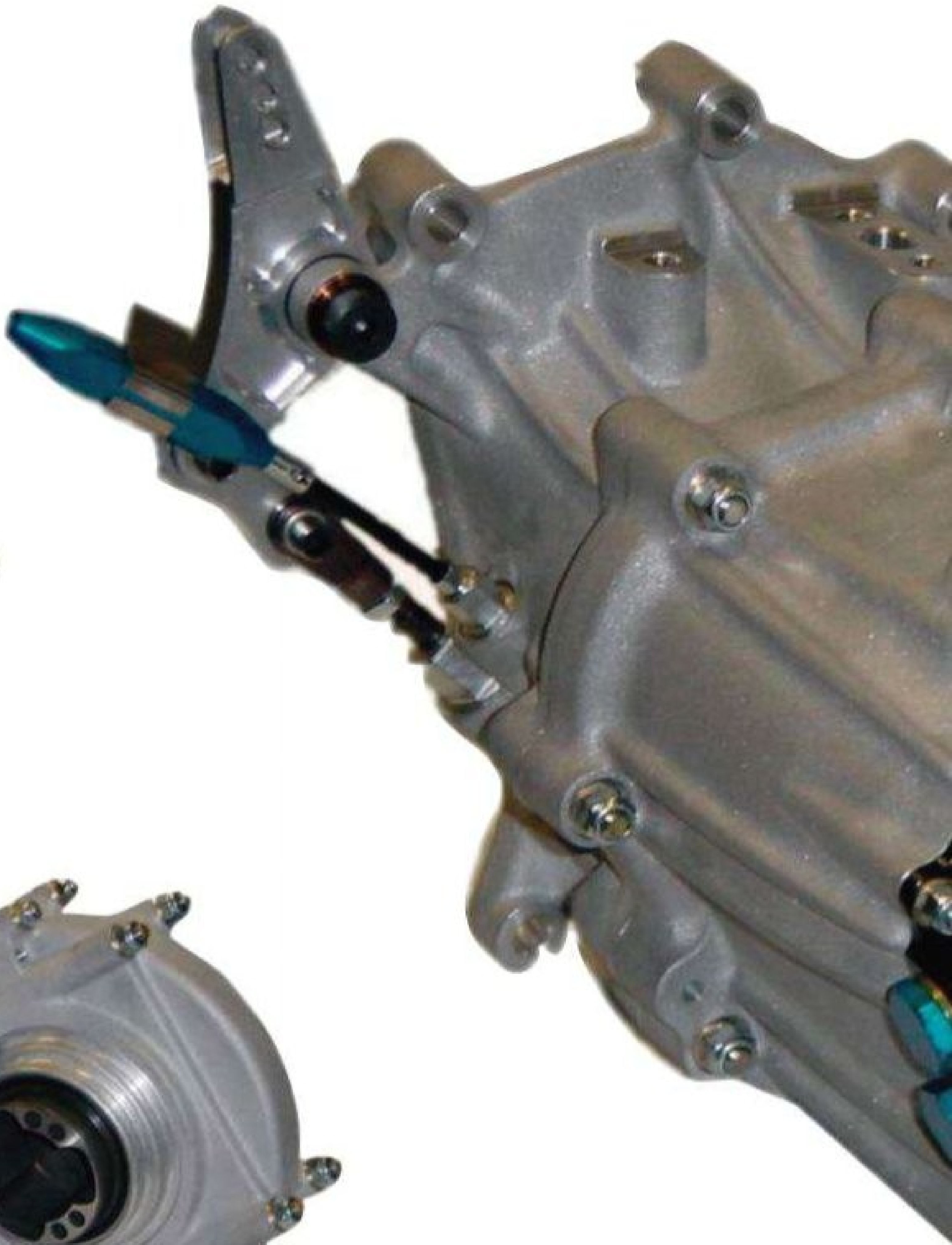
As if these demands were not enough, when Xtrac tendered for the British Touring Car gearbox contract, it also had an eye on supplying the World Touring Car series with the same product. Both championships were migrating toward a similar set of rules, with parity in engine power and torque offering the potential of more sales for the same design and tooling costs. There was a problem, however. In the WTCC, transmission supply is open to any manufacturer. This means performance takes a higher priority than price because you cannot count on everyone having the same equipment.

If you could build a 'box with greater functionality, better stiffness for the mandated weight or lower parasitic losses than the competition, then hopefully customers will beat a path to your door. With this in mind, trying to design a single unit to serve both markets could be a risky strategy. The worst-case scenario would be to miss all the targets and, rather than earning more sales, end up with none.

Undeterred, Xtrac launched itself on this path in late 2009, and not only won the BTCC contract but has also secured customers in WTCC, too. The unit that performed this feat, the 1046, is a remarkable







combination of elegant design and pragmatism that looks set to be a Touring Car staple for some years to come.

As technical director, Adrian Moore, explains: 'We tried to cut costs in areas that won't affect performance. There's no point hitting a low selling price if the thing doesn't survive. These people have been our customers for a long time and we don't want to let them down.'

Project leader on the 1046 is the company's head of Touring Car 'boxes, Oliver Grant. Not content with spending his working week immersed in motorsport engineering, he spends weekends moonlighting as race engineer for a Touring Car team. In fact, Xtrac condones and even encourages this behaviour, for good reason, as Grant explains: 'Engineering allows me to see it from a customer's perspective. I get a good insight into what's important and it informs our designs. For instance, I've had 20p components put us out of the race [not on an Xtrac product he hastens to add] and it's very frustrating. I don't want that to happen to our customers.'

Fortunately, both series exclude exotic materials so the casing has to be aluminium, though front and rear-drive versions have to be available.

> **the new 'box is engineered to cope with up to 450Nm**

To say the unit replaces the previous Xtrac Touring Car 'box, the 516, is not entirely accurate. Xtrac gearboxes don't seem to be replaced, they just move into other race series, usually on other continents. The 516 is likely to be around in racing for some time to come and is even still being used by some competitors in the British series during this transitional season, as well as being raced in South America.

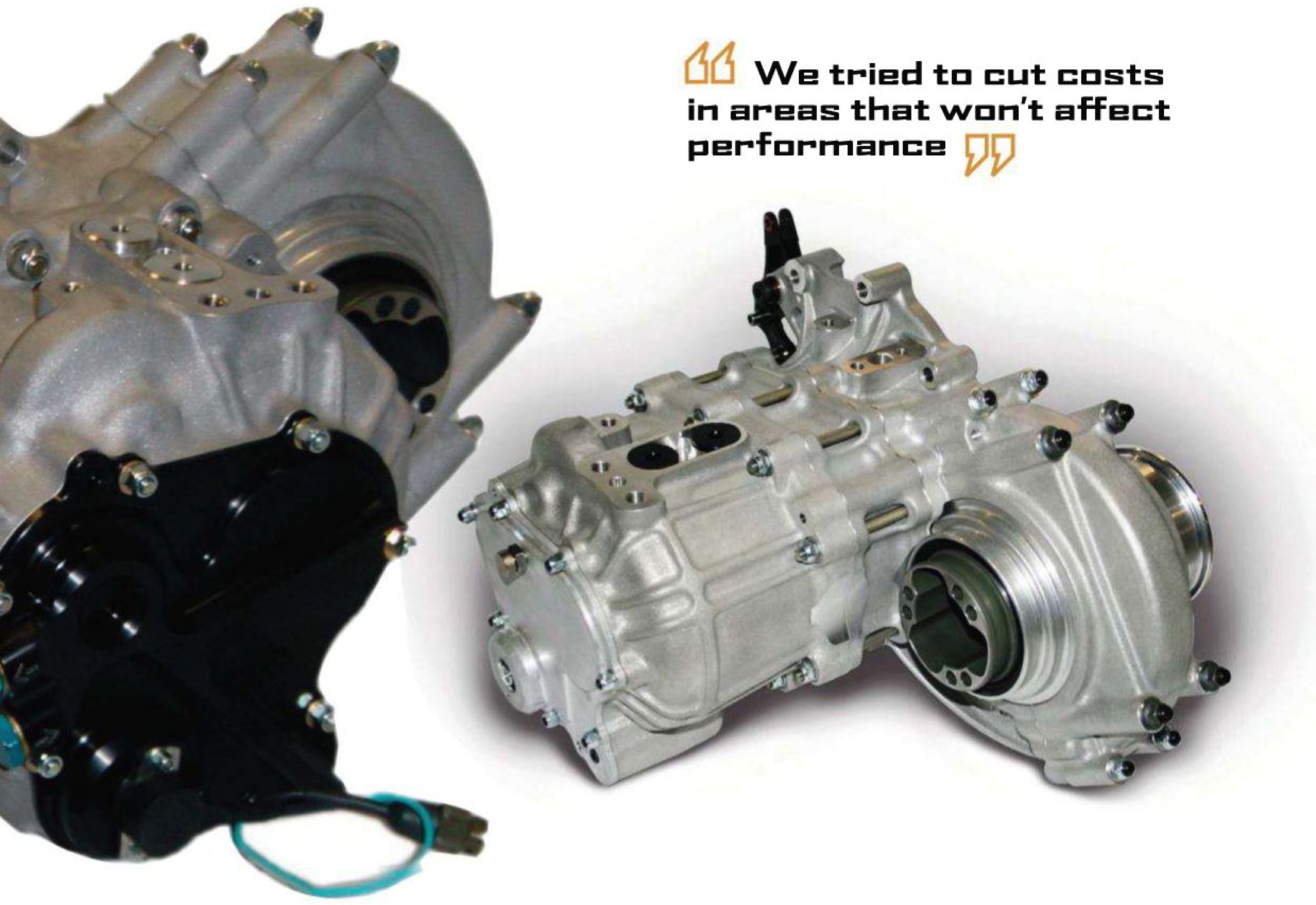
The reason for a new 'box is not just a change from open supply to controlled item, but also the potential to deliver more torque from the new generation of turbocharged engines. The 516 is equipped to handle 300Nm, offering plenty of headroom for the old-style, normally-aspirated, 2.0-litre engines. In this application it used ratios that were first added to the company's parts list for a Formula 1 project in the early 2000s.

The new generation turbo Touring Cars require more torque capacity, so the 1046 has been engineered to cope with up to 450Nm, and the designers were able to turn to its range of Super 2000 rally gearbox ratios for the project. With their broader teeth and larger gear centres, they were able to handle the extra load.

For the current season, this is much more than the turbo cars will need as their performance has been pegged back to try and achieve parity with the normally-aspirated cars. It is why some of the new cars are still able to run the old 516 gearbox. Xtrac has even issued an upgrade kit to help them cope. However, next season teams will be able to run more boost and the extra capacity of the 1046 will be used to the full.

LIGHTENING SEEDS

In the flesh, the gears are unremarkable looking items. They don't feature holes for lightness. Xtrac has found that lightening holes don't always make the best use of material, and prefer to machine a deep channel around the gear.



> We tried to cut costs in areas that won't affect performance

The real knowledge is in the dog and tooth design. The latest version of these gears uses a tooth profile that has come as a result of extensive development. The gears also benefit from shot peening, despite the extra cost of the process. Explaining this, Moore reiterates his belief that durability is paramount.

The dogs too have come as the result of research. 'We've been doing a lot of dog design over recent years,' he explains, 'and this is one of our most recent designs. We did a lot of high speed filming of gearchanges and that work has influenced the number of dogs, the spacings and the shape. The method of operation in Formula 1 and Touring Cars are quite different, with hydraulics operating one and the driver operating the other, but the bigger you can make that window without compromising the strength of the dogs, the more likely you are going to get the thing in gear because the chances of meeting dog to dog are minimised. We have all seen races where a driver gets a dog-to-dog clash and someone nips past them.' Five dogs per gear is now standard at Xtrac, including its F1 'box, but as Moore points out, 'the devil is in the details. It's all in the shape of the corner radiuses and the chamfers.'

> It's all in the shape of the corner radiuses and chamfers

Both championships have restrictions on the number of ratios teams have to choose from, fewer in the BTCC than the WTCC. However, Xtrac finds that some of the customer teams in the British series keep costs down by just fielding two sets – long and short to suit different circuits. Moore points out that ratio selection can cause an unexpected problem.

The 1046 is spot on the 35kg minimum weight limit for both series, but ratio sets can vary by several hundred grams. With some sets of ratios the 'box can be underweight and for the rear-drive version – the 1080 gearbox – Xtrac provides steel ballast strips to be bolted to the front of the casing to compensate.

The Xtrac approach to new designs has always been a modular philosophy and, like the company's other products, much of the 1046 already existed. This means that with each new design, there is comparatively little new content and that most of the new unit is well tested and understood. The fresh design is kept to a minimum, reducing the risk of problems.

That is not to say the design becomes frozen and dated, as Moore explains: 'We are constantly evolving parts, but we make sure they are always compatible with older designs.' So an older-spec Xtrac gearbox can be rebuilt to incorporate many of the company's latest detail developments.

This strategy helped Xtrac meet the tough price target required to win the BTCC contract as the development cost for much of the 'box had already been invested and spread across many units. The pricing was further helped by securing not only the BTCC contract, but also customers in the WTCC. Not only did the risk pay off, but it also gave the British series a particularly high-spec gearbox.

One feature Grant is

particularly proud of is the externally adjustable differential pre-load. 'Because it's a spec tyre series, success is all about tyre management. Once the front tyres go off on a FWD car, the RWD cars come back at you.' This is where the 1046 has a special advantage. 'You can change the differential pre-load with a ratchet spanner just by lifting the bonnet. If it starts to rain as you are going to the grid, you want to back the pre-load off. With this feature you can. In my do versions of the 516 that don't have it because it's an option. For WTCC it made sense because it's a competitive market. But for BTCC there is an argument that we shouldn't have put it in there. However, we wanted to include some features that would help us win the contract. It's a definite selling point.'

The differential itself is a typical Salisbury-type plate differential, but benefits from work on Xtrac's own differential test rig. 'We scoured the world to

"One feature [Xtrac] is extremely proud of is the externally adjustable differential pre-load"

race engineering it's something I would kill for.'

The system works very simply. When you press the adjuster in, it engages with a toothed adjuster wheel on the differential and a detent gives clicks that can be felt as it is adjusted. It was a feature available on the 516 and, before that, on Sportscar and rally boxes. 'It was a challenge to include it on something so price sensitive,' says Moore. 'In fact, we find one without success, so had to make our own,' says Moore. 'We've been using it extensively for differential mapping and it has proved hugely valuable. All people want from a differential is consistency. Whatever it does at the beginning of a race, they want it to still be doing at the end, and this is exactly what we've achieved.'

An important part of making the 'box a success was recognising the environment they are likely to be used in. The customers are generally small teams with no dedicated gearbox engineer, so operation has to be simple and straightforward. The manual is surprisingly brief and includes basic knowledge that anyone operating a gearbox would need to know, even how to change gear.

Much thought has also gone into how to remove the gearbox with the minimum fuss. So the oil lines are connected to the top, allowing them to be split without emptying the 'box, and the reverse cable can be released without losing its adjustment. Also the differential can be removed without disturbing the final drive, making it easier to change the number of plates and settings.

Xtrac makes sure there is an engineer on hand at each race, which is a big benefit to the small teams who need advice and answers to their problems quickly. He also carries a supply of parts, helping reduce the amount the teams have to invest in their parts stock.

Every 'box is tested before it leaves the factory and the pressure to change gear recorded. If any problems occur then they can refer back to the test data. As part of its continuous development, the 1046 will also be one of Xtrac's first products to be tested on a new rig at the factory. The 'box is mounted on gimbals and run at speed through a full range of angles, allowing oil flow to be monitored. Modelling it digitally proved impractical because most of the time the oil is in an aerated state and this more practical solution has proved to be a simple substitute.

Simple, practical, evolutionary and yet a class-winning product, it seems Xtrac's bold strategy has delivered a great value product for the customer.

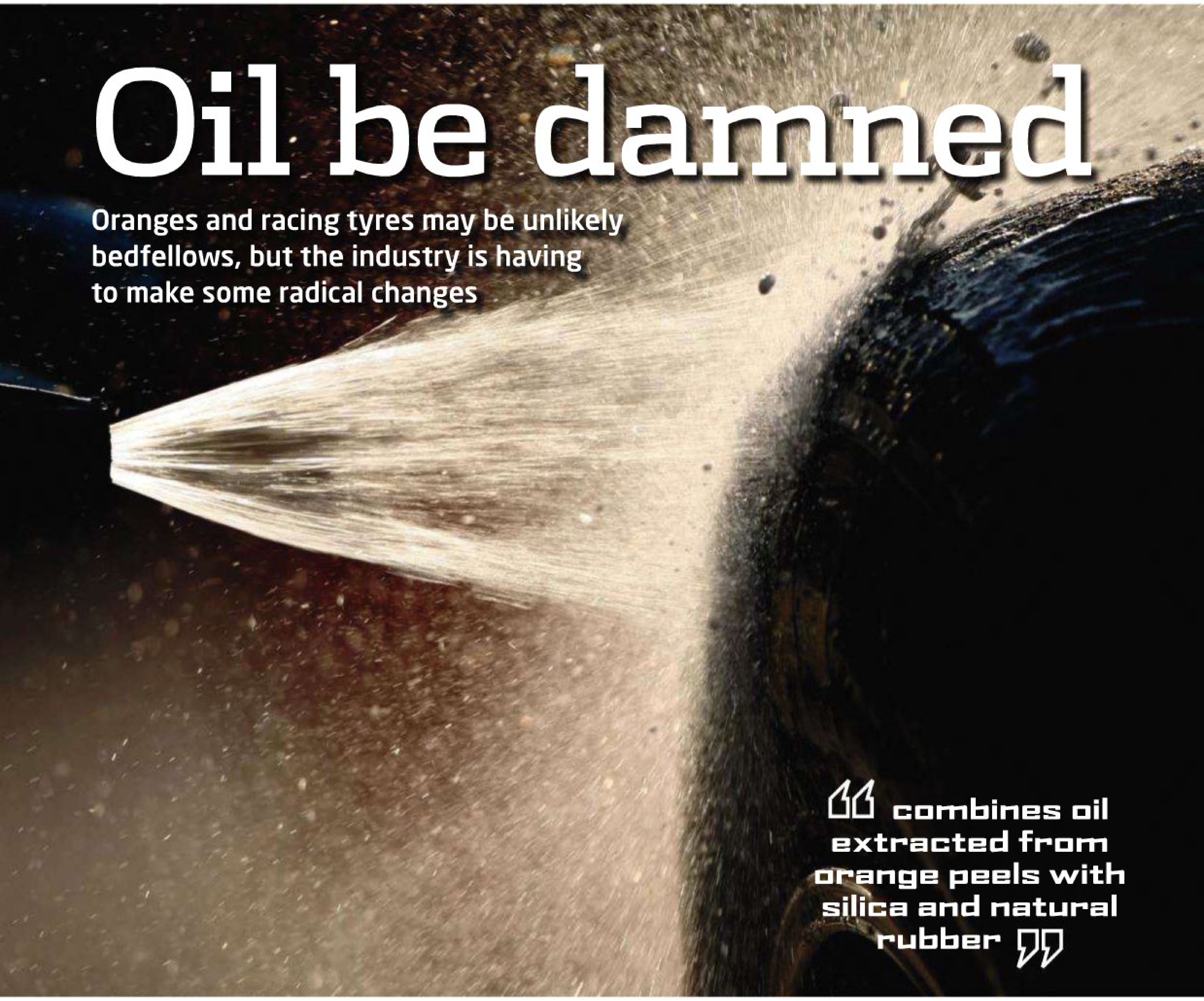
XTRAC GEARBOX LINEAGE

406: A transverse, six-speed, sequential racing gearbox, primarily designed for use in FWD Touring Car (BTCC) and rally car applications. The unit was first utilised as the spec gearbox for the British Touring Car Championship in 2001 but has been superseded by Xtrac's new 1046 gearbox. Designed with ease of servicing in mind, ratio changes are accomplished on the bench after the ratio cluster has been removed as one unit on its cluster plate.

416: A transverse, six-speed, sequential racing gearbox, primarily designed for use in FWD Touring Car and rally car applications. A re-package of the 406, the 416 design gave a lower c of g, and the encapsulating cluster casting made it easier to remove the gears for ratio changes. It saw success in the ETCC and WTCC and was also approved for use in the SCCA Speed World Challenge, being used by all of the top 10 finishing drivers in the 2009 championship.

426: Essentially a higher torque version of the 416 transverse, six-speed, sequential racing gearbox, capable of handling up to 650Nm. Primarily designed for use in FWD Touring Car and rally car applications it is the spec gearbox for the Argentinean TC2000 series. Customers using the 426 secured class wins at the Nürburgring 24 Hours. A recent variant has been made available for RWD GT2 / GT4 applications.

516: High performance, front-wheel drive Touring Car gearbox that was designed specifically for the World Touring Car Championship. It makes use of reduced centre distance, Formula 1-derived gear ratios to minimise the size and weight of the gearbox and to minimise inertia. The gearchange system incorporated the latest polynomial barrel track design and low inertia selector rack to improve response and driver feel. The low positioning of the gear cluster enables easy removal from the car under the chassis rail, and lowers the c of g. The gear cluster is fully exposed when removed from the gearbox, which allows for quick inspection and easy access for ratio changes.



BY ANDREW COTTON

Tyre manufacturers have been forced to re-think their production methods following the ban on certain highly aromatic oils and a continued drive to reduce the reliance on fossil fuels.

With the American Le Mans Series switching to second-generation bio fuels in its E85 fuel, the racing series has overcome much of the controversy over foodstuffs being used to fuel our cars. However, as oil manufacturers accelerate the development of this technology, the tyre industry is also turning towards alternative natural resources.

Japanese tyre manufacturer, Yokohama, has developed a tyre that utilises the oil from orange peels to reduce the use of petroleum. The process combines oil extracted from orange peels with silica and natural rubber to form a 'Super Nano-Power Rubber'. The manufacturer claims that it conserves fuel as it reduces the rolling resistance by up to 20 per cent, and highlights the need for tyre manufacturers, like every other sector of the automotive and motorsport industries, to look for alternative production methods.

The technology is not new, Yokohama debuted the tyre at the Sebring 12 Hours in 2010 and has rolled it out to a range of racing series around the world, including the Pikes Peak hillclimb. 'Yokohama is the only tyre company to have perfected this science,' said Mark Chung, Yokohama director, corporate strategy and planning. 'The ENV-R2 replaces the ADVAN ENV-R1, which debuted in 2009 at Sebring and became the world's first environmentally-friendly tyre used in a racing series. Now we have the ENV-R2, which is faster, grips better and has even more orange oil and natural rubber in it, further reducing petroleum use in the production of the tyre.'

Turning to vegetation may be something that tyre manufacturers will increasingly do. 'There is a lot of oil in the skin of an orange, and to get the oil from a potential product like that is not that difficult,' says Paul Brown, head of Advanced Materials and Product Development at the Tun Abdul Razak Research Centre (TARRC), the UK-based research and promotion centre of the Malaysian Rubber Board. 'The oils are out there in the plant world, but there are many other calls on plants and there are other oils to look at.'

Tyre manufacturers had plenty of warning that the aromatic oils would be banned and acted accordingly

The drive to find new tyre production methods was given added impetus by the European Union, which stepped up its tyre regulations and, in January 2010, banned the use of eight highly aromatic oils, which were known to be carcinogenic but helped with the tyre build process and contributed to better wear, better grip and lower cost of a production tyre.

The level of carcinogen was extremely low and tyres produced were not considered to be enough of a health hazard to be categorised by the EU as carcinogenic materials. However, the European tyre manufacturers agreed in 2003 to a level playing field, and committed to eliminating the oils.

The EU produced its directive in 2005, but it became law five years later as tyre manufacturers looked for, and perfected, alternatives. The oils, also known as Distillate Aromatic Extracts, helped with tyre performance and their ban meant that manufacturers had to maintain current grip levels, braking abilities and durability in the new tyre.

'The oils had three roles,' says Brown. 'The primary role is in mixing and processing, to make it easier to handle the material in the build of the tyre. The second is influencing the balance of the physical properties of the tyre. The third is that the oils can be used to cheapen the compound.'

RACERS UNSTUCK

While the directive did not cover racing tyres – other than those that would be used in road racing – pressure from the global companies forced the race departments to take out the oils ahead of the deadline, and that almost immediately had a detrimental effect on the performance of the tyre, particularly in wet conditions, and led to an immediate re-think of tyre production methods.

> **"Normal racing tyres contain little or no natural materials"**

At Le Mans in 2010, Michelin proudly announced that it had a new generation of eco-friendly tyres before it continued its long run of wins at the French endurance race. This year, the company had clearly addressed the wear issue too, as Andre Lotterer was able to complete five stints on the same set of tyres in his Audi R18, early on Sunday morning to bring the car back into contention against the Peugeot. Michelin may have shouted loudest, but the French company was not alone. All of the European manufacturers had taken similar steps ahead of the ban, and the race was on to develop competition tyres that were just as durable, and offered similar grip levels.

'We had to adjust the formulation to get rid of the aromatic oils, and it wasn't a straightforward change,' says Dunlop engineer, Firdos Favori. 'We were able to do it in one year and started proving it in other compounds almost immediately. It did change the performance of the tyre a little bit, and we had to re-formulate everything to get the performance back.'

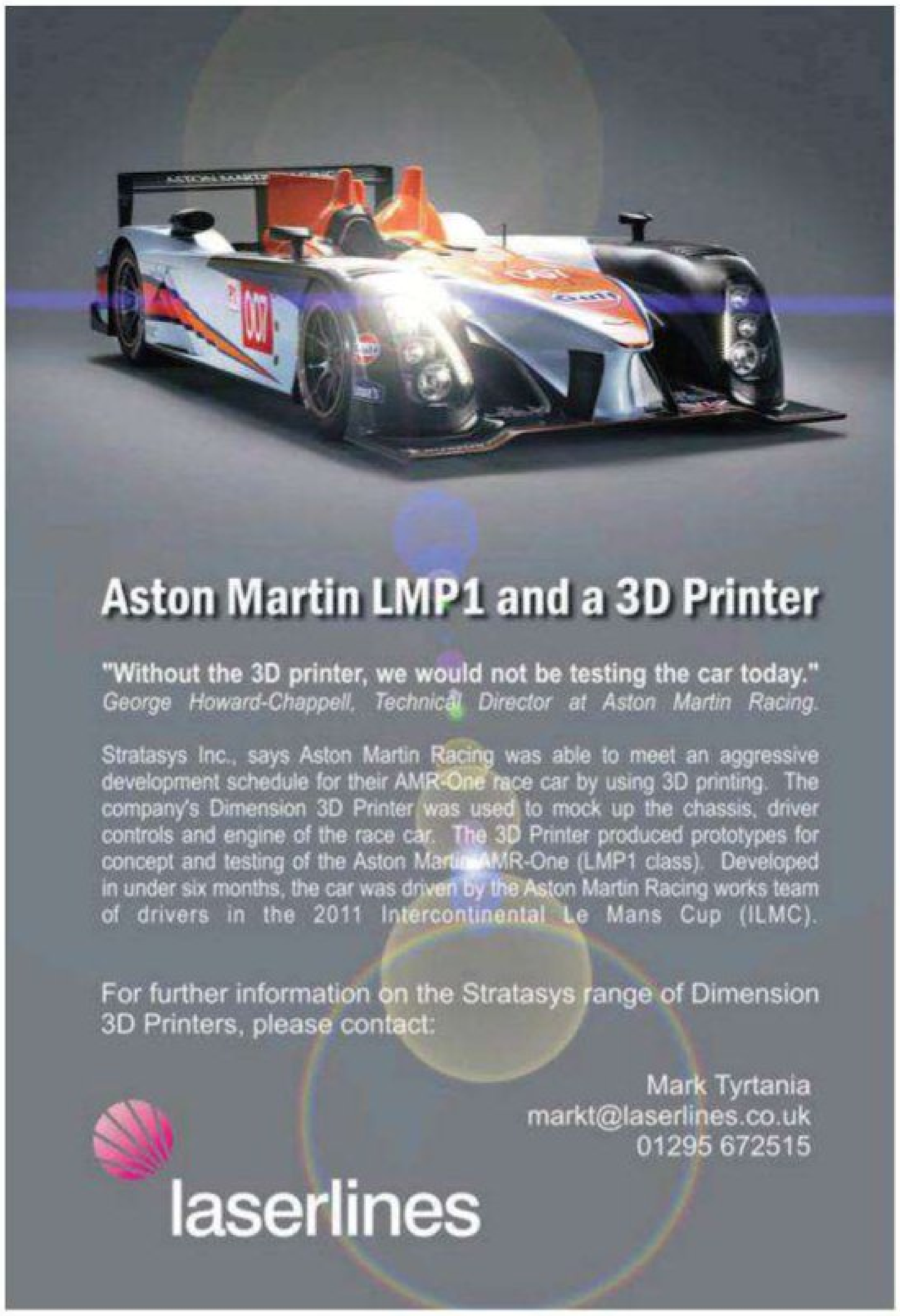
Pirelli had to design its Formula 1 tyres without the oils, and in such a high-profile series, it was no easy task, says Paul Hembery, Pirelli's motorsport director. 'To re-design a Formula 1 tyre without the use of banned oils was a complex task, as the formulae need to be effective in terms of stability, wear resistance and grip level. The required results were achieved by the combined use of special grades of polymers, the fine tuning of filler types and their amount, the modification of the vulcanisation system and the introduction of a new generation of plasticisers. Also the mixing process of the compounds had to be re-defined.'

Pirelli's compound specialists started to develop compounds without these banned oils in 2007 for all their product ranges (race tyres, street tyres, bike and truck tyres), three years ahead of the EU regulation deadline of 1 January 2010. The 'clean' tyres were used for the first time in the World Rally Championship from the beginning of 2008.

Hankook, which supplies the control tyre to the German DTM Touring Car series, also adopted the policy early. 'Hankook had stopped using these aromatic oils in all of our tyre line up since 2010,' said James Kim, Hankook Tyre chief engineer. 'The major impact on the tyre performance with a PAH (polycyclic aromatic hydrocarbon) is a lower grip performance, especially in the wet.'

'As we were already focussing on this, there was no specific action required for the new act,' said Satoru Ushida, marketing director at Falken Tyres. 'Achieving a good balance between performance of the tyres and reducing the environmental effect is the challenge for a tyre manufacturer and, to achieve this, advanced technical progress in materials and manufacturing is required.'

So, while the world watches the fuel companies developing alternatives to fossil fuels, the tyre industry has also taken steps to reduce its reliance on finite materials.


