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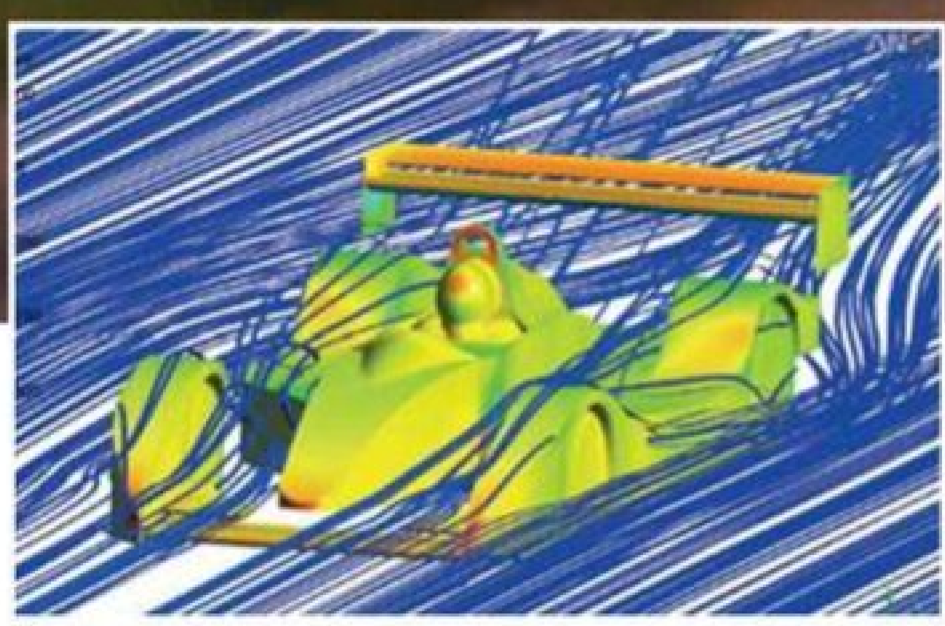

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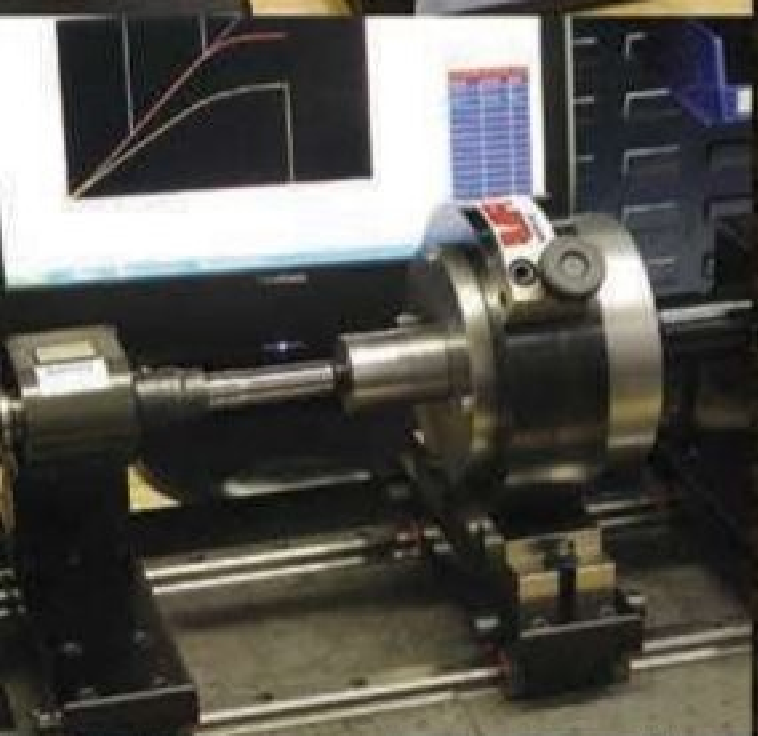

# On complexity

## Where our propensity for bells and whistles brings us to our knees

Several years ago, whilst on the Paris-Dakar, I had a basic Nokia 'brick' mobile 'phone. It had a stub antenna, with which it seemed to find networks in the middle of the desert, a good sound, a simple display and a huge, bulgy battery pack that stayed alive for a week without re-charging. It had no camera, no games and no mp3 player. Fast forward a decade and we have slim, all-talking, all-dancing, big display phones and a multitude of functions and apps. The one thing it doesn't do well though is enable you to 'phone well, from anywhere, and subjects you to being a slave of the plug to charge its ravenous batteries.

The fight to plug in your 'phone charger anywhere in the world, and particularly in a racing pit, reaches epic proportions, bordering on bloodshed, as there are now more chargers than plugs in this universe.

This propensity to add functions and new technology can also be seen in motor racing, and the breed being what it is, not necessarily developed enough, to the point that the innovators find themselves hoisted with their own petard. They do the heavy lifting by inventing and developing it in V1.0 and the competitors take it to new heights of efficacity by copying the basic idea, but in V2.0 form, with the bugs beaten out.

Yet complexity is but a view, depending on the knowledge of the user. Leibnitz, for example, had a different view on differential calculus to mine, probably considering it elementary, while some ideas are breathtaking for their simplicity and efficacity, and should be applauded with a loud Huzzah! Others should be taken behind the shed and shot, rather than being exposed to the cruel judgement of one's peers. No names will be mentioned to avoid shaming colleagues, but you know who you are.

Above all, it is important not to confuse complexity with complicated. Complex systems are possibly efficient, and sometimes necessary – CERN [the European organisation for nuclear research] being an example, as finding Higgs wouldn't be possible in a simple cloud chamber.

Complicated systems are ones where Occam's razor needs to be wielded as not good engineering, the KISS rule being operant here. 'Everything should be made as simple as possible, but not simpler,' sayeth Albert Einstein.

Complication is a symptom of bad design, such as when the car hasn't been thought out in a gestalt fashion, but just accreted by adding layers, like an onion.

I always admired Patrick Head's Williams, for they looked clean and simple, as did those cars penned by Gordon Murray, the outstanding designer of my generation. His cars were advanced, sometimes complex, but never complicated.

Anthony Colin Bruce Chapman's dictum that every part should do three functions is an example of complex, but not complicated. This did not impede him from being behind some really innovative cars.

Arthur C Clarke's 1951 short story, *Superiority*, is still relevant today, and was required reading for an industrial design course at MIT. It speaks about the accretion of new technology to the detriment of further developing existing knowledge, in a humorous but oh-so-truthful tale.

Parallels can be drawn on the evolution of fighter planes, where the USAF ended up building aircraft so complex that the maintenance ratio was around 40 hours of downtime for every hour of flight, needed highly trained technicians, a great quantity of specialised equipment and dedicated, highly trained pilots.

**"Complicated systems are ones where Occam's razor needs to be wielded"**

Expensive, difficult to service, planes pitted against basic design MiGs that could be operated from any airfield, maintained quickly by low-level technicians and built in great numbers as unit cost was low. A lesson in design to circumstance if ever there was one.

Modern fighters have improved since then, driven by the reduction of cash needed to produce and run them, plus the perception that superior performance has to be reined in by practicality.

As inevitably as a driver using the words 'for sure' in a post-race interview, engineers let to their own whims will gild the lily, adding un-needed bells and whistles and, in a Parkinsonian way, expand the design to consume all the money available in the team's budget.

This eventually gets corrected by other teams that use the dosh in the right places. Read my lips: ROI (return on investment). Ultimately, in competition the razor has to slice the budget based on a simple rule – cost / lap time gain, but factoring all the downstream costs.

Chapman's rule, 'a pound (sterling) per pound (weight)', succinctly prioritised funding, in as much as if it cost more than a £ to reduce a lb, money could be used better elsewhere.

The knock-on effect is one of 'monkey-see, monkey-do'. To quote Chapman again: 'If you win a race with a purple dong attached to the nose of the car, the next race will have opposing teams attaching red, yellow or green dongs to the nose of their cars. They might not be sure of what it does or how, but they will do it, just in case.'

One shouldn't assume a Luddite approach to innovation, but common sense, pragmatism and the use of good design precepts can produce winning cars without spiralling design and production costs, despite rules that skew functionality.

So, the next time you come up with a clever idea, apply the acid test – does it make the car faster? Is there a cheaper way of gaining this time? Does it reduce the maintenance time? If it does all of these, it *is* a clever idea, for engineering is about the best use of resources, at minimum cost and the shortest time to build and use. Anything else is gilding the lily. Mies van der Rohe again – 'less is more'. Simple.


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# Bare knuckle dusters

## Is DRS really the saviour of Formula 1?

I am going to make a prediction which, as this column is written weeks before you read it, may already have come true... An odd event during the British Grand Prix made me realise how close some teams' tactics have come to deliberate sandbagging. I won't name them, but I will estimate the next logical step to appear, if it has not already done so.

An F1 car is several seconds in front and a chasing car closes to a two-second gap. For the last laps of the race, the chaser maintains the gap but does not overtake. At the last DRS (Drag Reduction System) zone of the race, the chaser opens the wing and wins the race.

As Kevin Harvick says: 'I wish we could just go out there and wear 'em out one day, just not have to worry about waiting until the last lap. It does kind of seem like we wait until the last moments to really get going. It's probably somewhat of a bad habit.' It should be made clear for non-NASCAR followers that Harvick has made something of a career out of the last lap 'follow-'n'-take' pass.

Common in NASCAR, this tactic may soon be in Formula 1 as DRS is not just an attack mechanism but also a lock mechanism, if used when the attacked cannot then re-apply the same medicine.

DRS has enhanced the TV action, but the cost is that given reasonably equal competitors, only the last user of DRS gains, and to be that last user one has to wait behind rather than strive to race ahead. A fundamental shift in F1 culture then as, for the first time, we have mature rules that specifically favour one car, while disfavouring another.

NASCAR plots car set ups and races to ensure they are as unfair as possible to consistently faster teams, because the worst possible TV outcome is 500 miles of racing ending with a winner several laps ahead. And so the series is now designed to deliver endless miles of country ramble, followed by a photo finish.

In NASCAR's case, last lap overtaking is due to natural aerodynamics allowing a following car to use less energy than a leading car. At the last turn, the additional energy of the chaser enables it to slingshot past the leader to win.

In F1 terms, we still have an aerodynamic culprit, but this is the inverse issue of a chaser being unable to get close to a leader and overtake because the chaser loses downforce and cannot then keep up through the preceding turns, as Mercedes clarify: 'The [downforce] loss begins to occur when the gap between the cars is 3.5secs. When one second behind, the chasing car loses approximately seven per cent of total downforce. When 0.5secs behind, this rises to around 12 per cent.'

The FIA's answer was DRS, and it has had an effect, but to ascribe the recent overtaking to DRS alone is a claim for which the evidence is not clear cut.

According to research by Mercedes AMG Petronas F1, there were 623 overtaking events (excluding those on the rear three teams, inter-team mate passes, race starts or damage related) before the mid-point of the 2011 season, or about 69 per race. That compares with 547 such events for the entire 2010 season without DRS, or just 27 per race. The praise for DRS then is wholly justified. Or is it?

About 29 per cent of the 2011 passes were apparently attributable to DRS, but it is thought by some that Pirelli tyres with fast degrading characteristics may be equally significant in both DRS and non-DRS assisted overtaking. A degraded tyre on the leader favours a better equipped follower, making overtaking more about tyre choice than overtaking *per se*.

**A degraded tyre on the leader favours a better equipped follower**

**DRS is not just an attack mechanism but also a lock mechanism**

A detailed analysis by Mercedes before the 2012 Barcelona F1 race shows that for the three years before 2011, there were only 2.3 overtaking moves per race in Spain, and that increased dramatically to 51 in 2011 – the first DRS season – of which 22 were non-DRS and 27 were DRS assisted. One might conclude then that degrading tyres alone were about 50 per cent responsible for the overtaking increase.

However, although one can fairly accurately gauge the outcome from the change in tyre characteristics by looking at non-DRS assisted overtaking, the same is not true for DRS-assisted moves because the DRS system is always used in conjunction with the tyres, and it is not easy to accurately discriminate between the two effects.

Rather intriguing is that of the DRS-assisted events, some 48 per cent happened when the tyre life difference between the two cars was greater than five laps, compared with only 45 per cent of the non-DRS assisted events for the same tyre age gap. One might therefore be forgiven for thinking that just three per cent of the overtaking was specifically attributable to DRS alone.

In 2012, the situation is now swaying further in favour of the degraded tyre. For the first four races, the Mercedes analysis reports that the overtaking ratio of non-DRS assisted to DRS assisted was 55:45, instead of the 50:50 ratio from the same races in 2011, showing that 'tyre condition only'-related overtaking has now increased in relation to 'DRS + tyre condition'-assisted overtaking. In China, for example, 45 per cent were non-DRS assisted overtaking moves in 2011, but this rose to 59 per cent in 2012. The non-DRS to DRS ratio has also been convincingly evenly distributed as non-DRS-assisted moves exceeded DRS-assisted moves in the first four races of 2012.

Even if DRS is shown to be solely responsible for the overtaking bonanza, I still feel it is rather on a par with stuffing a knuckle duster in the glove of the losing boxer during a title fight – not something a gentleman would countenance, but then I don't have an 'action-packed' TV entertainment to sell.

# Second bite

**With a factory absence in the GT ranks dating back to the 2001 season, Dodge made the decision to time its return to ACO-based competition with the launch of its all-new 2013 SRT Viper**

BY MARSHALL PRUETT

What Dodge found upon the launch of its two-car American Le Mans Series Viper GTS-R programme at Mid-Ohio in August was that its Riley Technologies-built cars had plenty of potential, but picking up where it left off – with the 1999 and 2000 ALMS GTS championships in hand – would require a lot more time and development. 'We've got a pretty straight history with the Viper in ALMS, and it just happened to work out and made sense to bring the car back to ALMS,' said Dodge Motorsport's road racing manager, Gary Johnson.

'We'll always consider different series when we're looking to start a programme, and we're pretty familiar with the [SCCA] World Challenge series. We had a [Viper] Competition Coupe run that series now for about seven years. But, all in all, we think the ALMS really encourages you to bring your most advanced car, and we wanted to be out there with a lot of technology for the new car launch.'

With the base 2013 Viper model providing a suitable platform for Bill and Bob Riley to start with, optimising the new GTS-Rs for the rigours of ALMS GT racing was still a massive undertaking. Compared to the other race-bred factory entries, Riley and his counterparts at SRT would be required to design and manufacture every component deemed necessary for the cars.

'We started talking about the project last season,' said Bill Riley. 'Then we got the go ahead and began the major ramp up in January. A lot of the car fits the rules, but the homologation process with the ACO was obviously the starting point for everything we ultimately had to do.'

The SRT GTS-R would slot in quite easily in a class that contains everything from BMWs to Corvettes, but beneath the bodywork Johnson and Riley had 8.4 litres of problems to deal with.

With the GT category capped at a maximum capacity of 5.5 litres, the Viper's hulking V10 engine had no hope of being de-stroked by the necessary 3.9 litres – essentially the volume of Porsche's flat six engine – to meet the regulations.

Walking that tightrope was made easier after going through the ACO homologation process with the GT2-spec Corvette his company built in 2009. 'That helped us quite a bit,' he said. 'We knew what key points they were going to be looking for, and what to do and what not to do. I think we presented all our changes to the ACO in a very understandable way. And I think they'll be very pleased with the final results of that homologation effort.'

In between trips from France by the ACO, its compatriots in the ALMS played a central role in shepherding the process. 'I think the biggest hurdle was figuring out how the 8.4-litre engine was going to fit into the regulations when it clearly stipulates that the biggest engine allowed is 5.5 litres,' said Scot Elkins, the ALMS' chief operating officer, whose


purview also includes technical oversight for its sanctioning body, the International Motor Sports Association (IMSA).

Faced with practical limitations, a reduction from 8.4 to 8.0 litres was agreed upon, but with its 10 cylinders and a frightening excess of capacity still playing in its favour, harnessing the Viper's 640bhp and 600ft.lbs of torque to establish parity with the rest of the class would involve aggressive air inlet restriction.

'Primarily, it all boils down to the fact that everything running in GT has a sonic restrictor on it,' Elkins explained. 'So even starting with that and knowing the engine is that big, you size the restrictor to what we think the thing is going to weigh.

'And then, as much as most people hate to hear this, and as much as even I hate to say it, sometimes you give it a starting point on the performance in the car and let the adjustment of the performance take over. But you have to make sure it doesn't run away from everybody else, and it's still competitive.'

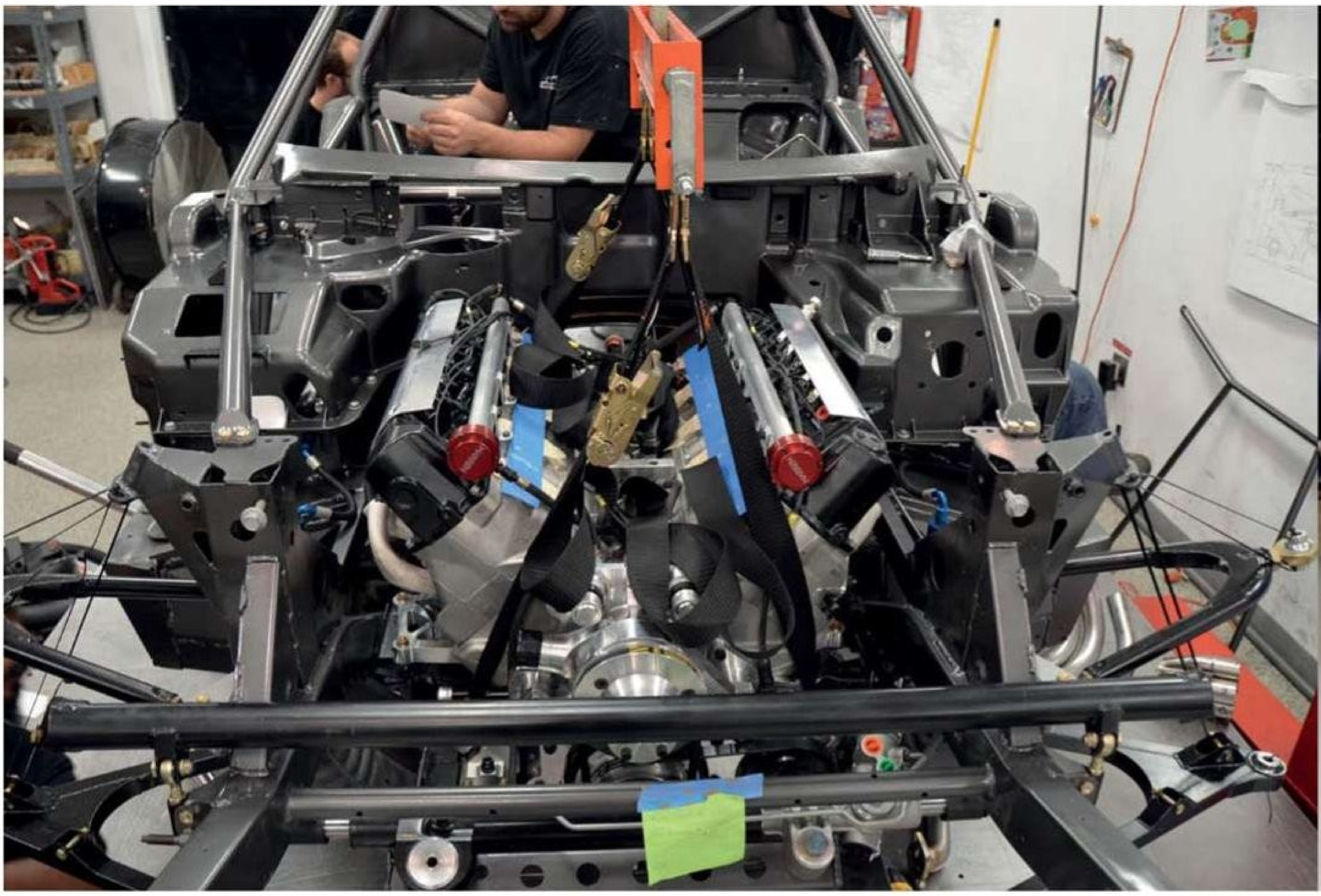
Although the total number of waivers for the Viper GTS-Rs and specific items contained in those waivers is kept private, obvious items like engine displacement and the permission to alter another major drivetrain component were approved. Elkins: 'It's almost a given – so much so, it's hardly a waiver any more – that the gearbox and bellhousing for the transaxle has to be changed, but almost every car that's a road car has to do that for weight distribution.

'Everything else was pretty standard stuff. It was the engine displacement that really needed to get worked through. And I think the thing that allowed that to happen was the car. It runs at a heavier weight than everything else.'

With the homologation discourse having taken place over the 'phone and through electronic communications up to this point, the build specs for chassis GTSR2C01 and GTSR2C02 would quickly become finalised when the ACO and Elkins paid a visit to Riley's facility in North Carolina.

Thanks to a simple but effective demonstration method used by Johnson and Riley, months of homologation conversations were distilled into a show-and-tell presentation for their guests.

'There are two major areas [of modification],' Johnson explained. 'Of course, both the engine and the chassis are production car-based and it's really amazing when you look at the chassis and how little it is actually modified to make it into a racecar. We had the ACO and IMSA over to the Riley shop to do the homologation. We took a raw frame, and painted all the parts that we changed a lighter green colour, so they could get a feel for it. They were amazed how little had changed – just some very minor things that helped attach the unique body, quite a few changes near the back because of the transaxle we installed, and, of course, the fuel tanks. That system was probably the biggest change.'



Sleeping the engine from 8.4 litres to 5.5 litres was never an option, so a compromise was reached and the car runs with an 8.0-litre displacement

Like its rivals at Corvette Racing, Riley was tasked with making what appeared to be little more than a four-wheeled engine into a racecar. With the Viper's V10 engine dominating the front half of the two-seater coupé and minimal rear cabin space or overhang, packaging behind the aft firewall was a challenge.

'The Viper is a 99in wheelbase car,' Riley noted. 'So getting the fuel tank fitted properly was a bit of a job because there's not a lot of room in there.'

**ENGINE AND TRANSMISSION**

The nose-heavy Viper begged to have its engine moved rearward in the engine bay – or to have the firewall sectioned and re-attached to permit the 90-degree V10 to protrude into the cabin, but with the rules prohibiting such invasive alterations to production-based GT cars, Riley focussed his list of detail improvements on the areas he could influence: 'The engine in the production car sits pretty far back compared to some others, so that's always a plus, but you always want to get that weight off the front axle,' he said.

'Weight distribution was key, and we moved what we could toward the back to counter what was already up front. We obviously tried to get the c of g down low, and to get the structural rigidity up. Overall, I'd say we were most successful at getting the c of g down.'

Although the 20-year old Viper design underwent a total makeover for 2013, the engine retained many of its fundamentals. Advancements in variable valve timing helped, and liberal use of aluminium in the block and heads also aids the GTS-R's performance, which is balanced by the two-valve-per-cylinder ethos employed by the V10's architects.

'The engine block is pretty much unchanged,' said Johnson. 'Of course, we had to reduce the capacity to 8.0 litres, and we did that with a new crank. The heads are pretty much stock – though we changed the valve seats to be E85 compatible – but the intake is unique, because of the restrictors we had to come up with.' The result of all this is a quoted 455bhp for the GTS-R, almost 200bhp less than the stock unit.

**"The engine block is pretty much unchanged... The heads are pretty much stock"**

As has become *de rigueur* for front-engined ACO GT cars, Riley made a beeline to Xtrac to solve its gearbox needs, at the same time shifting more weight towards the back of the car.

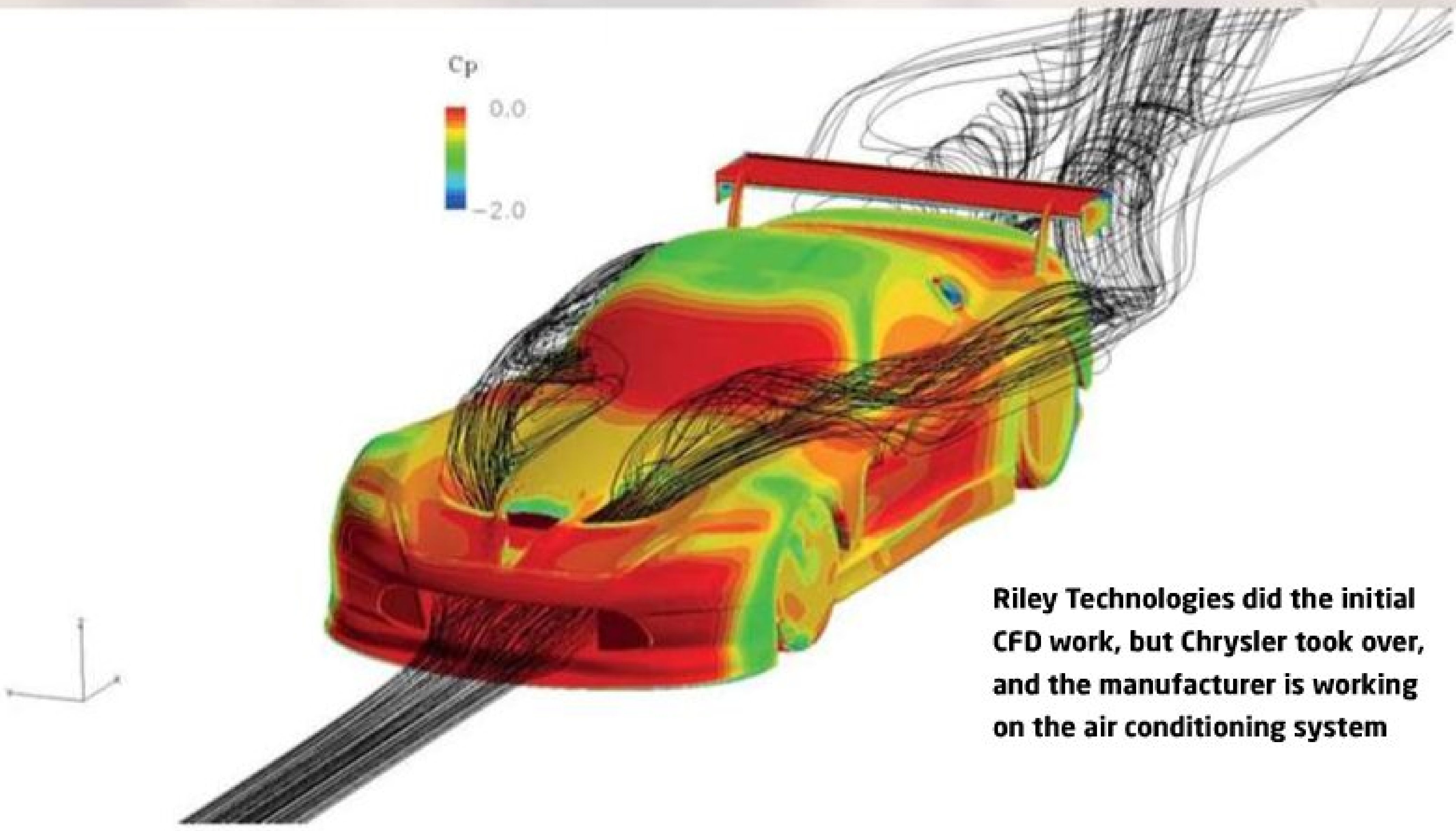
'We went with a gear rearward Xtrac two-shaft transaxle,' said Riley of the 549D model installed in the Vipers. 'It's similar to a Daytona Prototype transaxle, except it uses a wider case, and is a six-speed sequential. We had to go with a gear rearward design for weight distribution, and also to be able to package a fuel cell.'

Riley credits the modest power the V10 engines are asked to generate for allowing him to specify normal-sized radiators from C&R Racing: 'The power level is fairly low in these cars, so the water cooling wasn't too demanding. The one issue we did miss on the design, though, was the amount of cooling we needed to do for the transaxle. So we've gone through several different iterations of transmission cooler.'

As suspension and uprights are free in the category, bespoke a-arms were produced by Riley to work with the maximum allowable movement of the chassis pick-up points. 'We moved them 20mm from where they are in the production Viper, and then corrected the rest of the geometry for the ride height and so forth out on the upright. The production Viper is pretty skinny in the front, so we were able to put some pretty long a-arms on it, and the geometry we have on the racecar now is really nice.'

Riley is also following separate damper development paths with two manufacturers:

The aero package is under development and will be updated throughout this year




Riley Technologies did the initial CFD work, but Chrysler took over, and the manufacturer is working on the air conditioning system

'On shocks, we have two different directions we're going down. We're doing some development work with JRI, but we also have the standard Penske stuff on the car as a baseline.

'On the brake package, we looked at all the different brake companies and had people do proposals,' says Riley. 'Brembo had a very good proposal, so we decided to go with them.'

The six-piston front calipers work with 380mm discs, while four-piston rears utilise 330mm discs. On to these are bolted a set of 18in diameter forged magnesium TWS wheels, while Michelin outfits the GTS-Rs with 30/68-18 slicks up front and 31/71-18s at the back.

## AERODYNAMICS

Riley Technologies produced the GTS-R's carbon fibre body, using its proprietary CFD system and the manufacturer's aerodynamic tools. 'I was in charge of the design of the car and the aero also,' stated Riley, 'and we spent quite a bit of time doing the initial CFD work on our own system, but now we have switched over so Chrysler's working on it. They have their own full-size wind tunnel, so we use that. We use them for the development work, on the CFD and on the air conditioning system, so it's been integrated between both companies. Chrysler engineers, such as our lead engineer on the programme, is the one that directs all this from their side.'

Standard splitter and rear wing placement can currently be found on the Vipers and, with a few more races to gather data, Riley expects to use that information to refine the GTS-Rs for the 2013 season.

'We're looking at everything,' he said. 'We had our aero package developed for this year and we are looking to see if we can tweak that for next year. Then it's just tuning up all the little detail parts. But the main thing we're starting to work on now is the aero package for 2013.'

## THE BOTTOM LINE

To aid the Sportscar programme's bottom line, Johnson and his team capitalised as far as possible on its corporate partnerships. 'We have a really good relationship with Pennzoil right now, and factory fill for all the SRT products and Pennzoil Ultra. And between the two companies we've decided it makes a lot of sense to bring forward the connection between our production car and what type of oil it uses and how the racecar would use the same type of oil.

**Changes to the gearbox bellhousing are *de rigueur* in modern GT racing, a fact that Riley used to balance the Viper**

'And we've been talking to Forza for quite a while and they were interested in partnering up with us. They have a huge range of customers. We also have programmes with Magneti Marelli and, of course, Michelin. Even Mopar is helping us out.'

To further offset costs, and to widen its competitive base, offering customer cars for sale would seem to be inevitable, but Johnson isn't in a rush to flood the market with GTS-Rs: 'It's our intention, at least this year and probably next, to hang onto just the factory effort. That way we can work with the sanctioning body to get the car as competitive as possible, and get all the development done before we hand it over to customers. We think that'll come pretty fast, but it probably won't be next season.'

Riley concurred with Johnson's assessment and approach to limiting the programme's initial scope: 'Right now we're just working on getting the car perfected. If there are plans to build cars for sale, that has to be talked through.'

As much as it might seem that the works GTS-R ALMS programme would seed and strengthen the Viper's production DNA, Riley readily admitted he and his team continue to look to their counterparts at SRT for advice. 'Right now, it's the opposite of what you might expect,' he said with a laugh. 'We had an a/c issue at Mid-Ohio and SRT got involved to help straighten it out. We haven't necessarily given anything back to them, because they're trying to get the street car ready, but we have a strong relationship with SRT in the engineering stuff on the Viper.'

**"the ALMS really encourages you to bring the most advanced car out"**

That said, Johnson sees a more general benefit that will trickle down to the SRT staff over the course of its ALMS exploits. 'I think racing helps the engineering community – not necessarily point-by-point direct influence, but it really helps train engineers to be very quick on making changes.'

### THE ROAD TO LE MANS

The natural progression for the SRT Viper programme would be to return to Le Mans, where ORECA delivered multiple class wins for Dodge with its previous Viper project. 'We're in a development phase this year,' Johnson explained. 'But we're learning very quickly and, to be honest, the car's in spectacular shape, considering the fairly short development time. As far as next year goes, we do plan to run a whole lot, and beyond next season. Obviously, Le Mans is something we'd like to get back to, and our fan base is anxious to see us back racing in France. It's definitely our goal, but we have to be invited, and they won't do that until they feel we would be a good addition to that race series. So, we've got our work cut out for us this year, and we'll hope for an invitation to go to Le Mans next year.'

To bridge the two-second gap that existed between the front-running ALMS GT cars and the new GTS-Rs, off-season development will be required, and Elkins expects to receive requests to tweak a few parameters for next season. 'It's definitely allowed because the adjustment of performance criteria in the last couple of years moved away from limited means to improve a car through the rules. It used to be very clear – restrictor, weight and fuel capacity – but within the last couple of years it's opened up.

'Just changing a restrictor is not necessarily going to help somebody if they have an aero balance problem. Anything is possible, it just depends on what they come to IMSA with, and what they feel is going to be an appropriate change.'

While Elkins is clearly open to discussing changes, he insists that it's the job of the manufacturer to bring the right proposals to the table. 'The thing we do as a sanctioning body is try to work with the manufacturer, and let them do that as part of their job,' he said. 'We can work with what we have but, in terms of resources, there's no way IMSA can compete with SRT. I rely on the manufacturer to come to us and say, "hey, we feel that maybe raising the rear wing 25mm is the thing that's going to help us close the gap." I just try to use my experiential knowledge from being a racecar engineer to figure out if that makes sense. And if that's actually going to achieve what we want to achieve. But, we're not going to go to them to make suggestions, that's not our job.'

Riley closed the conversation with a note that spoke of the trust and tenure his company has developed with Dodge, that explains why Riley Technologies was signed to bring the marque back to the ALMS, and eventually, Le Mans, too. 'We did the Dodge Vipers for the Archer brothers in Trans-Am in the early '90s, and then we also did the first of the GTS-Rs in 1995, so we've kind of worked with them all. We've also worked with every American manufacturer over the years, but right now, being back with SRT, I think my father and I have found a nice home.'

## TECH SPEC

**VIPER GTS-R**

**Engine:** 8.0-litre V10

**Power:** 455bhp (restricted by series)

**Trans:** Xtrac six speed sequential transaxle, paddle shift

**Brakes:** front: Brembo six-piston calipers, 380mm discs; rear: Brembo four-piston, 330mm discs

**Wheels:** TWS 18in forged magnesium

**Tyres:** front: 30/68-18 Michelin slicks; rear: 31/71-18 Michelin slicks

**Wheelbase:** 2514mm (99in)

**Length:** 4463mm

**Width:** 1939mm

**Height:** 1245mm

**Weight:** 1295kg

# Future meets the present

## The future arrives for Australia's V8 Supercars

BY STEFAN BARTHOLOMAEUS

Even the most casual followers of Australia's V8 Supercar Championship should not have been surprised to see Triple Eight Race Engineering as the first team to hit the test track with one of the category's new-for-2013 Car of the Future (COTF)-specification vehicles. Led by its charismatic technical director, Frenchman Ludo Lacroix, Triple Eight has been one of the key players in assisting V8 Supercars' technical department in developing the new regulations.

