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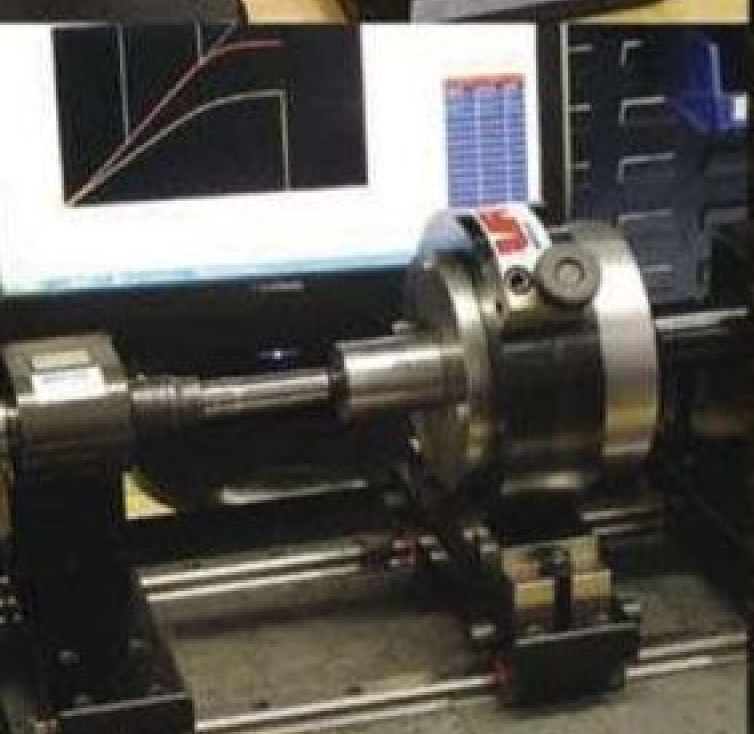


Where there's hope...

Our new columnist laments the old engineer and champions the new

In the course of the racing weekend at Monza I was booked into the legendary Hotel Fossati at Canonica Lambro, which was *the* hotel to stay in if you were a racing driver in the '60s and '70s. As you walk into the lobby, the walls are covered with signed pictures of all the name drivers of that period. A high percentage are not with us any more – the cost of racing in those days – but it set me thinking about the racing crews that also stayed there, building and maintaining the cars the celebrated drivers raced.

Without the anonymous unrecorded builders, engineers and mechanics, none of the drivers would have achieved what they did, and the same goes for racing nowadays. One can comment on them in a detached way, despite being a member of that class for far longer than is decent. And one also has a sense of humour, which explains the longevity.

The role of the racing engineer has evolved enormously over the last century. Initially, an engineer, in the English definition of the word, was a person trained and skilled in the design, construction and use of engines or machines, or in any of various branches of engineering.

If one runs a car, one can also throw in some unmentioned items such as child psychologist (useful for handling drivers), spin doctor (good for manufacturing excuses for lack of car's performance) and, of course, adopting the Swan Posture – better explained as looking calm, serene and regal, despite the little feet paddling away like mad to sort out the problem without alarming the drivers – a very susceptible genus – team or team owners.

Whatever happens, one must look and sound in control. The fact that one can shelter behind tech-speak helps enormously, as nobody will contest phrases pointing out that the lambda sensors were miscalibrated, and nobody is at fault as they are such sensitive items and prone to fits of sulking. Fellow engineers will, of course, back such tech-speak as they recognise the usefulness of the ploy.

Walk down a pit lane now and you will see the peripatetic engineer hunched over a laptop (the breed is know to have anxiety attacks when separated from said laptops), but it was not always like that.

"Whatever happens, one must look and sound in control"

Whilst at Daniel Sexton Gurney's AAR workshop in Santa Ana, I had the honour to see one of the icons of the trade – Phil 'Rem' Remington, the embodiment of the breed, at work. Rem designs, builds and runs cars, and has done for a very long time, from the dry lakes running hot rods in the '30s to being with the Lance Reventlow Scarab F1 at Monaco, to working with Carrol Shelby on the Cobras to Stock Cars with Holman and Moody to winning Indy with Gurney and endurance racing at Le Mans with the Fords. And he's still building parts for racecars, at a youthful 91 years of age. A legend in motor racing, and long may he wave.

And one cannot move away from this subject without tipping one's hat to the 24 Hours of Le Mans-winning Audi's engineer, Lena Gade – a woman showing that the other half of mankind (er, yes, non-PC, but one refuses to use 'personkind'. Age hath its privileges) can do a better job than the usual suspects.

In short, one does not believe the new generation is as skilled with its hands as their predecessors, but that also shows the evolution in the technology. That CPU in the laptop has revolutionised the work environment and brought a huge amount of information, analysis and simulation into the game, and the new generation of engineers brings to the track a plethora of shining tools. Yet the essential one has always been there and remains – the curiosity about how things work, are built and used, and how it can be improved.

Delving into an interesting mechanical (and increasingly electrical) concept from any field always seems to turn up a possible utilisation in a racecar, and the great thing about the technological advances of the last century is that it happened in all sectors. Even drivers are now computer literate and can spend more time on data plots than the engineers. I am flabbergasted. Perhaps there is hope for humanity after all.

Having just come to the staggering realisation that my time is up, I leave you with Nathaniel Hawthorne's quote, 'Easy reading is damn hard writing.' Cheered by the thought that if the dictionary is full of words, one will just have to pick the right ones.

Phil 'Rem' Remington worked on the Scarab Formula 1 car, and is still building parts for race cars today, aged 91

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Rallies, rumours, rats

Back to school, and a lesson, or three, in the three Rs...

UK Channel 4 TV recently screened an interesting 1980's Group B rally documentary. The dramatised argument was that the then FIA president, Jean-Marie Balestre, may have sought to increase manufacturers' investment in rallying by removing restrictions on the technology used by the cars, and that the subsequent changes had unintended and dreadful consequences.

It was certainly a period of incredible development, which arguably kick started the now enduring popularity of manufacturer-produced 4WD, turbocharged engines and hot hatchbacks as saleable ingredients for modern road cars.

It was also suggested that Group B had saved both the Audi and Peugeot car companies from commercial failure, due to the phenomenal global advertising from the rally successes of these two otherwise little known or little respected brands.

A spate of driver and spectator deaths led to Group B technology being blamed and then banned, after which rallying – excuse me fans – fell back into the relative obscurity from whence it had come.

Contrary to some of the TV programme's implications, the fault seemed neither to rest with FIA / FISA regulations, nor the motor manufacturers who built the lightweight and very powerful road rockets. The fact is we had all been here before, but the lesson had been forgotten.

Way back at the dawn of intelligent life, ie the early days of motorsport, public road racing was all there was. Nascent Edwardian manufacturers created unreliable machines with vast capacity engines and sent these barely controllable leviathans hurtling across continents on the unmade farm tracks and dust bowls that preceded roads as we know them today.

Rarely did these monstrous cars see each other as they were soon strung out across thousands of miles in line astern. To all intents and purposes, many of these events looked much like a modern rally, with timed starts, overnight stops for repairs and so on. And those early racers encountered exactly the same problem that Group B found 70 years later – large numbers of uncontrolled spectators lining the roads trying to touch the cars as they passed. Multiple deaths of drivers and spectators followed and, eventually, the authorities banned road racing, which is why we now use enclosed tracks on private land with spectators held well away from the action.

"No conspiracy, no mega acquisitions, just good business"

The Group B rally cars were brilliant, but the rally concept was flawed

Rallies were invented later as a way of using public roads for motorsport without falling foul of the racing ban. Cars would not be on the same section of road but spaced by timed intervals, long enough to avoid actual racing. Enclosed special sections were added as some parts of the sport got serious about speed and those special stages did at least take the cars off public roads.

The Group B fiasco though simply took the rally back to the original Edwardian public road race scenario, and inevitably produced exactly the same result as, unfortunately, no one had thought to remove the spectators. The environment the racers had recreated was exactly that flawed environment that caused the demise of road racing and the creation of rallying in the first place! Do we never learn?

Within hours of writing that, I watched an idiot deliberately and dangerously plunge in front of the two boats competing in the University boat race on the Thames, in front of millions of TV viewers, so that rather answers the question!

RUMOUR CONTROL

Several websites have published an item about the Formula One Group of companies borrowing additional money, and speculation has it that such extra funding could be used to buy Lehman Brothers' remaining F1-related shares, hand out cash to investors as dividends or just buy a few new jets. But it is not what it seems...

The official press announcement states that a new financing facility of $2.27bn will replace the current one for $2.92bn. It appears to be a simple rollover of debt from the current expiry dates of 2013/'14 to new ones in 2017/'18. The new loan facility will be smaller than the current one by some $650m (22 per cent), meaning that money is being repaid to lenders or the facility to borrow it is no longer needed. The announcement added that there will be no dividends paid out and the refreshed loan facility will be used for 'general corporate purposes', so probably no specific acquisitions – although they would not say, of course.

It seems the F1 commercial arm is making a sustainable $300m profit or thereabouts a year and the reduced loan arrangement will make the Formula One Group both more attractive to potential buyers and a more stable platform for the sport. No conspiracy, no mega acquisitions, just good business.

RATS PREFER PORSCHES

And talking of City matters. A colleague, one Alex F, lives in a sought after but highly congested area of the City of London where he keeps his rather nice Porsche. Not having a garage, he leaves it outside overnight. As he walks to work, the Porsche is used somewhat sparingly and, starting it up recently, he was shocked to see a handful of rats shoot out from underneath and leg it down the road at high speed (Okay, 'paw' it down the road, for the pedants amongst you). On detailed investigation, he found the rats had made themselves quite a nest in the engine compartment. Conferring later with neighbours, it transpired that rats had also been found in an Audi parked immediately behind the Porsche but they had gone. Perhaps even rats can be aspirational.

Joined-up thinking

With the aim of halving the cost of the cars and reducing running costs, Audi, BMW and Mercedes worked together to produce the 2012 DTM racecar

BY ANDREW COTTON

An explosion of carbon fibre amid a fog of tyre smoke signalled one of the worst crashes in modern DTM history, when Tom Kristensen's Audi A4 was hit on the driver's side by Alexandre Premat's similar machine at the first round of the 2007 season in Hockenheim. Unlike Kieth Odor, who perished in a similar side impact in 1995, the Dane recovered and went on to win at Le Mans a year later, but the incident sparked the rule makers and manufacturers to consider new safety measures in the new generation cars.

The 2012 season sees the culmination of that work as BMW's M3, Audi's A5 and Mercedes' C-Class compete in the championship. At first glance, the decision to switch from four-door cars to two-door coupés was a marketing-led decision and is the principal difference between the 2011 and 2012 cars but, under the skin, the new cars are very different to their predecessors.

A multi-year development programme, jointly undertaken by the participating manufacturers, has led to a common development of parts that are shared between each of the cars on the grid. Development potential has been limited to prevent budgets running out of control, with the arrival of a third manufacturer – BMW – this year.

The manufacturers collaborated to attempt to halve the costs of producing the car, reduce the running costs and increase the safety, particularly from a side impact. The result is a car that costs an estimated 30 per cent less than its predecessor in the first year, and is capable of withstanding much higher impact, leading to greater driver safety.

"If the Mercedes or BMW is failing in the race because the Audi design is not working, this is a difficult situation"

CARBON TUB

The monocoque is built entirely from carbon fibre, into which the 120-litre fuel tank is integrated for the first time. The chassis weighs 126kg and the rollcage 32.5kg, but is capable of withstanding a force of 360Kn in a side impact, compared to 80Kn in the old cars. In a frontal impact, the load stress of the driver is just 60g at 54km/h thanks to a new 65cm crash structure. For the first time, there are also four lateral crash absorbers.

'The Mercedes guys and us sat with the DMSB and decided what we could do,' said Audi's head of vehicle design at Audi Sport, Stefan Aicher. 'We decided the crash test loads, the mass, the velocity, the deceleration. The targets were around 1200kg mass of crash car, and 15m/s velocity, so 2m/s faster than a Formula 1 car, so it was a really big challenge.

'The crash cone on the side was not really working because you have the crash cone in the front coming together with the cone on the side. They destroy each other and you cannot create the deceleration. You have to create a monocoque with a very stiff sidewall.'

COLLABORATION

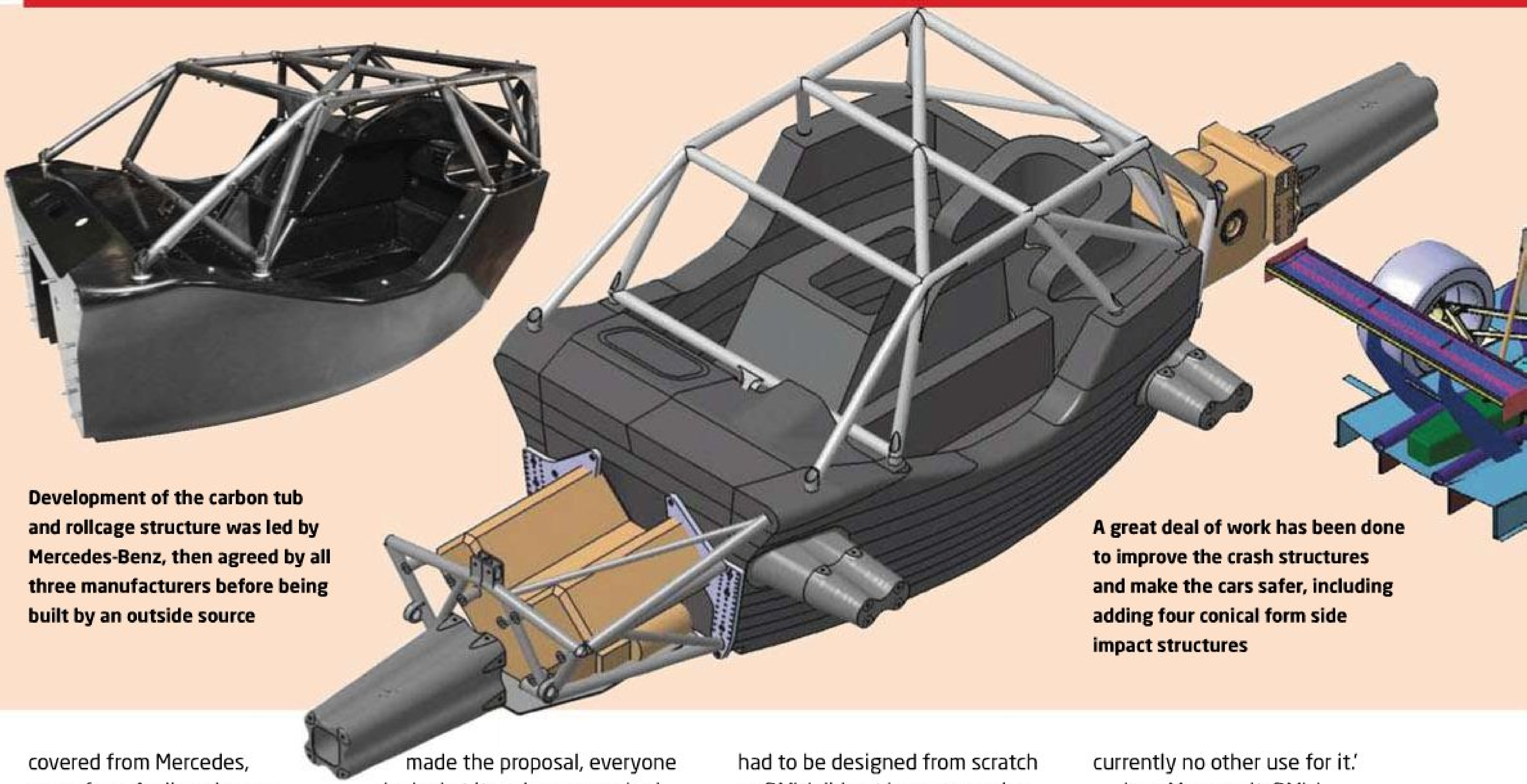
Much has been made of the collaboration between the three manufacturers, but this is evident in the way the monocoque was designed. Audi and Mercedes started on the design process to create cars for the new regulations, and came up with their own solutions. However, they quickly established that the workload and chances of reaching an agreement were slim.

And so, with the arrival of BMW, effectively the manufacturers agreed to split the car into three developmental parts.

Mercedes was tasked with the development of the rollcage and monocoque, Audi the driveshaft, propshaft and gearbox, while BMW went to work on the steering, fuel system and electronics. Each solution had to be agreed between the three manufacturers before it could be presented to the DMSB, which was a huge undertaking and part of the reason it took two years to create the finished product.

'It was always a development between the three manufacturers, working in a group, and some parts were

DEVELOPMENT PROCESS



Development of the carbon tub and rollcage structure was led by Mercedes-Benz, then agreed by all three manufacturers before being built by an outside source

A great deal of work has been done to improve the crash structures and make the cars safer, including adding four conical form side impact structures

covered from Mercedes, some from Audi, and some from us,' said Jan Hartmann, Head of BMW Sports and Touring Car Engineering. 'The monocoque was developed with the three of us, but with another manufacturer who did the calculation and the manufacturing. The steering was covered from us, but there were some more details and design that were done by Audi and Mercedes. The workload was quite even, but you had to put in your part, and the result was discussed and finally agreed.

'We developed the steering, made the proposal, everyone looked at it and everyone had their complaints or requirements, and finally it was the agreement of the manufacturers that we do it like that.'

ENGINE FREEZE

With each manufacturer working on its own department, the decision was taken to stay with the engines that have been produced over the previous four years, meaning the 4.0-litre V8 configuration will continue until at least the next generation of DTM car. The only exception to that was the BMW unit, which had to be designed from scratch as BMW did not have an engine that could be modified.

'We had a look what the concept could be for us, in terms of engine,' said Hartmann. 'We were not clear if the engine was to change, or continue. We had a look in our portfolio and found that we had to do a new engine to these regulations. The other manufacturers have their engines frozen, but they have their experience of racing and qualifying, and this is an advantage that we don't have. We have designed an engine from scratch, and best guess that it fits from the track. At least we don't have an advantage.

'First of all, we had a look at the engines that were existing, but we saw that we needed a white sheet of paper. But, if you look in the regulations, it is really strict, and masses are given for piston, crankshaft, con rods – the diameters are given and, if you look at this matrix of given geometry, it is almost a white sheet of paper. Because the regulation is unique, there is currently no other use for it.'

Jens Marquardt, BMW Motorsport director, added: 'The parameters were specified and defined, and they really were quite fixed and comprehensive, and by physics there is not much possibility to have a big variation. In that respect, that is the good thing about the DTM on the rules, engine side, that you have a fairly narrow band of performance

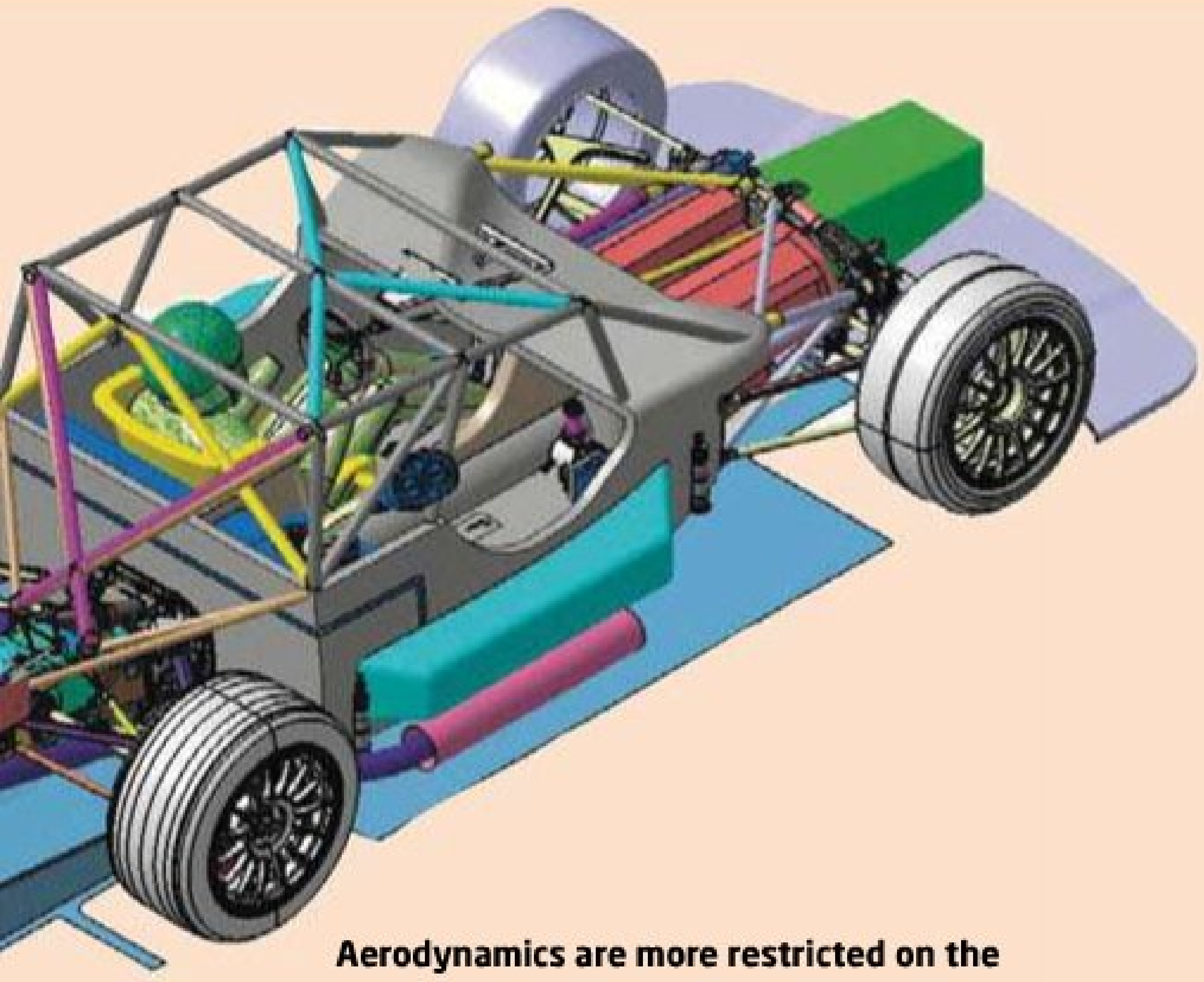
'The advantage of the existing engines is that they were refined and developed over the years before the freeze was put in place. We could put all of our thinking of our previous engines into this engine and think that this balances out.'

"The car costs 30 per cent less, and is capable of withstanding much higher impact"

TROUBLE AHEAD

While the configurations were frozen, and therefore development costs saved, it made more work for those creating the common parts, as the chassis had to accommodate the Audi, Mercedes and BMW engines, so the package around the airbox and steering in particular was a major challenge to create.

With more emphasis on mechanical grip and suspension tuning, as opposed to aerodynamics, tyre supplier, Hankook, has produced a wider rear tyre



Aerodynamics are more restricted on the 2012 cars, notably the airflow through and under the car, which is now directed out just ahead of the rear wheels

Although more heavily restricted than ever before, the DTM cars retain their brutal looks, which make them so popular with the fans. Road car relevant though? Not exactly…

With the three major German manufacturers competing head to head in increasingly similar cars, the 2012 DTM series looks set to be a more closely fought contest than ever before

Once the specifications were finalised and catalogued in the book of requirement, the next stage was to find a supplier who could design, engineer and build the common parts. 'The competitors from Mercedes, BMW and Audi should not be the ones to make this complete design of unit parts because we defined the concept, and we had to find suppliers which could also do engineering work,' said Aicher. 'For the rear wing, we said, "that is the concept, that is the area of the car, here are the fixing points, come up with a solution," and the supplier is doing the cut work, the FE work and coming up with a complete solution from a white sheet of paper.

'What we don't want is a situation that Audi designed the gearbox, and the Mercedes or BMW fails in the race because the Audi design is not working. This is a difficult situation.'

As a result, German company, Gerg Gruppe, was approached to build the chassis, Hewland the gearbox, AP Racing the carbon brakes (for which only three sets are allowed for the complete season) and Bosch the electronics across the range of cars. Fibretech completed much of the composite work with the ITR, while the three-plate clutches were produced by ZF Sachs, though that was increased to a four-plate version following a pre-season test at Valencia. The steering rack was supplied by Bishop Steering Technology Ltd.

CARS ON A DIET

Overall, it was a successful partnership, particularly as the three manufacturers succeeded in cutting the cost of producing the cars. It was all perfect, but then came that crucial first test at the Hungaroring, Germany, where an enormous problem was discovered – the cars were nearly 200kg overweight, and could not be raced in that configuration without undergoing complete crash testing once again.

Time was short and the three manufacturers had to go through the complete car to get down to the 1100kg weight limit, and do it by the time the cars arrived at the first race in Hockenheim at the end of April.

'Overall [the extra weight] was not as massive as put in some places,' said Marquardt, clearly stung by the criticism in the press regarding the weight of the cars. 'It was overweight. We had a target in mind, as we are running now – 1100kg with the driver included – and I think it was more a question of a mix of common parts, specified parts and individual parts. You always have the whole picture in your head. It was trimming and adjusting rather than re-doing the car, which I think was how it was put. It was an optimisation, a common process, and it took a group of people two afternoons to get it sorted.

'It is always [this way] in engineering. You take costs for what you get. You define a ratio that you don't want to exceed and you don't drop the weight

Airflow has been re-directed through the car to exit just ahead of the rear wheels. The only air allowed beyond that is for cooling the brakes

The rear wing, with its swan neck supports, will work in conjunction with the giant rear diffuser to produce vast amounts of downforce

at any cost. We were a little off, we had to get rid of the weight. There were individual areas for every manufacturer to work on and areas that we could commonly work on. I would say it certainly increased the cost because we had to do a second loop on things but, in the end, it was probably more a question of delaying things that were a bit of a problem for us, rather than increasing the costs a lot.

'The biggest parts are usually the ones where you gain the most, but he engine weight is defined by regulation, and the engine is frozen, so there is no change there.'

This last minute change was where the delays came, as the teams were not able to modify the cars immediately, as they had been able to do in the past. 'If you do a car like this just within Audi, you have a road map and you take decisions when you need it,' said Aicher.

'It just took a long time to make these decisions, and for all three manufacturers to say yes. And we also need agreement from the ITR and from the DMSB.

'We were at the Hungaroring in October, and there was a meeting between Audi, BMW and Mercedes, and we decided to make this car lighter. We decided to try to find 150-200kg. That is why we are a little bit late now.

'At first, we started with the wheel bearing from the production car, which costs about €30, but weighs 2.5kg, but the concept was to go back to a hybrid bearing, with ceramic balls and steel cages. We went to a welded steel upright, not an aluminium one, and we lightened the driveshafts, the propshaft, the gearbox housing, the internals of the gearbox and the battery. We had a really cheap battery with more than 25kg in the car, and now we run a lithium one which is 10kg lighter.

'We went through the complete car, and changed nearly every unit part, and the manufacturing procedure for individual parts such as the suspension and the uprights. This was changed really late, but this was the same for everyone. We were struggling a lot to get these eight cars produced.'

"This matrix of given geometry, it is almost a white sheet of paper"

There were obvious problems with this situation - namely that the cost criteria was going to have to be compromised. The ITR worked with the manufacturers, asking them to reveal the cost of parts for various parts of the car, took an average of the three, and then set the budget at exactly half. That, predictably, led to problems similar to those being experienced in IndyCar. While the American series opts to solve the problems through engineering solutions, the Germans took the decision to combine that with an injection of money. As an example, the propshaft alone went from a cost of €1000 in 2011 to €3000 in 2012 after the teams experienced problems with vibration.

After missing the initial target weight of 1100kg (inc driver) by some 200kg, a number of changes were made, including going to a lithium-ion battery

AIR BRAKE

Nevertheless, the teams are proud to boast that they hit their minimum target of cutting the production costs by 30 per cent, although Audi's head of motorsport, Dr Wolfgang Ullrich, says the figure is closer to 40 per cent, and that this will magnify in time as, without the bodywork, 80 per cent of the car for the next four years is already developed and frozen, including the chassis, the subframe, the engine, crash structures, drivetrain and driveshaft.

Two other issues also needed to be addressed though – the aerodynamics and the airflow through the cars. The first problem was probably the most difficult of all to solve, and the rule makers resorted to scaling the cars. 'We worked out a solution with a slightly scaled chassis in x and y axis because we had to find a way that if you make a longitudinal cut between the Audi, BMW and Mercedes then they are as close as possible. Otherwise, you will get very different aerodynamics,' explains Aicher. 'This is an easy way to scale the cars to nearly similar shape but, as you can imagine, this was also a long discussion until we finalised it!

'Once we decided, and got the go ahead from the boards of BMW, Audi and Mercedes, we then needed to find further restrictions for the aero. There were lots of wings and flicks and things around the old cars, and they were expensive to develop, produce and repair, and you have a lot of failed parts.

'We had tunnels under the car, but they are now forbidden. The only air that is allowed into the car is defined for a particular use. That is for the cooling of the engine, the brakes and the driver, and that is it. Everything else is forbidden. It is different to last year, where we tried to get the airflow through the car.'

The drive to get rid of the fragile carbon fibre aero devices led to a complete re-think around how to funnel the air through the car. Underneath, a boat-like shape takes the air from the front splitter and channels it out through the rear, 150mm ahead of the rear wheels. And with the regulations frozen, it means it is no longer possible to make a half second advance in aerodynamics. The only air that is allowed to pass through the car behind this exit is for the wheelarches and the brake ducts, but here the regulation is strict and no development can take place.

With these restrictions in place, the focus has turned to developing mechanical grip, putting an emphasis on the suspension, previously an under-developed part as aero was the area in which more gains could more easily be made.

The suspension is clearly different to last year's cars, as tyre supplier Hankook has developed a larger rear tyre to cope with the extra downforce created by an enormous rear splitter. The rear tyre size has risen to 320mm width and 710mm diameter, similar to Audi's R18 Le Mans car, as the manufacturers agreed that they were at the limit of tyre performance, but could do nothing with the old cars due to the complete lack of space in the wheelarches. This year, with the old engines still in use, the front tyres remain the same size due to the constriction of space.

The development of the new cars may have been made with an incredible collaboration between the manufacturers, but ultimately there are still races to be won, and now, admits the ITR, the real work will begin. 'You can split the two years of regulation into two parts,' said a spokesman for the governing body who did not want to be named. 'In the beginning, they were quite helpful in year one. But once they started to design their own car, they moved away because everyone had their own car in mind. The second year was a little more complicated because it was harder to find the right way to keep the series strong, but it was still fair. The first year is the easiest, the second year is the dangerous one. Everyone goes step by step, and now the business starts.'

"The rear tyre size has risen to 320mm width and 710mm diameter, similar to Audi's R18 Le Mans car"

TECH SPEC

DTM Touring Car

Chassis: CFRP monocoque with integrated fuel tank, CFRP front, rear and side crash elements

Engine: normally aspirated V8 engine, 90-degree cylinder angle, four valves per cylinder, 2 x 28mm regulation air restrictors

Engine control unit: Bosch MS 5.1
Engine lubrication: dry sump
Displacement: 4.0-litre

Power output : approx 340kW (460bhp)

Torque: +500Nm

Drive system: rear-wheel drive

Clutch: quad-plate by CFRP

Transmission: sequential six-speed sport transmission

Differential: adjustable multi-plate limited slip differential

Steering: power-assisted rack and pinion steering

Suspension: independent front and rear, twin A-arm suspension, pushrod system with spring / damper unit, Multimatic adjustable gas pressure dampers

Brakes: hydraulic dual-circuit braking system, monoblock light metal brake calipers, ventilated carbon fibre brake discs, front and rear, brake force distribution between front and rear continually adjustable by the driver, electro-magnetic starting valve

Rims: forged aluminium rims, front: 12 x 18in; rear: 13 x 18in

Tyres: Hankook, front: 300/680 R18; rear: 320/710 R18

Dimensions:
Length: 5010mm (inc rear wing)

Width: 1950mm

Height: 1150mm

Minimum weight: 1100kg (including driver)

Fuel tank capacity: 120 litres

Shooting for 225

How Dallara addressed the DW12's early running problems and IndyCar's desire to reach 225mph

BY ANDY BROWN

"Teams had to crank on more downforce, and hence more drag"

Early April, IndyCar series organisers bowed to the inevitable and organised a test day at Indianapolis. The test was attended by nine teams and work was carried out to help to set up the troublesome DW12 for one of the great motor racing events in the world.

As already reported in *Racecar Engineering*, alarm bells had rung after prototype testing. The handling of the DW12 on the speedways appeared questionable and, while IndyCar Series VP of technology, Will Phillips, had claimed that speeds of 225mph would be achievable, the teams felt this was unlikely, suggesting a drag and / or horsepower issue.

As far as the handling was concerned, it was discovered that the car would exhibit a vague feeling from the steering wheel, allied to the driver receiving little feedback about the level of grip at the rear of the car (leading the driver not to want to turn the wheel on entry). Once in the corner, understeer would develop, starting to build as the apex of the corner was approached to the point of becoming 'crossed arms' at the exit. Working on one of these issues was likely to accentuate the other.

Weight has been a problem throughout the programme and some of the major issues, especially those concerning handling, would appear on consecutive 'fault lists' from the teams. Xtrac managing director, Peter Digby, says that the gearbox manufacturer met its weight target, and that any increase over the initial figure was due to later requests to add mounting bosses. These additions have added a reported 10lb (4.5kg) to the unit and, in an effort to counteract this, Xtrac has produced some weight reductions such as a lightweight spool and some main case slimming down, which were in effect for the recent test.

In order to improve the car's balance, new inboard mounting blocks were made for the rear suspension, and the front and rear suspension pick-ups modified so the wheelbase is now one inch back at the rear and two inches back at the front. Only the front wishbones had to be re-manufactured

It was obvious the engine manufacturers were not going to be able to help as one of them had already applied to IndyCar to have the engine weight limit raised, and had the request granted. But this merely added to the weight distribution issue. So, in mid-December, Dallara itself decided to address the problem.

WEIGHT DISTRIBUTION

The car had originally come out with a 40 per cent front weight distribution, whereas teams had been running as much as 44 per cent with the IR07. Dallara had spoken of a target figure of 42 per cent, based on an average of all teams but, even if this figure had been aimed at, it was missed. If the gearbox remained at its target weight, as understood by some parties, and even allowing for the weight of the engines, the c of g should not have moved more than one per cent.

Dallara's answer was to adjust the wheelbase, moving the rear wheels back an inch and the front wheels back two inches. The original idea was to put a spacer between the engine and the bellhousing, but the engine manufacturers were not happy with that, as this would require modifications to exhaust and turbo manifolds and would involve the scrapping of the relatively expensive gearbox input shafts. As these are also a long lead time item, it would have been quite some time before the revised weight distribution could be tested. The eventual solution was a neat one of manufacturing alternative inboard mounting blocks for the rear wishbones, meaning the suspension would not have to be re-made. The front pick-ups were moved further outboard and the rear inboard pick-ups further inboard, plus the wishbone pick-up holes in the blocks were also moved slightly rearward to affect the full inch.

"Dallara's answer was to adjust the wheelbase"

The problem of rear crash fairing clearance to the rear wheels was taken care of by adding a one-inch spacer between the gearbox and the 'attenuator'. As such, the only new suspension parts required were front wishbones.

This, plus the provision of ballast plates that could be mounted in the footwell, achieved the desired two per cent shift forward in weight from the prototype. The downside has been an increased cost for the team owners, who asked if the wheelbase could now be fixed, but have been told that they have options. The one-inch spacer between the gearbox and attenuator is now a permanent spec piece, no matter where the rear wheels are being run. Most teams seem to have settled on the plus one inch position for the rear during the early road races, but at Barber cars were running different front ends. At the time of writing, though, it seemed highly unlikely that anything other than the two inch swept back front, and one inch swept back rear configuration would be used for the Indianapolis, Fontana and Texas speedways.

POLAR MOMENT OF INERTIA

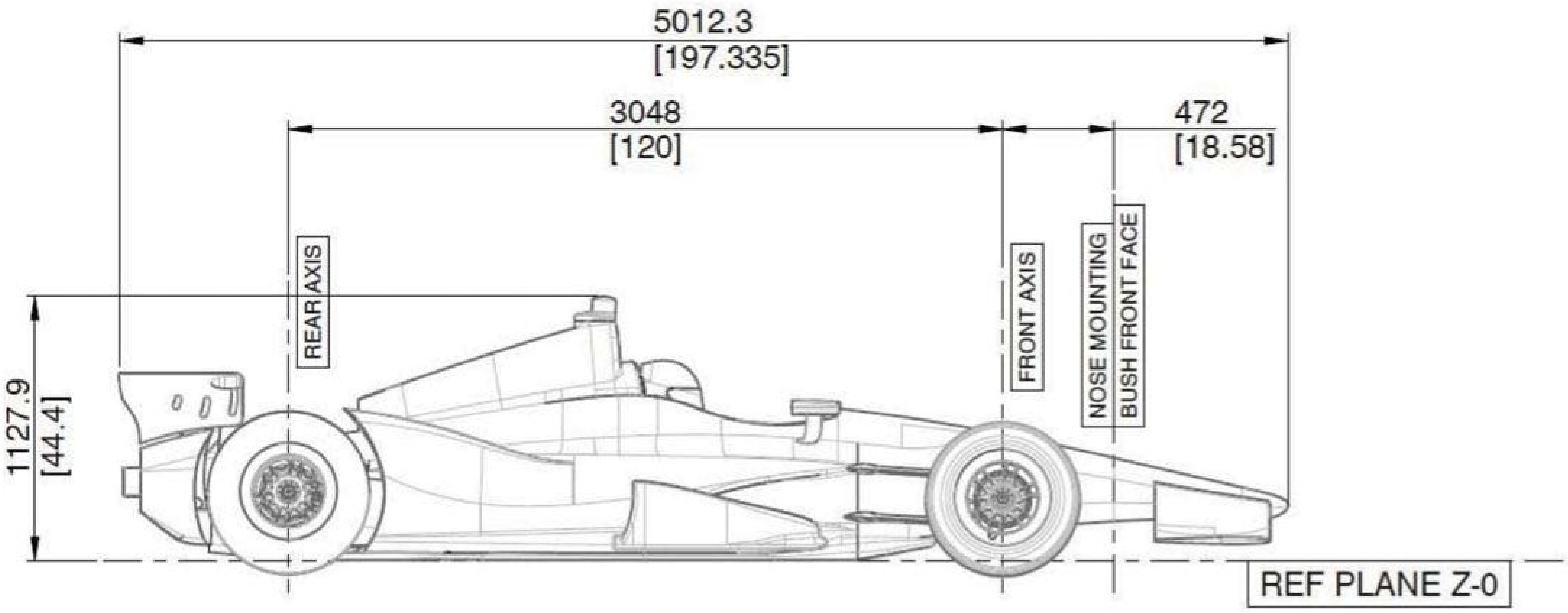
It is not just weight distribution *per se*, it is also the increase in polar moment of inertia in yaw that adds to the problems. With the significant additional weight of the rear crash structure behind the rear wheels and the substantial rear structure it is mounted to, there is an increase in the yaw moment of inertia for a car of similar overall weight. This would lead to a tendency for the car not wanting to turn initially and then, at the apex, it wanting to keep turning as the driver unwinds the steering.

The initial poor handling had some effect on the speeds achieved. During the 2011 testing of the DW12, even at 215mph things were 'not pretty'. Teams had to crank on more downforce, and hence more drag, than would normally be the case, in order to cope with the car's handling characteristics.

The fact that the car is heavier than originally intended also led teams into having to run more downforce / drag. A weight limit of 1380lb (626kg) was initially quoted for the new car in Indy trim, an intended saving of over 195lb (88kg) on the old car. An ambitious figure perhaps, but Phillips agrees this is close to the original target as put to the team owners. He also points out that, in the original proposal, more spec components were proposed, plus the wheels and tyres were to be narrower.

The owners then asked that the cost of implementing the new car be reduced by allowing items such as the dampers and wheel rims to be carryover items from the old car. The result is that the weight limit is now 1535lb (696kg) for the speedways, a saving of just 40lb (18kg).

Andrea Toso, Dallara's head of R and D and US racing business leader, points to the following as reasons why the weight grew out of Dallara's control: 'A lot of



The new body kit features fins on the rear wheel fairings, no end plates on the rear wing and a camera fairing above its outer leading edge. A rear wing angle of -10 or -11 degrees will be allowed for Indy qualifying

electronics for the media, extra cameras, the third elements, a heavier battery, extra driver ballast, extra engine weight and heavier brakes.' These added nearly 88lb (40kg).

NAGGING DOUBT

Even so, there was still the thought that the cars had inherently too much drag, or the engines were not putting out the originally quoted horsepower. There may be some truth in the latter for the early tests as there were few engines in existence. However, there was still a nagging doubt that the drag was higher than originally quoted. (Note that not only did the abandonment of the narrower wheels and tyres lead to an increase in weight, but also an increase in aero drag over the originally mooted figure.)

Originally, there were no deflectors on the outer leading edges of the under wing. These were put on for drag saving after the initial tests and are now included for all tracks. This was seen as an admission in some quarters that the prototype car had displayed a higher drag level than intended, while others said that Dallara was reacting to the lower-than-anticipated horsepower levels by producing these drag-saving components.

To address the drag level question, IndyCar and Dallara carried out a full-scale test at Windshear where the DW12, as tested at Indianapolis by Ganassi in early November, was compared to a Ganassi-supplied IR07, featuring Franchitti's qualifying set up for the 2011 Indy 500. It is claimed that these showed the DW12 to have a significant drag saving over the old car. Dallara then designed the new rear wheel fairing and wing arrangement, which was tested at Texas in January, leading the constructor to comment that the car then had more downforce and significantly less drag,

NEW BODY KIT

The new rear body kit has a fin on the wheel fairing instead of a rear wing end plate. The small end plate on the single element rear wing has also disappeared. One feature of the new set up is the camera fairing, which used to be on the outside of the end plate but now sits above the outer leading edge of the rear wing. It has been said -10 degrees (possibly -11) will be allowed on the rear wing in qualifying, but there is an uncertainty amongst the teams about how this will work.

Based upon the results of the earlier Texas track test, the above is the spec that was decided should be used for the April Indy test, and most likely for the Indy 500 itself.