Aston Martin LMP1 and a 3D Printer
"Without the 3D printer, we would not be testing the car today."
George Howard-Chappell, Technical Director at Aston Martin Racing.
Stratasys Inc., says Aston Martin Racing was able to meet an aggressive development schedule for their AMR-One race car by using 3D printing. The company's Dimension 3D Printer was used to mock up the chassis, driver controls and engine of the race car. The 3D Printer produced prototypes for concept and testing of the Aston Martin AMR-One (LMP1 class). Developed in under six months, the car was driven by the Aston Martin Racing works team of drivers in the 2011 Intercontinental Le Mans Cup (ILMC).
For further information on the Stratasys range of Dimension 3D Printers, please contact:
Mark Tyrtania
markt@laserlines.co.uk
01295 672515
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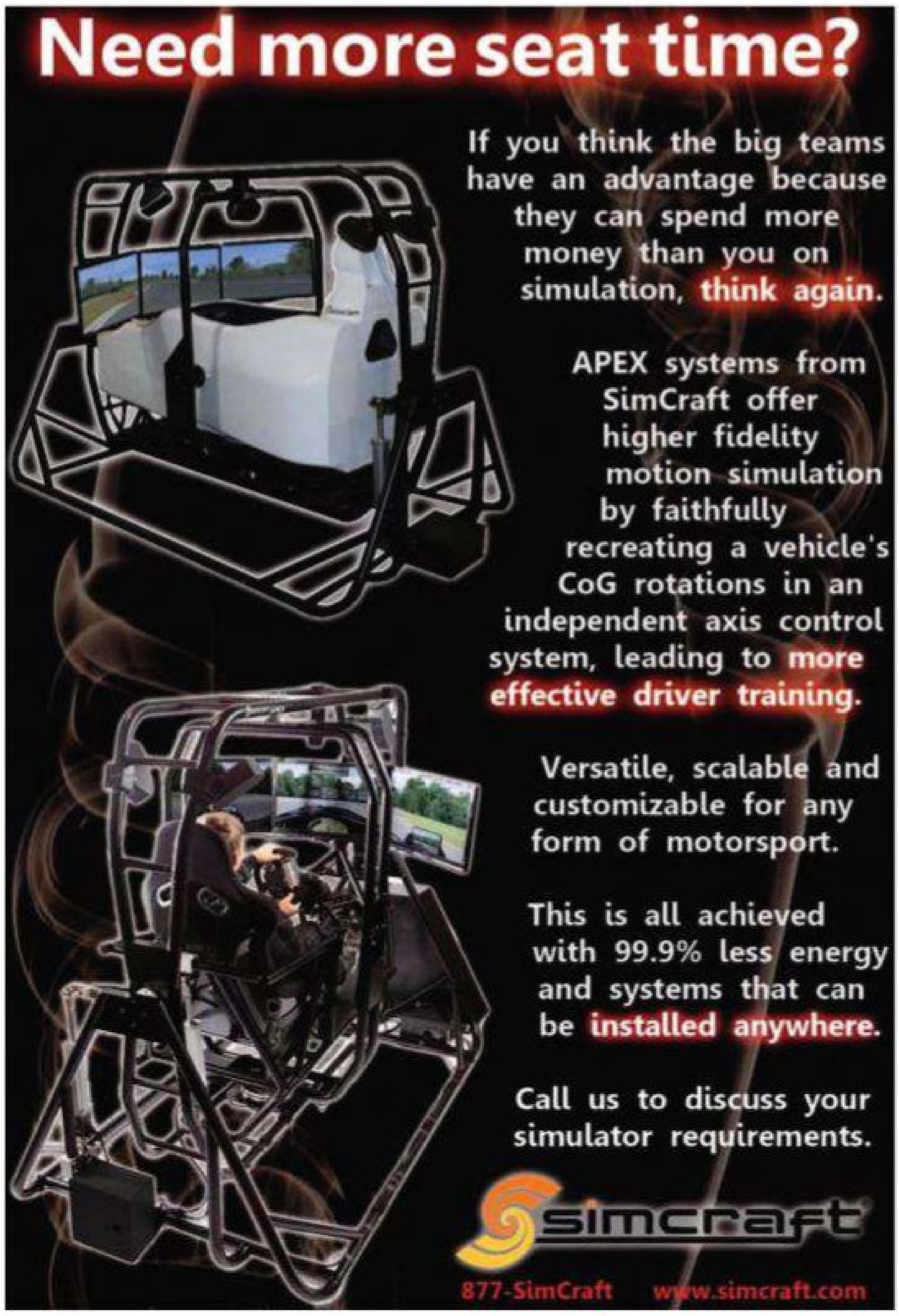
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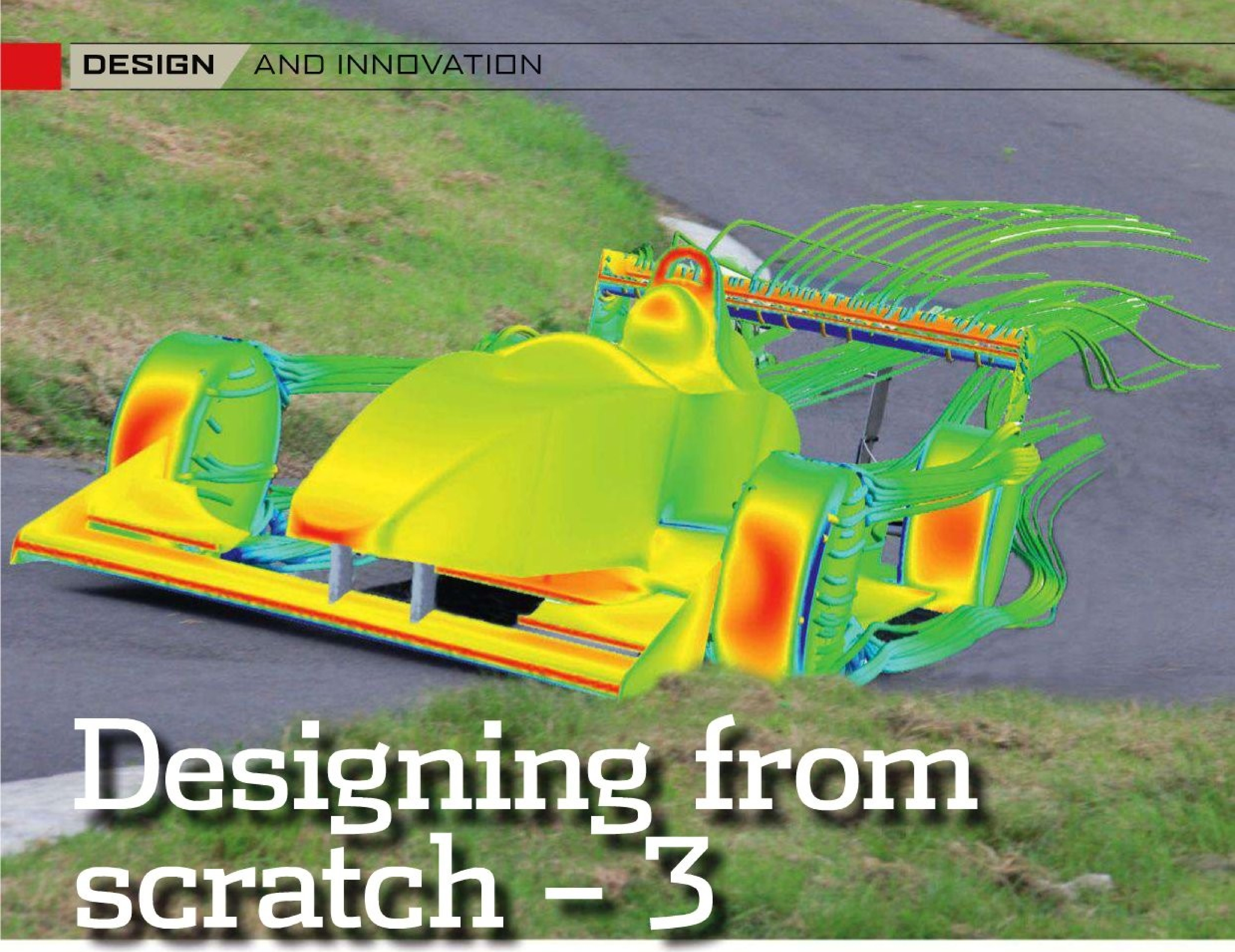


Designing from scratch – 3

For the next phase of his project, *Racecar Engineering* contributor, Simon McBeath, takes advantage of CFD to investigate some key design parameters

BY SIMON MCBEATH

Once upon a time computer-aided engineering tools like CAD, structural finite element analysis (FEA) and computational fluid dynamics (CFD) were the preserve of just the top racecar constructors. And although they remain pretty costly tools for individuals to purchase, they have become increasingly accessible through their use in universities teaching motorsport engineering courses. And with a never-ending flow of students looking for interesting projects to get their teeth into, it isn't hard for an individual or a race team to get some computational design or simulation work done in a mutually beneficial, and usually cost-free, way. If, like me, you are working on a one-off racecar project and are not in a position to purchase the kind of software required, a university project can provide at least some of what you need.

This preamble is by way of justification for the use of CFD on your writer's project racecar, the Vortex. But in this case, the availability of the software is thanks to support from Ansys UK, who have provided their latest entry level product, CFD-Flo, for use on this and other projects we shall feature. Regular readers may recall we have featured studies using Ansys FloWizard in the past, but this product is no longer available and CFD-Flo, which is a part of the Ansys 12 Workbench suite, has taken its place (see the sidebar on p59).

KEY CONCEPTS

Since embarking on this increasingly lengthy project, it has been my principal aim to evaluate two key external aerodynamic parameters prior to starting any physical construction, and some basic CFD on simplified models of the car was always going to be the way to try and achieve this. The two parameters that I saw as being the most important to evaluate right at the start, and on which, as far as I am aware, there has been nothing even semi-quantitative published, were: 1) nose height and 2) with or without sidepods and profiled underbody. The first of these would clearly be influential on the design of the chassis and, while the second probably would not affect the shape of the chassis itself, it would affect packaging of the cooling and exhaust systems.

It is clear that, compared to a low nose with wings on either side, raised-nose configurations expose more working wing underside to the airflow and, as such, should allow more front wing downforce to be generated. But it was often said that a high nose was used primarily to allow a better feed to the underbody, so enabling more underbody downforce to be generated, and this presumably was the reason why the concept has remained ubiquitous. But given the main disadvantage of a high nose – a raised c of g – was it a concept to be employed on a lightweight hillclimb single seater? Would the aerodynamic benefit be worthwhile? And would it be a concept worth using if the second parameter

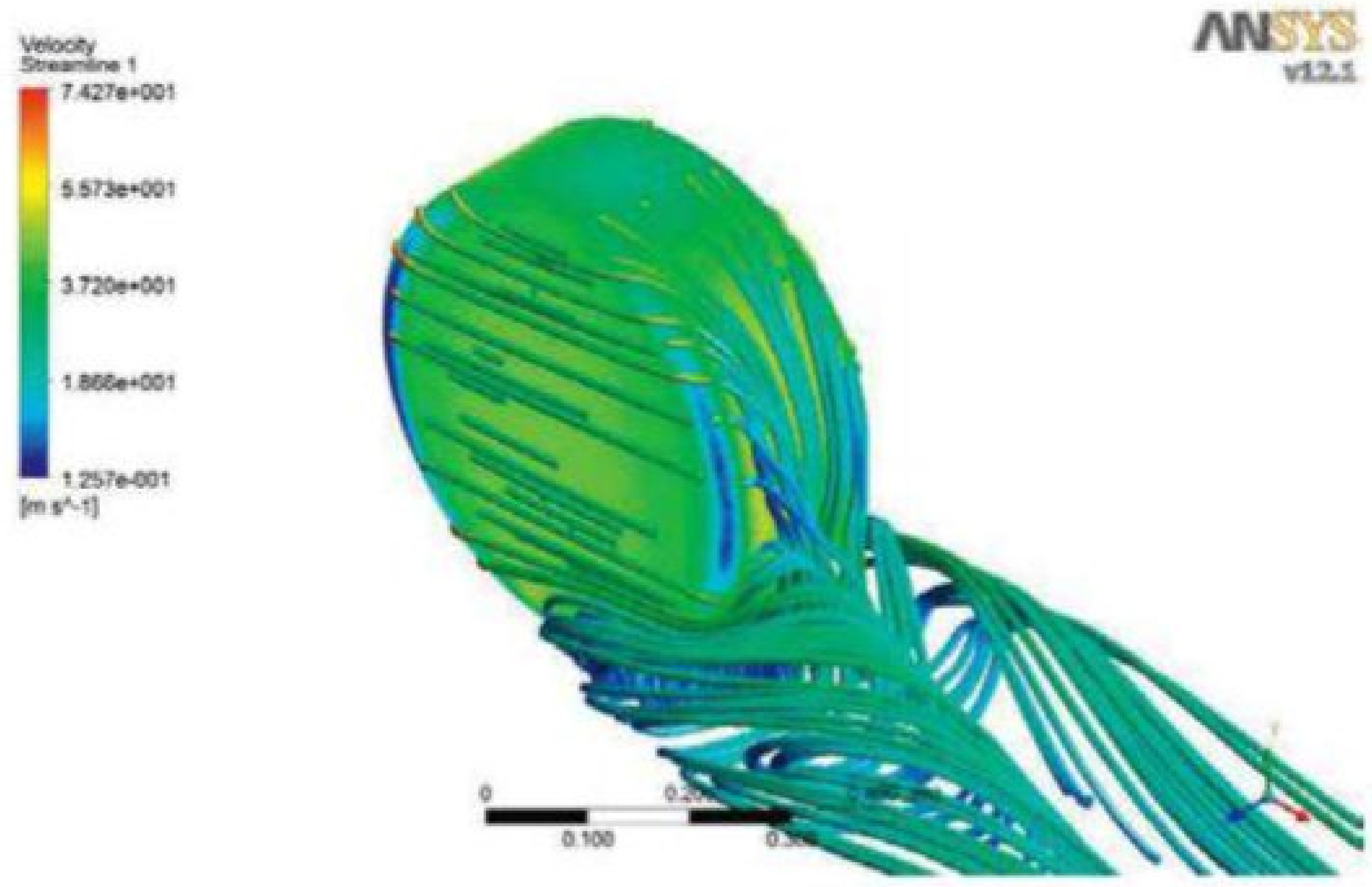


Figure 1: a wheel analysed in isolation, air and ground moved at 100mph (44.7m/s) from the top left, but the wheel was stationary. The wheel is coloured by surface pressures, the streamlines by velocity. The flow appears to stay substantially attached to the rear face of the wheel

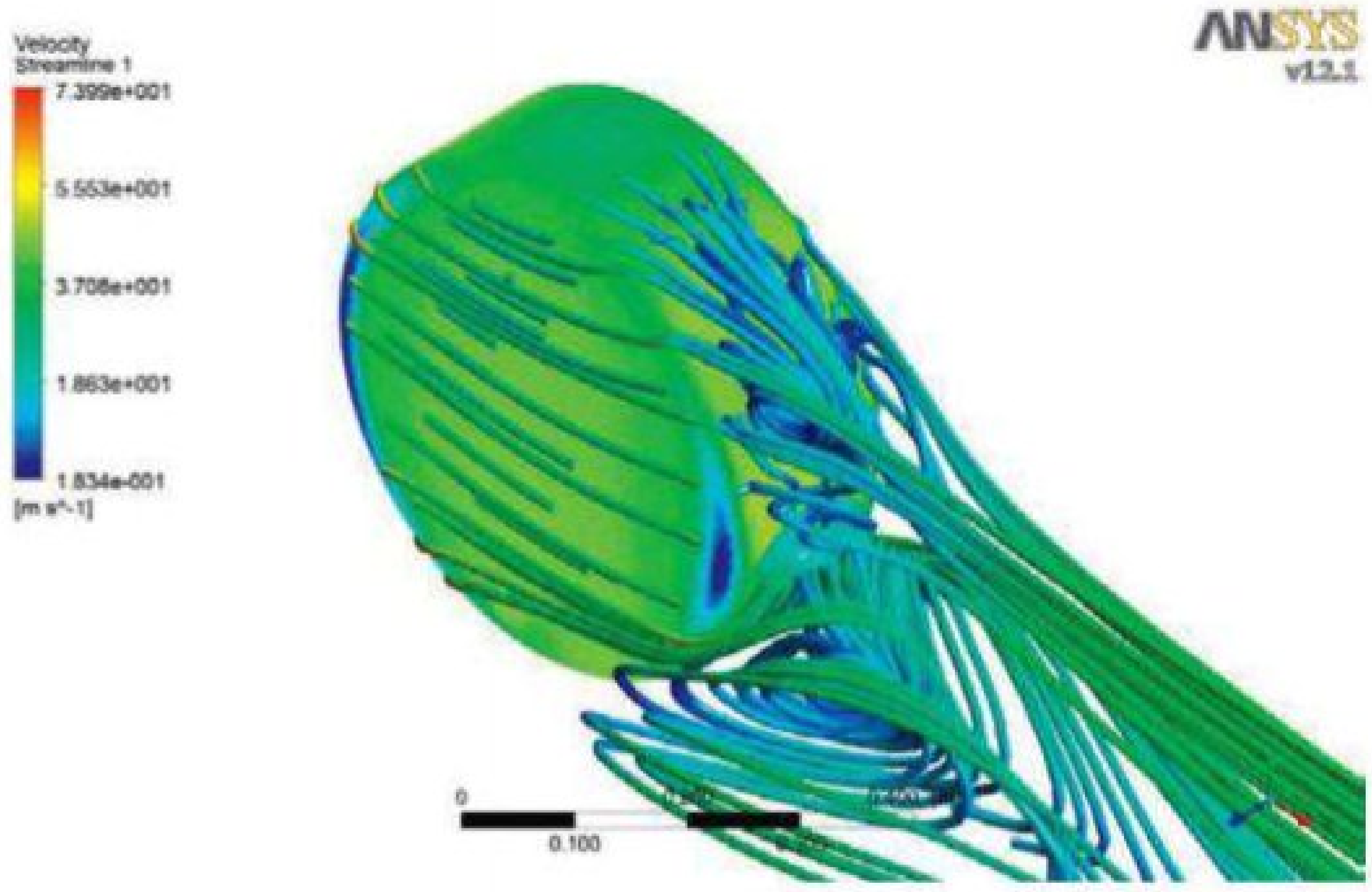


Figure 2: this time the wheel is rotating to match the ground speed. Now the flow separates just after it has passed the top of the wheel, leading to different wheel forces and different downstream flows