Currently running under the banner of Team Vodafone, the squad boasts two of the championship's premier drivers in Jamie Whincup and Craig Lowndes, and has won three of the last four championships, alongside four of the last six Bathurst 1000s. Not even the withdrawal of its Ford backing in 2009 and a switch to Holden a year later has stopped the team's run of success.

As outlined in *Racecar Engineering* V21N10, the COTF was first announced in March 2010, with the key aims of reducing costs and attracting new manufacturers into the long-held Ford / Holden mix. Initially slated for a 2012 introduction, a decision to add a transaxle gearbox midway through the build of the two prototype cars saw the project delayed by a year. The category's track testing programme subsequently kicked off in June 2011 and, aerodynamic parity evaluations aside, has now concluded.

For the teams, the development of the new rules has been a stressful and often frustrating process. Delays in locking down specifications have clashed with a natural eagerness to get the cars up and running as soon as possible, leaving some teams to start work on as many as three chassis before being able to complete their first.

Ongoing tweaks to the rules package may have forced V8 Supercars to abandon its vision of a compulsory group test for each of the eight car-building teams at Queensland Raceway on 6 August, but they didn't stop Triple Eight. The team's commitment to the date was so unwavering that it rigged up several of its own components – including a prop shaft and fuel bladder – in the absence of the yet-to-arrive control units in order to meet the target.

Aiming to churn out nine cars, both for itself and its two customer teams, before the start of the new season, the team has repeatedly pushed ahead with areas of its programme in which others have waited for the final regulatory confirmations. Consequently, a glut of other teams are expected to hit the track in relatively quick succession during September.

Not wishing to be drawn into what he describes as the 'polemics' of the process, Lacroix says simply: 'We have a policy at Triple Eight to always be on time, no matter what the task. When V8 Supercars said 6 August was the first test day we said we'd do it, so we did it.'

Triple Eight's managing director, Roland Dane, who has emerged as one of the most powerful men in Australian motorsport since taking over mid-pack Ford team, Briggs Motor Sport, in late 2003, said at the test: 'It's important to show that the category as a whole is getting on with the show, and that we at Team Vodafone are on top of it. I'd like to think we've stolen a march on everyone, but I suspect what we've really done is made our life a bit easier over the next few months by giving ourselves a longer period of time to get ready for the new season.'

### NEW CHALLENGES

Although the fundamentals of the 5.0-litre, pushrod V8 engines and double wishbone front suspension are being carried over from the current cars, the move to larger wheels and tyres, independent rear suspension, a transaxle gearbox, a mid-mounted fuel cell and a control chassis / rollcage design ensure that the new generation cars are a significant step forward from their predecessors.

Triple Eight put an estimated 300km on what it describes as its 'laboratory car' over the course of its near eight-hour long first test, with the team never electing to complete more than a handful of laps between stops for checks and adjustments.

> **"a significant step forward from their predecessors"**

Hand-held timing showed that the car, shod with the harder compound control tyres, managed to lap marginally quicker than the soft tyre race pace from the preceding weekend, despite Whincup and Lowndes fighting pronounced oversteer for much of the day. According to Lacroix, though, the imbalance was no great surprise: 'The 18in tyre is a different animal so, along with reliability, getting a feeling of what the tyre needs was the goal for us during the test,' he said of the Dunlops, which utilise the same compounds (one soft and one hard) but a vastly different construction to the existing 17in variants.

'With a new rear end as well, there is a lot to learn. The feedback from the prototype testing was that the rear end was a little light and unstable, so we knew we were going to be busy at the rear making a lot of kinematic changes. By the end of the day though, we had a quite balanced car, so it can be done.'

### INDEPENDENT REAR

Having been engaged to design the rear uprights and work closely with V8 Supercars on developing the kinematics of the control, but highly adjustable, IRS, Triple Eight can be expected to be well ahead of the game in understanding the characteristics of the 2013 vehicles.

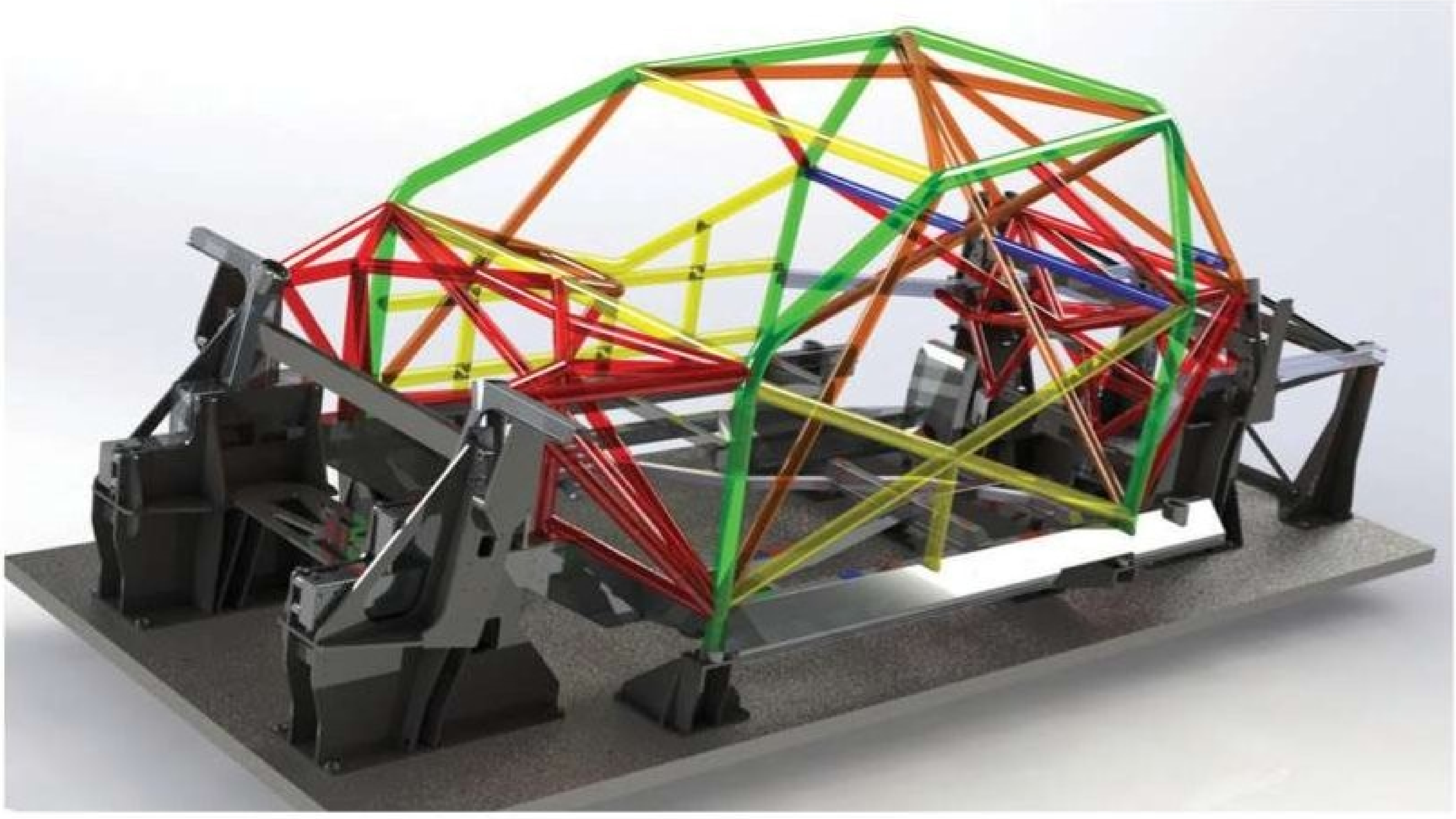

**A control chassis and rollcage design is just one of several fundamental changes to the V8 Supercars for 2013**

After two decades of developing geometry designed to unload the inside wheel of the solid rear axle in the current cars, the teams need to deal with vastly different pitch and roll properties with the COTF vehicles. Each squad's ability to come to grips with the key differences of the IRS, including the effects of bump steer, suspension-derived camber change and the latter's natural relationship with the rear roll centre, will be vital in unlocking the enhanced grip and tyre life expected from the new set up.

'There is a fair bit of adjustment on the current car, but there is probably even more on the IRS,' comments Lacroix. 'There's a lot of things to go through, and everything is combined – when you change one, you change the other, so you have to pre-empt it a little bit. That's why we are doing a lot of checking in this area.'

The move away from the current Watts linkage spells the end of the in-race roll centre changes that have proven an important tuning tool since the class moved towards longer races a decade ago. While a series of shims on the uprights will enable the teams to at least make roll centre adjustments within approximately five minutes, in-race tuning will rely solely on the front and rear anti-roll bar adjusters in the cockpit.

The rear anti-roll bar itself had been a significant discussion point during the development of the new rules, with the use of a basic control item floated before a decision to grant greater freedoms was made. Although teams are said to be experimenting with a few different solutions, Lacroix is quick to play down the importance of freeing up the bar design: 'At the end of the day, small changes will mean cars perform slightly differently at the various tracks or in certain stages of a race, which is what you want, but you can't spend a million dollars on a rear roll



Surprisingly, the new chassis / rollcage assembly is thought to be some 20 per cent less stiff than the current one

bar, so it's not something that's going to dramatically change the performance of the car.'

The IRS was the subject of a significant re-design midway through this year after a wishbone snapped on one of the prototype cars during track testing. The major teams subsequently collaborated to find a solution, which Triple Eight volunteered to re-draw. Although there were some calls to modify the uprights, Triple Eight had already machined theirs, and the changes were eventually limited to a minor alteration to the top one and a slight change in length of the bottom wishbones.

At the centre of the rear end, the category's tradition of using a locked differential remains, which is expected to ensure the cars continue to demand a rather specialised driving style.

Having previously been housed inside Ford's venerable nine-inch differential design, the spool now lives within an Albins transaxle. Triple Eight was quick to sing the praises of the Australian designed and built gearbox after its maiden test, despite the cooling of the six-speed unit proving a challenge.

Temperatures issues were a persistent presence during the prototype testing and, by its own admission, Triple Eight's solution trialled at Queensland Raceway failed to remedy the situation. Although the cooling system will eventually be a control design, V8 Supercars has subsequently asked the remaining manufacturer teams to test their own ideas when rolling out their respective first cars and report back the results.

For drivers Whincup and Lowndes, the gearshift mechanism itself was a bigger talking point, with the former describing the feel of the standardised lever / lever position as 'a major concern'. Lowndes, however, was more pragmatic, suggesting the drivers will simply have to get used to the new set up after previously enjoying individually customised units.

### FRONT SUSPENSION

The dramatically different rear end, of course, does not work in isolation, leaving teams to 're-learn' the behaviour of the front of their cars as well. Although an early decision to retain the relatively free front suspension regulations in the current rulebook wasn't without its cost-conscious detractors, mandating that the existing wheel and brake packages must fit on the new generation cars has removed a lot of the scope for re-development.

Adapting current front suspension designs to the control chassis has proven a different challenge for each team, but few describe it as an area of great focus. 'It's early days,' says Lacroix. 'We need to produce a fair number of cars before next year, so I don't think a re-design of the front axle will happen any time soon.'

The new, AP Racing-supplied brake package, however, was a major point of interest for Triple Eight at its first test. Larger, albeit still cast iron, brake discs have been implemented to lower in-race brake temperatures – a move that is expected to eradicate the need for the water spray cooling systems some teams have adopted in recent years. 'We were running the prototype caliper because the final items weren't quite ready yet, but I can say that we were very impressed with the brake system,' comments Lacroix. 'The drivers reported a good feel, and the temperatures were well controlled. I don't believe we will need to start the season with a water-cooling system. The days of water pissing out of the windows or the wheels are over, which is good. At the end of the day, when we put water on the brakes it's not racing, it's surviving. The 18in [wheel] and the bigger disc, it will do the job, even with a new tyre and a car that is going to go a bit quicker.'

**"the spool now lives within an Albins transaxle"**

The steering, meanwhile, is largely a carry-over system. Only Ford Performance Racing, which has traditionally run rear-steer racks in its cars, has had to re-design its set up to fit the new chassis. 'The steering is quite efficient with the current car, but with the new tyre it's very efficient,' enthuses Lacroix. 'The new tyre is definitely sharper, so I don't think you'll change the steering. Adjusting the camber and roll centre to the gains brought by the new tyre should give everyone a good front end.'

### CONTROL CHASSIS

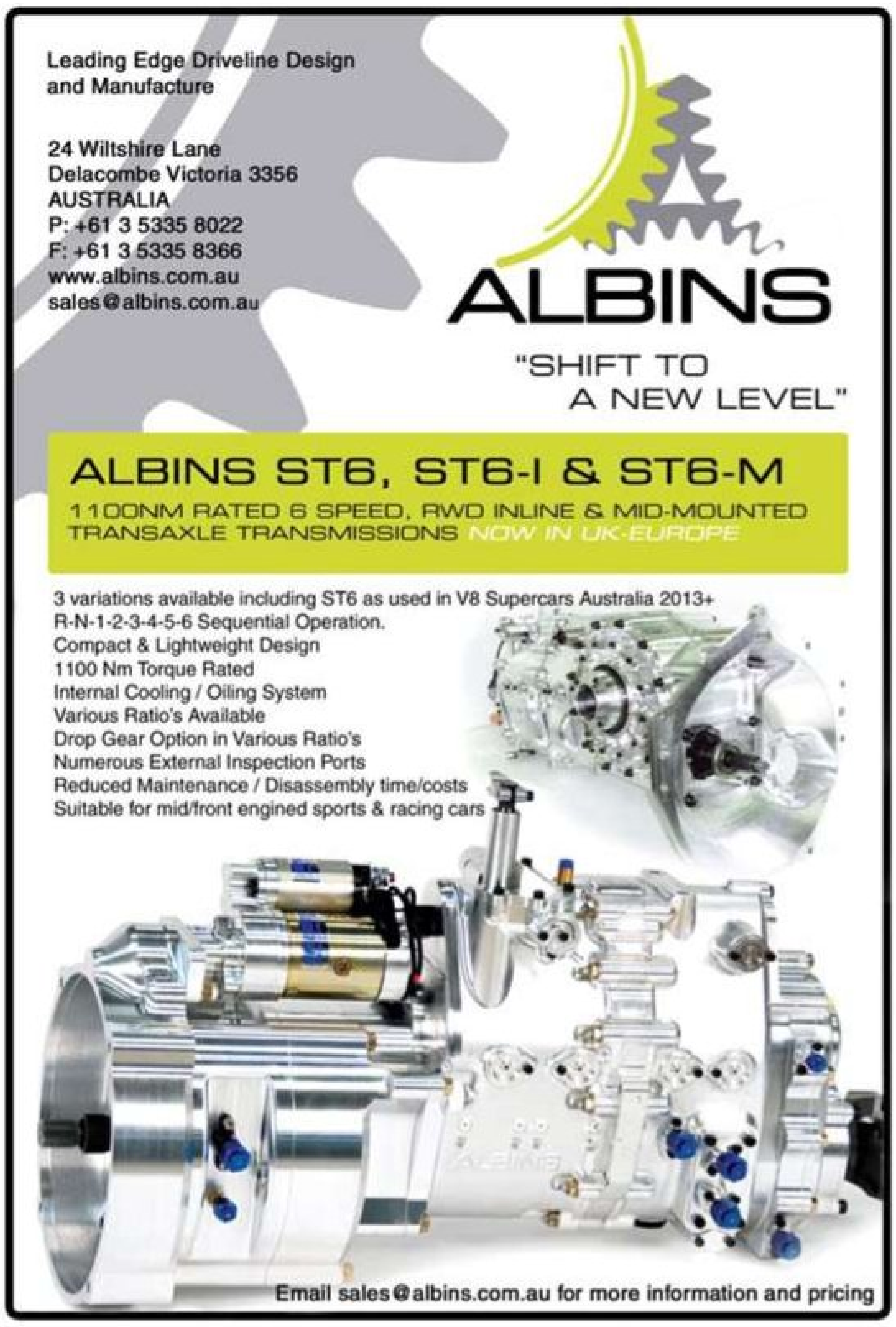
Like the gearshift mechanism, the control chassis came in for some criticism from the drivers during the test, with Whincup lamenting the stiffness loss inherent in the move away from team-designed units. Unlike the gear lever, of course, the rollcage is not something that can be the subject of a late fix. 'The chassis is clearly not as stiff as the current ones, and I'm sure we'd all make changes to it if we could, but we can't,' says Lacroix. 'You can polish every corner, you can try and weld with a diamond torch and a bit of gold, but it's not going to make it stiffer.'

Although teams are yet to put one of the new chassis on a K and C rig, it is estimated the new units will check in around 20 per cent below the current 60-65kN/degree stiffness values. That, Lacroix emphasises, is still very stiff for a racing saloon car. Some on-track losses, it should be noted, will also come courtesy of the switch from bonded glass front and rear 'screens to NASCAR-style polycarbonate units.

The layout of the COTF chassis is essentially the same as the current cars, with two centre chassis rails, two outer rails and a common floor welded to a chromoly rollcage. The Pace Innovations-designed structures do, however, remove the lingering remnants of the road cars that remained in the shotgun rails, front firewall and transmission tunnel of the current cars.

Material importers, Pace and Kelly Racing, are both supplying COTF chassis kits to teams in varying forms, with Triple Eight joining fellow leading squads, FPR and Stone Brothers Racing, in receiving its kits with the front firewall to rear roll hoop section already constructed.

TiG or MiG-welded 'cages are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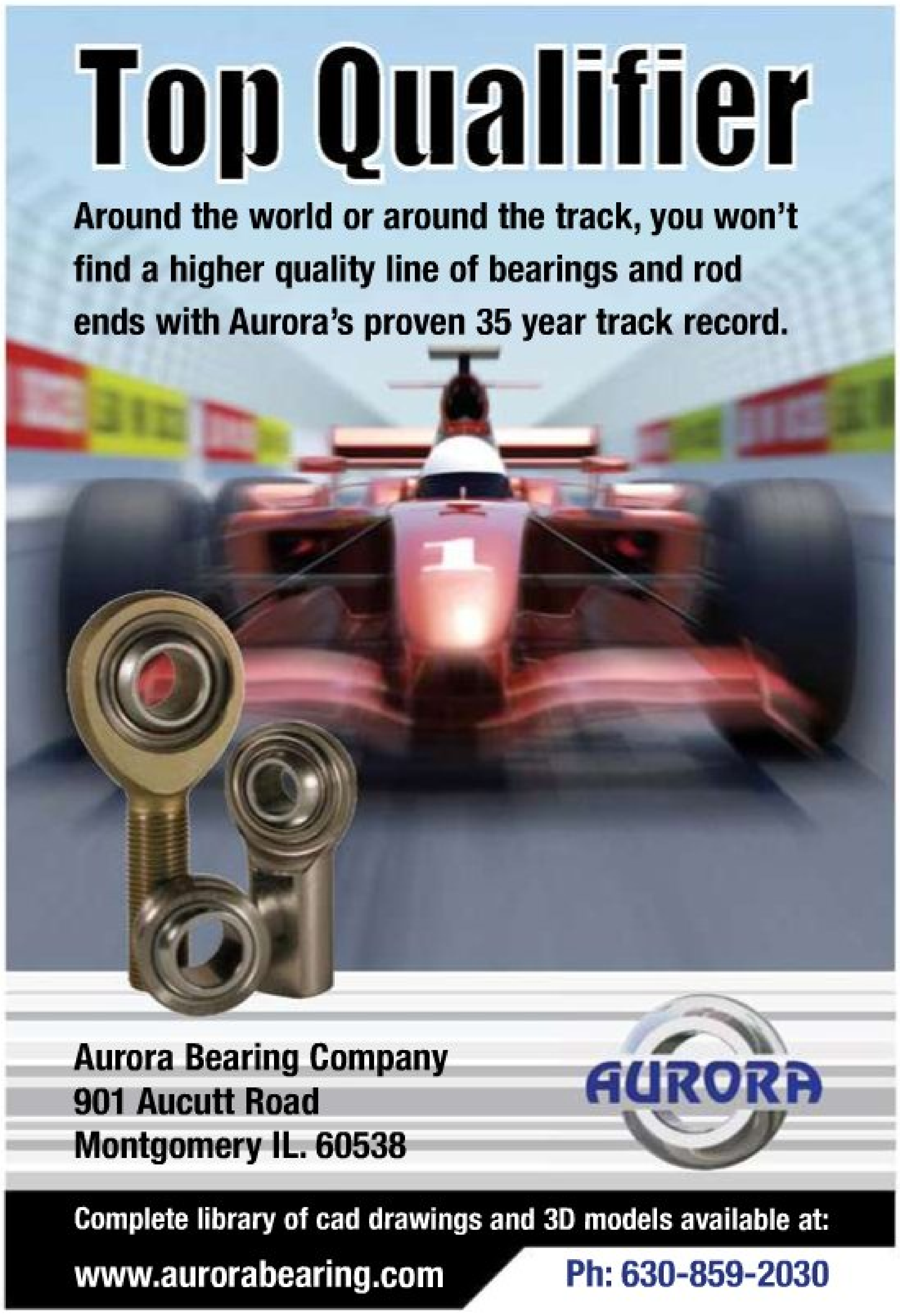
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the only true difference in the various chassis once they are complete, with Pace offering both services to its teams. Lacroix points to minor weight and quality advantages as the reasons behind choosing the TIG method, despite what he estimates as an extra 20 or 30 hours of welding time required per chassis.

Along with the control rear end, the chassis design is undoubtedly where the biggest cost savings are being achieved on the new cars. Currently, teams spend between 900 and 1000 man hours welding each unit, whereas the 2013 cars are said to be in the 300-600 range. Ending the chase for increased stiffness and weight savings within the chassis will also contribute to cutting expenditure.

**AERODYNAMICS**

Complicating matters for the Holden teams is the fact that 2013 will see the introduction of a revised Commodore body shape, codenamed VF. A desire to avoid homologating the current VE bodywork has pushed forward the racing debut of the new model, which is set to become the first Commodore V8 Supercar to hit the track prior to its road car brethren arriving in showrooms.

While Lacroix has liaised with Holden over recent months to design the new aerodynamic package, it is expected that Triple Eight will continue to test with the existing sheet metal until the new year. 'It [the model change] makes it difficult for us, but such is life, we have to plan for it.'

Again, Triple Eight is perhaps in the best position of all the teams to adapt to a new aero package. Its switch to Holden in 2010 means that the VF will be the fourth significantly different model of car the team has run in six years. Ironically, though, the squad's current VE package is the only one Lacroix didn't design.

The COTF, though, will bring different aerodynamic properties for the Ford teams too, due to its different undercarriage treatment. Moving the fuel cell from behind the rear axle to within the cabin has contributed to a flatter bottom and effectively longer floor


**Bigger wheels and tyres will put pressure on the new brake package from AP Racing, but temperatures will be easier to control**

profile, and can be expected to put a greater emphasis on the aerodynamic treatment behind the rear axle.

Lacroix: 'There is a serious difference between the new and old cars underneath, but you have to remember as well that these are not Sportscars. The aero on our cars is probably 250kg at 200km/h, and with 1300kg [total car weight], there are very few corners that are aero affected. It's not vital, it really just adds stability. With the parity measures we have, no one ends up with more downforce anyway, so the only other thing you can work at when designing a package is making sure it's stable and efficient in terms of drag through a range of yaw angles.'

Due to the prohibitive costs of a full wind tunnel programme, V8 Supercars will continue its recent practice of open air aerodynamic parity testing for the COTF vehicles, and Lacroix is confident the current system will find an acceptable solution prior to next year's season opener. 'Achieving good aero parity between the three brands in the next four months will certainly be a difficult one, but we've come across this problem before and we've overcome it,' he says. 'Even if it's not perfect parity, it's been enough for both brands to win races and championships over the last three or four years. It's not easy, but it can be done.'

## "engines sitting 100mm further back and 15mm lower"

**ENGINE INSTALLATION**

Nissan's new engine will be a big point of interest next year, but for the Ford and Holden teams the powerplants are largely carry-over items.

The main work has come in the area of installation, with the engines sitting 100mm further back and 15mm lower under the COTF rules. Again, the new regulations have affected the teams differently, with many required to spend considerable time re-designing items such as engine mountings, exhaust system, oil sump and cooling package, which now features a mandated radiator position.

Moving the oil tank from the boot to the left rear corner of the engine bay has arguably required the most attention, necessitating a full re-work of pumps and lines, as well as tank internals.

Electronically, adapting the new MoTeC ECU (upgrading from the M800 to the M190) to the engines remains a work in progress, with the software still being formulated. 'There is a lot in the electronics,' says Lacroix, 'but we're still learning the system.'

A coil pack ignition system is the only other major change in the engine package after a move to a fly-by-wire throttle was postponed until 2014, upon the request of several teams. The move necessitated minor modifications to the new pedal box, which has been designed and produced for all teams by Triple Eight under tender. A simple electronic throttle system, described by one senior engineer as 'effectively a $2000 cable', had been run on the prototypes before the decision was taken.

**THE ROAD AHEAD**

While testing of the current cars has been limited to four days this year, the eight teams building their own COTFs have been given a total of 12 days to run the new cars between 1 August 2012 and 31 December 2013. Providing the planned late August arrival of the remaining control components comes through, as many as four of Triple Eight's rivals are expected to hit the track in September, before joining together with the Holden squad for a group test in mid-October. Triple Eight is then likely to complete its third day in December, where it will debut its second car. 'Every time you hit the track you need to something new to make sure you're moving on,' says Lacroix. 'We're not in the business of going round and round for no reason.'

The 2013 season is expected to kick off with the gruelling Clipsal 500 next March.


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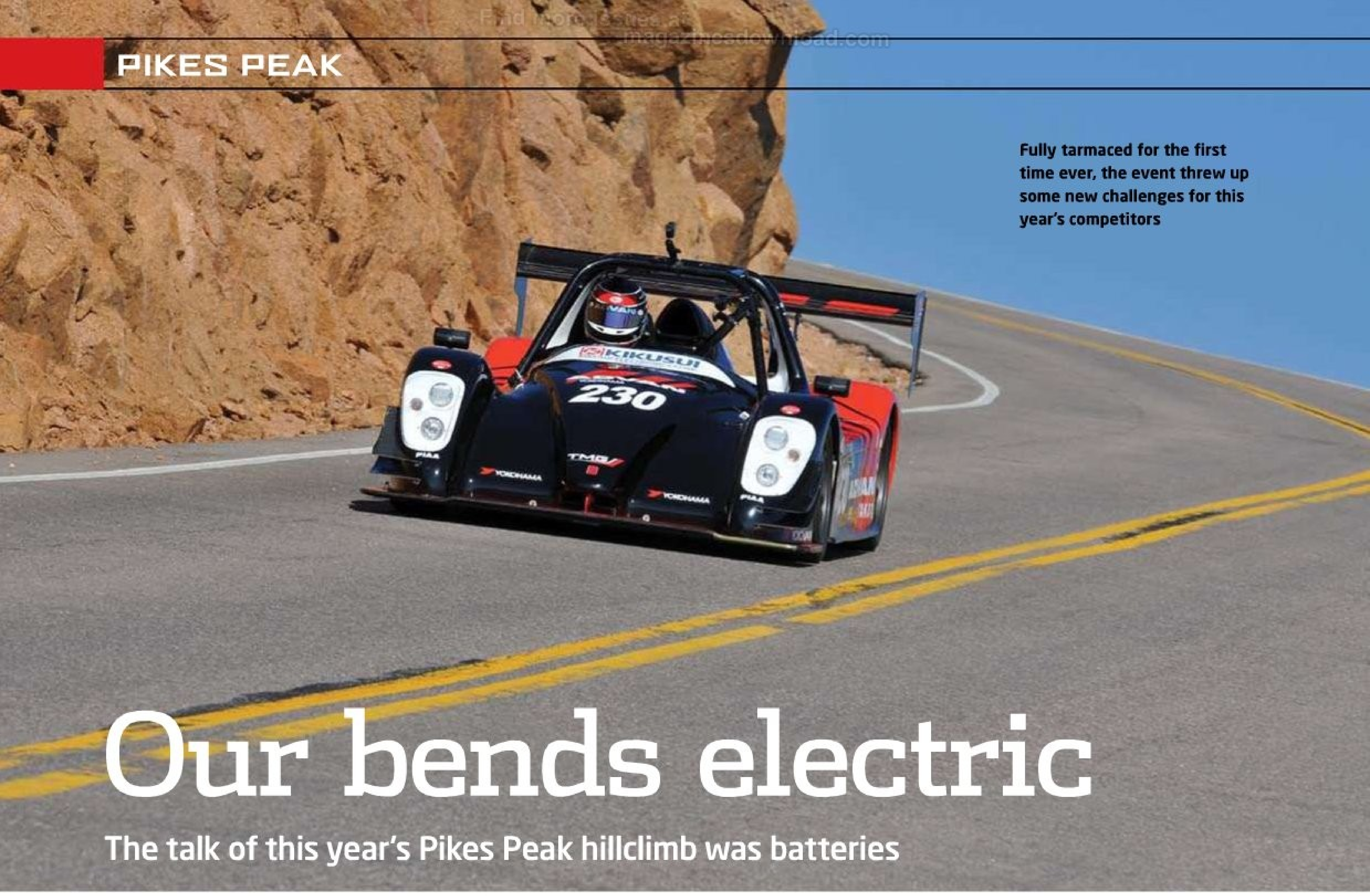

Fully tarmaced for the first time ever, the event threw up some new challenges for this year's competitors

# Our bends electric

## The talk of this year's Pikes Peak hillclimb was batteries

**BY ANDREW COTTON**

That Toyota set an electric car record at this year's Pikes Peak hillclimb was pretty much a given as the circuit was paved from bottom to top for the first time, but the manufacturer faced a host of hurdles to overcome to achieve its goal.

Toyota's TMG EV P002 is based on the machine that set the new electric lap record at the Nürburgring in 2011, but with an all-new rear end, a new inverter, motor and rollcage in case it fell off the side of the mountain.

Most of the development work was software related, changing the parameters to cope with the 1500m climb. The car was driven up the 19.99km course in a time of 10m15.380s, beating the old electric record by more than two minutes.

In terms of setting the record, it was an open goal, but the first challenge was to charge the car in preparation for its run up the hill. A lack of charging points meant Toyota resorted to a Hi-Ace van fitted with a charging system linked to a generator, which could then be used to charge the car.

Thermal management is key to the performance of the batteries, as overheating at any point on the run up the hill would instantly curb the delivery of power, and therefore performance. So in the pit, Toyota rigged up a cooling bath for the batteries to ensure the best possible delivery of power for the maximum amount of time.

Once on the hill, the goal was to deliver power smoothly and constantly throughout the climb. As electric cars are not susceptible to changes in air density at altitude in the same way as a combustion engine, provided there was charge in the batteries and temperature was controlled, theoretically the P002 could still deliver full power at the end of the run.

The P002 had a top speed of 240km/h in Pikes Peak configuration, with a maximum power output of 350kW, with 900Nm of torque. This was a significant upgrade compared to the car that set the record at the Nürburgring, as was the torque vectoring that helped multiple Japanese rally champion, Fumio Nutahara, negotiate the tight hairpins on the course. 'Torque vectoring is an issue at Pikes Peak, and is used to deliver understeer or oversteer as required,' said a Toyota spokesman. 'That is dialled in using software, and that is where the development has come over the last year.'

> **"Thermal management is key to the performance of the batteries"**

'Following our new electric record at the Nürburgring Nordschleife almost exactly a year ago, TMG wanted a new challenge for our electric powertrains,' said TMG's director of business operations, Rob Leupen. 'The Pikes Peak hillclimb gave us the chance not only to prove the motorsport potential of electric powertrains in motorsport but to do so in a very competitive environment as well.

'It's a great achievement from the team here in Colorado and also all those back at TMG in Cologne who have played their part in this successful record attempt. Thanks to them and also to our colleagues at Toyota Racing Development here in the US who gave us so much support. Now we can start the search for the next milestone for the TMG electric powertrain.'

### TECH SPEC

| TMG EV P002 | |
|---|---|
| **Chassis:** | Radical SR |
| **Length:** | 4100mm |
| **Height:** | 1040mm |
| **Width:** | 1790mm |
| **Torque:** | 900Nm |
| **Power:** | 350Nm |
| **Max revs:** | 5000rpm |
| **Electric motor:** | 2 axial flux |
| **Inverter:** | 2 x TMG Inverters |
| **Transmission:** | Single reduction gearing |
| **Battery:** | Lithium ceramic |
| **Battery capacity:** | 42kWh |
| **Charging:** | Off-board DC charging |

To comply with regulations that state electric cars must make a noise, the Monster Sport team broadcast a soundtrack from last year's petrol-engined entry

# Monster Sport Special

## The fastest of the privateer EVs was eight-times winner, Nobuhiro Tajima

This year's Pikes Peak event saw eight-time winner, Nobuhiro 'Monster' Tajima, attempt to beat his current record of 9m 51secs. For the 2012 challenge, however, there was one significant difference – a switch to a pure electric powertrain.

Pikes Peak is the second oldest motorsport event in the USA, and 2012 saw the 90th running of the race that features a course that climbs to 14,110ft. 156 turns at an average incline of seven per cent over the 12.42-mile course. In the 1950s and the 1960s it was an event that Indy 500 participants wanted to do. In the 1980s, the Group B cars came and the records tumbled but, in recent times, it has been Monster's mountain. Tajima has won the last six consecutive events in a variety of highly developed Suzukis but, for 2012, he built his own car – the Monster Sport E-Runner Pikes Peak Special.

Built in Japan, it is 5.5m long, 4WD, with a 2.7m wheelbase, and uses an aluminium spaceframe chassis clothed in a carbon fibre / Kevlar body. Hydraulically controlled differentials front and rear transmit the unspecified power from two liquid-cooled motors. There was surprise in some quarters that individual motors and torque vectoring were not employed, but the builder's knowledge and expertise with mechanical differentials led to the more conventional layout. The battery technology was closely guarded during the entire weekend and remained covered, even whilst the car was being worked on at a local McCloskey Motors car dealership.

**"environmental benefits are at the heart of the switch"**

Manufactured by Mitsubishi Heavy Industries, the lithium-ion cells were packaged on either side of the central cockpit.

### ALL CHANGE

'Historically, Pikes Peak hillclimb cars were notorious for three things – huge wings, high horsepower and an ability to cope with the mixed surface,' says Yujiro Otsuki from the Monster Sport team. 'Now it's all changing.' Primarily because the newly all-paved track meant the cars could run lower and with stiffer suspension.

Designer, Yasuhiro Sakoh, who worked on many of Suzuki's WRC campaigns, told *Racecar Engineering* that hardly anything was carried over from last year's car, save the driveshafts. 'The package requirements for the powertrain and architecture led us to the design we have today.' The firm's own wind tunnel in Japan was used to refine the aero and led the team to settle on a driver canopy. 'We found some small aero gains with the canopy,' adds Sakoh. 'It was also Tajima-san's preference to run enclosed.'