"This, it was felt, might 'sort the men from the boys'"

There are still various arrangements for the under-wing diffuser that IndyCar specified could be run at the test. Originally, for Indy, this was meant to be just a plain ramp with no outer wall to the diffuser and no strakes in the diffuser itself. The idea was that the diffuser would do less work and the rear wing would be brought into play. This, it was felt, might 'sort the men from the boys', with those feeling confident being able to back out more rear wing (and hence drag) and gain a speed advantage over those feeling less comfortable. However, because the car was difficult to drive and short of its speed target, it was decided to allow an outer diffuser wall. This is, in fact, a standard road course piece that has been introduced to assist on the speedways, along with a very efficient strake from the road course configuration. These pieces have added significant downforce to the car, some sources quoting as much as 20 per cent, for a relatively small drag penalty. However, the teams are finding they are now running with these highly efficient pieces fitted, with -10 degrees on the rear wing (the minimum allowed in the regulations for this test) and with no viable options with which to trim out the car further, and yet were still 'too slow'.

The IndyCar Series has found itself talking to the engine manufacturers about running more boost, and enabling some of these pieces to be taken away again, and for the rear wing to be brought back into play, in order to then achieve 'acceptable' lap speeds. Phillips says IndyCar is still undecided about the under-wing configuration that will be specified for the race.

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Whilst a 225mph target speed is the intention for qualifying, it is the race configuration that is important. To have everyone running the same (perhaps with more downforce than necessary) aero spec will not lead to a safe and entertaining race, but Phillips is hopeful that working with the engine manufacturers will enable IndyCar to specify a suitable aero package for the race, whilst achieving the speed target for qualifying, via the use of additional boost for 'Fast Friday' and qualifying.

The prototype of the DW12 displayed some alarming characteristics, which now appear to have been resolved, although speeds are still below 220mph

LIMITED OPEN TEST

Originally, a manufacturers' test was organised for Indianapolis, with one car being selected to represent each engine supplier. But Lotus said it did not have sufficient engines and the organisers felt it would not be enough having just two cars circulating, so this was changed to a 'limited open test'. With some not taking advantage, this eventually meant nine cars took part, all fitted with the new rear bodywork. They were also allowed to run another drag saving device in the form of backing plates within the inside face of the front and rear wheel rims. This was the first time the rear ones had been seen as a production part, only prototype pieces having been tried by one or two teams in previous speedway tests. A new radiator inlet blocker could also be used.

There are now only three areas where wickers can be used – the front wing main plane trailing edge, the rear wing main plane trailing edge and on the rear crash structure beam.

The result of all this was the handling was found to have been significantly improved, although it was felt there was still more that could be done. Ganassi driver, Scott Dixon, reported, 'the car is a whole lot better, the balance is way better.' Penske Racing president, Tim Cindric agreed with Dixon, saying the handling of the car is now predictable. Julian Robertson, TCGR's head of engineering, said the steering trace looked much more like a typical Indy trace, close to a sine wave in appearance, with the shape on exit almost a mirror image about the mid-corner of the trace on entry. The previous trace had shown little increase in lock on entry, with more and more lock being applied through the mid-corner and still increasing on exit, before rapidly unwinding as the straight was entered. The handling was now in the ballpark, although more still needed to be done. At least now though, the 'usual' tweaks were having an effect, whereas before nothing made any difference.

Others reported that the cars received a bigger tow from the car in front than with the previous car. Cindric stated that Penske's driver, Helio Castroneves, never ran in traffic but said he had heard some drivers comment about the issues of running in the wake of another car and how unsettling this was. This was in stark contrast to their experience at the earlier Texas test when the new aero kit was tried for the first time. There they found they could run right up on the gearbox of the car in front, without a hint of handling issues, 'and you could have sat there all day'. But pulling out to try to overtake resulted in the now oft reported, 'hitting a wall', and hence not being able to clear the car to complete the pass. This gave rise to the comments about the fear of a 'pack race' developing at Texas, something everybody has avowed to avoid, following Las Vegas.

Following Marco Andretti and Tony Kanaan's reported comments about handling issues in the wake of another car, Cindric wonders if it is the extreme nose-up rear wing angle for Indy (being run even in 'race trim' because of the efficient under-wing diffuser add ons) that is causing the instability in turbulent air, as the rear wing was not being run anywhere near as nose up at Texas.

However, there are also signs that these issues can be tuned out, Andretti made his comments to Phillips after a particularly hairy moment when getting close to another car in the morning. But by the end of the afternoon, he had posted the fastest time of the test, produced when towing up behind another car but then also being able to make a clean pass and proceed to drive away. Allen McDonald of Andretti Autosport reported that Andretti was then comfortable with the car, comments that Toso and Phillips confirmed.

> **"Only three cars were in the 218mph category"**

SETTING THE PACE

As far as speed was concerned, there were some who struggled during the morning of the Indy test, although this could have been down to engine tuning. Then, when the teams started playing with the under-wing configurations, one of the quicker teams had only achieved 215mph by the afternoon. Its car was trimmed out as much as possible with no under-wing strakes and with the rear wing at -10 degrees. The only way to go quicker was to put on more wing and look for a tow. By the end of the test, during which the track was green for just three hours 42 minutes, 218mph had been achieved, which would suggest there were still problems. Only three cars were in the 218mph category – Andretti, Kanaan and Dixon – and these times were set with the benefit of a tow. Cindric: 'The car seems even more drag limited in speedway trim than it has been in previous years.'

The ambient conditions for the test were just 16degC and, as Toso pointed out, it is not inconceivable that it could be 10degC hotter for qualifying and predicted an increase in lap speeds of 1.5mph. Previously, although warmer temperatures meant less drag, with the normally aspirated engines it also meant less horsepower, and the two therefore tended to cancel each other out. With the turbocharged engines, being able to maintain the boost level to compensate for the heat of day should now see the fastest times being posted then rather than in the traditional cooler happy hour at the end of the day.

After the problems with the normally aspirated engines of the previous seasons ('too fast' for the speedways, 'too slow' for the road courses), the new turbo motors were designed to run at three different boost levels, the lowest of which would be used at the speedways, in order to keep the speeds in check without adding drag plates to the body. However, it appears someone has missed on the horsepower vs drag requirements, or else why would the DW12 be 'too slow' on the speedways?

As a compromise, it is suspected the mid-boost level (originally intended for short ovals) will be used for qualifying at Indy in an attempt to reach the 225mph target. This should add 4-5mph to the speeds seen at the test, although the best no-tow laps observed were still in the 215-216mph region. So, for a four-lap average in clean air, a 225mph qualifying average is still a way off, but perhaps achieving this in a tow will mean honour will be satisfied.

Big boys join the fray

With two major teams now running NGTCs in the British Touring Car Championship, development should now progress more rapidly

BY LAWRENCE BUTCHER

The 2011 season saw the debut of the much vaunted Next Generation Touring Car (NGTC) regulation package in Britain's premier saloon car championship, the BTCC. The regulations marked a brave departure from the current S2000 rule set, utilised not only by the UK national series but by international championships, including the WTCC. The technical specification has been covered extensively in previous issues of *Racecar Engineering* but, to summarise, the main impetus behind the rules was to provide a more cost-effective route into the series. However, as with many major change in regulations, the initial expense for teams adopting the new package proved greater than expected.

The biggest disappointment of 2011, for the governing body at least, was the fact that no front-running teams chose to run NGTC-spec cars in the debut season. The teams that did adopt the NGTC were smaller operations, some complete newcomers to the championship. Though these teams were just the type who should have benefited from the news rules, the untried nature of the package presented them with a lot of problems. The teams were essentially running the R and D programme for the NGTC and, as the feature in *Racecar Engineering* V22N2 highlighted, this was by no means a smooth process. The big sticking point being that the teams involved, despite their best intentions and a great deal of blood and sweat, did not posses the resources to fully develop or understand an all-new vehicle. This placed them very much at the mercy of component supplier, GPR, and, when problems were identified, they were not best placed to proffer solutions to the technical working group, set up by the series organiser, TOCA. However, 2012 sees this situation altered. Two key players have opted to run with the NGTC concept, Team Dynamics, using a Honda, and 888 Racing with an all-new MG. Both these operations were able to turn their substantial engineering resources, both in terms of man power and access to testing and simulation facilities, to the task of developing the NGTC package.

"The real initial workload came in the shape of the 'cage and 'shell preparation"

The first car to break cover was the Honda Civic, developed by Team Dynamics with support from Honda UK. The team has had great success as an independent, winning the 2011 championship with an S2000-specification Civic. In July 2011, the operation began work on a NGTC-specification version, with the intention of running the car in the 2012 championship. The car would be based around the same basic 2KC five-door bodyshell and 2.0-litre turbocharged engine as the 2011 car, but would feature the spec front and rear subframe / suspension system specified by the NGTC regulations.

Following the Honda, and rather late in the day, was the 888 Racing-prepared MG6, the first of a new generation of cars to reach British shores under a revitalised MG brand. The cars are campaigned under the KX Racing banner, with the tie up with 888 only agreed at the end of January 2012, resulting in a somewhat rushed development process.

Team Dynamics worked with MIRA to develop the Honda Civic's body design, undertaking a full CFD analysis and using MIRA's full-scale wind tunnel to validate the results

Racecar Engineering caught up with both teams at Donnington Park for the second round of the BTCC to gauge first hand their experiences with the NGTC so far.

CHASSIS

Though the new regulations are intended to make life easier for teams, the initial preparation of the bodyshells to accept the spec subframe assemblies is an involved process. Barry Plowman, technical director at Team Dynamics Honda, gave his opinion on the complexities of developing the new chassis: 'The whole thing has been quite challenging to be honest. There were a lot of changes in the way that we had to do things, forced by the regulations. The one thing I would say is that the concept behind it was to be easier for the teams that had less knowledge. Now, though, I would have to say that the bodyshells are more difficult to make, so unless the 'shell and the whole set up is supplied as a kit, it is harder [than an S2000].'

Carl Faux, chief designer at 888 Racing, agrees, with his team facing the added challenge of having just 10 weeks to take the MG6 from concept to the grid. 'The real initial workload came in the shape of the 'cage and 'shell preparation. With the NGTC regulations comes a design specification for the 'cage, but it is not set in stone and you can adjust things to fit your chassis, which you have to do.' It is here that an understanding of building a car from scratch, as opposed to simply building from a kit of parts, sets teams with considerable engineering experience apart from smaller operations, as Faux explains. 'This is where having a firm grasp of what will make a car fast comes into play. What will make it light? What will make it handle? Normally, we would spend at least a month doing an FEA study into about 40 different iterations, then spend time rig testing the road car to see where improvements could be made. Unfortunately, we had no time for that!'

"There is room for optimisation in the regulations"

Both 888 Racing and Team Dynamics have access to high end simulation and design packages, which allowed them to optimise the cars within the areas permitted by the regulations. This capability is what separates them from the teams running cars in 2011, and the benefits were clear to see, with wins for both the Honda and MG in the opening rounds of the championship.

While certain components are controlled and can only be procured from GPR, others are free for the teams to produce, and there is some flexibility in the regulations in terms of overall chassis design. One particular area open to interpretation is the attachment of the front suspension subframe to the main chassis. Here, the location of attachment points is specified, but the means of attachment and structure of the bulkhead area is open. Both teams took advantage of this, using a selection of virtual and physical tools to optimise the structural performance.

Naturally, 888 Racing were keen to make the most of any potential performance advantage. 'There is room for optimisation in the regulations. Everything that holds the front subframes on is free for the teams to decide what to do. We have six hard points, but between there and the 'cage is free,' explains Faux. 'You submit the design to TOCA for approval and, if they are happy it fulfils their strength requirements, it is fine. It is little

Though there are specified hard points and fitment guidelines provided by TOCA, both 888 Racing and Team Dynamics have found performance advantages from optimising the attachment of the spec front and rear subframes

areas like that which, if you get them better than everyone else, performance comes from. There isn't much freedom, but it is the same process as with any racecar of making everything one per cent better that gives an advantage.'

Team Dynamics also found this to be an area where performance could be gained, as Plowman explains: 'We were given points that we had to go to, and in the build manual there is a guideline that you can choose to follow if you want, but we didn't particularly like what they had done. We put a lot of effort into a slightly different approach.'

Despite the considerable engineering capacity available to the two teams, problems with taming the cars' behaviour, which had dogged those running the NGTC in 2011, still reared their heads. The difference being both Team Dynamics and 888 Racing have access to K and C rigs and chassis simulation packages to investigate and understand them. The knowledge gained is then fed back to TOCA and benefits NGTC development as a whole.

Plowman points out that obtaining a consistent handling chassis has been a challenge. 'It has been difficult, and it's still an ongoing process. It doesn't have a particularly good rocker ratio front or rear, and the big problem is that as a saloon car – with the way they drive them – it needs a good amount of suspension travel. This becomes an issue, with the level of travel we need at the wheel compared to what is going on at the rocker not correlating. The same goes for spring rates and damper curves [the cars are required to use a spec Penske unit].' One of the big problems encountered has been that, though the team use a progressive rate spring at the front of the car, the falling rate of the rocker cancels out the increase in stiffness, meaning the suspension ends up behaving in a linear fashion. Though the solution is clear to the engineers, to implement it would require all of the other NGTCs to be bought up to the same spec, with the resulting cost implications, or be rendered obsolete. So, for the time being, both Team Dynamics and 888 Racing are left to find clever compromises to circumvent these shortfalls.

“at the end of the day, the cars have to look good”

AERODYNAMICS

When it comes to the bodywork on the new generation cars, the teams and TOCA are at somewhat crossed purposes. The competitors obviously want to gain maximum aerodynamic performance, while the organisers want the cars to be aesthetically pleasing. There is, however, plenty of scope for the designers to work within, and both the Honda and MG represent the first of the NGTC body designs to utilise wind tunnel and CFD tools in their development.

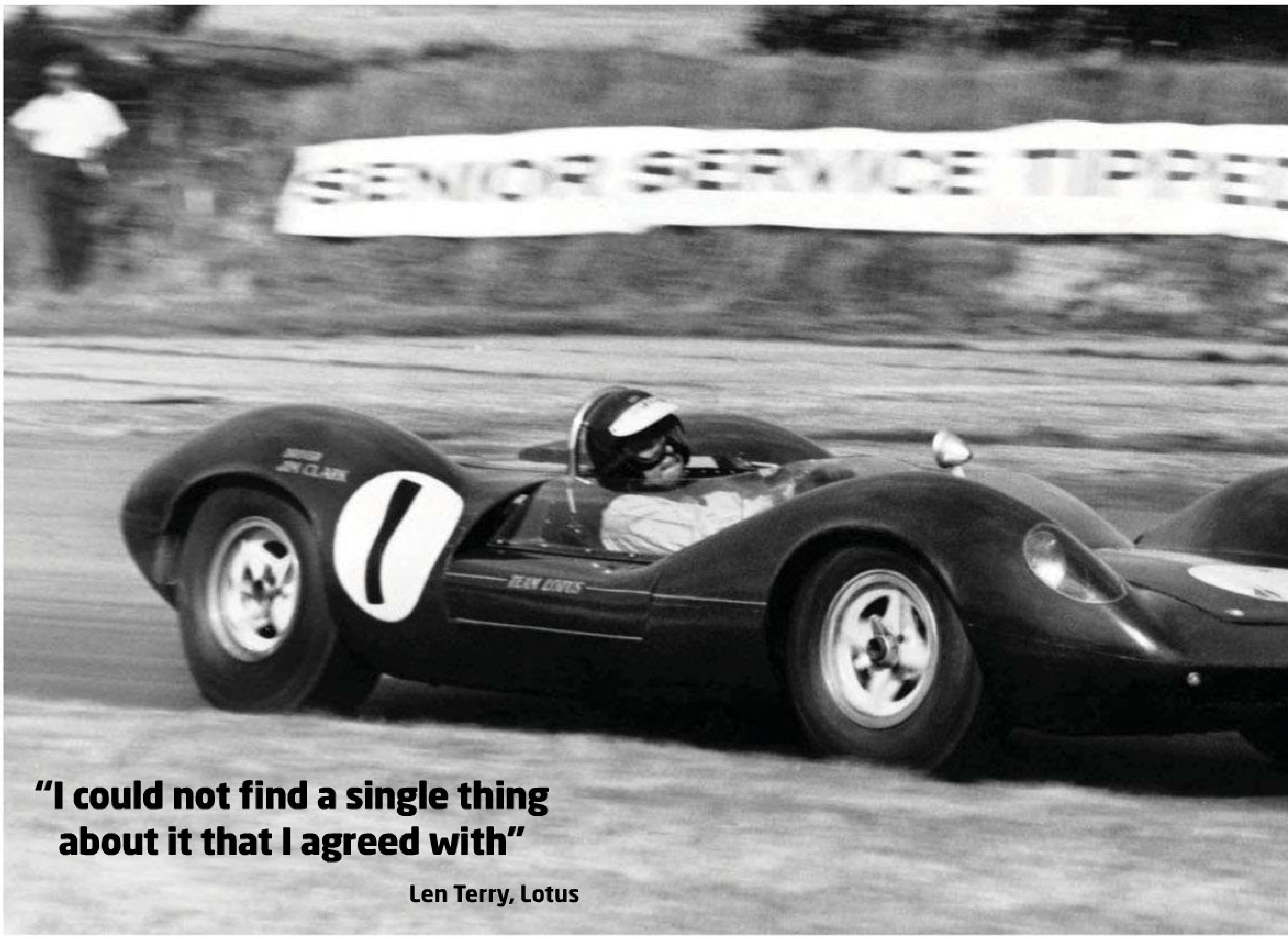
First, the Honda Civic was subject to a comprehensive CFD analysis. Team Dynamics do not have this facility in house, so the work was completed by MIRA, with whom the team have a longstanding relationship. This enabled the initial body design that had been completed by the team's aerodynamicist, Stuart Beaton, to be refined, and Plowman is keen to point out that Beaton's concept was not far off the mark to begin with.

TOCA did then demand some changes, in order to conform with their vision of a Touring Car, but nothing significant. 'There were a few things that they didn't like and we had to change after we did the initial work,' explains Plowman, 'but they were small changes to things like the radius of curves on the outer body, which didn't represent a major aerodynamic compromise.'

The added time constraints that 888 Racing faced with the MG meant that bodywork design was a key area to be addressed early on in the project. The lead time on producing panels such as the wheelarches was considerable, with initial design, pattern making and then production taking a minimum of five weeks. As Faux explains, producing this in the team's compressed schedule was no mean feat: 'The bodywork on an NGTC car is a lot more complex than on an S2000 car, and there is a lot more of it. For example, the rear arch on this had to be a three-piece item – we need a bit on the door, a bit on the rear quarter and a bit on the bumper – which pushes the cost up dramatically. We also have to submit the designs to TOCA, because, at the end of the day, the cars have to look good.'

From their initial performance at the start of this season, it is clear both teams' approaches have paid off, with their cars claiming wins and poles in opening rounds. Faux is in no doubt this is down to the resources available to them: 'Simulation is a big thing for us. This is day three of running the car and without it, we wouldn't be in the position we are now.'

Both cars are early in their development, but what is already clear is the benefit the work these teams are doing will bring to the overall NGTC project, providing a greater understanding of the problems and, more importantly, offering effective solutions.



"I could not find a single thing about it that I agreed with"

Len Terry, Lotus

Unsporting chance

The Lotus 30 and 40 share a reputation as Lotus' failures, but is it deserved and what were the problems that earned them that status?

BY CHARLES ARMSTRONG-WILSON

An ex-Lotus employee from the Chapman era once confided that every morning Colin would arrive at the office with 10 fresh ideas, nine of which were unworkable. 'It was our job,' he said, 'to try to convince him about their unsuitability and then take the one good one and run with it.'

The reputation of the Lotus 30 suggests it falls into that category of Chapman's ideas that should not have seen the light of day. But is that fair, considering most of the cars are still racing in historic events today, and with some success? What exactly were its flaws and how do those operating the cars today get around them?

The project was born out of Chapman's anger at being passed over for the Ford Le Mans project that became the GT40. Considering Ford's links with Lotus, he felt it was rightfully theirs. However, the

Features like the central fuel filler and one-piece body were clearly not thought out and often changed by customers

Ford directors were worried that Lotus had too much on and harboured concerns as to how two strong characters, Chapman and Carroll Shelby, would get on. The contract therefore went to Lola and, incensed at losing out, the Lotus boss decided to create his own American V8-powered sportscar to show what the company could do.

Len Terry is often credited with designing the car but insists, emphatically, that he did not. 'Colin brought the scheme to me and dropped it on my drawing board,' he recalls. 'It was just a scheme, but he explained some of the ideas and all the details, then said, "Give that some thought and tell me what you think about it." He then left it with me for a couple of days.

'So I made my list – two foolscap pages – and they were all criticisms. I could not find a single thing about it that I agreed with.' At the heart of the design was a backbone chassis folded up from sheet steel. This idea had first appeared a few years earlier as a brilliant new concept on the Elan road car. However, its conception was rather unglamorous. Whilst refining the mechanical layout for this new model, the engineers had lashed together a simple backbone structure to keep the mechanical components in place. Chapman took one look at this stopgap and recognised its potential.

Posterity has shown how well the concept worked on the little road car, but the Type 30 was intended to be a racecar with a large, torquey, American V8 and Terry had some strong views. 'To me, a backbone chassis was all wrong, especially in this case, because you've got a car that is well over 5ft wide and the further out from the centre the stiffer the structure becomes. So I felt the chassis should go out to full width rather than just a few inches wide. It didn't make sense.'

FATALLY FLAWED

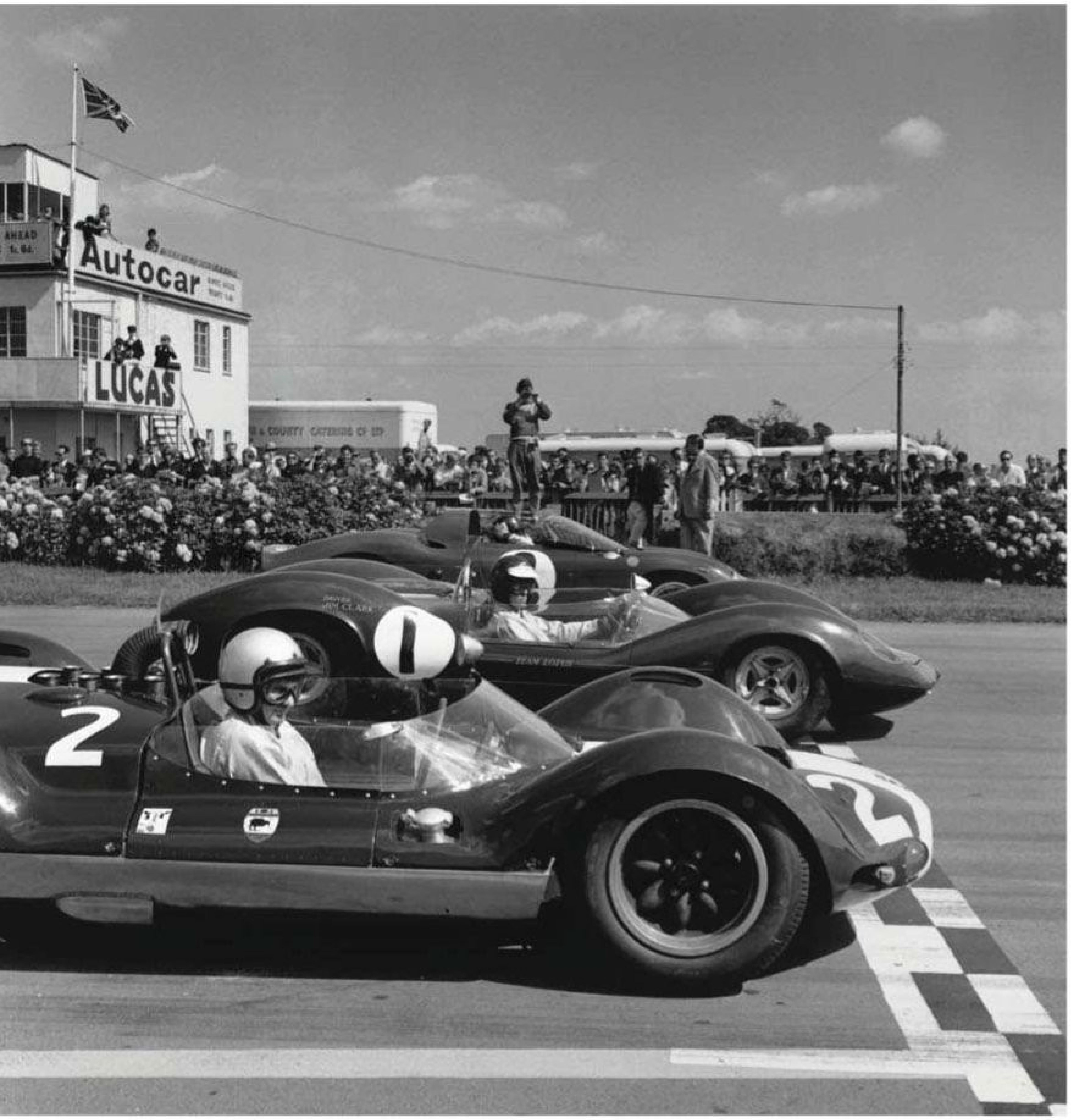
His exasperation continued as he reviewed the proposal. Chapman's chassis concept was tuning fork-shaped with channel-section prongs either side of the engine. As Terry points out, it just about worked on the Elan but only because its chassis flared out from the backbone creating straight load paths. The Type 30 chassis had kinks at the base of the prongs that compromised rigidity. Add to that the weakness of a channel structure and he believed the concept was fatally flawed. 'I said, "The very least you need to do is box in those members and put diaphragms in at the kinks. I still don't like it but that's what it needs."'

Terry continues, 'The front end where the pedals were was a sort of a box section with holes in the top and the master cylinders were down inside the box. So you can image what it was like trying to adjust the brake balance bar and the clutch through a slotted hole. No good.

'He wanted it to run on 13in wheels, Formula 1 wheels. This was at a time when we were running a 1.5-litre engine in F1, and this was a 4.7-litre V8. He wanted these piddly little 13in wheels with piddly little brakes.

'Another thing was he was going to have a one-piece fibreglass body that would just drop onto the chassis like the Elan. But not in a racecar where

"the Type 30 was intended to be the pattern for a range of five Lotus cars"



Even Jim Clark's enormous talent was stretched beyond its limits as he struggled to squeeze results out of the recalcitrant Type 30, which was designed to take on the new breed of big-engined sports racers of the early 1960s

you have to adjust the toe in and camber and work on the engine. All the racing Sportscars up to then were sort of back and front, but no, he wanted it one piece.'

Actually, there was method in Chapman's madness, as the Type 30 was intended to be the pattern for a range of five Lotus cars. In addition to the V8 racecar, there was to be a road going V8 coupé, a 1.6-litre road car version in coupé and convertible form and a racing version of the 1.6 coupé. This objective had extensively informed his thinking on the V8 car. His aim was to have as many interchangeable components as possible, but this was largely responsible for its shortcomings.

'I gave him this list,' continues Terry, 'there were probably 40 or 50 different criticisms of it, but the only thing he was willing to change was to box in those chassis legs. He had specified it in 20-gauge steel and I said it really needs 16-gauge. He said, "Well, we'll do it in 18-gauge." So we built a prototype and put a very simple torsion test on it. Before there was any real weight on it it took a permanent set. The centre section needed diaphragms in it.

'There was so much wrong with the car I just washed my hands of it. I said, "I'm not having anything to do with this because it's going to be a failure," but he wouldn't accept it. And so I told him to give it to Martin Wade. I didn't want my name associated with it any way shape or form whatsoever.'

The Type 30 was unveiled in 1964, much as Chapman had conceived it, complete with backbone chassis and one-piece bodywork. Thanks to its 13in wheels it was under braked and the problem was further aggravated by the car's twin radiator elements that were angled to vent hot air into the front wheel wells.

> **"right from the start its problems were apparent"**

HIGH EXPECTATIONS

It was powered by Ford's 289ci (4.7-litre) V8 driving through a ZF five-speed transmission, and expectations were high as Lotus had just won the Formula 1 World Championship the previous year. Everyone expected the 30 to demonstrate a similar domination of Sportscar racing, but right from the start its problems were apparent. The brakes were clearly not up to the job, overheating at the slightest provocation, and vibrated horrendously when used hard. Even the faithful works driver, Jim Clark, found his talent unable to compensate for the car's shortcomings.

The spot welds on the work's prototype chassis had been made at the wrong temperature and regularly failed. It was solved on the production cars by investing in new welding equipment, but many other problems were not. From time to time, even Clark let the torque of the iron-block V8 overcome the chassis' ability to keep the wheels in the right place and succumbed to a spin.

CUSTOMER CHANGES

The following year, *Motor Racing* magazine was able to take a close look at one of the customer Type 30s owned by earthmover heir, Anthony Bamford. Writer, John Blunsden, catalogued a long list of changes the JCB team had made to the car to give driver, Trevor Taylor, some chance of success.

Firstly, they had taken a saw to the one-piece body, creating front and rear clamshells that could be removed for access. They also tackled the aerodynamics because, pretty though the original 'shell was, it generated terrifying amounts of lift. The team responded by re-modelling the front and rear ends with large air dams.

Under the front end they also changed the layout extensively to get more air to the brakes. Firstly, the angled twin cooling elements in the nose were replaced by a single, flat matrix further back and the spare wheel moved up to behind the dash to make room. Also the oil cooler was repositioned closer to the engine, behind the driver's shoulder. Finally, the solid front discs were replaced with Girling vented versions.

JCB's mechanics were unimpressed by the central


ARROW

The folded steel backbone chassis is clear in this view

fuel filler at the base of the windscreen – not very convenient when staggering under the weight of a five-gallon fuel churn. Instead, auxiliary tanks were fitted either side that fed into the original central tank inside the chassis backbone. Not only more accessible, they still allowed the car to be fuelled from either side and fuel could be retained in one side tank to give a weight bias. Even with all these changes, Taylor struggled to shine in the car.

A Series II version was unveiled to tackle some of the problems. This included an aluminium floor and side pontoons riveted to the bodyshell and the chassis giving the structure more integrity.

THE TYPE 40

Finally, in 1965, another revised version, the Type 40, was offered. It featured larger, 15in wheels, bigger, 11.25in vented brakes and modified bodywork front and rear to reduce lift. It was an improvement, but Californian racing driver, Richie Ginther, referred to it as 'like the 30 but with 10 more mistakes'. Just three were built and its reputation was sealed.

A MODERN OPINION

Yet today, most of the 36 Type 30s and 40s built are still racing in historics. Are they really that terrifying and do modern competitors take their lives in their hands every time they climb aboard?

Andy Bradshaw parted with a Lotus 11 to acquire his Type 30 about a decade ago because he says he wanted a challenge. First sold in the US, Bradshaw believes it has been raced pretty much continuously throughout its life.

Knowing the model's reputation, he began his relationship with the car by taking it to Llandow circuit and pounding around, getting to know the car and its problems. He admits his first reaction was, 'Oh my God, what have I done?'

Undaunted, though, he set about addressing a list of issues. 'I found that fitting a full width roll bar with triangulation and twin stays down onto the rear chassis legs made a big difference. It cured the stiffness problems with the rear.'

Historic racing rules allow any developments from the later Type 40 to be fitted to the Type 30, including the 15in wheels and the bigger brakes.

"the car's just like a drop of gin"

Bradshaw runs the later car's vented brakes without problems, despite retaining the original split radiators. Unlike the original rules the car was designed for, historic regulations don't require the cars to carry a spare wheel. That frees up a lot of space in the nose and Bradshaw has relocated the battery there.

Of course, brake temperature is one thing, but what about the Type 30's famous vibration? During his own investigations, Bradshaw has noticed how fragile the lower wishbones are. 'Even on a car sold at Goodwood recently that had been in a museum and had a very low mileage, the front wishbones were bent.' The original design was made from a z-section folded up from flat steel. Fortunately, Lotus specialist, Peter Denty, supplies uprated items that are boxed for extra strength. In Bradshaw's experience, they entirely solve the vibration issue. He is even able to run slicks, putting a greater demand on the chassis that it was designed for, without problems.

Aerodynamically, like most Type 30s, his car had already been fitted with a chin spoiler when he bought it, and he added a rear spoiler. Together they make a pretty good job of countering the lift generated by the original shape.

When acquired, the car had already been upgraded to Series II spec with the aluminium floors and panniers adding structural integrity. Like most cars, the rear bodywork has been separated to create a clamshell, improving access to the engine. However, the front is still intact, with access restricted to the bonnet hatch, and Bradshaw believes it adds valuable rigidity to the car. Pedal adjustment is still restricted, but cutting a small slot in the fibreglass 'shell helps, and is a common modification.

So, after that initial shock and a decade of ownership, how does Bradshaw rate the car now? 'I love the thing,' he enthuses. 'It has never let me down. Nothing has ever broken, the engine revs to 8000rpm and is bombproof. The car's just like a drop of gin.'

Given its success in private hands, it seems the design was not fatally flawed after all, but the company failed to address its problems fast enough to reassure customers before it was overtaken by progress. Lotus promptly left Sportscar racing with its tail between its legs and never returned.

TECH SPEC

Engine
Type: Ford iron-block V8
Bore and stroke: 101.6 x 72.9mm
Capacity: 472cc (289ci)
Induction: four twin-choke Weber downdraft carburetors
Power: 350bhp at 6500rpm
Torque: 278ft.lbs at 4500rpm

Transmission
Type: ZF five-speed, all synchro
Ratios: 1st 2.50, 2nd 1.765, 3rd 1.43, 4th 1.172, 5th 1.00
Final drive: 3.00 3.22, 3.40, 3.56 (std), 3.78 and 4.00

Chassis
Mild steel, fabricated backbone
Wheelbase: 2400mm
Track front / rear: 1346 / 1346mm
Length: 4191mm
Width: 1727mm
Height: 673mm
Weight: 635kg
Weight distribution front / rear: 40 / 60 per cent

Brakes: Girling 10 9/16in discs

Tyres: front 6.00 x 13in, rear 7.00 x 13in

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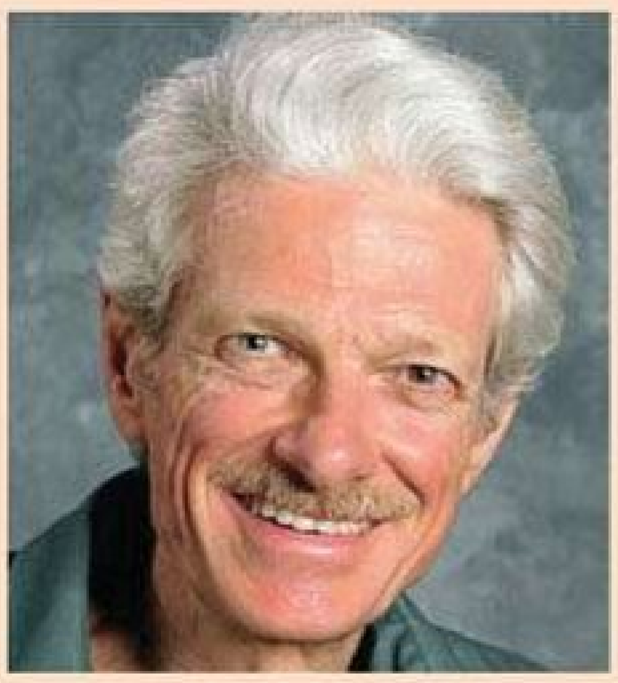

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Email: markortizauto@windstream.net
Tel: +1 704-933-8876
Write: Mark Ortiz
155 Wankel Drive , Kannapolis
NC 28083-8200, USA

Change of direction

Effects of universal joint angularity on handling

Q I would like to discuss the dismal performance of the Williams F1 car last year. The car had a low line gearbox to make room for airflow to the rear wing and, as a result, had severe angularity in the rear driveshafts. The shaft misalignment is in the vertical plane, that is the inner ends are about six inches lower than hub height.

All year the drivers complained about turn-in and mid-corner instability, so my thoughts are the precession, especially at high speeds, will try pull the suspension into droop. Turning in means the weight transfer has to fight the precession on the loaded wheel prior to the suspension actually being able to do something.

Despite the team claiming they had special CV joints that would accept the angular drive, I wonder if this design was causing the fundamental problem.

What effect would gyroscopic precession in the shafts have on the performance of the suspension? Would it have inhibited its operation, giving the problems the drivers complained about?

What is notable this year is that with a return to a more standard transaxle layout, the Williams GP car is much more competitive.

I have my own thoughts about this, but thought it might be a good topic to discuss, especially for students involved in FSAE where highly angled driveshafts are rife.

I would be surprised if the driveshaft angularity would cause poor turn-in and mid-corner instability. Reliability problems, maybe, but not more.

A driveshaft has such a small radius and mass that there are no significant precession forces – certainly not compared to the wheels and brakes, or the crankshaft and clutch.

As I understand it, a tripod joint running with angularity induces an axial force, but that's not properly termed precession. Precession is the induced force when a rotating object with significant rotational inertia is moved from its previous plane of rotation (I looked for definitions of precession, and those I found didn't all pertain to gyroscopic effects).

Anyway, what happens with a top's axis describing a conical path, or a spinning bicycle wheel trying to yaw when it's rolled, is that when the object's axis of rotation is given an angular velocity about one axis perpendicular to it, a torque is induced about the other axis perpendicular to it. For example, if one holds a bicycle wheel at arm's length and spins it (about a transverse or y axis), then rolls it to the right (about a longitudinal or x axis), the spinning wheel generates a yaw torque to the right (about a vertical or z axis). When a spinning top starts to lean from gravity, the velocity imparted by gravity induces a moment that makes the top move about the other axis perpendicular to its axis of

The Williams FW33 of 2011 had a very low gearbox, meaning extreme driveshaft angles were required rotation. And it keeps doing that so, as a result, its axis describes a conical path.

I don't know what they teach mechanics in other countries, but what I learned here was that the reason for trying to have equal and opposite angles (or really just equal ones) in the U-joints of a driveshaft – and also making sure the joints are correctly indexed – does not have to do with any gyroscopic effect, but rather has to do with the pulsation or sinusoidal variation in output shaft rotational velocity when a single Cardan joint runs at an angle, with a constant input speed. If a second joint is in series with such a joint, it is possible to arrange things to get a cancelling pulsation at the second joint, so that the output after that does not pulsate.

I believe a traditional U-joint creates a small self-straightening moment, but not enough to materially affect suspension systems. I read that a tripod joint does not have either of these effects, but does induce a small tension load in a driveshaft. If the suspension's front view instant centre is below hub height – or more properly, if the driveshaft centreline passes above the suspension's instant axis – that might produce a small pro-squat effect, but I don't see how that would lead to poor turn-in or to mid-turn instability.

If there is a tension force induced in the driveshafts, that might jack the rear suspension down a little, but it would do that on both sides of the car, so I would not expect wheel loads to be much affected. If a car is tight on entry, and then goes loose more than would reasonably be expected, I look for stiction under cornering load in the front suspension. If a car is generally unstable under cornering loads and this doesn't respond to adjustment, I look for something flexing, or binding, or bottoming.

Another thing I'd look at is the differential. If Williams tried to get everything lower and more compact, what was the diff like?

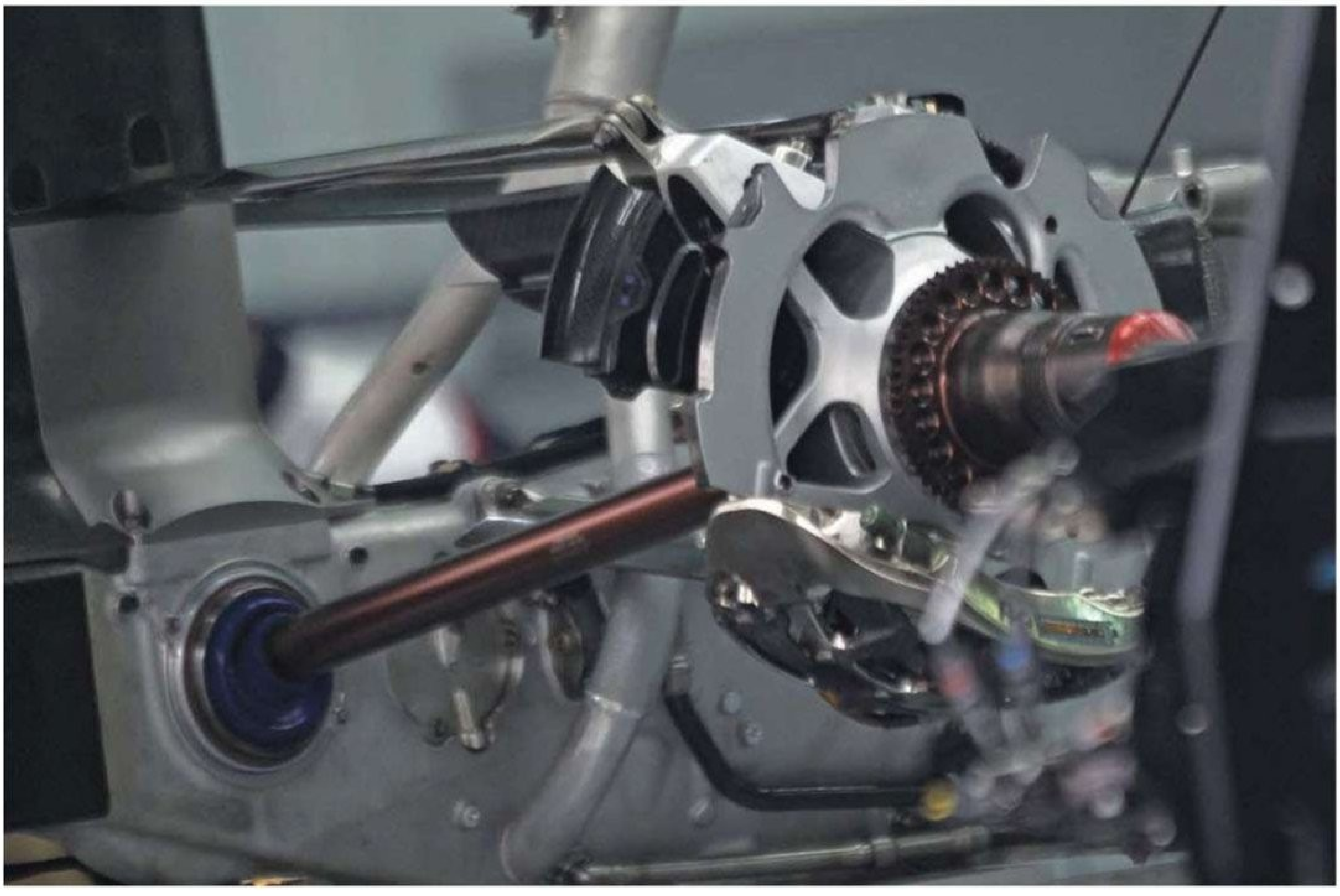
As this relates to FSAE judging, I don't think I'd penalise a team for having visible angularity in the driveshafts, either in top or front view, provided it didn't look enough to create a reliability problem.