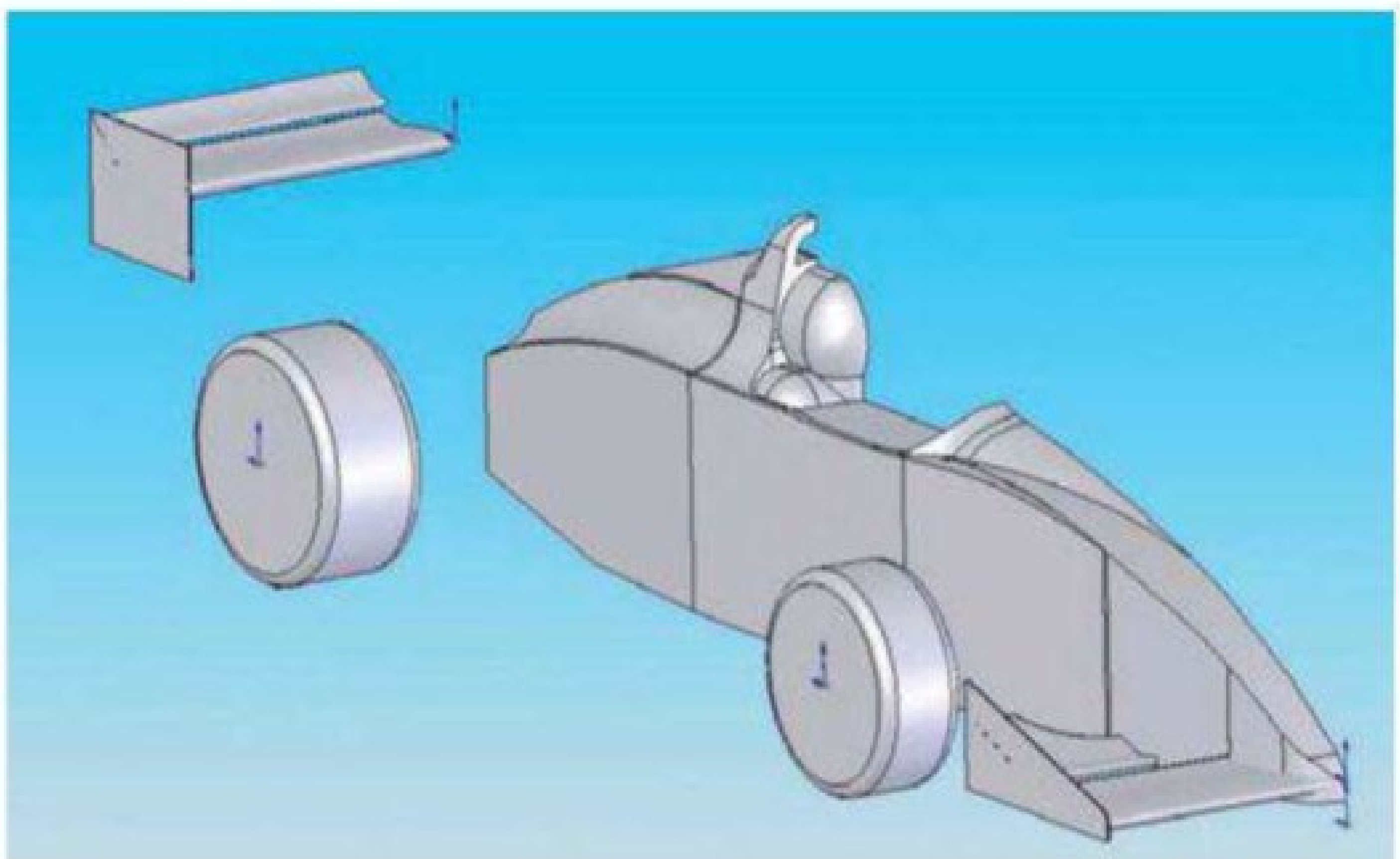


Figure 3: the low-nose, narrow-body model

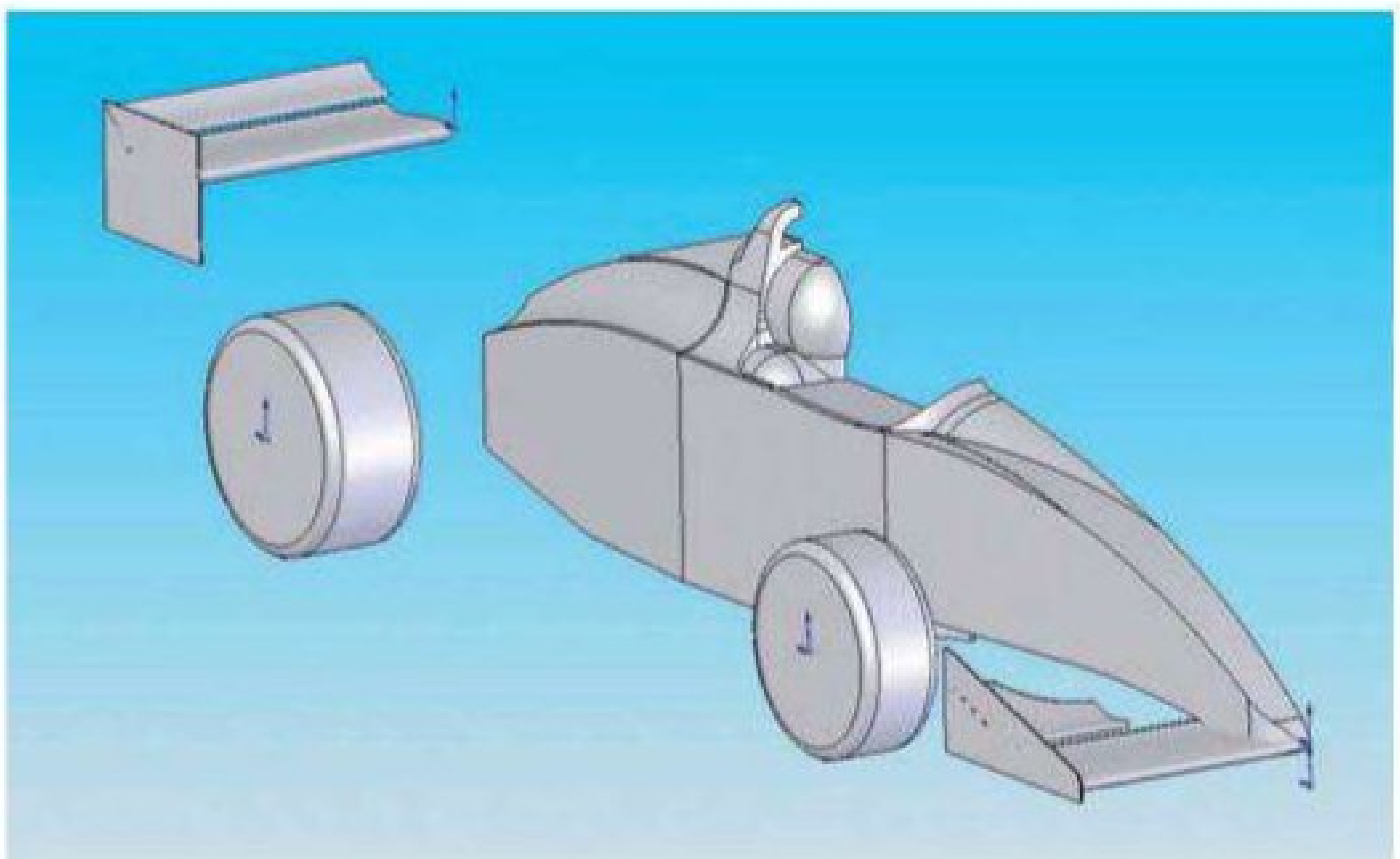


Figure 4: the medium-nose, narrow-body model

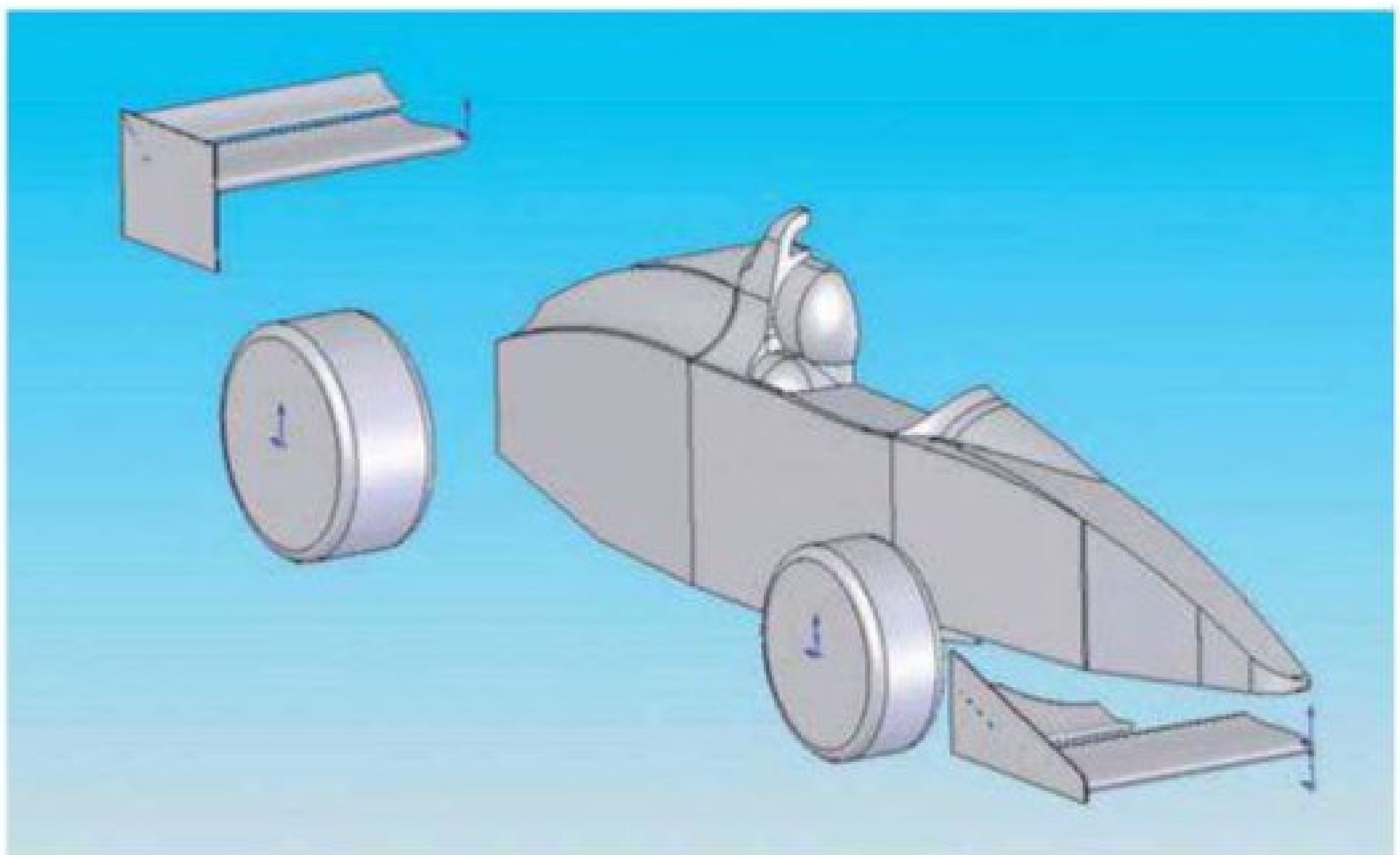


Figure 5: the high-nose, narrow-body model

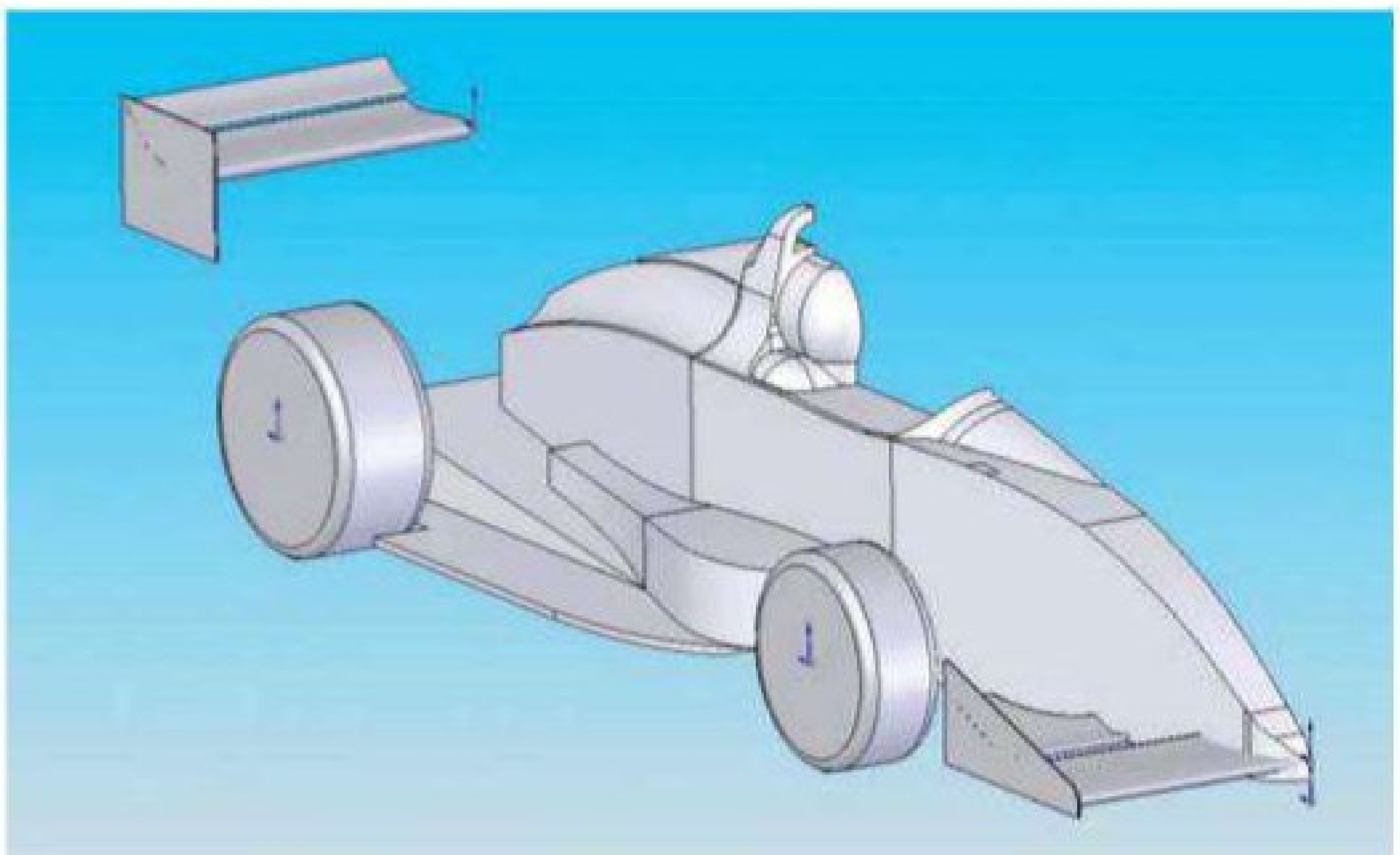


Figure 6: the low-nose, wide-body model

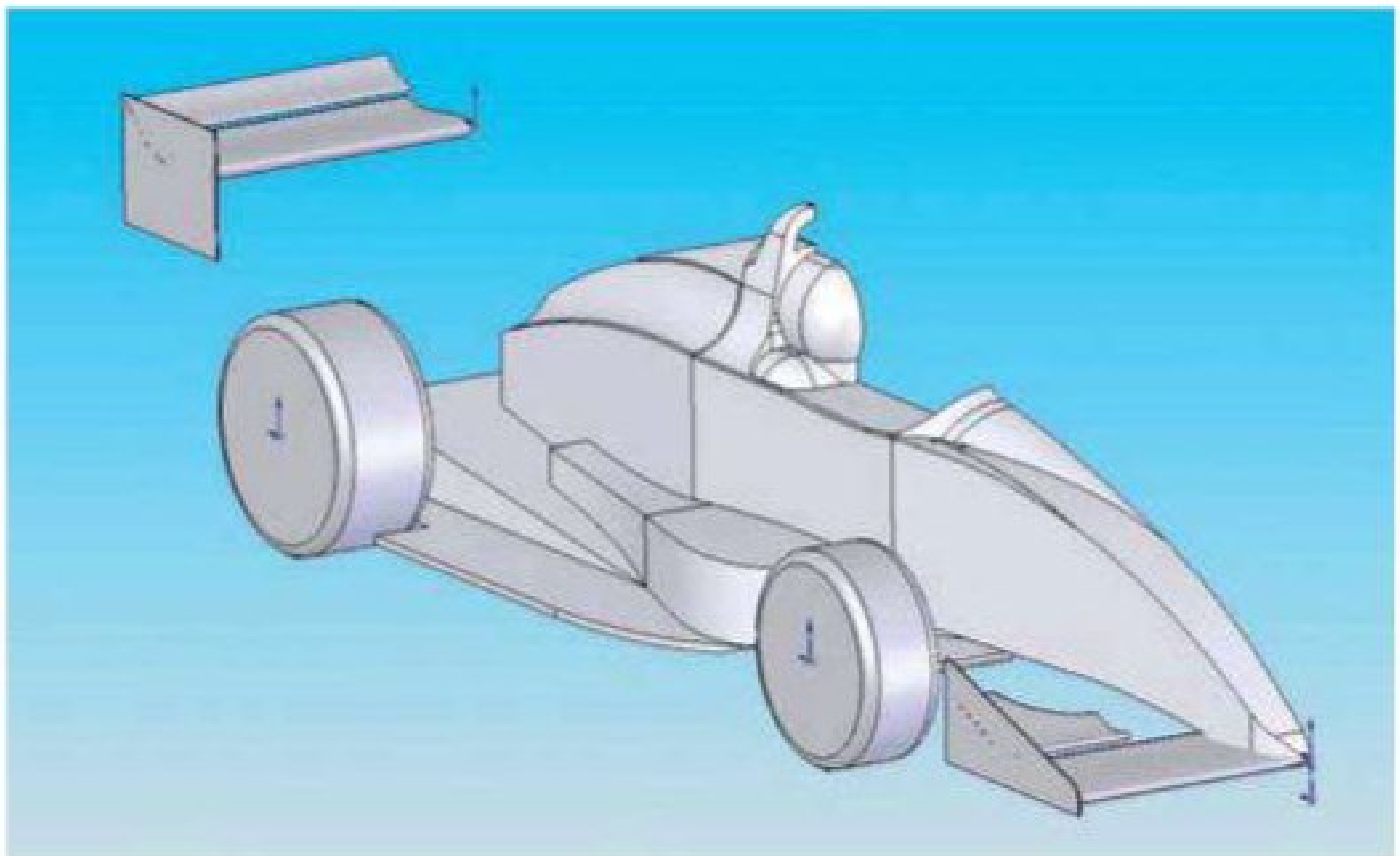


Figure 7: the medium-nose, wide-body model

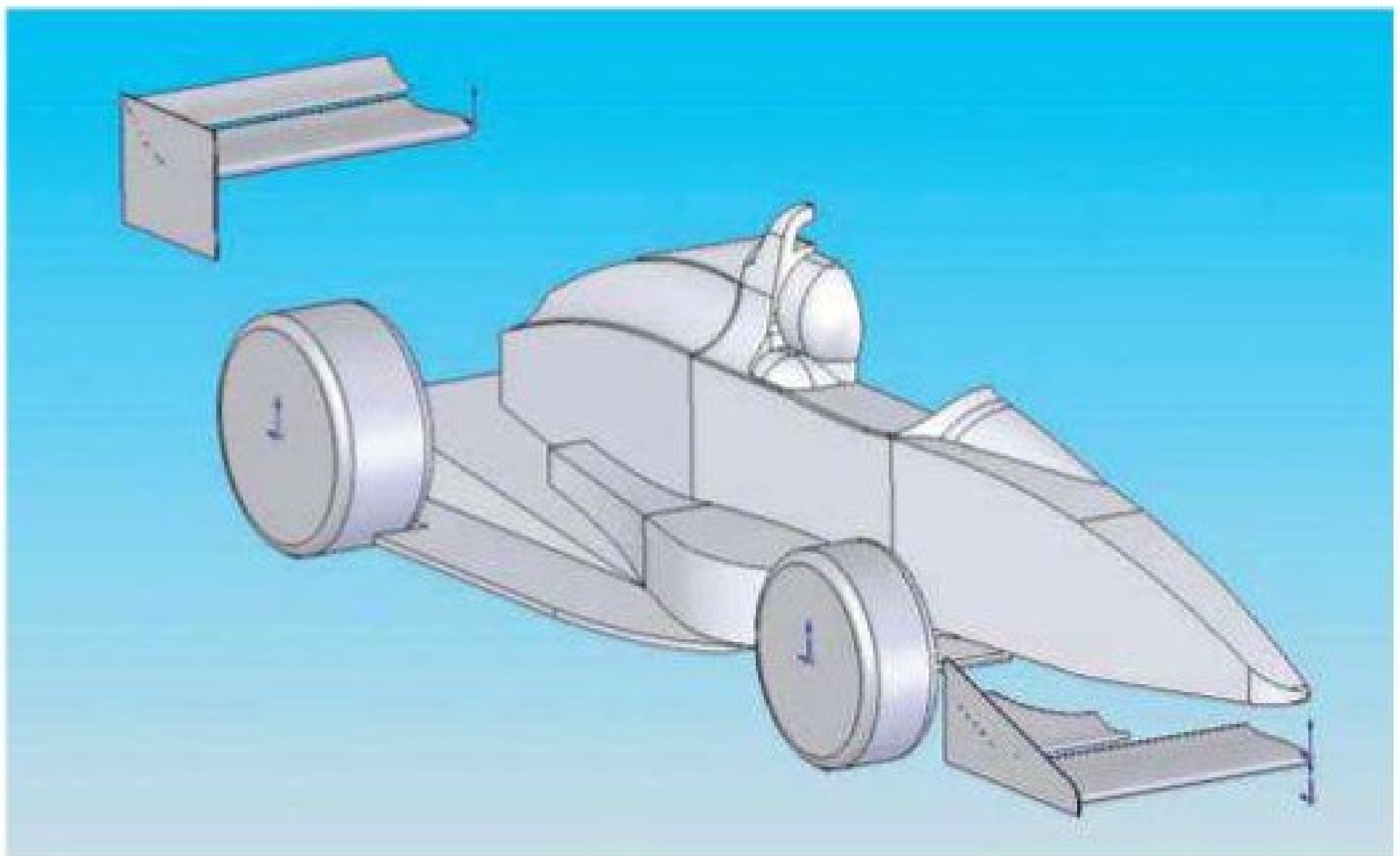


Figure 8: the high-nose, wide-body model

under discussion here – whether or not to employ sidepods and a profiled underbody – were questionable?

A number of the smaller capacity hillclimb single seaters nowadays feature high noses, but not all run sidepods and profiled underbody. As discussed in the previous article on this project in V20N2 (February 2010) there is divided opinion in hillclimbing, most notably but not exclusively in the smaller capacity classes, on whether to run sidepods and an underbody at all, and the gist of that article was to try and evaluate the gains and losses of the potential extra downforce vs the extra weight. In straight performance terms, the simplistic analytical approach of that article suggested that a quite significant extra chunk of downforce would be needed to offset the disadvantage of carrying the extra weight. So could a sidepod and underbody kit generate enough downforce? And whether it could or not, was a high nose going to be better than a medium or low nose?

EARLY LEARNING

Some preliminary runs examined the components of the Vortex model one at a time in order to determine the 'mesh budget' that could be apportioned to each part. As explained in mesh size on the surface of any designated parts, so it was relatively simple to find some mesh size settings that utilised the available total element count in a way that hopefully reflected the relative importance of each part of the model, and provided adequate mesh density to solve the flows reasonably reliably. Note that the models did not include suspension at this stage, nor was there any wheel detail, and no radiator was simulated either. These runs simply evaluated the flows and forces over simple representations of the major components.

With the facility to very easily set up a moving ground plane and just as easily to rotate

> **"could a sidepod and underbody kit generate enough downforce?"**

the sidebar, with a limit on total mesh element count, the available mesh budget had to be spread out between the wings, the wheels and the main central part of the car model (referred to henceforth simply as the 'tub', although this covers the nose, chassis, central bodywork, cockpit, driver and faired-in rear compartment, too). CFD-Flo allows the user to control the the wheels in the simulations, it seemed sensible to take advantage of those benefits, too. Some comparisons with stationary and rotating wheels were carried out, and it was noteworthy that the software seemed to simulate the flow separations on the rotating wheels very realistically. This obviously made differences to the flows downstream of the

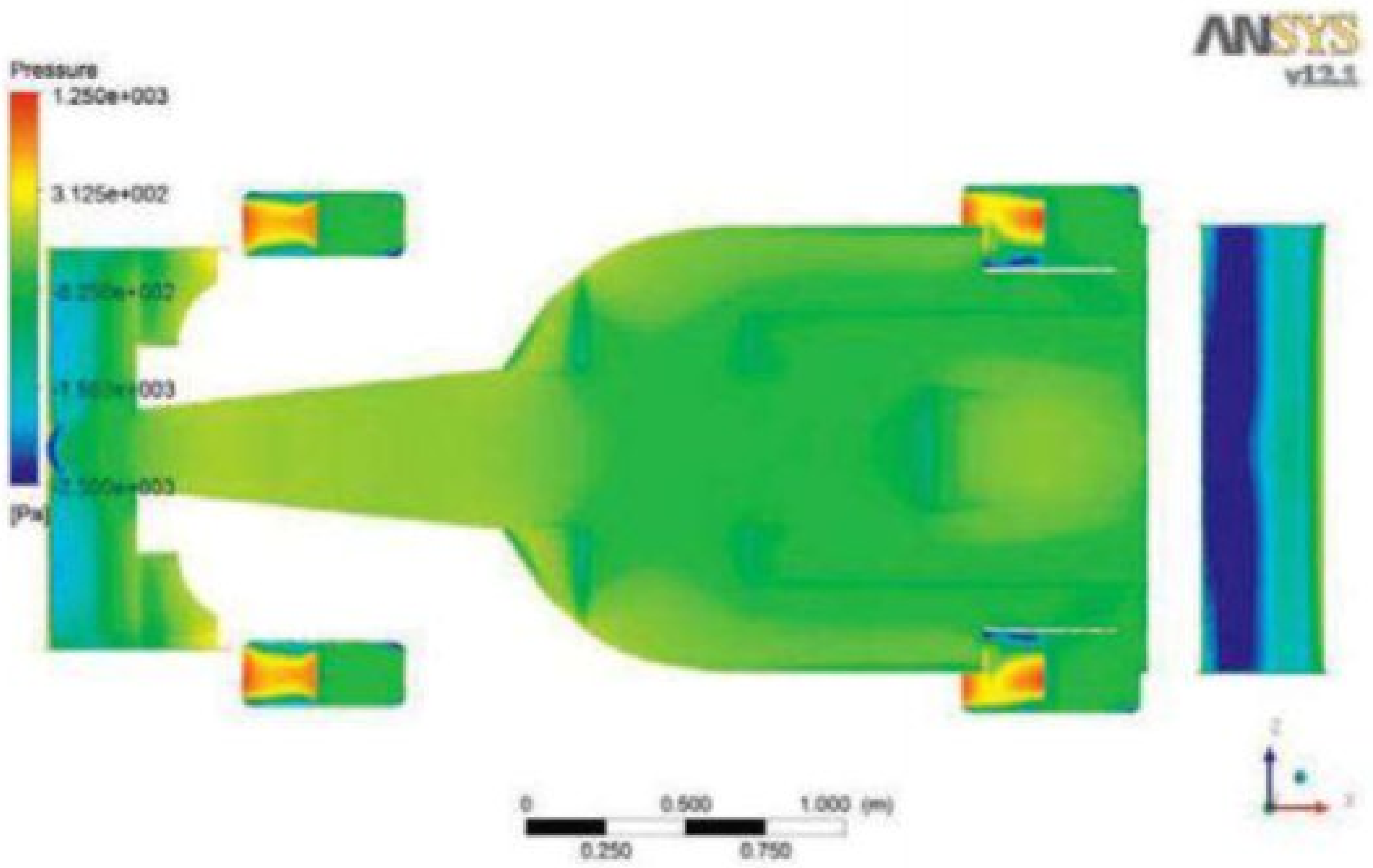


Figure 9: surface pressures on the underside of the low-nose, wide-body model

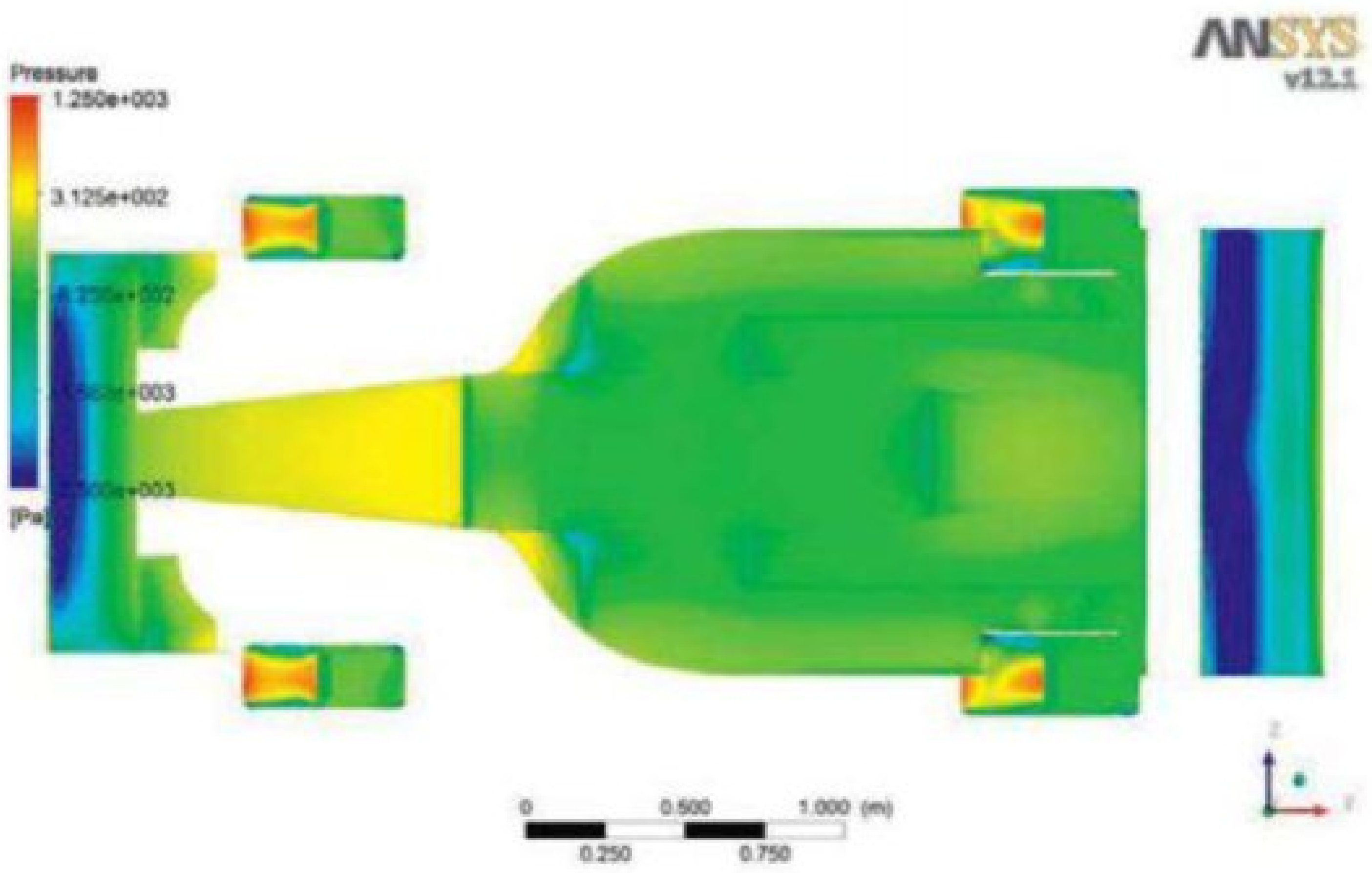


Figure 10: surface pressures on the underside of the medium-nose, wide-body model. Note especially the lower pressures under the front wing, but also the raised pressure under the forward, narrow part of the chassis

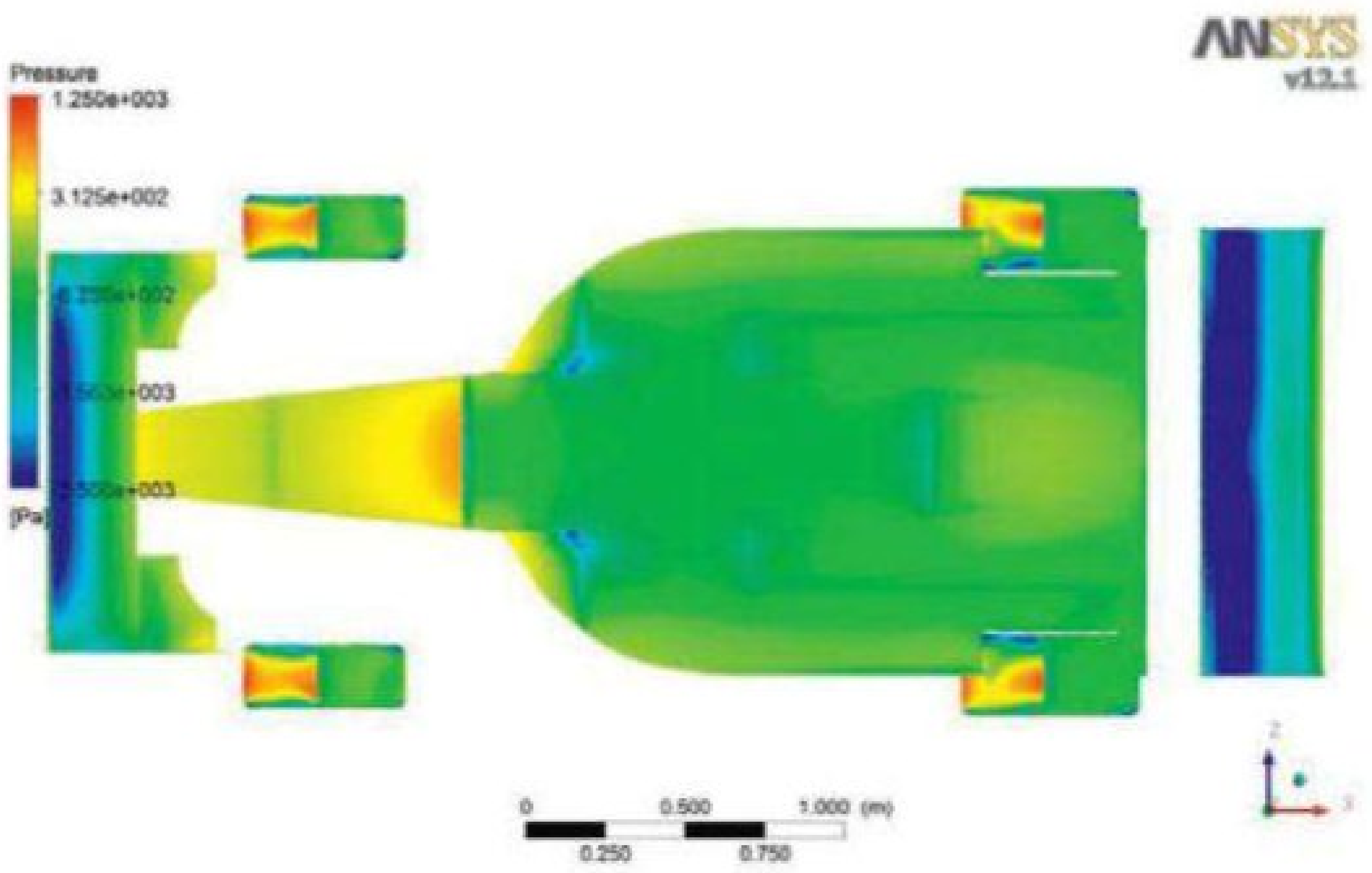


Figure 11: surface pressures on the underside of the high-nose, wide-body model. Note the higher pressure ahead of the 'splitter / divider', but also the generally lower pressures in the wider underbody

THE CFD SOFTWARE

CFD-Flo is part of the Ansys 12 Workbench suite, and provides access to the entry level fluid flow modules that are based on Ansys meshing and the CFX solver and post-processor. Gambit is now a legacy mesh generator and, in future, fluent users will also benefit from the same mesher as comes with CFD-Flo. This allows users to easily manipulate the size of the surface mesh applied to each part within a model, and also to the outer walls of the flow domain. The models featured in this article took about 15 minutes to set up and only five minutes to mesh running on one half of an Intel Core 2 duo-equipped PC.

The set-up module is also fairly easy to use (though slightly clumsy compared to the mesh set-up module) in order to allocate boundary conditions to the various parts of a model, and there is a choice of five turbulence models to pick from. CFD-post, the post-processing module, enables results and report generation, as well as a pretty good range of visualisation tools. In short, Ansys' assertion that CFD-Flo is making *powerful* CFD available to mainstream users seems entirely reasonable, and it is certainly well advanced on FloWizard, the previous Ansys entry level product.

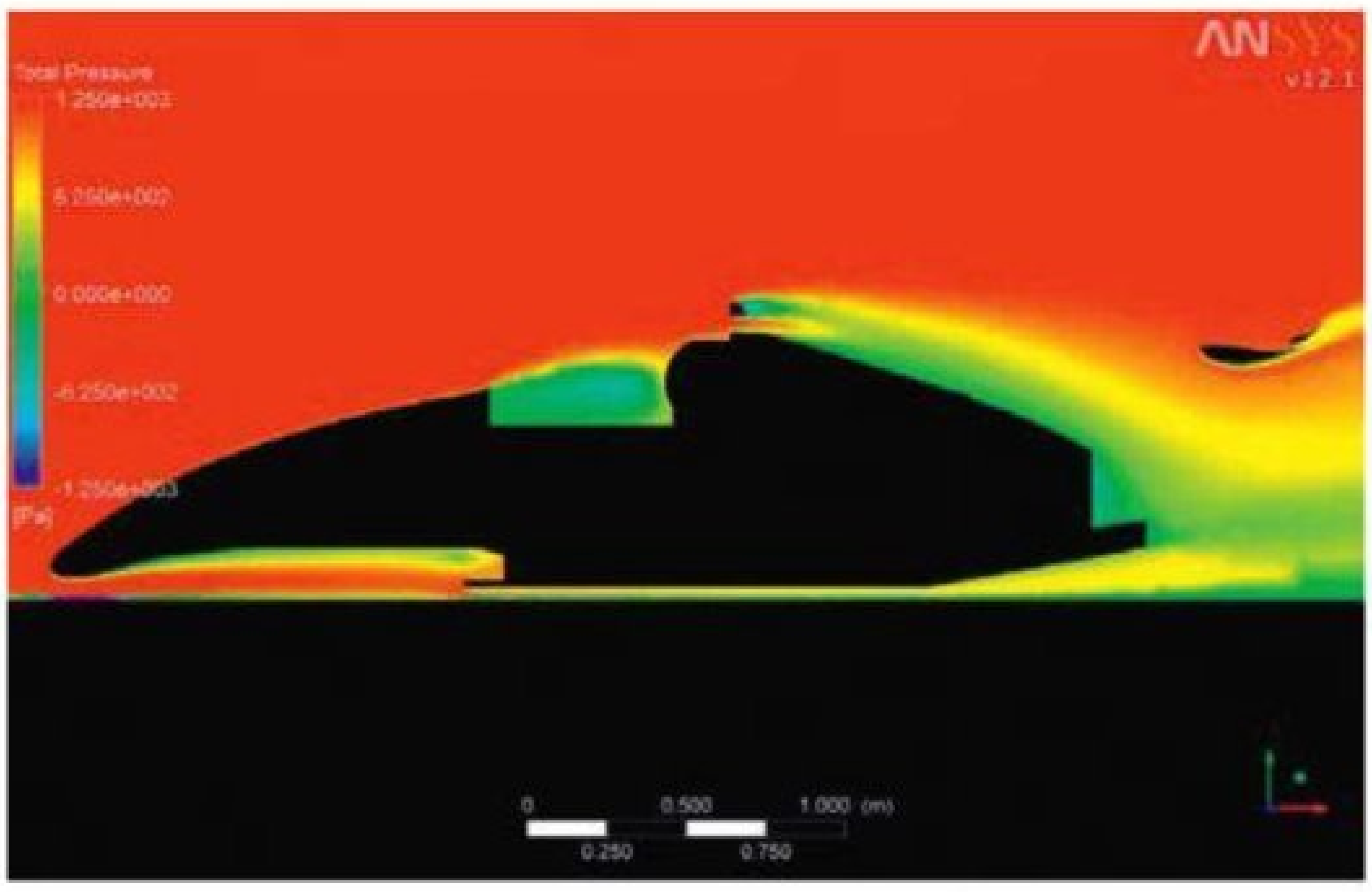


Figure 12: total pressures on the vertical symmetry plane of the medium-nose, wide-body model. Note the losses of total pressure aft of the nose / wing underside

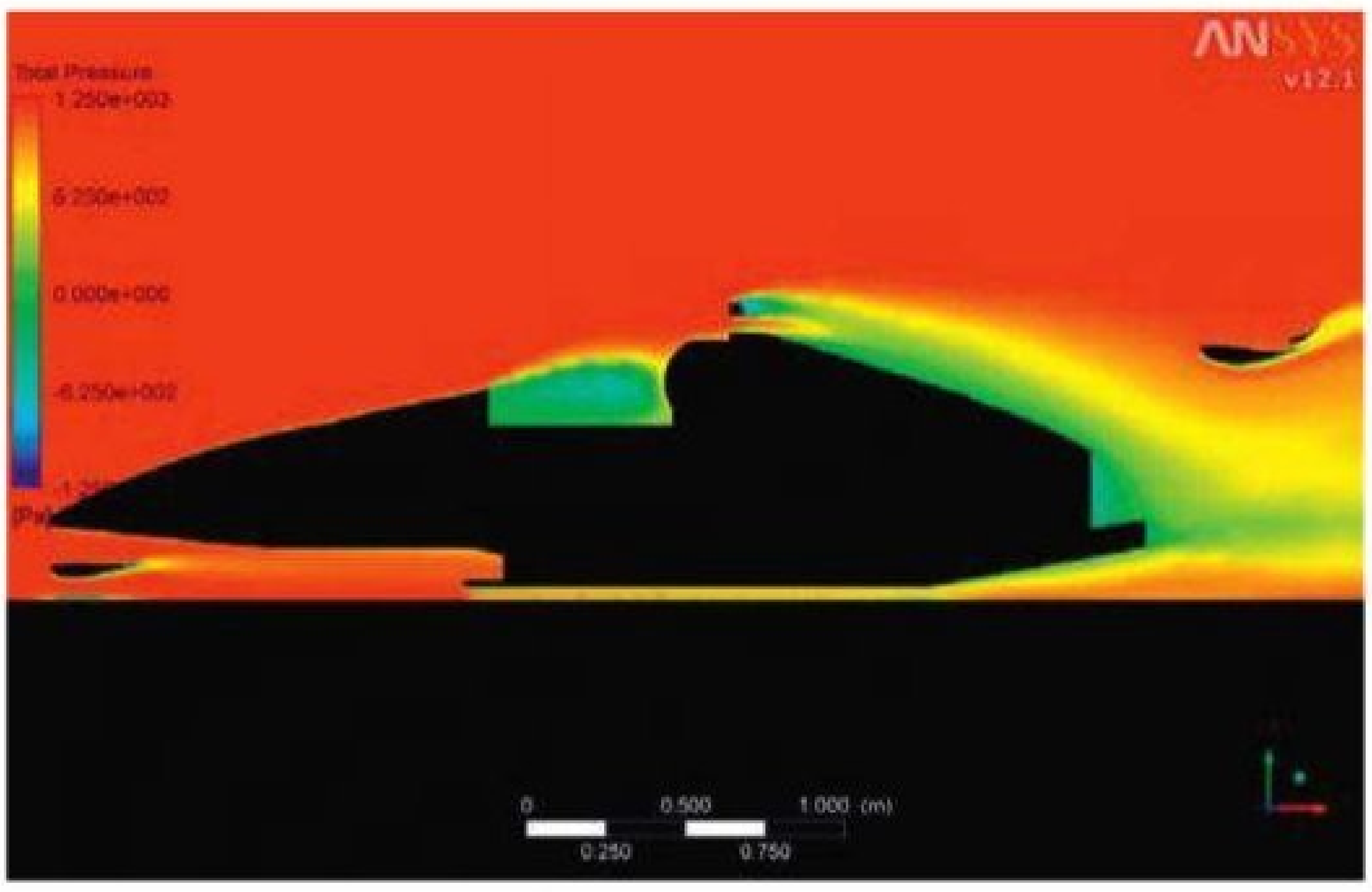


Figure 13: total pressures on the vertical symmetry plane of the high-nose, wide-body model. The losses from the front wing are minimal in this case, leading to increased energy in the underbody

wheels. The lift forces on the wheels were also markedly different, depending on whether they were rotating or not, while the drag forces were less affected. Figures 1 and 2 show the differences in the streamlines emanating from the wheels, tested in isolation here, and also the different pressure distributions on the wheel surfaces.

EVALUATION AND RESULTS

So, to test out the two concepts, six variations of the Vortex model were drawn up in 3D CAD: three nose configurations, designated low, medium and high, were applied to two different 'tub' configurations, designated narrow (no sidepods or underbody) and wide (with sidepods and a profiled underbody). Figures 3 to 8 show the variations. The basis for these CAD models was the central narrow tub, including nose, cockpit, driver, roll hoop and rear end, drawn up originally by motorsport engineering graduate Michael Bottomley, now studying for an MSc in Motorsport Engineering and Management at Cranfield University, to match the writer's 2D concept drawings. The writer then added the wings, wheels and sidepods and underbody, wing and wheel positions being identical in all six models here. The wing configurations were chosen on the basis of experience equipping cars in this and other hillclimb classes. Each model in turn was then run through CFD-Flo, and the forces on the various components were derived from the post-processing module. Total forces were then summed, and '-L/D' (efficiency) and '%front' (aerodynamic balance) were calculated.

The aerodynamic balance was a rough estimate only. It was assumed that wing downforce was applied directly to each axle, any counteracting leverages cancelling each other out. And the proportion of underbody downforce that was applied to the front end was estimated by examining the surface pressure plots on the underside. Visually, the lowest pressures were biased slightly forward of half way along the wheelbase, and so the aerodynamic centre of the underbody was assumed to be biased 55 per cent to the front. Wheel lift was subtracted from the downforce figures in this calculation, too.