The E-Runner uses a classic double wishbone suspension with Öhlins dampers, while braking is by way of 370mm ventilated discs and AP Racing eight-pot calipers all round. For tyres, a crucial element of event, the team retained its relationship with Japanese manufacturer, Falken (see sidebar on p24) and custom 20 x 11J wheels came from HRE Performance Wheels.

Tajima was enthusiastic about the switch to pure electric and, whilst environmental benefits are at the heart of the switch, performance is also relevant to the project that runs in partnership with Association for the Promotion of Electric Vehicles (APEV), and its chairman, Souichiro Fukutake. 'Fukutake-san has always encouraged our project, even when it was only an idea in my head,' says Tajima. 'Many still view these vehicles as having a short driving range, less power, and a high price. This image is poor for innovation and electric vehicle development, and I want to make the statement that that's the old and wrong way of thinking.'

### DRAMATIC PROGRESS

The progress of electric cars since Joe Ball piloted his Sears Electric in 1981 to the summit in 32mins 7secs is dramatic. The removal of the unpaved sections has contributed, of course, but battery pack development is equally as crucial. 'The E-Runner



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It was the fastest of the EVs, but not the fastest car on the hill this year, though the experience will be invaluable

has been conceived to secure the record,' says Paul Wilding, Monster Sport team manager. 'We know what power and torque is needed to win.' With last year's car pushing out close to 900bhp, it gives some indication of what power the E-Runner is producing, but it's not the full story. That's because there is a vital benefit the EV runner has over its petrol-engined competitors – an immunity to altitude. Whilst the quickest petrol cars can lose as much as 30 per cent of their power high up on the course, the EV cars don't suffer any losses, or any overheating due to leaner running either. There is still one issue that both types of car face, though, and that's the changing boiling point of water. At Devil's Playground, four miles from the summit, water boils at 83degC.

For the driver, the race to the clouds is just as punishing. Altitude causes the drivers to work harder to breathe and saps energy from their muscles. Like many of the leading cars, Monster uses power steering, and reported this year that the EV was easier to handle. And, with a single-speed transmission, he was able to keep his hands on the wheel for longer. 'This car has more torque, and it's easier to control than last year's car. It has a torque curve that is much longer and flatter that I can use everywhere, so it's very nice.'

**"a vital benefit the EV runner has… an immunity to altitude"**

Regulations at Pikes Peak require the silent EVs to emit a warning sound, but Tajima's team went one better – using an iPod, the team broadcast a recording of the engine sound from last year's car through an array of speakers in the front of the car. A myth quickly spread across the mountain that Tajima used the sound to see if he was quicker than last year, but the team quickly scotched that.

### A STEP TOO FAR

In the end, the mountain was a little too high to climb this year. Qualifying went well, but the mountain is split into three sections, with groups of cars attempting a different section on each day. Officially, every driver must qualify within 115 per cent of the fastest time in class on the bottom section of the course. The E-Runner was often the quickest of the EVs and Tajima topped the times notably in the most daunting 'summit' section where the single-speed gearbox seemed to eliminate the 'bogging down' associated with the petrol cars. Despite the promise shown in practice, just a mile into the course Tajima spotted smoke coming from one of the motors, and aborted the attempt. 'This year we have showed real pace,' he concluded, 'We'll be back…'

## SHOEING THE MONSTER

This year at Pikes Peak there was considerable talk about tyre choice. With it being 100 per cent tarmac for the first time, there were a number of teams running slicks, often with just a single or two grooves cut into them, but Tajima once again partnered with Japanese tyre manufacturer, Falken, for his racing rubbers. 'The rules require a treaded tyre,' explains Stefanie Olbertz, Falken Europe's motorsport manager. 'There are a number of teams not running to the spirit of the regulations.

'Just like our participation in the Nürburgring 24 Hours, it's the unique challenge of Pikes Peak that appeals to Falken and our engineers,' says Olbertz. 'This year we have lost the challenge of mixed surfaces, but we now have to cope with the immediate and significant torque generated by the electric motors. Through Falken's growing experience and close relationship with the Monster Sport team, we have created 295/40 x 20in tyres and built a small batch for practice in Japan, qualifying and the race.'


Falken's motorsport department in Japan produced both soft and medium compound versions of its ZIEX S/TZ01 road tyre. 'The compound is the only change from the road tyre,' adds Olbertz. 'We have kept both the tread pattern and construction exactly as the street version.'

The new tyres were shaved to minimise tread block temperature and heated to 100degC before each run, then the tyre carcass temperature was measured at the summit.

The mix of weather experienced this year, which includes sun, rain, hail and snow in a single run, highlighted why a proper tread pattern is the sensible choice for participating racers. With a thunderstorm claiming a number of cars and resulting in serious accidents at significantly higher speeds, it could be an area that organisers consider in the future. 'Depending on the class, there are numerous options available, but no full slick race tyres are supposed to be allowed. The final decision on grooved slicks is down to the organisers, but a single groove cut in the tyre maybe too much of a compromise for safety and weather,' concludes Olbertz.


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# Same, same, but better

After a disastrous 2011 season, and major personnel changes, Williams looks to be back on form with its 2012 challenger

BY SAM COLLINS


**"We ensured the bad bits didn't carry over and the good bits did"**

It was the worst season the Williams Formula 1 team had ever endured in terms of point scoring. A finish of ninth in the 2011 World Championship had many questioning the English team's long-term viability. The prospects for 2012 did not look much better, with two reputed 'rent-a-drivers' signed for the season, but all that appeared to change at the Spanish Grand Prix when one of those drivers, Pastor Maldonado, was victorious. It was the first win for the team in eight seasons.

Throughout the 2012 season, the Williams FW34 has run near the front of the field, sometimes aggressively so.

Surprisingly, despite the poor performance of the FW33 in 2011, it forms the basis of its more competitive successor, perhaps because those poor performances sparked a major re-shuffle of the Williams technical team.

'When I joined the team, I felt it had everything it needed in terms of equipment and resource to be successful,' explains Mike Coughlan, who took the role of technical director in the summer of 2011. 'I felt that the engineering side lacked general focus and direction, but that it wouldn't take much to make the team competitive again. We started by instigating regular meetings across each area of the car to make everybody understand the overall vehicle is what is important, rather than just one particular faculty. We had to make sure everyone realised it wasn't just their area that was going to make the car faster, it was the overall package.'

It was a view shared by both Jason Somerville and Mark Gillan, who both joined over the following months as head of aerodynamics and chief operations engineer respectively. With the 2011 season still in progress, it was decided to use the remaining events to work on the FW33's positive traits, and to find improvements for its weaknesses.

'The championship position wasn't very good, so we used the last number of races almost as an extended test session to try to understand the shortcomings of the FW33,' explains Gillan. 'We simply concentrated on the weak points we found. Aerodynamically, it wasn't bad. it had a few areas needing a tweak. Mechanically, it was good too, though it was very hard on the tyres and we had to understand that. There were a few other problems, which we can't go into, but we fixed those, too. We ensured the bad bits didn't carry over and the good bits did, like the rear end with the very clean airflow to the rear wing and diffuser.'

'We couldn't afford to take our eye off the ball,' adds Somerville. 'The FW34 was the future, so we had one round of aero updates on the FW33 and worked a little bit on the exhaust-blown diffuser, which was a big performance benefit last year. Unfortunately, it became quickly apparent that we weren't going to be able to easily tap into the sort of advantage that other teams were exploiting.'

**CHANGE OF HEART**

Attention was then firmly on the 2012 car and, at its heart, one of the biggest changes of all – the engine. Williams switched from the Cosworth CA to the more popular Renault RS27 and instantly the team found it a very different piece of equipment, as Gillan explains: 'The initial feedback on the engine from Pastor Maldonado was very much positive, even on the installation lap, which is very unusual. Indeed, it is incredibly unusual for the driver to get out of the car and comment on the improvement he felt straight away.' The installation of the engine into the car also opened up some design scope, according to Gillan: 'The Renault engine differs in a number of ways to the Cosworth. It has opened up a lot more flexibility in terms of mapping and it allows us to run a lot hotter with the water and oil, which from an aerodynamic point of view is much better. Now we can close up the bodywork a bit. It also has less degradation with mileage and, at the end of the season, that makes a big difference.'

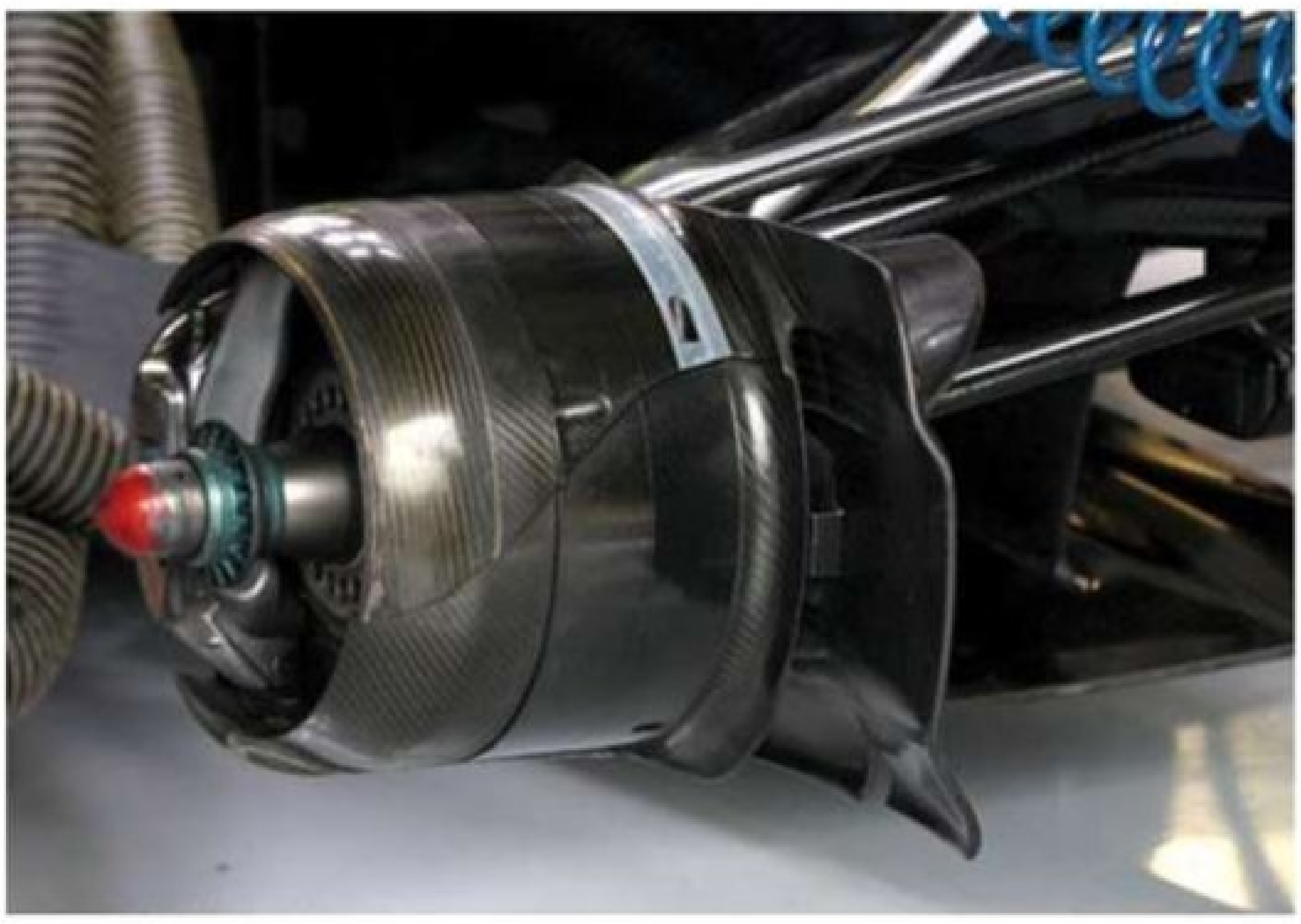
One part of the car that seems little changed is the rear end, which retains the very low transmission which drew admiring glances in 2011. 'If you look at the rear end of the car, we have a lot of free space as a result of the gearbox design. It's a nice thing to have from an aero perspective and we carried it over after tidying up a few bits and pieces along the way. That whole area is really an evolution of last year's car. We have tried to ensure that what we gave up mechanically for the aerodynamic benefits we get back,' explains Gillan.

Aside from the regulation-driven nose hump, and the lack of an exhaust-blown diffuser, the FW34 is clearly a continuation of the FW33 concept but, according to Gillan, it has much better detailing. 'The car is a lot tidier in every aspect, especially under the bodywork. But I can't show you that. Otherwise the design is similar to 2011, but it's all those details that make the

**Driver errors have seen the Williams team lose many points in the 2012 season, such as here at Monaco, but they have helped reveal some of the car's underbody and technical details...**

long way in that respect, from the design idea to how we test a component, and that whole process has been dramatically improved. We are not where I want to be yet, but it's a dramatic improvement,' he explains. 'I think the big difference is that when you make changes, the car reacts well, so the driver has a platform they can work on. Last year, when we made changes, it was very difficult to push anything forward as the car didn't react as expected. This year the correlation with the wind tunnel is very good, we also have a high hit rate in terms of performance items we put on the car and generally the car is kinder on its tyres, easier to driver and better overall.'


**The very low gearbox height is carried over from the 2011 car, as is the clean air flows to the rear end**



**Mark Gillan: 'Brake duct improvement has been significant... We have very good aero data and correlation in this area. Sometimes brake cooling can be a problem, but not for us!'**

### RATE OF DEVELOPMENT

Whilst the base car was clearly a step forward, there was a lot of work still to do, not least in understanding how the car interacted with the notoriously fickle Pirelli tyres. 'The rate of development this season has been tremendous,' says Gillan. 'To be in the mix, you have to keep that up, as a couple of tenths makes a difference very quickly now. A lot of pieces are being tested on Friday and, looking down the grid, all the aerodynamic areas are being developed, so there is no single item and you have to improve the whole cars. In the past, you could focus on a single area like the diffuser, but now base performance and tyre management are key.'

Getting a handle on those tyres has been the biggest challenge for engineers up and down the F1 paddock this season, and it is no different for Williams. So far no team has consistently proven they are able to exploit the rubber's potential. 'Like all teams, our understanding of the tyres has been improving. They have a very small operating window, so you have to manage them carefully, and the drivers have had to learn that. It also has a lot of set up implications. I don't think any team has a definitive handle on it, the integration of the car, the drivers, the aerodynamic loadings, the mechanical balance... it's a complicated puzzle,' Gillan continues. 'The drivers are especially important, and that feedback is crucial. We are lucky with our three. They

## TECH SPEC

**Williams FW34**

**Chassis:** monocoque construction laminated from carbon epoxy and honeycomb composite structure

**Front suspension:** carbon fibre double wishbone arrangement, with composite toe link and pushrod-activated springs and anti-roll bar

**Rear suspension:** double wishbone and pullrod-activated springs and anti-roll bar

**Overall height:** 950mm

**Overall length:** 5000mm

**Overall weight:** 640kg (with driver)

**Wheels :** RAYS forged magnesium

**Engine supplier:** Renault 2.4-litre 90-degree V8; pneumatic valvetrain; fuel and lubricants by Total; high energy inductive ignition system; engine materials include block and pistons in aluminium alloy; nitrided alloy steel crankshaft with tungsten alloy counterweights; titanium alloy con rods

**Transmission:** Williams F1 seven-speed seamless sequential semi-automatic shift, plus reverse gear; gear selection electro-hydraulically actuated

**Cockpit:** six-point safety harness with 75mm shoulder straps and HANS system; removable, anatomically formed carbon fibre seat covered in Alcantara

**Cooling system:** aluminium oil, water, KERS and gearbox radiators

**Tyres:** fronts - 325mm wide; rears - 375mm wide, Pirelli

**Brake system:** AP Racing six-piston calipers all round; carbon discs and pads

**Brake material:** Brembo

**Dampers:** Williams F1

Following the Spanish GP, the Williams garage was destroyed by a freak fire, though this did enable us to see the front suspension and bulkhead

are all quite different, but all of them understand the tyres and what we want from them. They understand the problem in different ways and they have subtly different requirements, so we get three sets of feedback, which is interesting to dissect in terms of tyre understanding.

'A good tyre model helps, but it is still a whole car championship and the driver is an important part of that. Even with all of the best models and simulations, the driver is the most highly tuned sensor in the car. They are incredibly sensitive and I don't remember them contradicting one another, but they do have different cues and it's a case of translating that into useful data and feeding it back to the other drivers in the right way.'

One of the main tools the engineers would like to use to be able to get the best out of the tyres has been removed from the box, as the weight distribution of the cars is restricted to a very small window and, says Gillan, it is not an ideal one.

'Using a car's weight distribution is a key driver in tyre management. If it was open, you would be looking to move it a bit from where it is now, but we work within the limits and it's the same for everyone.'

Despite its win, Williams was only in seventh position in the World Championship going into the mid-season break. But this is not really representative of the car, as driver errors have cost the team a significant number of points. It could be argued the real performance potential of this car has yet to be realised.

## WILLIAMS ADVANCED ENGINEERING

Williams is unique in that it designs, builds and runs its own Kinetic Energy Recovery System, something the organisation is very keen to promote: 'Our KERS is very good,' enthuses Mark Gillan, Williams' chief operations engineer. 'Hybrid power is part of our business model and we are confident in our capabilities, though packaging is the main constraint, so many of the systems have similar set ups. But our system is continually evolving in terms of packaging and, looking at it, you realise it is very state of the art and we do a good job. Our system never appears on my radar for reliability or performance issues, and the integration with the RS27 is great, too. It's first class.' Whilst only Williams uses the system currently, it has made it clear it is available to customers, too. Indeed, a new company has been formed as part of the Williams Group, tasked with getting the best out of the technologies and IP's created by the F1 team.

'Rule changes often drive our innovation. Why did we never race the flywheel KERS on the F1 car? Rule changes. A ban on refuelling meant a bigger fuel tank was required, and that in turn meant there was insufficient space on the car for a flywheel,' explains Kirsty Andrew, business development manager at Williams Advanced Engineering. 'So we developed our own battery electric KERS. That's created a whole new skill set – the battery management system, cooling, MGU, KCU and inverter are all designed and built in house. That's a very obvious technology for use in cars, and that's the basis of some of the work we are doing with Jaguar on the new C-X75.

'We take the IP and know how we have developed in Formula 1 into other areas and we have a very clear direction from Frank Williams and the board that is something we should do if it benefits a wider society. Of course, it is also an alternative revenue stream.'

**"Hybrid power is part of our business model and we are confident in our abilities"**

Williams Advanced Engineering started initially as a department within Williams Grand Prix Engineering, but has now grown to a 150-person company. 'We started with what we know. We did the gearboxes for Toyota in their final seasons in F1 and designed the F2 car,' reveals Andrew. 'So some of our work is still in Formula 1. We make the gearboxes for the HRT team and we lease one of our wind tunnels to Caterham F1. They are a customer type we understand. It's our market, our operating environment, with people we know and understand, with similar aims to ourselves.

'It's not just motorsport though. We see the hybrid offering as a great opportunity going forward. If you look at our flywheel, for example, we created a flywheel for F1 in 2009 and it has won Le Mans, raced at the Nürburgring and, later this year, it will be on a London bus. It's a great example of the rapid flow of our technology to other applications. Anything which has a stop-start duty cycle, it can be made to work on. It can be a mobile system or an off-board system with the flywheel beside the track in the station – for example in a railway application.'

Williams Advanced Engineering is also handling the development and construction of the Jaguar C-X75 supercar, and will be constructing a dedicated factory next door to the F1 team to build the new hybrid. 'The head of the C-X75 programme works for Williams Advanced Engineering. It's a blended team, with staff seconded from Jaguar, as well as some other people from third party suppliers, and the majority from Williams,' reveals Andrew. 'Some of those from Williams come from the F1 team, and there are some new recruits experienced in low volume, high performance car production. The production line will be blended. We have no knowledge of interior and trim, for example, and the styling is all Jaguar, too. We have done the aerodynamcics, the composites, the battery and hybrid technology and the vehicle control module. The composite chassis production is sub-contracted, but the assembly is here. We are doing 200+ vehicles here, building them up from parts made both in and out of house.'

For Williams, while racing is always going to be its core business, it seems there are some interesting times ahead.

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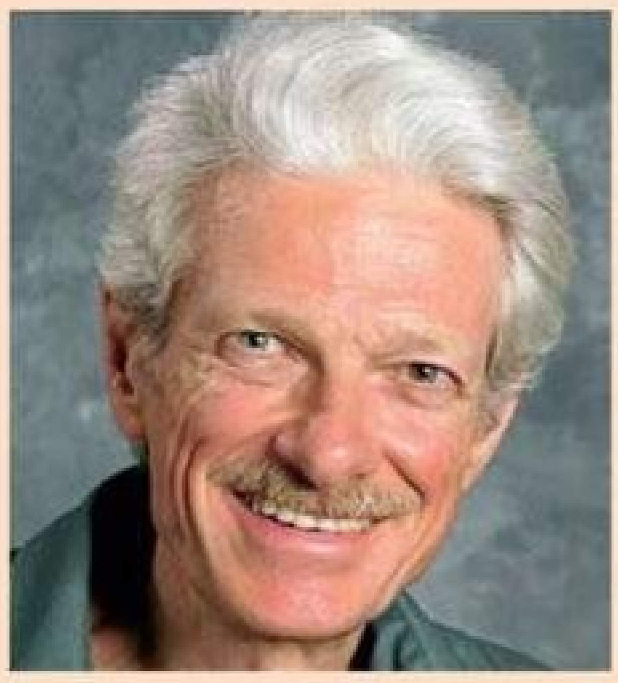

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# Tuning gas-filled dampers

## Or why it's better to buy the right ones in the first place

**Q** **I was wondering what your thoughts are on the tuning of Bilstein monotube dampers using the gas charge pressure?**

**We are running north eastern-style Dirt Modifieds with very soft spring rates, typically 225lb/in (LF), 175lb/in (RF), 156lb/in (LR, calculated at static ride for torsion bar), 171lb/in (RR, calculated at static ride for torsion bar), plus beam axles front and rear.**

**Here's what I think I know:**

**Stock Bilsteins are charged with 150psi nitrogen from the factory.**

**The Bilstein rebuild manual recommends 180psi minimum nitrogen charging after rebuild.**

**The lift force is strictly a function of piston rod area due to the area difference between the rod side vs the non-rod side of the piston.**

**The lift force will increase at some rate as the piston rod enters the shock body in bump, displacing an amount of oil equivalent to the rod volume, which will cause the free piston to compress the gas charge, therefore increasing the rod lift force by a small amount. This depends a great deal on the free piston area and the volume of the gas chamber.**

**Gas pressure increases due to heat build up of the gas charge during operation.**

**A 14mm shaft damper will have 43lb of lift force, fully extended, with a 180psi charge.**

**A typical starting point for valving is: LF and RF - 162/55 at Bilstein's rating of 10in/sec and LR and RR - 208/72.**

**The shocks have a 46mm bore. The fronts have a 7in stroke and the rears 9in.**

**We are not allowed to use externally-adjustable shocks.**

**The tuning range used currently vary between a low of 80psi and a high of 175psi. This seems low to me, considering the recommended factory charge starts at 180psi.**

**At what point would you expect cavitation to start to occur?**

**How do you incorporate the shaft lift force into the overall spring rate at the corner of a car?**

**Taking all this into consideration, do you feel the pressures I have quoted to be on the low side? Do you consider the rod lift force an additional form of spring rate? (The fronts are coilover units, while the rears act very close to the torsion arm contact point ie the motion ratio is very close to that of the springing). Finally, what is the effect of oil column pressure on valving operation?**

First of all, it's important not to confuse spring force with spring rate. When we measure gas force in a shock, that is not the rate of the gas spring, it is the force exerted by that spring at a particular displacement value, or point, in the shock's travel. The rate of the gas spring is the amount per unit of displacement (per inch of travel, using English units) that the force changes. It is the first derivative of the force with respect to displacement.

The gas spring force at full extension can be considered a pre-load on the gas spring.

The rate will be a much smaller number, and it will not be a constant. It will also rise as we compress the shock. If the gas volume is small and the shaft is large, we get more non-linearity, especially near full compression. However, for shocks of the dimensions the questioner describes, the rate is fairly close to linear over most of the travel, and it is small – on the order of 2-15lb/in. We have a very soft spring here, with lots of pre-load. When the ride spring is also soft, the gas spring force will affect ride height noticeably, but it will add only a little to the overall wheel rate.

**"The gas spring force at full extension can be considered a pre-load on the gas spring"**

We can measure the rate of the gas spring on the car, in most cases – or at least, we can measure a good approximation of it. Since the gas spring is somewhat non-linear, the rate is never the same over any interval of displacement. However, the rate does not change suddenly and dramatically, so we can measure force change over an inch of travel, and that will give us a very close approximation of the instantaneous rate at the mid-point of that interval.

With most suspensions, we can remove or disconnect the ride springs and anti-roll bars (if present), while leaving the shocks connected, and the suspension will still hold the wheels in place, although it won't hold the car up. We can then support the car's frame on jacks, at whatever ride height we want, with scales under the wheels. If we do this at just one end of the car at a time, we can use the brakes to keep the car from moving around, or chock the wheels at the opposite end of the car.

We can use scissor jacks or jack stands to support the car about half an inch lower than normal ride height, or a chosen estimated running ride height. We then raise the car an inch using hydraulic floor jacks, or a lift, if we have one. We note how much the shocks travel in that inch of suspension movement. That closely approximates the instantaneous shock-to-wheel motion ratio at the mid-point of the travel interval.

We note the reading on the wheel scales. This will be the sum of the unsprung weight as acted on by gravity (not quite the same as unsprung inertia mass, but close to it for simple suspensions) plus wheel load due to gas spring force.

We let the car down onto the jack stands or scissor jacks, and immediately note the change in wheel load. This will be a close approximation of the wheel rate of the gas spring at the mid-point of the travel interval. The rate of the gas spring at the shock will be that number, divided by the square of the motion ratio.

This works for coilover or strut suspensions, or any other design where we can remove the spring, leave the shock installed, and still have the rest of the suspension operational. It is necessary when we cannot remove or disconnect the shock without also removing or disconnecting the spring.

**LEAF SPRING SUSPENSIONS**

For most leaf spring suspensions, the rear suspensions on most sprint cars, or any system where the spring or torsion bar arm serves as a suspension member, we have to use a different technique. We can't remove the spring in such cases, but we can remove or disconnect the shock. So what we do is measure wheel load at both ends of a measured travel interval, with and without the shock, and compare the amount of load change with and without the shock.

In a big spring Stock Car, or any case where the spring neither mounts on the shock nor acts as a suspension member, we can use either method.

We can also calculate the gas spring force change over a displacement interval if we know the shaft diameter, the gas chamber / separator piston diameter and the pressure at the beginning or end of the displacement interval.


**Non-adjustable dampers and leaf springs are hard to find in motor racing today and tend to be the preserve of historic formulae**

It is best to model the compression as adiabatic compression, rather than constant temperature. Some readers may not be familiar with the difference, so I will briefly explain: if a body of gas is maintained at a constant temperature, and compressed to a smaller volume, the absolute pressure (pressure relative to total vacuum, or gauge pressure plus roughly 14.7psi atmospheric pressure) is inversely proportional to the volume.

$$P_1 = P_0 (V_0 / V_1) \qquad (1a)$$

where,

**$P_0$ = absolute pressure before compression, psi**
**$P_1$ = absolute pressure after compression, psi**
**$V_0$ = volume before compression**
**$V_1$ = volume after compression**

Or, using gauge pressure, with English units:

$$P_1 = (P_0 + 14.7)(V_0 / V_1) - 14.7 \qquad (1b)$$

However, when we compress a gas, it doesn't stay at constant temperature, it gets hotter from the compression, and the temperature rise exaggerates the pressure increase. If we let the gas sit long enough to cool to its previous temperature, we get the pressure given in equation (1a) or (1b). But, when a shock is in operation, there normally isn't time for that to happen. The behaviour is therefore better approximated as adiabatic compression, where heat is not lost from, or added to the system.

In adiabatic compression, the absolute pressure after compression is inversely proportional to the volume ratio raised to the power of 1.4, which is called the adiabatic exponent.

$$P_1 = (P_0 + 14.7)(V_0 / V_1)^{1.4} - 14.7 \qquad (2)$$

A shock with a 46mm gas chamber and a 14mm shaft has a shaft cross-sectional area a bit less than a tenth of the separator piston area, so the separator piston moves about a tenth of an inch for each inch the shock compresses, or a little less. If the gas chamber is one inch long at half an inch extension from static length, it will be about 0.9in long at half an inch compression from static length, and its pressure will increase about 15 per cent. That will increase the shaft force by the same 15 per cent. If the shaft force is around 50lb before compression, it is then around 58lb after compression, for a spring rate of 8lb/in.

**"The behaviour is better approximated as adiabatic compression"**

If we cut the pressure in half, we get around 4lb/in. If we double it, we get around 16lb/in. If we double the size of the gas chamber, that halves the rate.

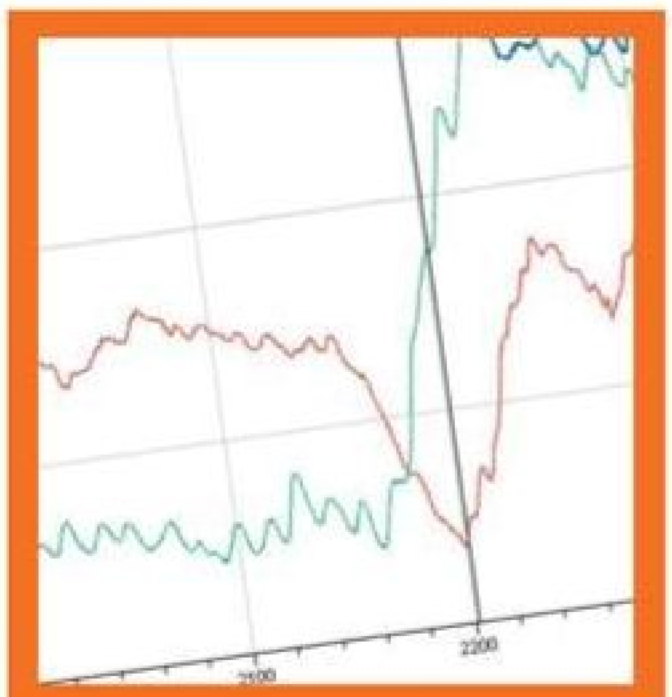
So there is an effect from changing the gas spring pressure, but it is small in terms of spring rate. It is bigger in terms of ride height, but we can adjust that on a racecar. It will have an effect on ride heights and wheel loads if we set up the car with the shocks disconnected. However, I do not recommend doing that when the shocks have significant gas spring effect.

One advantage of having a low gas pressure is that temperature will have a smaller effect on ride heights and wheel loads. At recommended pressures, change in wheel loads with temperature is not usually a big concern, but the effect is a reason not to go with extremely high pressures.

Cavitation is localised boiling of the fluid, either in the passages through the piston or on the trailing side of the piston. It causes jerky, erratic and sometimes vibratory damping action, and is tough on the hardware as well. The gas pressure is there to prevent it. It is hard to predict exactly when cavitation will occur, but we can say that it becomes more likely as shaft velocity increases, as temperature increases and as damping force increases.

It is possible to design a shock to run with no gas pressure at all, or very little, but that requires the use of a foot valve, or a through-shaft configuration. Actually, for a through-shaft design, it is desirable to have pressure, but the pressure doesn't result in a shaft force. As long as cavitation does not occur, gas pressure has little effect on damping behaviour.

Because of the problem of cavitation, and because the rate of the gas spring is small and the effect of charge pressure on overall spring rate is small, I recommend adhering to the manufacturer's recommendations when choosing gas pressure for a conventional single-tube gas shock with no foot valve.




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

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

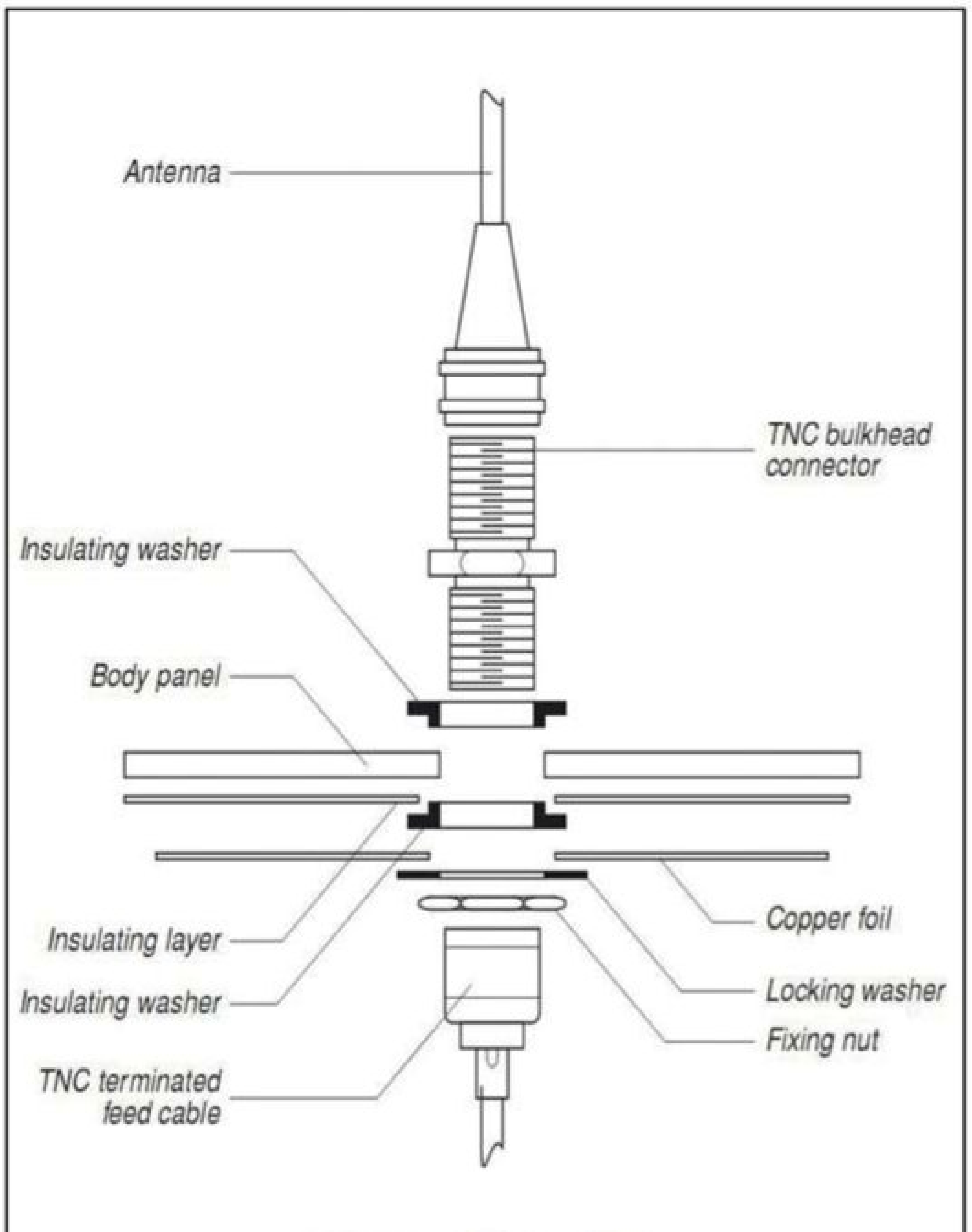
# Telemetry considerations

## Some thought in setting up a system will yield benefits in terms of quality of data

The ability to transmit data from a racecar live back to the pits offers some great advantages when it comes to race strategies and the general running of a car. It allows more than one set of eyes to monitor the car's health and to follow any parameter that could be interesting or beneficial to watch. Telemetry has therefore become a vital part of data systems in high-end racecars, at least in series where regulations permit its use.