"It would surprise me if there were any correlation at all"

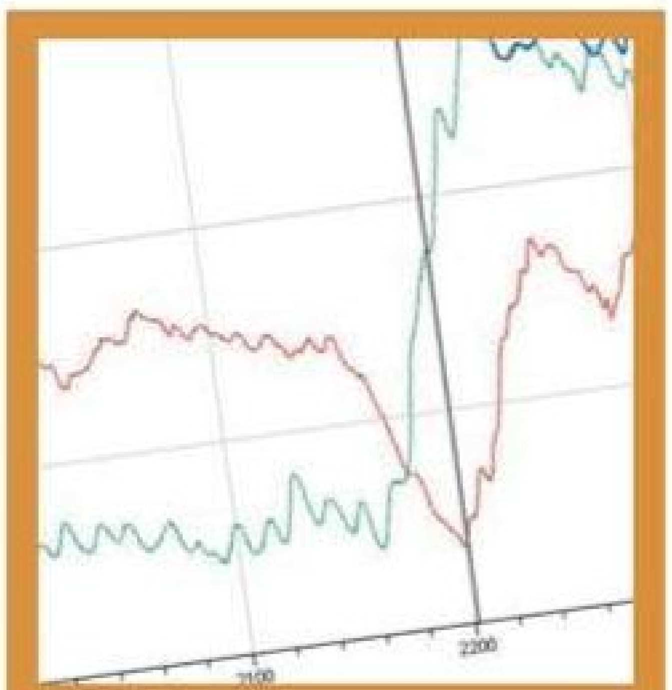
The 2006 UNC Charlotte FSAE car had very short driveshafts. They didn't have a lot of angularity at static condition, but they did when there was significant suspension displacement. Not only was there significant shaft angularity (some of the time, at least), but there were big changes in shaft angularity, too. The effect was sufficient to cause serious reliability problems. The car had to be set up with just the right combination of track and camber, with the one dependent on the other. If this was not done exactly right, either a tripod roller would come out of its slot on a bump, failing the joint instantly, or the shaft would bottom lengthwise against its buttons.

Despite this joint angularity (and plunge) problem being bad enough to cause reliability headaches, the car handled fine.

If highly angled driveshafts are commonplace in a group of cars, and driveshaft angularity *does* cause handling problems, the expectation would be that all cars exhibiting this characteristic would have handling problems. It would be difficult, if not impossible, for any car with pronounced driveshaft angularity to handle well. I haven't been to an FSAE event for a few years, but I don't think serious handling problems are as rife as pronounced driveshaft angularity is, and indeed it would surprise me if there were any correlation at all.



The tiny Williams gearbox would not have been possible without work on the joints by Austrian firm Pankl



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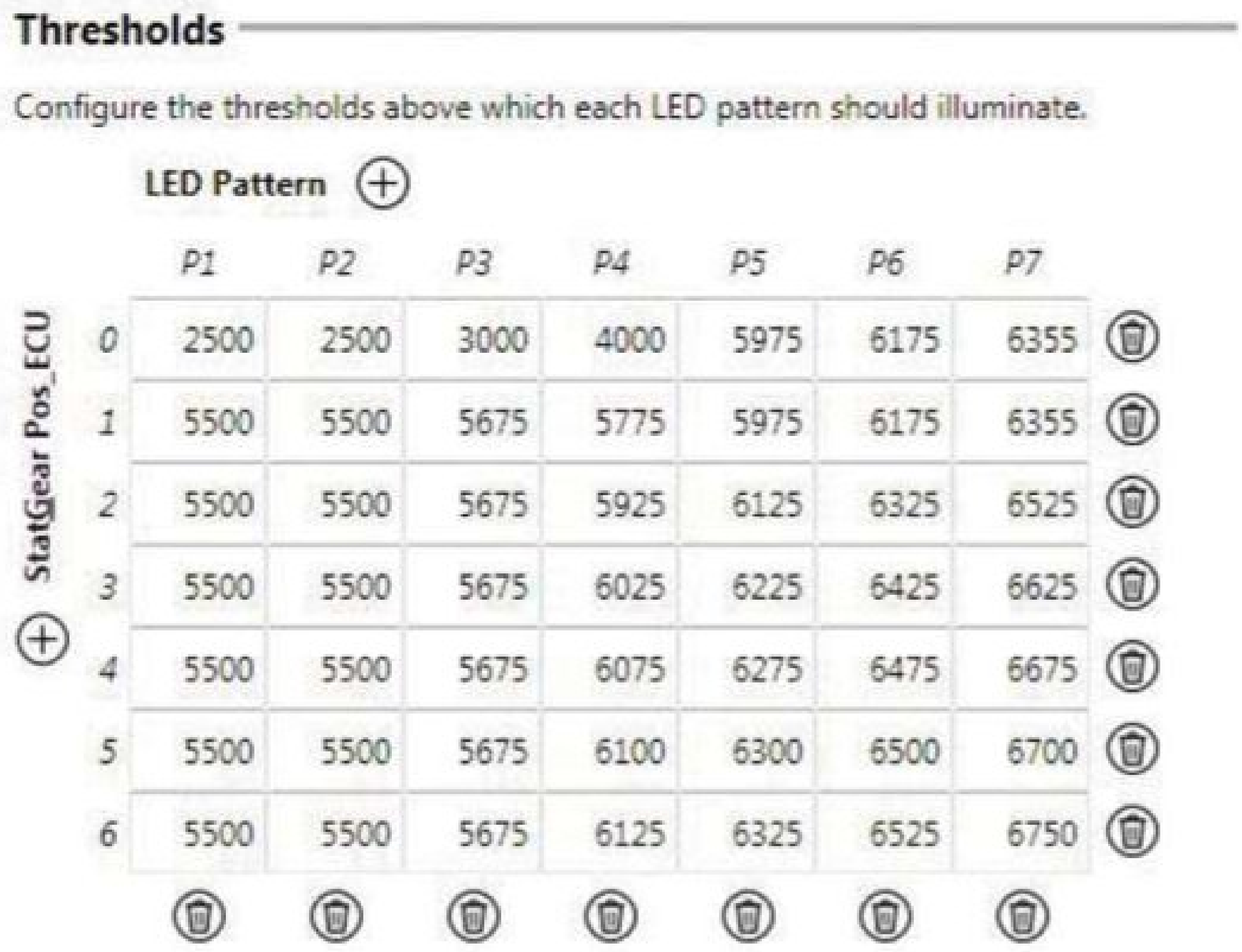
To allow you to view the images at a larger size they can now be found at www.racecar-engineering.com/databytes

Display strategy

Optimising the car / driver information interface

Relaying information to a racing driver is vital to optimising the overall performance of the car / driver package. The driver needs to be aware of many parameters that concern the car mechanically but, more importantly, how the lap times are progressing. A team that is able to do this efficiently will find it easier to extract that last tenth and win the race.

For the purpose of this article, we will mainly be looking at the configuration of a display for closed-top racecars with internal combustion engines. Displays in those types of vehicles can often hold more information than in other forms of racing, but most of the principles of display strategy still apply.



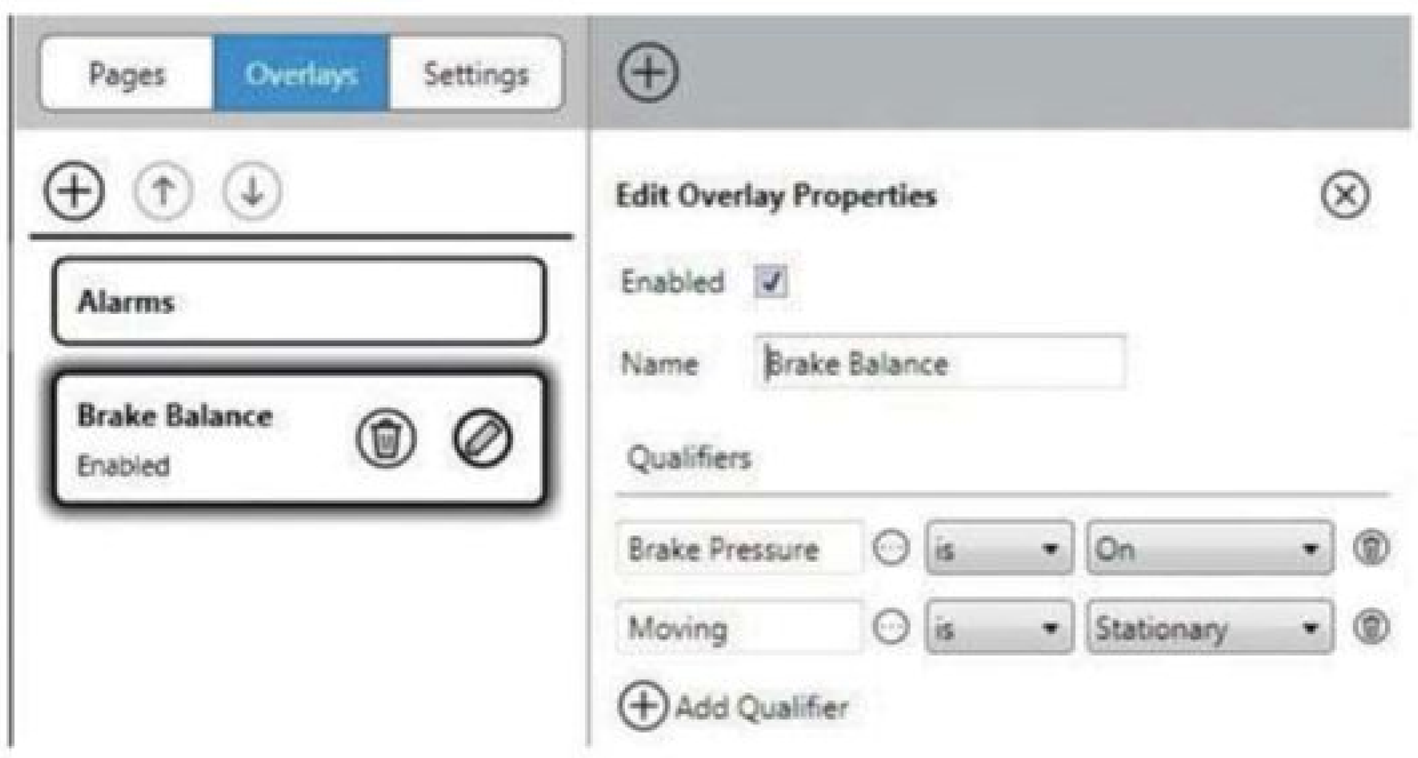
	P1	P2	P3	P4	P5	P6	P7
0	2500	2500	3000	4000	5975	6175	6355
1	5500	5500	5675	5775	5975	6175	6355
2	5500	5500	5675	5925	6125	6325	6525
3	5500	5500	5675	6025	6225	6425	6625
4	5500	5500	5675	6075	6275	6475	6675
5	5500	5500	5675	6100	6300	6500	6700
6	5500	5500	5675	6125	6325	6525	6750

Figure 1: in this case the shift light points have been configured to allow the pit crew to ensure they work in the pits by having low limits when the car is in neutral. The lights are then configured in order to achieve consistent shift light speed and optimised shift points for each gear

Figure 2: a water temperature alarm. Not only is the alarm threshold configured, it is also qualified by engine rpm. The threshold has been set intentionally low so the driver can cancel the alarm. When the cancel command is seen, the threshold increases by five degrees, allowing the driver to realise whether the alarm is only due to circumstances, ie following another car closely, reducing the efficiency of the cooling system. If an alarm is seen and the driver goes back out to the airstream, water temperture will be reduced

Starting at the beginning, it is important to realise what the basic parameters are that need to be displayed, and how best to display them. First is basic engine information – rpm, water temperature, oil temperature and oil pressure. In all racecars these are parameters that are needed to maximise the performance of the engine and to make sure the car makes it to the finish. This can be done fairly efficiently with most basic display equipment but, in the digital era, the bar is set much higher. Using computer-controlled LCDs allows for information to be

In order to achieve and maintain this level of control over the display, it is necessary to generate some specific system states. In our brake balance overlay, a system state using a brake pressure qualifier is needed



In order to generate system states such as these, some maths channels need to be created to set up the conditions needed. As the system state is an on / off condition, the channel information needs to be cast as a U8-type channel. This allows the data system to use channel data as a simple state that is either on or off (0 or 1)

Figure 4: system state for brake balance activation. This maths channel goes to 1 as soon as the brake pressure reaches more than 10bar

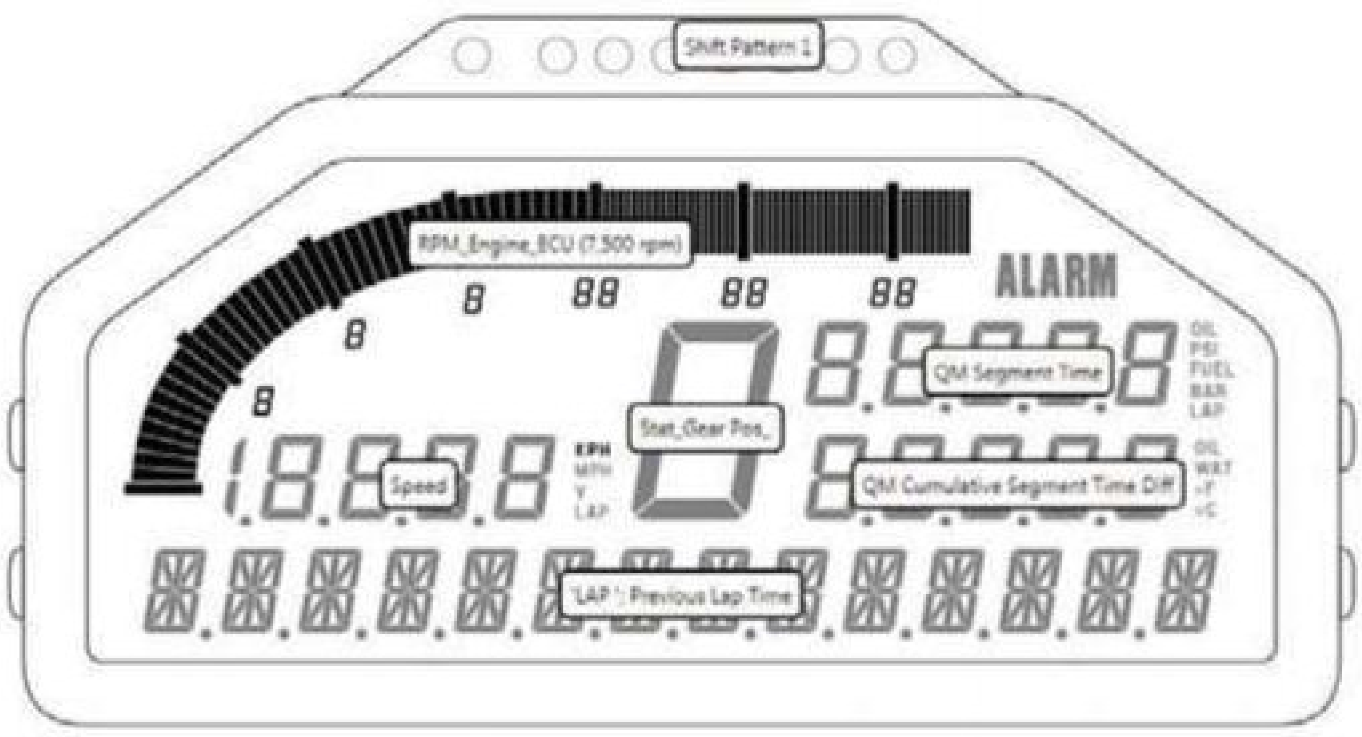


Figure 5: an example of different types of timing information possible. QM Cumulative Segment Time Diff is the channel that shows the time difference between a reference lap / segment and the current one

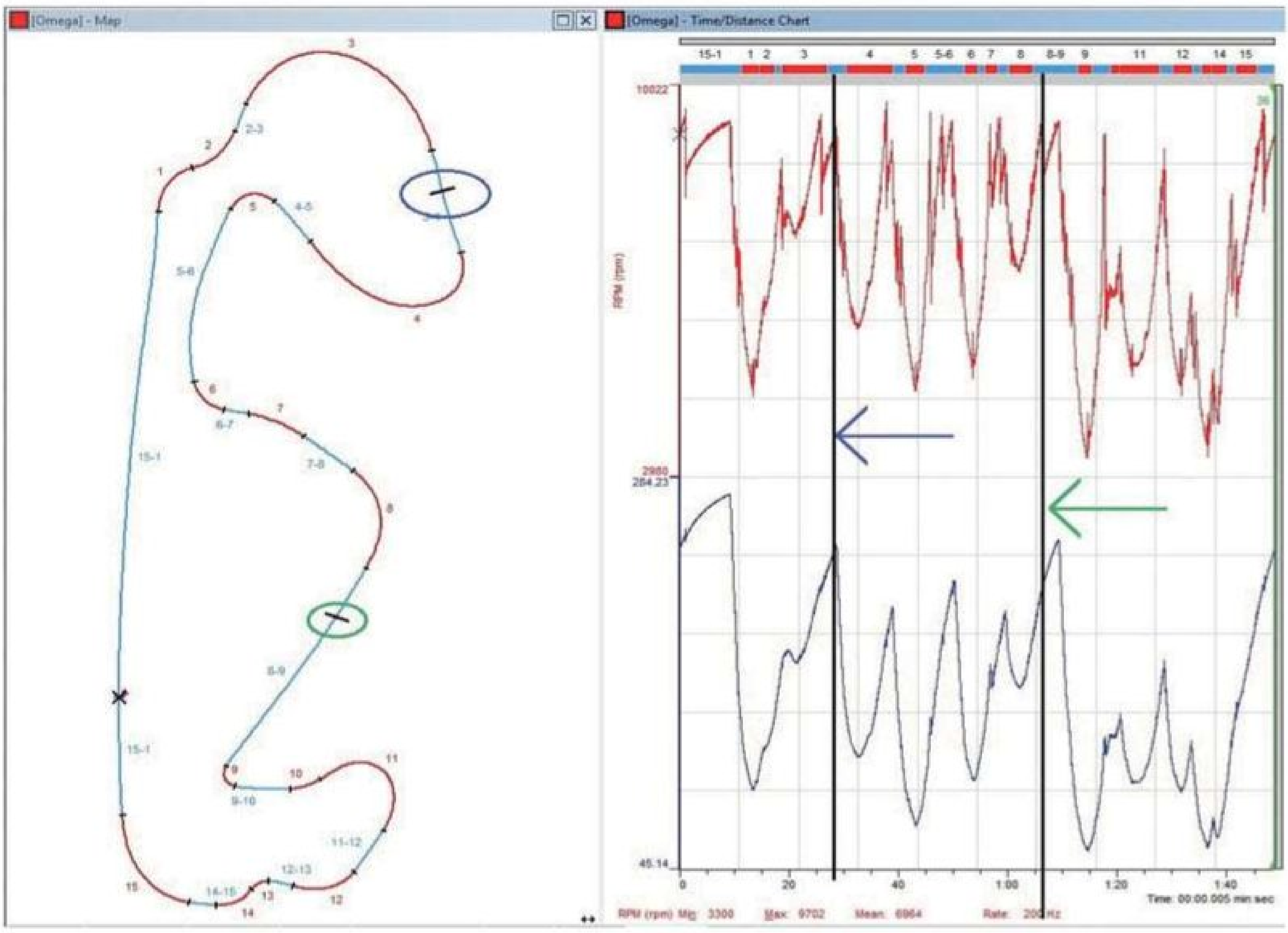


Figure 6: a qualifying mode file can be created based on logged data. Note the sector splits visible on the track map and in the data set on the right

displayed at just the right moment so the screen is not cluttered and so it is clear to the driver what is going on. For example, full control over the shift lights means they can be optimised for each individual gear and alarm conditions running in the background mean that only necessary information is displayed at all times.

All good data systems that can control LCD displays will have a number of different pages to scroll through. This means that it is possible to create a specific page for the pit crew to use when firing up the engine, a page for the driver when racing and a page for the race start. The really clever bit is setting the system up so there is no need to ever change the pages manually. For example, the pit page could be enabled only when the car is not moving and the race page could be qualified by wheel speed so it pops up when the car rolls out of the garage.

"The really clever bit is setting the system up so there is no need to ever change the pages manually"

In some instances, the driver, or pit crew, will want to check the brake balance. In some high-end systems it is possible to set the display up in such a way that the brake pressures and balance pops up as soon as the brake pedal is pressed. This type of overlay information would be qualified by the brake pressure and the wheel speed so that it would only appear when the car is stationary and the brake pedal is pressed.

TIMING INFORMATION

Using logged data to compare two different laps and analyse how they are different is an exceptionally useful tool. It has one major drawback though, and that is we are looking at what happened after the fact. So what if it could be possible to give the driver an indication of the time comparison whilst driving on track? Good data systems will have features where this kind of timing information can be displayed whilst running, and there are a number of different ways this could be accomplished. A simple method is to let the data system learn the distance of the track and automatically chop the lap up into sectors. Then, once it has information about the lap distance and time, the difference between the fastest and current lap can be displayed. It is also possible with some systems to load the lap information into the data logger from a previous session, or even from another driver if they were quicker. An additional advantage of this method is that it is also possible to manually split the lap up. This could, for example, be done using the official timing sectors. An alternative could be to run a continuous update on the time difference. It is all up to the driver's preference, but it is down to the data engineer to implement it and ensure that the best quality information is available to all parties. Get this right and you will gain a real performance advantage.

CHALLENGE

A driver is struggling to make consistently quick starts off the line at the beginning of a race. What passive aids could be developed to assist the driver in this situation?

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Mirror image

The last in our series on the Greaves Motorsport Zytek Z11 SN LMP2 Sports Prototype

We conclude our studies this month on the Zytek Z11 SN LMP2 Sports Prototype of Greaves Motorsport with a look at the effects of the mandatory increase in mirror size, and summarise the overall effect of the 2012 modifications.

The team evaluated every configuration across a range of yaw angles from zero to six degrees, the latter representing the slip angle at which the tyres generate their maximum grip. How, then, would the 2012 mirrors, whose mandatory viewing area had been increased from 100cm^2 to 150cm^2, affect the aerodynamics over the working yaw range?

For the record, drag was very similar with the 2012 mirrors across the yaw range tested, but downforce and balance were affected to an extent. The change in total downforce is also fairly easily explained. With the 1600mm span rear wings now in use on LMP cars, when the car was at zero yaw the wakes of the mirrors essentially passed outboard of the ends of the wing. However, when at yaw the wake of the 'upwind' mirror did impinge on the rear wing, and we can see from figure 1 the effect on reducing downforce was increasingly apparent as yaw angle increased. Indeed, the data on front and rear downforce suggest there was no change in front downforce levels, within the bounds of repeatability, but rear downforce was reduced by about one per cent at six degrees yaw.

Figure 2 suggests there was a small difference in aerodynamic balance, expressed as '% front', with the gap between the two

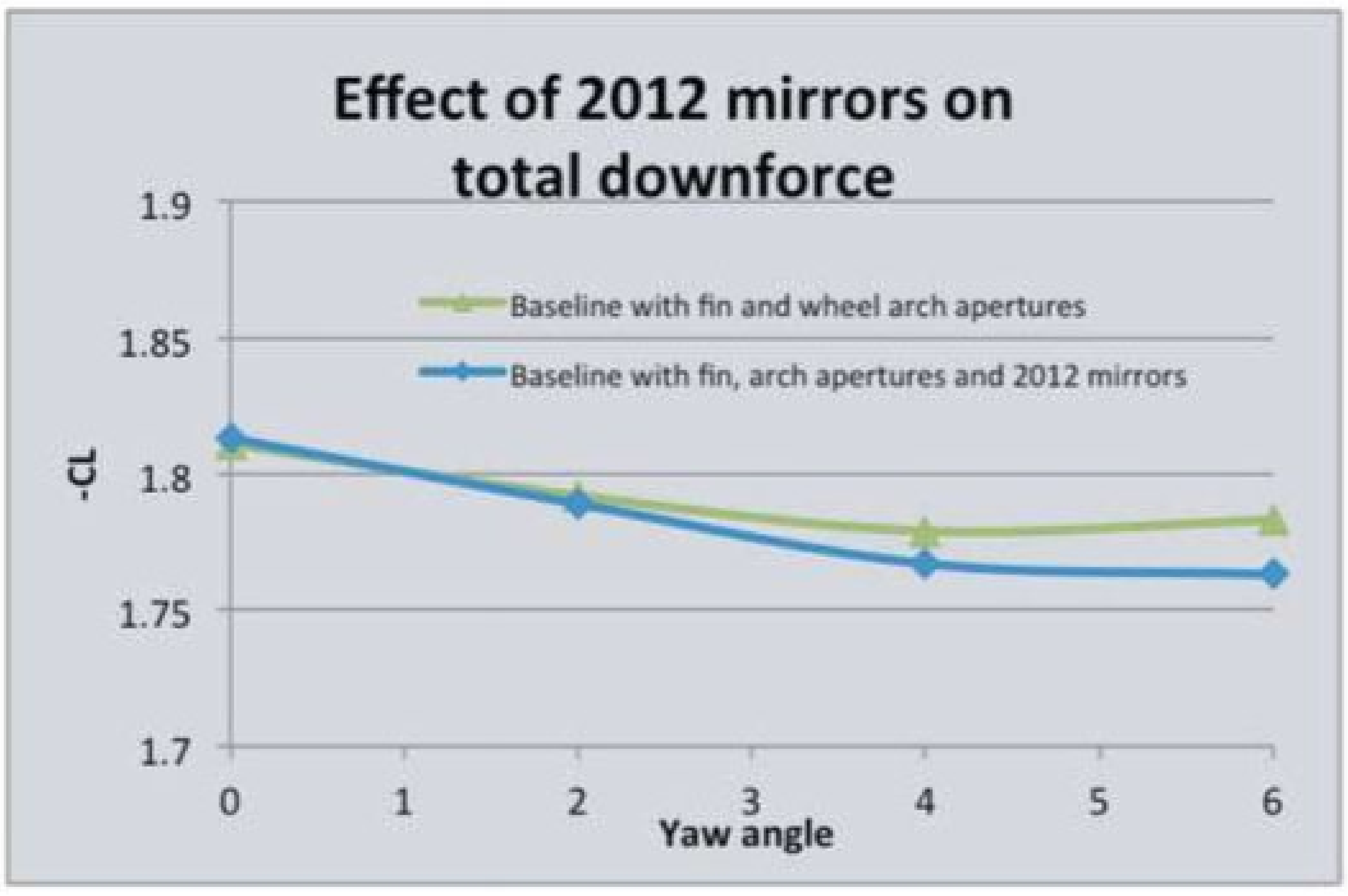


Figure 1: the larger 2012 mirrors had no effect on straight-line performance, but did affect downforce when the car was at yaw

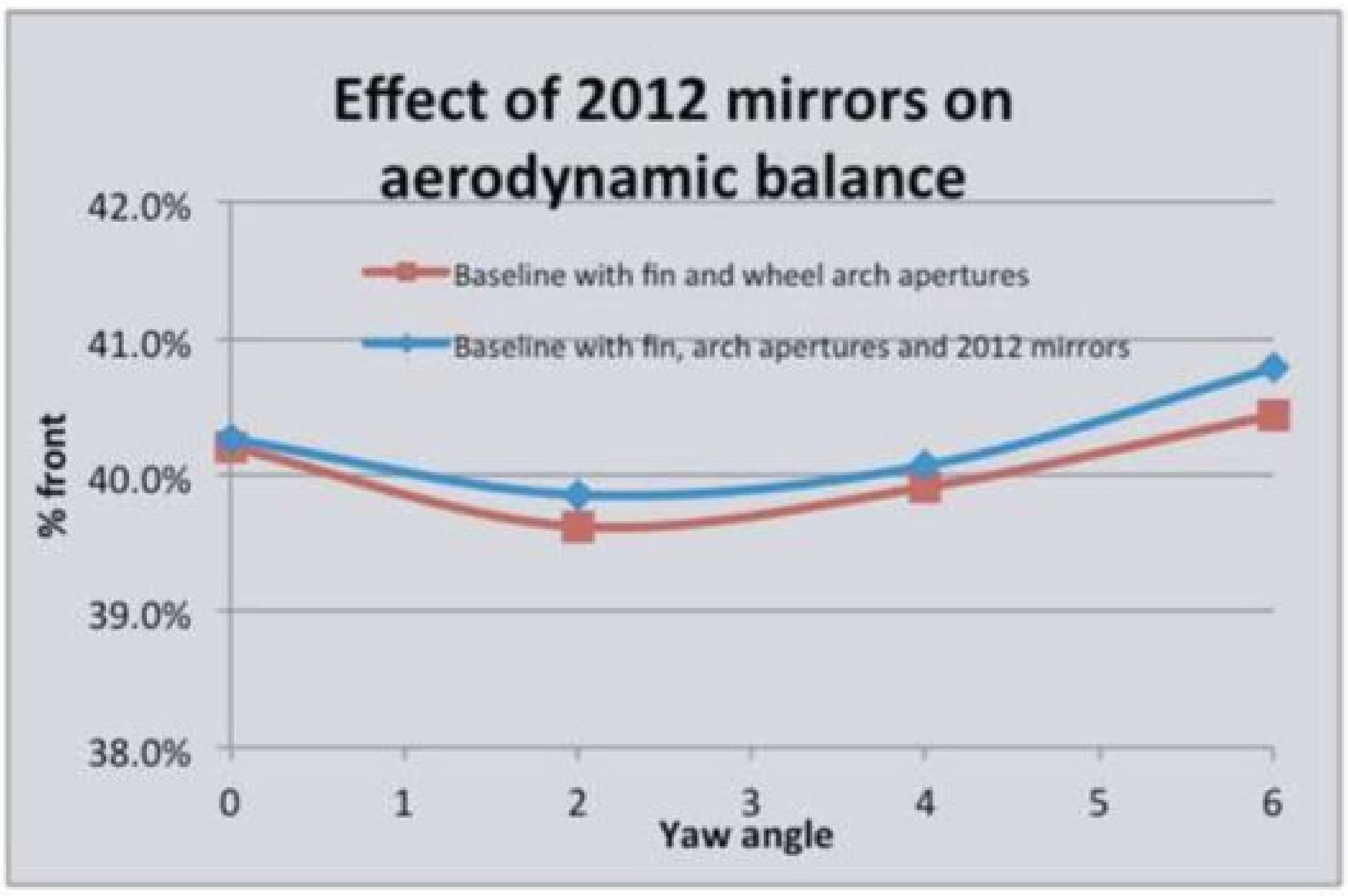


Figure 2: the effect of 2012 mirrors on aerodynamic balance

The 2011 specification mirror

The 2012 mirrors have a 50 per cent larger viewing area

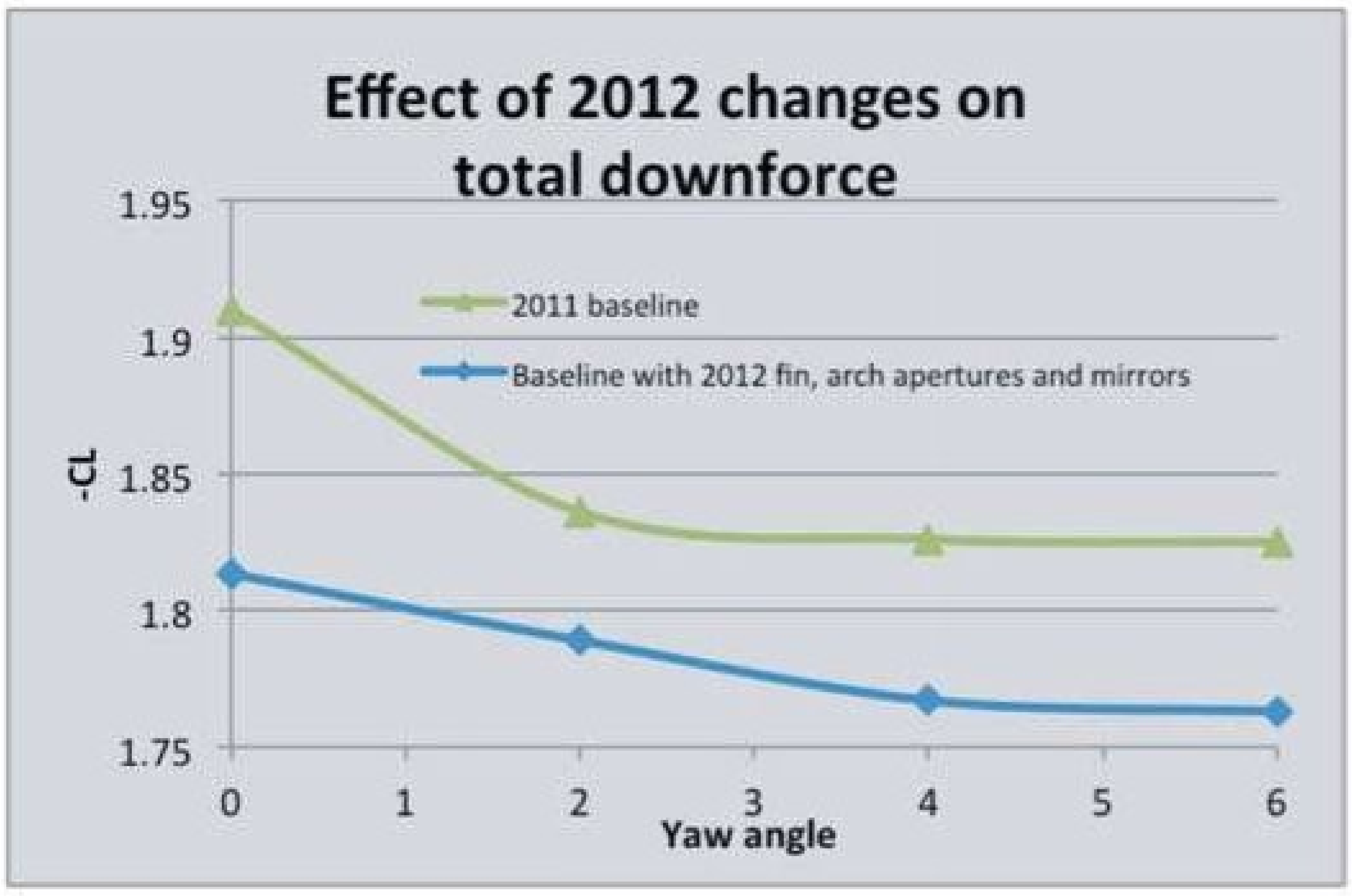


Figure 3: the effect of the 2012 modifications on total downforce

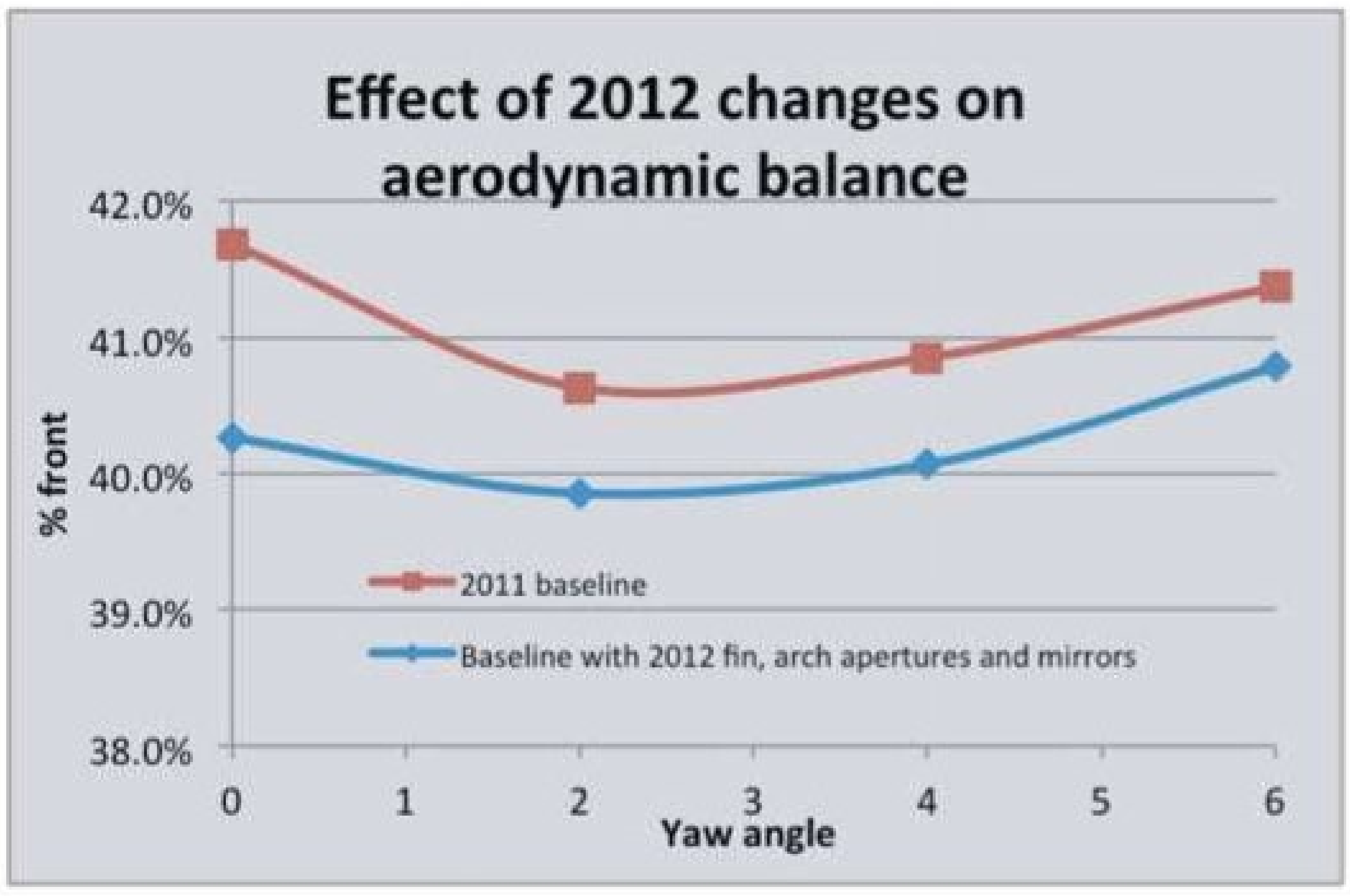


Figure 4: the effect of the 2012 modifications on aerodynamic balance

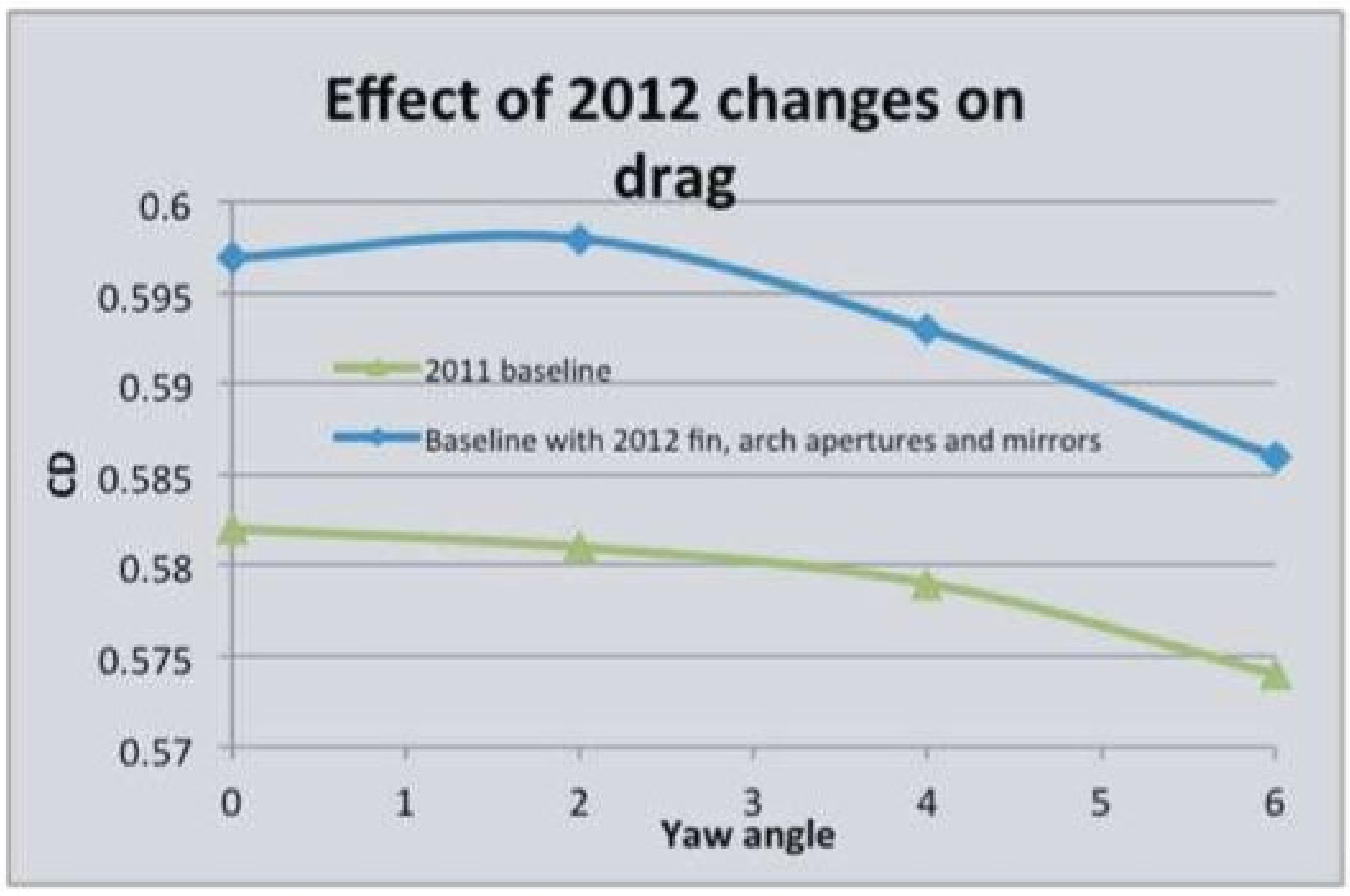


Figure 5: the effect of the 2012 modifications on drag

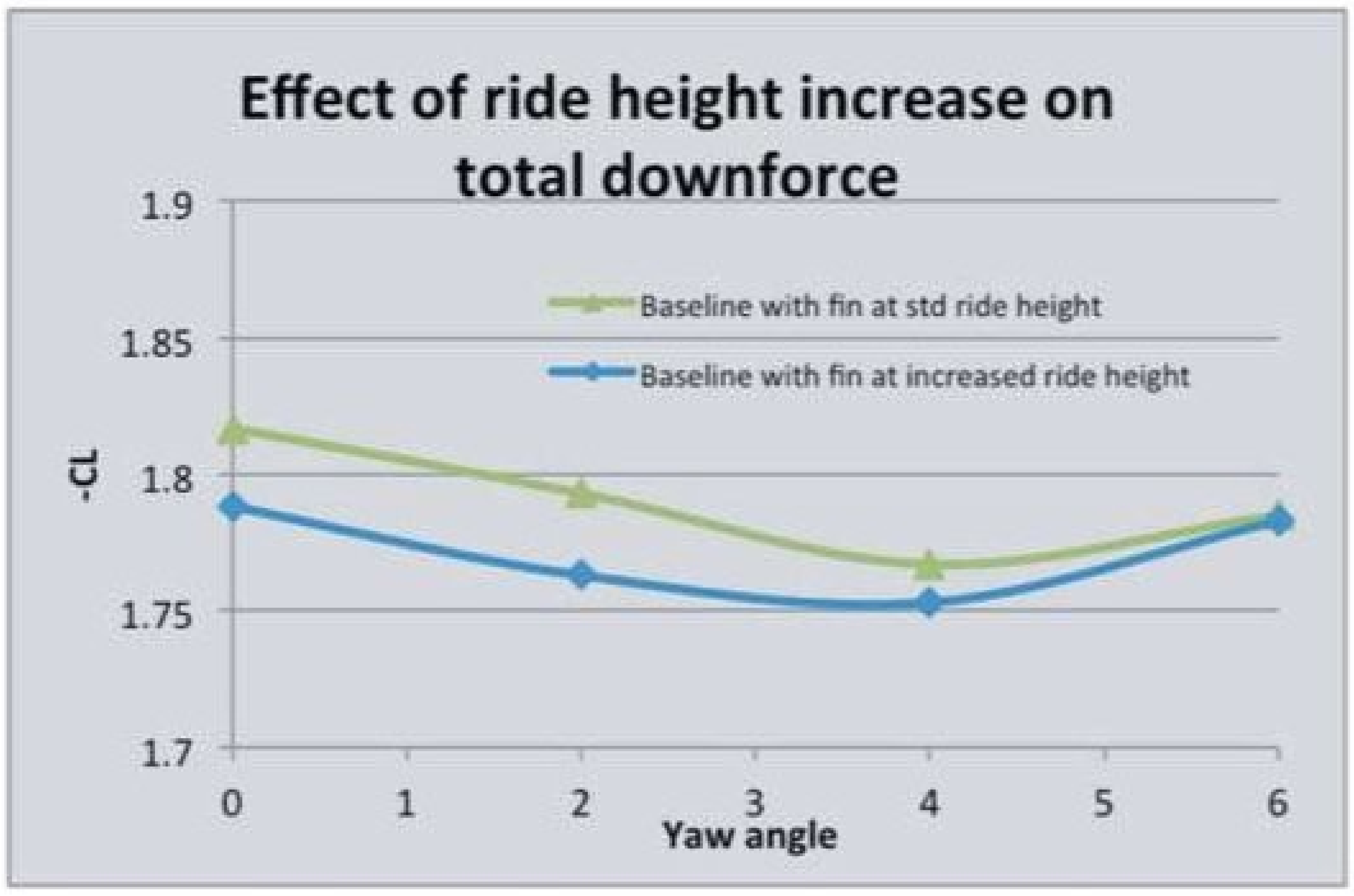


Figure 6: the effect on the 'baseline plus engine cover fin' specification of increasing the ride height