Looking at the results of the narrow tub variants first in table 1, it was evident that the low-nose variant produced the lowest downforce figure of the three and also the lowest -L/D. Furthermore, the front downforce figure was considerably lower than in the other two cases, the natural assumption being that less available front wing area simply

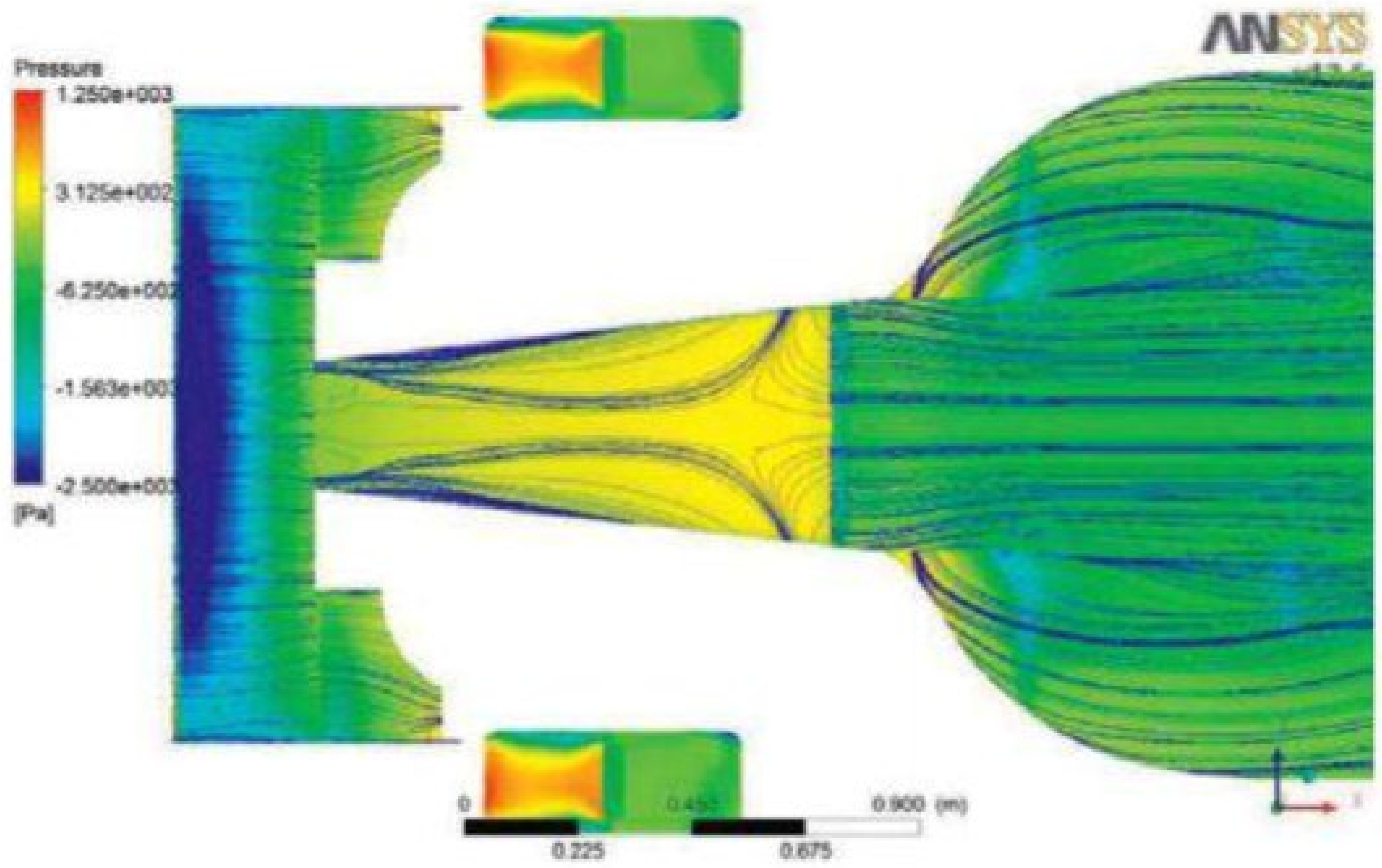
THE CFD APPROACH

The aim of using CFD on such a project raises some questions, key among them being whether the requisite ingredients were available for meaningful output to be derived. When speaking to anyone using leading-edge CFD today you would probably be told that to perform useful CFD on a full racecar model, a pretty serious computer cluster would be required, running a detailed CAD model with a computational mesh comprising at least 20 million cells. Formula 1 teams are reportedly using clusters of hundreds of processors and meshes of hundreds of million cells these days, and those numbers will continue to grow.

But this project has available just some very simple CAD and one dual-core PC. Early trials showed that larger meshes would flag up a shortage of available memory. The machine has the maximum available 4GB RAM, but 32-bit Windows XP Pro can apparently only address half of that per processor and the serial license available for these trials was limited to one processor. So three million cells seemed to be the limit the system would deal with.

This meant that the CAD model had to be kept pretty simple, and also limited the fineness of the mesh. However, if the reader will forgive the writer from referring to one of his own works, in *Competition Car Downforce* (Haynes, 1998), the predecessor of my current book, *Competition Car Aerodynamics* (Haynes, 2006) is a section on the CFD capability of the then Benetton F1 team in 1996/97. At that stage it seems that clusters of PCs in parallel were being used to solve problems, and the technology was 'just about capable of solving whole car problems... over a period of several hours.' Such complex cases involved 'a million or more mesh nodes' (equivalent to perhaps four to five million elements). Figures 16 and 17 show the typical density and tetrahedral type of mesh in use then, and the kind of visualisation output possible.

This helps to put the current state-of-the-art into a different perspective - 20 million mesh elements might well be the minimum in the 2010s for working at what could be referred to as the 'micro-aerodynamics' scale, as in Formula 1 for example. But, if a mesh comprising four to five million elements was just about good enough in the mid-'90s to solve problems on F1 cars, then three million elements ought to be adequate to apply to a simplified model of a project car now. The 'meso- and macro-aerodynamic' configuration changes envisaged for basic design optimisation of the Vortex involve some substantial shape changes, adjusting wing locations and configurations and so forth. And it was felt that performing CFD at this level ought to be not only extremely useful, but also a whole lot better than guessing or following fashion. Figures 18 and 19 show the mesh on part of the Vortex and a comparable visualisation to the Benetton image.



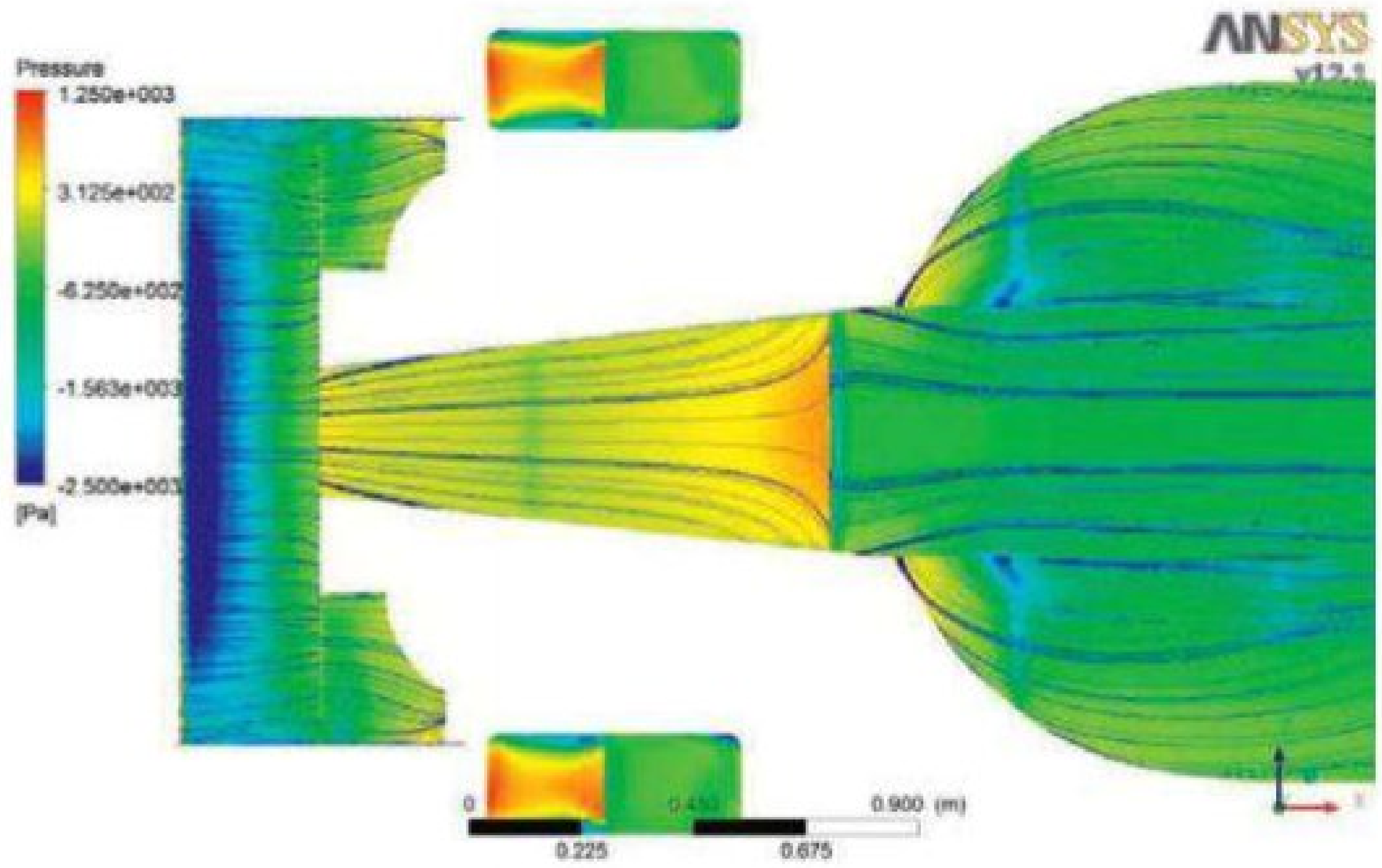


Figure 14: surface streamlines under the front end of the medium-nose, wide-body model. Flow separation is evident from the centre of the front wing trailing edge to part way along the forward chassis underside

Figure 15: surface streamlines under the front end of the high-nose, wide-body model show no flow separation

Table 1: forces (N) calculated by CFD-Flo at 100mph, with moving ground and rotating wheels on the narrow-tub variants

Narrow variant ie no sidepods or underbody (no simulated radiator either)						
Nose height	**Total Df**	**Drag**	**L/D**	**Net Front Df***	**Net Rear Df***	**% front**
Low	1865.7	668.9	2.79	509.0	1356.6	27.28%
Med	2024.8	672.9	3.01	706.8	1318.0	34.91%
High	1962.8	671.9	2.92	660.8	1302.2	33.67%
Nose height	**Tub Df**	**Fwing Df**	**Rwing Df**	**Fwheel Df**	**Rwheel Df**	
Low	95.6	467.4	1379.8	-11.0	-66.2	
Med	4.8	722.4	1382.6	-18.2	-66.8	
High	-16.0	695.0	1380.6	-25.4	-71.2	
Nose height	**Tub drag**	**Fwing drag**	**Rwing drag**	**Fwheel drag**	**Rwheel drag**	
Low	137.6	65.0	153.2	137.8	175.4	
Med	164.0	62.6	150.4	120.2	175.4	
High	160.4	63.4	149.8	122.0	176.6	

Table 2: forces calculated by CFD-Flo at 100mph, with moving ground and rotating wheels on the wide-tub variants

Wide variant						
Nose height	**Total Df**	**Drag**	**L/D**	**Net Front Df***	**Net Rear Df***	**% front**
Low	2465.4	731.6	3.37	817.5	1648.1	33.16%
Med	2535.0	732.0	3.46	957.6	1577.4	37.78%
High	2729.2	731.8	3.73	1054.4	1677.0	38.63%
Nose height	**Tub Df**	**Fwing Df**	**Rwing Df**	**Fwheel Df**	**Rwheel Df**	
Low	712.2	450.2	1377.4	-24.4	-49.8	
Med	592.4	681.2	1366.4	-49.4	-55.6	
High	765.8	669.4	1382.0	-36.2	-49.6	
Nose height	**Tub drag**	**Fwing drag**	**Rwing drag**	**Fwheel drag**	**Rwheel drag**	
Low	221.8	63.6	146.0	134.8	165.4	
Med	243.8	58.2	151.8	115.6	162.4	
High	245.0	60.4	145.8	114.4	166.2	

produced less front downforce.

It was also clear that the medium-nose variant produced the best downforce and –L/D of the three narrow tub variants. The margin over the high-nose variant was not large though and, perhaps taking into account the simplified models, a more reliable conclusion might be that there is little to choose between the medium and high-nose versions of the narrow tub variant. However, lending some credence to the better result with the medium-height nose, the breakdown of the lift forces shows differing contributions from the tub and the front wing and also the wheels between the two variants. Whether or not this might be a general conclusion for single seaters like this is hard to say, but in this case it looks as though a medium-height nose with which the front wing is integral was actually slightly better than a high nose. Note that overall drag barely altered between the three cases, even though the contributions from the major components did alter.

Moving on to the 'wide' variants, the picture became somewhat different, as the results in table 2 demonstrate.

This time the three variants fell into a neat pattern: downforce and efficiency increased as the nose height was raised. Again, total drag barely changed. And it's illuminating to see how the downforce trend came about by looking at the contributions from the tub and the front wing in particular, rear wing downforce remaining similar in each case and the wheel lift figures only changing by relatively small amounts. The low-nose variant's front wing produced the least downforce, presumably for the same reason as in the narrow-tub case: it presented less plan area to the airflow. But the tub in this case generated more downforce than with the medium-height nose, yet the wing on the medium-height nose model again performed better than on the low or high-nose models. However, in the high-nose case the sum of the front wing and tub downforce was greater than in either of the other two cases, even though the front wing didn't perform quite as well as it did on the medium-height nose.

STATIC PRESSURES

If we look at figures 9 to 11 we can see the static pressure on the underside of each of these three cases. Looking at the front wings first, it is apparent that as well as presenting less plan area for downforce generation, the wings either side of the low nose (figure 9) did not generate static pressures as low as in the medium and high-nose cases either. And the area of minimum pressure (dark blue) is slightly greater under the front wing on the medium-height nose (figure 10) than the high nose (figure 11).

ASTON MARTIN
Gulf
en•dur•ance |ɪnˈdjʊər(ə)ns| |ɛn-|
noun
the ability or strength to continue or last, especially d
stress, or other adverse conditions;
• the capacity of something to last or to withstand wear
ORIGIN late 15th cent. (in the sense [continued existence, a
lso as indurance): from Old French, from endurer 'make
Goodridge fluid transfer systems, built to last
lap after lap, race after race
PUSH THE LIMITS
MOTORSPORT INDUSTRY ASSOCIATION
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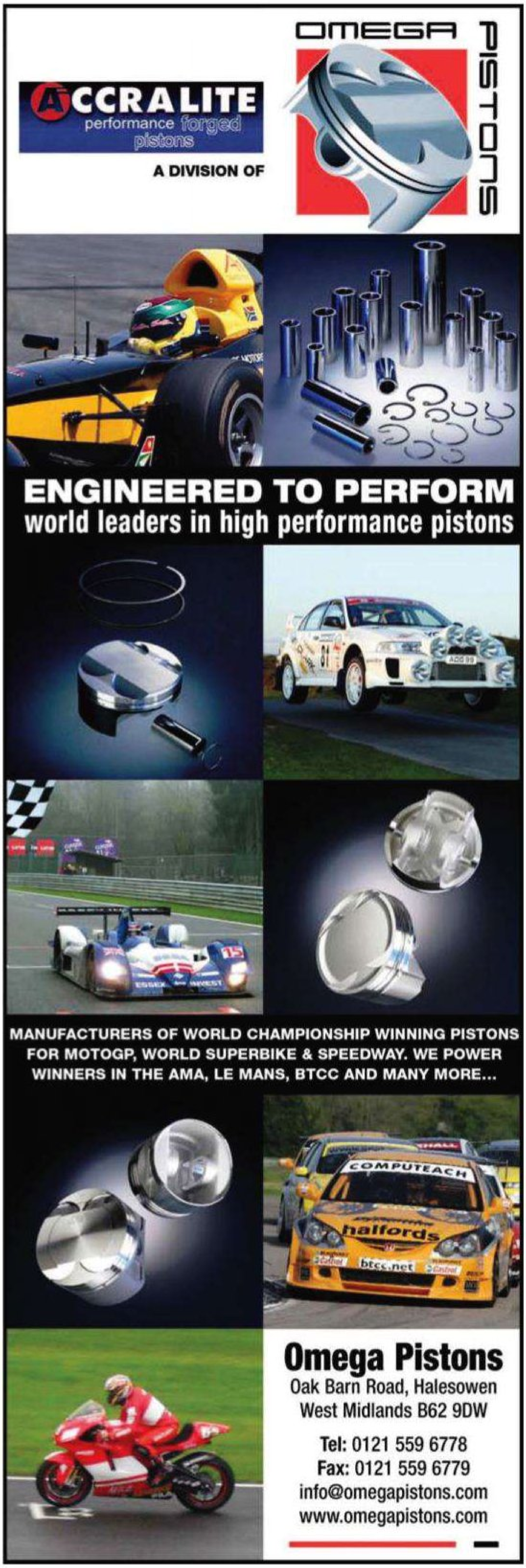

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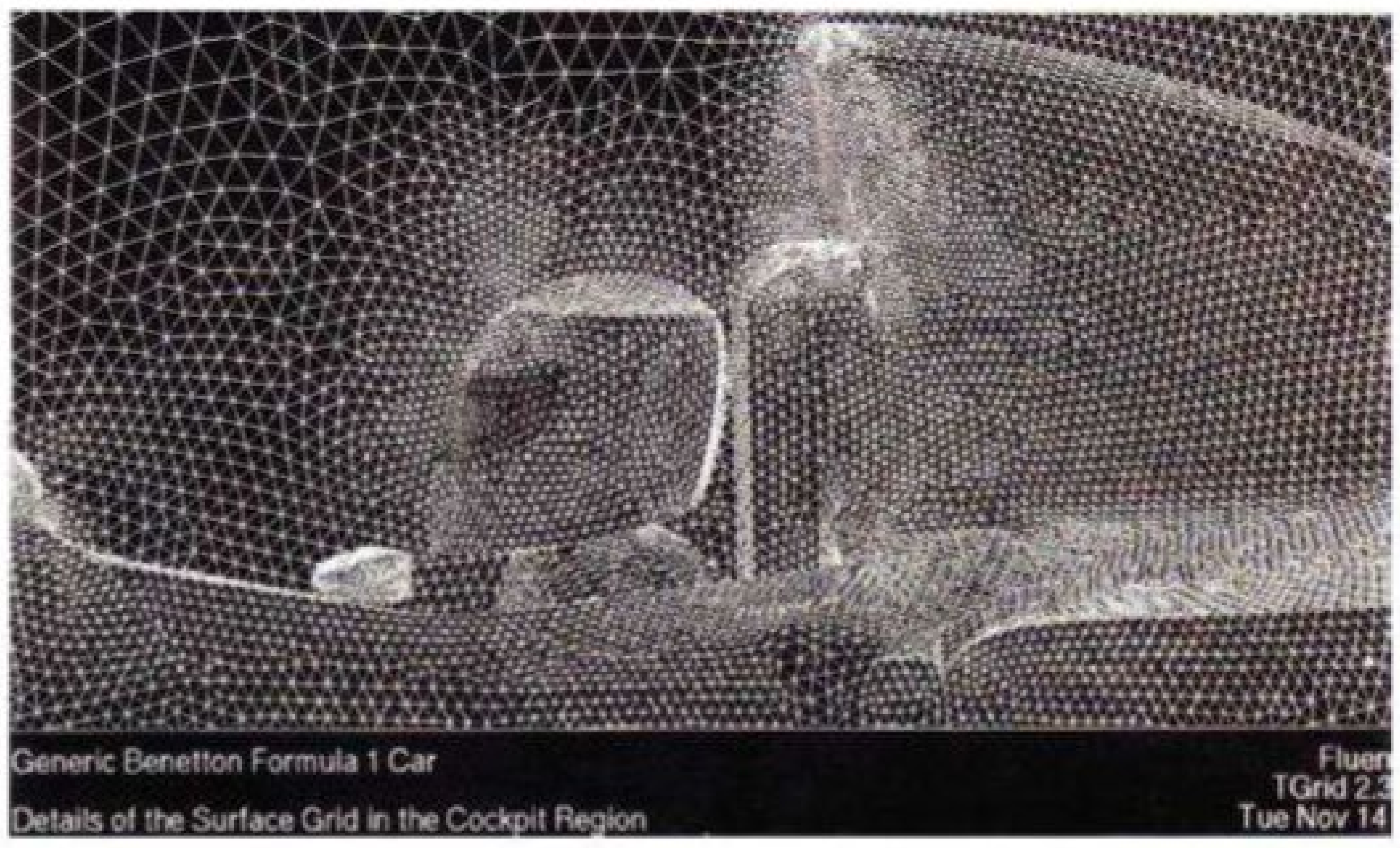

Image courtesy then Fuent Europe

Figure 16: mesh detail on a Benetton F1 model from 1996/'7

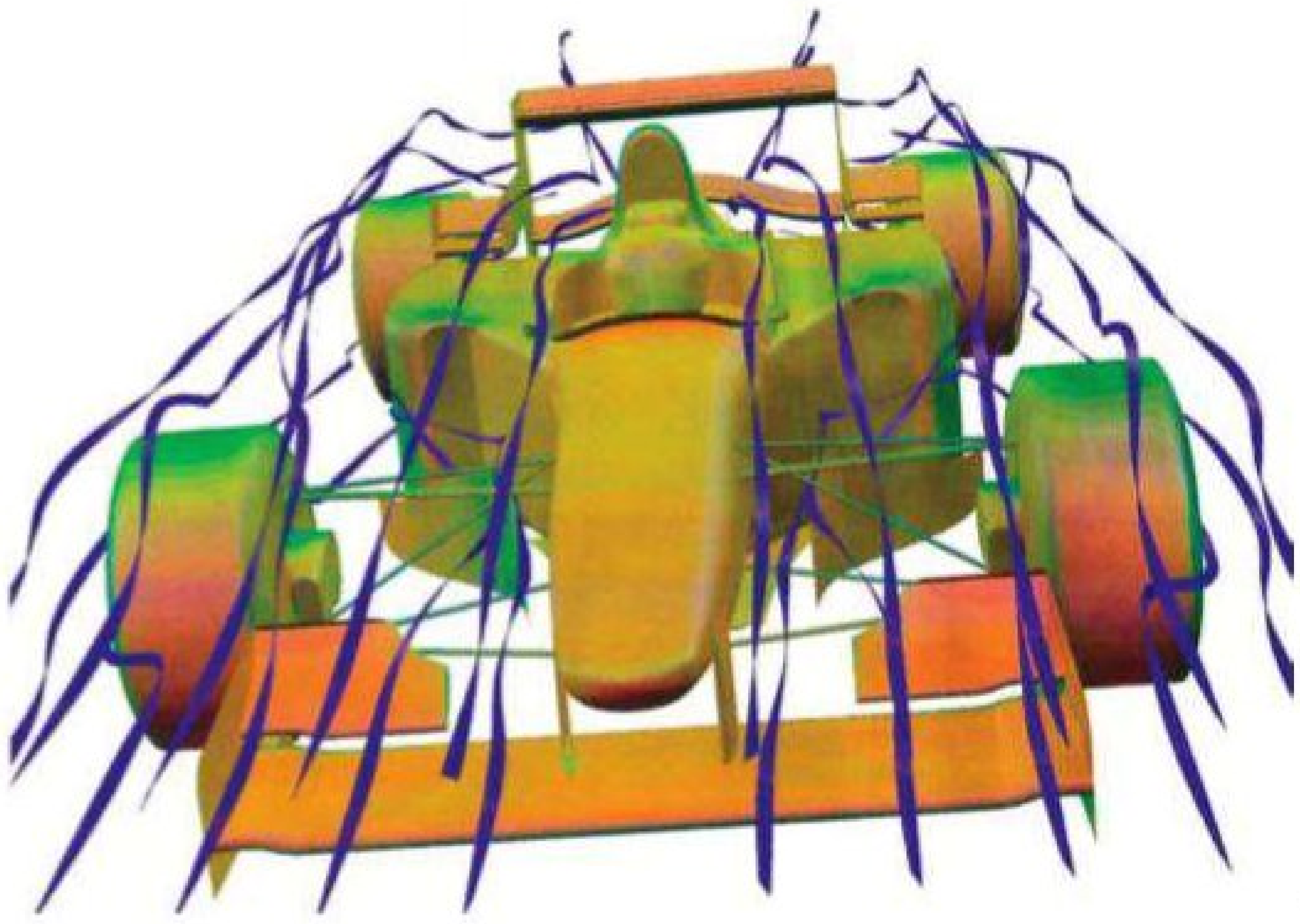

Image courtesy then Fuent Europe

Figure 17: surface pressures and streamline ribbons on the '96/'7 Benetton

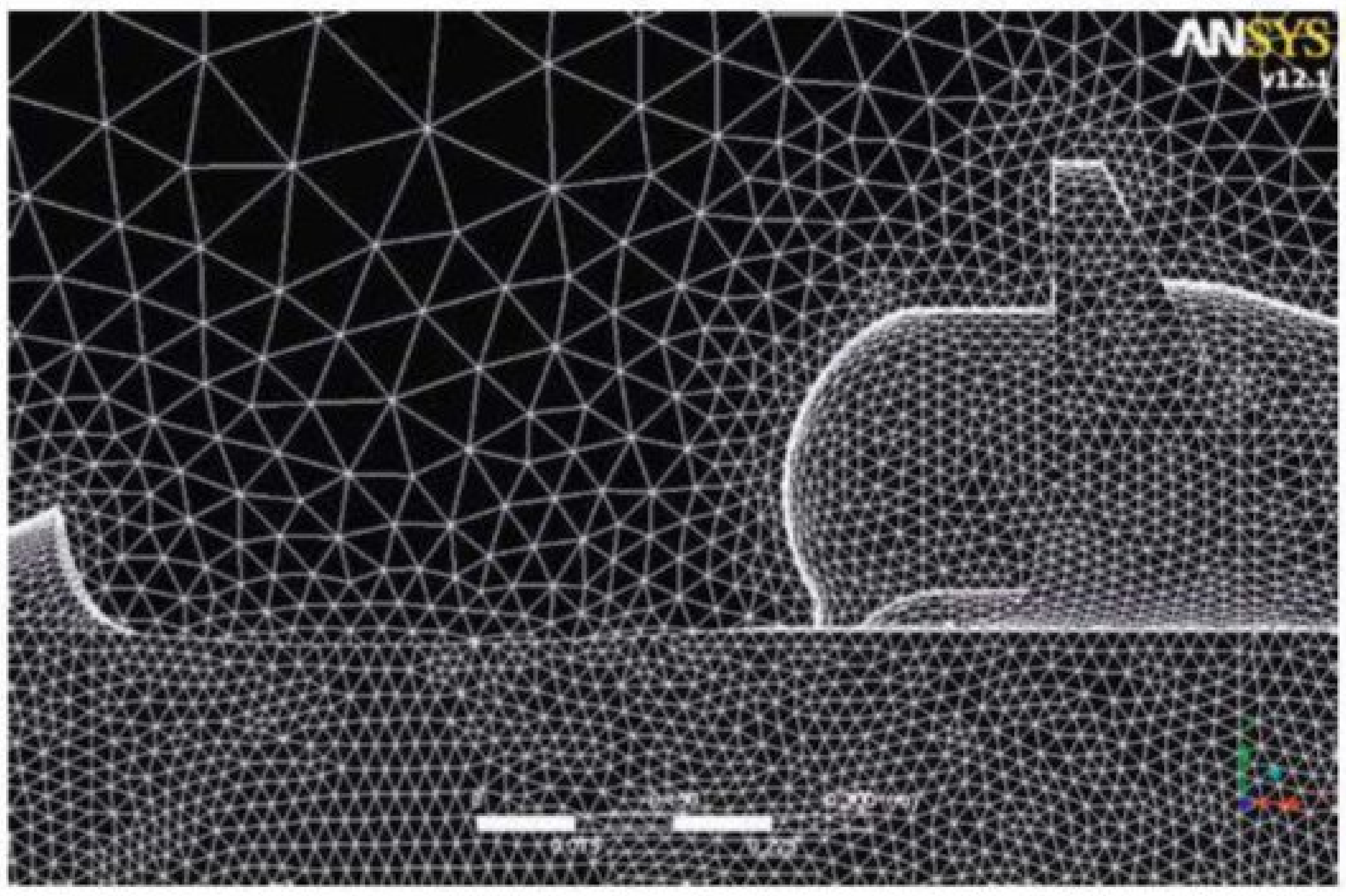

Figure 18: mesh detail on the simple Vortex model

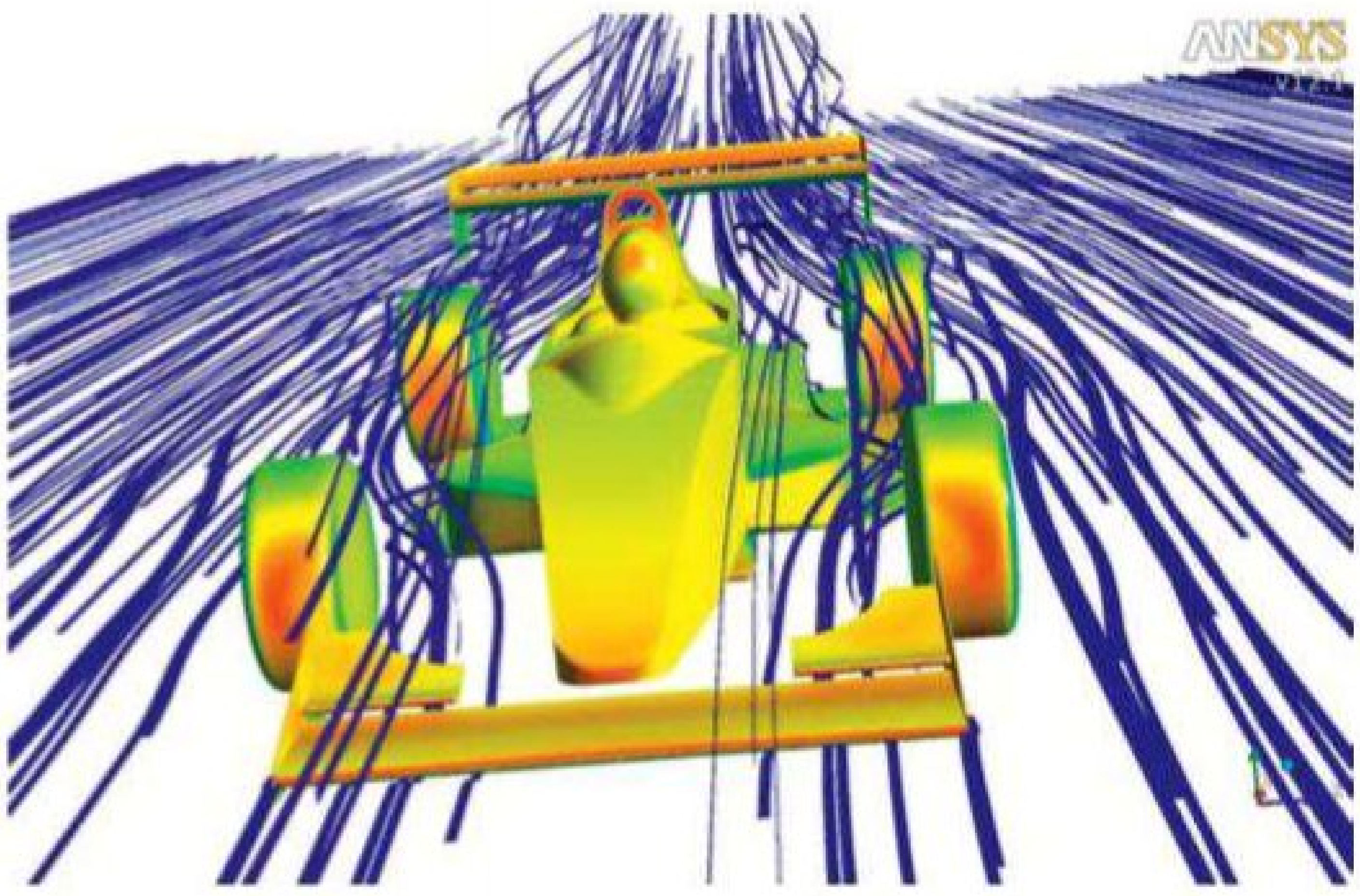

Figure 19: surface pressures and streamline ribbons on the Vortex model

However, moving to the forward part of the 'tub', ahead of the sidepods, it is evident that in the medium and high-nose cases this part of the tub produced more yellow to orange colouration, indicating slightly *raised* pressures, so this area is generating some positive lift. This was much less pronounced in the low-nose case.

Further rearwards in the underbody beneath the sidepods it was clear that as the nose was raised, more blue and green appeared, indicating lower static pressures here, and the high-nose tub generated the most downforce, in spite of the high-pressure area ahead of the 'splitter / divider'.

It's interesting to look at a plot of total pressure on the vertical symmetry plane in the medium and high-nose cases because this would appear to help explain the difference in the tub's downforce contribution. In figure 12, the medium-nose case, we can see there were total pressure (effectively total energy) losses from under the nose, stretching toward the main underbody, whereas in figure 13, the high-nose case, these losses were much less reduced. So the energy of the airflow reaching the central underbody was reduced in the case of the medium-height nose. Further investigation with surface streamlines showed some flow separation from near the trailing edge of the front wing stretching back along the forward tub underside, absent from the high-nose case (figures 14 and 15), so this could simply be a problem with the specific shaping here rather than a generic problem with a medium-height nose. Nevertheless, it seems logical to suppose, as we did at the outset, that a raised nose *should* allow a better feed to the underbody.

CONCLUSIONS

Taking the data generated in this exercise at face value, the conclusions seem unequivocal. If a narrow configuration is to be run, the medium-height nose worked best. If sidepods and an underbody are to be utilised, then a high nose is clearly best. The question of whether to go 'narrow 'or 'wide' superficially looks clear cut too – adding the sidepods and underbody added approximately nine per cent drag, but this first iteration of underbody design yielded nearly 35 per cent more downforce than the best 'narrow' set up tested here, with -L/D increasing by nearly 25 per cent. However, feeding the downforce numbers into the simple spreadsheet-based performance simulation tool showcased in V20N2 showed that the downforce gain is a little short of the target required to offset the extra mass, so optimisation work will continue! There are also plenty of other areas that have attracted attention from this initial CFD work where design details can be improved – the trick will be to draw a line at some point in order to get on with construction.