### CAR-SIDE EQUIPMENT

Telemetry systems are effectively radios capable of transmitting data, so it is therefore important to make sure everything is done to optimise both the transmit and receive side of the system. Looking at the car side, the radio transmitter needs to be securely mounted, preferably on AV mounts, and away from any source of radio fequency (RF) interference, such as ignition coils, plug leads, alternators etc. The radio




Antenna installation detail

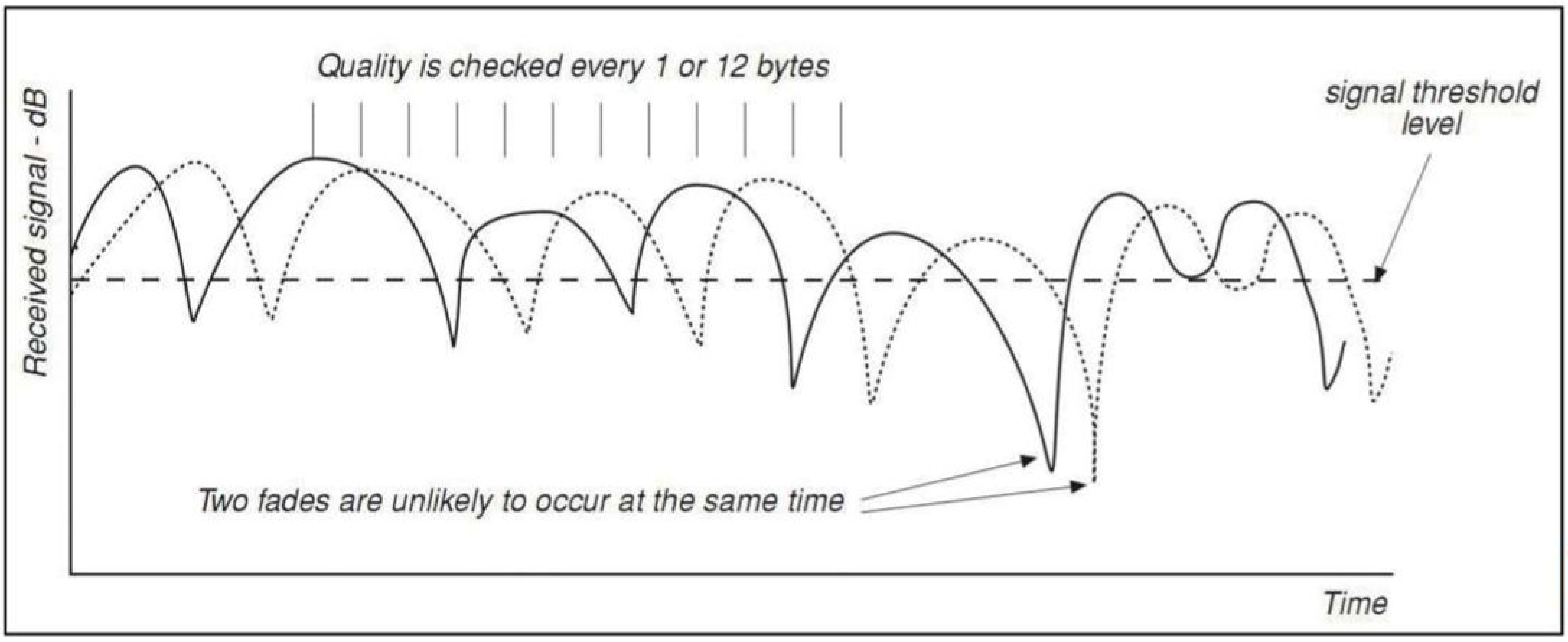



**Figure 1: graphical representation of multi-path fading, and how a diversity receiving function can avoid them**

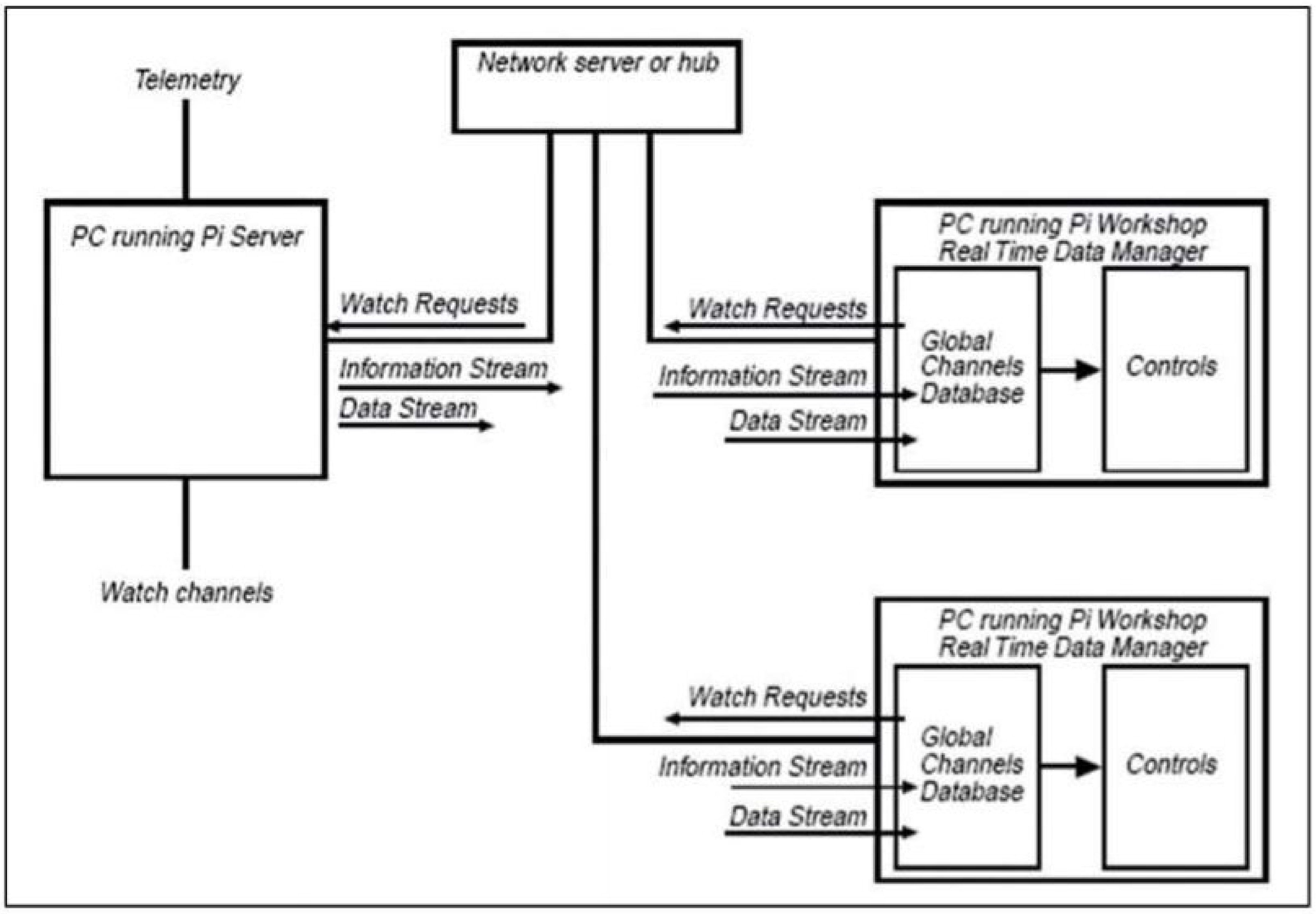



**Figure 2: real time broadcast network**

transmitter is also liable to get quite hot, so feeding fresh air to it can be beneficial. Equal attention should be paid to the car-side antenna. It is very important that this is isolated properly from the chassis of the car and that a suitable ground plane is constructed to reduce the amount of power reflected back into the radio module. In most cases, a suitable ground plane is relatively easy to construct using such as copper tape. The ground plane should be circular, with a radius equal to the antenna length, with the antenna sat in the middle. It is important that the ground plane does not make any electrical contact with any part of the vehicle that is likely to conduct, including carbon fibre. In cases where you might be mounting the antenna on a carbon panel, it is useful to have an insulating layer under the ground plane to ensure no electrical contact is made.

One other thing teams tend to overlook when it comes to telemetry is that the cable for the antenna is not a normal electrical wire. It carries an RF signal and therefore needs to be routed carefully and away from any sources of interference, just as with the radio itself. It is amazing the effect using high quality cables that are as short as possible, with no sharp bends and good quality connectors, can have on the telemetry reception.

### PIT-SIDE EQUIPMENT

The pit-side antennas should be mounted as high as possible and preferably at least 2m away from any other transmitting antenna. When there is no direct line of sight between car and pit, the reflected signals can destructively interfere with each other. This is generally referred to as multi-path fading. Using two antennas spaced at least 0.75m apart (or ¾ of a wavelength) it is possible to avoid any anti-node, a point where multi-path fading diminishes the signal strength. A good telemetry radio will monitor the signal quality from the two antennas and always choose the better of the two, thereby avoiding any anti-nodes.

It goes without saying that if the antennas for the pit side are far away from the pit-side radio receiver, the coaxial cable used needs to be good quality, with crimp-on TNC connectors. As a rule of thumb, use URM43 coaxial cable for distances up to 10m and URM67 for anything longer. Any join in the cable should be avoided.

Once the pit and car hardware are complete and set up, the data needs to be distributed amongst the team's engineers. For this, the most efficient way is to have one server computer that receives the data from the pit-side radio and then distributes this across an local area network. An example of a real time broadcast network can be seen in figure 2, where three computers have access to the data streams from the car.

It is good practice to keep monitoring the performance of the telemetry system, and a good way of doing this is to log the telemetry data set and then compare the received data with the current lap time. A maths channel can be constructed to do this automatically for each lap. It should then be a part of the data engineer's check list to note the telemetry coverage and flag any potential issues.

Below is a sample maths channel that can return the telemetry coverage



## SAMPLE MATHS CHANNEL

```
register @a1 = 0;
register @a2 = 0;
register @a3 = 0;
register @a4 = 0;
register @a5 = 0;
register @a6 = 0;

@a2=[Elapsed Lap Time];
@a3=choose(@a2<@a4,1,0);
@a4=@a2;

This part detects a falling edge every time a new lap is started

@a1 = choose(@a3==1,0,@a1);
@a1 = choose ([Engine RPM] > 0 , @a1+1 , @a1);

This part counts up only if the channel Engine RPM is available,
which is only true if telemetry is present and the counter is
reset every lap using the above falling edge reset

@a5= @a1/100;

Here we need to divide by the frequency at which the maths
channel is calculated in order to obtain our value in seconds

@a6 = @a5 / @a2;
@a6*100

The returned channel value as a percentage of lap time
```


-35mm
Worlds apart
Our technology centre is the most advanced in Europe.
That is how we can achieve a negative radius of up to -35mm. Extreme engineering and precision that other performance cam manufacturers in Europe cannot match. All our camshafts and ancillaries have been developed by the best to be the best.
Nº1 Kent Cams – the best in Europe:
No.1 for product development expertise
The greatest performance increase of any single modification
The widest range of camshaft ancillaries produced on site
The most advanced technology:
Negative radius to -35mm
CBN wheels with constant surface speed
Multi-angle lobes with CNC dressing
Marposs 3D C and Z axis position probe
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**Tel:** +44 (0) 2476 355000
**Email:** enquiries@mira.co.uk
**Website:** www.mira.co.uk

# Tuning for drag

## Dallara F3 cars in the wind tunnel for the last time

For the last time in this series, we delve into the aerodynamic details of the new and previous generation F3 Dallaras in the MIRA full-scale wind tunnel. This month we look at the rear wing as a potent drag adjuster and balance tuner, and also at the effects of some of the pre-2012 aerodynamic paraphernalia.

To briefly re-cap, we had at our disposal an F308 in 2011 specification, and what at the time of our test last winter was a very recently delivered F312. Our feature in *Racecar Engineering* V22N6 described the F312 in full but, in short, the F312 featured cleaner bodywork with less aerodynamic 'clutter', a higher nose, a larger front wing (with no raised centre section) mounted slightly further forward, and a sharply terminated engine cover with a gearbox top shroud below.

### REAR WING

On a single-seater racecar, the rear wing is not only a major downforce generator, it can also create a significant contribution towards total drag. And, unlike the wheels, say, about which you can do very little, the rear wing is adjustable and, as such, is the most important drag adjuster on the car. This applies to Formula 1 cars just as much as the Formula 3 cars we are looking at here. But F3 cars have perhaps 210bhp at their disposal under the current engine restrictor regulations, so it's fair to say that drag plays a bigger role in achieving best lap time in F3 than in F1.

F3 rear wing assemblies must be made up of no more than three elements, whose profiles are defined in the regulations. One of these elements is used as the lower wing mounting beam, so that leaves teams free to juggle the top two elements. Sometimes, on tracks with long straights like Monza, they run just one top element, or flatten off the two elements to a very low angle. Elsewhere, it's about tuning the top elements as a pair.

Here we illustrate the results of sweeping the two top elements from minimum to maximum angle, and **figure 1** shows the effect on the drag of the two cars. Note that the front wing was at its minimum angle in both cases, although front wing angle had only a small effect on total drag (16 'counts' on the F308 and 24 counts on the F312, where 100 counts is a coefficient change of 0.100).

So, over the adjustment range investigated, there was a difference of around 15 per cent in drag on both cars, and clearly if one of the two upper elements were to be removed altogether then this range would be extended. But what effect does this have on the cars' aerodynamic balance? **Figure 2**, overleaf, illustrates.

Once again, we can see that the 2012 car had a more forward bias, the result of its more potent front wing arrangement. But in terms of the total shift in

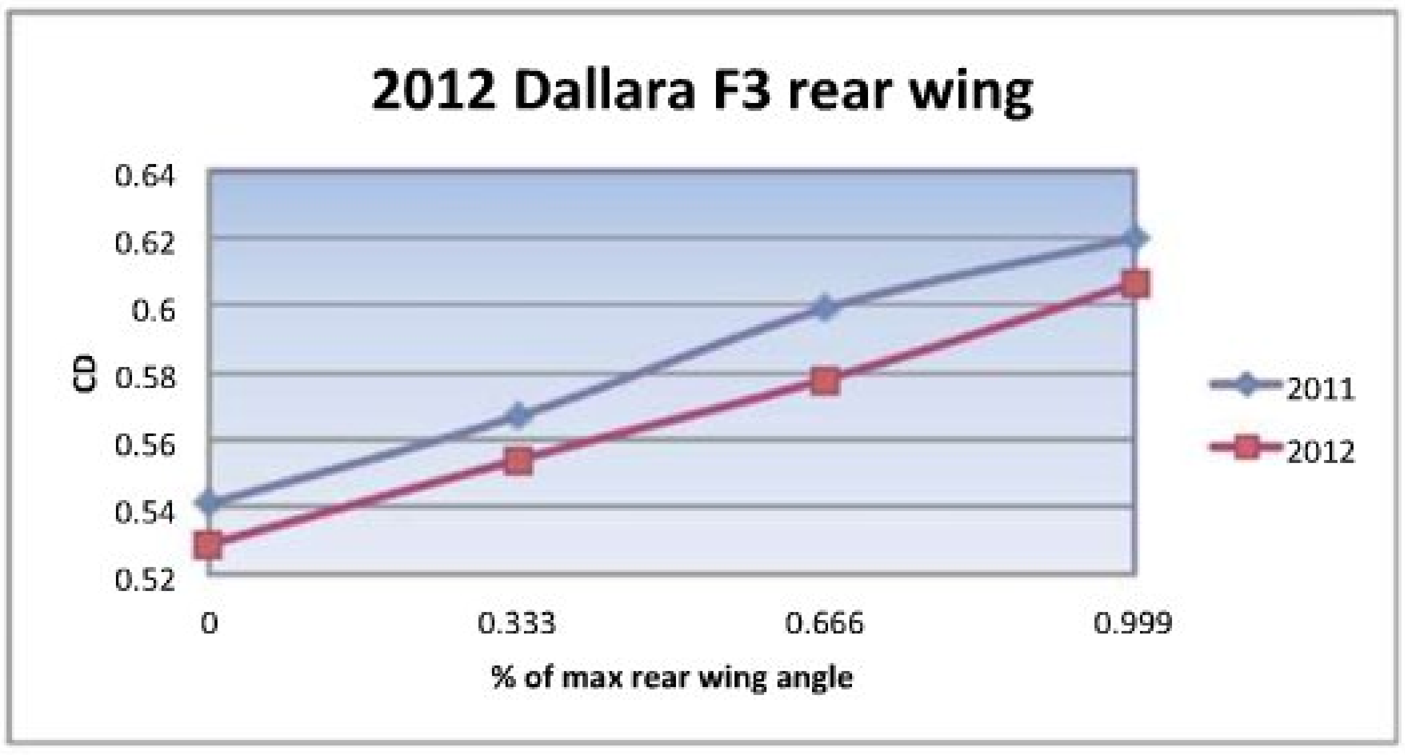
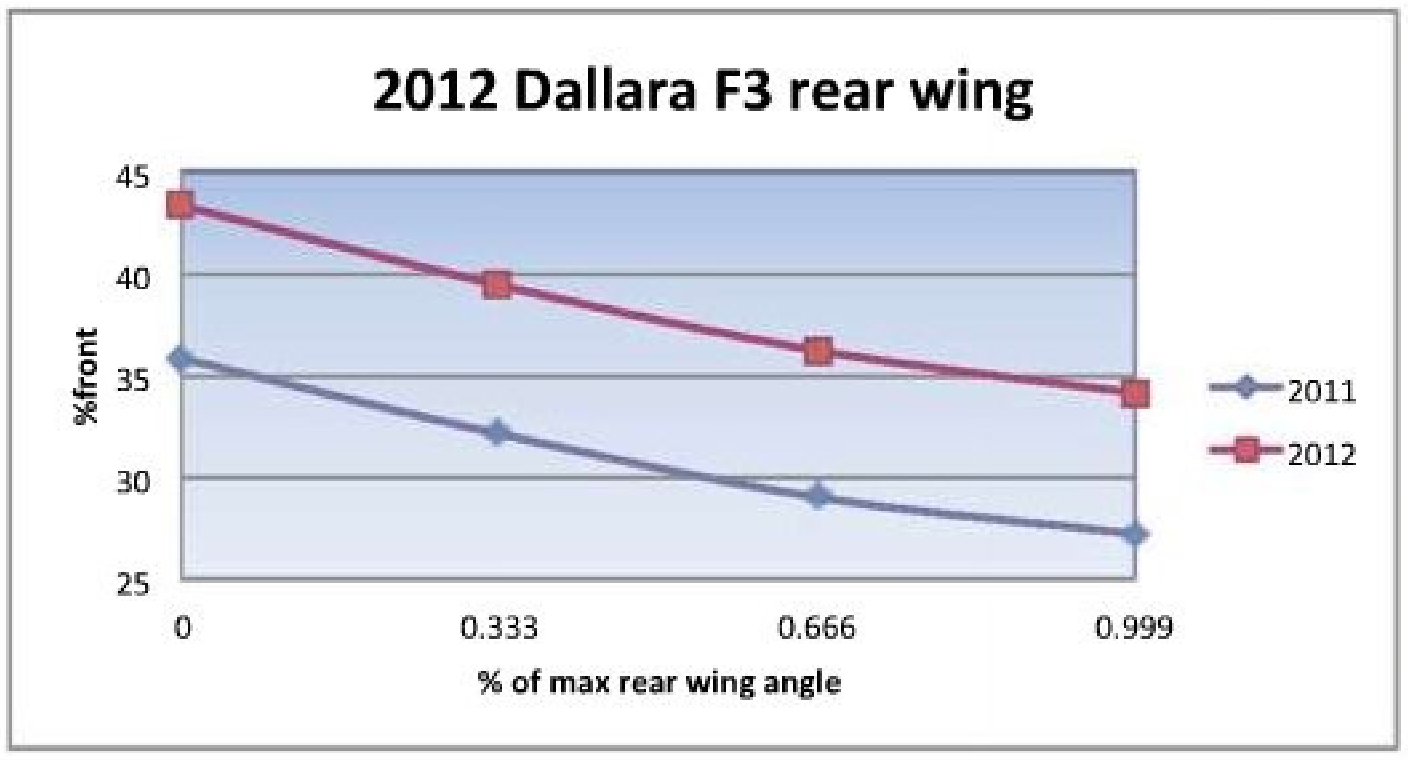



**Figure 1: the effect on CD, overall drag, of changing rear wing angle**

**Adjusting the rear wing on the 2011 Dallara F308**

**The rear wing is a potent tuner of balance and drag on an F3 car**




The effect on '%front', or aerodynamic balance, of changing rear wing angle

The 'front sidepod fenders' were quite efficient


The rear wheel 'flip-ups' were even more efficient


The twin turning vanes under the front wing were also effective

'%front', or the proportion of total downforce felt at the front axle, both cars saw about a nine per cent shift in %front across the range of rear wing adjustment. With a target in the region of 40-42 per cent of total downforce on the front to roughly match the static weight distribution, the 2012 car could obviously be balanced with the rear wing at just under a third of its available angle of attack with the minimum front wing angle used here. The 2011 car, however, would need the front wing angle to be raised in order to attain a balance even at the lowest rear wing angle here.

## PRE-2012 PARAPHERNALIA

The remaining minutes of our session on the 2011 F308 saw a few of the add-on bodywork devices removed from the car, one at a time, so we could measure their effect on the car's aerodynamic parameters. The first of these were the devices known to the team as the 'front sidepod fenders', the vertical vanes attached just outboard of the front of the sidepods. The results, shown as Δ (delta) values show the change in counts of adding these devices, and we can see that adding them produced a quite efficient, forward-biased downforce increment of 31 counts of downforce for 10 counts of drag.

Next, the rear wheel flip-ups were removed, and the results of adding them are shown in **table 2**. Once again, an efficient downforce benefit was gained with the flip-ups, and this time the bias was towards the rear, although there was also a gain in front downforce. The mechanism here would most likely be of the flip-ups acting as conventional inverted but very thin wings.

Finally, before the session ended, there was just time to remove the turning vanes from under the front wing main element. There were two pairs of these, outer and inner, and the outer ones were removed first and the inner ones second. **Table 3** shows the results of adding the inner ones first, followed by the outer ones. In this case, the inner turning vanes had a very small effect, adding a little rear downforce but having almost negligible effect at the front. The outer turning vanes were quite another matter though, adding a decent downforce increment for negligible extra drag, and they provided a forward balance shift in the process. Of course, we cannot tell if the inner and outer turning vanes were acting jointly, or whether the outer ones were doing all the work and would have done just as much on their own. If their mechanism was to control the wing tip vortex and steer it in a way that helped the wing and other downstream components, then one suspects the outer ones on their own would have done most of the job, but perhaps not as well as the combination did. Nevertheless, the benefit of having them both there was clear.

**Next month** sees the start of a new mini series, this time focussing on a 2007 F1 car. *Racecar Engineering*'s thanks to Fortec Motorsport.

**Table 1: effect of adding 'front sidepod fenders'**

| | ΔCD | Δ-Cl | Δ-CLf | Δ-CLr | Δ%front | Δ-L/D |
|---|---|---|---|---|---|---|
| + 'fenders' | +10 | +31 | +27 | +4 | +1.1 | +11 |

**Table 2: effect of adding rear wheel flip-ups**

| | ΔCD | Δ-Cl | Δ-CLf | Δ-CLr | Δ%front | Δ-L/D |
|---|---|---|---|---|---|---|
| + flip ups | +10 | +45 | +10 | +36 | -0.5 | +37 |

**Table 3: effect of adding inner, then outer turning vanes under the front wing**

| | ΔCD | Δ-Cl | Δ-CLf | Δ-CLr | Δ%front | Δ-L/D |
|---|---|---|---|---|---|---|
| + inner | +2 | +5 | +1 | +4 | -0.3 | +1 |
| + outer | +1 | +53 | +38 | +15 | +1.4 | +87 |


AP RACING

# The hills are alive

**A tie-up between the UK's All Wheel Drive Club and the organisers of King of the Hammers has produced the UK's first off-road Challenge event**

BY LAWRENCE BUTCHER

Off road racing does not achieve a great deal of exposure in the UK. Beyond the odd appearance on mainstream motoring shows, people are generally not aware of its existence. This probably has something to do with the UK's lack of accessible off-road driving areas, with the majority of the country's small highways and byways closed to motor vehicles, thanks primarily to the protestations of the environmental lobby. There are some competitive off-road events regulated by the MSA, which tend to take the form of either 'Safari'-type rallies – essentially sprints across rough terrain – or 'Expedition'-type events, that are slower paced but involve more extreme terrain. However, this situation looks set to change, thanks to a tie up between the UK's All Wheel Drive Club and the US organisation responsible for the King of the Hammers event – what could fairly be called the toughest off-road race in the world. The result is an event called 'King of the Valleys' and runs to what has been dubbed a 'challenge' format. This combines the high-speed style of the Safari-type events with some extreme rock crawling sections, in a similar style to the King of the Hammers event covered in *Racecar Engineering* V22N4.

**Held in the area known as Walter's Arena in Wales, the terrain includes woodland sections and boulder-strewn tracks**

**Component damage is the biggest hurdle the racers face. The twisted splines on this driveshaft say it all**

### VARIED TERRAIN

The UK event could not be much further removed from the US competition in terms of location. While the American racers compete in 200,000 acres of desert set aside for the purpose, the King of The Valleys is held in the Welsh hills, just north of Cardiff, at a venue called Walter's Arena. This is one of the UK's few large off-road racing areas, and has a mix of forestry tracks and boulder-strewn climbs, making it a favourite with OEMs testing their all-terrain kit. The going is highly varied, helped in part by the unpredictable nature of the Welsh weather (well, not that unpredictable, it tends to rain). The King of the Valleys course prescribed a tortuous 39-mile route around the area, with the intention being to complete the track in the fastest possible time, with competitors having to complete a total of four laps over a race weekend. For competitors, this was a new experience and no one really knew what to expect, so they could only prepare as best they could for the inevitable punishment over just shy of 160 miles of racing.

In the US, this type of off-road racing stemmed from a mixture of Baja-type desert races and the activities of the rock crawling fraternity, with competitors' vehicles based on either jeeps or one-off buggies. In the UK, however, the stalwart of the off-road community is the Land Rover, which holds the same mythical status as the jeep does in North America. It was therefore not surprising that the majority of the field was made up of highly modified Land Rovers, invariably based upon the classic Defender body style. The basic layout of these vehicles, for those not familiar with their details, consists of a ladder frame chassis, with a front-mounted engine driving all four wheels through a transfer box. The axles are of the solid variety, allowing for excellent wheel articulation, and power is normally provided by either a four-cylinder diesel of Rover V8 of between 3.5 litres and 5.0 litres. Very few components remain standard, with common modifications including heavy duty steering rods and differentials, attached to uprated axles with dislocation cones in the suspension. These allow the springs to detach from the locating points, giving increased axle articulation – vital when crawling over boulders up to a metre in height. Every single vehicle was also fitted with winches front and rear, to drag them out of situations where wheels are of no help at all.

**"a tortuous 39-mile route... just shy of 160 miles of racing"**

### POLARIS OPPOSITE

Despite the proliferation of these vehicles, there were other types present, ranging from custom built, tube-framed racers down to a diminutive 'Polaris' buggy. This tiny vehicle was of particular interest as it took a different approach to addressing the demands of the competition. For

Land Rover Defenders are the weapons of choice in UK off-roading. With surprisingly few modifications they are very capable competition vehicles

Suspensions are often largely standard in design, but with uprated components and dislocation cones on the springs to allow for increased axle articulation

Purpose-built buggies are still unusual in European off-road competition, but this long-travel entry had been built with speed and crawling events in mind

Bead lock wheels are essential, with tyre pressures as low as 10psi used on the rocky sections, which makes for 'interesting' handling on the fast gravel sections

most, the approach was build it bigger, build it stronger. However, the Polaris was the complete opposite, relying on light weight to survive. While super heavy duty vehicles are no doubt tough, they also have an awful lot of inertia – most weighing upwards of two tons – which not only means they needed more power for propulsion, they also had a lot more energy when they hit immovable chunks of Welsh mountainside. The Polaris, on the other hand, weighs in at a mere 600kg, and was essentially a standard production ATV with just the addition of a more substantial rollcage to suit British MSA regulations. The only other modifications were the addition of a winch and onboard generator to provide power as the vehicle's engine does not feature an alternator. Though the buggy lacked the massive wheel travel of some of the other vehicles, its very light weight meant it was easy to simply drag it over the rock sections that it could not straddle. Its light weight also worked in its favour in terms of durability, with the buggy tending to bounce off the scenery rather than crash into it, only recording a DNF due to a lack of spare tyres after punctures.

### SELF-BUILT RACER

Amongst the other competitors, the self-built racer of Frenchman, Nicolas Montador, stood out. Based around a chromoly tube frame and powered by a BMW V8, driving through a four-speed automatic transmission, it was built with Challenge-type events in mind, and King of the Valleys was its competition debut. The use of a chromoly frame allowed for a fairly svelte all-in weight of around 1600kg, while the long travel, solid axle suspension provided a good compromise between agility on the speed sections and rock crawling capability. Unfortunately, teething problems saw it only complete one competitive lap.

Talking to competitors, it was clear the biggest issue they faced – beyond destroying components – was selecting correct tyre pressures. The steep crawling sections require tyre pressures as low as 10psi. But running such low pressures seriously compromises handling integrity on the fast, flowing gravel tracks that are also part of the event. Several drivers did not hesitate to refer to their steering control as 'petrifying', after travelling at over 60mph on gravel on essentially flat tyres. This meant they had to try and calculate whether more time could be saved running faster on the road sections and relying more on their winches through the rocks than by retaining grip in the rocks and battling wayward handling at speed.

One thing was certain, the event format was more challenging than anyone expected. Supposedly indestructible components were ripped apart, and even the MSA rules governing the competition seemed counterintuitive, one competitor stating: 'The scrutineers are insisting that we have mudguards fitted half-way down the wheels. As soon as we back into a rock, they break off. This is our third set so far!'

The winners of the event, Italian outfit, Team Acerni, were rewarded with an all-expenses paid entry to the King of the Hammers event in the US, where no doubt they will learn many lessons from the more advanced cars raced in that competition. What is also clear is that while all of the competitors found the event format tough, they revelled in the challenge, and no doubt next year will see development of Challenge-specific vehicles gather pace.

# Designing from scratch Part 4

## 'Project Pipedream', otherwise known as the 'Vortex' hillclimber, grinds slowly along and our writer finds himself changing direction...

BY SIMON MCBEATH

While acknowledging the general wisdom of the idiom attributed to Abraham Lincoln about changing horses in mid-stream, it has to be said, with due respect to the former president, that whether or not it is a good idea rather depends on the horses, and the stream. If the risks are high, then sticking with the original horse generally makes good sense. But if there is little or no risk, and the swap gets you on a better horse, why not jump?

So it was over the past year with my 'Vortex' hillclimb car project, the last update on which we published in V21N10. Having spent a number of fascinating sessions in the MIRA full-scale wind tunnel recently on a variety of sports racers, slowly but irresistibly the realisation dawned that a sports racing concept offered more aerodynamic interest and, indeed, more potential than the originally envisaged single seater. With greater plan area than was possible within the single seater regulations, similarly few restrictions on underbody shape – apart from a 40mm minimum static ground clearance – full width wings and covered wheels, surely a highly efficient car could be created? Aesthetically too, sports racing cars have more appeal. So could the project be adapted in the UK hillclimb context?

### ENGINE CHANGE?

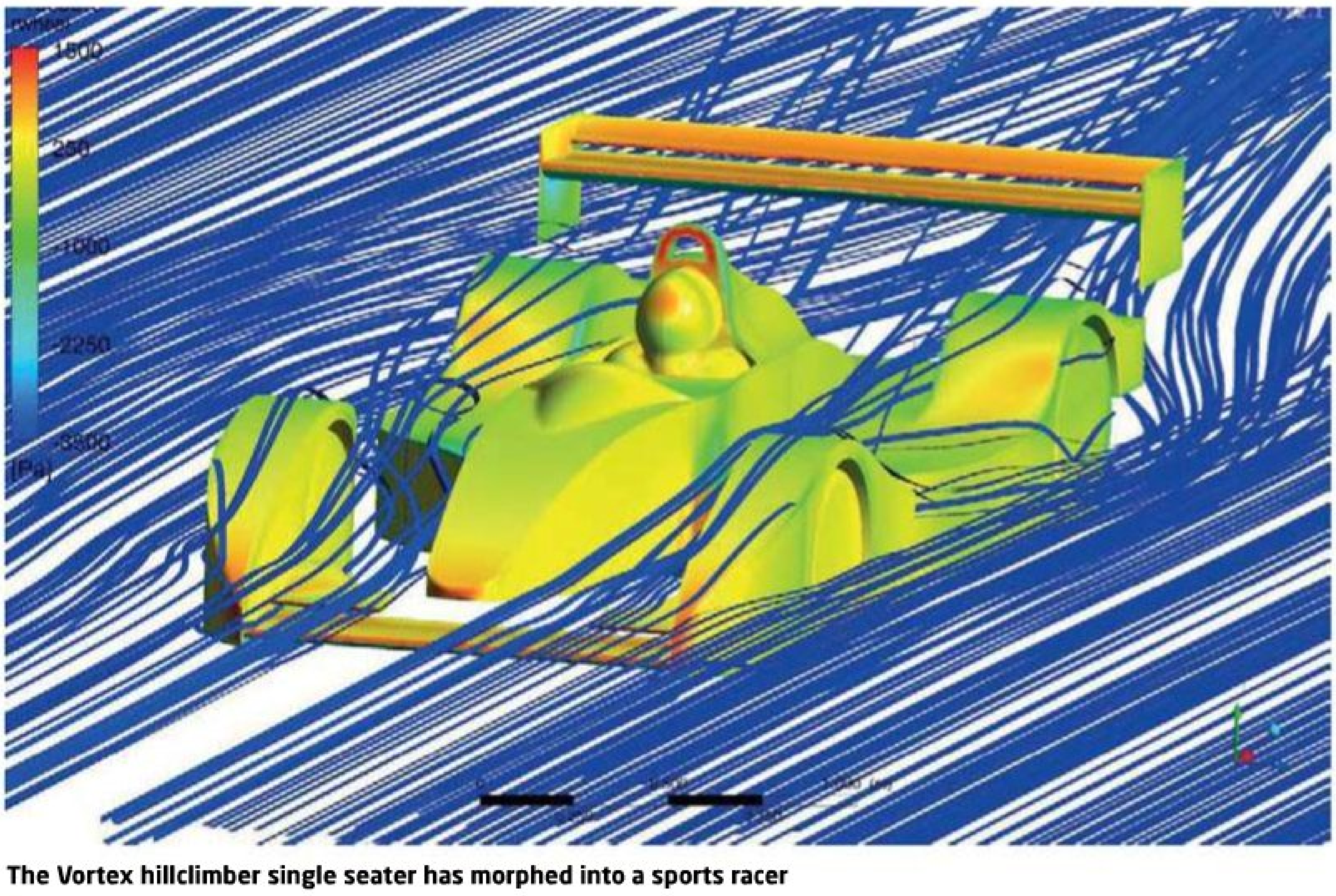
The original idea was to create a composite chassis single seater to run in the up-to-1100cc racecar class with a Suzuki GSX-R 1000 engine, although it was always in mind that a later switch to the up-to-1600cc class, or the up-to-2000cc class, might happen. However, the 'sports libre' category, as it is known in UK hillclimbing, which caters for 'pure' sports racers, as well as a wide range of what one might, without being derogatory, call 'misfits' from earlier superseded categories, features just two classes – up to and over 2000cc. The up-to-1400cc sports libre class was dropped many years ago, rather ironically in view of the popularity and availability of the Suzuki GSX-R Hayabusa engine, that starts life at 1300cc.