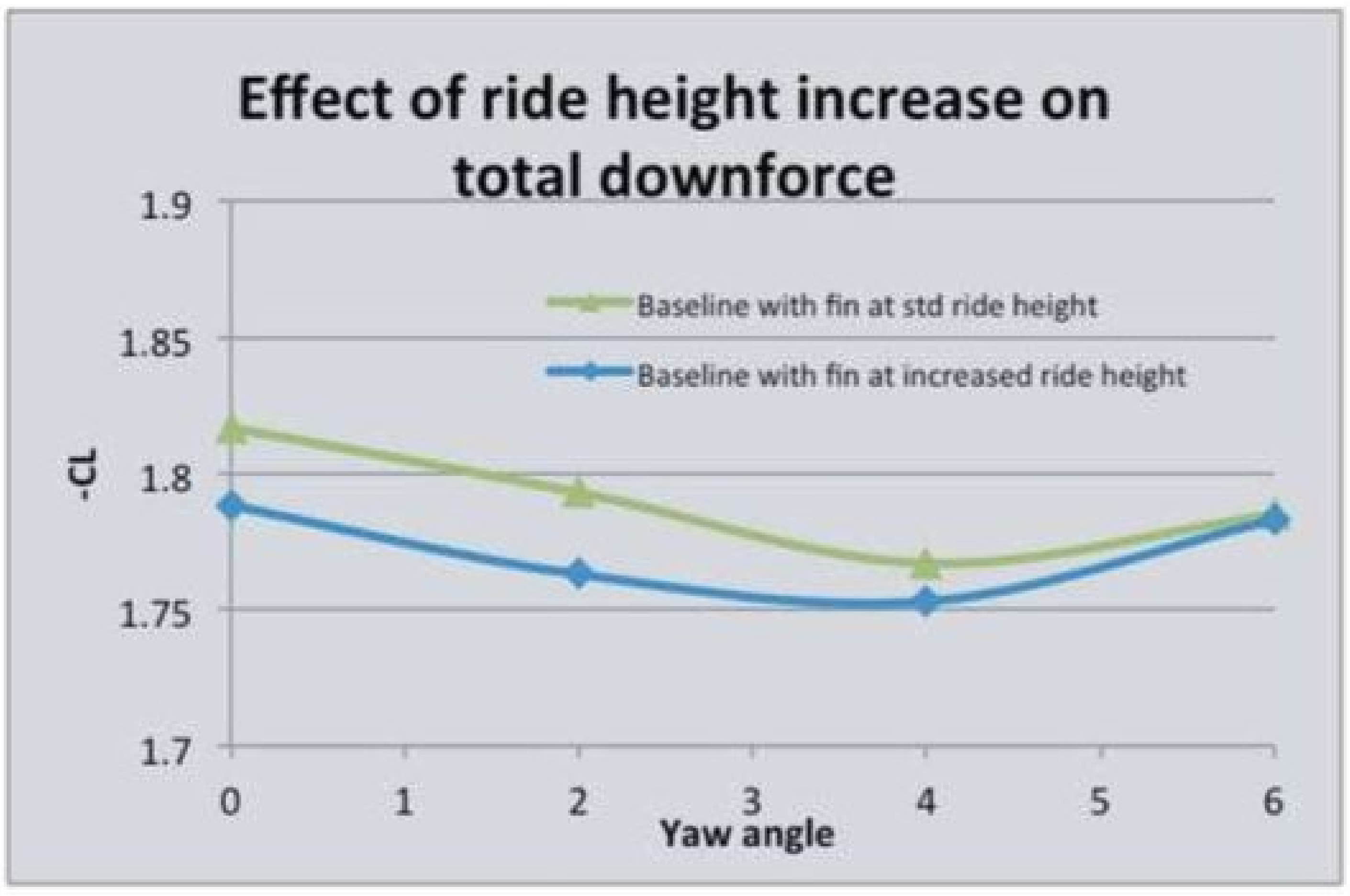


Figure 7: the effect on the 'baseline plus fin and wheelarch aperture' specification of decreasing the ride height

configurations being slightly wider at six degrees yaw. But in truth, the balance shift resulting from the mirrors was modest.

2012 SUMMARY

So what was the overall effect of the mandatory-for-2012 engine cover fin, wheelarch openings and larger mirrors? Figures 3-5 illustrate.

Total downforce was reduced across the whole yaw range, by between 3.4 and 5.1 per cent at six degrees and zero degrees yaw respectively. In terms of aerodynamic balance, this shifted rearwards across the yaw range, though the effect of yaw on the 2012-spec car was greater, with the '%front' value higher at six degrees yaw than at zero. And drag was higher too, between 2.1 and 2.6 per cent at six and zero degrees yaw respectively.

So whatever else the 2012 modifications were intended to achieve, on the basis of this evaluation they made the cars less aerodynamically efficient, with less downforce and more drag over a typical working yaw range. This would obviously decrease corner speeds as well as straight-line speeds, unless the teams come up with ways of mitigating the losses.

MORE TALES OF YAW

We'll end this project with another look at why evaluating each configuration across a working yaw range was such a useful exercise. Part-way through the session it was decided to try raising the car's ride heights, (10mm front, 15mm rear). The engine cover fin had already been installed but, after raising the ride heights, the wheelarch apertures were opened up and the car was lowered to the standard ride heights again. Figures 6 and 7 show the different total downforce plots.

Clearly, the responses of the car across the yaw range in the two different specifications were different but, had we been testing each configuration in the straight-ahead position only, then in figure 6 we would have seen that overall downforce decreased as the ride height increased, which would have been expected and would not have been questioned. What was surprising is that at six degrees yaw the total downforce had not in fact decreased, although the balance had shifted rearwards.

Conversely, in figure 7 it would appear that in this configuration in the straight-ahead position, re-setting the ride height from its raised level to its standard height made almost no difference to total downforce (though once more there was a balance shift), yet at six degrees yaw, downforce did increase as the ride height was reduced again. Hence, the value of the additional data collected is abundantly clear.

Racecar Engineering*'s thanks to Greaves Motorsport.*

Understanding change

Market-leading constructor, Dallara, has produced another masterpiece for the F3 market it still dominates

BY SIMON MCBEATH

"The new car will be cheaper to run, above all in terms of maintenance"

Formula 3 is technically still open to any constructor who wishes to build and homologate a car to the regulations in FIA Appendix J, article 275. So, despite it being utterly dominant in the category, Dallara still feels the need to stay on its toes when producing a new Formula 3 car. This is evident in the approach to the latest F312's design, as too is the influence of regulation changes, especially those relating to bodywork and aerodynamics, which produce the most striking visual differences with the new car's predecessor.

The FIA extended the usual three-year life of the F312's forerunner, the F308, by an extra year in the interests of cost savings at a time of widespread economic tension but, for various reasons, a new car was deemed necessary for 2012. One of the reasons for the new car was itself a cost-saving philosophy, which superficially seemed contradictory. However, the whole car has been re-designed with this new philosophy in mind, and Dallara asserts that through-life costs on the F312 will be significantly reduced compared to the F308. So let's take a closer look at the car that will be the F3 benchmark for the next four seasons.

UPRATED CHASSIS

High among the reasons for adopting a new F3 car was the FIA's desire to raise the chassis' safety standards closer to those applied in Formula 1. Among the changes made to achieve that was the adoption of new anti-intrusion side panels, 6.2mm (0.244in) thick, made from 16 plies of Zylon encapsulated in outer carbon plies. The new regulations stipulate the type of fibres and resin systems to be used, and the lamination method in order to standardise these panels. Even the adhesive type to post-bond the side intrusion panels to the chassis after static load testing and homologation is specified. Dallara, of course, was already familiar with the use of Zylon in this application, it having been introduced on Indy cars some time ago.

There are new definitions for the dimensions of the cockpit opening, as well as modifications to the dimensions of the survival cell.

All new carbon composite monocoque approaches Formula 1 safety standards, and features new side intrusion panels

Inside the chassis, the torsion bars feature rockers operating the dampers and the anti-roll bar drop links, one of which can be seen left of centre

Combined with uprated static load tests, plus new front end aerodynamic concepts (partly regulation driven) and a new front suspension spring medium, it's clear why a completely new chassis was required. Even the roll hoop, though superficially similar in appearance to before is new, and weighs 1.2kg less than the previous hoop!

Dallara's F3 project manager, Jos Claes, stated that the new chassis is a few per cent stiffer than its predecessor, even before adding the side-intrusion panels, these accounting for another small stiffness gain.

SUSPENSION REVISIONS

Much has changed in the suspension systems. The most obvious difference compared to the F308 is the switch from twin coil springs to torsion bars at the front, providing a lighter, more compact solution within, rather than on top of, the chassis. The front dampers also reside within the chassis, ahead of the driver's feet. An external rocker on the torsion bar abuts an adjustable rebound stop to provide pre-load. Further rockers inside the chassis actuate the dampers and anti-roll bar, as well as the option of a compact third element that would run horizontally within the upper chassis.

Entirely new uprights are used front and rear, featuring larger hubs and bearings, and are said to be better able to cope with the loads generated by a modern F3 car. The new front upright was required principally because of the new front suspension geometry resulting from the much higher chassis underside. The new rear upright was more about installation stiffness, as Claes explained: 'We decided to increase stiffness in order to improve toe-variation control. That means that under side load the wheel location is improved. At the limit in a fast corner, a small [uncontrolled] toe variation will be a signal to the driver of having reached the limit, though probably the real limit is still a little further up. Increased rigidity helps drivers to drive closer to the car's real limit. Both the front and rear wheel nuts are of greater diameter, this also contributes to a better wheel location.' As on the previous car, the bottom pick-up point for the pushrods is located on the upright rather than on the wishbones.

ENGINEERING THE NEW CARS

Pre-season, Fortec Motorsport's chief race engineer, Andi Scott, summarised the approach to running a new car: 'We're trying to find the differences in the car and then to understand what will change on track. Lots will carry over from the old car, but the biggest question is the front end, with very different suspension geometry and front wing. The torsion bars seem to perform the same as coil springs, looking at the data Dallara has provided, as long as they don't take a set. So that should at least be the same.'

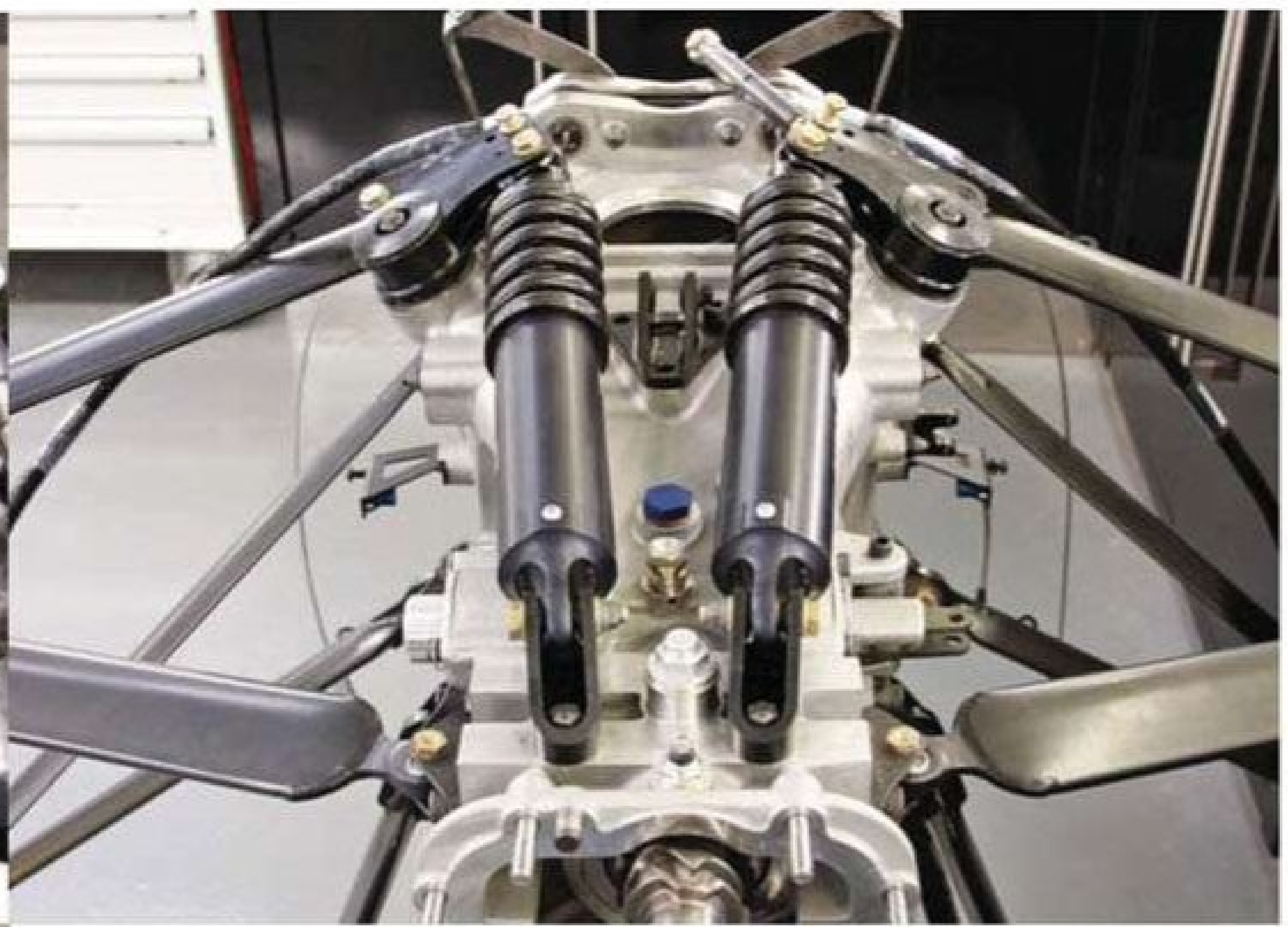
What about the use of variable spring rates though? Scott: 'We had moved away from rising rate springs. There was too much variation, and anyway rising rate proved easier with bump rubbers. Also it's all too easy to over-engineer when you're dealing with such a good product as the Dallara, and too many bits can confuse. Having said that, we won races with and without third elements, but maybe we should keep it simple initially. We made our own inerters for the F308 but we probably won't do that for the new car, at least not until it's better understood.'

Fortec Motorsport spent a modest amount of time on aerodynamic testing in MIRA's full-scale wind tunnel (more in next month's *Racecar Engineering* as we feature the car in Aerobytes), and also carried out some straight-line testing to correlate with that. And a couple of days were spent on the Multimatic seven-post rig to improve understanding of the chassis response to loads. 'At least Cooper Tires tell us the tyres haven't changed for 2012, so we have a pretty good understanding of those,' remarked Scott.

Two months later, and the first pair of meetings had been completed at Oulton Park, UK, and Monza, Italy. Fortec scored three wins and three other podiums from the six races. So had those pre-season preparations helped? 'Yes, the shaker rig enabled us to get a good handle on the car as delivered from the factory. And the wind tunnel helped too, despite its fixed floor, but we've been able to get a good correlation with that. We haven't had time to do much, but we appear to have an efficient car with more straight-line speed than others.' Indeed, had the Monza meeting been dry (torrential rain fell) Scott feels confident that Fortec would have done even better than one win, two seconds and a third.

Had the new front suspension geometry presented any issues? Scott: 'No, it's been a really easy transition to the new car and there have been no problems with the torsion bars, although, as someone pointed out, the car has gone from a mechanic's dream with twin springs on the F308 to a mechanic's nightmare with the new torsion bars! They're just like F1 cars now.

'Like the previous car, which was also very good, the drivers can feel the effects of set up changes. The car seems very responsive. We did struggle to get temperature into the front tyres in pre-season testing but that's been resolved now.'



The rear suspension features conventional twin coil springs located on top of the spec Hewland FTR gearbox

Above: new brake balance bar assembly reduces friction and hysteresis and will improve balance consistency during long braking events

Right: new front uprights feature larger bearings and hubs but retain the lower pushrod mounting concept of the F308

AERODYNAMICS

Dallara spent a great deal of time on the aerodynamics of the F312 using both CFD from CAD generated in PTC's ProENGINEER (see sidebar on p52) and a 50 per cent scale model in its own wind tunnel facility. This effort was in response to a number of factors. The regulation changes certainly required a fresh approach, and Dallara's wish to remain at least one step ahead of any potential opposition will have created its own impetus. Also, it had been said that the front end aerodynamic package on the F308 was not strong enough to obtain an aerodynamic balance to match the static weight distribution.

The new regulations have, Formula 1 2009-style, defined exclusion zones between the front wheels and the sidepods in which previously a plethora of downforce-inducing devices existed. Add to that the aforementioned suggestion that the previous front end was aerodynamically on the weak side, then it's no surprise to see the F312 feature a front wing main element approximately 20mm larger in chord fitted with larger flaps. The whole assembly is mounted roughly 50mm further forward on the car relative to the front wheels, and closer to the ground, all of which will have added front end wing-generated downforce. The newly profiled main element has also lost the raised centre section, giving further increased ground effect across this section of the wing.

Claes: 'Our initial target was not to regain the full 16-17 per cent of lost downforce. That would have been too ambitious. But we did reach our target and, in the end, actually exceeded it. It is definitely more complicated to develop aerodynamics without many of the add-on parts of the past. Basically, you have less areas of good potential.'

There are now just two 'off-body' aerodynamic devices – a small bargeboard just ahead of the sidepod and a tall vertical turning vane on the forward shoulder of the sidepod. The pods themselves feature undercut lower sides with triangular cooling inlets and large vortex generators on the lower outboard leading edge. Aft of this, the bodywork is very clean with the 'Coke bottle' shape leading to the upper surface of the rear diffuser.

F3 ECONOMICS

Much has been said about the intention to reduce the costs of F3 with the new F312, and Jos Claes, Dallara's F3 project manager, explained the rationale: 'The new car will be cheaper to run, above all in terms of maintenance, and this is thanks to the new regulations, which we supported in full. Assuming that the annual budget in F3 is €500,000 (£407,515 / $656,235) and that the car has a racing life of four years, then the overall budget is around €2,000,000. The cost of the car itself, at slightly less than €100,000 (£81,500 / $131,275), represents just five per cent of the total cost. Also, at the end of the cycle, the car retains at least half of its original value, so its true cost represents just 2.5 per cent of the total.

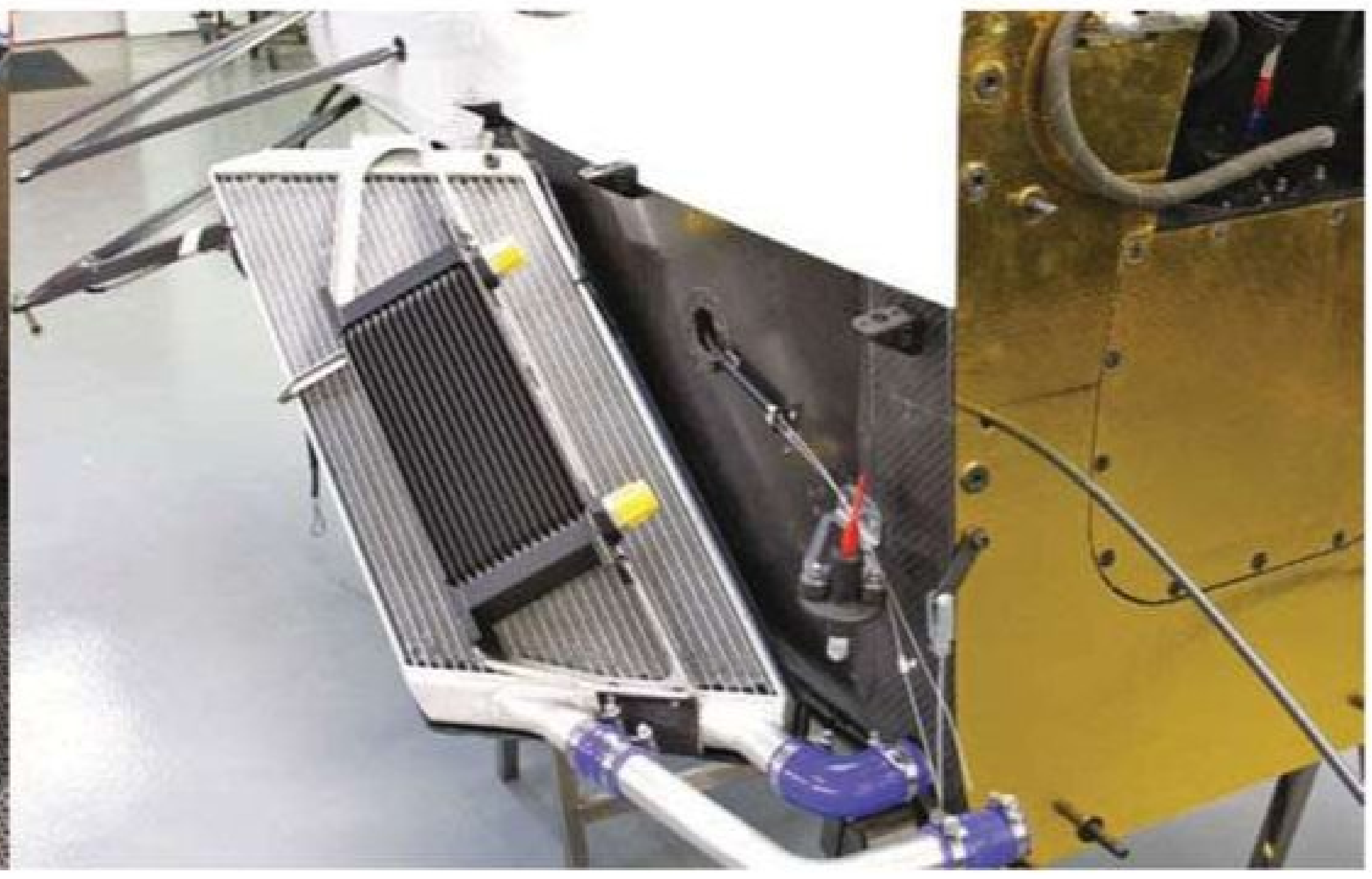
'Hence it is more important to reduce the running costs rather than the cost of the vehicle itself. Teams will spend less on running costs per mile. Some parts will have longer life, others have just disappeared from the car and won't need replacing or repairing. And a relatively simple and good quality gearbox, with minimum weights and / or dimensions will stop teams investing every few months in the next slightly lighter part. These ever-lighter parts never increased their life time...

'When the new engines are phased in next year, running costs [on engines] will be halved. With brakes, bodywork and gearboxes that are easier to manage, running costs will be considerably lower.'

This sounds entirely reasonable, and savings of €100,000-€150,000 on the budget of running one car have been mooted, although actual budgets may be somewhat larger than the €500,000 per season per car used in this illustration. Could we see further cost capping, such as restrictions on development as proposed in Formula 1? We have seen meagre F3 grids in Europe and, to an extent in the UK, this year amid rumours of possible mergers of the British and European series. So have the cost savings come soon enough?

Claes: 'F3 continues to school the vast majority of drivers that finally reach a professional career in motor racing, be it Formula 1, Sportscars, GT or Touring Cars. All the grids are mainly filled with drivers that learned their skills in F3.' He might well have added a similar thought about race engineers and technicians, too.

In 2011 spec, the F308 sported a number of aerodynamic devices ahead of the underbody that have now been outlawed by the new regulations



The current ultra-high compression ratio engines need to run cool so, despite producing only 210bhp, two large radiators are required

The engine cover has a new pointed tail, and there is a carbon cover over the rear dampers. The rear wing comprises the mandatory elements prescribed in the regulations, which at most circuits are deployed as an upper dual-element wing and a single lower beam just above the diffuser exit. The diffuser appears to be of similar shape and dimensions to the F308's, with some relatively minor differences to the centre section and the outer fences. Neatly, the rear light now integrates into the rear crash structure.

OTHER MISCELLANY

The Hewland FTR has become the specified gearbox for the F312 as part of the cost-reduction philosophy. Claes: 'Small changes were introduced, but nothing major. The casing and some of the internals are new but similar. Since the same car runs on different tyre makes, we make sure the rear suspension is very adjustable, so there is a large range of roll centre heights, anti-squat and anti-rise settings.'

Further new regulations to contain costs limit the number of ratio sets per year per competitor to 30 and, to prevent expensive modifications, there are minimum weights and widths for the gear ratios, differential and crown wheels. Materials must always be steel. Brake calipers must also be manufactured in materials with a modulus of elasticity no greater than 80GPa and there are minimum weights for discs, calipers and road wheels.

ENGINES

Originally, it was planned that a new, bespoke race engine not based on production units would be adopted in 2012. However, this was postponed until 2013, but it will see power increase from around 210bhp to nearer 250bhp. The 2012 F3 regulations include the regulations for the 2013 engines, and half a dozen independent tuning firms in the UK, Germany and Japan had submitted declarations and homologations to build units for 2013. It is expected that the first engines will run this autumn.

The rationale behind the new engines is again based on cost savings, and the technical regulations actually state that the running costs of one engine for one driver will not exceed €50,000 (£40,750 / $65,545) per season, said to be roughly half the current cost. There are also maximum prices for some of the major components, stated as:

- Cast block and cylinder head with CAD drawing €3500
- Fully machined block €5500
- Cast sump €2000
- Four steel liners €1000

Among those eager to get hold of the new units are the tyre companies, and this long-awaited overhaul of the engines in F3 will be sure to create interesting new challenges for the engineers, as well as the drivers.

Meantime, any constructor thinking of entering the F3 fray has to set its sights on the Dallara F312.

"The running costs of one engine for one driver will not exceed €50,000"

TECH SPEC

Dallara F312

Class: FIA Formula 3

Chassis: Carbon composite with aluminium and Nomex honeycomb

Engines: Mercedes-Benz, VW or Nissan in Europe and the UK, 4 cylinder, 16 valve, DOHC
Power: 210bhp at 6000rpm approx

Data system: Bosch Motorsport steering wheel-mounted logger

Transmission: Hewland FTR six-speed sequential

Suspension: Double wishbones, front torsion bars, twin rear coil springs, anti-roll bars, optional third element

Dampers: Koni 2812

Brakes: Brembo four-piston calipers, ventilated discs

Wheels: OZ magnesium, 9in front, 10.5in rear

Tyres:
UK: Cooper, 180/550 R13 front, 250/570 R13 rear
Europe: Hankook 180/550 R13 front, 240/570 R13 rear

Fuel tank: FIA/FT3 bag, 42 litres

Dimensions:
Length: 4350mm
Width: 1845mm
Height: 945mm plus ride height
Wheelbase: 2800mm
Track: 1595mm (f) / 1540mm (r)
Weight: 550kg minimum, with driver

DALLARA AND PTC

Dallara first started using Pro/ENGINEER 3D computer-aided design (CAD) software from PTC in 1993. Since then the constructor has adopted other PTC products, including Pro/ENGINEER Mechanica for design analysis and Pro/INTRALINK for managing CAD data.

More recently, Dallara installed Windchill PDMLink on IBM Blade servers running on the AIX operating system for an initiative called 'Project Collaboration', which aims to promote communication and information-sharing across the company. Windchill PDMLink enables web-based management of releases and approvals and, together with Windchill ProjectLink, can manage not only CAD data but also critical processes, such as change / configuration management and release to manufacturing.

Dallara's relationship with PTC has gone from being a customer to a 'performance partner', a designation for engineering design firms that focus on high-performance industries and provide brand awareness marketing support for PTC.

Extreme engineering

In designing an engine to meet the DeltaWing's strict performance criteria, RML has come up with some novel solutions

BY ANDREW COTTON

The identity of the engine supplier for the DeltaWing has long been kept under wraps but, as Nissan announced its support for the programme, it became clear that British engineering company, RML (Ray Mallock Ltd), was behind the architecture of the powerplant.

Under the direction of Arnaud Martin, RML set to work creating a brand new engine for the project. RML was commissioned to design a bespoke engine based on the 1.6-litre turbo engine fitted to the Juke, and produced a prototype with relatively high weight, before refining it in the second iteration.

The DeltaWing tested in the US, completing 700km with the interim engine before the new unit was fitted for an extensive test programme at Snetterton in April, ahead of its much anticipated race debut at Le Mans in June.

'The targets were set by Ben Bowlby, and they included a fully dressed engine, complete with heat shields, turbo, exhaust manifold and so on, for less than 95kg,' said Martin. 'We believe that we should hit 90kg, but it was a lot of work in terms of choice of material and design of the block to make it as light as possible, while still maintaining durability.'

Other parameters included a power output of 300bhp for the 500kg car, and a flat torque curve to be able to bring the car up to LMP2 speed in a straight line. But it was the weight saving techniques employed to meet all these criteria that set this engine apart from other models that will line up alongside it on the grid at Le Mans.

'The weight of the chassis is more important than anything else,' says Martin. 'The car is less than 500kg and that is what gives it the incredible performance for power, so every kilo you put on it, you go backwards. It is more important to save weight than to find performance.'

TREMENDOUS FAITH

It is a different way of thinking and, with the relatively low power output, the RML team was able to take some risks. By creating a crankshaft weighing just 7.8kg – achieved with holes bored into the unit – they have put tremendous faith in their choice of metals, and their engineering calculations. The engine revs to 7250rpm, and can go to 7500rpm where necessary, but any more than that and there is a worry that there will be torsional problems with the crank. There is, of course, a back-up plan with a heavier crank, but ahead of the first test of the car with the new engine fitted, and before it has even seen a dyno, Martin is confident the figures add up.

'The crankshaft was a massive weight saving, whilst achieving the same balancing characteristic as the crank in previous engines,' Martin continues. 'We use a certain percentage of reciprocating mass in our calculations. We have achieved exactly the same in this engine as in our other engines, while at the same time reducing the weight. The crank has tungsten balance weight on it, holes everywhere and is an interesting piece. I doubt you have seen one like it before.

'Some of the weight saving

"It is more important to save weight than to find performance"

Low height carbon plenum is one of the few parts from the interim engine

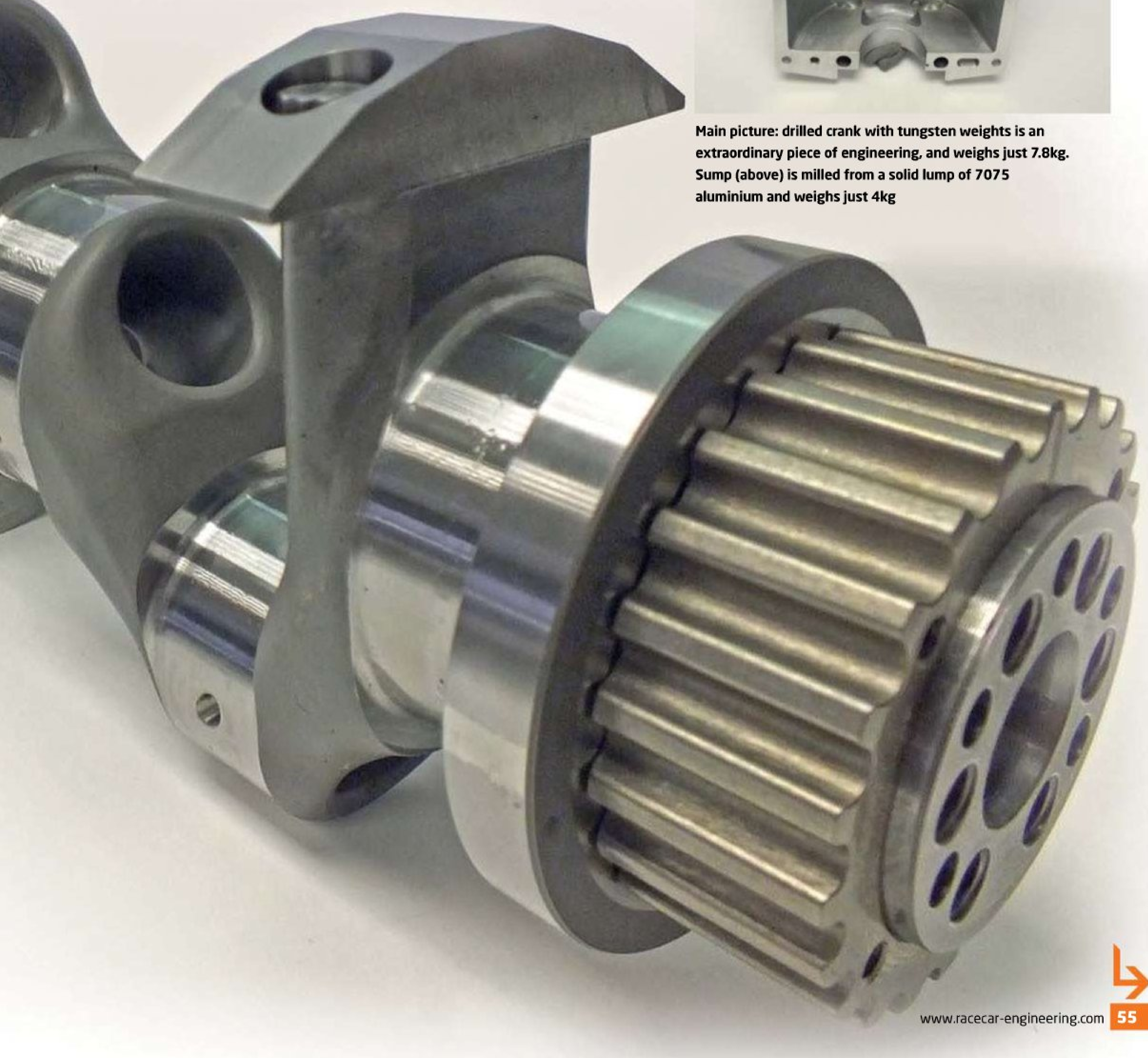
came from dislocating engine vibration from the chassis, so basically you can assume chassis reliability is broadly driven by engine vibration, which will fatigue the chassis. The total disconnect between the engine and the chassis is pretty much as you would find in a road car.

'But in the first place we have tried to create an engine that vibrates as little as possible. Then there is less you have to do to the chassis, and that was a design parameter.

'If you designed a crank without the tungsten weight, it would have been a heavy crank. That is why it is an extreme design, with a high level of reciprocating mass.'

The crank was designed by the RML team, but to manufacture it the company turned to specialist company, Capricorn. Many of the ancillary devices have been designed in-house, and some of the technical know how from the RML Global Race Engine has been carried over. For example, the team stuck with the Life engine management system and a similar water pump system that keeps flow to 25 litres per cylinder. Externally, the engine also looks similar to the Global Race Engine, in as much as they are both turbocharged, in-line fours.

However, the RML team itself designed all new internals, and even the all-aluminium block is new. 'It is all to do with the way we conceived the block,' explains Martin. 'Basically, the aluminium in the block is not structural. We used some parts of it to make it strong and take the load without stressing the aluminium, which allowed



Main picture: drilled crank with tungsten weights is an extraordinary piece of engineering, and weighs just 7.8kg. Sump (above) is milled from a solid lump of 7075 aluminium and weighs just 4kg

us to take out more weight. The block is less than 15kg, the sump is fully CNC machined from a billet of 7075, and is just 4kg, including the engine mount.'

ROAD CAR RELEVANCE

Much of the criticism levelled at the car concerns its relevance to road cars. One leading engineer sniffed in the air at the car, saying that of course, as it was not built to any particular rules, it should not be taken seriously, but Nissan argues that it will learn much about 1.6-litre engines from this programme. Actually, there is an element of reverse engineering, with the RML team taking weight saving and friction reducing cues from Nissan.

Nissan wanted a highly efficient motorsport engine and RML delivered this, using as a base the 1.6-litre DIG-T engine selected by Nissan. The racing unit retains all the concepts that the RML team believed to be useful in a racing application. The throttle body, for example, is taken from the Juke. 'The concept behind it is lightweight, low friction, high efficiency. They are the three parameters. Some of it is achieved using Nissan's technology. Some of their production engines have low friction through the use of DLC coating and beehive valve spring, all linked to reducing the reciprocating mass of the valve return. The lower the mass, the lower the force to open the valve, so the reduction in friction.

'We knew about racing engines. The dry sump system is a pure racing design, which evolved from the last engine that we designed. It is not the same, but it is similar – there have been changes, improvements and we have carried on improving things.'

"This engine is all about efficiency"

The plenum chamber is almost comical by its small size, but clearly it works, as it was one of the few pieces that carried over from the interim engine to the new one that began testing in mid-April. The dry sump was also re-designed, and is just 87mm in height to the top of the stud on the sump side, so the majority of the chamber is just 79mm high. So efficient is the engine, in fact, that one tiny radiator is capable of cooling the engine, water and oil systems, offering an even greater saving of weight.

Fuel consumption figures are always going to be hard to quantify, and only some hard running at the Le Mans test day will start to give real performance indicators as to the true potential of the DeltaWing.

As much of its potential comes down to the aerodynamics as the engine, but RML has worked hard to deliver a small capacity, direct injection engine with the performonce to match.

'This engine is all about efficiency,' says Martin. 'The plenum design was constrained by packaging, as was sump height. Weight was obviously a big factor, as was low friction, a stratified charge and lean running, all designed to achieve best BSFC [Brake Specific Fuel Consumption] to ensure we use as little fuel as possible.'

What will happen to the engine post Le Mans has yet to be determined, but Don Panoz has a plan to use the car for the LMP2 or LMPC classes in the ALMS. For a car that was originally proposed to the IndyCar fraternity, and rejected, it would be fitting for it to be run in the US after all.