Thanks to Ansys UK and to Mike Bottomley for their valued support.

Relevant technical regulations UK hillclimb 'racing cars'

- Maximum width ahead of front wheels: 150cm
- Maximum width behind the front wheels: 140cm
- Maximum height of parts ahead of the front wheels and more than 110cm wide: no higher than the top of the front wheel rims
- Maximum height: 90cm from the ground (excluding roll hoop and airbox)
- Maximum rear overhang: 150cm behind the rear axle line
- Minimum ground clearance 4cm on the simple Vortex model

Project outline

Composite single seater to UK speed hillclimb regulations

Engine/transmission: 988cc Suzuki GSX-R, chain drive, LSD

Power: 150-180bhp

Target weight: 300kg max (without driver)

Wheelbase: 2280mm

Track: 1410mm

Pulling power

Don Gatherer is using Formula 1 technology to break new ground in sports physiotherapy, including coaxing more performance out of racing drivers

BY CHARLES ARMSTRONG-WILSON

Though it looks fraught with inconsistency, repeating the exercises gave remarkably similar results, though naturally fatigue will eventually set in

The load cells used by Gatherer are supplied by Beru F1 and are the same as the ones used on the suspension of Formula 1 cars

Neck muscles are particularly important for racing drivers, so tests have been designed to measure the muscles' resistance to an applied load. The subject resists as long as possible, and a graph of the results is produced

"applying [F1] load cell technology, we can do objective analysis of muscle and joint actions"

What is the least quantifiable facet of a racecar? Aerodynamics perhaps? Or maybe the tyres? Actually, it has to be the driver. Despite the almost robotic ability of some pilots to deliver repeatable performances, all drivers on occasions are inconsistent. It could be their state of mind, nutrition or physical health but, unlike a racecar, there is never much recordable data on the driver.

This is a problem that has exercised Don Gatherer's mind over the last decade. He is a physiotherapist specialising in the health of sports men and women. In addition to extending the careers of professional rugby players in the face of injuries, his client list includes Red Bull Racing driver Mark Webber.

Webber hit the headlines last year when it emerged that for the last few races, whilst in contention for the championship, he had been nursing a shoulder injury.

Through working with Webber, Gatherer had been exposed to much of the data-logging technology employed in Formula 1 and noted the contrast with physiotherapy. 'While we try and get as close to a diagnosis as possible, we are somewhat hamstrung by a lack of objective analysis. But we really should base as much around objective analysis as we can,' he says.

There are some devices out there that the medical profession uses. 'Current options would try to analyse strength using a very basic programme of digital pressure devices, or you might give them a weight. There are machines out there, but they are difficult to set up and very time consuming, so we are up against it with objective analysis.' Unhappy with his technical armoury, Gatherer was looking for a better solution. 'How can I improve physiotherapy with a good simple, quick device that can be used around people?' he wondered.

Early experiments with load cells were disappointing: 'They were clunky, heavy and unreliable. [But] I was helped a lot by Mark and was directed to the people and companies that provide the high spec data logging used in F1. Now I've applied that technology to a system we use in medicine.'

The load cells he uses are supplied by Beru F1 and are the same as the ones used on the suspension of F1 cars. 'What we are doing is, by applying load cell technology, we can do objective analysis of muscle and joint actions. Once we have a profile of those actions we can then see if there are any deficits between left and right exposing any existing problems. This will also give us the parameters that the muscle can work within so, if we then want to apply a training programme, we know that we can design one that won't exceed the forces that can be generated by that muscle or action, thereby avoiding damage.

'We can measure peak force and how much it can generate then, using that figure, we can then calculate its endurance ratio at whatever percentage we want. So, if we want to look at 50 per cent of the peak torque, we can then see how quickly the muscle will fatigue at that level. This will then give us the training programmes. We can then look at strength gaining programmes and endurance programmes, or a combination of both.'

ACCURATE MEASUREMENT

Any athlete, racing drivers included, can be harbouring problems about which they are completely unaware. These can go unnoticed, but have a significant effect on their performance.

By accurately measuring the driver's strength and endurance these problems can be exposed. Gatherer demonstrated his technique to us using Nissan GT racer, Peter Dumbreck, as a willing subject.

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The load cell is incorporated into a device that allows measurements to be taken in either tension or compression. An endurance test using a constant load can be used to measure a subject's stamina

PRE-DEFINED TESTS

The load cell is incorporated into two devices that allow measurements to be taken in tension or compression and recorded over time by a software package Gatherer has had written specifically for his purposes. It allows more than 90 pre-defined tests to be carried out and the results recorded and analysed.

For the demonstration, he concentrated on the muscles associated with the neck, which are particularly important for a racing driver, not just due to cornering *g*, but also under acceleration, braking and the constant jostling of a racecar as it covers a lap.

The load cell is mounted in a unit about the size of a drinks can and communicates wirelessly with a standard laptop computer running the software. During the test, the physio holds a handle connected to one end of the cell and a cable connected to the subject is anchored to the other.

During his early work with Webber, Gatherer experimented with a crash helmet as a means of feeding loads into the head but found it was not a good system. Many drivers do use their helmet as an anchorage point for training the neck muscles, but Gatherer cautions against it. He points out that the way the helmet grips the head is not designed to take large load inputs and using it this way could actually cause damage to the neck. Instead, he uses a set of harnesses that are designed to grip on the surface of the body and apply the force from the right point.

> “there is never much recordable data on the drivers”

THE NECK TEST

With Dumbreck's head in the harness, Gatherer applies a load and tells his subject to resist it as long as he can. The force rises and the driver's muscles tense until they can't resist any more and his head flops over. And there, on the computer is a graph of the load rising with time and reaching a peak value before falling off rapidly.

It all seems rather imprecise but, to prove his point, Gatherer repeats the process and comes up with a very similar figure. So it is repeatable, but can it be fooled? He insists not. 'You can tell by looking at the curve and how it falls off. You can't fake that.'

Then, when he repeats the test twice each on all the muscle groups of the neck, something interesting is revealed. 'You are weaker on right side,' he announces to Dumbreck's surprise. 'We don't know why, it could be legacy of injury, but we know you've got a problem on the right-hand side. We can check the side flexors to see if there are any problems. If not, then it's a rotative problem.' More importantly, having identified the weakness, Gatherer explains how he can then plan a treatment programme to correct the problem.

'We look at the neck in a very global way, so we know the forces the neck can generate in a safe position, the flexors, extensors, side flexors etc in rotation. This then gives us the baseline to apply forces in rehabilitation.'

Finally, he does an endurance test by seeing how long his subject can resist a constant load to measure stamina.

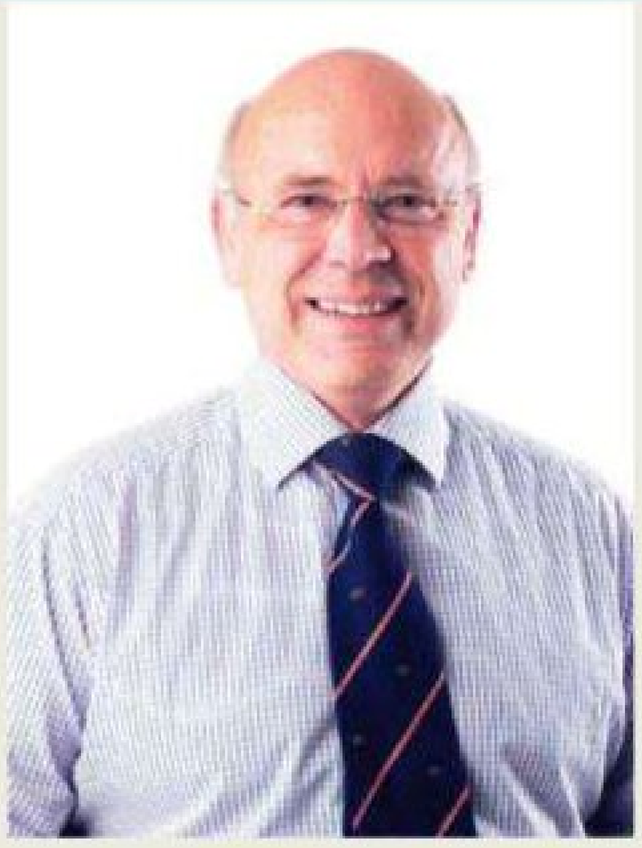
This is particularly important for racing drivers in resisting g forces. 'So if we want to look at 50 per cent of the peak torque, we can then see how quickly the muscle will fatigue at that level. This will then give us the training programmes,' Gatherer explains. 'It's not just strength but stamina.'

THE WUSSIE BUTTON

Drivers who lack the stamina to keep their heads up during an entire race can lose performance toward the end of the distance. Resting your head on the side of the cockpit, or what Webber calls 'the wussie button', is not a good way to sense what the car is doing. And, once the neck gives out, it cannot recover until the race stops. Gatherer has even been given a *g* load plot from the car's data logging so he can quantify how much work the neck will have to do in a race and design a training programme to suit.

With the data collected, a subject's condition can be assessed and their training tracked to ensure they have the capacity to perform at their best through an entire event. So, by applying a piece of F1 technology to his profession, Gatherer believes he has eliminated one of the unknowns from the complex package that is a race entry.

DON GATHERER



A renowned research physiotherapist with over 40 years' experience, Don Gatherer enjoys an unrivalled reputation in sports and research physiotherapy. After playing rugby at international level for Singapore, he has provided his physiotherapy services to the British Lions and England teams.

Away from rugby, Gatherer was chief physiotherapist to the Great Britain Olympic Team, including tending for Steve Ovett and Sebastian Coe at the 1980 Moscow Games. He has also worked with footballers, F1 drivers, skiers, boxers, horse riders, rowers and field athletes, providing conditioning and rehabilitation programmes and support.

After opening his own practice (Tudor House) in Aylesbury that has provided over 400 cervical (neck) case studies, Gatherer has focussed on proprietary research, specialising in cervical and lumbar analysis through the design and development of objective data logging procedures. Projects include *g* force tolerance, motor function testing and working closely with neurosurgeons to provide analysis as a diagnostic aid for surgical intervention decisions. Gatherer believes this knowledge offers benefits outside of sport and, in 2010, set up The Gatherer Partnership to provide the tools and skills for objective analysis in the sport, leisure, defence, public health care, insurance and other sectors.

Plus ça change...

The 2014 Formula One cars will look similar to the current crop, and will be almost as fast, yet the sound and technology will be new

BY SAM COLLINS

To say that there will be a new look Formula 1 in 2014 would not be correct. There will be little difference visually – a slightly smaller front wing, and perhaps a few new liveries, but the dimensions and core aerodynamic components will all remain essentially the same. However, the cars will most definitely sound different, with all-new, 1.6-litre V6 engines powering the cars.

The FIA had originally intended for a new powertrain formula to be introduced in 2013, very loosely based around the purpose built, four-cylinder, 1.6-litre global race engine concept used in WTCC and WRC. It was all meant to make grand prix racing more relevant to series production cars. But after protests from some of the teams, the introduction of the new regulations were delayed until 2014 and the in-line fours gave way to six-cylinder engines of the same capacity.

The layout change did not suit all manufacturers. Renault was highly advanced with the development of its four-cylinder unit before the rules were changed: 'Substantial amounts of work from the four had to go straight in the bin,' explains Rob White of Renault Sport F1. 'Not all of it, thankfully. We tried to recover what we can and re-orientate it to the new programme. As ever, we may need to structure the engineering programme counting backwards from the first race in order to arrive in the most competitive possible state.

'It is important to recognise that this is a massive technological change for the engine people in F1. A clean sheet of paper, new engine, fundamentally very different to its predecessor, hasn't happened really since we made a switch in the opposite sense, from turbo to normally aspirated engines at the end of the 1980s.'

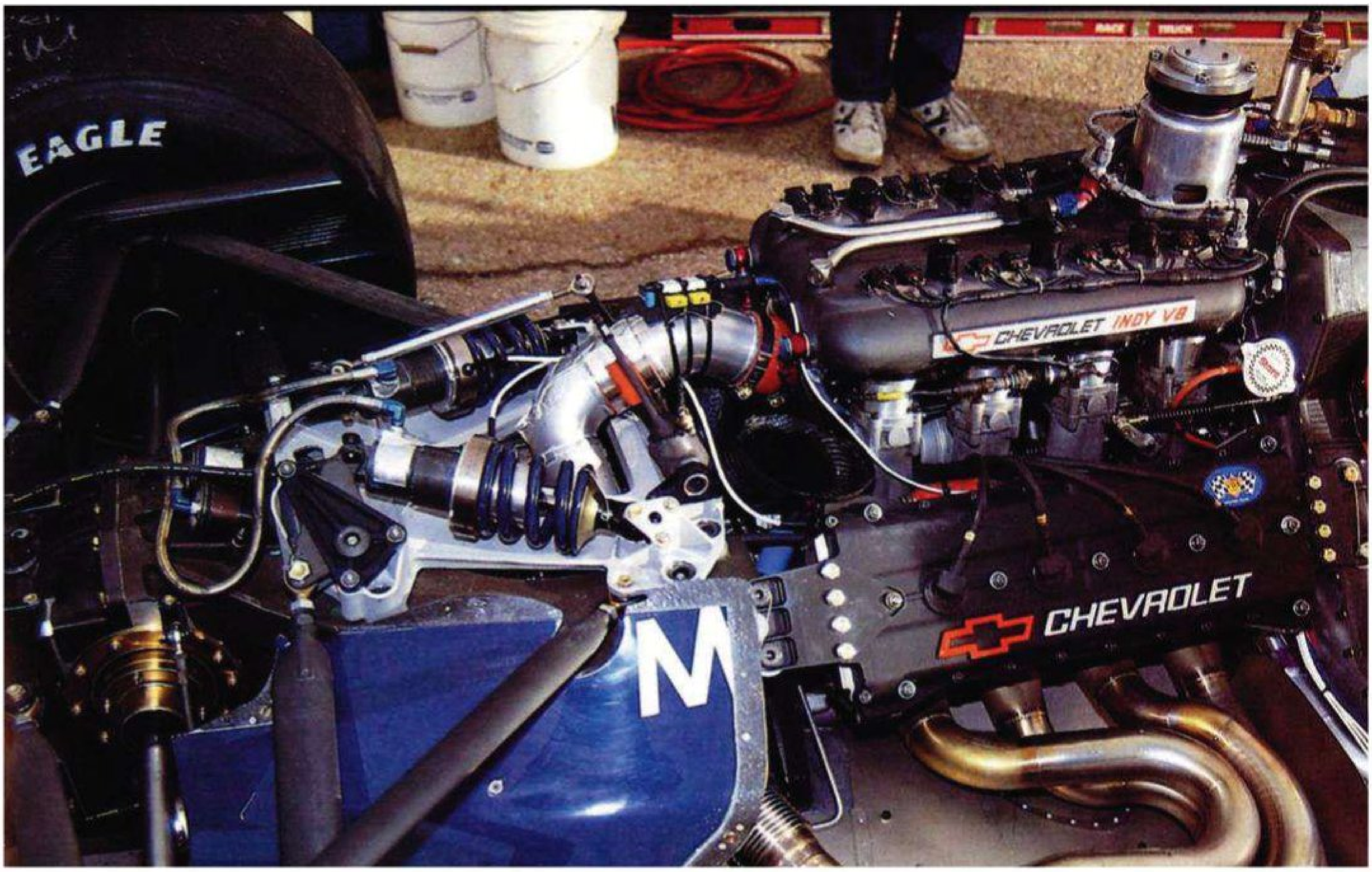
> “this is a massive technological change for the engine people in F1”

Cosworth's staff have a more positive attitude, with boss, Mark Gallagher, saying, 'the V6 engine has got a lot of people in Northampton smiling because we have very talented people who, quite frankly, live for the day when they can get out of bed and design new racing engines. Particularly when we are taking on some of the giants of the sport.'

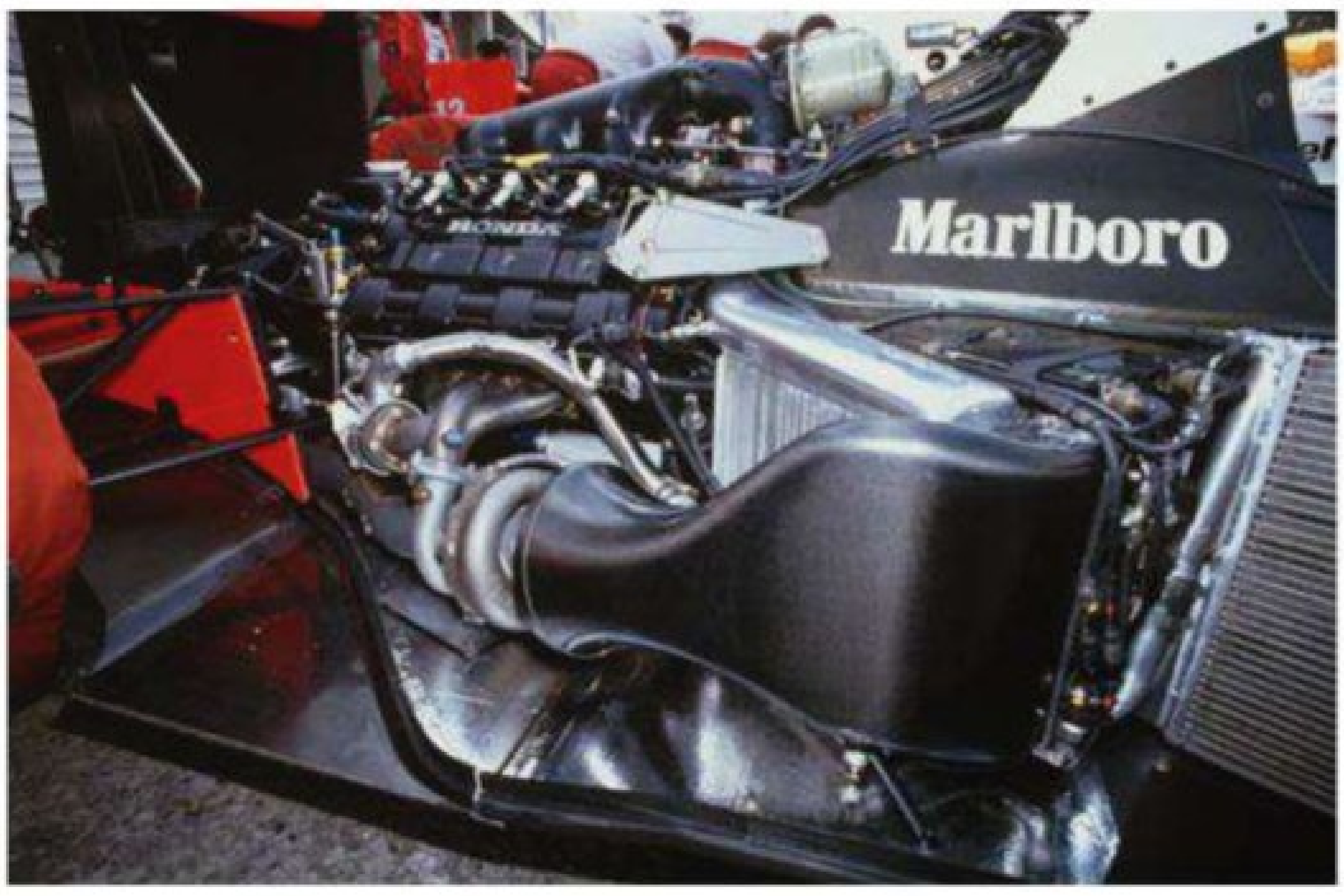
Along with downsizing, one of the key changes to the engines is the re-introduction of turbocharging. All of the new engines will have a single turbo, but the regulations specifically do not allow them to adopt the layout pioneered by Audi on its mono-turbo R18, with the turbine mounted inside the v of the engine. Instead, it is likely that most teams will opt to mount the turbocharger behind the engine and above the transmission, or perhaps in the bellhousing, as on the 1993 Galmer Indy car.

TURBO TECHNOLOGY

A new technology for grand prix racecars will also feature in the exhaust system – energy recovery. This will be a variant of electronic turbo-compounding (see Ralph Koyess' description in V20N8). Interestingly, Peter Wright points out that Keith Duckworth warned in the Renault days that turbo-compounding would be



The Indy 500-winning Galmer, which has a single turbo mounted in the bellhousing behind the engine - a layout likely to appear in F1 in 2014



The last time forced induction was used in Formula 1 was in 1988, when McLaren dominated the formula with twin-turbo Honda power

inevitable if turbo engines were allowed back into the formula.

Exhaust gas energy recovery by turbo compounding is of real interest to the automotive industry for the future, but its past is firmly rooted in the aviation industry. 'The development of turbo-compounded aircraft engines was leading to less power from the piston engine and more from the turbine,' says Wright. 'The logical conclusion of this was that the piston engine became the last stage of compression and the combustion chamber the first stage of expansion of a turbo-shaft engine. Now, if one throws away all the reciprocating parts and puts in some extra compression and expansion stages, and a combustion can, how much simpler that would be!'

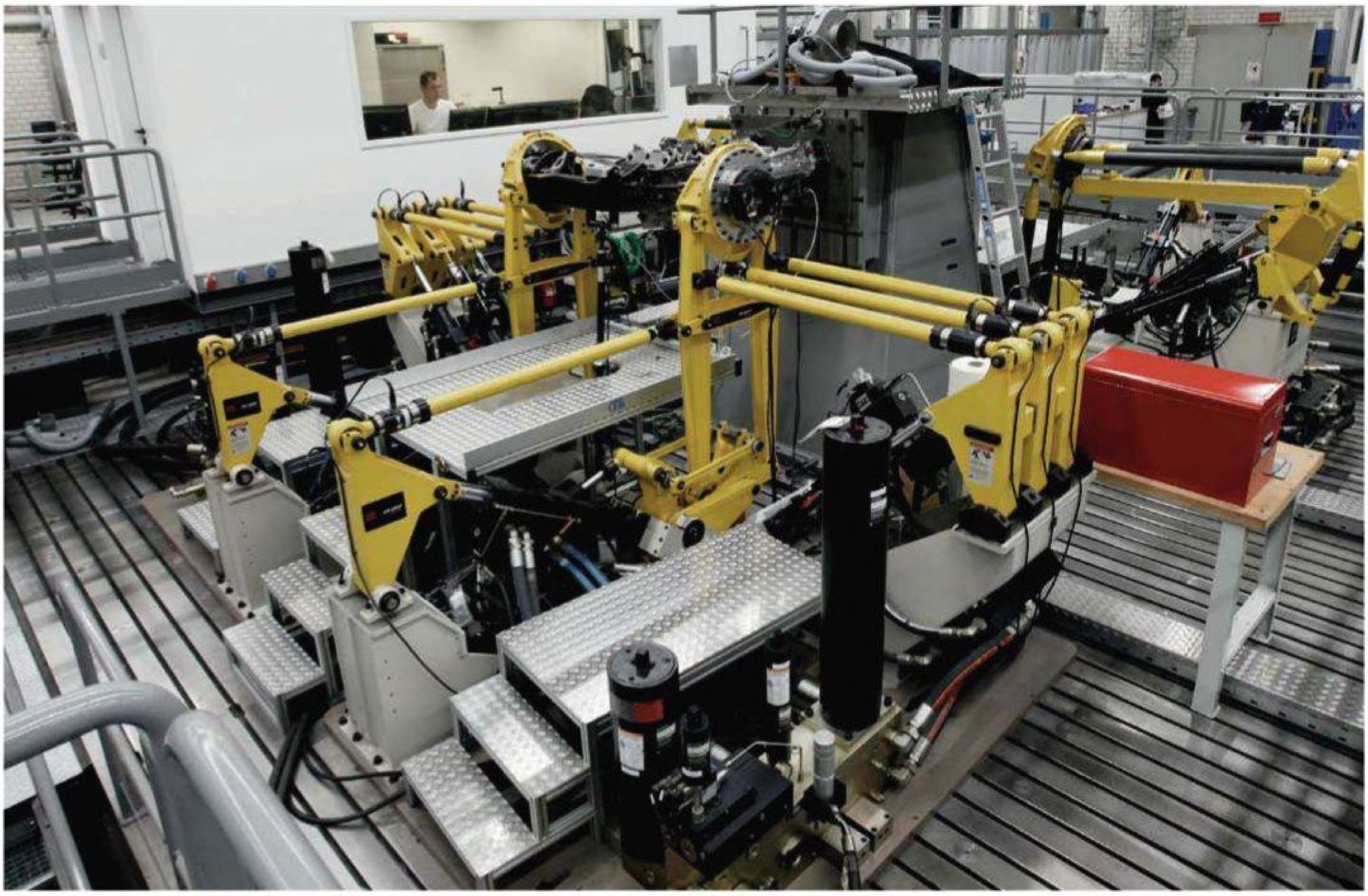
Energy recovery systems will not be limited to the exhaust gasses, the current crop of KERS will be substantially increased in performance, from 60kW to 120kW. Cars may also be required to travel in pit lane on electric power only.

'Of course it will give a bigger performance boost than what F1 is used to handling with current 60kW / 400kJ KERS,' says Pascal Vasselon of Toyota Motorsport. 'This 120kW system will still be recovery limited from the kinetic energy side. The limit will be the amount of energy it is possible to recover during braking. You have the possibility of 120kW, which is for power in and out. For power out that is good because the time on the throttle per lap is quite long, so theoretically you are allowed to use this 120kW for quite a long time to accelerate the car. Therefore the energy released could be big (but limited by regulation). The issue is that after emptying the initial battery charge you can use only the energy you can recover, and you have this 120kW limit during braking as well. This is when you recover the kinetic energy, and this places a limit on the energy available to you because of the short braking times in F1.

'On top of the kinetic energy will come the recovery of exhaust gas energy, so the total performance gain will depend on the actual realistic figure for exhaust recovery, without hurting the performance of the combustion engine.'

These higher capability systems are likely already in development, and will certainly make F1 more relevant in the field of battery technology, with the cells all having to be mounted inside the monocoque beneath the fuel tank, where restrictions on cooling, volume and mass will place a real challenge in front of the chemists. Currently, the location is free and teams have the units mounted in a number of locations, including in the sidepod and alongside the transmission as on the Red Bull.

The systems will likely cost more but it does not seem to concern Mike Gascoyne, technical director at Team Lotus, who explains that 'the overall costs will inevitably be higher but, as everyone will have to have the same larger systems, everyone will be affected the same. There will also be an associated cost with the higher capacity system in terms of implementing the larger system and the logistics of operating it worldwide. Does that mean higher budgets? No – it probably means using



R and d facilities such as TMG in Cologne are gearing up to cope with the difference in brake balance the proposed new energy recovery systems will bring

budgets more effectively elsewhere to fit within what can be spent.'

Integrating the systems will be a substantial challenge for not only the electrical engineers and loom specialists, but also for the vehicle dynamicists, as Vasselon reveals: 'With this level of KERS power F1 will now experience the need for a controlled brake balance. The 60kW power was roughly corresponding to what engine braking can achieve, so the teams were trading off engine braking and replacing it with KERS torque to control the brake balance using a normal, passive brake system. But with 120kW, whether you have KERS on or off creates a difference in brake balance that you cannot compensate for with engine braking torque, and this creates a potential controllability issue for the driver. To cover this problem you need to develop a controlled brake balance system - an intelligent, variable, active system. This is an interesting challenge in terms of control and vehicle dynamics. Here at Toyota Motorsport we have a very active hybrid and electric powertrain department and we have already experienced - and satisfactorily addressed in most cases - the effect of a larger KERS units on braking.'

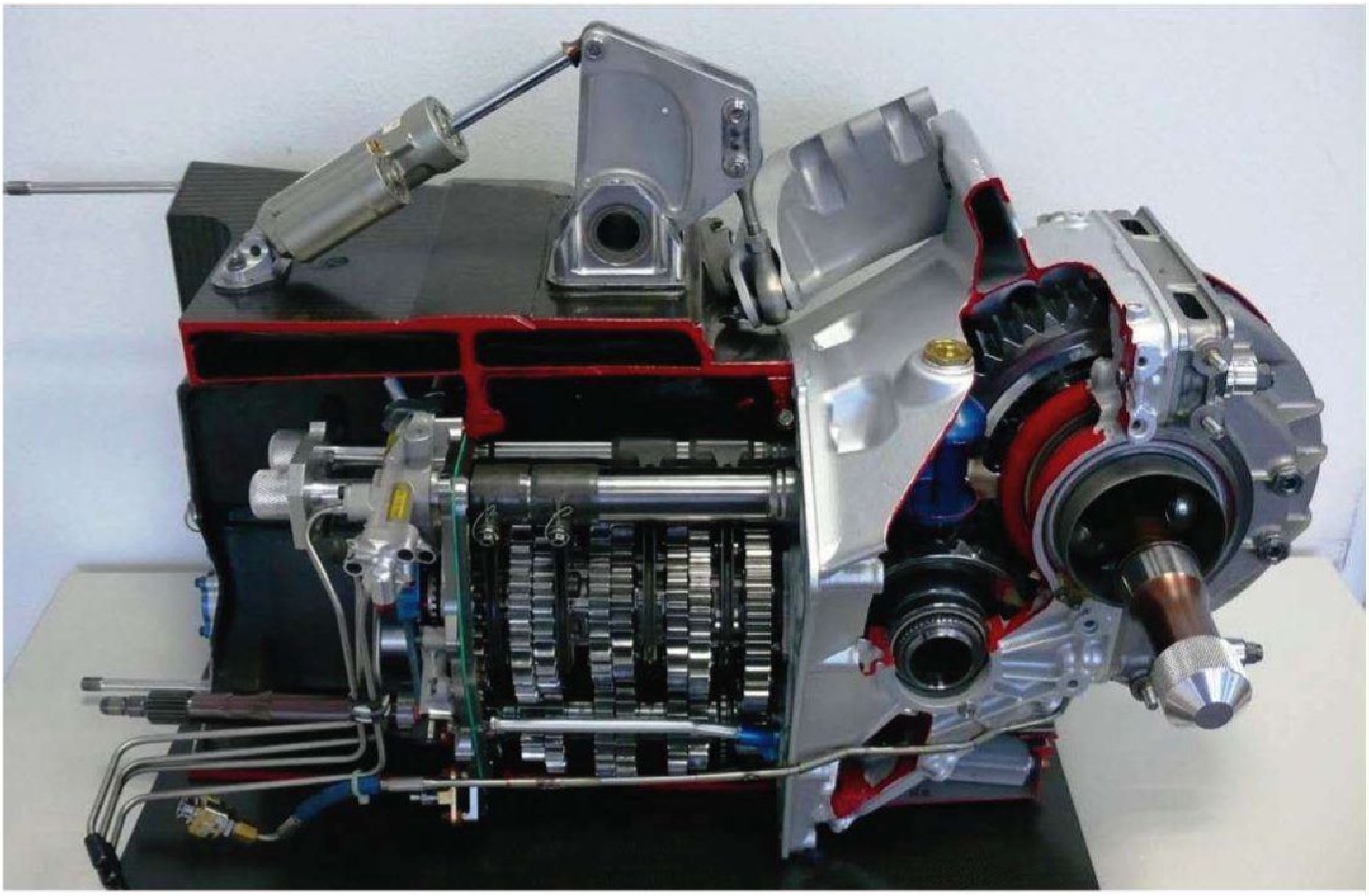
Current trends in powertrain design will have to be revised, with an as yet undisclosed regulation limiting fuel consumption and flow by around 35 per cent - something that could prove a challenge with the bodywork regulations

It is no surprise therefore that Vasselon's team of ex-Formula 1 engineers have already constructed a special facility in Cologne, Germany to allow teams to develop their systems.