Anyway, the up-to-2000cc capacity sports libre class would be the one of choice and, at writing time, the most competitive cars are powered by either normally aspirated 1600cc Hayabusa-derived units or supercharged and turbocharged 1300cc and 1400cc variants of the same engine (a 1.4 equivalency factor applies to pressure charging). The 2.0-litre, bike-based V8 engines, and automotive engines like the Ford Duratec, plus the necessary transaxle in either case, are nice options, but at a price. So the bike-based options seem like far and away the best value.

> **"my challenge was to try my own idea on this new (to me) concept"**

### ONE SEAT, OR TWO?

The other main aspect to be decided upon is the number of seats. Purists would point out that 'sports racecars' are, by definition, two-seater vehicles, and the 2012 UK Motor Sports Association (MSA) Yearbook still states this. However, in recent seasons, a number of bespoke sports libre designs have appeared on the UK hills featuring a central driving position and a single seat, albeit within a cockpit that met the minimum cockpit width regulation of 32in (81cm). There were some grey areas in respect of the rollover protection system required, but the idea of a single-seater sports libre car was not out of the question. Nor should it have been, given the designs running elsewhere in the world, for example in the FIA European Hillclimb Championship, or where



The Vortex hillclimber single seater has morphed into a sports racer

Twin Hayabusa-engined Force SR8 and single-engined SR4 sibling featured a central driving position, but fairly conventional front aero treatment

The Force LM was the first sports libre car with a single seater-style front wing, plus front wheel pods, but the regulations mandated a wide chassis

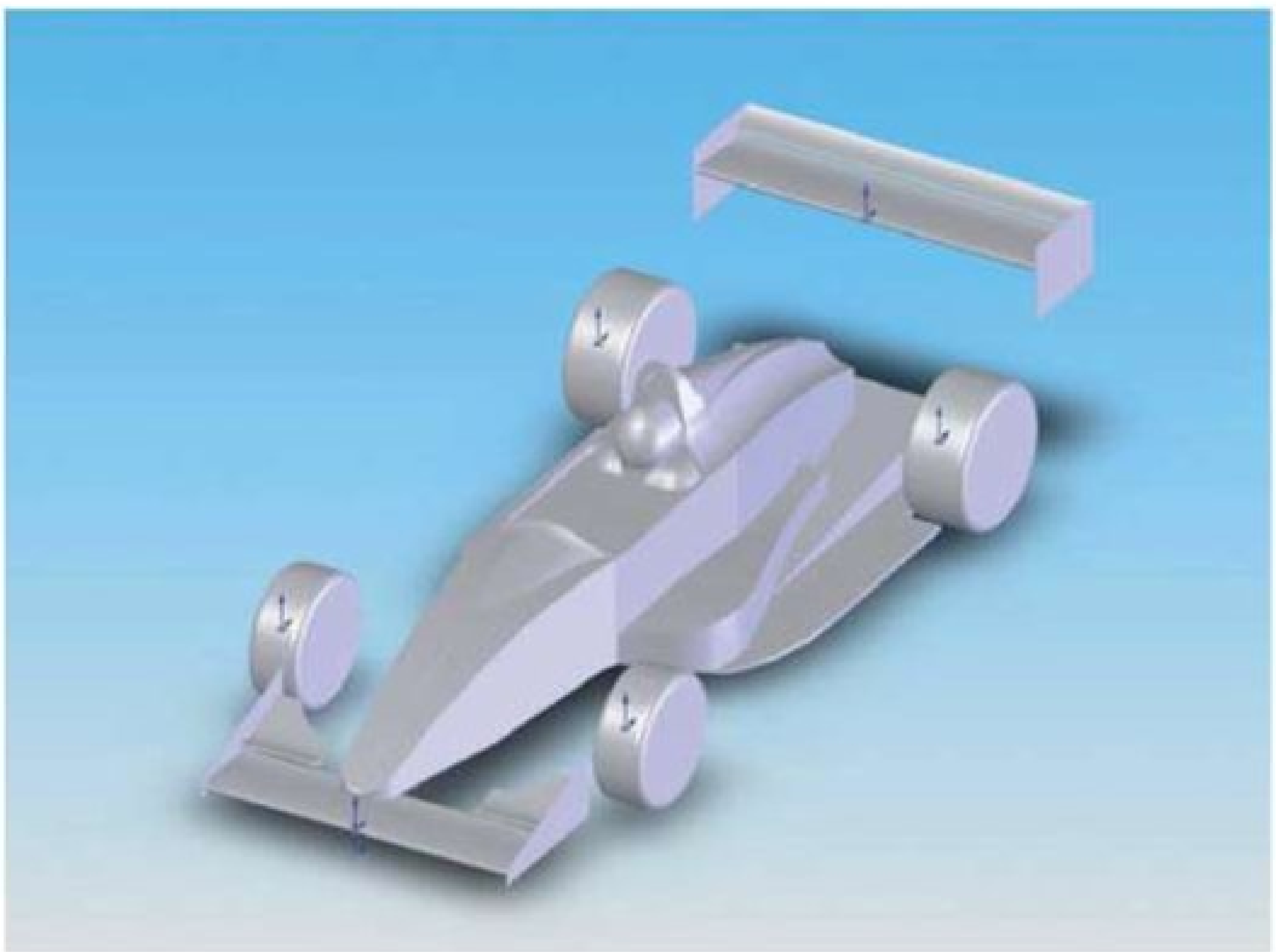


Figure 1: original single-seater Vortex concept in phase 1b guise, with raised nose, sidepods and ground effect underbody

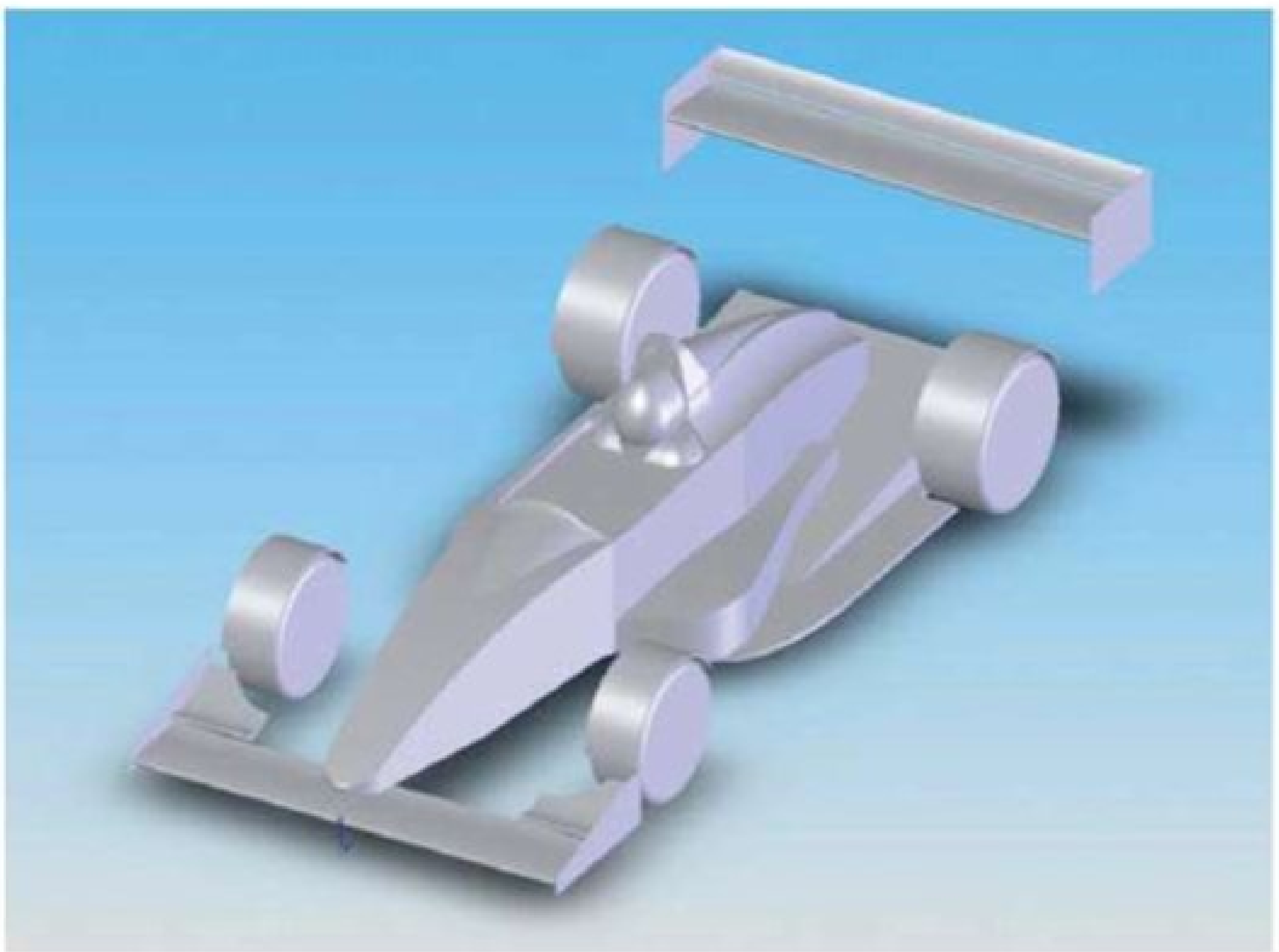


Figure 2: sports libre concept #1 – put wide wings and cycle-type mudguards on the phase 1b single seater

**Table 1: refinements to the single-seater model produced progress in the aerodynamic results, forces (N) calculated by CFD-Flo at 100mph air, ground and wheel rotation speed**

| Phase | Downforce | Drag | L/D | Net front Df | Net rear Df | % front |
|---|---|---|---|---|---|---|
| Phase 1 | 2729.2 | 731.8 | 3.73 | 1054.4 | 1677.0 | 38.63% |
| Phase 1b | 2986.5 | 745.8 | 4.00 | 1203.5 | 1782.9 | 40.30% |

Sports Car Club of America (SCCA) CSR and DSR regulations apply. And with my interest being focussed on creating the most aerodynamic design possible, my thinking was that a slim, central chassis would be the way to go.

Then the UK MSA re-jigged the sports libre regulations for 2012. An entirely new vehicle group was inserted into the rules to cater for, and I quote: 'any vehicle that does not comply with any other category, as defined in...' It then listed the clauses that defined all other hillclimb vehicles, including single-seater racecars. While the intent of this new rule may well have been to lump the aforementioned 'misfits' from previous superseded categories into one single new group, it was also possible to interpret it as permitting a single-seater sports libre design. Communications ensued with the MSA's technical department who indicated that their interpretation of this new rule would be the same as mine. And the basis of this interpretation was that a single-seater racecar clad with bodywork and aerodynamic devices to the dimensions specified for sports libre cars clearly no longer met the rules for single seaters, so it would therefore fall into the new sports libre category, providing it otherwise complied with the category regulations. And, as an 81cm (32in) cockpit opening would not be required, a slim chassis was possible.

Inevitably, it was not long before the grapevine revealed that others with a hillclimb car-construction pedigree had spotted the same opportunity, so there is no doubt I will be beaten to the track with the idea. And with manufacturers like Osella in European hillclimbing, and Stohr, West, Galmer and others in the SCCA-regulated CSR and DSR categories, the single-seater sports racer idea was far from new. What's more, the aerodynamic design of some of those cars appears to be quite thoughtfully worked out. So my challenge was to try my own ideas on this new (to me) concept, and I began with some broad brush investigations on a range of possible sports racing car 'templates' using simple CAD models and Ansys CFD.

## CONCEPT #1
## SPORTS LIBRE CONVERSION

Reviewing briefly where we last paused, with the aid of Ansys CFD-Flo it had been determined that fitting a narrow chassis, single-seater model with sidepods and an underbody to the maximum permitted width of 1400mm, together with wings to the maximum widths permitted (1500mm front and 1400mm rear), the front wing suspended under a raised nose produced the most effective aerodynamic results of the single-seater models tested during that phase of study. Further developments on aspects of the underbody were subsequently implemented on this phase 1 model with satisfying results, as shown in table 1 under phase 1b, although

**Table 2: the first sports libre concept**

| | Downforce | Drag | L/D | Net front Df | Net rear Df | % front |
|---|---|---|---|---|---|---|
| Sports libre concept #1 | 3157.3 | 905.6 | 3.49 | 1153.2 | 2003.8 | 36.52% |

**Table 3: the favoured sports libre concept**

| | Downforce | Drag | L/D | Net front Df | Net rear Df | % front |
|---|---|---|---|---|---|---|
| Favoured concept #2 | 4483.6 | 984.2 | 4.56 | 1940.7 | 2542.9 | 43.28% |

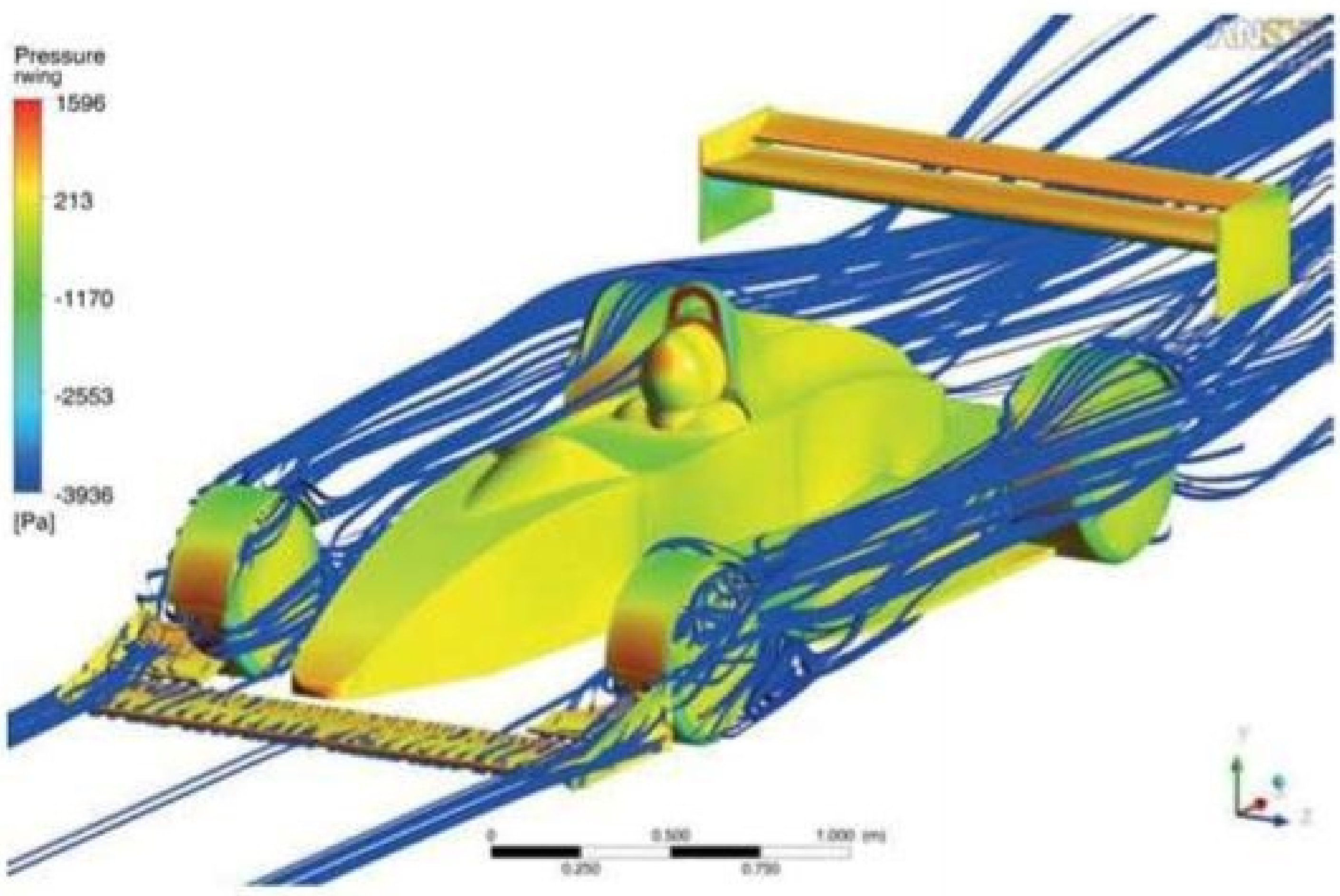



Figure 3: mudguards affected downforce and drag

Figure 4: concept #2 featured front wheel pods, a narrower front wing and sidepods enveloping the rear wheels

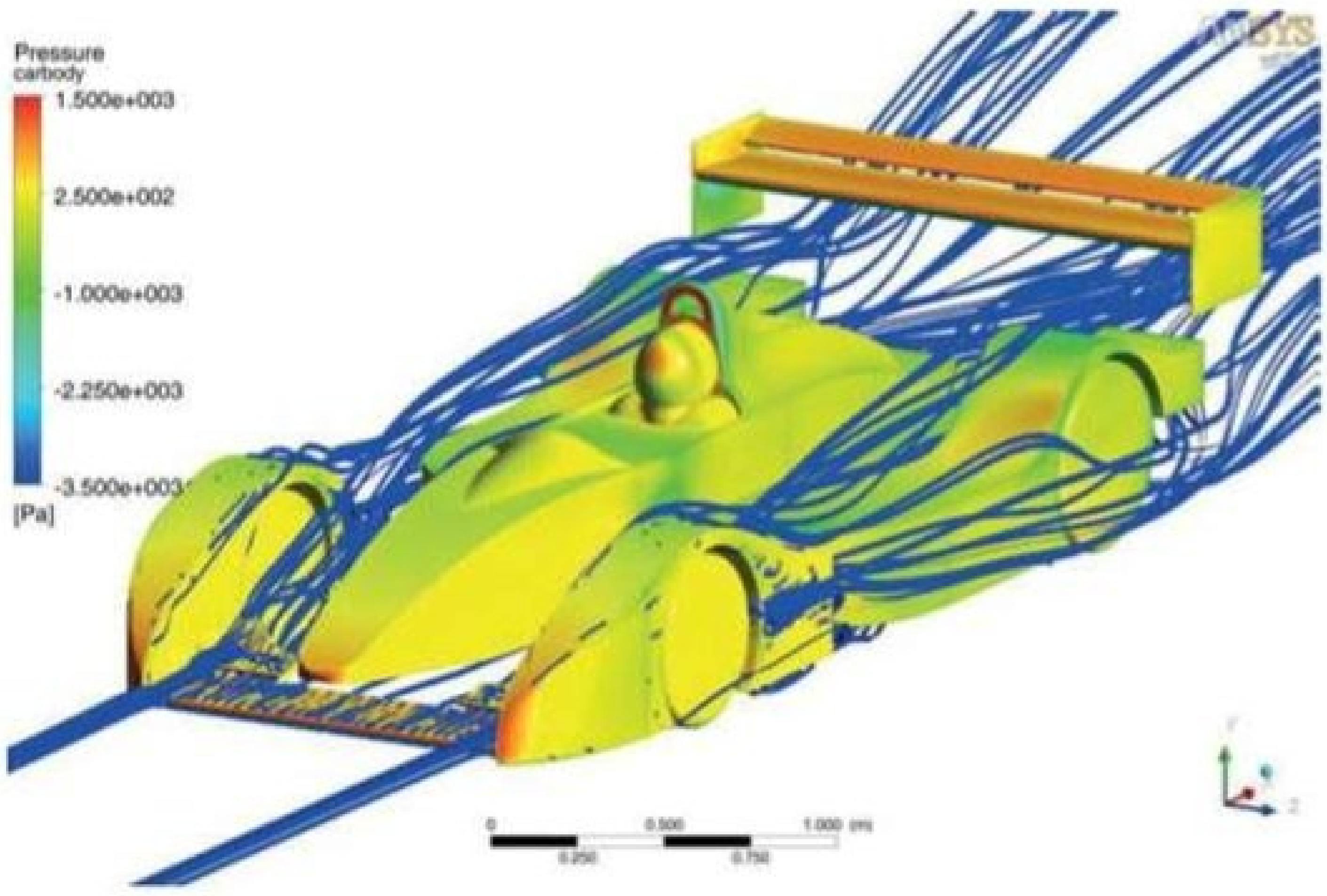



Figure 5: much improved aerodynamics with concept #2

there remained many avenues still unexplored (see figure 1).

Taking the concept from Phase 1b, and its data, as a new baseline then, the simplest step towards it becoming a sports libre car involved nothing more than increasing the wing spans to the car's maximum width (the rules actually permit them to be 20cm wider than this, but stopping at the car's width seemed sensible), and adding cycle-type mudguards to cover the wheels, certainly the lowest weight method of converting to sports libre (figure 2). The CFD results are shown in table 2.

These results looked rather disappointing, with just 5.7 per cent more downforce, but 21.4 per cent more drag. Clearly, there was no increase in underbody plan area with this simple first step, so the downforce gain was mainly due to the increased rear wing width, there being a decrease in front downforce. However, closer examination of the data showed that although there was an increase in front wing downforce, the combination of decreased forward underbody downforce and increased lift from the wheels and mudguards resulted in the decrease in calculated front downforce.

Of the increased drag, over 80 per cent of the increase came from the mudguards and wheels, and it seems probable the loss of body downforce was in part due to the messy wakes from the front wheels and mudguards adversely affecting flow to the underbody. This did not look like a good option, aerodynamically speaking at least. See figure 3.

**THE FAVOURED CONCEPT, #2**

So the next model to be evaluated was the concept that had been in mind since the outset of the sports libre phase, with wheel pontoons over the front wheels and a front wing between them and the chassis, full width sidepods extending over the rear wheels, and the full width rear wing, as shown in figure 4. The results achieved are shown in table 3.

Clearly this model produced a large increase (50.1 per cent) in downforce compared to the phase 1b single-seater baseline model, and 42 per cent up on sports libre concept #1 for a 32 per cent increase in drag over the single seater and just 8.7 per cent up on concept #1. The majority of the additional downforce relative to concept #1 came from the body. But, interestingly, the front wing saw an increase in downforce despite being considerably smaller in plan area (width) than on concept #1, presumably through the 'end plate effect' of the front wheel pontoons being more beneficial than the extra wing span ahead of the wheels and mudguards.

> **"Shapes were still very crude and detail optimisation had yet to be invoked"**

Additional drag relative to the single seater and sports libre concept #1 came mainly from the body, a function of increased frontal area, at least in part no doubt, although rear wheel drag was significantly reduced and the combination of front wheel and front pontoon drag was less than exposed front wheel drag and considerably less than the drag from wheels plus mudguards. This is shown in figure 5.

Overall, the efficiency of this configuration compared to the best single-seater model evaluated in phase 1b and sports libre concept #1 was a significant step forward. Yes, the drag was higher at this stage, but no refinements of the basic body components had been done as yet. Shapes were still very crude and detail optimisation had yet to be invoked. But before getting

Figure 6: concept #3 featured covered front suspension and a front splitter and diffuser instead of a front wing

Figure 7: despite bluff appearance, the drag of concept #3 was very similar to concept #2, but downforce was disappointing

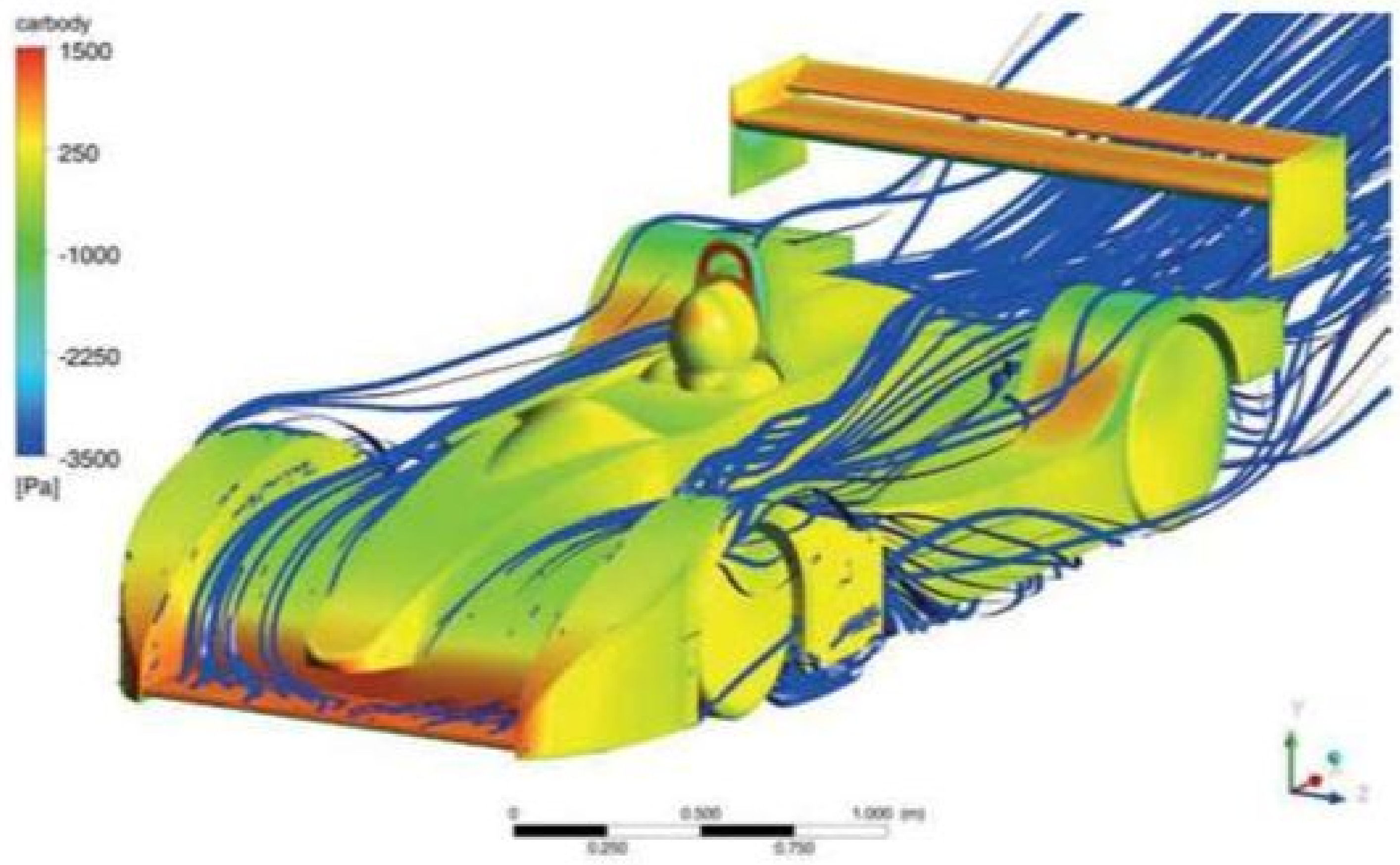



Figure 8: in concept #4 the front upper body integrated with the sidepods, but the splitter and front diffuser were the same as concept #3

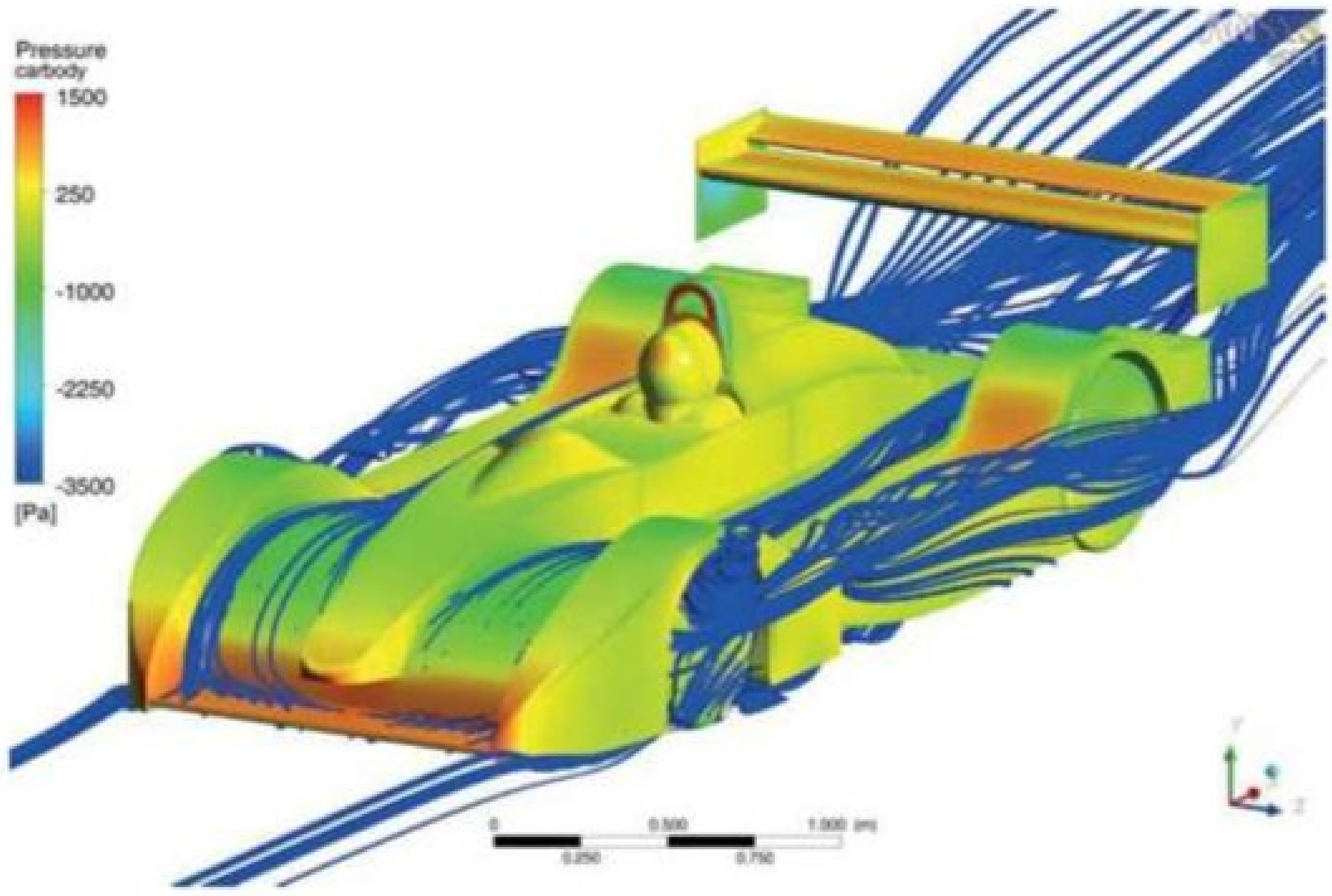



Figure 9: concept #4 saw a downforce improvement, but a shift in balance

into the detail, how would concept #2 compare to other sports libre options?

**CONCEPT #3**
**COVERED SUSPENSION**

Although the UK MSA's rules do not currently embody the following constraint, one of the requirements of the SCCA's CSR / DSR regulations is that suspension components must not be visible when viewed from above. So, the next configuration involved modifying the front end to incorporate a splitter with a diffuser that blended underneath into the raised chassis underside to replace the front wing and flap, and the splitter's upper surface butted up to a convex panel that curved over where the front suspension would be, between the front wheel pods and the central chassis. There was still a gap between the front wheel pods and the sidepods to provide a route for air to exit from the front diffuser (as shown in figure 6). This layout is not dissimilar conceptually to that of a number of the popular CSR / DSR cars in the USA. Table 4 provides the raw data.

Clearly, the first iteration of this concept did not work as well as 'favoured' concept #2. There was a reduction in total downforce of around 25 per cent and a big shift off the front end in terms of balance, suggesting, of course, that quite a bit of front downforce had been lost. And looking at the pressure distributions on the upper body in figure 7, it can be seen that the convex surfaces between the front wheel pods and the chassis, absent from the 'favoured' concept, are showing reduced pressure (green colouration), which would be generating lift. Furthermore, the flows under the splitter and in the front diffuser were less than optimal, which is something we will re-visit on the next concept. It's interesting to note that total drag was really very little different compared to concept #2, despite the more bluff front end. But downforce and efficiency were not as good as concept #2.