Above: every part of the engine was designed by RML, including the non-structural aluminium block, that weighs just 15kg

Above right: the crank and pistons (whose top surface cannot be shown as RML do not wish to reveal combustion chamber secrets just yet) were designed by RML and manufactured by Capricorn

Right: this small, single radiator is the only cooling matrix for the entire car

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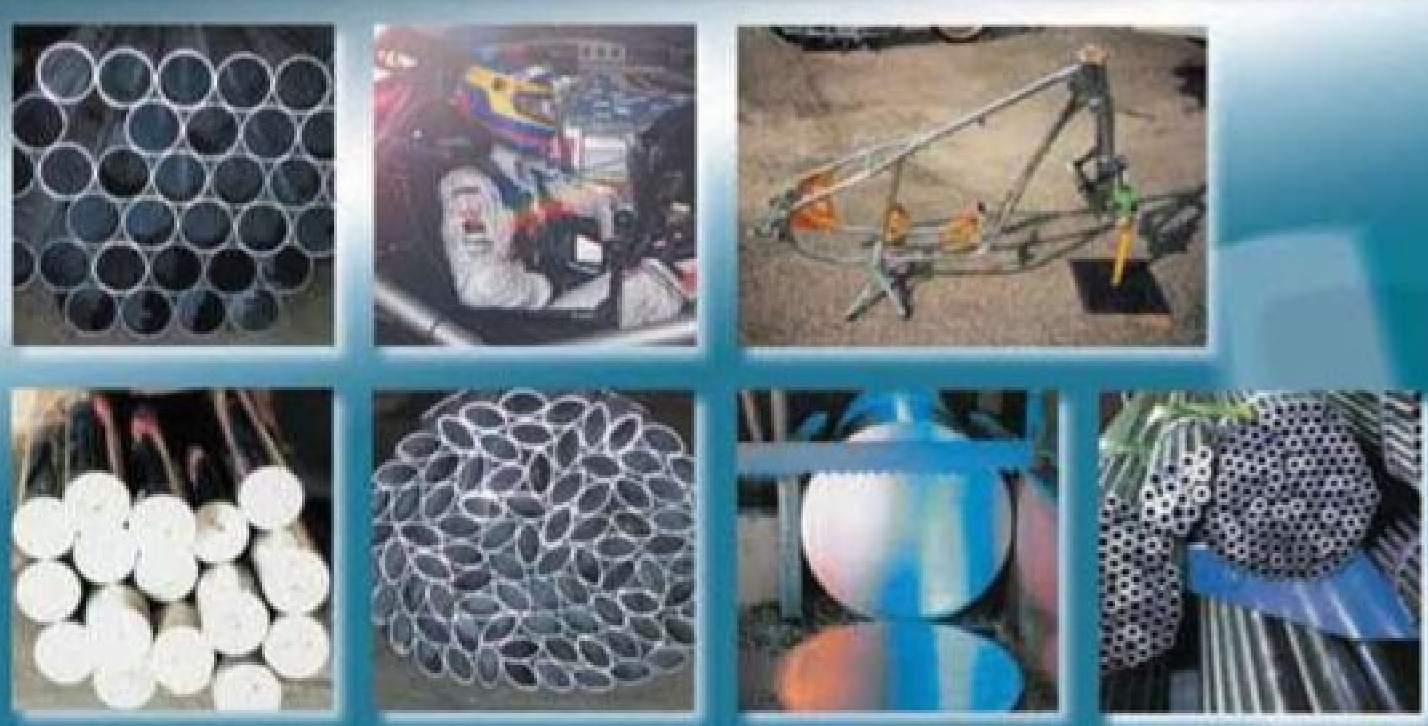

Head to head

Running the DeltaWing at Le Mans against a representative LMP1 car

BY DANNY NOWLAN

Of all the cars I've seen in recent times, none has had the polarising effect or interest level of the DeltaWing. When it was first released in early 2010 to compete for the IRL 2012 car it actually took headlines away from the Daytona 500. Some of my colleagues hate this car with an abiding passion, yet some think it's the best thing that's ever happened to racing. Given this car has an entry at Le Mans 2012, why don't we run a simulation at the circuit against a representative LMP1 car and see how the two compare. Whatever the outcome, the results are going to be interesting.

Let me state from the outset that what we are about to perform is a preliminary, first cut analysis. So don't regard what I am about to write here as gospel. Indeed, I would encourage the engineers at the DeltaWing consortium to provide a detailed analysis about their thinking. I should also add that in my comparison I've run it with more downforce than you would typically run at Le Mans. This is to accentuate comparisons, particularly in high-speed corners.

In this article we are going to do a hand calculation analysis, followed by preliminary simulations. And to kick things off, let's discuss the positives of the DeltaWing concept, namely that it needs half the power of a conventional racecar. This is actually quite believable, but let's first consider the diagram of the DeltaWing, as shown in figure 1.

As we can see, the direct frontal area of the car is a fraction of what you'll see on a conventional car. Furthermore, its planform area is about half of a conventional car. All this adds up to a CdA value that could potentially also be half of a conventional car.

"In my comparison I've run it with more downforce than you would typically run at Le Mans"

Also, given we are dealing with something with a much smaller engine and half the planform area, it's not too much of a stretch to envisage the other claim of the DeltaWing, that it will be half the weight of a conventional car. I realise this is highly subjective, but given you need only half the engine power, it follows you'll need half the cooling systems and ancillaries to manage it. This in turn has a knock-on effect in terms of weight of the gearbox, differential and other systems. All this translates to reduced weight and some interesting flexibility when it comes to tuning engine power and its effect on performance.

The final advantage the DeltaWing has is the fact the regulating bodies might actually cut it a bit of slack in the regulations. This is a good thing because it will encourage some genuine innovation, which is sorely needed in our business.

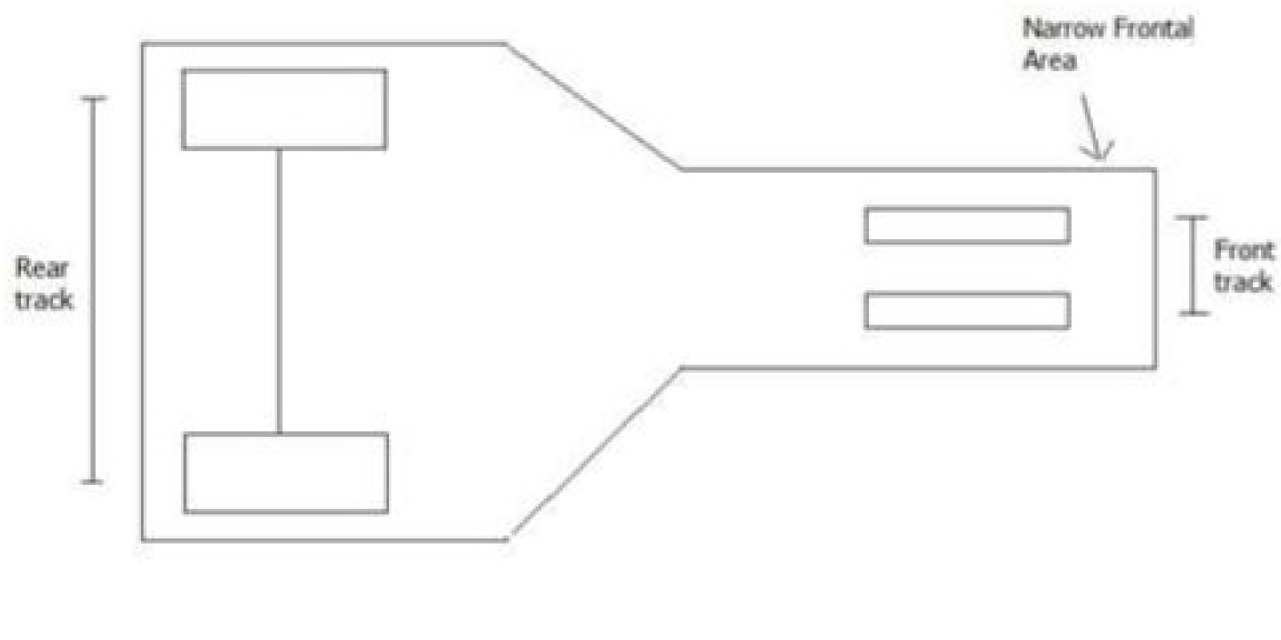

Figure 1: schematic diagram of the DeltaWing

However, the DeltaWing is not without its drawbacks, and we would be foolish to ignore them. The first disadvantage is that it will simply not be able to produce as much downforce as a conventional racecar. These produce a large proportion of their downforce through the floor, and the DeltaWing is at an immediate disadvantage due to its significantly reduced planform area. To an extent this should be mitigated by the reduced weight, but this is still going to hurt, particularly through places like the Porsche Curves that are taken at over 200km/h. The provisional simulated speeds should be quite revealing.

The second disadvantage of the DeltaWing is that the bulk of the load transfer is going to be happening at the rear axle, and this has massive implications on car performance. To consider why this is, let's once again consider the beam pogo stick model of the racecar, as shown in figure 2.

When the car is rolling, the differential spring forces are effectively a function of roll angle and differential hub movement. Effectively, the differential spring forces are a function of the following equation:

Where,

$$\partial F_S = k \cdot \left(\frac{t}{2} \cdot \phi + \partial y \right)$$

δF_s = differential spring force
k = spring rate (N/m)
t = track width (m)
ϕ = roll angle
δy = differential wheel movement

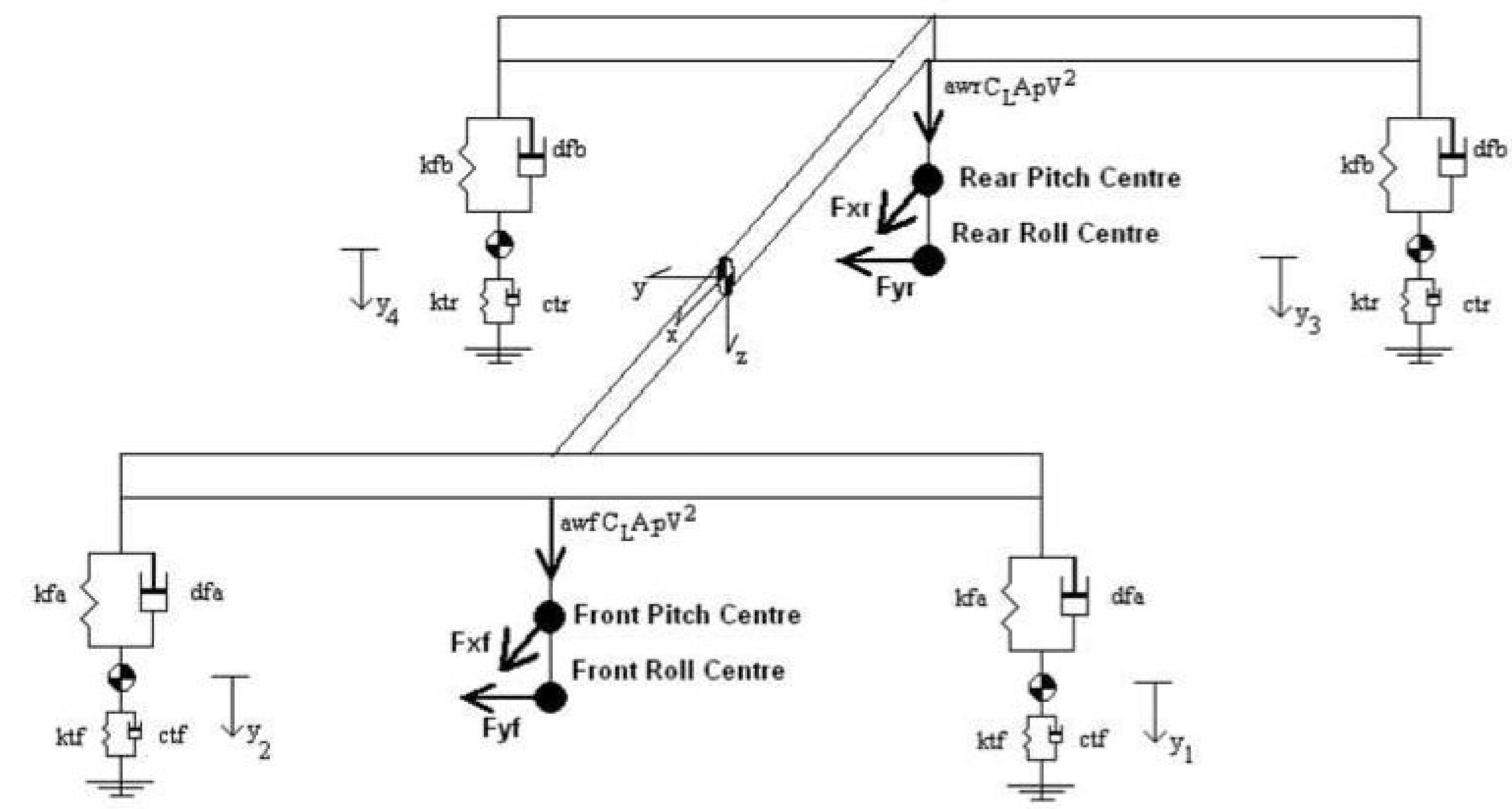

Figure 2: beam pogo stick of the racecar

Table 1: car parameters for the DeltaWing

Parameter	Value
Car mass	450 kg
C_LA	2.5
C_DA	0.8
Front weight distribution	0.4
V_1/ay_1	70km/h/2g
V_1/ay_1	200km/h/3g

Table 2: required balancing forces for different balancing forces

Balancing condition	Required force
V = 70km/h at 2*g*	108.9kgf
V = 200km/h at 3*g*	289.3kgf

Table - 3 load transfer for our two cornering conditions

Condition	Load transfer	Static tyre load
V = 70km/h at 2*g*	168.8kg	164.5kg
V = 200km/h at 3*g*	253.1kg	279.7kg

Table 4

Parameter	LMP1	DeltaWing
Mass	900kg	450kg
Max engine power	600bhp	300bhp
ClA	5	2.5
CdA	1.3	0.72
tm	1.7	1.8

"all of the bulk of the load transfer is taken on the outside wheel"

You can mitigate the load transfer issue to some further extent with choice of roll centres, but this is really a matter of disaster management. What all this means in practice is that the outside rear tyre is going to have to handle the rear cornering force and balance the drag forces. This has the potential to play complete havoc with achieving a consistent balance when the car is at peak lateral *g* throughout the speed range, which is what you have at Le Mans. To illustrate this, consider figure 3, which shows a free body diagram of the car while it is cornering.

As we can see, for a right-hand turn as illustrated, the drag force (illustrated as Fx) provides a positive moment, or a torque that will reduce oversteer. To show why this could play havoc with the balance, let's consider the forces we need to balance the car, using the car parameters shown in table 1.

Please note, for the purposes of our examination, I'm sticking with F3-style numbers, even though I realise the DeltaWing has a front weight distribution of approximately 30 per cent. The reason I'm doing this is because it is something I know very well and so we can make an appropriate comparison. I'll discuss the drag figures shortly. Bear with me, for there will be a method in this apparent madness.

Now let's discuss the forces we'll need to balance the car that take into account aero and cornering drag. Assuming a peak slip angle of six degrees, crunching the numbers we arrive at the figures shwon in table 2.

Given the magnitude of these forces, you can see this has the potential to vary the balance wildly as we go through the speed range. To an extent this can be mitigated by rolling into the corners at high speed but, if you have a constant radius speed corner, you are just going to have to live with understeer in the low-speed corners.

LOAD TRANSFER

The other problem you are dealing with is that at mid-corner all of the bulk of the load transfer is taken on the outside wheel. To understand this, consider a track width of 1.6m at the rear. For the two cases we have just illustrated, the load transfer for both these conditions (assuming the aero load is distributed equally) are shown in table 3.

As we can see in all of these cases, the outside tyre will be doing most of the work. Naturally, this has massive implications for tyre wear, particularly if we need to triple stint the tyres.

The other thing we need to consider is how we load the front tyres. I have written on a number of occasions on the importance of tyre temperature in the generation of tyre grip. On a conventional, high downforce open wheeler / Sportscar we do this typically through high bar rates to drive temperature into the outside tyre since it's not doing anything in the lead up to cornering. In the DeltaWing, we are not going to have that option. To an extent we can do this with high values of pitch centre to achieve the same end, but this could be a potentially tricky situation to deal with.

So, all this being said, let's know perform some ChassisSim simulations at Le Mans to quantify all this. The two car parameters we'll be simulating are shown in table 4.

Before we discuss the simulation, I want to explain the numbers we are using for the DeltaWing and where they are coming from. As I touched on earlier, to enable an appropriate comparison I'm basing these numbers on those of an F3 car. In terms of weight and downforce, the DeltaWing is very comparable

to an F3 car, which is something I know very well. I should also reiterate this is a rough analysis to establish what we are dealing with. Hence why we are using the F3 numbers.

However, there is one area where I would agree to disagree with the DeltaWing consortium, and this is their drag numbers. DeltaWing Racing Cars claim a CD of 0.24. Assuming a frontal area of about 1.6m^2, this translates to a CdA of 0.384. I realise the DeltaWing team have access to CFD tools and wind tunnels I don't have, but I still have my severe doubts that they'll hit this target. By the time you've put in an engine, a driver and all the other ancillaries, the wind tunnel results could be a distant memory. The CdA we are using is taken from an F3 car in low-downforce configuration.

The reason I selected this is, in terms of frontal area and ancillaries, it is the racecar that is most comparable to the DeltaWing car. I realise that an F3 car has front tyres directly exposed to airflow, which will push up the CdA. I could be wrong about this, but experience tells me otherwise. Either way, we'll find out soon enough when the car hits the track.

For the time being, though, we'll have to content ourselves with the simulation, and the overlay is shown in figure 4. So that we are clear, the LMP1 data is coloured, the DeltaWing is black. I should also add the bump profile is a very rough cut, so there will be a few inconsistent results. However, as we examine this closely, a number of things become apparent.

The first thing to consider is the difference in the balance between the cars in the low and high-speed corners, as shown in figures 5a and 5b (speed ans steering traces).

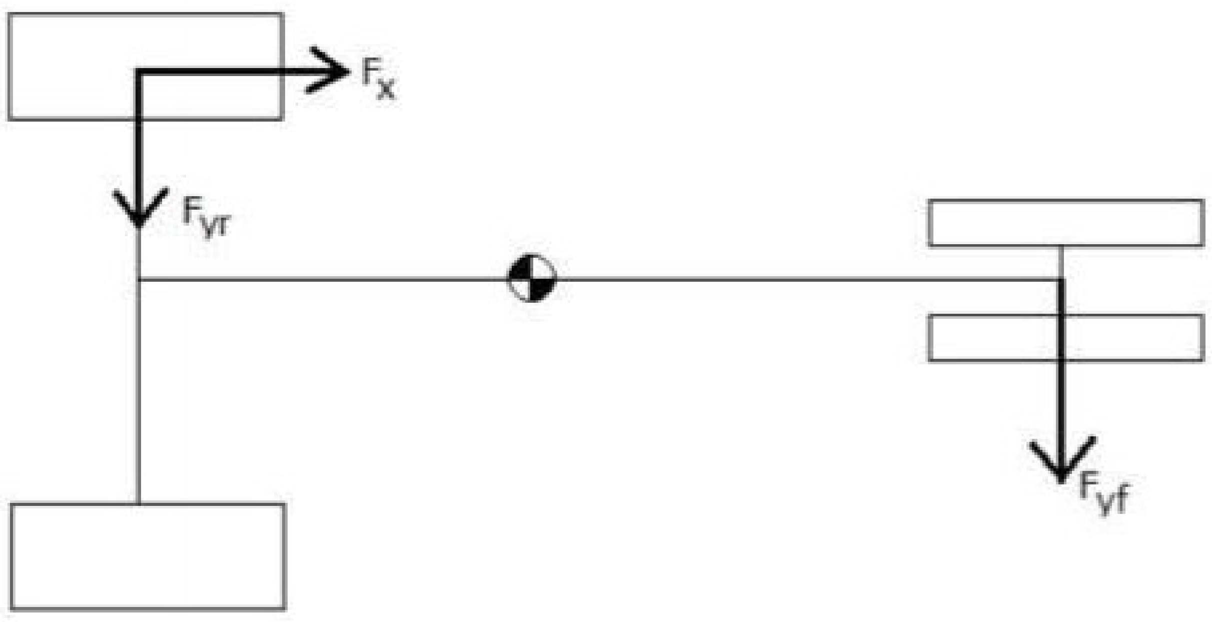

Figure 3: an FBD of the lateral and longitudinal forces at mid-corner

Figure 4: comparison of an LMP1-spec car with the DeltaWing

Figure 5a: comparison of an LMP1 and DeltaWing in a low-speed corner

Figure 5b: comparison of an LMP1 and DeltaWing in a high-speed corner

In the low-speed corners, both of the cars have understeer, but the DeltaWing has less understeer than the LMP1 car. Where things get really interesting, though, is in the high-speed corners. In figure 5b I have deliberately selected a high-speed corner where the DeltaWing was quicker. In some respects this doesn't surprise me because remember the numbers we have selected for the DeltaWing represent an F3 car. However, remember also the force unbalance we saw in figure 3. You can see this manifesting itself in the steering trace. While the LMP1 car has maintained its balance, the DeltaWing is undriveable. Yes, technically it has the grip for the corner, but a steering trace like this would annihilate driver confidence – something that is critical for the high-speed corners.

The reason for this is the inside rear wheel unloading, which means a fundamentally unbalanced car. To illustrate this, consider figure 6, which shows tyre loads for the DeltaWing in the high-speed corners,

As we can see, the inside rear tyre load is unloading quite violently. This, in turn, affects the front tyre load, which upsets the steering. This is one of the key limitations of the DeltaWing.

DISPLACEMENT THEORY

The other area we need t consider with the DeltaWing is that, despite its reduced weight and drag, it can't match the LMP1 car in a straight line. In our rough model the LMP1 has a maximum speed of 295km/h, yet the DeltaWing has a speed limit of 284km/h. I will be the first to admit this is a very rough analysis, but it really defines the old adage, 'there is no replacement for displacement'. Technically, the DeltaWing can get over this by going for a more powerful engine, but that invariably means increased weight, which will exacerbate the handling problems present that we just discussed.

That being said, one thing I will say is if DeltaWing Racing Cars hits its drag targets, this could be a whole different picture. For example, if we give the DeltaWing a CdA of 0.5,


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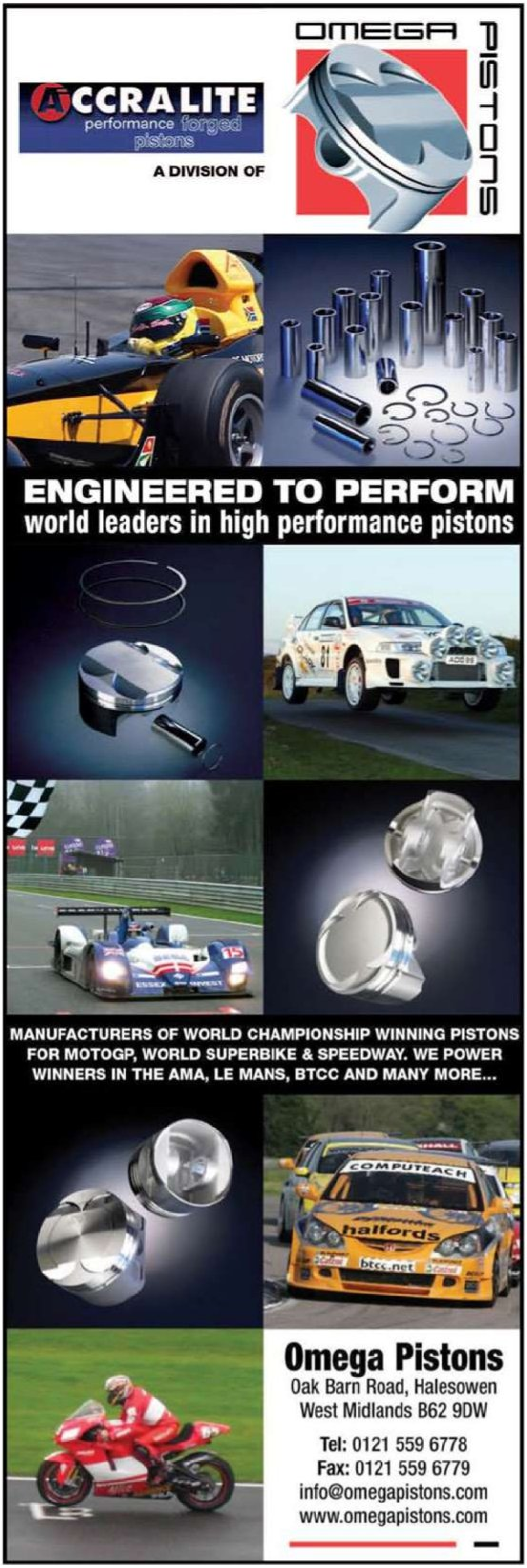
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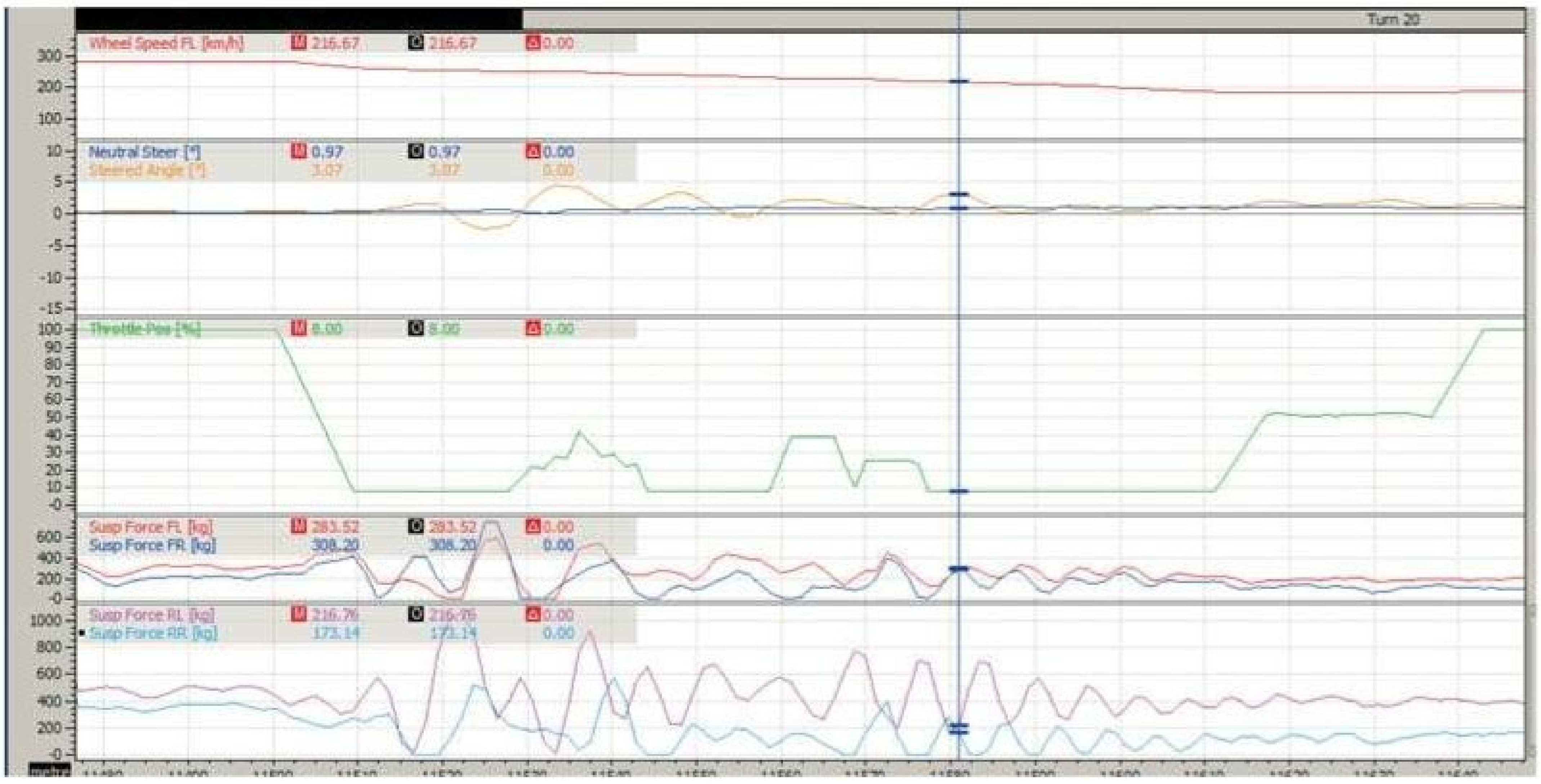

Figure 6: examination of tyre loads for DeltaWing in a high-speed corner

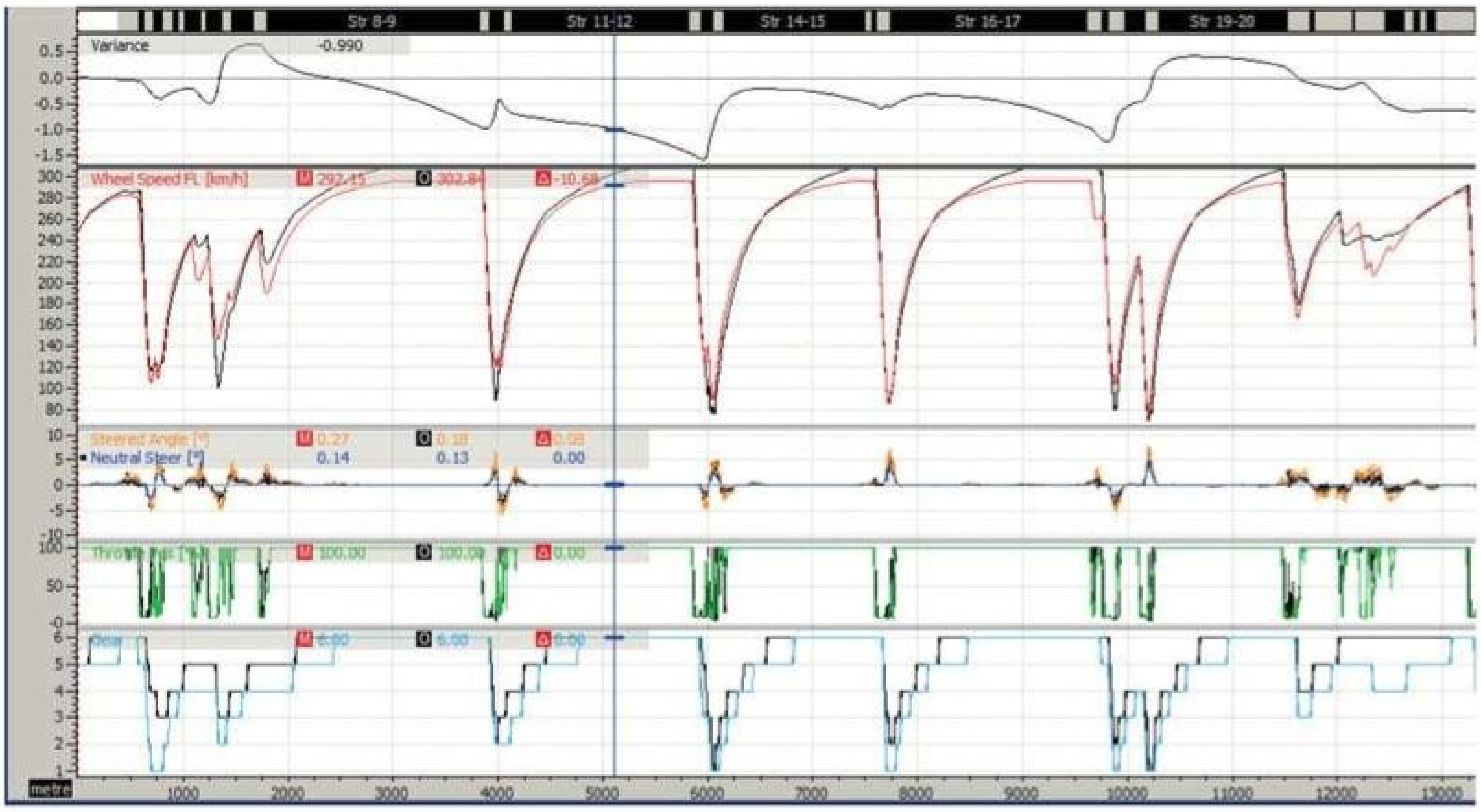

Figure 7: simulation of the DeltaWing run with the drag numbers claimed by the designer and DeltaWing Racing Cars

on the provisional model I've established for the DeltaWing, it will comfortably match the LMP1 car in a straight line. However I have serious doubts about this.

The glimmer of hope for the DeltaWing is we have the classic turtle vs the hare race. In terms of lap time, there is a nine-second differential. Let's say, with some development we can reduce that differential to, say, four seconds a lap. Also, let's presume they have equal fuel tanks. So, let's say our LMP1 has to pit every hour and, at this point has completed 15 laps and has a lead of 60 seconds. If the pit stop for the LMP1 takes 60 seconds, including rolling down the pit lane and the stop, while this is going on the DeltaWing can claw back track position. However, in the course of a lap, my simulations show it would be hard pressed to stay with the LMP1 car.

CONCLUSION

Taking all this into consideration, even taking into account the ACO's desire to not have the car interfere with the fight for the overall win, I doubt the car could compete against an LMP1. Fundamentally, it simply doesn't have the force balance to achieve consistent handling, and for it to get the engine performance to compete in a straight line would compromise it in other areas. The one caveat I would put on this is it could be a different story if they get close to their drag claims, but I think there are some fundamentals this car won't be able to overcome.

"it simply doesn't have the force balance to achieve consistent handling"

On the positive side, the DeltaWing certainly offers advantages in fuel consumption and, as a symbol to get people thinking, it is definitely a good thing, but the fact the rear tyres have to handle all the load transfer in my opinion leaves it compromised in the mid-cornering condition. Not just in terms of balance, but in terms of tyre wear as well. Also, as we can see, halving weight and engine power doesn't immediately lead to an increase in straight-line performance. One way or other, though, we'll find out soon enough when the car runs at Le Mans for real.

SETTING UP THE DELTAWING

In some respects, setting up the DeltaWing is not the same as a conventional racecar. There are some things that are very specific to this type of car – for example, all of the roll stiffness distribution is at the rear. Therefore if you put a much bigger anti-roll bar on you wouldn't change any distribution of load through a corner. So what are you changing when you change the rear anti-roll bar? In fact, you change the roll angle of the car and the rate at which it rolls, but we have not done that yet so we don't know what the impact is!

When you look at the rear suspension layout, you will realise that we anticipated quite a complex requirement in terms of damping the roll. We have overdriven the damper in roll but not in heave, so there is a linkage with a swinging beam that, in turn, has an anti-roll bar in it. Where the drop links attach and where the damper attach, you have an overdrive in roll as opposed to in heave. That is because the front suspension doesn't see any roll and therefore the car is at risk of being under damped. We had to take care of that to make sure we had enough roll damping so the driver has a secure rear.

But as the initial simulations and track tests show, it's a very secure reaction to have the majority of the roll damping at the rear of the car. It makes you feel that you can ride the rear tyre, so to speak. If you talk to the drivers, they will tell you that the security in the rear was mind bending. That is counter intuitive when you think it's like having a sledgehammer with the weight at the back, but the reality is that because the balance between the tyre, the mass and the aero is actually all in harmony, it behaves as you hope.

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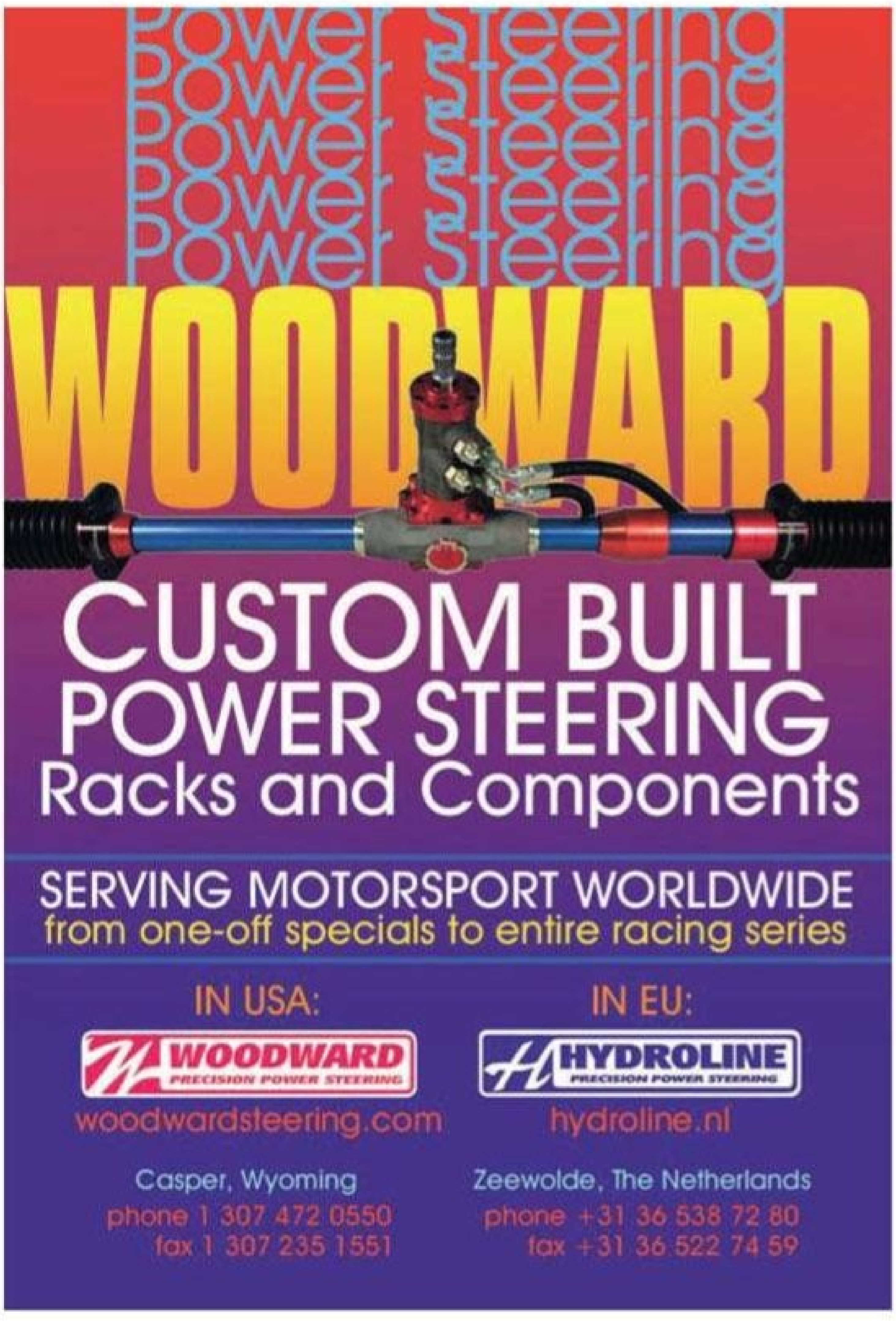
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Heat treat tricks

Boosting part performance with improved surface treatments

The metalworking industry now offers new and improved tools for the thermal processing of a large variety of metal alloys. Thanks to recent advancements in vacuum furnace technology and continued process development, automotive components can be treated with accurate, predictable and reproducible results. This is especially true with applications relating to surface treatment.

When working with parts subjected to demanding performance requirements, such as crankshafts, camshafts, gears, transmission mainshafts and valvetrain components, carburising and nitriding are two of the most common forms of surface treatment. They are similar in that the surface composition of steel is altered by chemical diffusion in a thermal cycle, but different in that carbon is added during carburising using a relatively high temperature method, whereas nitrogen is added during nitriding in a relatively low temperature method.

Both processes are performed to significantly increase surface hardness / strength of the part. The resulting improved tribological properties (friction and wear) include a lower coefficient of friction, combined with greater wear resistance. Fatigue strength / life is also increased by putting the surface into residual compression through interstitial strain hardening by the carbon or nitrogen solute elements.

Carburising is performed at temperatures in the range of 1650degF-1825degF (900degC-1000degC) and requires rapid cooling to complete a required phase change transformation in the steel from austenite to martensite. This makes part distortion an important factor to consider and evaluate before processing and extra stock for 'clean-up' finishing often is required. Conversely, nitriding is performed at temperatures of 925degF-1050degF (500degC-565degC) and commonly on pre-hardened alloy steel (eg 4140) that already has a martensitic structure. As such, distortion is typically not an issue with nitriding and finished parts are commonly processed.