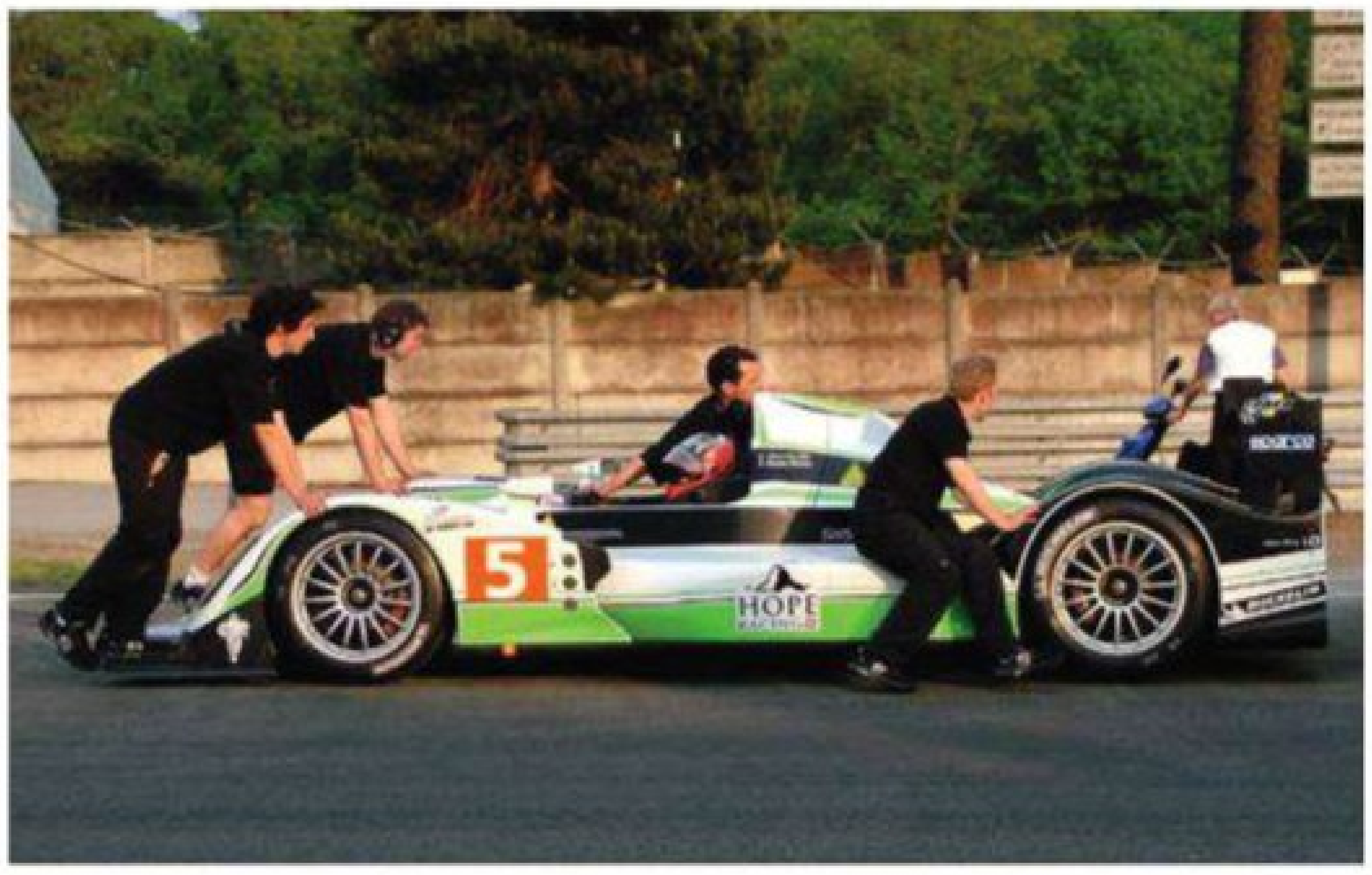
GEARBOXES

Transmitting the power and torque from the electric and internal combustion motors will be eight-speed 'boxes with a fixed set of gears. Teams will have to nominate the eight ratios they want at the start of the season and use them for the entire year. This will not provide a great issue with the level of simulation technology available, but it will mean the ratios selected will have to cope with everything from the super-tight hairpin at Monaco to the high-speed straights of Spa and Monza.

'The eight speeds is a FOTA proposal, and it is something that was suggested by the teams and accepted by the FIA,' reveals Vasselon. 'The rationale behind it is to reduce the operating cost of the gearbox without damaging the



F1 gearboxes will have eight speeds in 204, as opposed to six or seven speeds, as it the trend currently (seven speed shoen bove). Reverse gears will no be required due to a very subtle change in the regulations with electric motors taking upo that role



As is the case in LMP1, Formula 1 cars in 2014 will have to be capable of driving the full length of the pit lane on hybrid power alone, though there is substantial opposition to this regulation from powerful figures in F1

spectacle of F1. This approach has been made possible by the big changes in the engine regulations. At the time this gearbox regulation was proposed and agreed, the engine was to be a four-cylinder turbo revving to 12,000rpm with a very wide torque band. When you have this kind of engine with low revs and a wide torque band, with eight fixed speeds you can expect to cover all tracks of the season with almost no performance loss, compared to the current situation where ratios can be optimised for each single track. For sure, in Monaco or Budapest you would not use the eighth gear, which has to cover Monza. It means that you don't need a huge range of ratios, and consequently you don't need a large stock of gears. This is limited to 30 by the current regulations, but a few years ago teams had 70-80 different ratios, so it is easy to measure the progress made.

'In my opinion it is a good move. It is sensible and it will certainly reduce costs in terms of gearbox parts stock. It will also make the operation of the gearbox much easier because you don't need to go through the saga of ratio changes which we had in the last years.'

A subtle change in wording in the gearbox regulations also allows teams to no longer have a reverse gear in the transmission. In the 2011 rule book it states that 'all cars must have a reverse gear operable any time during the Event by the driver when the engine is running'. In the 2014 version, the same rule says 'all cars must be able to be driven in reverse by the driver at any time during the Event'.

This, combined with the requirement for all cars to be capable of driving the length of the pits on electric power only, means that the cars should be able to use the same electric power to drive in reverse. However, with the electric motors connecting directly to the crankshaft (by regulation the input from the ERS must be before the clutch) this would require the engine to turn in the wrong direction. But it is an area teams could exploit for weight and packaging reasons.

The 2014 Sporting Regulations have not yet been published, and will likely change some elements of the application of the technical regulations. Also, a number of detail changes are likely to be made to the regulations in the next two years. But one thing does remain certain, Formula 1 will sound different in the future.

> **"You need to develop a controlled brake balance system – an intelligent, variable, active system"**

THE DESIGNERS
ALAN JENKINS

"Starting my motor racing career by working for Ron Dennis and following him with Roger Penske taught me a huge amount"

With stints in both F1 and IndyCar, Alan Jenkins has had his fair share of ups and downs, but his underlying philosophy has always been to look at the bigger picture

BY IAN WAGSTAFF

Alan Jenkins is a thinking man with a lot to say… and not just about racecars *per se*. His design experience encompasses both Formula 1 and IndyCar, and he is one who always tries to look at the bigger picture. 'I was involved in the roof of the new building at Silverstone and wondered why we couldn't make this the greenest circuit – and I didn't just mean the grass on the infield. Why isn't the roof covered in solar panels? The generators for F1 TV consume more fuel than the racecars, so why not develop a more efficient generator installation – before, or at least in parallel with, new engine concepts for the cars themselves.'

What, though, are the questions Jenkins asks when he's about to design a new car? 'It is the same for everything. In principle, cars are no different from food mixers. What am I trying to achieve and what do I know about it already? If you have been on a Formula 1 path for some time what you do is generally a series of evolutionary steps, with the occasional big regulation change that makes you think outside the box again.

'There used to be the question of when do you start to divert resources to the design of a new car, but now it is more likely to be a continuation of a set of parallel processes.'

"In principle, cars are no different from food mixers"

One of the biggest concerns Jenkins has for racecar design in general is one-make formulae. Apart from obviously limiting competition, and therefore work opportunities, they nearly always end up being designed to an unoriginal and basic spec. That way the governing bodies find it easier to get major manufacturers to add their brand name and technical regulations are easy to enforce.

He believes that the discussions with regard to the 2012 IndyCar were 'the first attempt for a long time to actually ask what everyone wants out of all this. However, the result hasn't really generated any enthusiasm, so maybe that points more to the wrong questions being asked. A more fuel efficient engine package is fine but, aero kits apart, the issues of improving the show and cost efficiency haven't really moved forward. Incidentally, I have utmost respect for Dallara and this is in no way a criticism of their contribution to the process.'

That leaves Le Mans, and here Jenkins acknowledges that it 'still seems to allow people to go off and build something different. Racecars inevitably gravitate toward similar solutions over time, but the shift toward diesels, and now maybe even to hybrids, has kept things on the move, as have the ongoing efforts to maintain equivalency.'

Though Jenkins has collaborated with a number of groups to try and put a Le Mans project together, and come quite close, he admits to being 'slightly frustrated that I have not yet done a car for Le Mans.' His more recent attempts have involved hybrid technology, but the investment involved tends to means this needs manufacturer backing and the technology involved for the stop / start urban cycle does not always relate well to racecars able to win a 24-hour race at Le Mans.

GREAT BRITISH INSTITUTION

He is also concerned about the state of the motor racing industry in the UK. 'This great British institution that people go on about is certainly not what it was. For sure, there are some success stories and new companies being formed, but the UK racecar industry itself has lost many well-known brands, whilst Dallara seem to go from strength to strength. Those that have survived have often done so by diversification into areas such as the defence industry. It is hard

The Footwork Arrows FA16 is the car Jenkins describes as 'the most complete' of his time at Arrows

to see a situation repeated where the group we put together for the Onyx F1 team mostly stayed together, formed G Force, and then went on to design and build successful IndyCars for many years.

When asked about which of his cars mean the most to him, the Onyx is high up the list. However, it seems it was not so much about the car but the people, in particular Stefan Johansson, who had been a friend since his days as a Formula 3 driver for Project 4 and who was an integral part of the Onyx F1 from its inception.

'The first complete cars I did were the Penske IndyCars. When the time came to move on from McLaren I felt that having been part of the unique team that Ron (Dennis) had put together, and working with John Barnard, made it distinctly unappealing working for another F1 team. The exception was, and always will be, Ferrari and I had a few interviews with Ferrari over the years, including a very memorable lunch with 'the old man' himself, when Harvey Postelthwaite was there. They initially kept the whole thing secret but, after Mr Ferrari got involved, they took me to the airport in a factory prototype. By the time I got home the whole world knew I had been to Ferrari.

> **"Winning the Indy 500 at my first attempt as race engineer is something I will never forget"**

'The Penske period started well enough, and winning the Indy 500 at my first attempt as race engineer is something I will never forget. Danny Sullivan was the driver and the car was a Penske development of a March chassis. In parallel with running the March cars, we were also developing our own car, starting a wind tunnel programme and testing a brand new engine (the very first from Ilmor). Add to this the relentless commuting back and forth to the USA, for every race and test, and my main recollection is that it all went by very quickly. I enjoyed working with Nick Goozee, who ran Penske Cars in the UK, but the inspirational part of the whole experience was working for Roger Penske. Staring my motor racing career by working for Ron Dennis and following him with Roger Penske taught me a huge amount.

'In a different way to McLaren and Penske, Onyx F1 was very special, and very personal, but if you mention Onyx F1 now not many people will know what you are talking about. I drew the first version on a board in our spare bedroom. Onyx was a very good F3000 team, but had no design office or manufacturing facilities. Finding the great bunch of people was not so difficult and many of them were friends from previous lives.

'Penske had been one of the first race teams to use 3D CAD and I was determined that the Onyx F1 car would be designed using this technology. IAD was nearby in Worthing and, after asking if I could rent a couple of CAD guys, we ended up moving the whole design operation to IAD's premises and quickly went from only having a laptop to having at our disposal a CAD facility capable of doing work for leading car manufacturers.'

Jenkins says that Onyx had a 'tremendous relationship' with engine supplier Brian Hart. 'He was very single minded about what was right and wrong, but was a tremendous racer. Working with Brian allowed me to develop a much better understanding of the engine side of things. My first real exposure of working closely with an engine designer was with Mario Illien at Ilmor because during my time at McLaren there was no necessity for me to visit

Jenkins first exposure to Formula 1 was with Hector Rebeque in 1979 (top left). The Onyx F1 project (bottom left) only lasted two years, but Jenkins rates it as one of his favourite designs, while the Arrows FA12 (top right) he says was one of the least satisfying, blighted by its heavy and problematic Porsche V12 engine. The following year's car, the FA13 (bottom right), had to be a success, and as a result, was quite conservative in its design philosophy

Nicholson McLaren Engines, nor Porsche at Weissach.

'The first Onyx cars were built out of boxes in the garage at Brazil and the team thought it had been "allowed" to shake down the first one along one side of a section of dual carriageway. This was blocked at the last minute so plan b was to take it on a flat bed truck to a kart track in the hills. During this episode one of the drivers ran over a snake, which flipped into the cockpit. Then, after a clutch failure and an accident, the cars went on to occupy the bottom two slots of pre-qualifying that weekend. This was our first F1 outing!

The pinnacle of a curtailed couple of seasons was Stefan Johansson's third place in the 1989 Portuguese Grand Prix. 'We were running a tyre until it was nearly bald and trusting the driver. Everybody else stopped near the end and we didn't. Being on the podium with Berger's Ferrari and Prost's McLaren was very satisfying.'

UNSATISFYING TIMES

Jenkins went from a car that meant much so him to one he describes as 'one of the most unsatisfying I have been involved in, the V12 Porsche-engined Arrows / Footwork FA12. 'I already knew before joining Jackie Oliver at Arrows that my first car would be using the Porsche engine, and it's easy to convince oneself that problems are just there to be solved, and you are the one to do it.'

> **"it's easy to convince oneself that problems are just there to be solved, and you are the one to do it"**

The engine was basically two V6 blocks back to back with the cam drive in the middle and the final drive above the block. This resulted in a long and heavy engine with a high c of g and significant problems, such as the oil filling up the heads in corners, which even the most complicated oil tank could not fix. The engine should also have produced 700bhp and the team later found it had just over 500.

After only six races the team was obliged to replace the Porsche with a Hart / Cosworth DFR. The decision was supposed to be a temporary one but it never went back. The conversion was carried out between two races and a complex transfer box had to be designed to accommodate the high gearbox input shaft required for the Porsche engine. Jenkins recalls 'Xtrac did brilliantly to get the parts made, but they always had doubts that it would be reliable, and were proved to be right.'

The whole episode was not good for Arrows, so the next car just had to work. The FA13 (and FA14) had Mugen Honda engines and were, for the most part, relatively conservative, although FA14 did finish the 1994 season running the McLaren active ride system, which resulted in some quite spectacular performances.

'The FA15 should have been the car where we got it all together. In 1994, after two seasons with the Mugen Honda V10, we rediscovered the Cosworth HB. That was a cracking little engine.' Immediately competitive, finishing fourth in its second race, it had a trick diffuser, but these were banned after Senna's death and Wendlinger's serious accident

the mark of success

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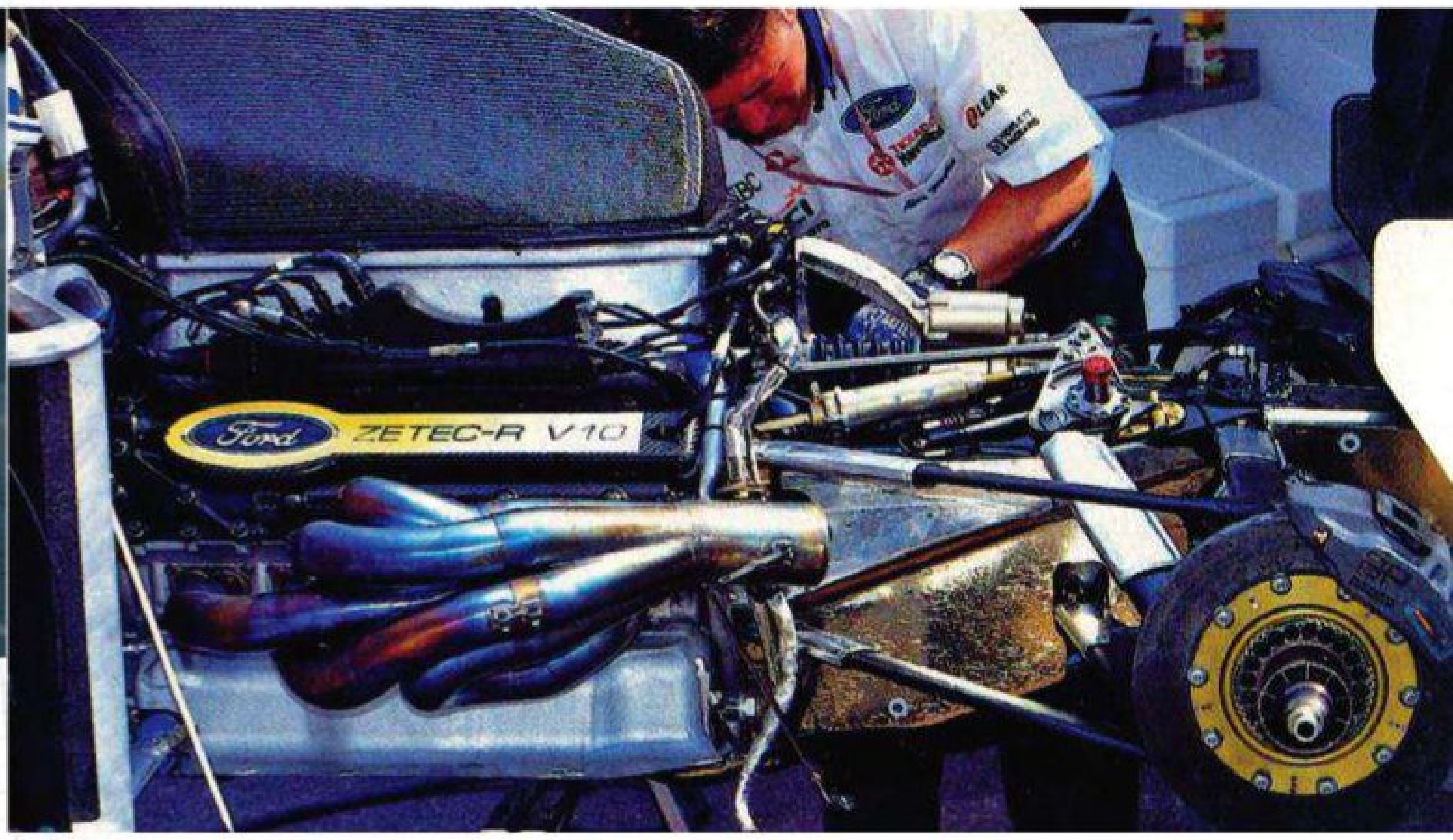


The Stewart-Ford SF2 featured a revolutionary carbon fibre gearbox, but it proved to be a massive resource drain and was dropped for the following season, which saw the SF3 win at the Nürburgring

and consequently the car lost a lot of the competitive edge it had started out with.

Jenkins regards his most complete Arrows as the following season's FA16. 'The HB was no longer available, but Brian Hart was convinced he could build a super-light V8. That was one of those nice projects where you could do the car and the engine together. Gianni Morbidelli put it on the podium in Australia, which was my last race with Arrows.'

TALENTED PEOPLE

Stewart Grand Prix was one of the highest profile start-up teams for years, thanks to the involvements of Jackie Stewart and Ford. Jenkins remembers that this helped attract talented people from other teams. The start-up year was difficult to pull together, yet he still believes the first Stewart was 'surprisingly good. Occasionally you would hit the sweet spot and get it near the front, but repeated engine failures were the main problem.' The high spot was obviously Rubens Barrichello's second place at Monaco.

Jenkins reckons that, for any new team, the second year is the hardest and this rang true at Stewart. 'When you are one of the smaller teams you feel that you have to do something different to beat the bigger ones. It is a bizarre concept, almost self-cancelling, as you don't have the resources.' The result of this thinking was a unique composite gearbox in the SF2.

The concept centred around using titanium bulkheads because aluminium expands too much, making it hard to get reliable bonded joints. 'We were machining the titanium bulkheads ourselves, which was pushing the boat out in those days. Unfortunately, we had to change to aluminium to save time and they leaked as soon as they got hot. We also underestimated the heat rejection of a composite 'box. Eventually we achieved some reliability, but the gearbox drained resources away from other areas where it was needed.'

> "You like to think you are a creative person but often it is the spark from other people that matters"

By contrast, Jenkins declares himself 'very happy' with the Nürburgring-winning SF3, even if he left before it raced. 'The SF3 was probably the most focussed car design programme I ever did.'

Working with Mario Illien and Brian Hart had taken him close to the engine department and, in a similar way, collaborating with Xtrac's Mike Endean was the best possible way to get an understanding of the demands of racecar transmissions. The first example of this was during his IndyCar period. 'The March we were using had the rear end angled up 2.5 degrees to get the driveshafts to survive. This was a compromise because it raised the c of g. In a Dorset pub near Penske's base, Mike drew an idler gear on a napkin that set everything off at the right height. We also did a six-speed gearbox to run at Indy that had two top gears, one of them an overdrive. With that we were able to save fuel and extend our pit stop window by flicking it into overdrive, especially when running in the draft.'

The Onyx F1 transmission was also designed with Endean, and that was Jenkins' first real involvement with a gearbox from a clean sheet. 'You like to think you are a creative person but often it is the spark from other people that matters. It is exciting to sit with others and get two and two to make five. With Mike that was always that way.'

ONE PHILOSOPHY

If Jenkins has one philosophy, it is that a designer should to try and look at everything the whole time, but concedes that is hard to do. Great racecars look like one person had a hand on every part of them. He points to the middle Colin Chapman era at Lotus. 'Chapman had many talented people working for him, but it didn't matter, it looked like one bloke had done it. John Barnard certainly had that strength of will, to the point where even if he did not force you to do it, you still felt compelled down a certain path. Again, the Barnard cars looked like one bloke had done them.'

Jenkins admits to now being on a crusade about safety and would like to see a group, sponsored by national bodies (or ideally the FIA) bring a common approach to all levels, including club racing and rallying. In what he describes as his 'mythical spare time' he once 're-invented the Lancia D50', aping its side panniers for safety reasons, and tried to persuade the FIA to use this method to stop wheels interlocking.

He would like to see a range of stock crash structures. If we are stuck with spec series then there is no reason why these should not have identical crash structures, which meet a common set of safety regulations. In this way a new car would not have to undergo a series of crash tests before it could be introduced. NASCAR is already doing this.

He also has other worries for the future: 'The lecturers at the motorsport courses do not 'get' some of the major issues, and are preparing students for jobs that don't exist. Students are often forced down narrow avenues rather than encouraged to not only follow the brief they are given but to also question the premise behind it. Resource limitations make this less likely in the future and the relatively poor performance of the "new teams" perhaps points to experience being undervalued.

The Lola Group: from the grid to theatre

The Mantis UAV, built using Lola expertise

It is a given that technological advances in the defence sector accelerate during times of conflict, and also that motorsport competition is akin to a constant conflict. This is why many top motorsport companies are moving into the defence sector.

However, the current surge of defence technology advancement is being affected like never before by an increasingly important driver: the court of public opinion. Within our 24-hour news environment, complete with embedded journalists and uploaded user-generated content on the likes of YouTube, defence technology is constantly under review, not only by the defence industry itself, but also by the viewing public.

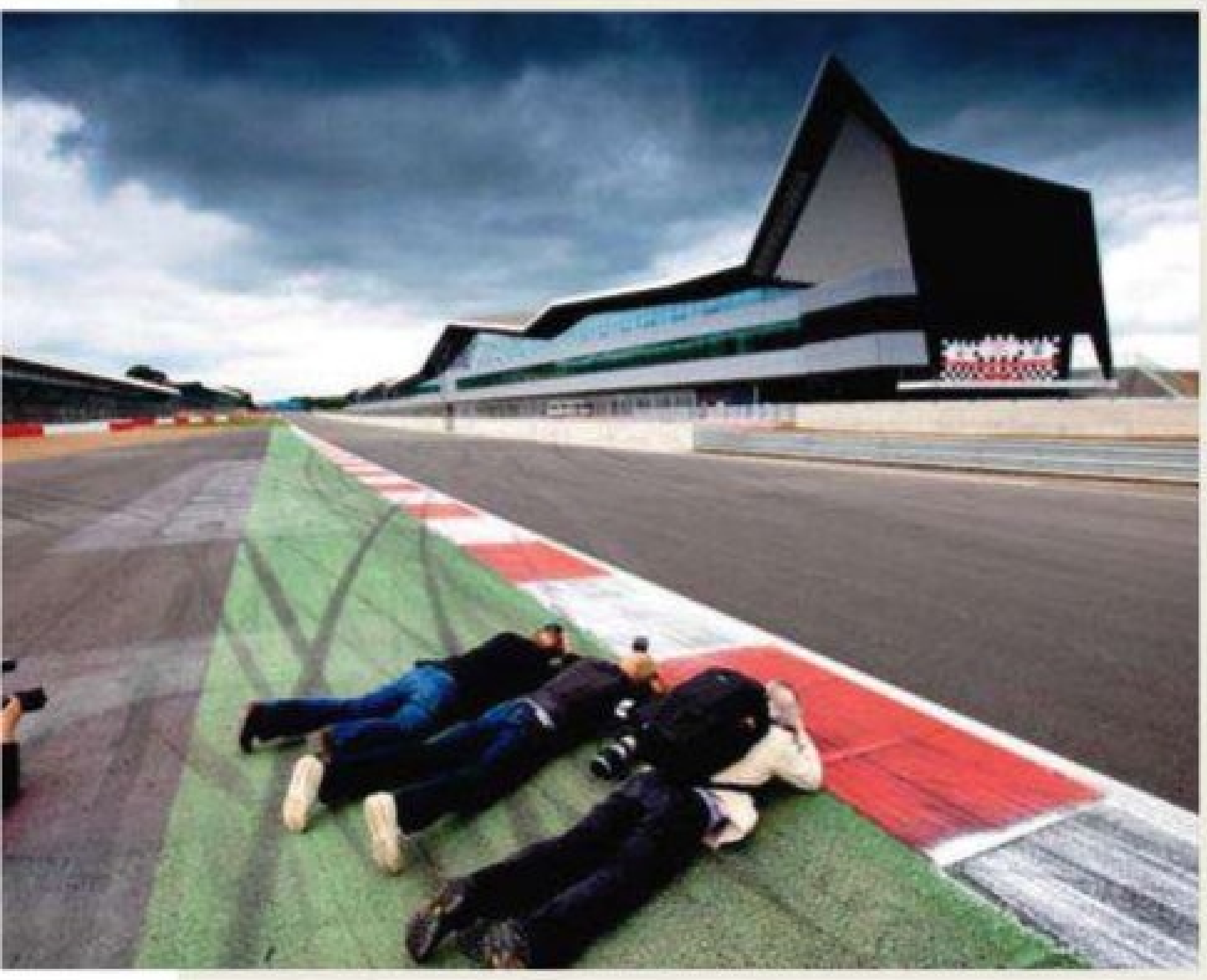
As a result, collateral damage is no longer tolerated. Misplaced ordnance and any consequent civilian casualties will be immediately amplified by the enemy using social media platforms (as well as by an increasingly media savvy 'anti' lobby at home). In the face of such a media onslaught, today's militaries are reliant on pinpoint defence technologies that deliver the commander's intent, with the minimum risk of unintended consequence. This is the age of drones and semi-autonomous surveillance systems. The UAV (Unmanned Aerial Vehicle) sector is flourishing like never before.

One particular British company is benefiting significantly from this changing face of warfare. The Lola Group, best known for its motor racing pedigree, is a composites manufacture now at the forefront of the drone and UAV sector. In its guise as a racecar manufacturer, Lola has designed and built winning cars for a wide range of global manufacturers, including Ford and Aston Martin. At Le Mans 2011, Lola had three cars in the top 10.

However, in addition to Lola's racing record, the company has also been broadening its new technology and testing offering to other sectors, including defence, aerospace and renewables - resulting in a 100 per cent increase in turnover this year. Lola's managing director and former racing driver, Robin Brundle, is quite sure that the company's racing experience gives it a competitive advantage within the defence industry: 'The race track is a demanding environment - cutting-edge technology, meticulous specifications and tight timeframes. We are used to the pressure and know how to deliver on time. As a result, we've never been busier.'

The firms' technical capability has seen it successfully undertake a number of projects in the defence sector, including the tooling design, complete airframe manufacture and assembly of the Mantis and the WK450 UAVs. Lola has also had recent involvement and experience with an Unmanned Combat Air Vehicle (UCAV) programme.

Silverstone circuit submits planning application



Following the completion of the new pit complex area, the Silverstone circuit in the UK looks set to continue its expansion. A comprehensive planning application has been submitted to the local council, outlining plans for the further development of the circuit facilities. Included in the plans were proposals for a new business park, technology park, education campus, three hotels and improved spectator facilities.

Stuart Rolt, chairman of the British Racing Drivers' Club, who own the circuit, commented: 'The submission of this planning application is a big step forward in releasing the commercial potential of Silverstone and its 760-acre estate. The timing of this planning application is closely linked into the process we are currently undergoing to seek potential investment from third parties that will enable us to move forward with our plans more rapidly.' Richard Phillips, managing director of Silverstone Holdings Ltd, added, 'This is the most important initiative that Silverstone has taken in its 60-year history. Things have changed dramatically since the early days. Approval of this planning application will help maintain Silverstone's position as a leading global centre for sport and leisure, education and technology and support its vision of becoming a world leading motorsport destination.'

The British composites manufacturer is finding its years of experience in motorsport is making it an attractive partner in the defence industry

The Lola Group is currently also working on various classified orders through its partners for the Pentagon and MoD, as well as additional private sector clients, including BAE Systems and Thales UK.

'The growth of the UAV sector has certainly been of real benefit to our business,' says Brundle. 'Our clients need strong, lightweight composite solutions that can deliver to their challenging operational needs. That is why they choose Lola products. "If you want the edge, you want Lola." That seems to be what our customers are saying. We're very proud of this reputation – and of course we're working especially hard to maintain it. We are used to the demands of the racetrack and we meet even the tightest deadlines with no excuses. That's how we have always done business. Our defence customers certainly seem to be delighted with our speed of turnaround. The nature of warfare is changing and we are changing with it. We do not rest on our laurels. We have a range of industry-leading development technologies at our disposal, including Computational Fluid Dynamics and Finite Element Analysis. We are inventing new ways to improve our composites offering for our clients and new ways to give them the edge in the theatre of war. It's maybe a legacy of our racing background, but we always want our clients to come first!'

Wildcat variant

Off-road racing specialists, Supacat and QT Services, have agreed to create a fully-integrated military variant of the Wildcat 500 DKR off roader, with the aim of providing high-speed performance in harsh environments. The modification and transfer of an entire vehicle from the UK's motorsport industry into a military role by Supacat is an industry first. Jamie Clark, sales and marketing manager at Supacat, said of the venture: 'This is the first time we have taken an entire platform from the racing sector and marketed it into defence. It's very exciting! Wildcat's rugged and high-performance profile is an ideal fit with Supacat, as we have an unrivalled pedigree in off road performance military vehicles. The Wildcat is a different level in terms of performance and durability – as its race results prove – in the desert and rugged environments. We continue to successfully use the motorsport industry to enhance our current products.'

The Wildcat will be on display at the 2011 DSEi (Defence and Security Equipment international) show in London on 13-16 September.

MIA working to improve Government links

The UK's Motorsport Industry Association (MIA) took leading employers from the UK high-performance engineering and motorsport industry to meet key members of the British Parliament recently. The group outlined the jobs and investment opportunities arising from a surge in export and domestic business, which the Government could access through closer engagement with this world-beating UK industry. Meetings with ministers, select committee chairs, shadow ministers and MPs heard the proposals made to help the UK economy. The industry is not seeking grants or funding, but wants Government to help access business from diverse UK sectors, so creating more employment and bringing new investment.

Lord Drayson, former MP and principal of Drayson Racing, commented: 'The day was a tremendous success. As well as providing an opportunity for the industry to explain to parliamentarians the significant contribution high-performance engineering and motorsport businesses bring to the UK economy, it allowed us to explore the potential for increasing economic and employment growth in wider industrial sectors, such as aerospace, defence and clean energy.'

Millers support MIA initiative

Nevil Hall, joint managing director at Millers Oils, has applauded the introduction of the MIA's Motorsport to Automotive (M2A) initiative, arguing that it has the capacity to drive the UK automotive sector forward. 'At the beginning of the year, the MIA used the Autosport International show to launch its M2A initiative to bring companies in the automotive and motorsport industries closer together. This is a key initiative to introduce at a time when the importance of both sectors to the overall UK economy is borne out by the figures. In 2010, 75 per cent of all cars manufactured in the UK automotive sector were exported, with more than one million cars and two million engines built in the country. The UK motorsport and performance engineering industry alone boasts an annual turnover of £6 billion – with the average R and D spend of 30 per cent of turnover dwarfing the spend of the UK's pharmaceutical and IT industries.

'Both sectors also employ over 850,000 people in the UK, including some of our most skilled engineers. But despite the great number of similarities between the two sectors and the growing contribution to UK GDP, a clear gap in communication and business objectives has developed, which I believe is to the detriment of some of the UK's brightest, most innovative companies – and to the future of UK manufacturing itself. I believe there is a still a largely untapped market of opportunity for the motorsport sector in the UK, which deserves better recognition for its contributions to the evolution of the modern vehicle.'