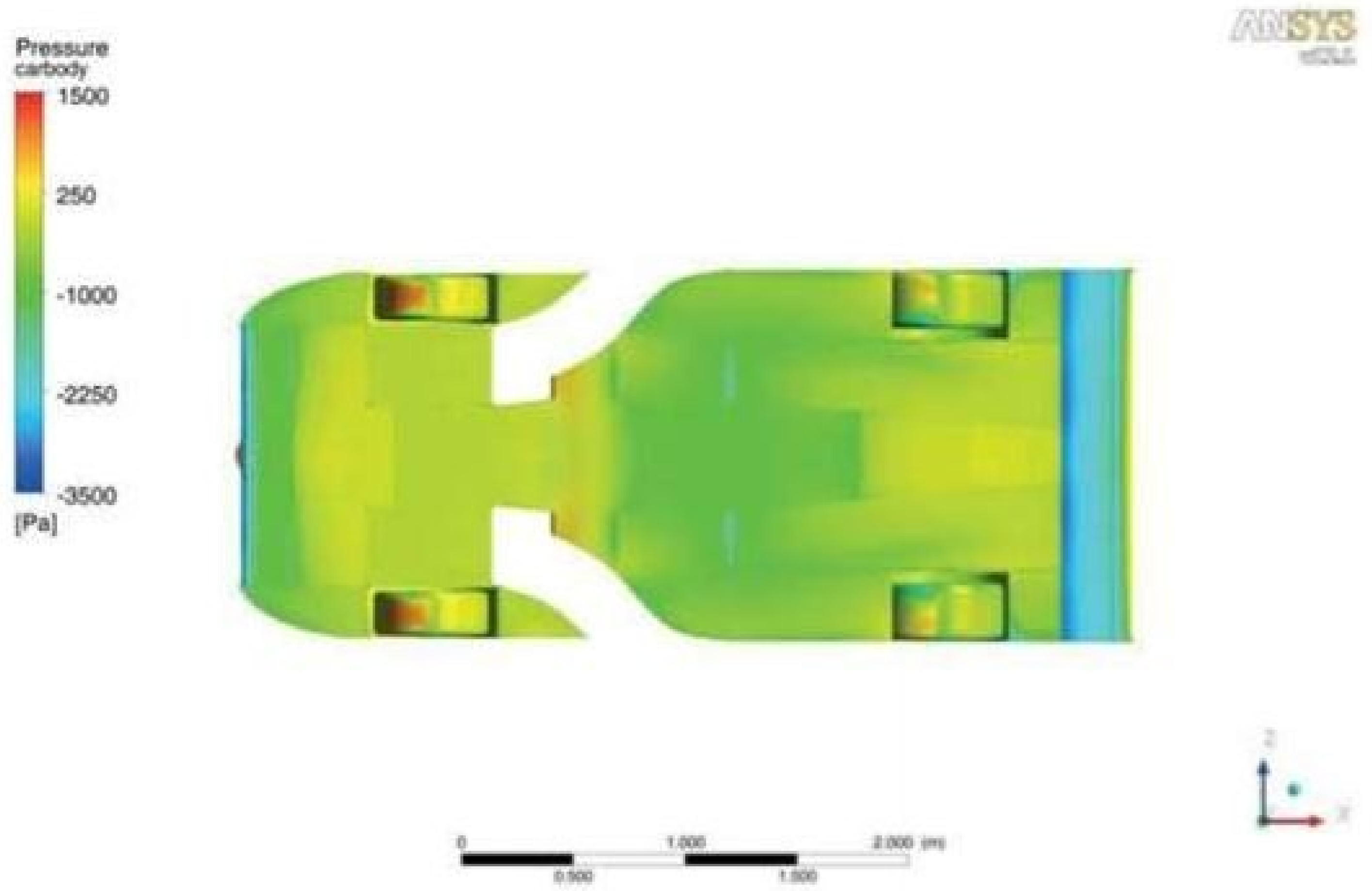
**"For once, it looks as though a preconception was actually correct"**

**CONCEPT #4**
**FULL UPPER BODY**

The final concept looked at during this phase was an extension of the previous one, where the forward upper body was continued further back to integrate with the upper surface of the sidepods. (as in figure 8). Again, there were large exits behind the front wheels for air exiting the front diffuser to escape, and the splitter and diffuser were the same as those used in the previous concept. This is a more traditional sports racer layout, and there are plenty of cars out there that broadly feature this concept running in Europe, the USA and elsewhere. Table 5 reveals all.

Interestingly, this produced more total downforce than the previous concept and slightly less drag, but the balance of downforce had shifted even more to the rear. Again, there seemed to be greater reductions in surface pressure on the convex upper surface between the wheel pods and the chassis than in the previous case (as per figure 9).

Overall, the main body, which includes the underbody too, produced significantly more downforce in this case, and a comparison of the static pressure on the lower surfaces confirm



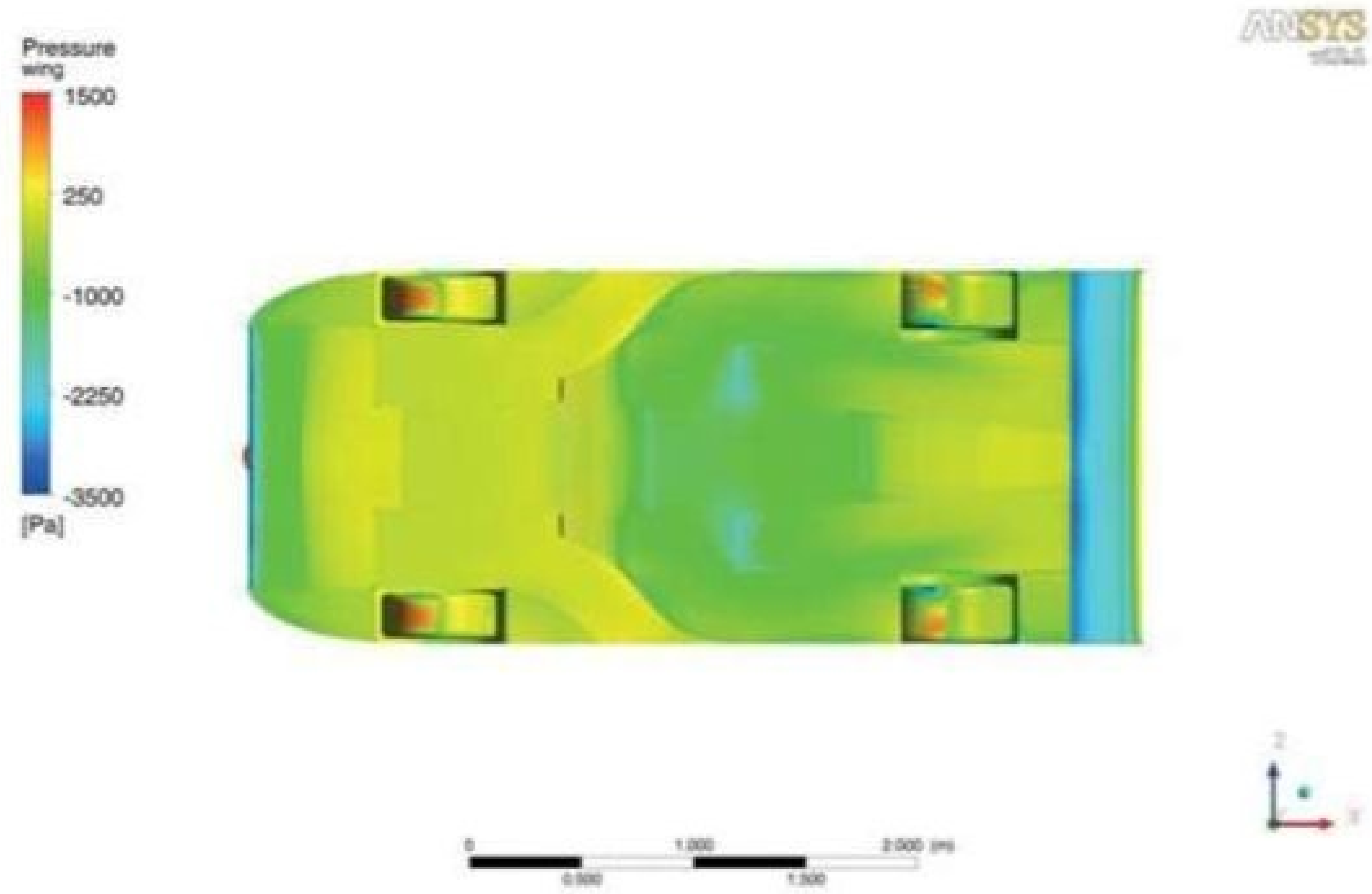




**Figure 10 and 11: the static pressure plots on the lower surfaces of concepts #3 and #4 show more low pressure (green / blue) in the front underbody of #4**

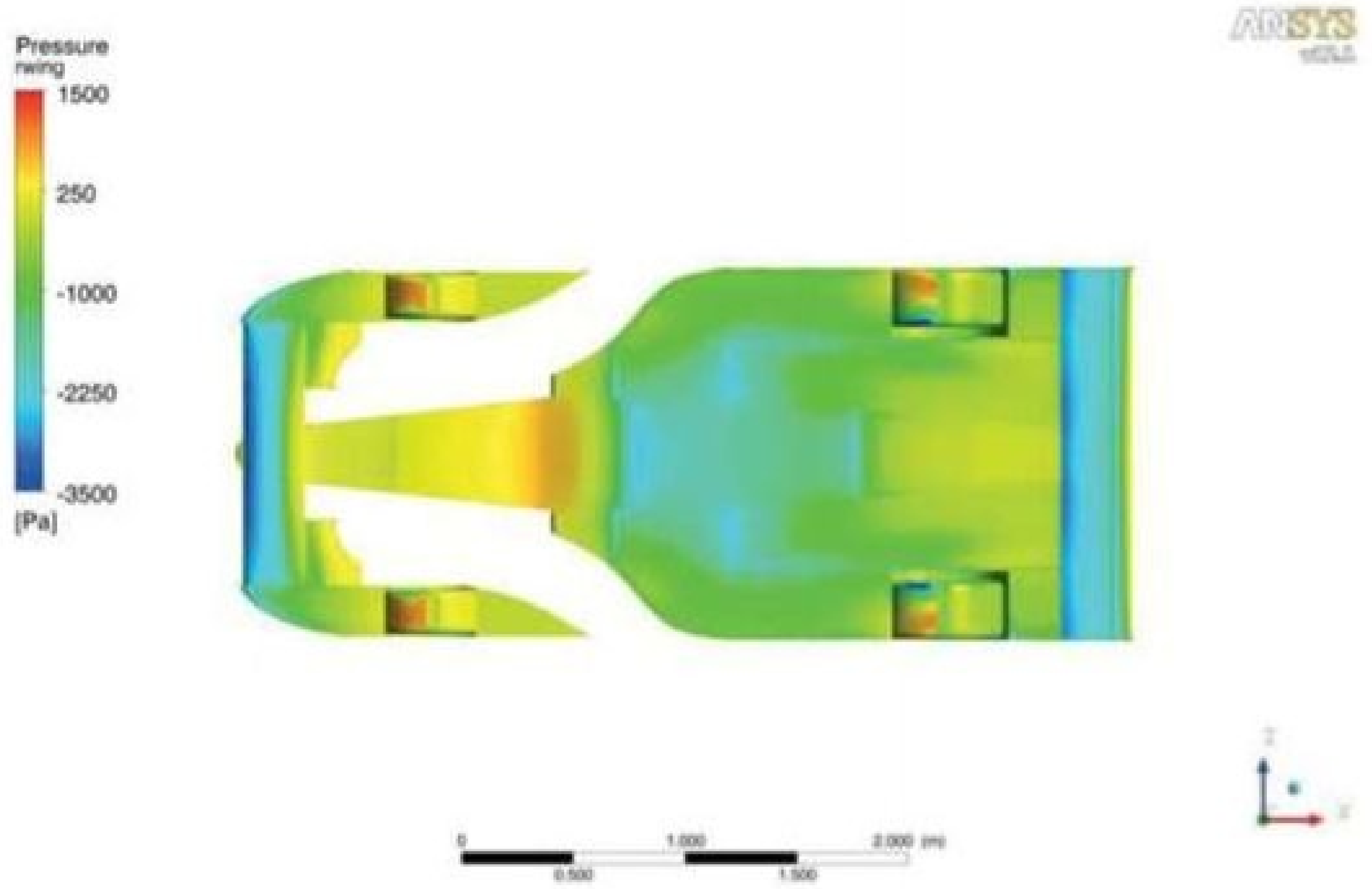



**Figure 12: the static pressure plot on concept #2's underside shows more widespread low pressure in the underbody, as well as under the front wing**

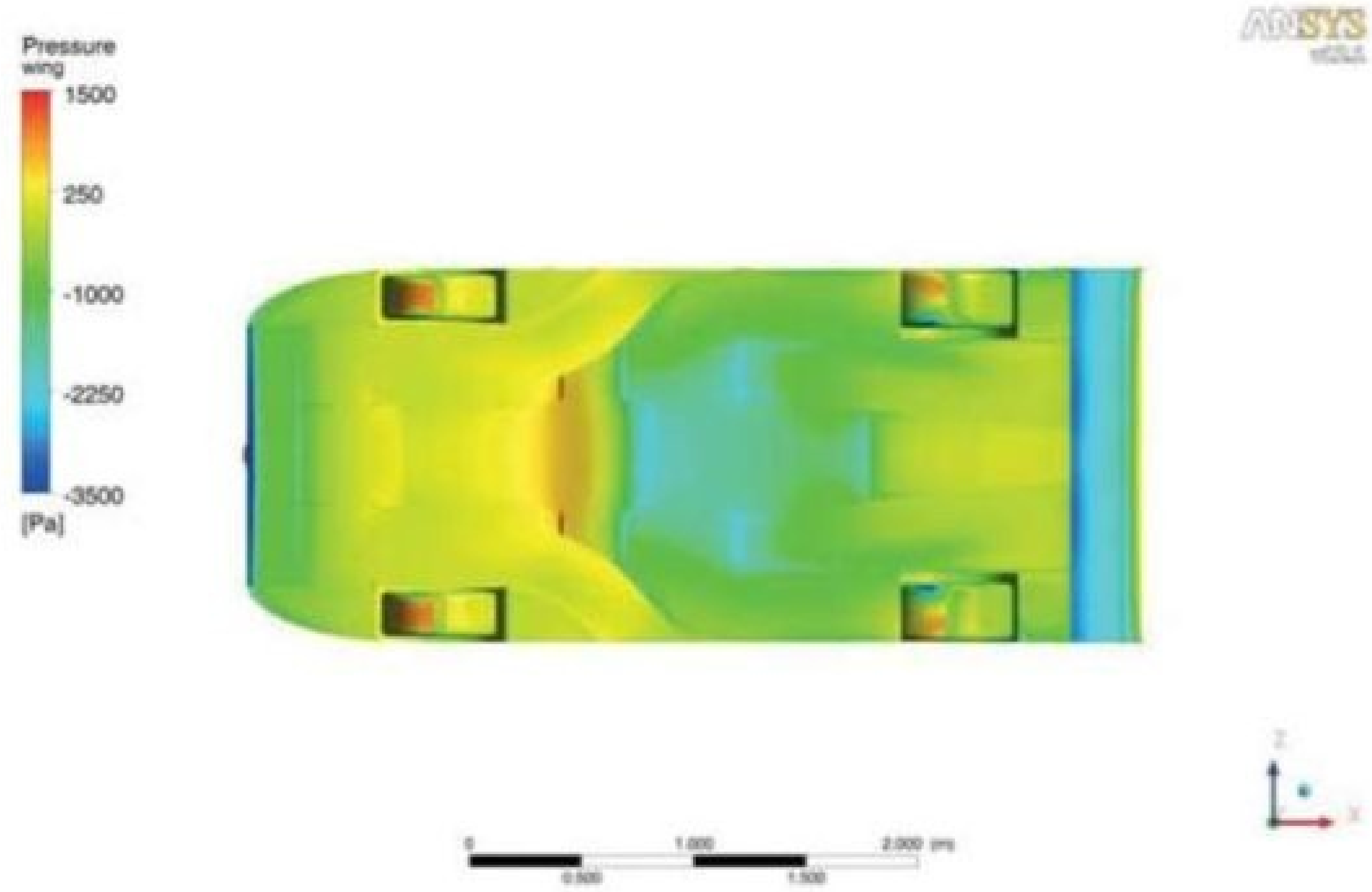



**Figure 13: with modifications to the splitter and diffuser, concept #4 was markedly improved, but still fell short of concept #2**

**Table 4: the front splitter / diffuser / covered suspension concept**

| | Downforce | Drag | L/D | Net front Df | Net rear Df | % front |
|---|---|---|---|---|---|---|
| Concept #3 | 3343.8 | 995.1 | 3.36 | 1126.8 | 2217.2 | 33.70% |

**Table 5: full upper body concept with front splitter / diffuser**

| | Downforce | Drag | L/D | Net front Df | Net rear Df | % front |
|---|---|---|---|---|---|---|
| Concept #4 | 3629.4 | 952.4 | 3.81 | 1174.0 | 2455.4 | 32.35% |

**Table 6: concept #4 with splitter and front diffuser modifications**

| | Downforce | Drag | L/D | Net front Df | Net rear Df | % front |
|---|---|---|---|---|---|---|
| Refined concept #4 | 3980.3 | 967.1 | 4.12 | 1400.9 | 2579.6 | 35.19% |

that the forward underbody of concept #4 did generate lower pressures than the previous model (as shown in figures 10 and 11). It is possible, therefore, that the extended body above the channels behind the front wheels was constraining more air to flow into the underbody, leading to faster flow and lower pressures.

However, the pressures were nowhere near as low as they were in concept #2's underbody (see figure 12). But just how might we explain that? Probably the front end of this configuration was sending less air over the upper body, encouraging more mass flow to reach the underbody, hence the airflow's acceleration was greater still and the drop in local pressure more pronounced as a result.

## SPLITTER AND DIFFUSER

It was mentioned earlier that the flow in the front diffuser of concept #3 (and, hence, also of #4) was less than optimal. In fact, the diffuser appeared to be stalled in the centre. As this was part of a 'quick look-see' phase, four simultaneous modifications were made to attempt to improve this. The whole splitter leading edge was raised 25mm further above the ground, the leading edge radius was increased from 12.5mm to 25mm, the diffuser angle was reduced from 100 to 70, and a pair of fore-aft strakes was installed in the diffuser at chassis width to prevent any airflow deficiencies in the central section from adversely affecting the outer sections, where the flow was not previously stalled. The results were as shown in table 6.

So total downforce increased by 9.7 per cent for a 1.5 per cent drag increase with these modifications, stall in the front diffuser was eradicated, and both splitter and body downforce increased, leading to a useful forward shift in balance.

## SUMMARY

Despite the gains made with refinements to concept #4, the results still fell short of those achieved with the first iteration of concept #2. And, although further developments of the more traditional layouts might bring them up to the level of concept #2, the point of this exercise was to identify the most promising configuration. For once it looks as though a preconception was actually correct, and future development will focus on concept #2.

Plainly there is a plethora of parameters to pursue, and the level of detail needs increasing to become a little more realistic. This will mean investment in improved computing capability to enable better exploitation of the extremely potent CFD software. Nevertheless, even with the minimal resources available to date, very useful indications of which fundamental configuration to go with have been obtained.

*Many thanks to Ansys UK for their much valued support.*

# Spare a thought for the tyre

**They're round, they're black, but they're definitely not all the same. We look at how Avon makes race tyres for a wide range of applications**

BY SIMON MCBEATH

Race tyre development is an ongoing process involving, what seems to this observer, to be a fascinating mix of engineering, physics and chemistry, with more than just a dash of the dark arts. There isn't actually a cauldron involved, or a man wearing a tall, pointed hat standing over it, chanting indecipherable spells and waving a wand. At least, none of that was visible during a recent tour of Avon Tyres Motorsport's facility at Melksham in Wiltshire, England. Nevertheless, the effort involved in designing, manufacturing, supplying and developing race tyres is considerable, and well worth a closer look. We spoke with the senior technical personnel at Avon Tyres Motorsport to discuss aspects of what is a very tricky business.

## DESIGN

One of the first questions that comes to mind is where do you start with a new application that requires a clean sheet design approach? Initially, the number of parameters described by design manager, Gavin Johnson, that come into play leaves you somewhat taken aback. 'The exact nature of the application – the type of racing, the size and weight of the vehicles, aerodynamic loads, diameter and width options, the requisite number of tyres per meeting or season, the durability or longevity of the tyres, whether there's a qualification tyre as well as a race tyres… All these are factors that have to be taken into account.'


**Pic1-ACB10 The 'world' Formula Ford tyre, the ACB10, developed in conjunction with the organisers (courtesy: Avon Tyes Motorsport)**

General manager, Paul Coates, added yet more parameters to the list: 'We also have to ask what are the organisers' objectives? Do they want a peaky or a forgiving tyre? What regulations apply – FIA or national authority? Does EU or DoT legislation apply to the ingredients we can use? Do the tyres need to be road legal? What is desirable, and what is absolutely essential? Really, it's about being a tyre partner to develop towards a common objective, be that with an organiser or a constructor. And it's a lot better being involved from the start of a new project rather than late in the day.

'A good example of how well

Images courtesy of Simon McBeath and Avon Tyres Motorport

**CAD software is used for pattern development and mould design**


**Following the creation of the compound and of the various constituent parts, this is an assembled 'green' crossply tyre awaiting curing**


**A green crossply tyre being positioned in a two-piece mould at the curing stage**


**Radial cases awaiting conversion to 'greenstock' prior to curing**

the process can work is when we worked with Ford on the ACB10 'world' Formula Ford tyre, one of the benefits of which was a drastic reduction in the time wasted by teams buffing their race tyres.'

### TECHNOLOGY CROSSOVER

Avon are quite open about what they refer to as 'applying shelf technology', wherein an existing product can be tailored to suit a new application, or where certain aspects of one application can be applied to another. But there are also some unexpected technology crossovers, too. Johnson explained some of the background to Formula 3 tyre development, where Avon's products are branded as Cooper Tires, reflecting the American parent company's name. 'We try to make all our tyres as predictable as possible. In F3, for example, the tyre is very stable and consistent through its life. This takes account of the fact that F3 is a training ground with budget and tyre restrictions. Nevertheless, the teams wanted a faster and a more consistent tyre, and we achieved that with a pretty steady through-life drop off [in performance]. With F3, it was a relatively simple case of tweaking compounds we already know, but in this instance compounds that we developed for GT racing produced by-products that were applicable to improving the consistency of the F3 tyres.' And with commendable honesty, Johnson added, 'It's always interesting to look at why a compound hasn't worked in an application, to analyse why, and to see if it could help elsewhere [in the application range].'

Faster, but also more consistent, is a theme that's been applied in GT tyre development too, highlighted by the latest tyres from Avon for the British GT championship (that the company has been title sponsors of since 2006), which are also being supplied to the Italian GT series and were used in the Gulf 12 hours in Abu Dhabi In January 2012. Seemingly, it's not so much about whether a compound is hard or soft, as it is about the heat generated, managed and dissipated through the tyre's life. The new tyre is said to be around a second a lap quicker around most of the tracks used in the British GT championship, as well as more consistent, and with a wider operating range, too.

**"Front [tyres] are obviously a different shape to the rears"**

Returning to the topic of the up-front tyre design process though, Johnson continued. 'We also have to pay attention to the required shape of the tyre. For example, fronts are obviously a different shape to the rear [because of greater camber and / or caster]. And then we have to come up with a practical mould design. We will already have sketched the construction into a mould schematic to get, for example, the correct size 'fillers' (see fig 1, p58) and all the other component parts. We generally have a good idea of the generic construction, although we may

Converting radial cases to greenstock

Radial greenstock positioned in a mould at the start of curing


New F3 radial slicks. Note Cooper branding to denote Avon's US parent company

Vintage formula ACB9 tyre

have to refine that to suit the specific application.

'We then look at the range of materials available, or source others to test – preferably these will be off the shelf. We will also have an idea of the compound to use, but again this is something that can be adjusted if needed. And then we make some tyres and go testing. It is possible that we may have to alter the mould shape subsequently, but hopefully not, because that starts to get costly! Having said that, we're developing a drag racing tyre at the moment, and we have factored in possible mould changes to the project plan.

'Because of the amount of testing we like to do, it can take a few months to sign off a new tyre. Political factors can come into play in some categories too, where we want to use the best team and driver... But our test rigs help in this regard. Data accuracy has improved a lot over the years and rig testing gives a good idea of what's going to work well.' This timeframe of a few months' testing can sometimes be curtailed when necessary – it seems the new tyre for USF2000 was under the lap record just two days after the new moulds arrived!

**CREATING COMPUNDS**

Compounds are something tyre engineers are naturally reticent to discuss in detail, but creating compounds with different properties involves adjusting key ingredients like oils, resins, carbon black and other fillers and additives. 'Wet' tyres tend to be heavily silica loaded, rather like road tyres. There is apparently some natural rubber still in drag and off-road tyres but, generally speaking, partly to fully synthetic elastomeric polymers are now used. The additives, the process and the even the rate of mixing can all affect the final compound.

External influences have also affected the compounds used by tyre manufacturers. For example, European tyre manufacturers (though, according to Avon, not all US or Far Eastern ones) are

CR500 road legal tyre, as used on Caterhams and Westfields


The tyre bay at an F3 test


Nearly new, just one careful owner...

compliant with legislation on low polycyclic aromatic hydrocarbons (PAHs) brought in a few years ago on health and safety grounds, but in an impressively short space of time Avon, like other European tyre producers, had worked around the problem with no noticeable effects. Apparently, during one F3 test session at the time, the test driver apologetically reported that he could feel no difference with a new set of tyres that had been bolted on. To his surprise, Avon's engineers appeared unexpectedly elated, but what the driver didn't know was that this was exactly the result that was hoped for, given that the new tyres had been created using new chemistry.

**RAW MATERIALS**

Given that other chemical ingredients have a petro-chemical origin, another obvious question is how the manufacturers are dealing with the increasing cost, and ultimately scarcity, of such raw materials? As you might expect, they're well ahead of the game here, creating synthetic compounds from other sources, perhaps most notably bio-based replacements for petro-chemicals. And confidence seems high that this will be entirely sustainable.

Avon's race tyres are manufactured in a dedicated facility using broadly similar equipment to that used for road tyres, but the rate of throughput is perhaps a quarter or a third of the road tyre production rate because of the extra care used throughout the process, with a surprising proportion of 'hand-made' techniques involved. One of the principal reasons for this is to try and ensure as homogenous a product as possible. For example, any areas of excessive overlap of material within the plies or the tread 'gauge' can lead to hot spots during actual use on track. Ultimately, these hot spots could lead to blistering, and then to tyre failure. So great care is taken to ensure overlaps are correct and consistent to ensure even temperatures within the tyre once it is in use.

It's interesting to note some of the differences between tyres with respect to operating temperatures. As Johnson commented: 'Tyres generate temperature when they're in use, and rubber is an insulator. More rubber means more insulation, and therefore more temperature build up because of a high volume-to-area ratio. So, tyre wear can be your friend in some applications because it reduces the volume-to-area ratio, reduces the insulation and hence temperatures come under control.'

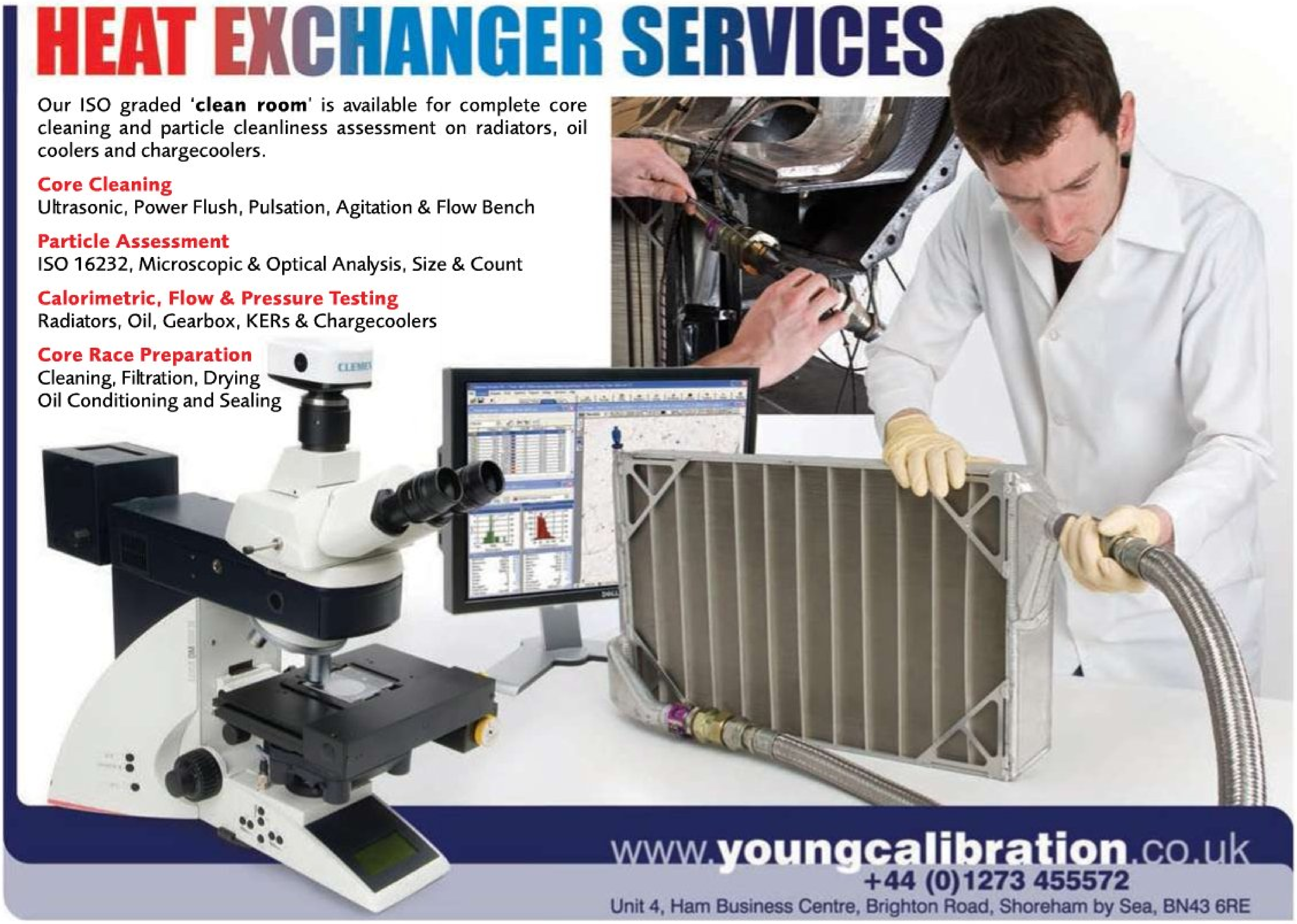
To this Coates added: 'The tyre sections are actually over-engineered. Generally, there is only just enough tread gauge for the expected life, so the tyre can run to its temperature capacity. But for example, with hillclimb tyres, we run more gauge in order to retain heat.'

And with such a broad spectrum of applications, from hillclimb at one end to GT racing at the other, plus off-road, Rallycross and a variety of formula car categories from vintage to modern, finding the right balance cannot be easy, especially when you throw in the variables that the manufacturer cannot control, such as car set up, driver technique and the different temperature cycles that teams may put their tyres through, which can alter the properties of a given compound.

**TOO HOT TO TROT?**

Across the range of applications Avon supply, hillclimb tyres start working from ambient and slightly above, depending on track temperature and course length, but F3 tyres operate best between 90degC and 110degC (180degF-230degF), while GT tyres have a broader range that peaks at 135degC (275degF). Avon prefers to be in the 100degC to 110degC (212degF-230degF) range if the regulations and the cars allow it.

Coates continued on the temperature theme: 'Obviously, compounds that work at ambient temperature for 40 seconds on a hillclimb will be no use for two hours in GT racing, so we employ very different methods, materials and constructions to achieve what's needed and to be consistent. Hillclimb and Formula SAE / Student tyres use bespoke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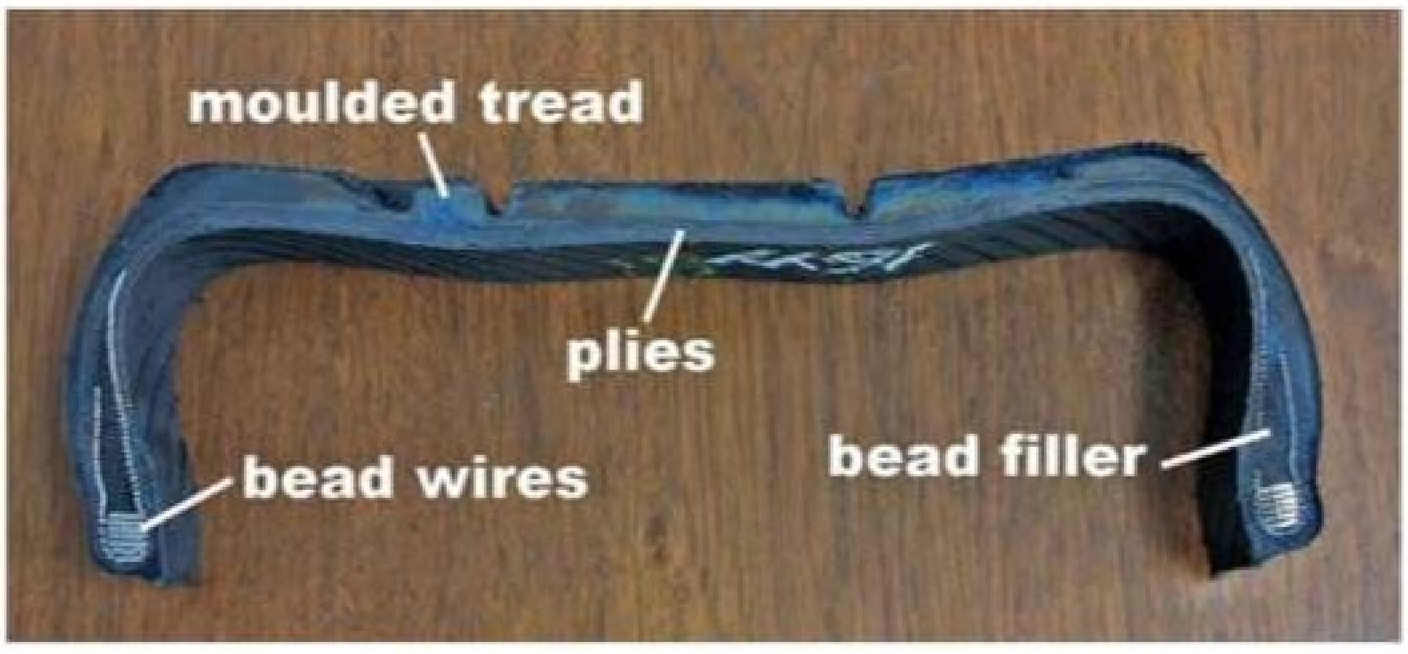
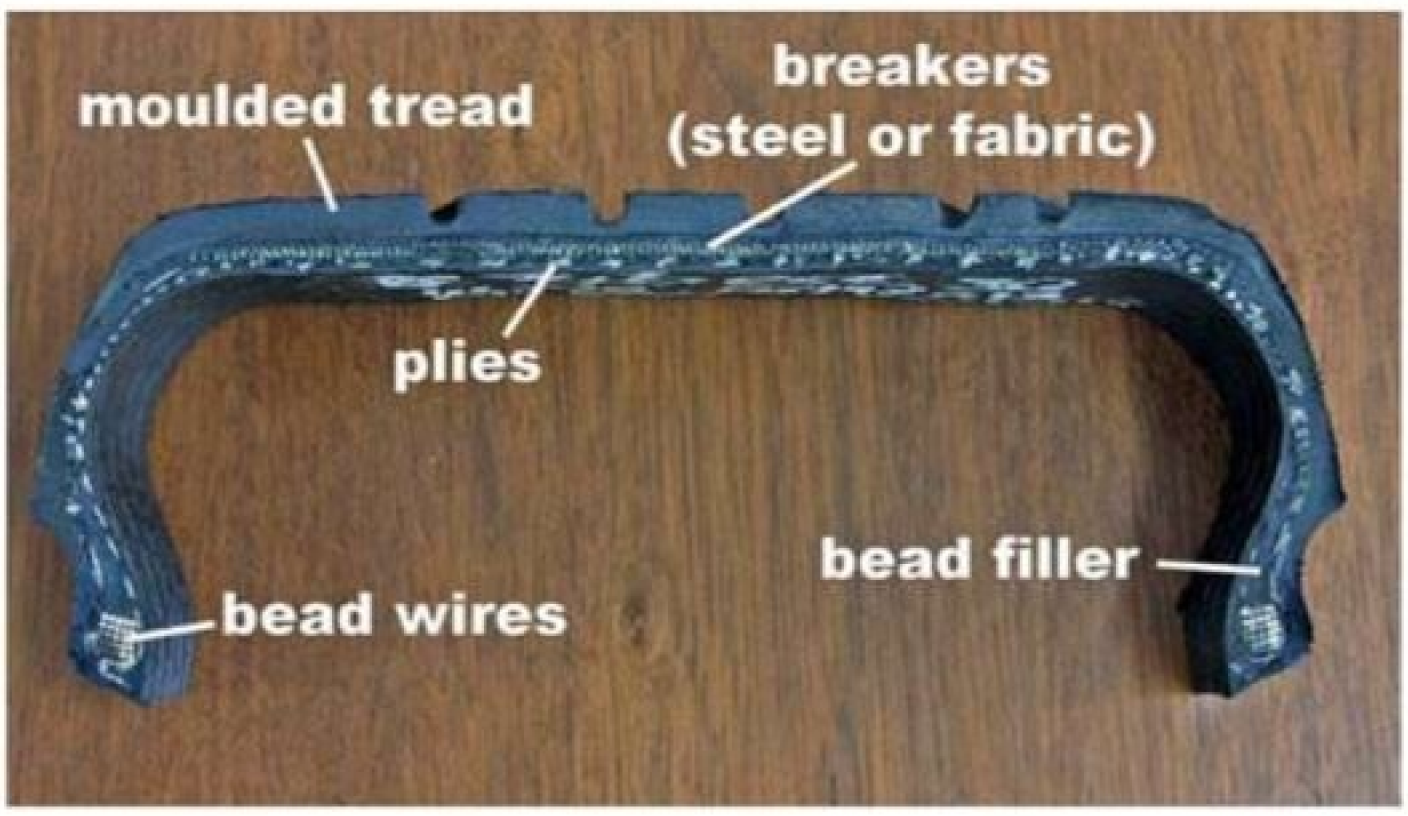



**Figure 1: section through a Rallycross crossply tyre**




**Section through a CR500 radial tyre. Note the addition of the 'breakers' between the plies and the tread, and also the different ply orientation visible on the inside surfaces compared to the crossply Rallycross tyre**

**Two GT tyres, a race tyre (top) and a hillclimb tyre (bottom). Note the thicker tread 'gauge' (depth) on the hillclimb tyre**

compounds and possibly revert to older constructions, using thicker treads to retain some heat. The corollary is that a small volume-to-area ratio is used on race tyres in order to dissipate heat.