CARBURISING

Low Pressure Vacuum Carburising (LPVC, or simply LPC) is one of the hottest topics in the heat treat industry. The use of low torr range carburisation – typically less than 15torr (20mbar) – is an important advancement for the generation of optimum metallurgical structures and, as such, mechanical properties in steel parts. Unlike traditional gas carburising performed slightly above atmospheric pressure, LPC is a non-equilibrium process whereby a small amount of the carburising gas is continuously pumped in and out of the furnace at a rate that allows the carbon on the surface of the steel to reach the austenite solubility limit (eg 1.3 per cent C at 1750degF (950degC)). The whole process involves four or more distinct stages. In stage 1, the parts are heated in a 'soft vacuum' or in a 'partial pressure' gas (eg nitrogen or hydrogen) to the carburising temperature and allowed to soak. In stage 2, the carburising gas is introduced and the parts adsorb carbon on the surface. For stage 3, the reactive gas is removed and the surface carbon is allowed to diffuse below the surface in a soft vacuum or partial pressure gas. Stages 2 and 3 are then alternatively repeated, or pulsed, until the requisite case depth for the desired carbon content is achieved. In the final stage, the parts are quenched to produce the desired microstructure or cooled and then re-heated for a sub-critical annealing step, and / or the hardening step, and quenched. The re-heating

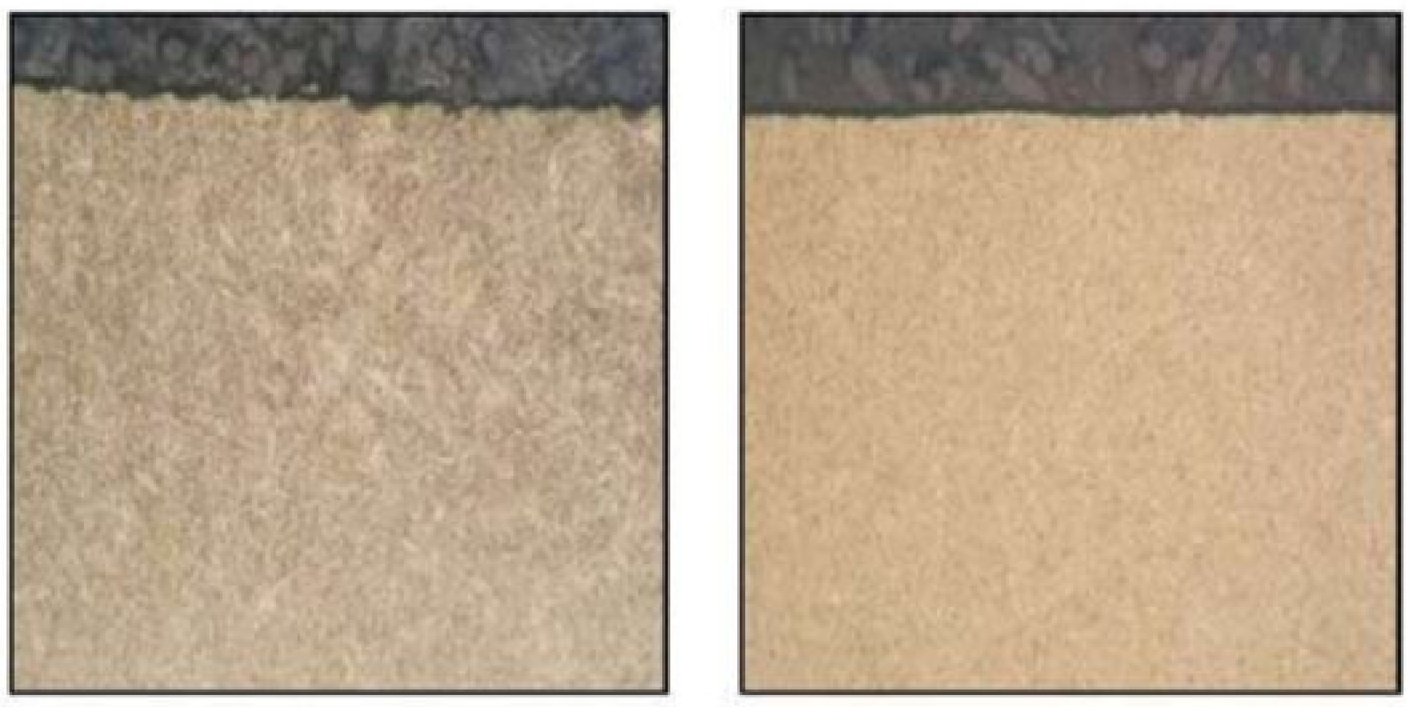

Figure 1: the difference in grain structure produced by re-heating. Left shows the micro-structure resulting from a high pressure gas quench directly following carburising. Right is the structure produced after a mild cool down following carburising, then re-heating and high pressure gas quenching

Figure 2: this shows the uniform, fine grain structure free of coarse precipitated carbides that is imperative for optimum bending fatigue resistance

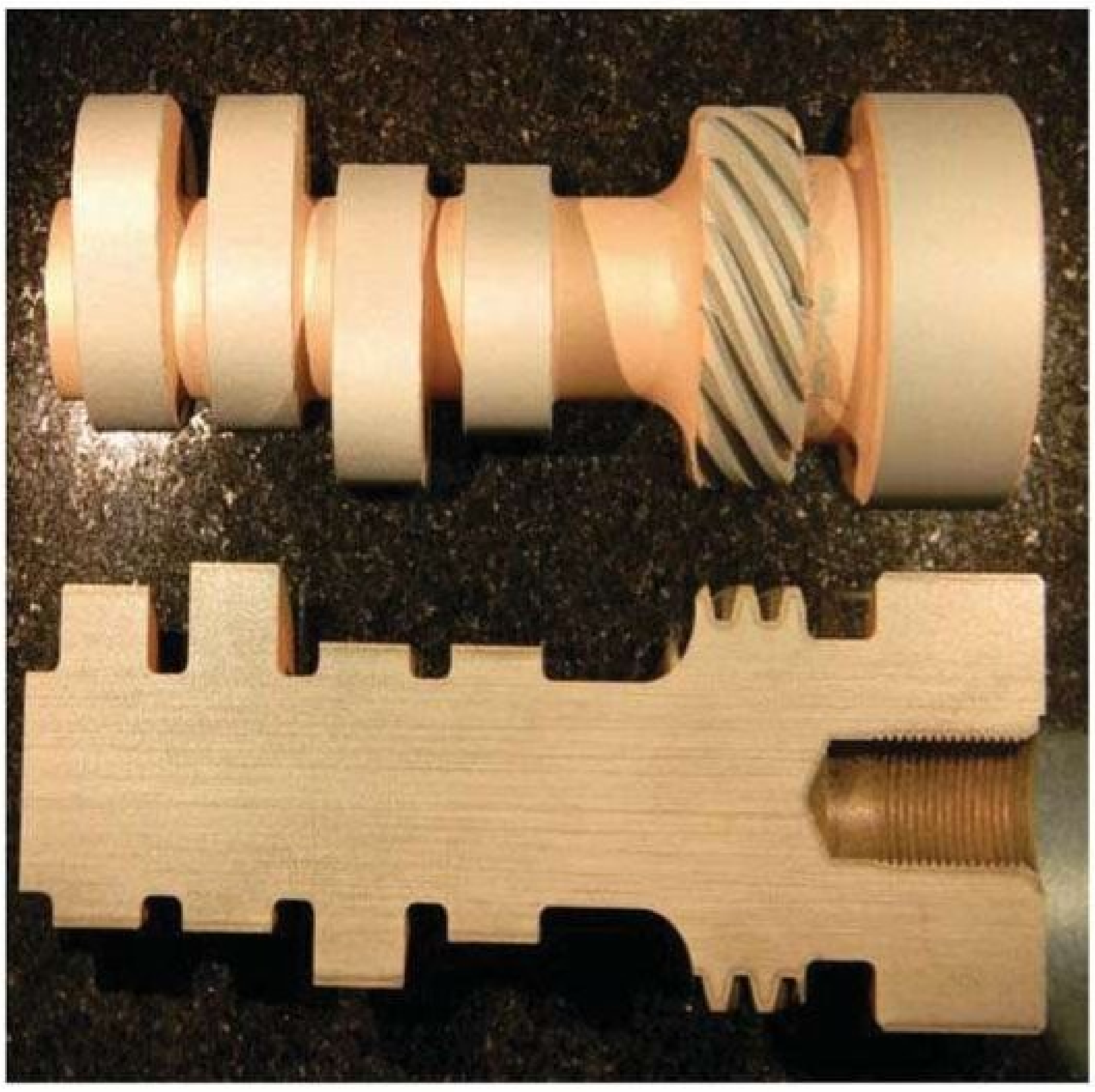

Figure 3: a 'macro-etched' cross section of a carburised 9310 alloy camshaft

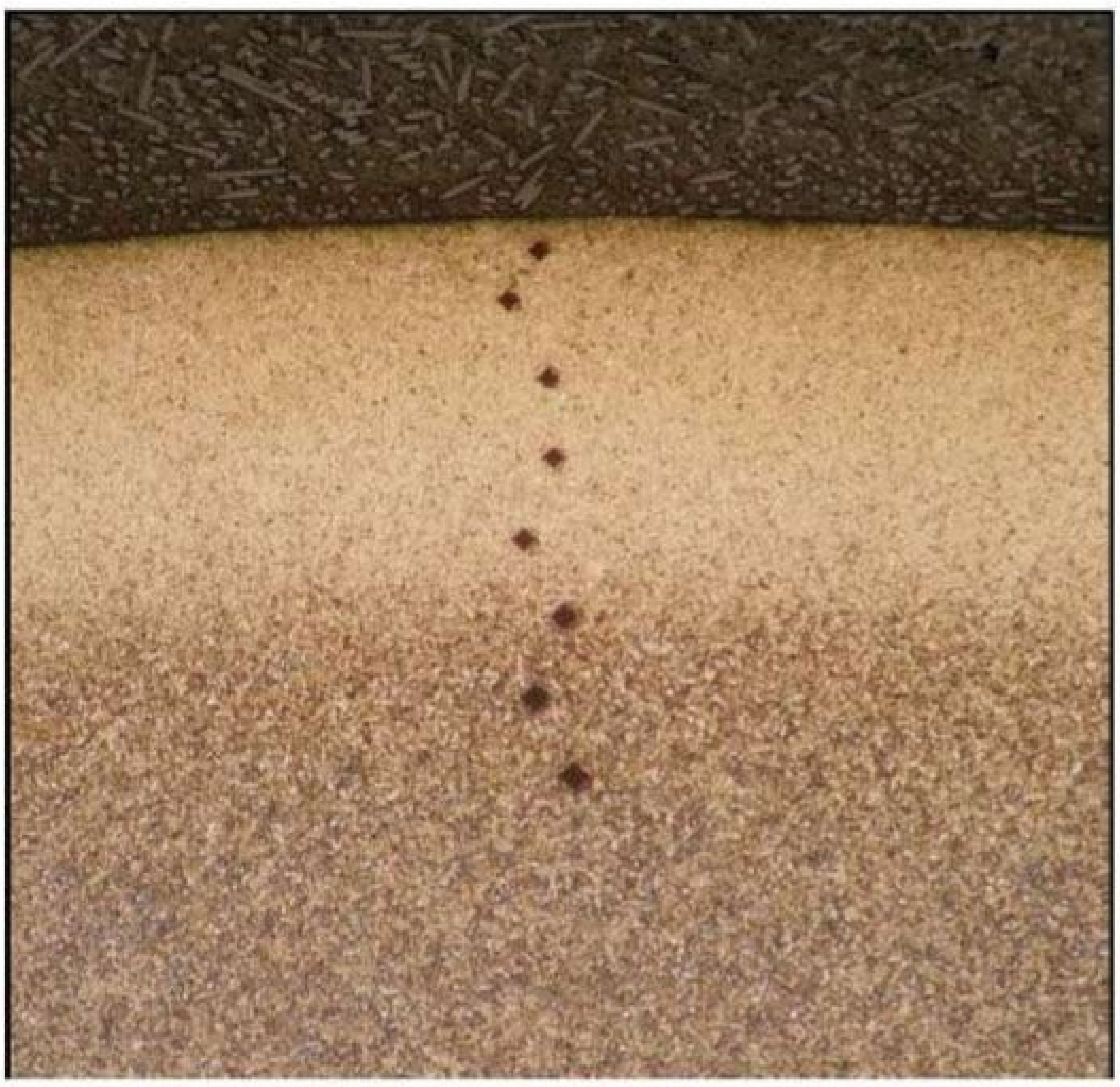

Figure 4: a 'micro-etched' section of the 9310 camshaft and associated micro-hardness profile diamond indentations

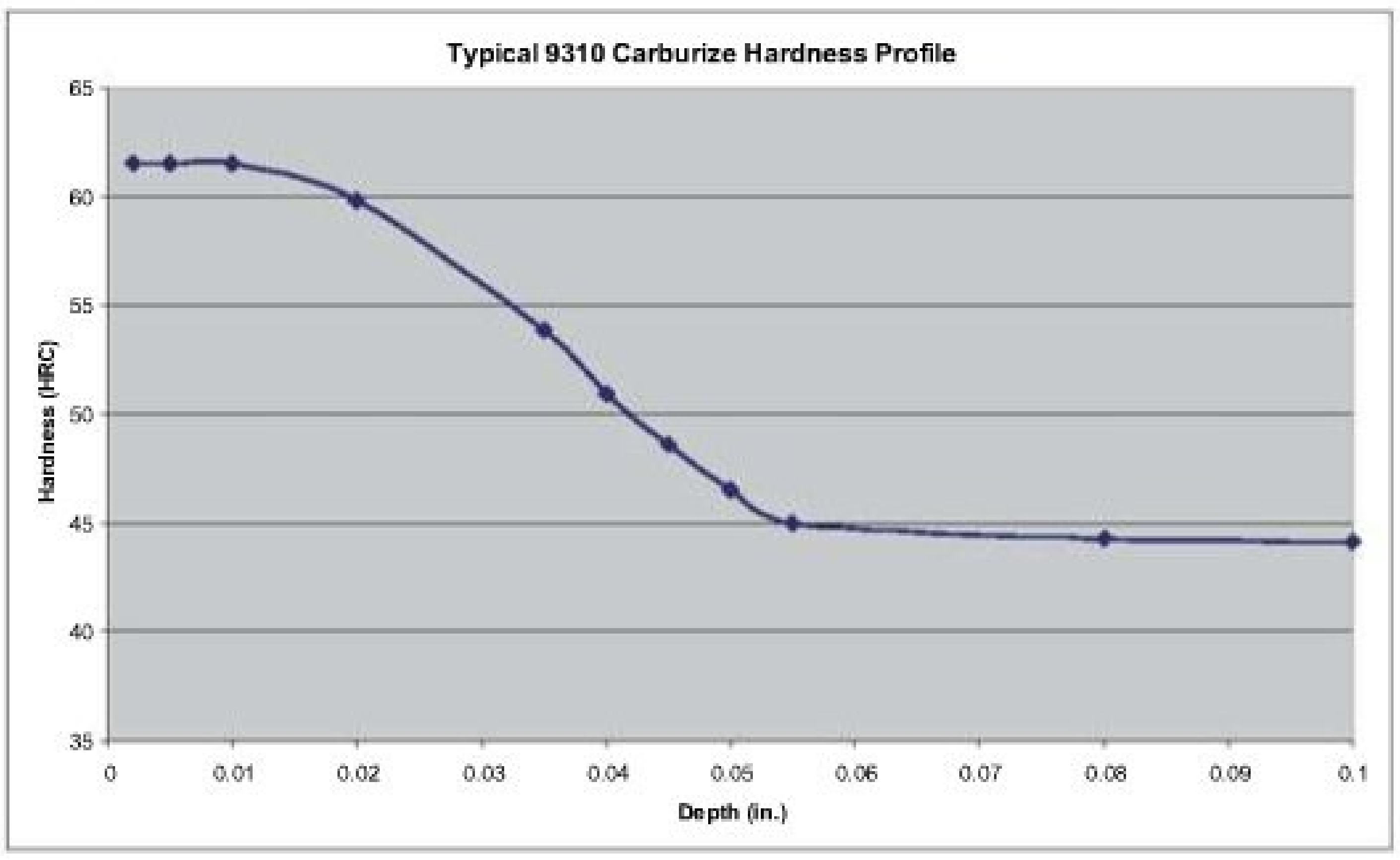

Figure 5: the microhardness profile hardness data exhibiting an effective case depth of 50 HRC minimum at a little more than 0.040in (1mm).

treatment is principally performed for grain refinement of the structure to improve mechanical properties. Figure 1 shows the difference in grain structure produced by re-heating.

LPC offers a level of precision not available in conventional atmospheric equipment by incorporating state-of-the-art microprocessors for cycle control, optimisation and repeatability. This allows critical cycle parameters to be pre-programmed, including the multiple pre-determined boost / diffuse pulsing and cool down sequences of the process. Since LPC is performed in a vacuum furnace, the process also provides distinct metallurgical advantages. Unlike atmospheric carburising in which inter-granular oxidation (IGO) is inherent, LPC offers the major benefit of essentially eliminating oxygen during processing.

The resulting high-integrity case eliminates the need to allow finishing stock on parts to remove IGO, which can drastically reduce the fatigue strength / life of the parts. Additionally, the accuracy of the computerised process allows for the presence or absence of carbides to be controlled to meet specified requirements. For example, carbides may be undesirable in a bending fatigue application, but can be desirable in an abrasive wear application.

The use of a vacuum furnace also allows for considerably higher carburising temperatures to be used (>2000degF) for high alloy steels with grain stabilising constituents, significantly decreasing carburising time. Since virtually all carburising alloy steels have good hardenability, many newer LPC furnaces use a high-pressure gas quench to harden the steel after the carburising step, usually with nitrogen as the quenchant, as opposed to oil quenching used in a traditional carburising process. Gas quenching not only results in clean, bright parts, but also less distortion as the quench is considerably less drastic and removes heat more uniformly compared to oil. Clean parts with less distortion means less post-process finishing operations, and thereby reduced costs.

LPC is performed today using acetylene gas usually as the principle carbon source for carburisation, along with proprietary quantities of one or more other gases. Solar Atmospheres uses hydrogen as the companion gas with acetylene. It is well known in the heat treat industry that hydrogen is a 'reducing' gas. It cleanses the metal surface of oxide impurities, 'de-passivating' it, or making it readily 'active' for chemical reaction. In carburising, the surface is instantaneously receptive to the catalytic 'cracking' of the acetylene molecule into nascent atomic carbon that is adsorbed on the surface and then absorbed into the part. In Solar Atmospheres' vacuum carburising furnace and process, parts are heated to the carburising temperature in hydrogen partial pressure gas to activate the surface. At this point, acetylene gas is introduced while maintaining a partial pressure of hydrogen gas that acts as a 'carrier gas' for uniform distribution of the acetylene gas throughout the workload.

The prevention of IGO, along with the use of hydrogen gas in the heat-up and carburising boost stage of the cycle, coupled with the computerised processing controls, provides a process that produces extremely uniform and repeatable case depths and microstructures. Carburised depth uniformity is particularly beneficial to optimising the root-to-pitch case depth ratios in gears (see figure 2).

Noteworthily, LPC routinely produces root-to-pitch ratios greater than 90 per cent. This is as much as 20 per cent better than standard atmospheric gas carburising. The improvement effectively allows for the design of less massive / weight / costly gears, as well as shafts with varying diameters and / or narrow cut-outs. Carburising case depths vary widely depending on the application loads, but common case depths for automotive parts are in the range of 0.015-0.050in (0.35-1.3mm). See figures 3-5.

NITRIDING

Like LPC, modern day gas nitriding uses state-of-the-art microprocessors for cycle control

optimisation and repeatability. Here again, this provides the ability to pre-programme critical cycle parameters, including multiple pre-determined boost / diffuse pulsing if desired. Older gas nitriding technology measures the 'percent dissociation' of the ammonia gas to control the requisite ratios of ammonia and diluting gas, which was and still often is performed manually using a burette and water technique. Today's technology measures the hydrogen or nitrogen gas content of the atmosphere directly exiting the hot zone of the furnace and automatically controls the 'nitriding potential' by means of gas mass flow controllers to provide the requisite gas mixture ratios. This is a significantly more accurate and precise method for controlling the nitriding process. In fact, the most recently developed Aerospace Materials Specification for nitriding aerospace parts (AMS 2759/10) requires the nitriding process be controlled by the 'nitriding potential' as the title of the specification is 'Automated Gaseous Nitriding Controlled by Nitriding Potential'.

A nitrided case typically consists of a 'compound' or 'white' layer at the surface of the part. Beneath this is a 'diffusion' zone to varying case depths. Like carburising, nitriding produces a very hard, wear resisting surface, yet a nitrided case compound layer is even harder than a carburised case at the surface. White layer thicknesses typically range from 0.0001-0.001in (2-30microns), and actually have the characteristics of a ceramic. This provides extremely good sliding wear and scuffing resistance, with the additional benefit that it increases the corrosion resistance of the steel (again by having the characteristics of a ceramic). The increase in corrosion resistance can be enhanced even further by an in situ oxidation treatment, directly following the nitriding step of the process. The white layer thickness must be controlled, however, for optimum performance. If it is too thick it is susceptible to cracking and spalling. Herein again lies the enormous advantage of current day nitriding technology, as the white layer thickness can be closely controlled or prevented, as the application requires.

In nitriding, the obtainable surface hardness is directly related to the starting core hardness level. With medium carbon low alloy steels, it is common to purchase stock in the pre-hardened condition of 28-32 HCR, followed by machining and then nitriding of parts. However, as stated, higher surface hardness can be obtained as the core hardness increases. In the 4140 steel example, if the steel is hardened and tempered at 1000degF (538degC), it would be expected to exhibit a core hardness of around 38-39 HRC. Nitriding this material at 950degF (510degC) could produce a surface hardness of around 60 HRC. Similarly, if a tool steel of H-11 or H-13 is hardened and tempered to a core harness of 55-56 HRC, then a surface hardness of around 70 HRC is possible with nitriding.

In Solar Atmospheres' vacuum nitriding furnace and process, parts are loaded into a vacuum chamber and the atmosphere pumped into a 'soft vacuum' pressure range to essentially eliminate all presence of air. The parts are then uniformly heated by convection in an inert nitrogen gas atmosphere. Once the parts are at the nitriding temperature, a calculated amount of nitrogen gas is pumped out of the chamber and immediately replaced with ammonia. This allows the nitriding process to start with the exact ammonia / nitrogen gas ratio desired for optimum process control and precise, consistent results. Instead of processing in a heavy metal nitriding retort, as is typical in conventional nitriding, heating and forced gas cooling in a vacuum chamber significantly reduces the cycle time by as much as 50 per cent for a typical 24 hour nitriding cycle.

Nitrided cases tend to be considerably thinner than carburised cases and therefore cannot withstand as heavy a load. Common depths of the case 'diffusion zone' range from 0.006-0.020in (0.15-0.5mm). The heavier the load of the application, the deeper the case required. Fortunately, like carburising, nitriding puts the surface into residual compression, which increases the fatigue strength / life of parts. Regardless of the loading requirements, the presence or absence of white layer needs to be factored into the design consideration. Where corrosion is not a factor under impact or considerable bending loads, no white layer at all may be the most desirable condition for the application. This can easily be obtained through precise nitriding control of the nitriding potential in the modern vacuum gas nitriding furnace.

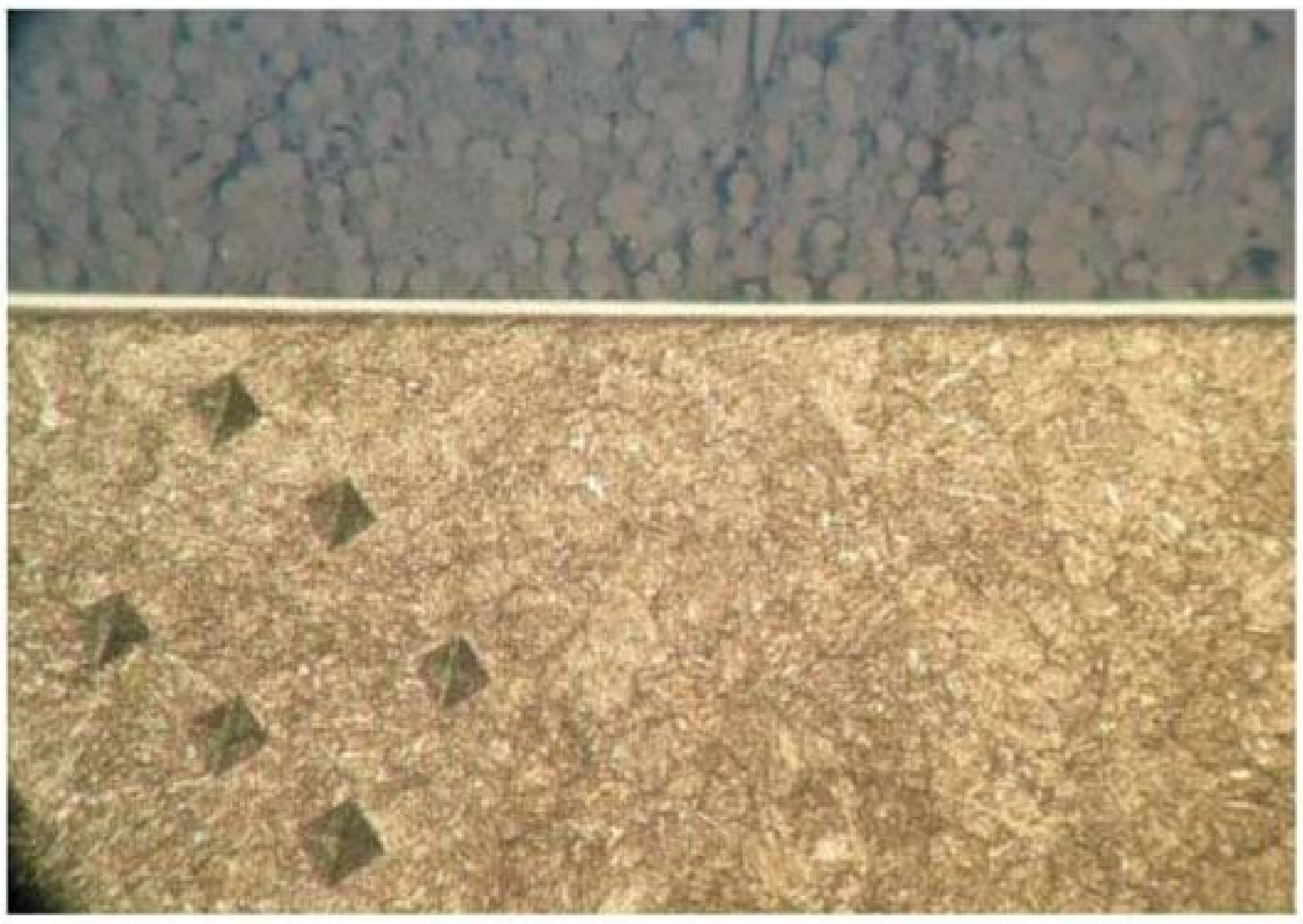

Figure 6: a good example of a quality nitrided case micro-structure on 4140 steel, exhibiting a compound white layer of 0.0002in (0.005mm)

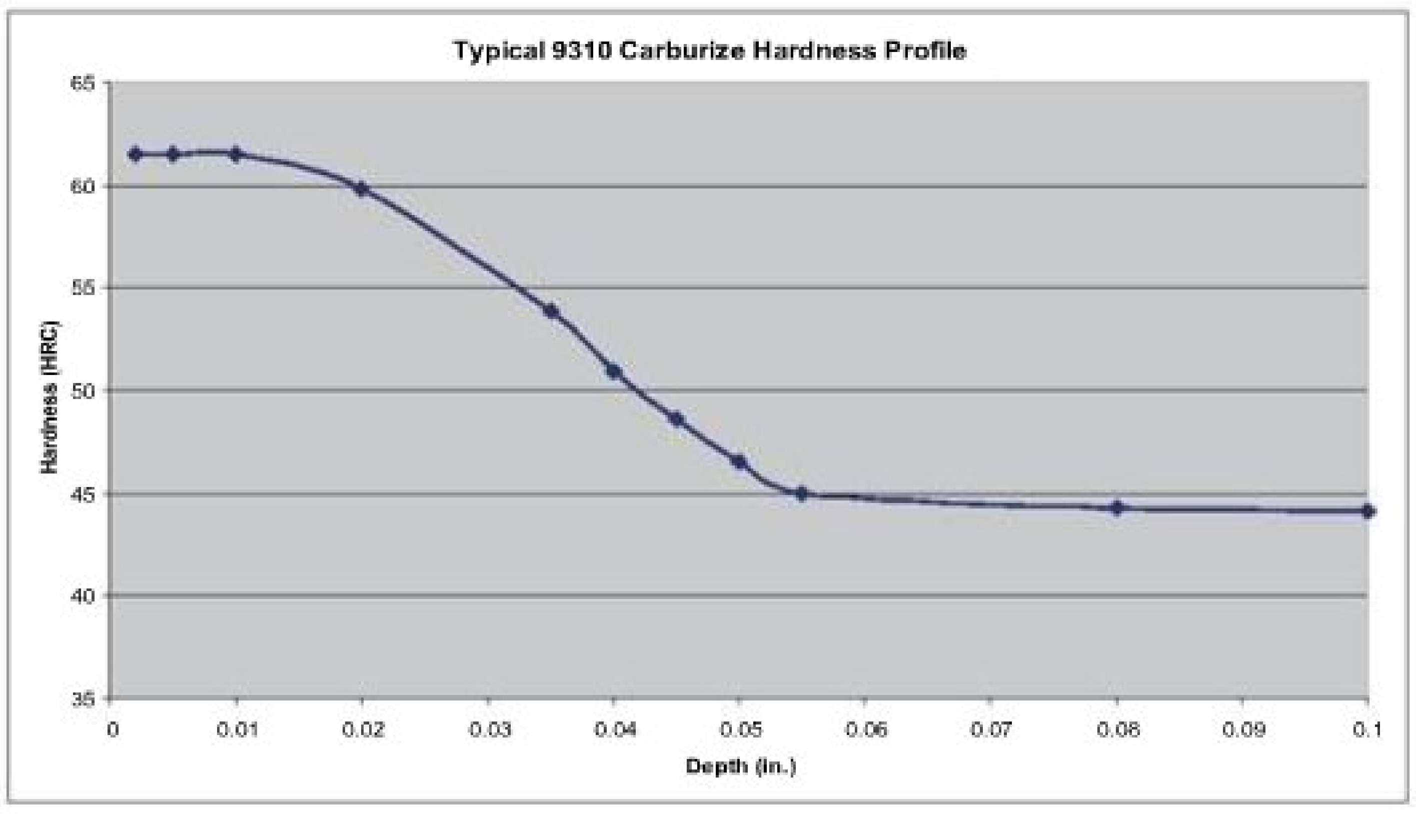

Figure 7: a surface hardness of 56 HRC was obtained with the steel shown in Figure 6 that had an original a core hardness of 32 HRC

ADVANTAGES OF VACUUM CARBURISING AND VACUUM NITRIDING

1 Vacuum carburising

A. Better quality and repeatability of the process
B. Results in extremely clean parts, free from soot and oil
C. Absence of oxygen and so elimination of IGO
D. Will produce extremely uniform case depths
E. Ability to control the presence or absence of carbides
F. Less distortion due to uniform case depth and gas quenching
G. Reduces post heat treating machining and finishing
H. Fully penetrates recesses
I. Reduces cycle time for faster work turnaround

2 Vacuum nitriding

A. Cleaner parts as a result of vacuum processing
B. Precise and accurate programming of nitriding potential for repeatable results
C. Faster work turnaround due to shorter cycles
D. Ability to control the white layer thickness depending on the specific application

Current thinking

How teams and racecar battery manufacturers are competing to find the next technology

BY SAM COLLINS

The Varley Red Top battery is one of those products that defines its marketplace. For years it has been the default setting for pretty much all levels of motorsport, as the company's range of lead acid batteries are known to be both strong and reliable. As a result, for years there was little to say about batteries in motor racing, other than that they were an inconvenience, due to their weight. There was only really lead acid technology around, which was cheap, but heavy. Lighter variations came along over the years, but these were really refinements. In recent years, however, there has been something of a revolution in battery technology – at least for those who can afford it.

Today's well-funded competitors save weight by using lithium batteries and a range of companies supplying them has sprung up. One of the first was Dutch company, Super B. Its lithium iron phosphate SB10P weighs just 1.75kg, compared to the 5.4kg of the Varley Red Top 15, which has almost identical applications. However, the price differential is notable, with the Super B battery costing around £400 ($650) compared to the more affordable £123 ($200) of the Varley.

According to battery manufacturer, Lithium Pros, there are two reasons this new type of battery is more expensive. 'First, the cost of the cells is high, usually about three or four times higher than lead acid for the same capacity. Second, every lithium ion battery has, or should have, a battery management system. This checks for high voltage, low voltage, over current, short circuit or over temperature and, if any of these conditions exist, the BMS literally disconnects the battery from its load and turns off the output terminals. This mini-computer inside a battery adds cost, especially if it is sized to handle your starter! For this reason, larger lithium ion battery packs are usually less expensive per watt-hour than smaller ones.'

One other reason the cells are expensive is that the cells themselves may contain some hard-to-obtain metals, such as cobalt, the largest deposits of which occur in the war torn Democratic Republic of Congo.

Over the last 20 years, rising oil prices and environmental concerns have seen car manufacturers start to develop hybrids and electric vehicles (EVs). The first of these, like the Toyota Prius and Honda Insight, both used nickel metal hydride batteries.

More recent models have switched to lithium cells and the motorsport industry has taken note. When KERS was re-introduced to Formula 1 in 2009, lithium-ion cells eventually became the preferred option, though initially teams did not know what route to take.

Lithium-ion battery technology was best suited for our KERS system for a number of reasons, including safety, response time and flexibility in packaging options,' explains Andy Cowell, engineering and programme director at Mercedes-Benz HPE 'In racing, it is crucial that the driver gets instant response in terms of torque on the rear axle. You also want to design new systems to respect the vehicle's aerodynamics, while keeping weight down to ensure there is no lap time penalty. A battery-powered KERS system satisfies both criteria, while also allowing for flexibility in terms

The Varley Red Top lead acid battery leads the motorsport market

Weight saving is the key advantage of lithium batteries, though other weight-saving methods such as braille's composite casings are also employed

of how you can deploy it on a car – something you cannot do with a flywheel, which has a fixed, modular shape.'

Specifically, Mercedes-Benz HPE commissioned A123 to develop a cell with a power density of about 9300 watts-per-kilogram (W/kg), while maintaining an energy density of 44 watt-hours-per-kilogram (Wh/kg). The increased power capability would enable Mercedes-Benz HPE to deploy fewer battery cells in its KERS design to maximise performance while minimising weight.

However, A123's cells could only produce about 4300W/kg, so to meet the KERS specifications and amplify rate capabilities, A123 modified several aspects of its existing cell design. This included increasing thermal, electrical and ionic conductivity within the electrode stack and terminal hardware. The resulting cell met the power density and energy density requirements for the Mercedes-Benz HPE KERS. But just six months before the first race of the 2009 F1 season, Mercedes-Benz HPE made changes to the design of its KERS that would require A123 to engineer a completely new battery cell.

'The motor in our F1 engine ran at a higher voltage than the KERS battery pack, so in our initial design we implemented a DC-to-DC converter to boost the voltage of the battery pack. However, we determined that this was unnecessarily complex and we should be able to run the motor directly from the voltage produced by the battery pack,' explained Cowell. 'Our new concept required a battery with lower capacity, and we would simply deploy more of them in series. We needed a complete re-design to meet the new capacity and system voltage parameters, all the while making sure the increased number of cells did not significantly add to the weight of the car.'

The initial cells that A123 provided to Mercedes-Benz HPE met the original KERS criteria, but they were optimised for a lower voltage. Working closely with Mercedes-Benz HPE to understand the new KERS system, A123 designed, developed and manufactured a completely new battery, delivering it to Mercedes-Benz HPE well ahead of the first race of the F1 season. For its new design, A123 decreased the mass of its existing cell by about 48 per cent, while increasing the rate capability by some 14 per cent. This enabled the KERS system to operate at the desired voltage, while providing Mercedes-Benz HPE with increased power density capabilities. The new cells were capable of producing more than 20,000W/kg for pulses lasting for multiple seconds and more than 40,000W/kg for millisecond pulse applications.

The life of battery cells is a critical factor for both starting and traction. Lithium-ion cells on paper last longer than lead acid, braille claiming its batteries offer up to 3500 cycle life compared to 1000-1200 cycle life for conventional batteries though, as always, the reality is rather more complex. Former Renault F1 technical director, Bob Bell, spoke to Racecar Engineering about this in 2009, as KERS was introduced into the series 'One of the key considerations with battery life is the charge / discharge rate (c-rate). The faster a cell charges or discharges, the shorter its life and the greater the cooling demand. We have to intelligently monitor the cycles throughout the battery life and make sure that all the 60-something cells in the pack are at the same state of charge. It's dangerous if you have one abnormally low or high, so the electronics to control and monitor all of that is an important part of it.'

The way a battery is used, of course, has a substantial impact on its life. In 2009, F1 teams did not expect batteries to last more than a single meeting, and questions have often been raised of how green battery-powered electric vehicles and hybrids really are. Recycling them can be a major challenge, as Bell explained. 'Companies like SAFT, who have being doing cells for military and other customers for years, have their own disposal processes, but it could be said that Formula 1 is adding to the stock of waste batteries around the world.' Much of their eligibility for recycling depends on the actual chemistry of the battery – some lithium iron phosphate cells, for example, are highly recyclable.

An added problem was rather more unexpected. As the F1 teams found out in 2009, there are tight limitations on shipping lithium batteries around the world. 'Air freight, for example, is not as straightforward as it may appear. Batteries that are in commercial use have

LEAD ACID TECHNOLOGY

The Varley Red Top is the best known lead acid technology battery in motorsport. Unlike the large and heavy lead acid batteries found in production cars, the Red Top range are constructed using an Absorbent Glass Mat (AGM), which separates the positive and negative plates. There are two main benefits to this:

1. The electrolyte (sulphuric acid) is adsorbed onto the fibres of this mat. There is little free liquid within Varley Red Top batteries as only enough acid is used to achieve the required performance levels. The AGM retains the electrolyte ensuring that, if the battery is punctured, there is minimal risk of electrolyte leakage.

2. The AGM also allows gas flow to occur between the positive and negative plates over a substantial area. This is important for a high level of gas re-combination to occur (re-combination is where chemicals within the battery are converted back into their original state during overcharge).

Re-combination allows the battery to retain gases internally and be maintenance free for life. In order for re-combination to occur, oxygen must flow from the positive plate to the negative plate. Re-combination in AGM batteries is generally more efficient than in gel-type batteries, which have a liquid barrier between the plates.

A123 Systems supplied the cells in the 2009 McLaren KERS

Many lithium batteries are physically smaller than comparable lead acid products

to be certified by IATA for air transportation. If you are just shipping them as prototypes you are okay, but you can obviously only do that for a certain period of time. Once it becomes clear that what you are shipping around the world is a commercial product, IATA may get a bit funny about it,' explains Bell.

Todd Kollin, president of Electric Motorsport, has extensive experience of this problem with his firm's wide range of EV motorsport projects, which include everything from outboard motors to bikes for the Manx TT. 'The sender has to have a dangerous goods certification to ship them just about anywhere. If they do not have the certification, they are breaking the law and are subject to some hefty fines. Many small firms ignore these shipping requirements until FAA officials show up at their door and threaten to shut them down or slap them with hundreds of thousands of dollars in fines.'

DIFFERENT DIRECTION

Batteries are not the only way to store electrical energy on a competition car, of course. BMW-Sauber showed a different direction with its rather disastrous F1.09 grand prix car. The Kinetic Energy Recovery System onboard used capacitors instead of conventional batteries, and three years on others have followed the team's lead, notably Toyota with its TS030 Le Mans hybrid, which is also equipped with capacitors.

Renaultsport has also gone in a similar direction with its Dallara-built, 3.5-litre engine spec racer (see *RE* V22N5). Although not built as a hybrid, it replaced the conventional battery with a capacitor pack, which has proven both lighter and more compact – two factors that cannot be ignored on any racecar. Whilst the French firm would not be drawn on the cost of the set up in a car of this type, it would have to be comparable to the top level lithium batteries.

Capacitors were in fact invented in 1745, 15 years before the modern battery, in the form of the Leyden Jar – basically a liquid-filled glass jar with a layer of foil wrapped around the outside. The basic principle of operation is charge storage. Positively charged particles collect on one surface and negatively charged particles on a second nearby, but electrically separate, surface. The two surfaces are called electrodes. Capacitors store electrical charges in static form for later use.

Three main factors determine how much electrical energy a capacitor can store – the electrode surface area, the electrode separation distance and the properties of the insulating layer separating the electrodes. Over the years this has been continually refined to the point where we now have what are know as ultra capacitors, which barely resemble Leyden's Jar.

Ultra capacitors do not hold as much energy as lithium ion batteries, but have higher power. By using a hybrid of the two, some of the benefits of capacitors can be used with lithium ion batteries. This potentially offers very fast recharging times, though perhaps something of a battery management headache. Ioxus, an American firm, has developed a cell that does it all in one, and others are investigating different

SAFETY IN ISOLATION

Batteries are not the only components in this area that have seen development. The traditional master switch, which isolates the battery on a car, has recently been replaced as well. English firm, Cartek, has developed a new battery isolator, designed specifically to replace the traditional mechanical master switch and to overcome the inherent unreliability issues experienced when devices incorporating mechanical electrical contacts are used in the harsh motorsport environment. Being electronic, the fully-sealed Cartek isolator contains no moving parts and, as such, is totally resistant to shock and vibration.

Along with the reliability benefit, there are additional safety benefits with the Cartek system. With any FIA-approved master switch, there is a requirement for it to be possible to be activated by the driver sat inside the car, as well as safety personnel on the outside. This has traditionally been implemented by the use of mechanical pull-cables. Over time, these cables have been proven to be unreliable, with seizures and failures. In contrast, Cartek's electronic battery isolators are operated by push-button switches, which are connected using thin, lightweight wiring and configured such that, in the event of a serious accident, should any of the wiring become fractured the battery isolator will default to a safe 'off' state.

A further safety benefit the system offers is the opportunity to fit two external kill buttons – one on either side of the car. This way, no matter how a car ends up after an accident, there is a greater chance a marshal will be able to quickly kill the engine and isolate the battery by striking one of these buttons. These safety benefits saw Ford mandate the Cartek isolator on its new-for-2012 Formula Ford.

Super B lithium batteries have proven popular in karting


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routes. One of the alternative approaches is being conducted by Red Bull Racing on the RB8, which has mounted two small capacitor packs on the rear floor of the car. Journalist, Craig Scarborough, explains: 'Red Bull has taken a step forwards in KERS packaging. Now the energy storage appears to be slightly revised, with the unit inside the gearbox swapped for floor-mounted units. In this exclusive picture from MichaelD in Melbourne [see pic right], we can see the units remain fitted to the floor when it's removed. The two carbon fibre cases are closed with aluminium tops and are provided with electrical and cooling connections. They sit in the final section of flat floor known as the boat tail. Having the units placed on the floor, as opposed to between the gearbox and engine, means they can lower the c of g. Also, being quite heavy, they are placed near the rear axle line to suit the mandatory weight distribution.

'As mentioned, the units are supplied with a common cooling circuit, one pipe of which routes around the back of the floor to link the devices. There are also a number of electrical connections for both connecting to the KERS power control unit and for monitoring their status. Quickly detachable connectors are used to allow rapid removal of the floor, keeping the units in place.'