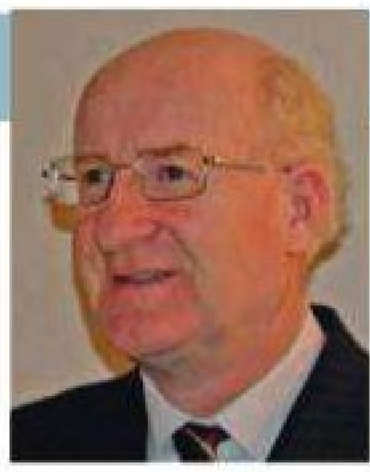
Demon resurrection

After a brief hiatus, plans are moving ahead rapidly to revive the popular Demon Carburetion and BG Fuel Systems brands. This new business will be run by a fresh team of race and performance enthusiasts that says it is committed to developing high quality products with exceptional customer support. The brand is due to re-launch at the 2011 SEMA show in Las Vegas. See www.barry grant.com for further information.

STRAIGHT TALK

World endurance racing

Series' organisers are struggling to consolidate the wants of the racers, engineers and public with the requirements of the EU



PAUL J WEIGHELL

The FIA World Motor Sport Council (WMSC) met in June to discuss a proposal that the FIA and ACO create a joint company (Le Mans Endurance Series Management) for the purpose of re-launching the ACO's Intercontinental Le Mans Cup as the FIA's World Endurance Championship.

The later public announcement stated that the FIA would hold the title and ownership to the championship, whilst the ACO would be the series' promoters and retain the rights to the 24-hour race at Sarthe.

The FIA will take control of calendar, safety and discipline issues, as well as collecting fees from participants and paying back an eventual 50 per cent of the income to the ACO.

It seems that the original plan was for the FIA to control sporting and technical regulations, but the ACO retains those, perhaps in order to avoid the problems that spilt the two organisations last time? Quoting an unquotable colleague: 'FIA Group C Sportscars of the past permitted any engine with a maximum fuel allocation according to the length of the race. At first it was the Porsche 956, then along came Sauber-Merc, Jaguar, Aston Martin, Nissan, Toyota, Mazda etc. But it all went wrong when the FIA changed the Group C rules to admit only F1 engines: 3.5-litre V8 / V10 / V12s didn't make good 24-hour engines. The same thing had happened at the end of the previous Porsche 917 / Ferrari 512 era, with the same result - a nosedive for Sportscar racing. The ACO eventually told the FIA to go to hell, wrote its own rules and opted out of the FIA Championship structure.'

Are there business synergies that make the joint effort useful? The background is complex, but is essentially one increasingly driven by EU legislation that is forcing big changes onto the shrinking number of manufacturers that form the backbone of both F1 and the WEC.

EU emission regulation, heavily sugared with tax payer subsidies and high manufacturer profit margins, means that marketing eco-boxes to the public requires small engine, hybrid or electric motor-powered racecars, complete with energy recovery systems lurking beneath acres of rather cynically painted green carbon fibre.

Opposing the EU are TV-watching petrolheads who crave loud, sulphur-breathing fire dragons eating each other on track in order to maximise TV drama and advertising revenue for CVC *et al.*

Walking the tightrope between all the vested interests is Jean Todt, FIA *el supremo*, who has been asked (tasked?) by the European Commission to create a number of electric-powered series as a means of marketing slow selling eco-vehicles to a reluctant public.

In response to this, and other long-running pressure, the FIA has established an electric car commission, a sustainability programme for the FIA Institute and the FIA Foundation now has links with the Global Fuel Initiative, and a number of other green and clean organisations.

So are the FIA and ACO both greening their rulebooks before European manufacturer sponsorship vanishes, or it is perhaps legislated away? The Japanese majors have already left, citing a lack of product relevance, and Renault threatened to leave if the FIA did not scale down F1 engines to more consumer friendly-sized units. If the remaining EU volume car manufacturers leave

Success on two wheels for McLaren

The McLaren F1 team is not the only part of the McLaren Group to see racing success in recent months. Cyclist Mark Cavendish won the prestigious Tour de France green jersey on an S-Works + McLaren Venge bike, winning five of 21 stages, including the final one, which ended on the Champs-Élysées in Paris. McLaren Applied Technologies (MAT) developed the state-of-the-art bicycle in collaboration with Specialized, the American performance bike manufacturer. It was launched in March this year and won its first race - Italy's Milan-San Remo one-day sprint event.

Specialized says it found the perfect match in MAT when looking for a carbon fibre expert to take the bike's frame to an even more extreme level of stiffness, weight and aerodynamic performance. MAT was able to improve its efficiency by 10-15 per cent by optimising the way the carbon was cut and applied.

'The collaboration with McLaren Applied Technologies allowed us to dive further into analysis, optimisation and cutting-edge manufacturing, which make the Venge truly state-of-the-art,' said Specialized's composite design engineer, Brad Paquin.

Dassault Systèmes appoints SSA as a Simulia re-seller

CAD / CAE developer, Dassault Systèmes, has appointed Strategic Simulation and Analysis (SSA) to enhance its analysis systems offerings on the UK market. SSA will use its expertise within the engineering market to sell the full range of Simulia products and strengthen its consultancy base. 'We are very pleased to be able to offer a truly world class analysis package to the market and to our customers,' said Laurence Marks, managing director of SSA.
For more information log onto www.ssanalysis.co.uk

racing then top class racing will collapse. We all need to remember that the reason diesels are winning Le Mans is that Audi and Peugeot want to sell diesels, not because they particularly want to win Le Mans with one.

> **the reason diesels are winning Le Mans is that Audi and Peugeot want to sell diesels**

Some argue that Porsche, Aston Martin, Corvette etc will still make for a globally interesting series, and there is certainly plenty of competition at that level, but it will not replace the main manufacturer-backed LMP1 level.

At least two competing heavyweights are required for a series to be taken seriously by many and Le Mans is already down to that minimum. Furthermore, the long endurance races do not attract mainstream TV because they are difficult to schedule, which has a knock-on effect on advertising revenue and advertising exposure for the participants.

Scaling the Le Mans 24-hour race up to the ILMC was a good enough move, but it gets tricky to administer and the ACO would probably prefer to focus on their main property, the 24 Hours of Le Mans at Sarthe.

In essence then, the ACO may be seen as having sold the ILMC to the FIA in return for about 2.2 million euro per annum (by 2015). In addition, the ACO gets the strength of the global FIA organisation to help it meet EU legislation and manufacturers' concerns over eco road cars, something the World Motor Sport Council is already promoting for WEC: 'In establishing this new category of motorsport championship, both the FIA and the ACO are keenly aware that it needs to be a laboratory for innovation and the development of new technologies, allowing motor manufacturers to express, through the rigours of competition, their ability to be inventive and, as this is an endurance championship, to also highlight their capacity to produce high quality and safe machines and components.'

The WEC is therefore an optimum 'manufacturers' laboratory' and advertising stream for the eco road cars being demanded by EU legislation. The ACO are arguably ahead of the FIA in new eco technology, with various fuels allowed, as well as hybrids like the Hope at Le Mans this year, which used one of Jon Hilton's Flybrid mechanical flywheel systems. So expect to see more WEC cars with either mechanical or electrical storage types, including those in the pipeline from Audi, Peugeot and Porsche. Cross-fertilised technology may be seen in F1 from Renault and Mercedes.

The ACO has even pondered dampers that recover energy to feed electrical storage systems (see *RE* V21N6) and the updated F1 ERS is expected to reduce fuel consumption by about 35 per cent, so is fully 'on message' with EU hopes.

Absolutely crucial is that the ACO and FIA require hybrid vehicle stored power be used to reduce fuel rather than to aid performance as a sole goal. That concept is essential in using racing to persuade the public to buy eco cars, as the EU does not want faster cars producing the same CO^2, but the same speed cars making less CO^2.

NASCAR approves new HANS device

The National Association for Stock Car Auto Racing has confirmed that the Sport II HANS device has been approved for use in competition. This is the latest offering from HANS Performance Products, the company that invented the eponymous head and neck restraint. Featuring a lower rounded collar, the Sport II's design makes fitting easier for drivers. It is also the lightest device in the company's Sport series.

The Sport II has also been approved for competition under the criteria established by the SFI and the FIA, too. 'We take pride in our innovative efforts to make the HANS device not only cost effective, but also user friendly for all racers without sacrificing our award-winning performance,' said Gary Milgrom, vice president of HANS Performance Products.

Thermal barrier coatings see BTCC success

Zircotec, the thermal coating specialist, has seen its latest range of barrier coatings provide significant gains in the British Touring Car Championship. Dynojet, who run an NGTC-specification Toyota Avensis with a 2.0-litre turbocharged engine prepared by XCTechR and funded by Toyota GB, have been testing the firm's products. 'The turbocharged application demands specific attention to thermal management, so we turned to Zircotec to help us optimise our overall engine performance,' comments XCTechR's technical director, Mark Faulkner. 'On the dyno the Zircotec coating gave improved turbocharger response, as more energy was retained within the exhaust rather than released as heat. Once on the vehicle the coating delivered a significant reduction in under-bonnet temperature when compared to the same set up with an uncoated exhaust, resulting in reduced air intake temperatures and so more engine power.' Zircotec and the team are now looking at other areas on the car where the use of its coatings can improve reliability, durability or performance. 'It's a great opportunity to get in with a hungry team at the start of NGTC rules,' says Zircotec's Terry Graham. 'As in F1, we are keen to co-operate with teams at a technical level to solve heat and reliability issues. We are looking forward to continuing this relationship with the team over the rest of the season.'

Toyota attempt Nürburgring EV record

Toyota Motorsport GmbH (TMG) has developed a high-performance electric powertrain to form the basis of a vehicle for a record attempt at the Nürburgring Nordschleife, scheduled for the end of August. The two-seater sports car chassis, fitted with TMG's EV technology, can travel from 0-100km/h in 3.9 seconds and has a top speed of 260km/h.

Rob Leupen, TMG's director of business operations, said: 'We are extremely confident we can break the record by some distance, which is an indication of how EV performance is continuously improving. TMG is a leader in high-performance powertrains and we want to show the world how far this technology has developed. Our mission is to advance this technology, not only in motorsport but in the automotive sector in general, to deliver products with more performance and better durability for our customers.'

Third dimension

40 per cent cheaper, 60 per cent common components, new safety concepts, KERS possible, and affiliated series in Asia and USA are planned for the DTM

The aggressive-looking BMW M3 will become the third manufacturer in the DTM next year.

BY WOLFGANG SIEVERNICH

As of next year, the Deutsche Tourenwagen Masters (DTM), the German Touring Car series, will be run to newly revised regulations. The high-end series, featuring prototypes disguised as touring cars, has been running since 2000 and originally comprised Audi, Mercedes and Opel entrants, with teams operated directly by manufacturers, tuning companies or even privateers. Since 2006, however, the championship has been fought out in Germany and in Europe solely between Audi and Mercedes, though BMW, the long-awaited third manufacturer, will now join the series in 2012.

The participating manufacturers work closely with their marketing departments and use the races as an international sales platform, more or less following the old proverb, 'win on Sunday, sell on Monday.' Though any similarities to actual production cars are absent in the DTM, well-publicised technical innovations feed back into the production of other Touring Cars and GTs. Given all this, it is perhaps no surprise that the DTM has not yet released its complete regulations for 2012, and answers questions only in general terms. But from those we can glean some insight into the path the series.

VEHICLE COSTS SLASHED

The reasons for re-working the regulations governing cost are obvious. In the current climate of financial unrest the cars have simply become too expensive. Development is too involved and the costs of producing such small production runs are excessive, effectively excluding all but the wealthiest new entrants. A mere five common components between the Audi and Mercedes racecars leaves little room for cost savings, so the new rules prescribe 60 common components per vehicle, which the series claims will lead to a 40 per cent reduction in costs. Some details have already been made known: common front splitters and rear diffusers; clutches from ZF Sachs; tyres from Hankook and dampers from one manufacturer only, quite possibly Multimatic. The flamboyant aerodynamic packages that traditionally characterise the series also look set to be reigned in.

Since every manufacturer must bring at least six racecars to the start line, the DTM series promoter, ITR (Internationale Tourenwagen-Rennen), is looking forward to full starting grids. New entrant BMW has already chosen Schnitzer, RBM and newcomer Reinhold Motorsport for its three two-car teams. Audi and Mercedes will make their announcements at the Internationale Automobil-Ausstellung (IAA) in September.

It is currently known that BMW will use the two-door M3 and Audi the four-door A5 as their vehicle models, and both have been testing in July, while Mercedes will present its choice at the IAA. The new regulations are designed to prevent vehicles competing that do not meet the spirit of a Touring Car – which is traditionally a four-door saloon – so actively discourage the likes of Audi's TT, Opel's Astra coupé and Mercedes' CLK model.

Monocoques are to be strengthened significantly and complete vehicle crash tests will be required

OVERSEAS EXPANSION

The planned expansion of the series in Asia (Super GT) and the USA (GrandAm) opens potential whole new markets up for the German series. It is not in the interest of the DTM to be a space filler in the Super GT or GrandAm calendars; it is only interested in being a race series in its own right, but the two continents will each present unique challenges. It is known that Nissan recently requested an international FIA license (this being a prerequisite to enter the DTM) and the ITR confirms discussions are ongoing with the Japanese manufacturer, but has so far released no further details. Christian Schacht of the German motorsport authority, DMSB, gives more information: 'The DMSB has been working for a few months together with the associations in the USA and Japan with the goal of applying the DTM rules in their countries. The goal, of course, is to be able to run identical vehicles in numerous markets.'

In Japan, this is most likely to mean a set of rules that enables Japanese manufacturers such as Nissan, Honda and Lexus to enter the series with ready-to-go vehicles. At the time of writing, representatives of Super GT and GrandAm have written new rules packages but neither see an effective start date any earlier than 2015, if at all.

FULL VEHICLE CRASH TESTS

In conjunction with the FIA Institute, the organisers have embraced the subject of safety for future DTM vehicles. 'The FIA Institute brings us its experience, at the same time we bring our know how regarding safety components,' says Schacht. Of particular interest will be improvements to the monocoque. Extra strength will be gained by having the b-pillar in front of the driver's head, while the use of carbon, Zylon and Rohacell will increase the cars' ability to withstand a static side load by a factor of four. 'Up until now, a force of 80kN was applied at a single prescribed point. As of 2012, a force of 360kN will be applied along the structural side of the car. In other words, the monocoque will not be strengthened at a single point but rather along its entire length,' explains Dr Martin Mühlmeier, head of technology at Audi Sport. In response to Audi factory driver, Alexandre Premat's dramatic accident in Adria in 2010, the FIA now require a crash test of the complete vehicle. Mühlmeier continues: 'According to an FIA standard, the entire car must withstand a 14m/s forward and rearward impact against a solid barrier. Previously, only the front and rear crash components were installed on a sled and were crashed into a barrier.'

KERS OPTIONAL

In these times of hybrid and electric powertrains and downsizing in series production cars, one has to assume that the DTM is not going to be left behind. However, Audi's proven V8 from the current A4 DTM will, for the time being, also power the new A5 racer. And it is expected Mercedes and BWM will do something similar. 'A KERS system is foreseen in the new DTM regulations, but the decision as to when and how the system will be introduced and implemented has not yet been taken,' says Audi motorsport head Dr Wolfgang Ullrich. Regarding engines, ITR has raised the lifespan of components and stipulates that only two, instead of three, engines may be used per vehicle per year, leaving a number of the German suppliers into the DTM struggling to comprehend the correlation between limited component production and, at the same time, increased component life.

Up until now, private racing teams such as Colin Kolles' Audi team Futurecom TME played a small, modest role in the DTM, but such teams will disappear under the new regulations. The ITR is planning the future of DTM solely around factory teams and, for marketing reasons, wants to position the series as a pure manufacturer-based series. With BMW's entry, the DTM will certainly increase its appeal in Germany. As to its expansion outside of Europe, only time will tell.

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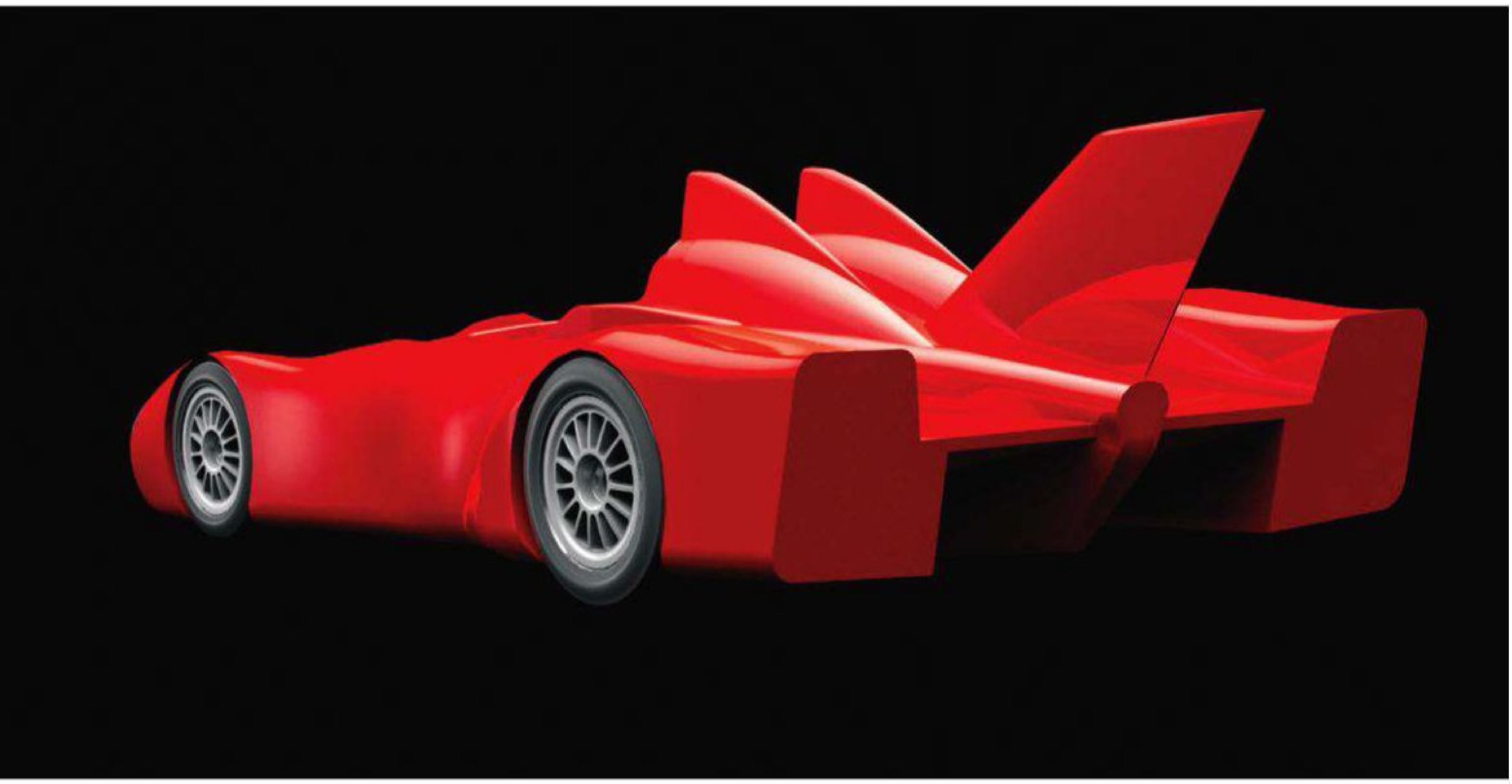
Delta discussion

Racecar designer John Travis takes a close look at the DeltaWing concept and raises questions as to how it will work



Ben Bowlby's DeltaWing concept is still garnering controversy, this time from another car designer

What follows is a reasoned discussion on the merits of evolution vs revolution, questioning whether there is anything about the DeltaWing concept that would be detrimental to the safe, competitive and predictable behaviour of the vehicle compared to a conventional car.

The analysis put forward here relates to the three fundamental concepts of vehicle dynamics: control, stability and handling. That is, the car's response to the driver's inputs, its ability to maintain course despite external influences and the ease with which the driver can obtain cornering potential and the perception of the behaviour. Anything that is detrimental to these concepts will make the car unpredictable and less safe.

The first impressions of the DeltaWing are certainly thought provoking. Whilst I am not against revolutionary thinking – after all, Le Mans' history has been one of radical changes – we tend only to remember the successful ones and not the failures. Therefore I cannot be more than a little concerned that some of the decisions made in the DeltaWing concept go against justifiable sound engineering and vehicle dynamic practices.

NARROW FRONT TRACK

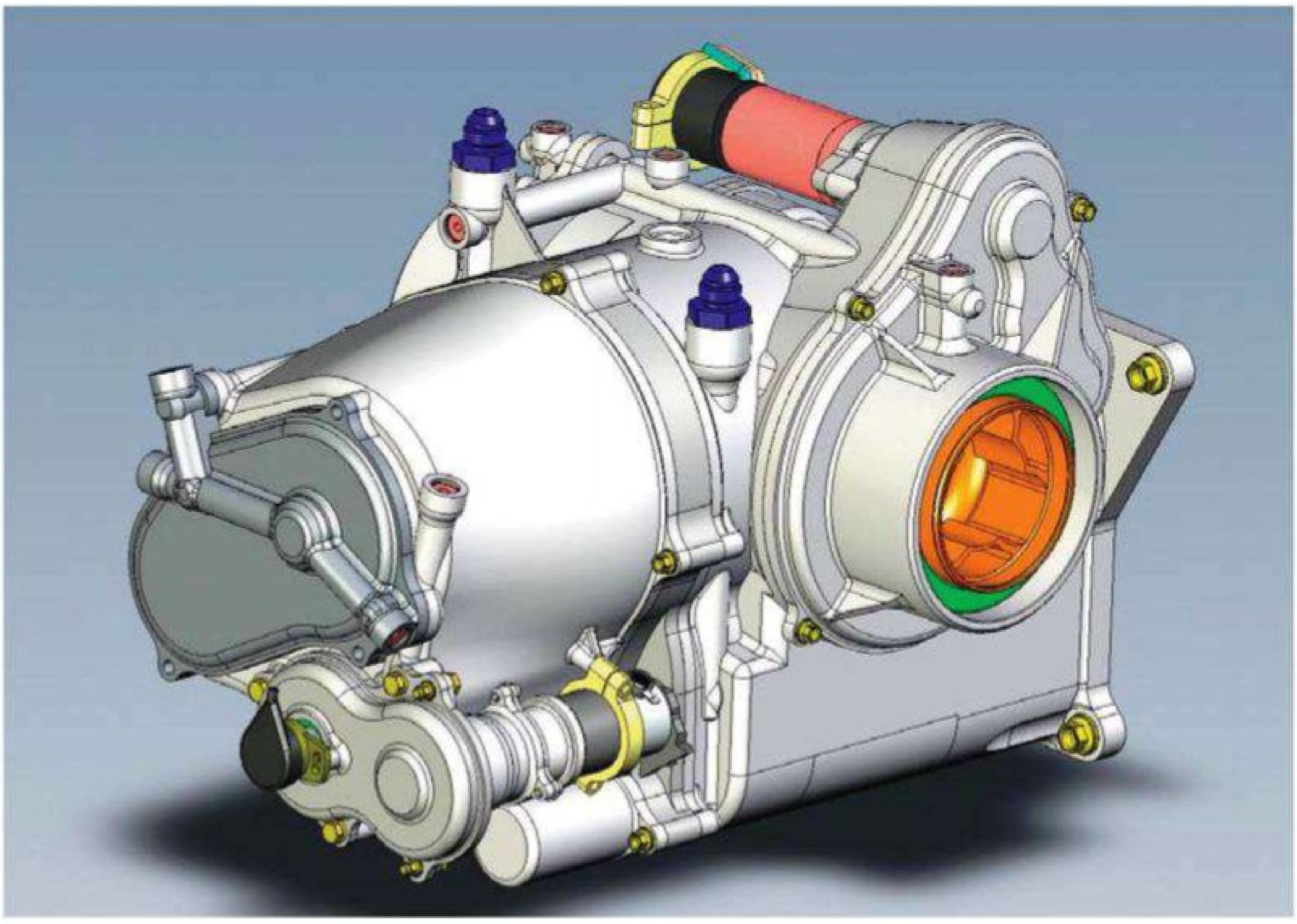
Let's investigate the dynamic implications of this design philosophy. Lateral weight transfer (lwt) is the enemy of high-speed cornering, especially if it is distributed unevenly between the front and rear of the car. As we know, the tyres' response to changes in normal load are not linear, and a net loss of grip results from lwt. The DeltaWing concept has probably over 90 per cent of the total lwt occurring at the rear, compared to 60 per cent front on a conventional car. This equates to the conventional car being in a slight understeer condition dynamically, whereas the DeltaWing is in a large oversteer condition dynamically. This might be able to be fixed aerodynamically (at high speed) or at low speed with the torque-vectoring differential in the overall package. But this begs the questions, 'should not the driver be in control of the car and not the electronics?' And 'why should one want to build a dynamically unstable racecar in the first place?'

PREDICTED HANDLING

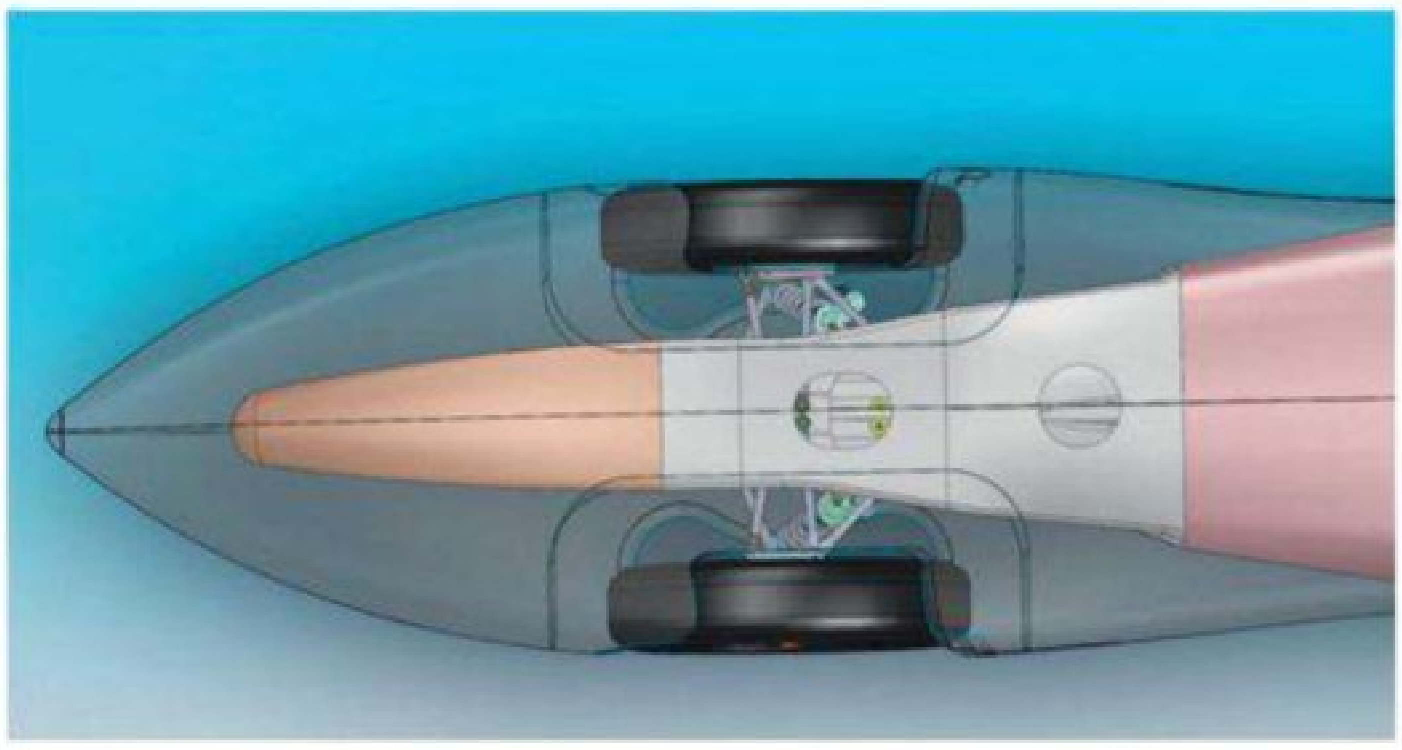
With a normal weight distribution, the fact that the rear tyres have to provide the dual role of traction and cornering can be balanced by having a larger proportion of the roll stiffness at the front. The wheel rates and tracks [of a traditional Indy car] are similar, resulting in a predictable response.

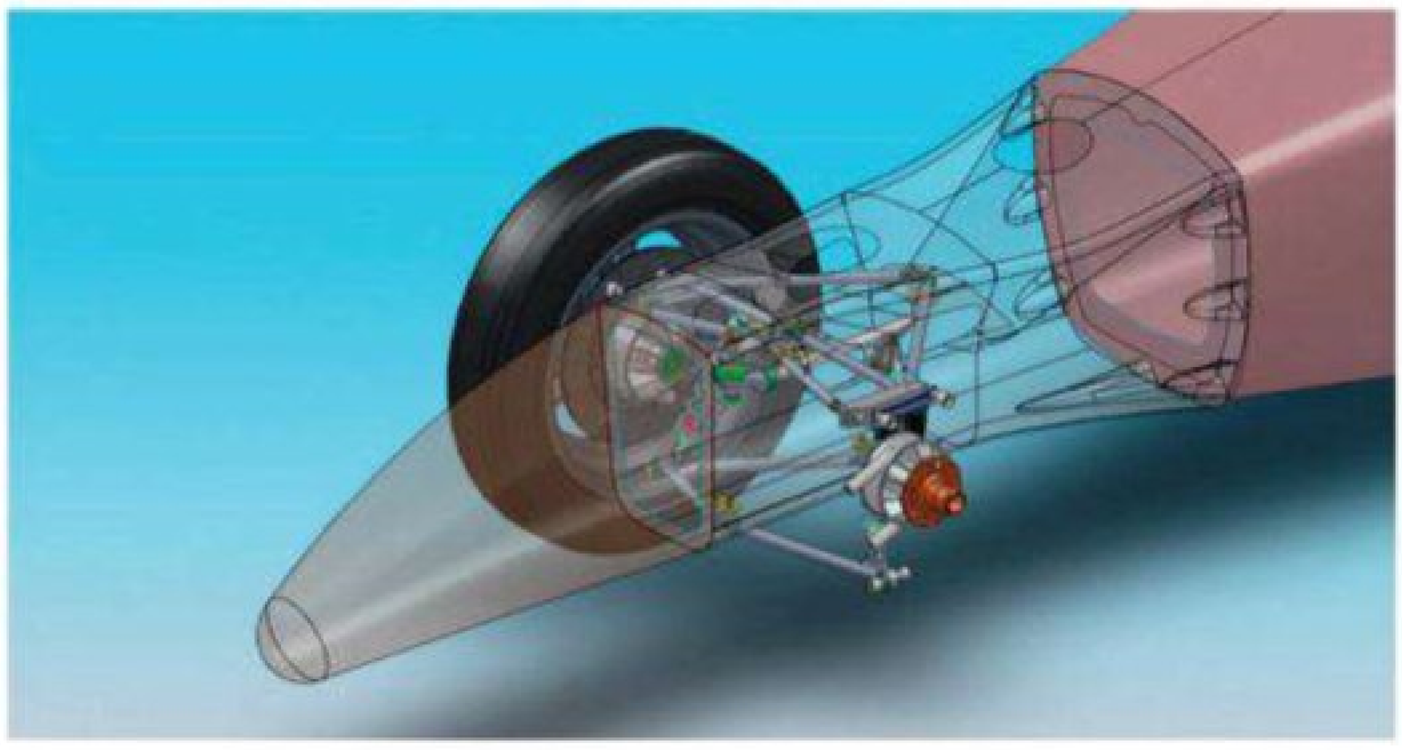
But the DeltaWing, with its 72.5 per cent weight distribution to the rear and narrow front track has nearly all of its lwt at the rear. This cannot be balanced by increasing the roll stiffness at the front as it is dependent on the width of the track squared. Both front wheels would therefore act as one, turning the car into a true three wheeler. The wheel rates cannot be increased by much at the front either because of the weight distribution.