'And then there's the juggling act with durability. Tyre cooling from the airflow passing over a single seater is not present on closed-wheel cars, and wheel temperatures in saloons can get hot enough to melt the valves, so that's something the tyres need to be able to deal with. Different companies approach these challenges in different ways, which makes it very interesting.'

### SPECIAL CHALLENGES

Some applications provide special challenges. For example, Rallycross, with its variety of loose and tarmac surfaces. As well as making such tyres physically tougher to avoid punctures, the compounds have to deal with a wide range of operating conditions. Johnson highlights one particularly challenging Rallycross event in the USA to demonstrate some of the difficulties that can be encountered: 'All our technical people, from mould designers to compounders, spend time trackside in order to learn from different situations. So our development chemist was sent to a Global Rallycross Championship event that was to run as a support race at Charlotte, NC. We had received information about the split of tarmac and gravel, but at quite a late stage the jumps were removed and the gravel wasn't allowed, so the event ended up entirely on tarmac and in high ambient temperatures! So the actual requirements were somewhat different to what we'd originally expected. Nevertheless, our man provided excellent feedback and we are able to come up with a shallow gauge tarmac tyre that is much better suited. This is one of the advantages of being a small organisation – we can be very responsive when necessary.'

**"A small volume-to-area ratio is used on race tyres in order to dissipate heat"**

Other applications provide different types of challenge. Formula Palmer Audi was a case where, being a one-make series, outright performance was not key, so a consistent radial that didn't need frequent corner weighting was ideal (seemingly crossplies vary more in inflated diameters and require corner weighting when changed). The Big Open Single Seater (BOSS) series was different again, requiring a tyre that was not on a knife edge, not as fast as possible, but 'safe' and forgiving, given that the drivers were not top-line professionals. Another interesting project Avon did was to supply front tyres for the Tyrell P34 six-wheeler, with original designer, Derek Gardener's, help. 'That was not commercially viable,' said Coates 'but it helped secure supply as Avon could now supply any F1 car made after 1965.'

Spare a thought then for what goes into getting those round, black objects to the track for you to abuse. The ingenuity involved is worth reflecting upon.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# High speed wi-fi

## The race is on to come up with a workable solution for electric racecar and road car recharging

Electric racing has become the Holy Grail for motor manufacturers as headline race series, including Formula 1 and Sportscars, embrace hybrid. Toyota and Peugeot developed their electric racers, and Paul Drayson unveiled an all-electric Lola to challenge lap records.

There are, however, significant problems with electric racing. The first is where the electricity is coming from, the second is how to manage the life of the battery. A large amount of energy stored requires a large battery, and therefore more weight, while a lightweight battery will not store as much charge.

Drayson's car therefore carries a wireless charging system, developed by Halo IPT, a company that was bought by Qualcomm, a giant in the mobile 'phone industry, supplying 3g and 4g computer chips. The company has achieved such efficiency in the recharging mechanism that in July, its latest car charging system was rolled out on a trial basis in London.

Initially, the system is fitted to parking spots but, as the recharging cycle shortens, it can be accommodated at traffic lights. In the long term, it could even become completely dynamic and recharge cars as they travel on the road.

'The resonant magnetic induction system is very similar to that found in a toothbrush,' says Joe Barrett, senior director of strategic marketing for Qualcomm. 'The charging coil and the receiving coil have to be closely aligned to couple, but you can't do that in a car. The challenge was how to get good efficiency across an air gap, and for a range of ground clearance, from a sports car to a 4x4. The industry requires more than 90 per cent efficiency and we have achieved 97 per cent across the air gap.'

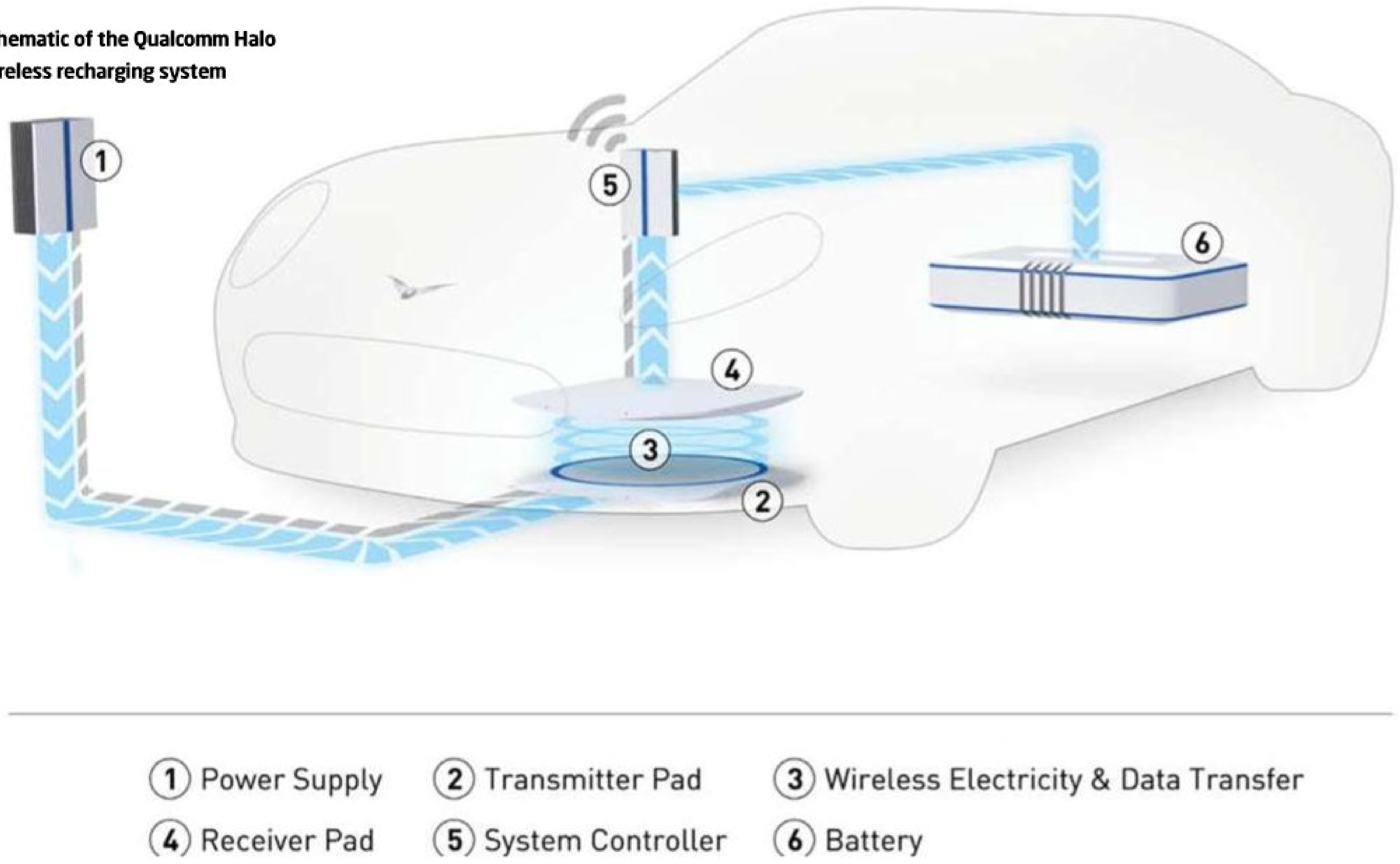
**"The challenge was how to get good efficiency across an air gap"**

Qualcomm bought the Halo technology from a university in Auckland, New Zealand, in 2011 and has developed the system to be smaller, lighter and more efficient, in line with legislation and the demand of car manufacturers interested in the system. Toyota, Nissan and General Electric are all working on rivals to the Halo system, and Audi believes in the future of wireless charging also.

At the launch of its R18 hybrid Le Mans car, Audi also gave a presentation of its vision for future road cars, including a self-parking car that would find a wireless recharging point in a car park. The car, says Audi, would be summoned by mobile 'phone, and delivered back to the car park entrance fully charged for the drive home.

The power supply takes electrical power from the mains and energises a lumped coil, with a current typically in the 5-125A range. Since the coil is inductive, compensation using series or parallel capacitors may be required to reduce the working voltages and currents in the supply circuitry. In the secondary pad, pick-up coils are magnetically coupled to the

Schematic of the Qualcomm Halo wireless recharging system




**Drayson Racing Sportscar features a wireless charging system that, its developers say, will enable it to be charged as it travels round the racetrack**

primary coil. Power transfer is achieved by turning the pick-up coil to the operating frequency of the primary coil with a series, or parallel, capacitor. The power transfer is controllable with a switch-mode controller.

### BATTERY AGNOSTIC

The system is battery agnostic and the pick-up controller interfaces directly with the proprietary battery management system on the vehicle. This allows the use of precise battery management algorithms and temperature and state-of-the-art charge sensing to ensure a longer life battery.

The result is that charging can take place in a parking bay with high efficiency, and developments in the pad itself have made it more manageable. The pads started out the size of doormats, but the car companies claimed that was too big, and the latest generation pads are the size of the average laptop.

The advantages to a company such as Qualcomm are obvious – a wireless charging system for the mobile 'phone, laptop or music device would be instantly popular in the home but, for the time being, the company is developing its product in racing, and on the road.

Drayson has predicted long distance races with electric cars in the future, using recharging pads laid into the track that will recharge the passing cars, but Barratt does not believe that will happen any time soon. Dynamic charging is a long way off, and will require significant investment in road building. 'It is not a reality today, but it is a question of how long it will take to happen,' says Barratt. 'Dynamic and semi-dynamic systems, ones that can recharge at traffic lights, are very relevant,'

**"There is enough energy from the sun in the Sahara desert to power the world for a year"**

Barratt continues. 'To get the cost of the fleet vehicles down, the most expensive thing is the battery. To put in a high energy battery is more expensive. it would be better to fit a smaller, lighter battery that can be charged at work, home or in the supermarket. Full dynamic roads embedded with wireless charging systems requires a lot of new thinking from the government and the industry and it takes years for that to happen.'

### FORWARD THINKING

The second issue is that of where the electricity is coming from. Already there is huge demand on the national grid, and estimates range from an increase of between two and five times the current levels by 2050. Nuclear power stations are unwelcome, particularly following the earthquake in Japan and the fall out in Fukushima, and coal-fired stations are also not a palatable option in the modern world.

Clearly, significant investment in new power stations is an important step, but Barrett believes there is another solution. 'We are not building enough power generators to meet demand, so we need to upgrade the network,' he says. 'Solar power and activities around solar generators are important. There is enough energy from the sun in the Sahara desert to power the world for a year. We just have to re-think how we distribute it.

'I came from the telecoms side, and was working in mobile 'phones in 1985. Nobody in their right mind would have predicted that in 1990 there would be 5-6bn mobile 'phones by 2010. Predicting the past is easy. Predicting the future is more difficult, but we will find a way to meet the demand.'

BY CHARLES CLARK

I guess the first thing to say is that most of the Formula 1 companies have simulators, or have access to good quality 'sim' set ups. And they regard them as having so much competitive advantage that it's like pulling teeth to get any useful details. In fact, some of the prominent companies have more than one, so that they can satisfy media curiosity with a decoy simulator, whilst keeping the real stuff well under wraps.

Fortunately, there are some specialist suppliers who need to talk about their technology and what's new in their areas of speciality in order to stay in business. If you do a Google search, you come up with about 30 hits worldwide of companies supplying everything from arcade games to complex motion simulators.

### INDUSTRIAL STRENGTH PLAYSTATION

The main focus a few years ago was driver training, primarily to familiarise new or inexperienced drivers with unfamiliar or new circuits – a bit like an industrial strength PlayStation, with much better correlation.

With modern advances in simulator and modelling technology, the simulator is now very much a design / development tool, and the place where cars are set up before leaving for the track. As I write this, there are drivers preparing for the WEC race at Silverstone at the weekend in simulators throughout the UK's motorsport triangle.

They are also better for the environment and nothing gets broken when enthusiasm exceeds the laws of physics.

Perhaps the biggest and most expensive driving simulator of all is at Toyota in Japan. This machine is housed in its own warehouse, measures 35x20m and reputedly cost $30m when it was built. The main simulator hexapod platform, sometimes called a 6 DOF (degrees of freedom) or Stewart platform, is mounted on a travelling x, y platform. This device is designed for testing road cars at road speeds, so full speed turning can be simulated, as well as braking, accelerating and straight-line running.

Because the simulator driver cell is not moving more than a couple of metres in any direction, in a conventional motorsport machine, you can simulate every movement and driver / machine interaction except sustained longitudinal and lateral acceleration and deceleration. You can give the driver a jolt, or onset cue, to signify launch, or pitch him forward against the belts to simulate braking, but it's very difficult to simulate the sustained lateral or vertical acceleration of, say, Eau Rouge or the Curva Parabolica with the relatively minimal range of motion, even in the most expensive devices.

## "simulation engineers resort to trickery"

In addition, because track testing and wind tunnel testing is severely restricted in F1 these days, the simulator is the place where basket case ideas are tried and eliminated before wasting too much design and development time.

In many ways, the wind tunnel can be seen as the first physical verification device for the CFD. In the same way, the driving simulator verifies many aspects of car design and set up and allows you to check race tactics before the race, where things like tyre degradation and varying fuel loads can be simulated.

There is also the notion of 'driver-in-the-loop' design. There is no point in design innovation if it can't be maintained by the driver in a two-hour / 200-mile race, or even over a four-hour stint in an endurance race. While professional drivers are extraordinary individuals, they are not robots and the ability to assess their limitations with respect to new developments in a safe, low-impact environment is invaluable.

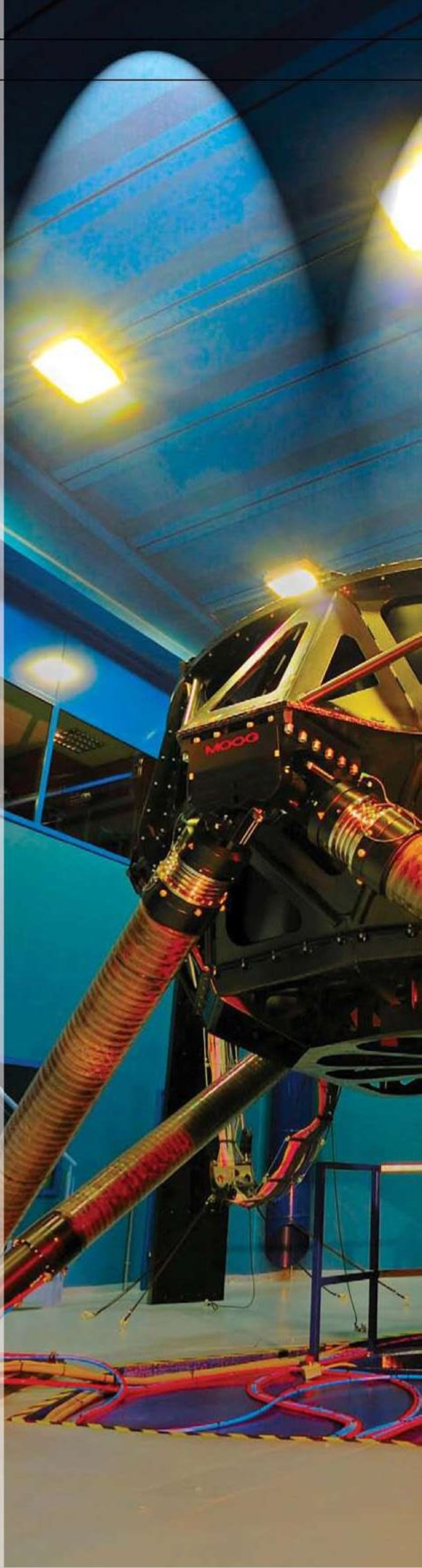
When you look at it in this context, even though the top quality systems are mind-numbingly expensive, they save considerable money in the long term.

In addition, when you have simulated excessive motion in one direction, you have to let the simulator creep back or 'washout' very slowly, so the driver does not receive an inappropriate motion cue as he is 'driving' the next section.

There are simulators on rails where space is available, but the motions on rails are not really compatible with high-speed race simulation and only really allow one or two large translations to occur – again, good for testing discrete events, but not compatible with a full race simulation.

Consequently, the simulation engineers resort to trickery to convince the brain that the driver is actually careering around a circuit at speeds up to 200mph, when in fact the chassis is hardly moving – though even this is not hard to achieve with the motion cues at their disposal today.

We've all had the experience when we are sitting on a train in the station and suddenly look up and think we are moving backwards, because the train next to us has just started to move forwards. Because we were stationary, the brain tells us that the train next to us is also stationary, so by that token we must be in reverse, because there



# Unreal life racing

**Full race simulators are now as complex as the machines they are simulating**


The full-motion race simulator with 210-degree, 8m screen at Bhai Tech Advanced Vehicle Science Centre in Italy

are no other visual or motion cues at that instant. It doesn't last long, but it works every time.

### ONSET CUE MACHINES

Most of the simulators in use in high-level motorsport applications have been taken from the civil aviation type of simulators, which usually have 6 DOF hexapod platforms. 'These kinds of platforms only give 'onset cues', or the initial movement,' explains Graham Campion of Cranfield Motorsport. 'Sustained phenomena have to be achieved in other ways. We have a device that we've used for the last 30 years in the aerospace, fast jet and helicopter simulator market, which is called a sustained *g* cueing seat.'

This seat has pneumatic cells within the seat, pads under the driver's thighs and bottom and between him and the harnesses. There is also another product, beneath the seat, which alters the driver's eye point, taking it down and forward as he brakes. This is called kinaesthetic cueing, where the eye point is moved to simulate a kinematic event.

This works to convince the driver he is actually moving but, because it uses sustained pressure, the virtual experience is one of sustained acceleration or deceleration, which is not possible to achieve with a conventional 6 DOF platform.

With a 6 DOF, the platform moves initially and stimulates the vestibular system (your balancing mechanism – inner ear phenomena) and the visual system is the only cue that remains and links to a sustained event. So you're totally reliant on the visual system telling the driver he is going round a bend, because that is what the visual system is presenting.

With the Cranfield system you actually feel the sustained pressure, as well as the sustained visual stimulation. If you are going into a right-hand bend, you're being propelled within the car out and to the left hand side, so the *g* seat applies pressure on the upper arm, the shoulder, the ribs, the hips and the thighs proportional to the *g* levels you're pulling. That, coupled with visual stimulation, gives you a much more convincing sustained simulation of the acceleration. Then, as you turn into the bend, you experience the onset of the pressure that builds as the *g* force builds, and is sustained for however long the corner lasts.

**"kinaesthetic cueing – where the eye point is moved to simulate a kinematic event"**

With the Cranfield system, if you lose traction, the pressure is relieved and you can simulate a slide. You can even feel the lightness of the car as it drifts, because of the controlled relief in the pressure.

'Within 20 milliseconds, we take away that pressure and you can experience the drift,' says Campion. 'Then, when the grip returns, so too does the pressure, and you get a real sensation of the 'snap back' when driving the car. Experienced drivers can actually balance the simulator, as they do the car on the track, and you can see this in the feedback data.'

The other benefit of this technology is you don't feel the motion sickness and the fatigue you can experience in a 6 DOF environment. Presumably, this is because it is a more lifelike experience, and you feel as comfortable as you do driving a normal racecar.

Cranfield has supplied F1 and NASCAR teams, and everyone using the system has said the product would complement every simulator they've ever driven. 'We have Nicholas Hamilton (F1 driver, Lewis', brother) as a driver coach and he is very enthusiastic about the benefits of our product in a more sophisticated simulation environment,' says Campion.

There is a sustained *g* seat at iZone in Silverstone and several of the leading F1 teams are putting their young driver candidates through iZone, which is putting pressure on the teams to bring this technology in house.

In a high performance driving simulator, a wraparound 'screen gives the driver a high-fidelity view of the circuit, PlayStation fashion, but with a lot more realism, and linked to the 'virtual' speed of the car.

One of the greatest challenges for the simulator designer is that the high-speed scenery is the result of driver input. If nothing goes wrong, most of the scenery display can be predicted, because the simulator knows where the driver is on the circuit, but if he spins, the scenery must also spin, so display rendering is left until the very last second, which requires serious computer power. If a simulator is using 3D rendering, it requires twice as many computers, as it is providing output for both eyes separately.

### SUPER COMPUTERS

Dallara is fairly open with the details of its system. It has a 2D, 180-degree field of view system, with 20 computers, 84 processors, 182GB RAM, 24 dedicated graphics accelerator cards and 48GB video RAM, with a total processing power of around 2800GFLOPS. To put this in perspective the Cray-2 in 1985 was capable of 1.9GFLOPS peak performance, and we used to call that a super computer.

'Simulators in motorsport companies have evolved to become a design and development tool in their own right, as well as a driver training aid,' says Frank Kalff, MD of Cruden, one of the leading suppliers of simulation technology. 'Data is shared between the simulation on the desktop and the simulator in the simulation lab.'

It is still very useful getting to know a track in a simulator, 'but in many respects it's a waste of the technology just to use it as a driver training aid,' Kalff continues. 'In fact, with the teams that have multiple simulators, the ones they are happy to show outsiders are generally driver training simulators, and the ones they use for full race simulations and car development are kept well under wraps. Driver training and familiarisation simulators can be a lot less sophisticated than the car development tools.'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All the major teams and the major motorsport consultancies use sophisticated simulators these days for car development. Anecdotally, it has even been reported that companies like Ferrari have suggested they are getting better feedback from a simulator test than they do at a track test these days.

### FULL RACE SIMULATION

Certainly, design development simulators are in constant use these days, and are being used to develop new aerodynamic parts, new springs and new dampers. They are also being used to evaluate tyres and weight distribution, develop race strategies and even to run full race simulations with different scenarios in terms of tyre compounds and stints. Such simulations have been done on the desktop for more than a decade, but now they can be tested in a physical environment that delivers an accurate simulation of track conditions, and includes driver input, too.

Simulators are also useful for evaluating what gear ratios the teams need to take to the track. Because the car will invariably have changed from the previous year, you can only really get a full appreciation of what gear ratios will be most appropriate by doing these kind of simulations. To some extent, teams can re-use data from the previous year, but there are always subtle changes, and the way to arrive at the track in the most prepared state is to do several full race simulation runs the week before.

The desktop simulation software can give you the optimum settings based on all the algorithms you use to arrive at these kind of optima. But, in the same way that you check the CFD desktop simulation in the wind tunnel, it is only when you've had a chance to investigate the interaction of the various settings in the simulator with a driver that you know whether the desktop simulation is appropriate or not, as the thing you cannot input is the effect of the driver. The driving simulator allows you to verify the digital desktop simulation by introducing the analogue human component.


**TMG's simiulator, six degrees of freedom, motion platform simulator**

You will always have the situation where the driver brakes a bit earlier or a bit later, or prefers to use a part of the circuit that has more bumps, or more grip. These kinds of things are down to driver choice and preference. You can't input that into a desktop simulation.

In many cases, the simulation will come up with the perfect lap, but some drivers may achieve that only once or twice in a race. It's also very difficult to do a perfect lap every lap when the tyres are degrading and the fuel load is changing. These characteristics can only be measured effectively in the simulator.

### THE COST OF SIMULATION

A basic engineering simulator from Cruden, with software and a canopy, is somewhere in the region of $250,000-300,000. 'This is very little money for what you get, and you can get started very quickly,' says Kalff. 'There are some simulators out there that cost between $1m and $2m, and most of that increase in price is down to the quality of the projection systems.

'As long as your simulation is accurate, it's very useful to get driver feedback from the simulation as we can do that much more frequently than we can go track testing,' says simulation specialist, Nick Wirth. 'Apart from the money it saves, it also saves considerable time by being able to get track feedback in the office. In the same way as 'garbage in' equals 'garbage out' in a computing sense, having a skilled and able driver giving you feedback on an inaccurate simulation will lead you in the wrong direction. You have to know what the limitations are, but it's amazing what can be achieved today.'

There's no doubt simulators play a vital role in the development of racecars and drivers today and, as in all motorsport endeavours, the sky's the limit with what you want to spend for ever more accurate simulation.

## INSIDER'S VIEW – IAN HOGAN, TOYOTA MOTORSPORT

'In a lot of driver simulators, achieving effective lateral acceleration inputs to the driver is difficult, and even the very sophisticated simulators struggle to achieve it in any sustained fashion. As most of them are static (that is, their base doesn't move) achieving anything other than onset cues is very difficult.

'On our simulator, and in most other sophisticated set ups, we trick the driver into experiencing this kind of acceleration by providing onset cues and attempting to maintain the experience with sustained visual cues provided by the projection system.

'The Toyota Sim is a classic hexapod rig. It can apply lateral acceleration for a short period of time, and within the limits of movement of the mechanical system. Some installations have the hexapod on rails to provide greater longitudinal and lateral movement, but again the movement is limited by the constraints of the room the simulator is housed in.

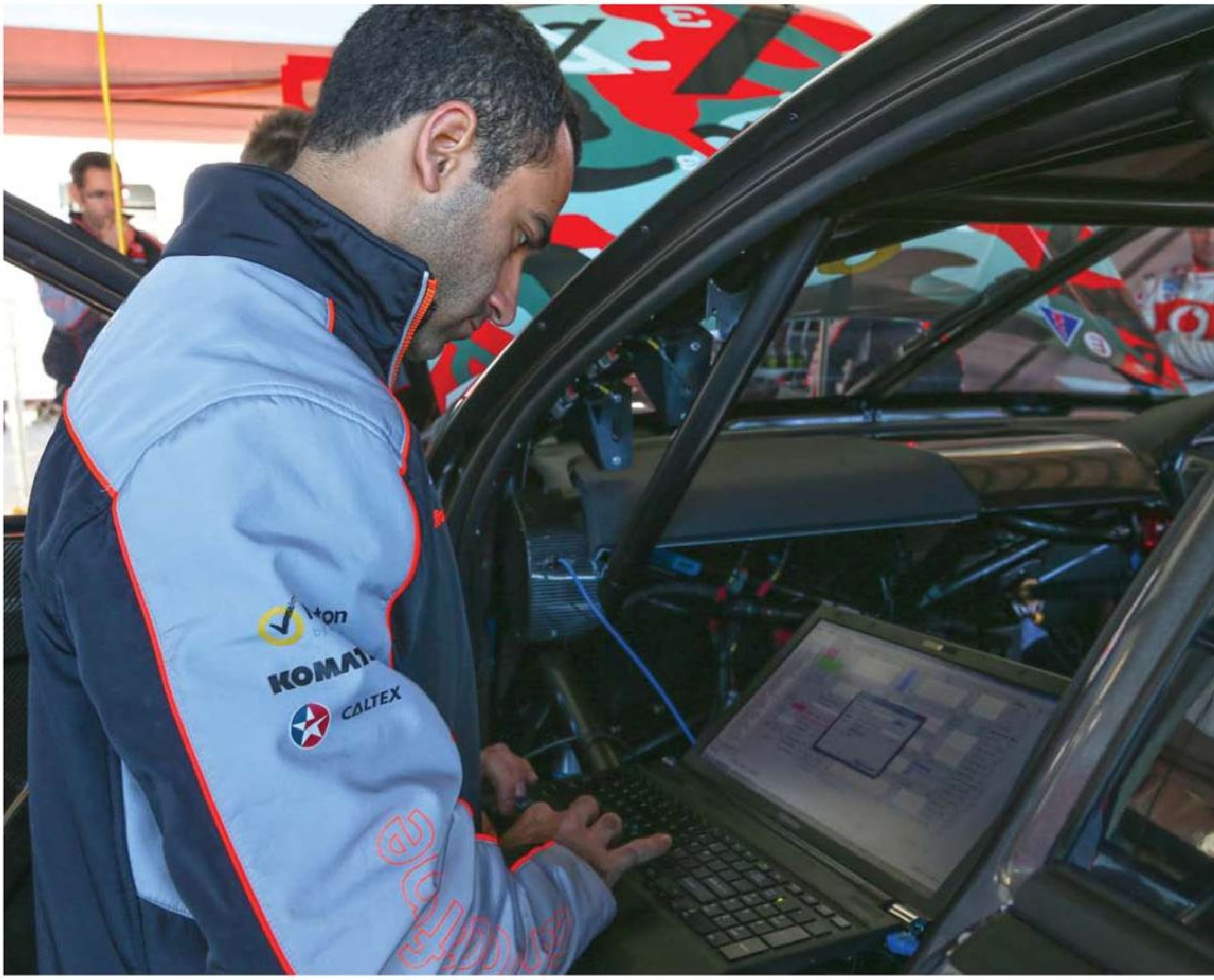
'It's very important to know the limitations of the system you've got, and in every case you need to push the level of technology as far as you can within the constraints of the financial budgets. For us at TMG, we are using the simulator as much as an engineering tool as we are a driver training aid. It's invaluable for testing new vehicle set up, new aerodynamic packages and new suspension set ups, not only to tell us how they are going to perform in a relative sense, but to enable us to get driver feedback before we go to the track.

'This kind of design verification depends heavily on the capability of the engineers to represent what's happening with the physical vehicle, and to translate the characteristics of the physical vehicle into inputs for the simulator. In this case, the virtual vehicle model is made up of a series of mathematical models for the various sub-systems. Tyres, suspension and aerodynamic components are usually generated in something like Matlab, or Simulink, or other high-level system simulators, using Modelica components like Dymola or Wolfram. There is considerable IP here, mostly developed in-house to feed the simulator.

'In the final analysis, we are probably saving considerable money and time using the simulator as we don't have to make so many prototype parts and we don't have to spend a lot of time at the circuit trying to arrive at the optimum set up. We can do all these things in the simulator and make our mistakes in a relatively inexpensive environment.'

# Connecting the dots Part 3

## Bringing the process of racecar modelling to a conclusion




In this final part of racecar simulation, connecting the dots, we'll discuss model refinement, so you have a model you can use in anger. To review briefly, in part one we discussed the steps to create your initial model, then in part two we broke down circuit creation and showed you what to look for in producing a circuit model that can be used in the real world. As we have discussed, there is no black magic involved, all we are doing is using attention to detail and some clear sequential steps. Model refinement will be no different.

**BY DANNY NOWLAN**

As with part two, what we'll be discussing here will be ChassisSim specific, as it is what I am in a position to give you the most accurate information on. However, remember the whole point of these articles is to show you the principle of how to do it so, if this doesn't quite apply to what you are using, take away the principles instead.

Our first order of business is to refine the tyre model by adjusting some simple parameters. We are doing this manually for two key reasons. Firstly, it's going to give you a clear knowledge of what to look for and it will greatly enhance your knowledge of the racecar. Secondly, it gives any tyre force modelling features a head start.

Your best friend in this endeavour is going to be the tyre model quick edit/start feature, as illustrated in **figure 1**. What this does is gives you quick access to the ChassisSim v3 tyre model approximation I wrote about in an earlier edition of *Racecar Engineering*. You'll also find the documentation on this in the help directory and the ChassisSim YouTube channel. The power of this feature is that in this dialogue, it gives you access to tune in the camber / traction ellipse properties, peak slip angles and slip ratios and the traction circle radius vs load characteristic. Consequently, this is the perfect tool to dial in your initial model.