The Red Bull RB8 houses capcitors on the car floor, just visible here

Despite this step forward, lithium-ion battery technology has not reached its limits. Indeed, SAFT, the leading supplier of cells to Formula 1 teams for use in KERS, has already employed lithium-sulphur dioxide cells in some defence applications. These batteries have a metallic lithium (the lightest of all the metals) anode, and a liquid cathode comprising a porous carbon current collector filled with a sulphur dioxide (SO2) solution. They have a high energy density (250Wh/kg) and a good capability for delivering repeated bursts of high power (up to 400W/kg). This capability derives from the spiral construction and is utilised in most of the applications addressed by this type of cell. Some in the defence and battery industry feel that lithium-sulphur cells are likely to replace lithium-ion as the state-of-the-art technology in the next few years. But Kollin is rather more sceptical: 'There is always a lot of chatter about this or that battery chemistry's potential energy, but the proof is in the pudding, and only time will tell what catches on. At the moment it seems lithium polymer pouch cells are becoming the latest craze in EV racing. This is a spill over from the hobby market. People are grouping the hobby-style polymer packs together for higher voltages and capacity. The only issue with this movement towards hobby polymers is that they are highly flammable and require more care in regards to their charge and discharge management.

'This may be a short-term fad, at least until larger polymer pouch cell packs become more readily available. In general, the industry consensus is that battery technology does not need to improve as much as their affordability does. The record for the longest electric vehicle range on a single charge is currently over 1000 miles, but you don't even want to ask what that vehicles battery pack cost.'

Double trouble

At last, a technical solution in Formula 1 that has not been banned, despite the best efforts of other teams

BY SAM COLLINS

From early in the 2011 season, rumours started to emerge about a clever new design solution being used by Mercedes. Nobody really understood how it worked, or even if it really existed, but the rumours grew in volume and soon pictures started to emerge of some unusual features on the Mercedes W03. It was clear something was going on. The car features what has been dubbed a 'Double Drag Reduction System', or DDRS for short. When the driver activates his conventional DRS wing, the movement of the flap exposes ducts built into each of the rear wing end plates. Two pipes running right through the car to slots on the underside of the front wing link to these ducts. It is thought that the device stalls the front wing, reducing its drag whilst the rear wing-mounted DRS is deployed.

FORMAL PROTEST

At the Chinese Grand Prix, after a few cross words in the media, Lotus decided to formally protest the system, with technical director, James Allison, arguing the case against it. He proposed five questions that he believed needed to be answered:

1. Does Article 3.15, which outlaws driver movements to adjust the car's aerodynamic characteristics (beyond pressing the DRS button) apply to the device being employed by Mercedes?

2. Does the system comprise any parts that are not 'necessary for the adjustment of DRS', as described in Article 3.18?

3. Can what Mercedes is running be described accurately as a 'car system', a 'device' or a 'procedure'?

4. Does the Mercedes device depend upon 'driver movement'?

5. Does the Mercedes device 'alter the aerodynamic characteristics of the car'?

Allison then asserted that if the answers to all these questions is yes, it must be concluded the Mercedes system is prohibited.

Ross Brawn spoke in defence of the system, and provided the FIA with a dossier of relevant information. Unfortunately, this was kept confidential, so neither Lotus or the press were able to see its contents, but Brawn's arguments *were* released. In answer to Allison's questions, he pointed out that, the 'device', or 'design' contains no moving parts and that there are no upper limitations provided in the regulations on what can be achieved using DRS. He also provided examples of teams making modifications to other parts of cars to take advantage of the different airflow resulting when DRS is activated.

"People talk about the huge cost, but there isn't really a huge cost"

He went on to add that the system being protested against was simply an enhancement to the existing DRS, but made after DRS was originally introduced. And it would be wrong to discriminate against any enhancement simply because it has been introduced later on.

Finally, he pointed out that there is nothing in the regulations preventing a hole in the inner side of the rear end plate and a duct running to the front of the car to take account of a change in the aero characteristics when DRS is operated, and that the system is simply an evolution to improve

"The sole purpose of the DRS is to improve overtaking. The Mercedes design is completely consistent with this objective"

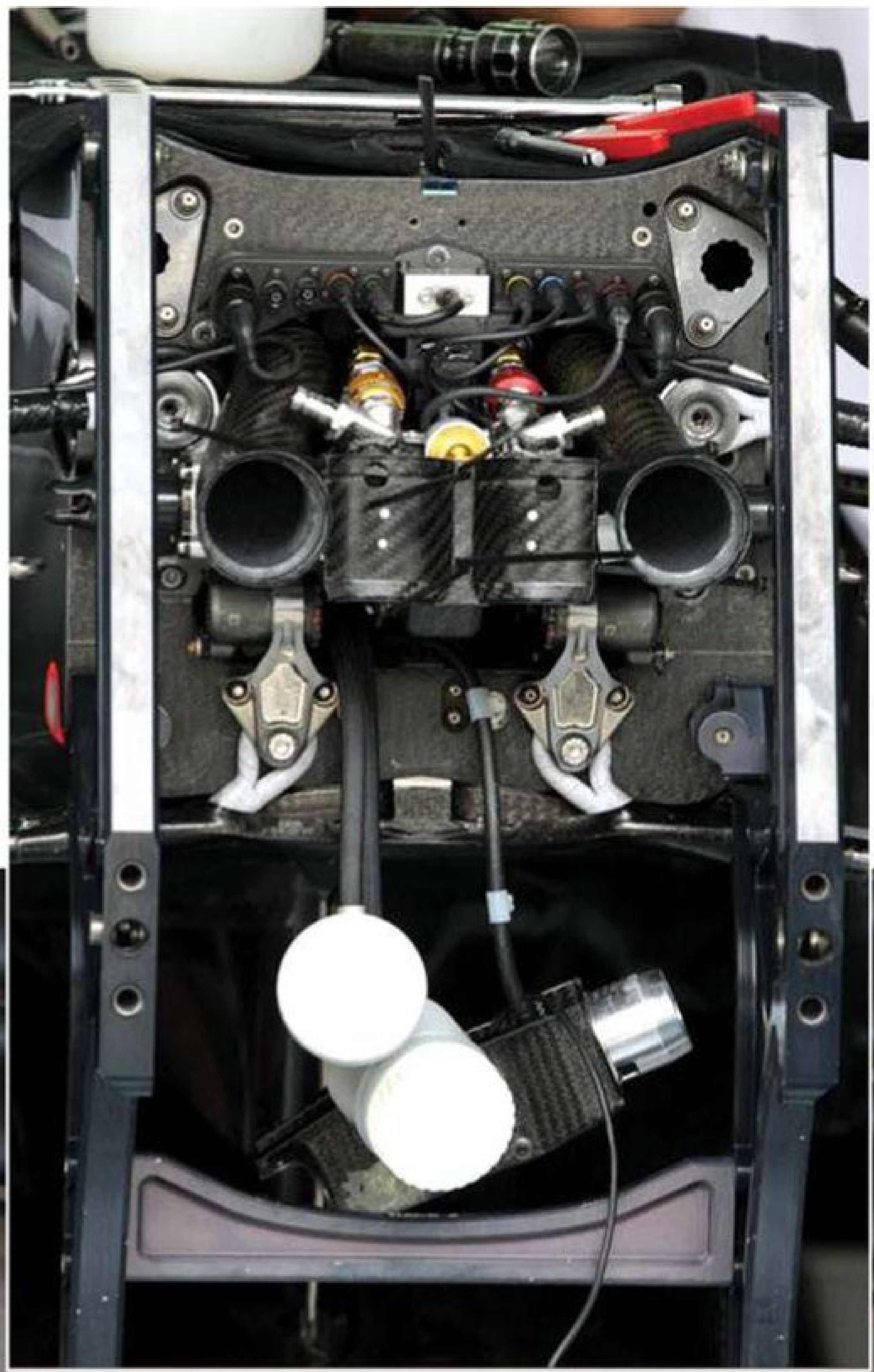
PHOTOGRAPHY BY WRI2

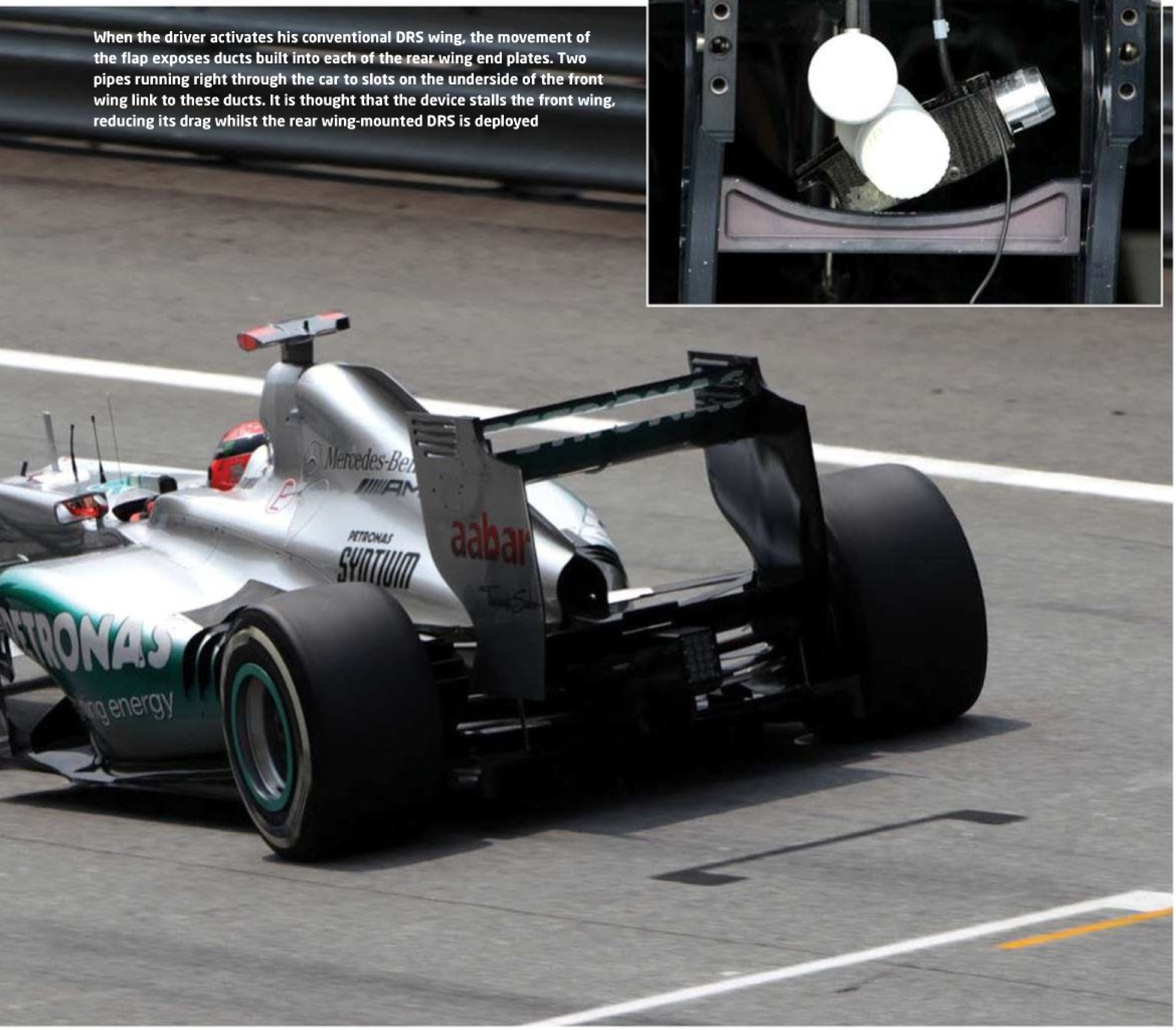
the performance of the DRS.

The FIA stewards agreed with Brawn and dismissed the Lotus protest, pointing out that the sole purpose of the DRS is to improve overtaking. The Mercedes' design is completely consistent with this objective as it gives the cars as much as a 20km/h straight-line speed increase, instead of the 10-12km/h they would get with conventional DRS.

There has been added criticism of the system on cost grounds, but Brawn argued this case too, in press conferences this time rather than in the the FIA stewards' room: 'It is a very simple, cheap system, but not so easy to implement if you haven't integrated it into your car... People talk about the huge cost, but there isn't really a huge cost. You all know there are a couple of carbon pipes running down the car, and the man on the street will tell you they cost a few thousands pounds. They are not millions of pounds. The benefit we have gained is because we have thought about it and designed it into our car, and that is not so easy for people who have not got it. That is why some of the opposition is so fierce. It is the recognition that it is quite a difficult thing to do if you haven't designed it.'

With the system now deemed legal, it will be interesting to watch the other teams race to develop their own versions.





When the driver activates his conventional DRS wing, the movement of the flap exposes ducts built into each of the rear wing end plates. Two pipes running right through the car to slots on the underside of the front wing link to these ducts. It is thought that the device stalls the front wing, reducing its drag whilst the rear wing-mounted DRS is deployed

Go with the flow

Is it time engineers started looking at ways of re-designing the basics of airflow to and through radiators?

Regarding the picture of the McLaren flow lines shown in *RE* V22N4, it seems to me that any conclusion from the study of the photo must take into account that dye flows are an indication of boundary layer flows. As boundary layer air nears the surface, the pressure gets to zero and so boundary layer air is pushed around easily. The air behind the mirror mount blade shows a diversion of the air. Also it looks as though the McLaren engineers anticipated the flow. Ideally, of course, the blade would twist as it reaches free stream air, so it would be in line with that free stream at the mirror.

Looking at the flow ahead of the sidepod duct, if one projects the dimension of the vertical intake forward it can be seen that the air volume provided for the intake is the same but, as can be seen, the air gradually spreads until about two thirds of it is pushed aside. Air pressure in the throat of the intake has built up enough 'push back', as shown by the disturbance in front of the intake. Also it shows that air is being forced out of the intake.

"Why don't F1 intakes separate out boundary layer air?"

I remember at a GTP race in Palm Beach, with an ambient temperature of arount 100degF and high humidity, Jim Busby's crew threw broken up pieces of ice into the intercooler duct in an attempt to cool the intercooler air. During qualifying, one could see vortices coming out of the front outer corners of the intake. In the throat of an intake duct airflows morph into vortices.

With the new range of turbo engines coming to Formula 1 and LMP1, I think cooling designs will have to change. The fins of radiators are fixed at 90 degrees to the face of the radiators, but with all the slanted radiators the flow in the throats follow the face of the radiators and have to turn 90 degrees to flow past the fins. It's mainly the built-up pressure that forces the turn in the flows but, if the air is first turned and the radiators are doubled or even tripled in thickness, the flows would initially be in line with the radiators. And why don't F1 intakes separate out boundary layer air?

It's taken quite a while for F1 designers to clean up the path of the heated air from the radiators, too. When I designed the ducting for the March BMW M1-C turbo four, I ducted the exit air all the way to the rear and at Sonoma, the intercooler temperature gauge did not budge from 21degC. In fact, McLaren North America's engine builder had us remove the sending unit bulb so he could apply the flame of a lighter to it, and the needle promptly moved up.

Finally, I've seen photos of F1 cars with wire screens mounted on the face of radiators, but even these have to be studied. For instance, a ¼in screen with 0.020in diameter wire has eight 0.020in wires per square inch. That works out to 0.160in^2 per square inch, which means a ¼in screen is actually only 0.840in^2 per square inch open.

Richard H 'Yag" Yagami
Connecticut, USA

Close scrutiny of the flow lines around the front of the sidepod intake indicates airflow into the throat of the intake is not quite as one might expect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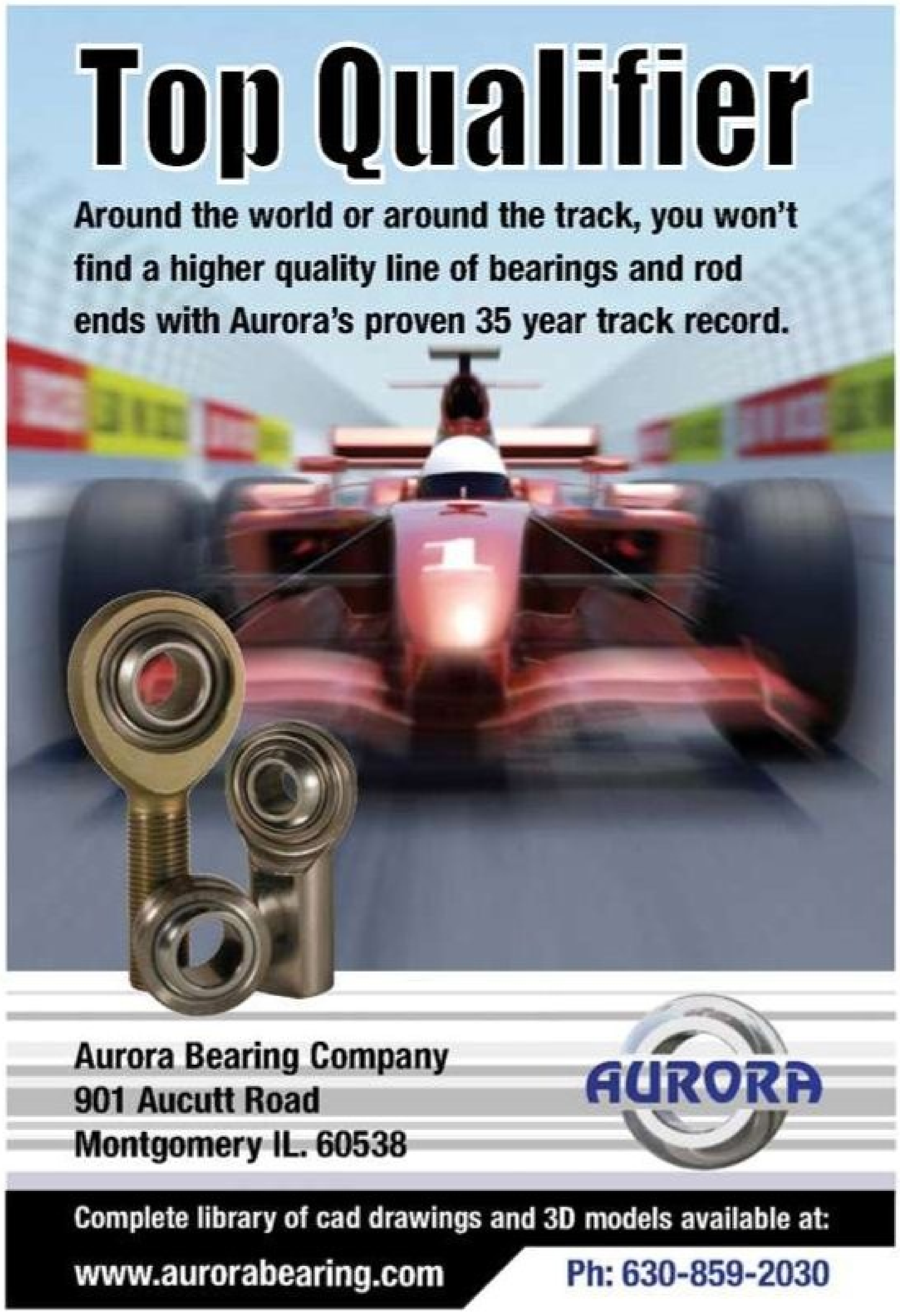
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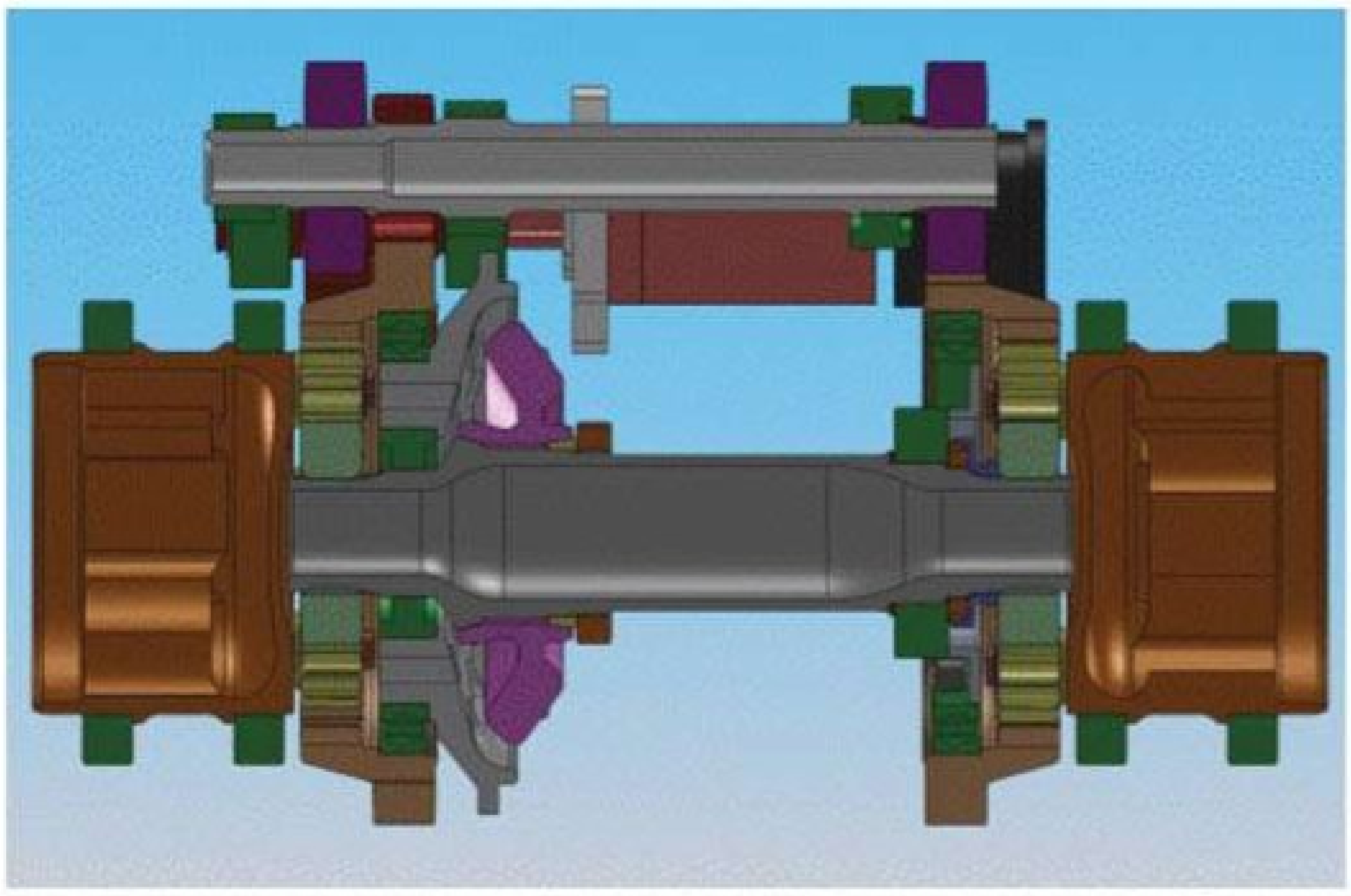
It's all torque

How the ETV differential can benefit the DeltaWing, and a great deal more besides

The ETV (Efficient Torque Vectoring) differential development and patents were inspired in 1998 by the results of a major rear tyre stagger change on a non-winged Dirt Sprint Car I was driving at Jimmy Sills' superb Sprint Car driving school in Marysville, California. The difference in grip balance, even in a car that operates in double wheelspin at 40 or more degrees of sideslip angle, really got my attention, and I thought the equivalent of real-time adjustable tyre stagger would be a very powerful tool, not only to balance lateral grip in racecars and high performance street cars, but would allow different sideslip angle strategies, from reduced yaw angle in turns for aerodynamic reasons, to 'drifting'-like high angles, frankly for fun.

Of course, torque vectoring differentials were nothing new, and had been used to great effect in Formula 1. Friends in F1 described the methods in broad principle after they had been banned. In fact, ultimately there was no major racing series where they were allowed. But there were other applications of interest, from military vehicles and twin-coaxial helicopters to high performance road cars and even powered wheelchairs. None of these applications suffered from oppressive rules, so I looked at optimum solutions.

It soon became clear that isolation of the differential speed and torque from the rotating differential would allow simple single-element control, such as a geared electric or hydraulic motor, or perhaps a flywheel in a passive application to use rotational inertance to stabilise turn entry and minimise understeer on turn exit, while preventing significant single wheelspin. Non-torque-vectoring applications would be simplified, too. For example, a motor that controls tyre-generated differential speed by loading a clutch stack, free from the complications of doing so, inside the spinning differential.



Torque vectoring diffs are not currently allowed in any major racing series

Twin simple planetary gear sets, arranged so the ring gears are controlled to rotate only at the same rotational speeds, but in opposite direction, allow isolated control of the differential speed and torque when both sun gears are driven at the same speed, and the planet carriers drive the driven wheels. The inherent speed reduction provides the function typically done by a final drive, with drop gears tuning the final ratio if necessary.

A US patent with sufficiently broad claims was granted, and my long-time partner in such endeavours, Ken Hill, founder and CEO of Metalore Inc (which has long supplied highest quality driveline components to top racing series) and I planned non-racing applications. One I did a complete conceptual design for was powered wheelchairs.

At the Indy 500, I had seen wheelchair-bound fans struggling with insufficient directional stability in their joystick-operated chairs when operated at the higher speeds that some of these guys travelled – being, after all, race fans. Of course, the instability was largely a control strategy problem, and Segways had good control within their wide operating speed range, but it was clear that separation of the directional control function from the drive motors had advantages in efficiency and ultimate speed.

Military applications such as tanks, on and off-road tactical vehicles and unmanned ground and air vehicles were within our sights, but both Ken and I were in the business of motor racing. Then came the Deltawing opportunity.

"instability was largely a control strategy problem"

It is difficult for me to imagine the Deltawing growing from a novel concept to a highly efficient, groundbreaking race car in any racing team but Chip Ganassi's. Chip and long-time managing director, Mike Hull, have created a highly effective and robust engineering culture that requires very little day-to-day intervention in the technical processes. Chip is all efficient and pragmatic business, but the engineering culture is one where ideas are encouraged in an environment of teamwork, while maintaining very high standards.

Ben Bowlby was well aware of my efficient torque vectoring differential, as I had demonstrated a 1/10th-scale R/C car with a miniature version of the diff for him. The DeltaWing design might truly need efficient torque vectoring, since we did not know what the innovative tyre requirements would bring to grip balance. I ran simulations and created a new Simulink vehicle dynamic simulation for the car, and also made an rFactor mod of its physics. Chris Hoyle and his amazing team from rFactor Pro helped to get the dense CAD mesh of the car and components into rFactor. But while rFactor Pro is the leading F1 simulation platform with easy incorporation of Simulink, Dymola/Modellica and other bespoke modules, the game rFactor has no provision for torque-vectoring differentials.

Fortunately, with our assumptions for the tyre models, and with good CFD data for the car, the DeltaWing was reasonably well balanced and stable with passive differential tuning, so we could make exciting but realistic video simulations for the car's introduction and for YouTube, while my own simulations showed the potential of the car with torque vectoring.

In the years since the ETV differential was conceived, we have seen the growth of torque vectoring in passenger cars, in some cases with dual-control motors, and in others with clutch or service brake actuation, for active stability control, and now more and more for better feel and performance. We are excited about the use of our advanced design in a truly innovative and efficient racecar.

Jim Hamilton
Target Chip Ganassi Racing

Lotus position still uncertain

Group Lotus was still in a state of limbo as *Racecar Engineering* went to press, although there were signs of interest from two Chinese companies, both believed to be in talks with the company's Malaysian owner about buying the car manufacturer.

The future of Lotus, which has a heavy presence in motorsport through its naming links to Lotus F1, its IndyCar engine programme (alongside Judd), Sportscars and even rallying, has been in some doubt since DRB-Hicom took control of Lotus-owning Proton at the beginning of the year in a £625m deal.

The Malaysian vehicle manufacturing concern has been conducting a review of the Lotus business since it took control of Proton in January. Lotus made a pre-tax loss of £26.1m in the year to March 2011, and a £12m loss the previous year. On top of this, the company's stated ambition to go upmarket with a plethora of new models relies heavily on a promised £200m investment from Proton.

It is now thought that DRB-Hicom will offload Lotus, and it has been reported that two Chinese companies are interested. One of these is Geely, which owns Volvo, while the other is China Youngman, which has been the Lotus importer in China since 2006. It has also been reported that Genni Capital, the company that owns the Lotus Formula 1 team, is interested in buying the company.

Lotus would not comment on the negotiations, but has said that rumours that the company is going into administration are 'rubbish,' adding, 'the takeover of our parent company, Proton, by DRB-Hicom couldn't have come at a worse time, but up until that point Proton was (and still remains) fully committed to our five-year business plan to create jobs and to expand the factory and business. With the takeover process, the funding has been restricted and DRB-Hicom is taking time to understand what to do with the business.'

Meanwhile, the uncertainty has led to the UK government holding back on a planned £10.4m investment in the company until its future becomes clear. Lotus was promised the regional growth funding last October when Proton announced plans to create 1000 new jobs at Lotus' Norfolk, UK base.

Dragon Racing stuck with Lotus in IndyCar, but two teams have been released

Jordan returns to Silverstone with new technology park

Commercial property consultancy, Lambert Smith Hampton (LSH), hopes that a high profile Formula 1 connection will help fill an all-new Silverstone business park.

The Jordan Technology Park is named after former F1 team owner, Eddie Jordan, who has an interest in the company that owns it. It is located opposite the entrance to the Silverstone circuit, next to Jordan's old Formula 1 factory – now the base for Sahara Force India F1.

The 15-unit park is purpose-built, and high quality business units are finished to the highest standards, with mezzanine floors, and are built from steel portal frames with steel profile cladding. Internally, the units have a clear span footprint, while each unit has allocated car parking, yard space and loading areas. The unit sizes range from 4908sq.ft to 11,291sq.ft.

Eddie Jordan, now a BBC TV Formula 1 analyst, said: 'This is a fantastic opportunity for hi-tech and advanced engineering firms to locate themselves right in the heart of the UK's motorsport community. They will be rubbing shoulders with the top names in Formula 1 and helping to make sure that Great Britain and the Silverstone area keep their reputation as the world centre of excellence for F1 and motorsport development capability.'

The Jordan connection is actually helping to attract interest in the site, LSH's Joe Smith told *Racecar Engineering*, but he also added there was more to the technology park than just a famous name: 'The name is helping, but it's more to do with the units to be honest, they sell themselves really. They're designed for motorsport and high performance engineering.'

New technology park in the heart of the UK is sure to prove popular

Smith also said the development would attract high added value companies and skills to the region. 'This is the only development of its kind currently happening in the region. Its location couldn't be better, in the heart of the motorsport cluster, which is synonymous with innovation and engineering excellence. The units are for sale or let and we are expecting a high level of interest.'

CAUGHT

Wayne Grubb, the crew chief on the GC Motorsports International no 27 Ford in the NASCAR Nationwide Series, has been fined $2500 after the car was found to be using 'hollow bolts in truck trailing arms and Panhard bar'. The infractions were discovered on the opening day inspection for the Texas Motor Speedway round of the second tier NASCAR championship.
FINE: $2500 (£1550)

The Motorbase Ford Focus driven by Mat Jackson in the third race at the British Touring Car Championship's visit to Donington Park was disqualified from the results after post-race scrutineering. The race-winning car was found to have exceeded the turbocharger boost levels during the race.
PENALTY: exclusion from results

New engines will not immediately slash F3 budgets

The new, cost-conscious Formula 3 engine formula is not expected to cut budgets in the formula next year, although it should bring financial benefits in the longer term.

Formula 3's new engine formula, which will come into place in 2013, calls for a fixed cost lease of €50,000 (£41,000 / $66,000) for 10,000km of running, which compares to costs of €90,000-€115,000 (£73,800/ $119,000-£94,300/$152,000) for current Mercedes and Volkswagen units.

There are six new engines under development, with Volkswagen and Mercedes seemingly now out of the picture. VW has confirmed it will not build an engine, while Mercedes has missed the FIA deadline to declare an intention to build.

The six new engines are from Neil Brown, Mugen, Toda, Spiess, Tom's and Tomei, the latter with its Threebond-branded unit.

However, teams do not expect the arrival of the new engines to cut overall budgets immediately. T-Sport boss, Russell Eacott, who is currently using Threebond engines in British F3 and is in talks with Tomei and two other companies about next year, told *Racecar Engineering*: 'From our perspective, while the engine costs might come down, there's a new spec Bosch [ECU], and that will add to the costs. Then we will have to do a new installation kit, then you have to do an exhaust system, starter motor, airbox, and then there's obviously the bodywork to fit the new engine. So by the time we pay for everything the costs, in year one, will be about the same, even though the engine is cheaper.'

Rene Rosin, team manager at F3 Euro Series champion, Prema Powerteam, agreed that the costs are likely to remain the same for year one, but added, 'In the long term – 2014, '15, '16 – I think there will be a cost reduction.'

Costs should also go down because the big manufacturers will not be developing the cars – for instance, VW runners currently receive aerodynamic development input from the manufacturer – which has led to greater spending in the category. Rosin: 'It is good the manufacturers are no longer involved, because in the past some manufacturers developed the car, making all the teams spend more to catch up.'

Bristol to make changes after crash fest halted

After a week of studying race fan input following a poorly attended March race, changes are to be made to the track surface of Bristol Motor Speedway, and work is scheduled to be completed by August. 'The majority we heard from said they wanted to see changes,' said chairman and CEO of Speedway Motorsports, Bruton Smith. 'I have ordered the equipment and work will begin within the next two weeks.' The half-mile bullring was transformed from a wreck fest to race track in 2007 but now it appears race fans are missing the wrecks. Smith has asked Tennessee Governor, Bill Haslam, for State financial assistance with the re-surfacing, citing a 50,000 drop in attendance resulting in less tax revenues and tourism for the state.

PEELING BACK THE STICKERS No2: LUCOZADE

The energy drinks market in the UK is worth a staggering £1.5bn a year and, according to marketing expert Mintel, it's set to balloon to £2.3bn by 2016. It's interesting, then, that the two top brands fighting to dominate this market on the high street are also fighting it out on the race track this year – Red Bull with the team that bears its name, and Lucozade with McLaren.

But talk to anyone at Lucozade about its involvement in F1 having anything to do with taking the fight to Red Bull and you will get short shrift: 'No, that's not the reason,' says Stewart Crooks, global sponsorship director at GSK (GlaxoSmithKline, the pharmaceuticals giant that owns the brand). 'The reason we have a relationship with McLaren is because we believe, and we're proving it, that GSK and McLaren have a lot of synergies. They are two businesses that are both built around innovation, and we feel that by working closely with McLaren Group as a whole our business can certainly benefit, and so can theirs. A by-product of that is that there are some opportunities with the race team and McLaren were keen to draw on our expertise in sports science and sports nutrition.'

The best of British brands: Lucozade and McLaren – synergy in innovation

Lucozade's involvement with McLaren started at Singapore last September, but this year the brand is far more visible, although it's interesting that the Lucozade name is set against a McLaren colour – rocket red – and not a Lucozade colour. 'It's the colours that were on the car at the time but, to be honest, that's still being worked through. McLaren have a colour pallet, which they tend to stick to on the car,' says Crooks.

The rear wing is actually prime real estate when it comes to sponsor placement, and while Crooks refused to be drawn on how much Lucozade – which is the UK's second biggest soft drinks brand and eighth biggest grocery brand – is spending on what he says is a 'multi-year' deal, market rates for an F1 rear wing tend to be around the $25m mark.

One thing is for certain, GSK can afford it. Its turnover was £27.4bn in 2011, with £5.5bn net profit, while at the close of last year it had a market capitalisation of £73.8bn, the fifth largest of any London Stock Exchange-listed company.

GSK is happy with the way the relationship is working, says Crooks, and while he insists that the actual signage is a 'very small part of the overall jigsaw puzzle', he says the company has already found benefits from McLaren's expertise in analytics and manufacturing and he is very pleased with the visibility, which he hopes might help spread the brand name globally.

'Lucozade is available in different countries, albeit a very large portion of the business is within GB and Ireland,' Crooks said. 'There have been a couple of recent launches into new territories in Asia and there's other territories being looked at, but it's a British brand at heart at the moment. But Formula 1 certainly provides a platform to grow brand awareness in other territories.'

Argentina close to Formula 1 return

It'a been 14 years since Argentina held a grand prix, at Circuit Oscar Galvez

Argentina looks set to find a slot on the 2013 Formula 1 calendar, thanks to a possible axing of the Korean race and a probable race-sharing future for the Spanish Grand Prix.

The return of the grand prix, which has been widely reported in the Argentine and Italian press, gains further credence because the South American state's current government has proved itself committed to promoting motorsport in the country, recently investing $21m in a deal to keep the national Touring Car series on free-to-air television.

Argentina has not had a place in Formula 1 since 1998, when the grand prix was held at the Circuit Oscar Galvez, near Buenos Aires. The new event seems likely to be run on a new street circuit that's to be built at Mar del Plata, a popular seaside resort.

Argentina's government certainly appears to be behind the race and, according to widely quoted remarks by minister of tourism, Enrique Meyer, it seems to be a done deal: 'The national government accepts the challenge of organising the Grand Prix of Argentina to promote the image of our country in the world. In May, the three-year contract will be signed between all parties involved.'

The Argentine government has already invested heavily in motor racing this year, inking a 100-million-pesos ($21m) per year deal to acquire the television rights for the country's two top race series, Turismo Carretera, and its sister series, Turismo Nacional, in a move that is part of its 'Motor racing for All' programme, which aims to ensure racing is kept on free-to-air TV.

Rapid bureau

Laser Lines Ltd is now offering their customers a bureau service for rapid prototyped and rapid manufactured parts using their market-leading FDM (fused deposition modelling) technology.

The firm has 15 in-house systems building in engineering grade thermoplastics such as ABS, PC-ABS and polycarbonate. Parts can also be built in Ultem 9085, a high performance, flight-approved thermoplastic and PPSF, a high temperature, chemically resistant thermoplastic. All of these materials are available up to a size of 914 x 610 x 914mm.

The materials are best suited to manufacturing tools such as jig, fixture and work holding applications, offering a rapid turnaround of three to four days, compared to the weeks and months of a traditionally manufactured component. All Stratasys' materials are batch traceable (currently the only additive manufacturing technology that can offer this), which enables Laser Lines to provide customers with inspection reports and Certificate of Conformity for all rapid manufactured parts, if required.

IRC enjoys huge TV ratings hike

The Intercontinental Rally Challenge (IRC) continues to go from strength to strength with the news that 107m people tuned in to watch coverage of the second tier rally championship in 2011.

Independent German sports research consultancy, IFM Sports, published the figures, which show an increase of 35 per cent over the previous year for the championship, which is backed by Eurosport Events – the sports broadcaster's wholly-owned subsidiary.

In total, the IRC enjoyed 500 hours of programming in 2011, while press coverage totaling 3293 articles achieved an exposure value of €8m for the series, which celebrated its fifth anniversary last season.

'We are delighted with this figure because it's further proof of the IRC's appeal around the world, but also another demonstration of how beneficial the IRC is to car manufacturers and other commercial partners,' said Antonello Lodoletti, the IRC's commercial director. 'They are using the IRC as a platform for their marketing and promotional activities, so it's very satisfying to discover the value and worth of the television coverage.'

Three rounds of the IRC were shown live on television in 2011 when Eurosport pioneered the use of SimulCam technology in rallying. The system allows viewers to watch two cars tackling the same section of a stage at the same time for comparison purposes, and will be utilised in the coverage of eight rounds of this year's series. In addition, all coverage on Eurosport will be shown in high definition.

Featuring 13 rounds between the months of February and November, the 2012 IRC season includes several events in the increasingly important Eastern European marketplace. The series also includes a number of classic rallying events such as Tour de Corse in Corsica and Rallye Sanremo in Italy.

Audi snaps up Ducati

German premium car manufacturer, Audi, is to buy iconic Italian motorbike manufacturer, Ducati, for a reported sum of €860m, making it the third Italian company owned by the Ingolstadt concern, along with supercar manufacturer, Lamborghini, and automobile design and engineering company, Italdesign. In 2011 Ducati sold around 42,000 motorcycles and generated revenue of some €480m, while it employs around 1100 people.

Audi AG chairman, Rupert Stadler, said: 'Ducati is known worldwide as a premium brand among motorcycle manufacturers and has a long tradition of building sporty motorcycles. It has great expertise in high-performance engines and lightweight construction, and is one of the world's most profitable motorcycle manufacturers. That makes Ducati an excellent fit for Audi.'

New York GP 'when, not if'

Formula One CEO, Bernie Ecclestone, has indicated that the new Grand Prix across the Hudson River from New York, which is currently scheduled to take place next year on an improvised street circuit in New Jersey, might be delayed for 12 months, apparently because of calendar congestion.

Ecclestone told the BBC: 'It's a 'when', not an 'if'. Maybe the New York race will take place in 2013, maybe 2014.'

The grand prix calendar is currently at its 20-race maximum capacity, but Formula One is under pressure to accommodate a return of the French Grand Prix next year at Paul Ricard. Ecclestone wants to solve this problem by alternating the French and Belgian events, but the deal is still not yet done. 'We don't want any more races,' he continued. 'They [France and Belgium] are close neighbours, and they're both French-speaking, [The event promoter at] Spa has agreed, and apparently they're going to do it at Ricard, too.'

This was a rather strange way of putting it, because Ecclestone is the owner of the Paul Ricard venue through his company, Excelsis, and would be highly influential in decisions over the frequency of the event. In fact, there is a problem in France to do with his fee proposals.

Ahead of the French general election in early May, the French government was at the centre of the bid to revive the event, but has made it clear it will use as little public money as it can. The Prime Minister, François Fillon, explained: 'The Formula One proposal is reasonable enough, but we need them to remove the 'enough' part. There is a €2m gap. The French state will pay the fee, but we will not go further.' In the meantime, it seems the proposed race in New Jersey is on hold.

Dyson buys Caterham

The first customer Caterham SP/300.R, an all-new car that is aimed at the race and high end track day scene, has been sold into the American market. The new car, a Caterham and Lola-designed Sports Prototype, has been delivered to Dyson Racing, which is Caterham's US distributor for the car. The US version of the SP/300.R will be manufactured to specifications appropriate to that market, with final assembly taking place at Dyson Racing's facility in Poughkeepsie. Dyson has actually been heavily involved in the development of the car, having sent former Le Mans 24 Hour race winner, Guy Smith, and technical director, Peter Weston, to its test sessions.