The intrinsic condition of a conventional car is slight understeer, while maximum understeer is shifted into the high-speed cornering ranges,



The DeltaWing transmission will have to be unique and consequently there have been questions raised over it





John Travis believes that the DeltaWing's narrow track front will lead to an inherent state of oversteer at Le Mans next year

giving the driver predictability and confidence. The intrinsic condition of the DeltaWing is oversteer. It is very worrying that at higher speeds and lateral accelerations there is quite a large shift into terminal oversteer, so careful design of the rear tyres is required due to the large normal load fluctuations and enhanced braking and traction requirements.

WEATHER CONSIDERATIONS

What happens when it rains? Tyre hydroplaning, or aquaplaning as it's known in Europe, was first identified as a serious problem for landing aircraft in wet conditions. Walter Horne at NASA's Langley Research Center made the first rational analysis of the phenomenon, finding that above a critical speed, the tyre footprint was raised from the surface by a wedge of water. Horne derived a set of equations based upon inflation pressure alone with bias-ply aircraft tyres, and his work has since often been inappropriately applied to car and truck tyres of radial construction. However, with racing tyres having aspect ratios of footprint length to width greatly different to aircraft tyres, and being more sensitive to changes in normal load and pressure, hydroplaning is now a real problem for formula cars. The conditions by which hydroplaning can occur are as follows: speed; water depth; aspect ratio of the tyre tread; water clearing; channelling properties and tyre pressure. Note that the weight of the car or its aerodynamic downforce is not a factor. Quite simply, when the hydrostatic pressure in the wedge of water in front of the tyre equals the tyre pressure then the tread surface will no longer make contact with the ground.

On a conventional car, the front tyres clear a path for the following rear tyres so the rears, although wider in aspect ratio, have less work to do and so maintain contact better. The DeltaWing's narrower front tyres, while better suited to wet conditions, do not clear any path for the rear tyres. The rear tyres are therefore likely to hydroplane *before* the front tyres, resulting in a serious loss of control from the rear of the car.

Unlike an aircraft tyre, the aspect ratio of a racing tyre also changes with normal load and tyre pressure, so water cannot be dispersed so easily around the contact patch. The aspect ratio of the front tyre on the DeltaWing is not as extreme as the rear and so can disperse water around the contact patch better.

WHEEL LOCK UP

It has been stated by DeltaWing that the propensity of the front wheel locking under braking on corner entry is greatly reduced. But what about the locking of a rear wheel? With 60 per cent of the braking force on the rear, the former will result in understeer, and the driver is more aware of the condition being in the line of sight. The latter will result in a snap spin. I am sure that a torque-vectoring differential will sort out the problem but, then again, why take away control from the driver?

KERB CLIMBING

With the DeltaWing's inherent oversteer behaviour, it will certainly be a case of 'keep off the kerbs'. With a conventional car, the kerb and front wheel are in line of sight. The driver also has a slip angle adjuster in his hands. With the DeltaWing, kerb climbing at the rear is sure to be common and less intuitive. As rear slip angles are generated by the yaw angle of the car and not by the steering wheel directly, catching the resulting oversteer condition will be interesting. Again, the torque-vectoring differential could come to the rescue, but why should it?

CONCLUSION

DeltaWing has stated that the concept has been simulated on each of the configurations of racetracks in the IndyCar series. Why not do the same for the other contenders? rFactor Pro would be capable of simulating all the contenders under similar conditions, and this could be done with an 'artificial intelligence' driver for direct comparisons, or a real driver in the loop.

John Travis
Karl Nikas, vehicle dynamacist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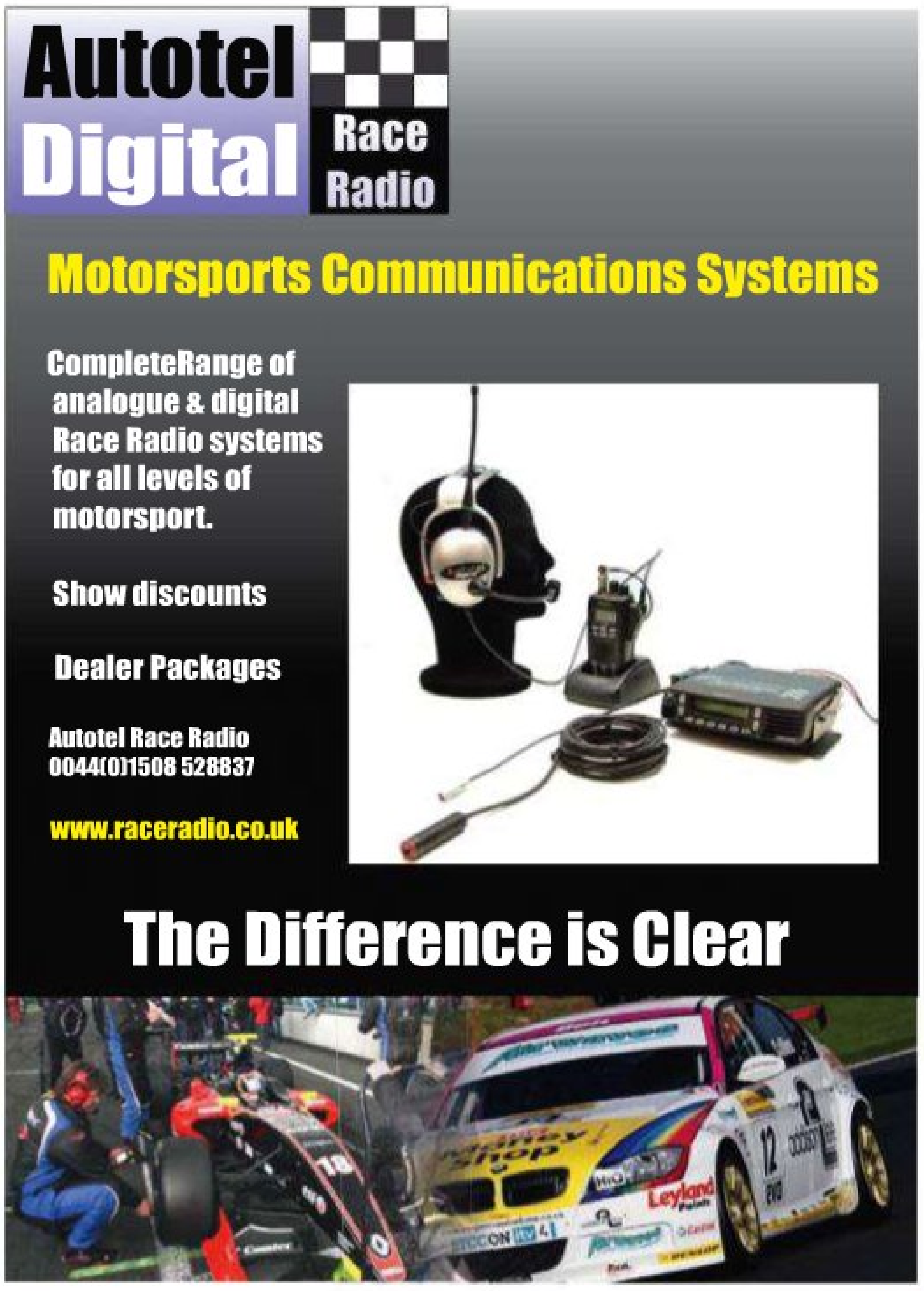
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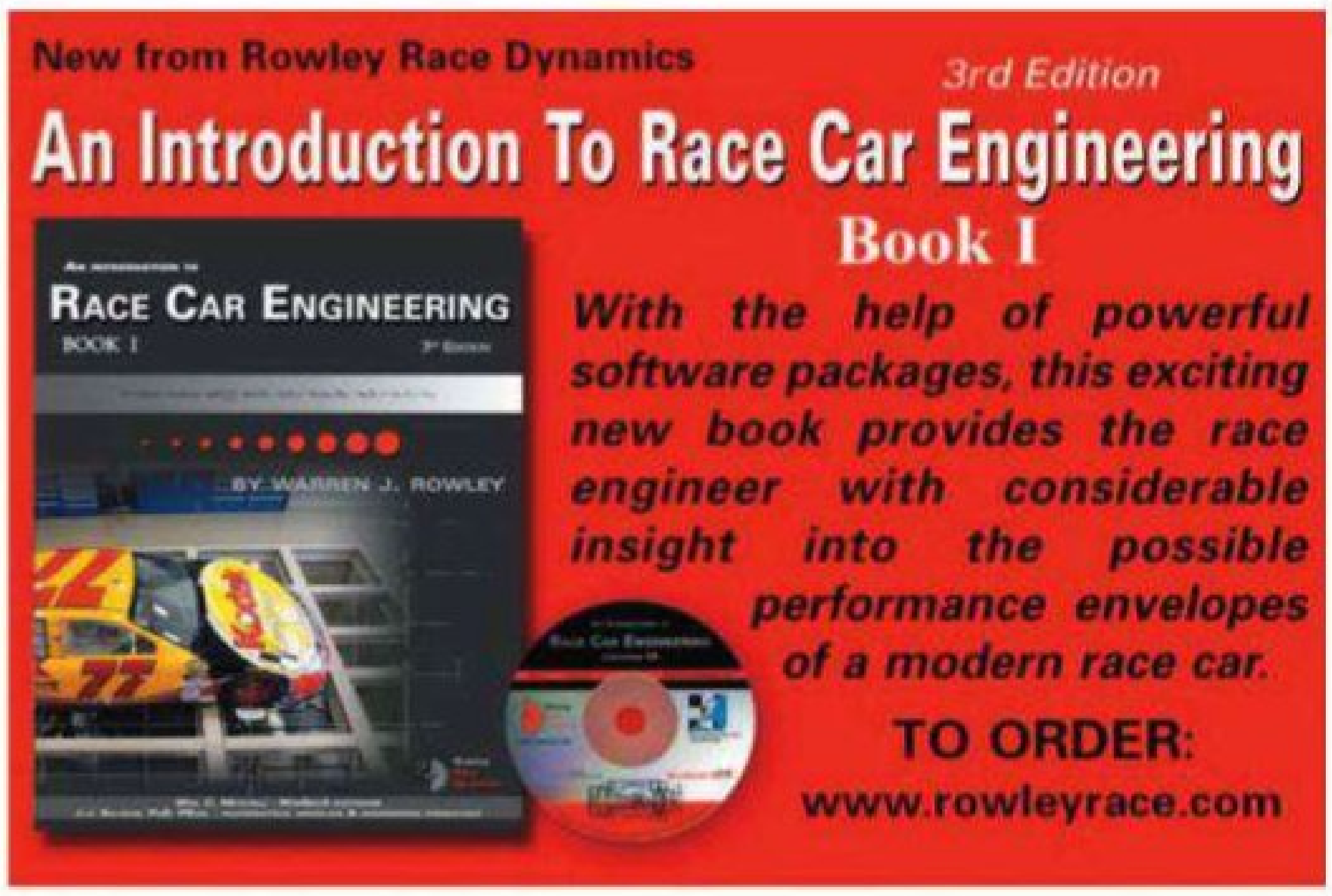
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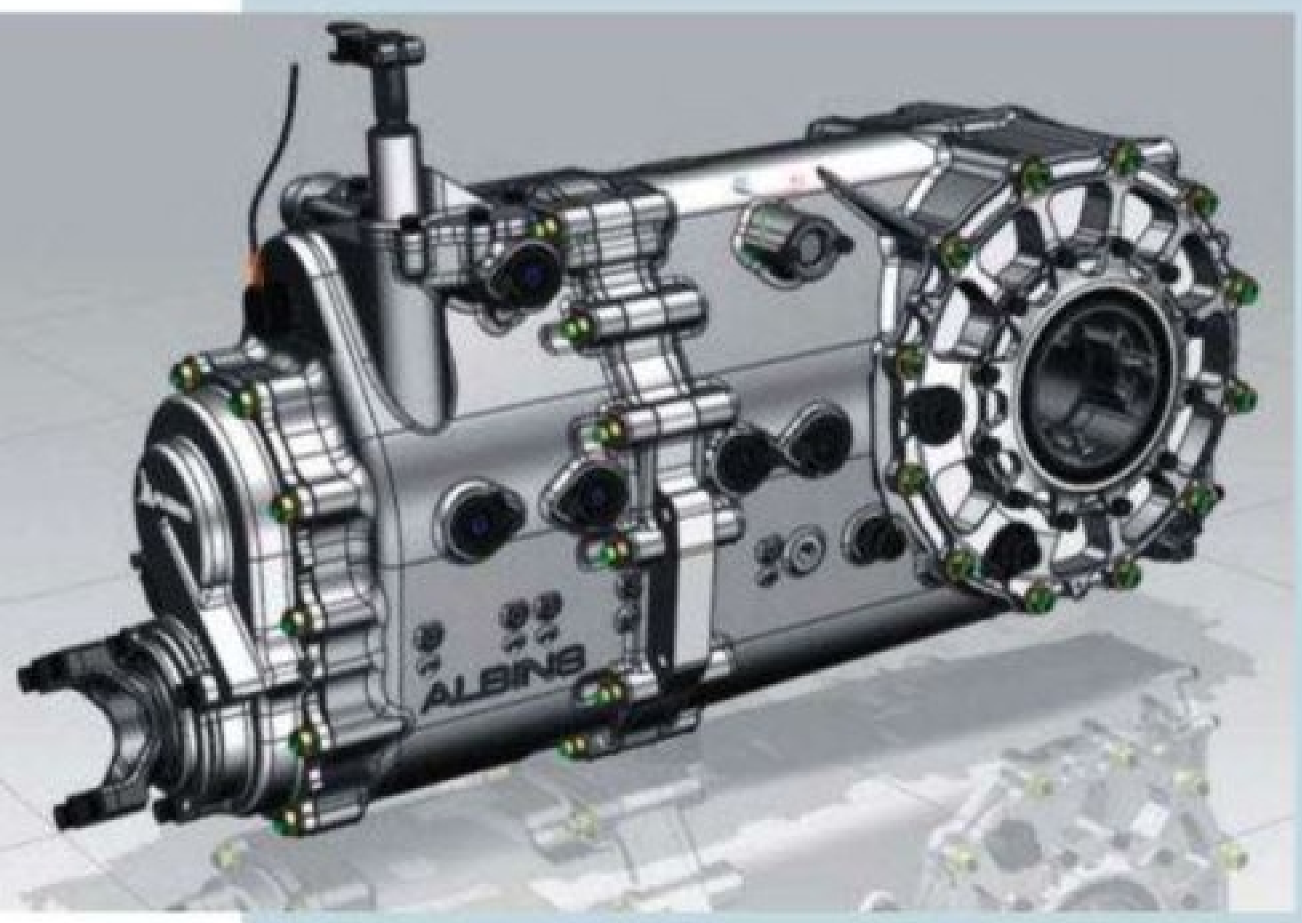
EXHIBITOR NEWS

Albins announced as official V8 Supercars Australia supplier

The Albins six-speed sequential transaxle has been selected as the official transmission for the V8 Supercars Australia Car of The Future. The Australian company has designed the transmission



specifically for the series, in order to reduce weight and friction, as well as provide a long service life with easy maintenance. The transmission and final drive are incorporated into one unit to provide significant financial benefits to the teams, while the lightweight design and high torque-bearing capabilities ensure loads can be sustained in endurance races over 1000km.

The quick change of different overall transmission ratios for different circuits has been facilitated by drop gears on the front of the transmission, leaving all other gears fixed, including the final drive. This results in a reduction of components required by the team, as well as reduced labour in changing gears. Other features include inspection ports located throughout the gearbox.

Albins will be located in Hall 9, Stand E238

St Cross Electronics illustrates versatility

Leading manufacturer in wiring solutions, St Cross Electronics, will illustrate how its technology crosses between sectors at Autosport International. Its range of clients include medical suppliers, Texas Instruments and Phillips, as well as the National Association for Stock Car Auto Racing (NASCAR).

'Medical and military projects probably make up about 80 per cent of our business,' says Dax Ward, the company's managing director. 'However, having processes in place such as stock bonding, stock lifing and the ability to produce large production runs makes us ideally placed for supplying series such as NASCAR. The standards that the medical and military industries require give us a real advantage over our competitors who only serve the motor racing sector.'

St Cross Electronics will display its offerings in Hall 9, Stand E726

K&N Filters return

Title sponsors of NASCAR's highest level development race series, K&N Filters, will continue as a firm favourite for show visitors at Autosport International. It has recently launched new filters for the Mercedes-Benz SLK 350 3.5-litre, BMW X3 3.0-litre and the Suzuki Swift, and will have its latest range of racing air filters on show in January.

K&N Filters can be found in Hall 6, Stand 6870

Stock up at Autosport International

Mechanix Wear, official NASCAR partner, will head to Birmingham's National Exhibition Centre in January. The high performance glove supplier is the perfect company to visit to ensure that you have your protective clothing prepared for the 2012 season.

Visit Mechanix Wear in Hall 6, Stand 6255

ATL racing fuel cells

Founded in 1970, Milton Keynes-based ATL Fuel Cells has been exhibiting at Autosport International since the show's inception, presenting its flexible bladder-type cells, which deform under high energy impacts. The products' durability, flexibility and compactness means that ATL now supplies all Formula 1 cars competing in the 2011 championship.

ATL's involvement in motorsport covers all disciplines: it equipped the Greaves Motorsport entry that won the LMP2 category in the 24 Hours of Le Mans this year, and has won the tender to supply both the British Touring Car Championship and DTM. As of 2012, all of the cars in these championships will be running ATL fuel cells.

Series across the globe feature ATL's products, including the NASCAR Sprint Cup, Nationwide and Whelen Modified series, the World Rally Championship and Super Touring Cars.

'Autosport International is one of few dedicated motorsport trade shows,' said Kevin Molloy, co-director of ATL Fuel Cells. 'Each year we use the show to meet and greet our European customers to discuss new products.'

ATL can be found in Hall 9, Stand E253

International Motorsport Business Week schedule

Don't forget to save the date in your diary! International Motorsport Business Week takes place from 9-15 January 2012, comprising a series of business and networking opportunities for those within, or wishing to develop their involvement in, the motorsport industry

Race Tech World Motorsport Symposium
9-10 January 2012
Oxford Brookes University, Oxford, UK

MIA's Low Carbon Racing Conference
11 January 2012
NEC, Birmingham, UK

MIA's Business Awards Dinner
12 January 2012
NEC Birmingham, UK

Autosport Engineering, in association with *Racecar Engineering*
12-13 January 2012
NEC, Birmingham, UK

MIA workshops
12-13 January 2012
NEC, Birmingham, UK

UKTI International Business Exchange
12-13 January 2012
NEC, Birmingham, UK

Motorsport Safety Fund 'Watkins Lecture'
13 January 2012
NEC, Birmingham, UK

Autosport International
12-15 January 2012
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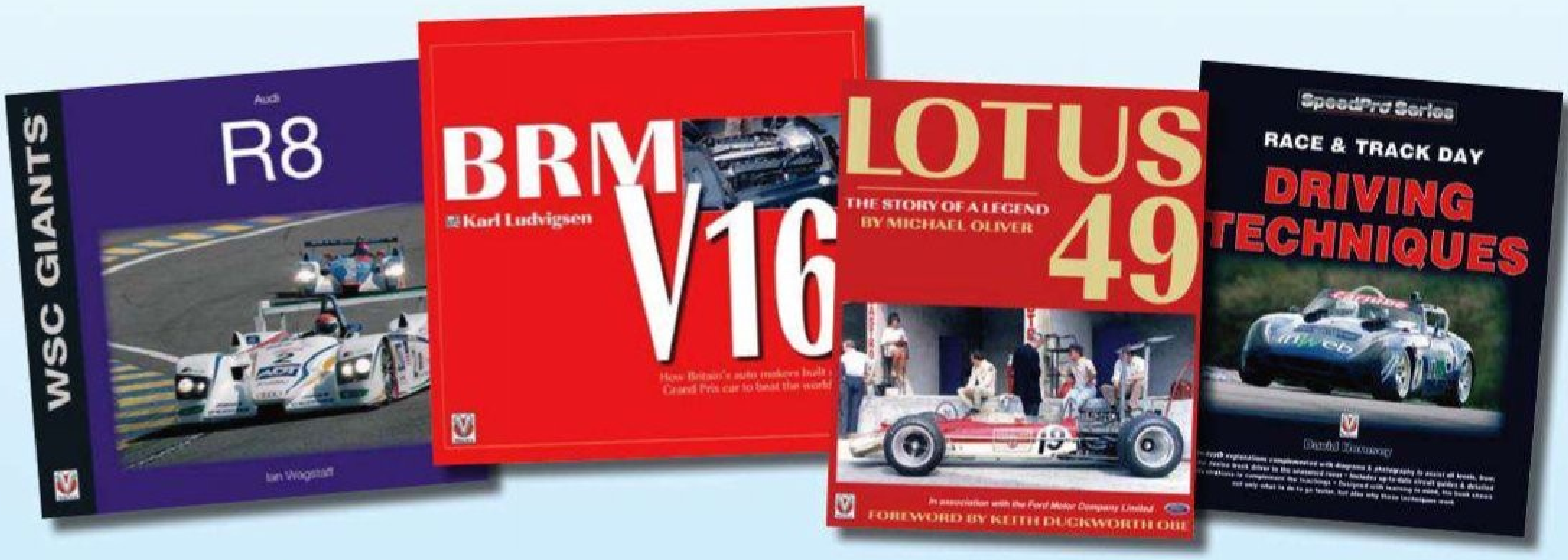

On 7 October 2011, Racecar Engineering will be running its first ever Twitter competition. On the day, tune in to Racecar Engineering (@RacecarEngineer) on Twitter where you will have 48 hours to answer our question.

Answer correctly and you will be in the running to win these four cutting edge motorsport books from Veloce Publishing worth £100!

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How Britain's auto makers built a Grand Prix car to beat the world
By Karl Ludvigen

Lotus 49
The Story of a Legend (Gold Leaf Edition)
By Michael Oliver

Race & Trackday Driving Techniques
Foreword by Adrian Newey
By David Hornsey

Join us at @RacecarEngineer on Twitter on 7 October 2011 to win!

RACE PEOPLE

Gavin Wills
INTERVIEW

Q What is the current Formula 3 programme at West-Tec?
We're competing in the European Formula 3 Open Championship this year. It's just been exceptional. The Spanish championship expanded and started running more races outside Spain than in it, so they had to re-name the championship. It runs the same class A and class B structure you see in the British series, but is more of a spec formula in that it has a control engine in both classes, and you have to run the Dallara chassis in a set specification to help control costs.

Q Does that make it less of an engineering challenge?
I don't think it takes anything away from it. The best driven and prepared cars still win. In fact I think at the moment it's a big bonus, and it's something that certainly attracted us to the championship because it meant that the budgets were significantly lower than running in the British Formula 3 Championship, yet you get to run a pukka Formula 3 car at some great tracks. So, business-wise, we were able to build quite a powerful case for potential customers and five years on, we're running five cars, and having the most successful year.

Q How does the budget compare to British F3?
You're talking half the budget of running in the British Championship. It's about £300,000 ($488,000). For a driver who is looking to progress beyond Formula 3, it's good, because the championship races on all the circuits that are relevant to his next step. So if he wants to do World Series or GP2 or anything like that, he's going to have the experience of racing on the tracks. We're also now going to run a car in the National Class of the British F3 Championship.

Q And now you're involved in drag racing [in the FIA European Top Fuel Championship, running Andy Carter]. Are you using drag or circuit racing personnel for this?
For the moment it's totally drag racing people, people who have done it before and have the experience – it's been set up as a completely separate operation, but I do see that there are transferable skills.

Some motorsport people are quite dismissive of drag racing, without realising the technical challenge it represents. There is a whole aspect of drag racing which I think is completely missed, and that is the difference that the crew makes. On the rare occasion that everything is absolutely perfect, it's a relatively straightforward job for the driver, but you need a good driver for when the car's not right, when things go wrong. For people who are interested in the technology and the technical challenge of running a car, I couldn't think of anything more engaging than a Top Fuel dragster. Basically you're building a bomb, and when lit it is right on the edge of what's physically and humanly possible.

Gavin Willis, managing director, Team West-Tec

Gavin Wills started as a driver running his own Formula Ford in the mid-'80s before setting up Gavin Wills Racing in 1988 when he was 21. This morphed into Team West-Tec, which has run cars in Formula 3, Formula Ford, Formula Renault and ASCAR (amongst others), while Wills is also responsible for designing the Swift 97 Formula Ford.

The team also acts as an engineering consultancy and, through this, Wills has engineered LMP cars. West-Tec is currently running five cars in the European Formula 3 Open Championship and is also running a front-running dragster in the FIA European Top Fuel Championship. The team moved from Devon to its current base in Corby, UK in 2001.

RACE MOVES

The Richard Childress Racing no 29 Chevrolet crew in the NASCAR Sprint Cup has won the second-quarter honours in the 2011 Mechanix Wear Most Valuable Pit Crew Award competition. Created 10 years ago, the award is one of the most sought-after titles for pit crews. Members of the winning crew include **Kyle Turner** (front tyre changer), **JD Holcomb** (front tyre carrier), **Zach Price** (rear tyre changer), **Bob Dowens** (rear tyre carrier), **Eric Wilson** (jack man), **Mike Morrison** (fuel man) and **Mike Scearce** (seventh man / windscreen).

Calvin Wells has parted company with NASCAR outfit, Michael Waltrip Racing. Wells was executive vice president and chief operating officer at the organisation, and was formerly an owner of PPI Motorsports, which fielded cars in the Nationwide and Sprint Cup Series. MWR has yet to announce a replacement for Wells.

Brian Moffitt has been named CEO of Richard Petty Motorsports. Moffitt, previously held the role of senior vice president of sales and marketing at the organisation and has been employed at RPM for the last 15 years.

Kenny Francis is to be crew chief for **Kasey Kahne** when he joins Hendrick Motorsports in 2012. Francis is Kahne's current crew chief at Red Bull Racing and also filled the same role for Kahne at Gillett Evernham Motosports. Francis will replace **Lance McGrew**, who is currently **Mark Martin**'s crew chief at Hendrick. McGrew will remain with the Hendrick organisation.

Mary Hendrick, former NASCAR car owner and mother of Hendrick Motorsports boss **Rick Hendrick**, has died at the age of 88. Often called 'Miss Mary,' Hendrick was the car owner of the no 25 Hendrick Motorsports Chevrolet in the Sprint Cup Series from 2005-2007 and in 2008 she

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RACE MOVES

became the owner of the no 5 Chevrolet. She won seven races as an owner.

Luke Lambert has replaced **Todd Berrier** as crew chief on Jeff Burton's Sprint Cup car at Richard Childress Racing. Lambert has been an engineer at RCR since

LAT

Todd Berrier

2008 and has been part of the team since 2005. Berrier has now left the organisation after 17 years service.

Two members of the Earnhardt Ganassi Racing NASCAR outfit, **Trevor Lysne** and **Jerome Frey**, have lost their jobs at EGR and have been suspended indefinitely from NASCAR competition after they were arrested during a drugs raid in Huntersville, NC.

Joseph Mattioli has retired from his position as CEO of Pocono Raceway, the track he opened with his wife, Rose, 30 years ago. Mattioli, who is 86, said that his eldest grandson, **Brandon Igdalsky,** would take his place as CEO (he is already president), while Brandon's brother, **Nicholas Igdalsky**, is to become COO. Their sister, **Ashley Igdalsky**, is now secretary and treasurer of the company.

Gilles Simon has left the FIA, where he was the director of powertrain and electronics, to join **Craig Pollock**'s new PURE corporation as its technical director.

LAT

Gilles Simon

PURE has been set up to build engines for the 2014 season. Simon was Ferrari's engine boss from 2006-2009.

Don Naman, the first general manager of the Talladega Superspeedway, has died at the age of 75. He was general manager at the track for 18 years from 1970 and, after his time at the track, went on to become executive director at the International Motorsports Hall of Fame and Museum.

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

Gavin Wills INTERVIEW

CONTINUED

DAVE HODSON

Andy Carter is the European Top Fuel champion, and now benefits from West-Tec backing

Q Is there anything from the aerodynamics side you can bring to drag racing from circuit racing?
You raise an interesting point, and we're trying to look at all aspects of it. We're fascinated by the whole aero side of the cars, but what is a real challenge to try and model is the huge effect that the exhaust headers and the burnt combustion gases have on the whole aero package, and you simply can't do that in a wind tunnel.
In the States it tends to be on-track development. Yes, there are good packages out there for modelling and testing the wings in isolation, but as an entire package... I mean, the car completely changes shape as it goes down the track. The tyres change shape, the whole car bends, twists and rises up in the middle because of the torque reaction. And then you've got the massive change in the conditions around the rear of the car from the exhaust. It really is fascinating stuff.

Q How many people do you employ at West-Tec?
In total we've got 35 people. That is a mixture of full time and part time, and contractors across the three teams: the drag team, Formula 3 and Formula Ford. Of these, the Formula 3 team is clearly the biggest operation. At Brands Hatch we had 24 people working for us over the course of the weekend.

Q What lies ahead for the company?
Well, we're incredibly happy with Formula 3 and we're totally committed to that, and the drag team is really very exciting. We're going to run a second Top Fuel car next year that's already here being prepared. Then there's Le Mans and Le Mans Series. In addition to our own engineering, we also supply a lot of personnel to other teams. At one stage we were supplying people to three different teams at the same time, so we've actually quietly built up a lot of experience in the LMS. I've personally engineered seven wins now in LMP2, and that's something we would very much like to do under our own name, running a team in our own right.

With 11 out of 16 wins this season (at the time of writing), West-Tec's F3 entry is storming

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BUMP STOP

Around the GT world

The FIA GT Championship will continue for a further year as Stephane Ratel has assembled seven of the 12 teams he needs for 2012, and hopes for more to join him at the start of next year. Ratel's plan is for his teams to run two cars each, and go with him around the world.

The continuation of the GT Championship does nothing to help clarify the endurance racing world, though, which already has the GT World Championship, the ALMS, LMS, Grand-Am and the ILMC. The World Endurance Championship next year is the interesting series, the GT World Championship is not. And yet, Ratel could be onto a winner after all. He does not accept failure, and does put his money where his mouth is. When everyone was telling him that the FIA GT Championship was dead in 1999, he joined us in a bar in Hungary and claimed: 'We are at the bottom of the circle, but we are going up!' He then funded the ill-fated Ferrari 550 'Millennio' project, which by a bizarre route led to Prodrive's iconic 550 Maranello programme. He then introduced the N-GT class, which developed into the GT2 and now the GTE category, widely credited with being the most successful of racing categories on an international level.

Then, he created the GT3 class, which no one cared about much as it was just aimed at his wealthy friends who wanted to race. Now, the GT3 has taken over the domestic scene, manufacturers are able to make a case for selling multiple cars around the world, and spread their brand name, all the while making money from sales of the cars, spare parts and update kits.

Those two were surely the peak of Ratel's circle, yet he went a step further and introduced the GT1 World Championship. He thought he was still on the up. I thought it was the beginning of the downward slide. The appetite was simply not there, either from the media, the manufacturers or the sponsors. The idea to 'go global' was taken because it seemed to be a step forward, but that was no solid reason to do it. You can only go global if the market demands it. As team owner, Hans Reiter, said: 'If we are making money from each race, make the calendar bigger. If it is costing us each event, please don't.'

From the outset, there were plenty of arguments. In one team owner's meeting at Zolder, Belgium, one set fire to a 50 euro note and told Ratel that was what it was like to compete in his World Championship. Separately, Ratel told me it was a cheap way to contest a World Championship, but I told him that it isn't. The amount of money is relatively small compared to F1, perhaps, but teams are spending money, lots of it in real terms, and therefore it is expensive.

With only limited interest from manufacturers to build new cars and limited interest from media and sponsors, it still seems that the financial argument does not stack up. To compensate, Ratel has widened the net to include GT2 and GT3 cars in his World Championship. But why not leave them alone to do what they do best? The answer is he now cannot afford to. So, we have GT3 cars able to compete in national championships, the Blancpain series in Europe, the European Championship and now the GT World Championship. Clear? No, I didn't think so.

> **"Could this be the start of a new technology war?"**

Yet Ratel appears to have pulled a rabbit out of the hat, with Audi, BMW and Ferrari all now looking to support his series, with McLaren selling its popular MP4-12C, and a wealth of GT3 machinery, including Mercedes, ready to jump in. Could you imagine them supplying cars for a World Championship, and not getting involved when they are not winning? Could this be the start of a technology war that will take the World Championship to the next level, and be another of Ratel's success stories?

It is difficult to judge, simply because Ratel is a man who makes the impossible happen. Recently he has been beaten by events beyond his control – a Romanian government changing its mind, a Brazilian circuit dropping off the calendar and Russia being a difficult nut to crack – yet he is a man who swims against the tide. One day he will tire, and be swept away, and I for one was pretty sure this was the project that would see him off. Now, however, I just don't know.

EDITOR
Andrew Cotton

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