First customer SP/300.R has been delivered to Dyson Racing in the US

BRIEFLY

Le Mans update

The race debut of the new Toyota LMP1 will not now take place until Le Mans after the first TS030 hybrid was crashed heavily at a Paul Ricard test, leaving Toyota without the time to build and test a new monocoque before its planned Spa debut. The debut of the Pescarolo-Judd 03 LMP1 car, which is based around the

monocoque and suspension from last year's Aston Martin AMR-One, will also now be at the Le Mans 24 Hours, rather than at the Spa 6 Hours. Meanwhile, the Dyson Racing team has withdrawn its pair of Lola-Mazda B12/60 LMP1 coupés from the 24 Hours, leaving the way open for reserve entries Status, with its Lola-Judd/BMW B12/80 LMP2, and the RLR-run Murphy Prototypes ORECA-Nissan 03.

Bosch backs Formula Student

Bosch is continuing to sponsor the Institute of Mechanical Engineers' Formula Student programme, while its specialist division, Bosch Engineering, is also supporting three UK university teams in the 2012 competition. Brunel Racing, Oxford Brookes Racing and Warwick Racing will each be provided with a development grant for Bosch Motorsport hardware, software and engineering services, including track and expert support. Head of Bosch Motorsport UK, Jean-Pierre Lihou, said: 'As a global automotive technology supplier, Bosch fully supports Formula Student and its aim to encourage young people to study engineering and pursue engineering careers.'

Chevy to build its own aero kit

Chevrolet has taken the bold decision to make its own alternative aero kit for IndyCar next year, rather than farm the work out to a specialist company. It is now in the process of putting together a team of experts to work on the project. Next year's series will allow for different bodywork packages and all three engine suppliers are planning on building kits, with Honda expected to work with Wirth Research for its bodywork, while Lotus is in the process looking for a partner. Other organisations are also planning on making their own alternative aero kits.

Williams finds new bus-iness

Williams is to supply its carbon composite flywheel KERS system to a London bus company on a trial basis later this year. The system, which never saw F1 action, will be fitted to six buses belonging to Go-Ahead, one of the UK's largest bus operators.If the experiment is successful, the company says it will consider fitting the system across its 4000-strong fleet of vehicles. It is hoped that the system will reduce bus fuel use by as much as 30 per cent. The flywheel will store energy generated by the constant braking of the 15-tonne machines, which Williams says equates to a similar force to that of an F1 car.

INTERVIEW – PATRICK MURPHY

Quantum Racing Suspension was set up by Ken Anderson, of USF1 fame, but is now owned and run by former F1 mechanic, Patrick Murphy, the managing director. It manufactures specialised motorsport dampers from its base in Pulborough, West Sussex

Q. How did you become involved in the damper business?
I started out in motorsport working with an engine builder in the late 1970s, then I did just about everything on the racing ladder as a mechanic, before ending up at the Onyx team in Formula 1 at the end of the '80s. Ken Anderson was doing the dampers at Onyx and I worked with him. Then, when I moved to Benetton as a number one mechanic, I carried on with the dampers there, too. They had a full time damper guy, but I did the flyway stuff. In the meantime, Ken had gone freelance, and I went to work for him in 1992.

Q. Was it at about this time that dampers were becoming more specialised in F1?
Yes, definitely. When I was at Onyx you could buy a Bilstein or a Koni, and that was it. But then Ken brought along his own damper, and this was the smart option because it was half the weight and worked better. He sold it to a lot of the teams. But they would buy a set of dampers, then say 'oh, that's great', and then they had the wherewithal and the resources to make their own versions, so they did!

Q. Does Quantum supply Formula 1 today?
We have no involvement now. The last team we supplied was Tyrrell in the mid-1990s, but after the first race someone had come along and offered them something like £25,000 to use their dampers, and Tyrrell then asked us what money we could offer them to supply our dampers. Their argument was that our KR damper was quicker over a lap, but it wasn't going to make enough difference to lift them up a place on the grid. They were thinking about the money, which is fair enough. You forget how uncompetitive Formula 1 could be away from the top end of the grid. Well, in those days anyway.

Q. What categories do you supply now?
Probably the sharp end for us these days is Japanese Super GT. It's all specialist, none of it is standard. It depends on how the car is built, but it's usually a three-way adjustable for them: low speed, bump and rebound, and high-speed bump. We also supply Formula Nippon in Japan.

Q. You have also built up quite a reputation in Formula 3?
I guess that Formula 3 is probably our biggest marketplace at that level. We made our name there, winning our third ever race in the formula in 1991 [with Paul Stewart Racing]. Dampers are still free in F3, and it's great really because they're all running heave dampers, so it's six dampers per car.

Q. What other formulae are you involved in?
We're still heavily involved in Formula Ford at a national and club level, and we are doing a lot more club racing than we used to. The historic scene is also very good. But over the years we've been involved in just about everything, including CART, DTM, F3000 and NASCAR.

Q. How important is it to work closely with the teams you supply?
That's what we try to offer, what the bigger companies can't really do – it's that personal service. Because we make everything in house, we're not like an off-the-shelf company where they buy the parts in and they've already decided what the damper is going to look like. We make a bespoke product.

Q. What sets Quantum apart?
Our biggest strength, but also our biggest weakness, is manufacturing in house, which we started doing in 1999. We have complete control over it, so we can alter and modify and improve all the time. But it's also our biggest weakness because it's so expensive to do it yourself, and the volumes are so small.

Q. What technology is in place at your West Sussex base?
It's quite a small operation, there are only five people working here. But we have the very best machinery available. At the moment we've got Mori Seiki CL-200 and CL-203 turning centres, a HAAS VF0 vertical milling centre, one Hardinge HLV centre lathe, Hardinge HCT and ESM capstan lathes, an Elliott Sturdimill vertical milling machine and one Sunnen precision honing machine. Everything is designed on CAD and we've our own in-house designed and built dynamometer for testing.

Q. What's the future for racecar dampers?
The future will be all about weight reduction and friction reduction. I'm not so sure adjustability is such a big deal, because the weight reduction is obviously more important, in formula cars anyway. These days companies like Dallara deliver a car that's so good it's very hard to improve on. So the only way we can improve on the standard car is to reduce the weight of the damper or reduce the friction.

There are some new materials we're looking at now, too. Sometimes they've been around for years, but have been secret because they've been used in military applications, so there might be some exciting developments there.

OBITUARY –

The creator of one of the most raced cars in history, the Porsche 911, has died at the age of 76. Ferdinand Alexander Porsche was the grandson of company founder and famed racecar designer and builder, Ferdinand Porsche, and the son of Ferry. Known simply as 'FA', he began his design career with the 911 while he was still under the age of 30.

Known as Butzi by his family and close friends, he graduated from the Ulm School of Design and joined Dr.Ing. h.c. F. Porsche KG in 1958, at the age of 22, to work in the engineering office under the supervision of Erwin Komenda.

Komenda was a hard task-master of the old school, more a metalworker than a designer, whose philosophy was to work on strong curves, typified by the 356's body shape, to achieve greater panel strength. Butzi, by contrast, looked to the future, and admired sleek sports cars such at the Mercedes SL sports car and BMW's 507.

Their brief from Ferry Porsche was to produce a successor to the 356, which had been in production, with minor evolutionary changes, for 10 years. Customers were asking for more interior space, especially for their growing children, more luggage space and, significantly, more power. In response, Komenda and Butzi set to work in quite different directions, the master developing a four-seater design with redolent body curves, Butzi a design that was actually narrower, yet wider inside. Had he not been a member of the family dynasty, his ideas might perhaps have not gone further than the four walls of the engineering office.

Butzi liked to work in plasticine, rather than at a drawing board, and his renderings of the 718 coupé (RS61), which raced in 1961, and later, the 356B 2000GTS of 1963, were admired, not least by his father. His next design in the public domain was

FERDINAND ALEXANDER PORSCHE

the design of Porsche's sleek eight-cylinder grand prix car, the 804, with which Dan Gurney won the French Grand Prix in 1962, months prior to the company's withdrawal from Formula 1 racing. In a nutshell, they needed the money to finance the cash-hungry successor to the 356!

Crucially, Ferry Porsche had to make a decision, to choose between the svelte sports car design executed by his son, or the bulky, four-seater executed by Komenda. It was Butzi's design that won the day, and Ferry commissioned the Reutter Carosserie company to build a prototype based on this design. 'I looked at what Komenda was doing and what Butzi was doing, and I knew that Butzi was going the right way,' said Ferry, who expressly disapproved of Komenda's four-seater design.

FA was also responsible for the 904 Carrera GTS – considered by many to be one of the finest looking cars of all time.

FA left Porsche in 1972 when it became a joint stock company, and he went on to found the Porsche Design Studio that same year, which developed watches, sunglasses and other Porsche-branded products. But he was never forgotten at the car manufacturer that bears his family name: 'As creator of the Porsche 911, he established a design culture that still moulds our sports cars today,' said Porsche AG's chief executive officer, Matthias Muller. 'His philosophy of good design is a legacy that we will honour in the future.'

Despite the stylish products associated with Porsche Design, FA's design philosophy was always to look to functionality first – perhaps unsurprising for someone who penned a race-winning F1 car. He once said, 'Design must be functional, and functionality must be translated into visual aesthetics, without gimmicks that have to be explained... Good design should be honest.' This was his utter conviction throughout his life.

Ferdinand Alexander Porsche 1935-2012

Ferdinand Alexander Porsche with his plasticine model of the celebrated Porsche 904GTS. Top: an early 904 being put through an early crash test...

RACE MOVES

Formula 1 aerodynamicist, **Ben Agathangelou**, has joined Ferrari. Agathangelou, who has worked for Red Bull, Jaguar, Benetton and McLaren in the past, left the sport in 2007, only to return to work with the HRT team in 2010, although he has most recently been employed at Marussia. Agathangelou's arrival is part of a concerted effort by Ferrari to bolster its aerodynamics department after a difficult start to the season.

Naoki Tokunaga has left the Lotus F1 team, where he filled the role of deputy technical director, and has now taken up the position of technical director for Renault's 2014 F1 V6 engine project. Tokunaga joined the Enstone-based team when it was known as Benetton in 2000, as vehicle dynamics engineer, and had been deputy technical director for the past two years. He will report to Renault Sport F1 deputy managing director (technical) **Rob White**.

Nick Fry

LAT

Toni Cuquerella is the new technical director at the HRT F1 team – a post that has not been occupied since **Geoff Willis** left the Spanish outfit in September of last year. Cuquerella has been with the team since 2010, working as head of engineering on track, a duty he will continue to perform alongside his new responsibilities.

The former chief engineer at Renault's Formula 1 customer engine operation, **Fabrice Lom**, is now working for the FIA as head of powertrain. Lom took up the position following the departure of **Gilles Simon** to Craig Pollock's PURE engine company. Lom will work alongside **Bernard Niclot** at the FIA.

NASCAR Nationwide outfit, JR Motorsports, has swapped the crew chiefs on its no 88 and no 5 cars, with **Bruce Cook** now on the no 88 Chevrolet and **Tony Eury jr**, who is also the organisation's competition director, taking over the role on the no 5 car.

Peter Sauber

LAT

Peter Sauber has told the German press that he aims to retire from the sport in the near future, and the 68-year old has also named the Sauber team's CEO, **Monisha Kaltenborn**, as his successor as team principal at the Swiss outfit. Kaltenborn has increasingly been the face of Sauber over that past year or so, particularly when it comes to media appearances, and now looks set to become F1's first female team boss.

Austin, Texas resident and keen motorsport fan, **John Paul Dejoria,** the co-founder of John Paul Mitchell Systems and a notable investor in tequila company, Patrón Spirits, has become involved in Austin's Circuit of the Americas, the venue for this year's US Grand Prix.

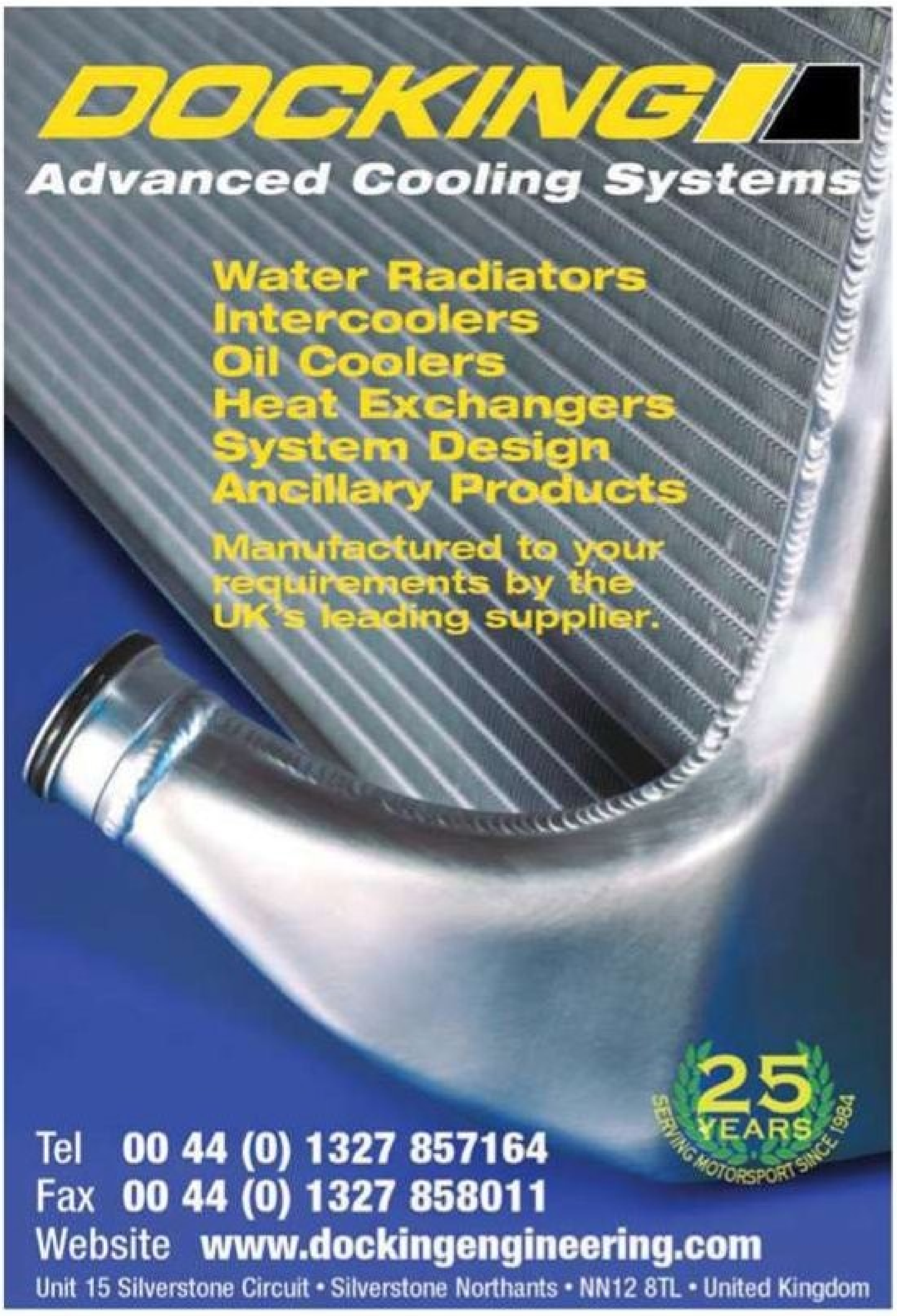
Nick Fry, CEO of the Mercedes F1 team, has joined the Executive Committee of the Motorsport Industry Association (MIA). Fry has over 30 years of experience in the automotive and motorsport industries and was recently appointed a UK Trade and Industry Business Ambassador.

Malcolm Swetnam has left the Dick Johnson Racing V8 Supercars team. Swetnam had been with the team since last season and oversaw its expansion to run four cars in the Australian series. He has now returned to the UK.

In the wake of Malcolm Swetnam's departure (see above) Dick Johnson Racing has decided to split the role of team manager. **Richard Swan** now provides direction for Steven Johnson's no 17 car and James Moffat's no 18 car, while **Cameron Clancy** is now team manager for Dean Fiore's no 12 and Steve Owen's no 49 entries.

Famed Stock Car engine builder, **Ray Fox**, and team owners, **Richard Childress** and **Rick Hendrick**, are among the 25 nominees for the 2013 NASCAR Hall of Fame class. **Leonard Wood,** part-owner and former crew chief for the Wood Brothers team is also on the list.

Australian V8 Supercars outfit, Brad Jones Racing, has switched its chief engineers. **Phil Keed** now looks after Fabian Coulthard's car while **Andrew Edwards** has taken on Keed's former role on the Jason Bright car. The move breaks a six-year working relationship between Bright and Keed.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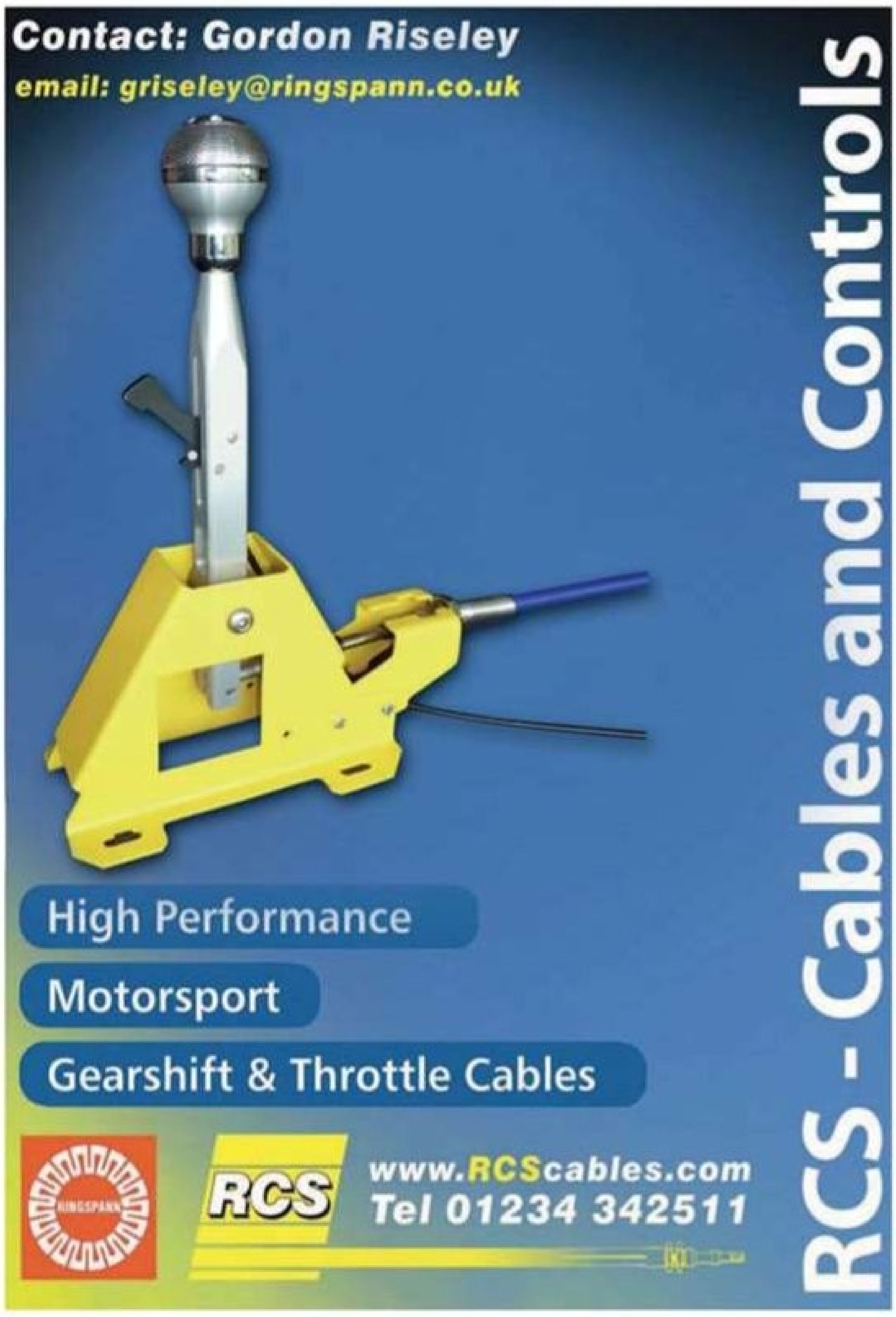
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OBITUARY - PETER AGG

Former Formula 1 boss, Peter Agg, has died at the age of 82. Agg had a hugely varied career in the automotive industry, but started off his working life in the family wine business, before becoming the UK importer for Italian scooter manufacturer Lambretta.

In 1959 he acquired the dormant, Croydon-based Trojan car company and negotiated a deal with Heinkel, the former bomber maker, then making light cars, to sell the German 'bubble cars' in Britain under the Trojan and Cabin Cruiser names. Five years later, he bought Elva, which led to an involvement with McLaren, building customer M1 Sportscars for Can-Am.

After a successful spell in F5000, with a Ron Tauranac-designed car, Formula 1 beckoned in 1974. The Trojan name was seen in eight grands prix, although it was far from successful, with the highest of three finishes being 10th, with Tim Schenken at the wheel.

Agg had more success on two wheels, though, running the Suzuki 500cc team throughout the 1970s and employing a certain Barry Sheene in the process.

Peter Agg 1929-2012

Amongst many claims to fame, Agg ran the Trojan F1 team in 1974

Call for industry award nominations

The Motorsport Industry Association (MIA) is calling on those involved in motorsport business to submit nominations for its annual award for Outstanding Contribution to the Motorsport Industry.

The leading nominees received so far for the prestigious award, which will be presented at the MIA's Members' Summer Reception at the House of Lords on Monday 2 July 2012, are Ron Dennis, Damon Hill and John Surtees. Previous winners include Adrian Newey, Ross Brawn, Frank Williams, David Richards and Bernie Ecclestone, among others.

Nominations should be sent before Friday 8 June to fiona.aylett@the-mia.com, along with a brief explanation as to why your nominee deserves the accolade.

MIA members can now also book their place at the Summer Reception. For further details, please visit www.the.mia.com. This event is open to MIA members and their guests, and for more information please contact Charlotte Austin on +44 (0)2476 692600 or email charlotte.austin@the-mia.com.

RACE MOVES

Trent Owens is to be crew chief on the no 50 Walmart-backed Turner Motorsports Chevrolet when it makes its Sprint Cup debut at Daytona in July. Owens currently oversees the outfit's no 30 Nationwide car and has been a crew chief with Turner Motorsports, formerly known as Braun Racing, for eight years.

Trent Owens

LAT

Rob Crawford, a former Holden Racing Team manager, has returned to V8 Supercars to manage two of the Kelly Racing entries in Australia's top Touring Car series. Crawford left Holden half way through last season after over 10 years with the organisation.

Susie Wolff, the wife of Williams shareholder and board member, Toto Wolff, has joined the Formula 1 team as a 'development driver'. Wolff, who is better known under her maiden name of Stoddart, has raced in the DTM for the past six years, amassing four points during that time with two seventh place finishes in 2010.

Hans-Joachim Stuck is the new president of the German Motorsport Association (DMSB). The 61-year old former F1 driver and son of 1930's racing star, Hans Stuck, has succeeded Torsten Johne in the position.

Ma Qinghua

LAT

Former F1 team boss and current BBC TV pundit, **Eddie Jordan**, has been awarded with an honorary OBE in recognition of his services to motor racing and to charity. Jordan's eponymous team first raced in F1 in 1991 and competed in 250 grands prix, winning three of them.

Jackie Christie, the man responsible for Kimi Raikkonen's left-rear wheel during Lotus F1 pit stops, returned to the cockpit as a driver after a six-year layoff recently, racing his 1994-spec Mondiale Formula Ford at Northern Irish circuit, Kirkistown.

Racecar Engineering would like to congratulate the son of Classic Stock Hatch racer **Martin Cayzer - James,** aged 13 - who built the engine in his dad's front-running Ford Fiesta XR2 for this year's campaign. Good work son.

JMW Motorsport team manager, **Tim Sugden**, acted as race engineer for the outfit in the opening round of the European Le Mans Series at **Paul Ricard,** a race in which its Ferrari 458 Italia, driven by **James Walker** and **Jonathan Cocker,** won the GTPro class.

The HRT Formula 1 team has added 24-year old Chinese **Ma Qinghua** to its Young Driver programme, with a view to running him in the special test sessions at the end of the season. Shanghai-born Qinghua first went to Europe in 2005 to compete in a round of the Italian Formula 3000 series with Team Astromega, and raced for A1 Team China in his national round of the 2005-06 A1 Grand Prix series. After driving for the West-Tec team in Spanish Formula 3 in 2008, and briefly the British series in 2009, he did a couple of Superleague Formula events in 2010, then won the 1.6-litre class of last year's Chinese Touring Car series with a Hyundai. Qinghua joins HRT's scheme alongside Spaniard **Dani Clos**.

Paul Philpott, currently chief operating officer at Kia Motors Europe in Frankfurt, is to become president and chief executive officer of Kia Motors UK and Ireland - the first time a non-Korean has been appointed to such a role at any Kia subsidiary in Europe. Meanwhile, **Lawrence Hamilton** is the new marketing director of Kia Motors UK. Hamilton joined Kia in 2004 as general communications manager. He replaces **Simon Hetherington**, who has moved to the newly created position of dealer development director within the company.

Masanori Nohara is the new executive director and coordinator of Toyota (GB) PLC. He has enjoyed a successful 25-year career with Toyota, holding a number of senior positions in Japan and Europe.

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

OBITUARY – BILL STONE

Bill Stone, who played a prominent part in the histories of March and Reynard, has died at the age of 72.

Stone first became involved in motorsport as a driver in his home country, New Zealand, taking part in sprints and hillclimbs before moving on to race in Formula Junior and then the Tasman Series.

A move to the UK followed and, after his driving career stalled through lack of funds, he was hired to build the first March racecar, the 693, while he also played a part in the design of the company's fist Formula Ford.

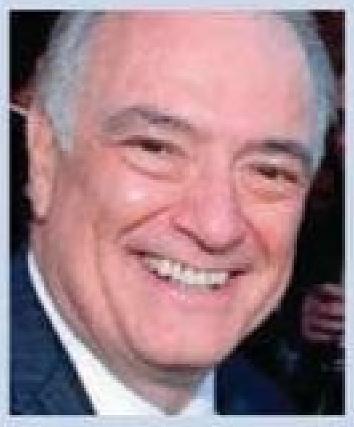
Stone became production manager at March, before a chance meeting with Adrian Reynard led to the setting up of Sabre Fabrications, which later became Reynard Racing Cars. Stone then moved back to New Zealand for a spell as a farmer, amongst other things, before returning to the UK to set up Bill Stone Engineering.

He also worked as team manager for Andy Rouse's Touring Car outfit until 1995, when he switched to the Chrysler North American Touring Car programme, before joining up with Adrian Reynard once again to help establish the BAR F1 team. Stone was actually the first employee at BAR, and was responsible for setting up much of the infrastructure that is now the backbone of the current Mercedes squad.

In 2001, Stone joined Minardi, where he finished his career in the mid-'00s, although he was not entirely finished with racing, and managed to win his last race, a Formula Ford event at Hampton Downs in New Zealand, as recently as February 2011.

Bill Stone 1939-2012

BUSINESS TALK – CHRIS AYLETT



Go Global

New motorsport markets are emerging all the time, and offer great business opportunities

I am regularly asked for advice about new motorsport markets, both geographic and other sectors such as automotive and defence. During these cautious times, companies have to balance risk and reward, and be willing to invest time and resource into developing new markets. Success will not be won 'cheaply'. Motorsport supply companies report brisk business right now, but capacity is short, and investment needed.

Recently, the chair of RBS said that lending terms and interest are 'not unreasonable', that his bank supports over 80 per cent of all applications, yet very few companies are seeking bank finance for new plant or resources, and without such investment, growth will be slow. New business must be found and experienced people require investment.

When motorsport potential is reported in Iraq, Iran, the Caribbean and now Nigeria, these become the 'sun spots' for global motorsport business. Local investment in a track, or a street circuit, to host a race imported from the USA or Europe captures media attention. Such local motorsport events may encourage some racing and track days for the well heeled in their high performance cars as a first step, but building such opportunities into meaningful business for genuine motorsport suppliers is a long, slow process.

Since Shanghai invested $450 million to build its F1 circuit in 2004, wider motorsport development has been slow, with very little business being secured. It will take three more years before solid, worthwhile business is created.

Successful international motorsport suppliers are, right now, investing time visiting China to increase knowledge, make contacts and gain insight. They will make at least two visits a year for the next three years, to meet and talk with potential customers and make very few sales. They will watch, listen and wait for business to develop, then decide where the best investment can be made.

I encourage exporters, new and old, to take a careful look at well-established markets, first to spot what niches are open to them, or have begun growing. My favourites remain Europe and the USA, but the former is going through tough economic times, while the latter goes from strength to strength as consumer spending grows.

"This is a 'new market' within an established marketplace"

One stable currency, one language and the world's largest single marketplace in motorsport exists in the USA. Take one example for new business – off road. Check out the LORR, Best in the Desert or Baja series and see how fast they are growing.

The latest development is Global RallyCross, a highly entertaining, made-in-the-USA variation of European Rallycross, with small, production-based cars racing on dirt and asphalt, featuring a 7ft gap jump on a 'joker' lap! Launched at the X Games in 2010, it features side-by-side racing in four-wheel drive, WRC-type cars. Now a seven-race series, with support from Ford, Subaru, Hyundai and Dodge, and star drivers from action sports, skateboarding and motocross bringing their young fans to motorsport. Their 2012 deal will see events run during NASCAR Sprint Cup weekends, at NASCAR tracks, with live TV coverage. The cars use European-developed rally car technology and some European drivers are already taking part. This is a 'new market' within an established marketplace that deserves attention. The MIA will be taking a group of businesses there in May to check it out – the first race of 2012 being at Charlotte Motor Speedway on the Saturday of the famous 600 NASCAR Race.

Global RallyCross reduces the amount of investment needed in time or resource as it delivers extra business to suppliers who have already invested in Rally engineering solutions.

Both automotive and defence sectors are showing increased interest in working in motorsport. In particular, fast-growing automotive companies have opened active dialogue with motorsport suppliers and are now, confidently, paying partners to provide R and D-based prototypes and innovations. Many in Europe are being helped to develop these relationships through the MIA's ' Motorsport to Automotive' initiative, where 'exhibitions of capability' are arranged inside the engineering studios of Ford, Nissan, JLR and others. The Technology Strategy Board has also helped provide funds through their various technology competitions.

This is the right time to chase new business, but take care to watch the investment needed in time and resource, so your capabilities are well targeted. Take advice from experienced friends, allow enough time, and enjoy the rewards that await. The MIA is always ready to help anyone in the industry find new business, just write to me on chris.aylett@the-mia.com or tweet us @Miamotorsport.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HARDWARE

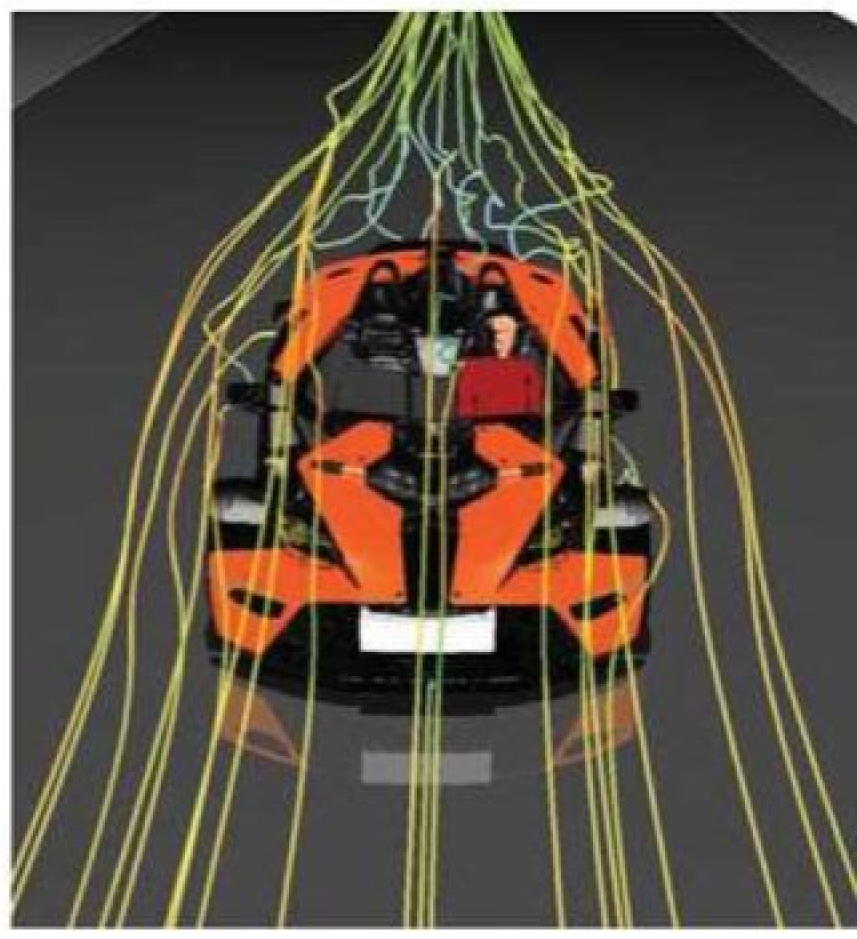
Quarter Master Optimum-V clutches

US transmission specialist, Quarter Master, has recently revamped its Optimum-V range of clutches. Whether it's competing in the NASCAR Sprint Cup Series, on the short tracks or road racing, Quarter Master can provide a version of the Optimum-V to suit. All of the clutches feature an open cover design that delivers maximum durability and, the company claims, the industry's lowest moment of inertia for a metallic clutch. Both two and three-disc versions are available in 4.5in, 5.5in and 7.25in diameters, all featuring a six leg slotted design for improved cooling, sintered bronze friction surfaces, a single piece aluminium cover and fully serviceable internals.

See www.quartermasterusa.com for more information

SOFTWARE

MSC XFlow 2012



Desktop Engineering (DTE), an engineering software solutions provider and strategic business partner of MSC Software, has announced the UK launch of MSC's XFlow 2012, a state-of-the-art Computational Fluid Dynamics (CFD) solution. The latest release of XFlow has been written to run on all Linux platforms, as well as Windows, and also now features distributed memory processing across HPC clusters to offer near linear scalability of analysis.

XFlow is a powerful CFD system from Next Limit Technologies, which uses a proprietary, particle-based, meshless approach that can easily handle traditionally complex problems. XFlow provides the ability to simulate the flow of gases and liquids, heat and mass transfer, moving bodies, multi-phase physics, acoustics and fluid structure interaction. This approach to CFD enables complex modelling and analysis in a straightforward way, minimising the presence of algorithmic parameters and avoiding the traditionally time consuming meshing process.

For engineers who require quick and accurate feedback on flow, thermal and acoustic behaviour, XFlow provides a number of benefits. Key amongst these are a high level of efficiency, reducing the compromises found between computing time and simulation accuracy. In addition, the programme allows complex problems to be solved using standard desktop computing power, rather than HPCs.

See www.dte.co.uk for more information

HARDWARE

Viper Performance tanks

UK-based Viper Performance is constantly increasing its range of motorsport-specific products. This month sees the debut of two new fuel system components, the 'PRO' range of alloy fuel tanks and a fuel surge tank.

The PRO fuel tanks are constructed from 3mm thick aluminium, robotically welded to ensure accuracy and weld integrity. Two standard sizes are available – five and 10 gallon – both fitted with a sump system to prevent slosh compromising consistent pick-up by the fuel pump. Tanks are supplied complete with a fuel sender unit already mounted, mounting brackets, internal foam baffling and an anodised, aircraft-style pull and twist filler cap.

The new Viper Performance surge tanks have a 1.5-litre capacity and can be specified with a selection of barbed or AN fittings to suit most fuel systems. The tank size is 115mm diameter and 200mm tall, with an integral base plate so it is ready to mount.

See www.viperperformance.co.uk for more information

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To browse our archive and order your back issues today, go to:

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HARDWARE

Jenvey TB45 throttle bodies

Jenvey has recently announced a new range of lightweight 'DCOE-style' throttle bodies that tip the scales at less than 500g each. As with all Jenvey throttle bodies, the significant components, including throttle body housings, spindles, butterflies and levers are manufactured in house.

The company hopes the new design will be popular in all forms of motorsport, offering a product that is 35 per cent lighter yet just as strong as the company's standard throttle bodies.

Jenvey has also announced the release of a new single rail fuel rail system, tailored for some of the most popular racing engine throttle body conversions, including the Ford Duratec and Zetec units. This simplifies installation, reduces potential failure points and provides a clean compact installation.

See www.jenvey.co.uk for more information

MEASUREMENT

Bowers configurable dial gauge

Bowers Metrology recently released what is claimed to be the world's first configurable dial gauge. The Dial Work is a configurable version of the Sylvac 213 series digital gauge and has the ability for functions to be precisely defined by the user. A comprehensive range of variables can be changed including min / max / delta measurements and tolerance allowance. When required for a new gauging task, the instrument can be rapidly reconfigured for completely different measuring routines. For multiple use situations, the Sylvac data and process control software, SylConnect, allows connection by USB of up to 16 instruments.

The gauges are able to transmit readings via RS 232, USB, Digimatic or by a wireless transmitter. Bowers says its Sylvac indicators are robustly made and can be fitted with a wide range of contact points.

See www.bowersmetrology.com for more information

HARDWARE

DEI Protect-A-Boots

Excessive heat generated from an engine block, exhaust system or turbo can easily affect a vehicle's ignition system. Spark plug leads and boots can harden, burn or crack, leading to arcing, engine misfires or even complete ignition system failure.

To combat this, heat protection specialist, DEi, has been producing thermal protection boots for spark plugs for many years, but has recently released a new generation of spark plug boots, said to provide more protection than previous types. DEI's Titanium Protect-A-Boots can withstand direct heat up to 1800degF (982degC), and radiant heat to 2800degF (1537degC).

The 'Titanium' in the title actually refers to the material's strength, rather than the base material. The boots are manufactured from pulverised igneous rock that is extruded into fibres and set in an extremely tight weave. This unique material and construction is claimed to provide added resistance to heat, chemicals, abrasions and contaminants, while providing maximum durability and toughness.

See www.designengineering.com for more information

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Contributors Charles Armstrong-Wilson, George Bolt jr, Andy Brown, Lawrence Butcher, Danny Nowlan, Mark Ortiz, Simon McBeath, Paul Weighell
Photography LAT, WRi2
Deputy managing director Steve Ross
Tel +44 (0) 20 7901 8011
Email steve.ross@chelseamagazines.com
Head of business development Tony Tobias
Tel +44 (0) 207 901 8026
Email tony.tobias@chelseamagazines.com
Advertisement Manager Lauren Mills
Tel +44 (0) 207 901 8026
Email lauren.mills@chelseamagazines.com
Publisher Luke Bilton
Managing director Paul Dobson
Editorial
Racecar Engineering, Chelsea Magazine Company, Liscartan House, 127-131 Sloane Street, London SW1X 9AS, UK
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Advertising
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A championship of style

Bizarrely, the comedy of Eddie Izzard is famed in the highest ranks of Audi's motorsport department. The Death Star Canteen sketch, in which Darth Vader goes to the canteen between battles to order a penne alla arrabiata is such a favourite that Audi's head of catering, Gerd Muthenthaller, is nick-named 'Mr Stevens'.

Certainly, 'Mr Stevens' runs an impressive set up – at Le Mans and in the DTM paddock, where Audi's two-storey building towers over that of Mercedes, in a tent hidden behind is an array of cars laid out for the public to ogle. So hidden, in fact, is the Mercedes tent that it is demarked by a single sign suggesting media hospitality, and two rather glamorous blondes on the front desk, who stand guard over those working feverishly inside.

My welcome from 'Mr Stevens' was to be given three different flavours of Red Bull, in blue, silver and red cans. I have no idea what they were, other than the silver apparently being of a lemon flavour, but such warmth saw me through the weekend.

The new kid on the block, of course, is BMW, whose hospitality unit towered over even that of Audi, and boasted a balcony from which team members and VIP guests could, presumably, watch the track action. At Hockenheim, the view was of the top of the trucks in the paddock, the back of a tent and a grandstand. No fewer than 63 personnel were recruited to look after BMW's guests, a number that I understand will be under scrutiny.

This was turf war, and helped to pass the time as the Audi crew wondered whether or not BMW could get their hospitality down in time to ship it to the second round at the Lausitzring. And then, what would it do about Brands Hatch?

This is all thoroughly facetious, and while it is mildly entertaining, it pretty much summed up the DTM paddock. This is a championship of style over content. How else, really, could one explain the release of a series of pictures of Audi drivers picking asparagus and waving it around in the air? Certainly, the drivers who escape DTM are delighted to be relieved of their shackles, though some are scarred for life. One of the current crop, for example, got into trouble for wearing the wrong shoes to a head and shoulders photoshoot.

It goes a little deeper than that, though. With the collaboration between the manufacturers to create spec parts across all three cars, the relevance to their production counterparts is pretty much zero. Some body parts come from the production car but, mechanically, these cars' engines are fit for only one purpose – DTM, and nothing else.

That is not to say that the teams have nothing to do. They have to find mechanical grip, they can play with the rear wing and ride height to make the car faster, they can still influence the pit stops (where the BMW teams think they will fall down this season, having had no practice at all) and the drivers can still race. They will be looking for those last few tenths of a second in pretty much the same car as everyone else, so the competition will be close.

What I cannot understand is the reasoning behind the change in the cars. I can fully understand why they wanted to make the cars safer – no one would argue that motorsport can and should develop new technology and these chassis are capable of withstanding high *g* loading, offering greater protection for the driver.

"what little extra cash there is in the kitty is just spent in different places"

But cheaper? The cars may be cheaper to produce, but generally the cost of the cars is only a small part of the budget. Look at the new Dallara Formula 3 car, which costs an estimated 2.5 per cent of the budget over four years, roughly the timescale being studied by the DTM for this generation, and the DTM runs on a considerably higher annual budget than Formula 3. I doubt that the DTM budgets are dramatically lower than in 2011, as what little extra cash there is in the kitty is just spent in different places.

Cheaper development costs may lead to even bigger hospitality units – three stories or more – a balcony with a view and better food than anyone could possibly imagine at a race track. One team owner of racing repute lamented that he completely failed to understand why such money was going on food and not on the car... This is racing, Jim, but not as we know it.

EDITOR
Andrew Cotton


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