The first aspect of the tyre

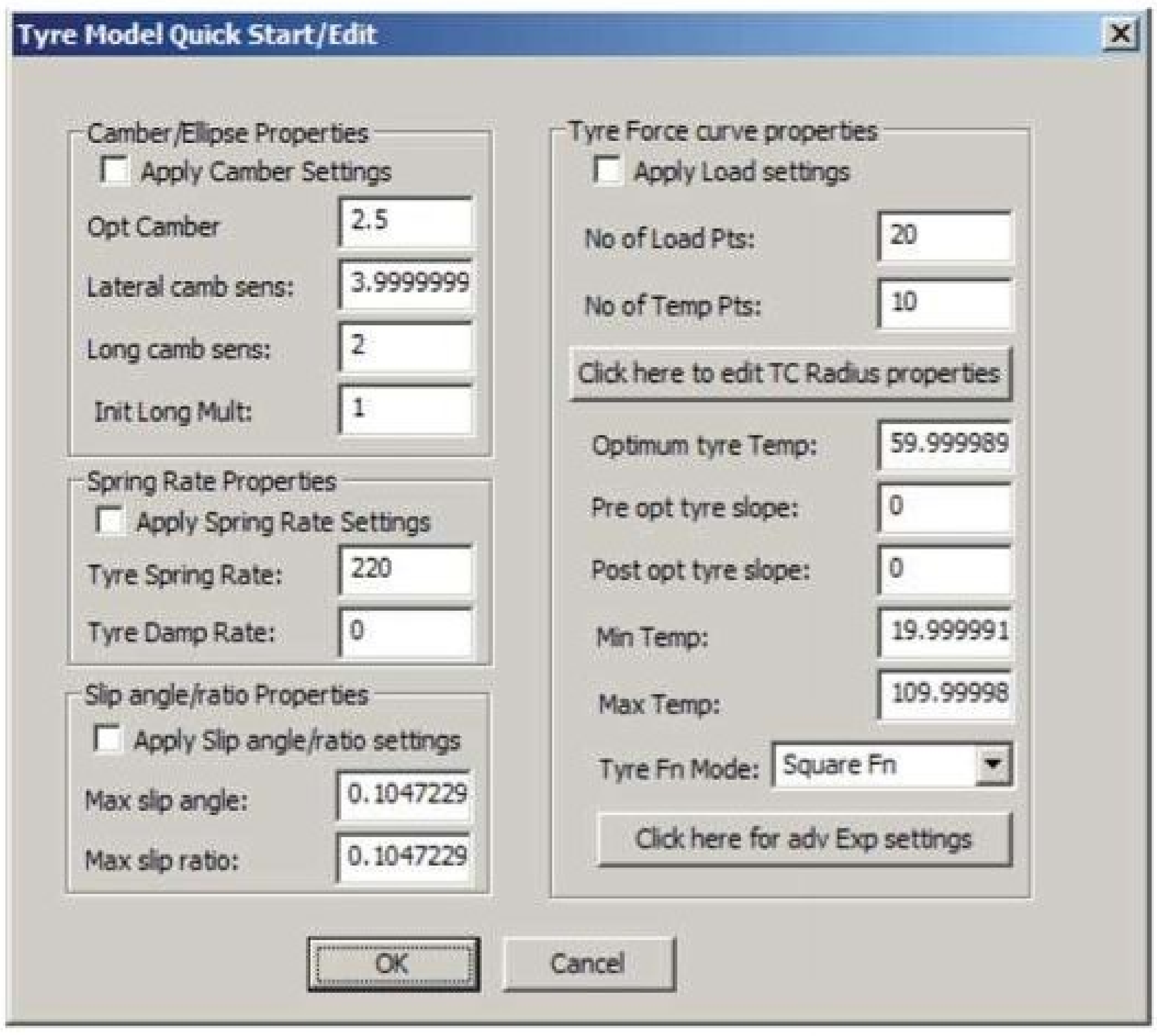



**Figure 1: ChassisSim tyre model quick start**

**Table 1: approximate values for camber sensitivity settings**

| Car type | Lat camb sensitivity | Long camb sensitivity |
|---|---|---|
| Open wheeler | 3 | 2 |
| GT car | 2 | 2 |
| Saloon | 0.5 - 1 | 0.5 - 1 |

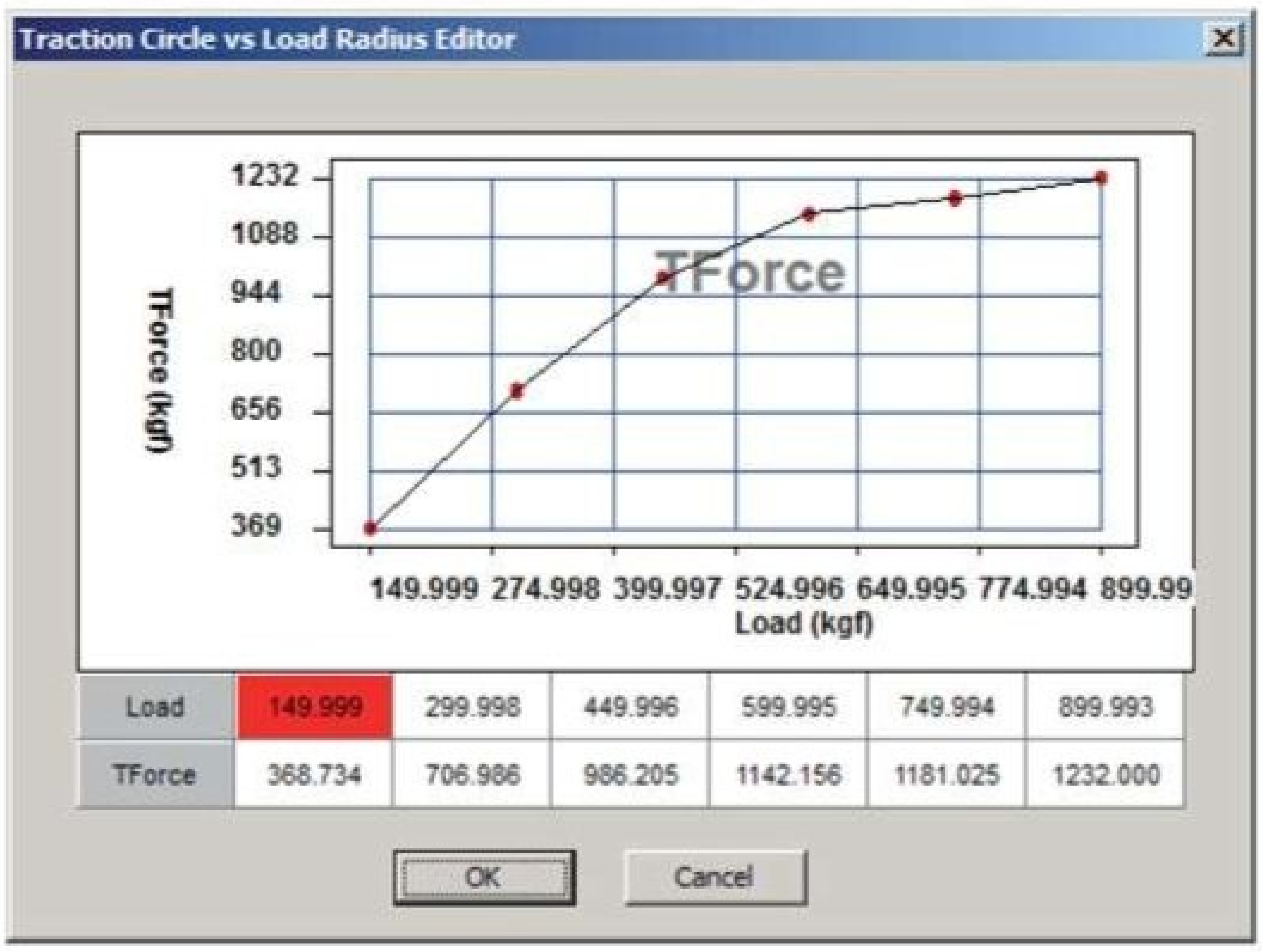
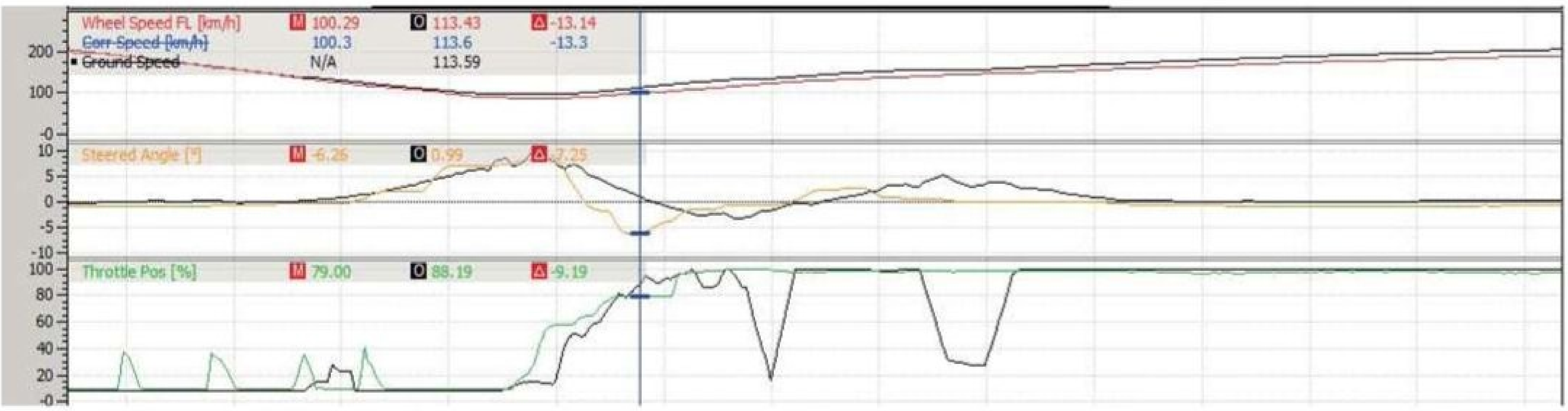



**Figure 3: TC radius vs load characteristics**

**Figure 2: acceleration into and out of the corner speed**




model quick start is dialling in the camber and traction ellipse properties. This is actually your first 'go to' when the mid-corner speeds match up but the acceleration into and out of the corner is too good. This situation is illustrated in **figure 2** (the actual data is coloured, the simulated data is black).

If you see the scanerio presented in figure 2, reduce the initial long multiplication as seen in figure 1. This has the immediate effect of flattening the traction ellipse, which in this case was necessary because we where simply too good on the way into and out of the corner.

You also adjust the camber sensitivity multipliers and peak lateral camber depending on the camber sensitivity you see with the tyre. The peak lateral camber as seen in figure 1 is the actual tyre camber where the tyre produces its peak lateral force. This should not be confused with static camber on your set up sheet. As a rough rule of thumb, I set it for my initial model at about 1-1.5 degrees greater than the camber in the set up sheet. That being said, this will also be affected by the camber gain you see in corners as well. In terms of camber sensitivity, you should find the following guide useful: the more sensitive the car is to camber, the more you increase the camber sensitivity numbers by. A more complete description of what these do can be found in the previous article I wrote about tyre approximation.

The next point on the list is to compare simulated to actual steer, and adjust the maximum slip angles. This is one area where you need to be very careful. If you have a good driver, you should be able to achieve good correlation. However, if you have a less skilled driver, don't expect miracles, because they are less likely to be as sensitive in detecting when the self-aligning torque is dropping off. This all being said, some rough rules of thumb are as follows:

- **If the simulated steering lock is down everywhere, increase the front and rear slip angles by, say, a degree.**
- **If you don't have enough understeer, increase front slip angles and decrease rear slip angles.**
- **If you are dealing with either a locked diff or limited slip diff with significant lock ratio and you have significant understeer, drop the max rear slip ratio.**

"If you have a good driver, you should be able to achieve good correlation"

The increments you should be working in are in the order of, say, 0.5-1 degree, or two per cent of the slip ratio. I should also say at this point that you are not looking for perfect correlation, you just want it approximately in the ball park. We'll discuss the refinement shortly.

The last point on the list for manual refinement is the traction circle radius vs load characteristic. You access this by clicking on the Edit TC radius load characteristic button of the tyre quick start. This will bring up the following:

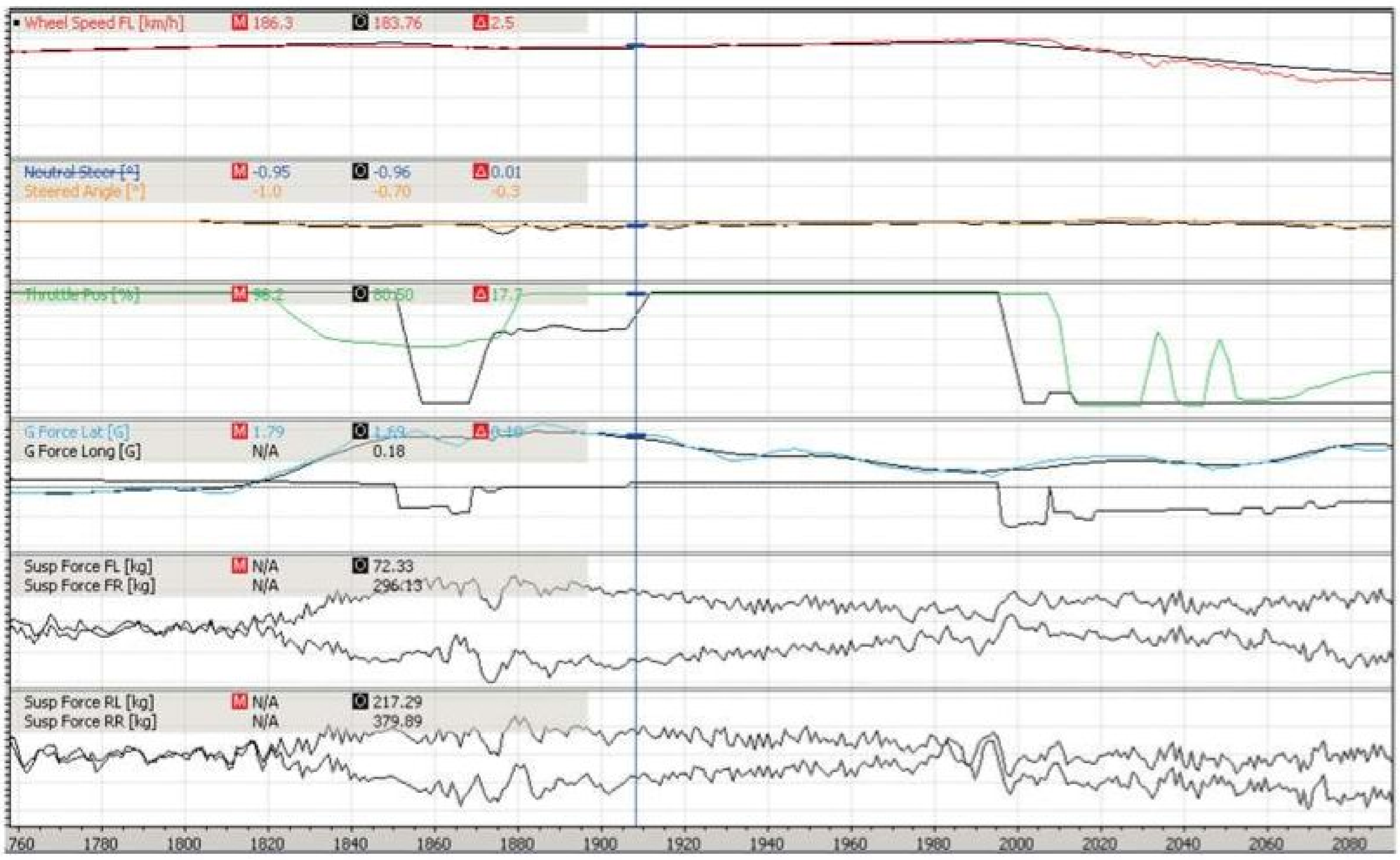



**Figure 4: a plot of simulated speeds and tyre loads**

| Run no | Set up |
|---|---|
| 1 | frh0 and rrh0 + baseline rear wing |
| 2 | frh0 and rrh0 + d_rrh + baseline rear wing |
| 3 | frh0 and rrh0 + 2*d_rrh + baseline rear wing |
| 4 | frh0 and rrh0 + 3*d_rrh + baseline rear wing |
| 5 | frh0 - d_rrh and rrh0 + baseline rear wing |
| 6 | frh0 + d_rrh and rrh0 + baseline rear wing |
| 7 | frh0 and rrh0 + baseline rear wing |
| 8 | frh0 and rrh0 + baseline rear wing + 2 holes |
| 9 | frh0 and rrh0 + baseline rear wing + 3 holes |

**Table 2: aero test procedure for a Sportscar**

**Where,**
frh0 = baseline front ride height as specified in the starting set up
rrh0 = baseline front ride height as specified in the starting set up
d_rrh = delta rear ride height
d_frh = delta front ride height

This is your 'go to' adjustment when you have some corners that match up well but others that don't. When you have this situation, you look at the tyre load plots. An example of such a plot is shown in **figure 4**.

What you are looking to do here is note where the speed differences are and adjust the tyre forces at the tyre loads at those points. This is greatly expedited by adjusting the values in figure 3 to suit.

Again, I should point out that the goal of this exercise is not to achieve perfect correlation, but to teach you about your tyres. Typically, you are looking for correlation to about 3km/h, steering to within two degrees. However, I guarantee if you do this exercise properly it will be the best preparation for using advanced tyre modelling features.

The next step is to construct the aeromap of the car. This is something I have written about at length in a number of different articles so there is no need to repeat what I have said before again here. However, here is a rough outline of the aero testing programme you should be considering.

The deltas you choose will depend on what type of racecar you are working with. For example, for an open wheeler or Sportscar, these might only be in the order of 2mm. For a Touring Car, these deltas might be in the order of 5mm. As a rough rule of thumb, choose the delta where you know it will have an effect on the car. The goal of tests 1-6 is to establish the pitch sensitivity map, the goal of tests 7-9 is to asses the variation in downforce levels.

Also, bear in mind if the aero configurations vary considerably, the tests in **table 2** will have to be repeated. A good case in point is the difference between high, medium and low-downforce packages on an F3 car. However, if you get stuck, you can stretch the results from one configuration. It's not ideal, but it will get you by. Also make sure the baseline you choose represents your current running configuration. This way you are modelling what you are running.

The last piece in the puzzle is employing the auto tyre modelling features to finish the tyre model. My goal here is not to talk about the specifics of running these toolboxes, as this will vary depending on the simulation package you are using. Here's the order you do it in:

- **Construct a 2D model first. That is traction circle radius vs load.**
- **Dial in camber / traction ellipse properties and slip angles.**
- **Dial in the temperature properties of the model if you have them.**
- **Construct the 3D tyre model. That is traction circle radius as a function of load and temperature.**

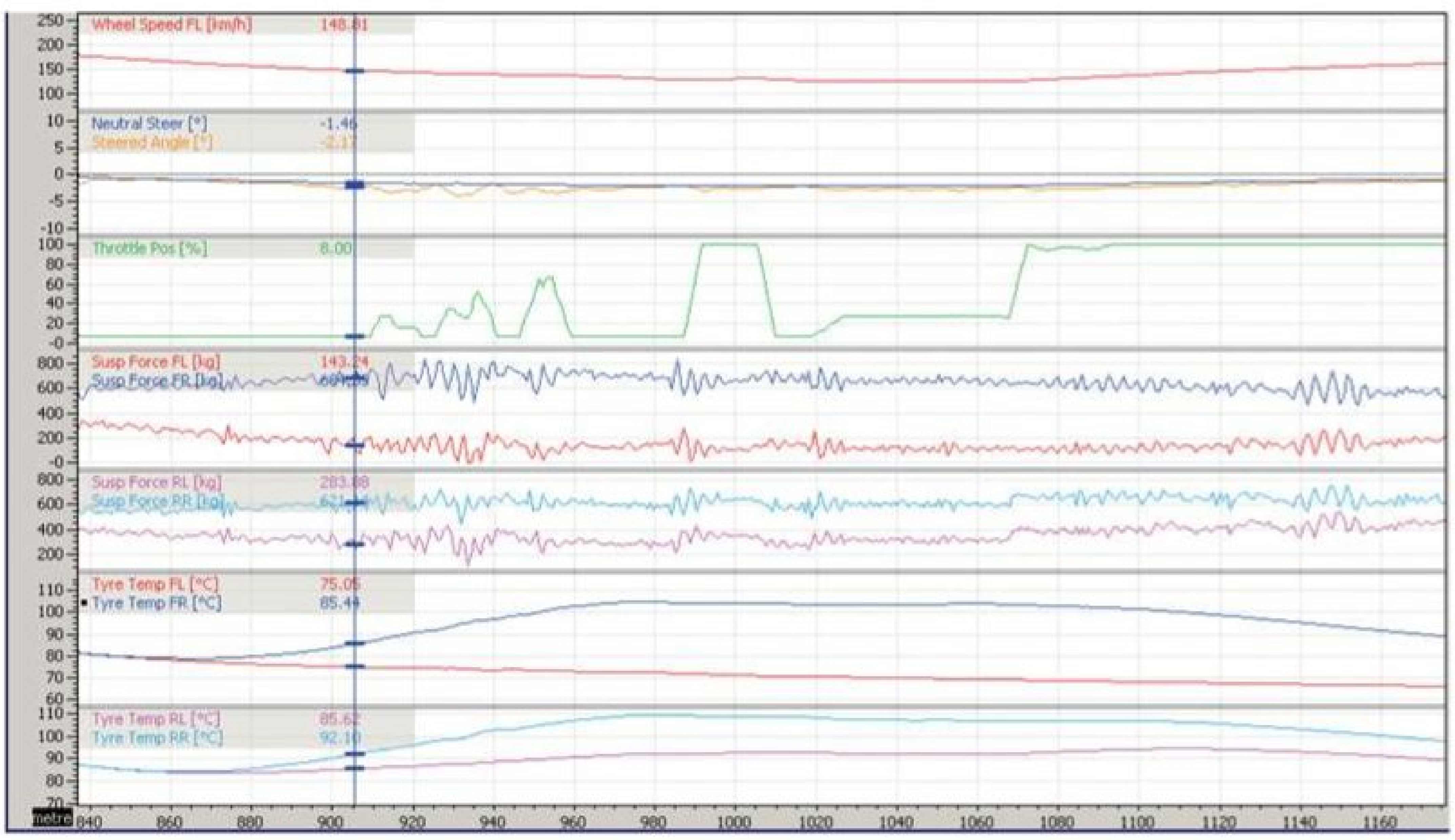
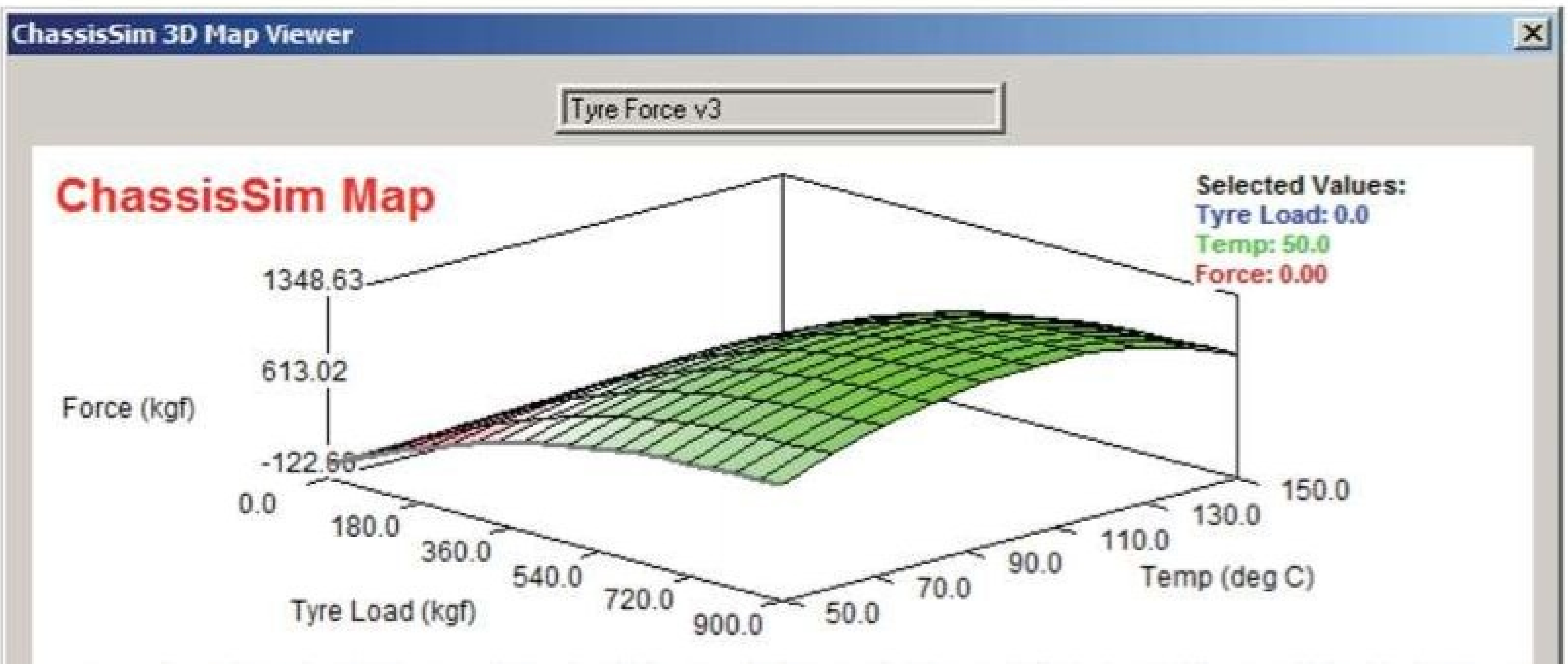



**Figure 5: temperature characteristic through a corner**




| | 50.0 | 61.1 | 72.2 | 83.3 | 94.4 | 105.6 | 116.7 | 127.8 | 138.9 | 150.0 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | 0.000 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 47.4 | 87.68 | 103.22 | 115.56 | 124.68 | 130.60 | 133.30 | 132.28 | 125.77 | 113.66 | 95.92 |
| 94.7 | 171.01 | 201.33 | 225.39 | 243.18 | 254.72 | 259.99 | 257.99 | 245.31 | 221.68 | 187.09 |
| 142.1 | 251.47 | 296.05 | 331.43 | 357.59 | 374.56 | 382.31 | 379.37 | 360.72 | 325.97 | 275.11 |
| 189.5 | 327.97 | 386.11 | 432.25 | 466.38 | 488.51 | 498.62 | 494.78 | 470.46 | 425.14 | 358.81 |
| 236.8 | 399.61 | 470.46 | 526.67 | 568.26 | 595.21 | 607.54 | 602.86 | 573.23 | 518.01 | 437.19 |
| 284.2 | 465.66 | 548.22 | 613.73 | 662.19 | 693.60 | 707.96 | 702.51 | 667.98 | 603.63 | 509.45 |
| 331.6 | 525.57 | 618.75 | 692.69 | 747.38 | 782.84 | 799.05 | 792.89 | 753.93 | 681.29 | 574.99 |
| 378.9 | 578.97 | 681.62 | 763.07 | 823.32 | 862.37 | 880.23 | 873.45 | 830.52 | 750.51 | 633.41 |
| 426.3 | 625.66 | 736.58 | 824.60 | 889.71 | 931.91 | 951.21 | 943.88 | 897.49 | 811.03 | 684.49 |
| 473.7 | 665.61 | 783.62 | 877.26 | 946.52 | 991.42 | 1011.95 | 1004.16 | 954.81 | 862.82 | 728.20 |
| 521.1 | 698.99 | 822.91 | 921.25 | 993.99 | 1041.14 | 1062.70 | 1054.52 | 1002.69 | 906.09 | 764.72 |
| 568.4 | 726.13 | 854.86 | 957.01 | 1032.58 | 1081.56 | 1103.95 | 1095.45 | 1041.61 | 941.26 | 794.40 |
| 615.8 | 747.53 | 880.06 | 985.22 | 1063.01 | 1113.44 | 1136.49 | 1127.74 | 1072.32 | 969.01 | 817.82 |
| 663.2 | 763.89 | 899.32 | 1006.78 | 1086.27 | 1137.80 | 1161.36 | 1152.42 | 1095.78 | 990.21 | 835.72 |
| 710.5 | 776.06 | 913.65 | 1022.83 | 1103.59 | 1155.94 | 1179.87 | 1170.79 | 1113.25 | 1006.00 | 849.04 |
| 757.9 | 785.10 | 924.29 | 1034.74 | 1116.44 | 1169.40 | 1193.61 | 1184.42 | 1126.21 | 1017.71 | 858.92 |
| 805.3 | 792.21 | 932.66 | 1044.11 | 1126.55 | 1179.99 | 1204.42 | 1195.15 | 1136.41 | 1026.93 | 866.70 |
| 852.6 | 798.80 | 940.41 | 1052.79 | 1135.92 | 1189.80 | 1214.43 | 1205.09 | 1145.86 | 1035.47 | 873.91 |
| 900.0 | 806.42 | 949.39 | 1062.84 | 1146.76 | 1201.16 | 1226.03 | 1216.59 | 1156.80 | 1045.35 | 882.25 |

OK | Cancel | Axes Properties/Calculator | Export text/Aero File | Import text file

**Figure 6: an example of a completed 3D tyre model for an open wheeler**

The reason to construct the 2D model first is it forms the foundation of what we'll work from. You may recall from an earlier article I wrote about set-up referencing, one sure fire thing the traction circle vs load characteristic gives you is a snap shot of what the tyre was doing at that internal temperature and pressure condition. While this may not be the complete story, as we narrow down what we are after, this forms an excellent start point. I should also add if we have done a good job in our initial tyre modelling, it should take the existing curve and refine it.

The next step is to refine the camber / traction ellipse and slip angles. This is where the work we did in the initial modelling is so valuable, because we have given ourselves a good start point. It will also inform us the ranges we should be looking at. If you are comfortable with your initial correlation, you can then combine the 2D modelling with the determination of the camber / traction ellipse and slip angle properties.

Before we discuss the temperature modelling, I think it would be prudent to discuss how to interpret the results you're getting from your tyre modelling software. Using ChassisSim tyre force modelling as an example, a delta is specified. So, for example, if you are trying to evaluate the peak slip angle, it will search in this range,

$$\alpha_p = \alpha_{p0} +/- \partial\alpha_p \qquad (1)$$

Here,

$\alpha_p$ = the peak slip angle being evaluated

$\alpha_{p0}$ = the start point

$\alpha_p$ = the delta range

You can be confident you are getting a good result when the optimised value returned is within the search range. If that is not the case, it's the tyre modelling toolbox asking you to increase the search range, or change something you are modelling. And remember to always review the data you get back critically – simulation is a calculator, not a magic wand.

The next step is to dial in the tyre temperature characteristics you are after. What you are looking at will vary depending on the simulation package you are using, but for dialling in surface temperatures, what you are after is illustrated in **figure 5**.

If you are after a temperature delta of approximately 35-45degC from the background temperature (this is measured just before the brakes are applied), you are aiming for the peak temperature to be occurring just after the mid-corner condition. In a perfect world you should have tyre temperature sensors to compare this to but, if you don't, what we have discussed is a good starting point.

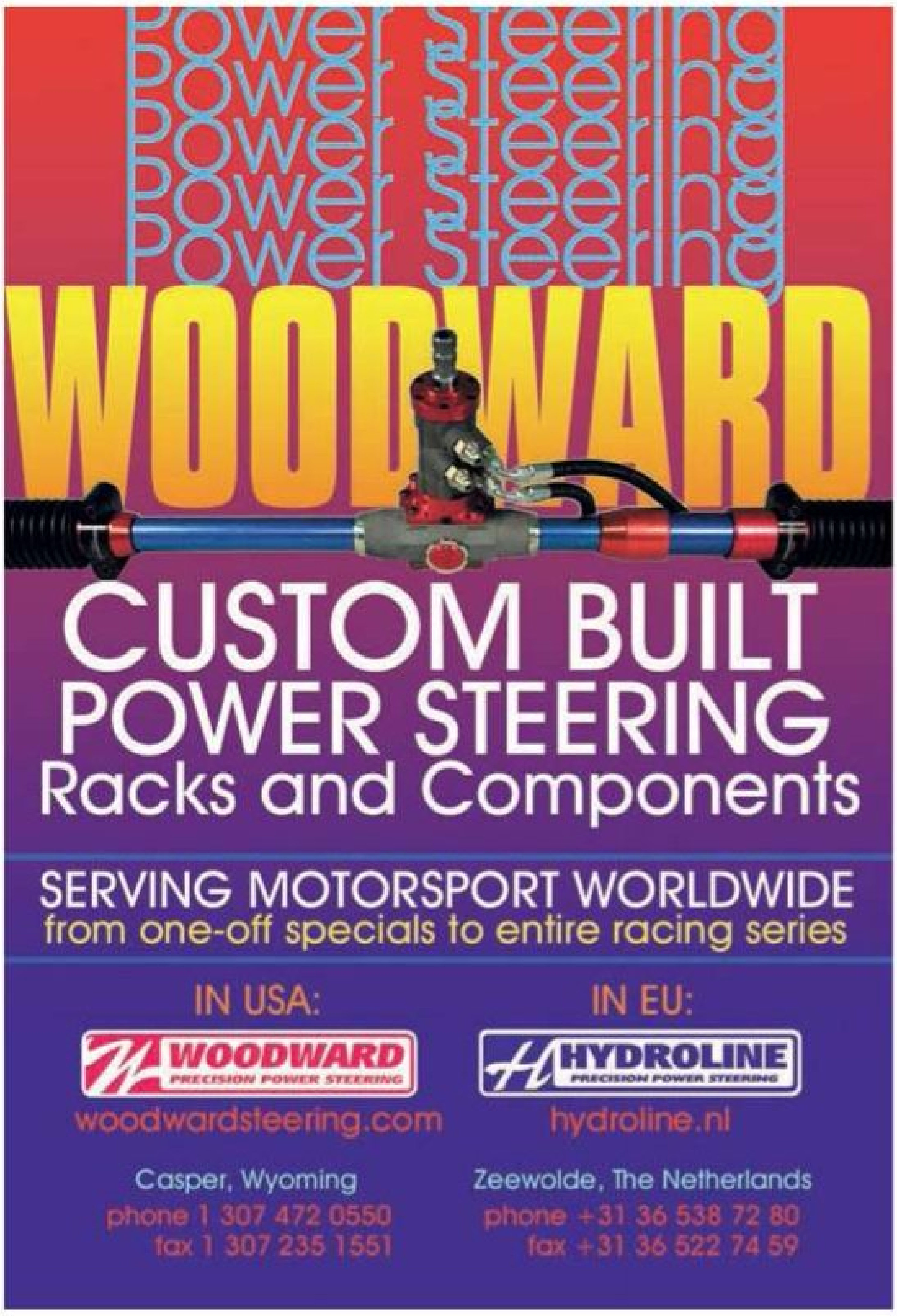
Once the tyre temperatures have been dialled in, the last step in the process is the 3D tyre model. This is the traction circle radius as a function of load vs temperature. How this will be implemented will be simulation package specific, but once you are at this point you only need to worry about this aspect of the vehicle model, since everything we have done in the lead up will bring us to this point. When you are done, you should have a tyre model that looks like **figure 6**. Congratulations if you have worked through all this successfully, as you now have a vehicle model you can use.

**"a good simulated change will be small and consistent and will make sense"**

## CONCLUSION

Before wrapping things up, let me just add some reflections and observations about how to use your new tool. First things first, when correlating your results, mid-corner speed correlation of 1-2km/h is good enough. Yes, 0.1km/h looks great to team management, but it takes a long time to get to that level of detail, and it really isn't necessary. Remember, our goal here is a representative environment. The second observation I'll add is that the simulated results will always be smaller than actual changes. This is because the simulator knows where the grip is and does not comprehend fear. The last observation is a good simulated change will be small and consistent and will make sense. If it passes these two simple tests, put it on the car.

In closing, as we have seen over the last three month's articles, constructing a useable racecar vehicle model is not difficult, it is just a case of attention to detail and following some simple steps. The key thing to remember is to take your time measuring the car, start with a simple model, and then construct the circuit model in a sequential and deliberate manner. Only when you have done this can you start refining your model, by doing a manual pass at tyre modelling, deriving the aeromap and then refining with tyre modelling. If you follow this process, the correlation will be a formality and you will be amazed what you learn along the way. Once you have a thorough understanding of all this, you will realise why racecar simulation is one of the most valuable tools a racecar engineer can have at his or her disposal.



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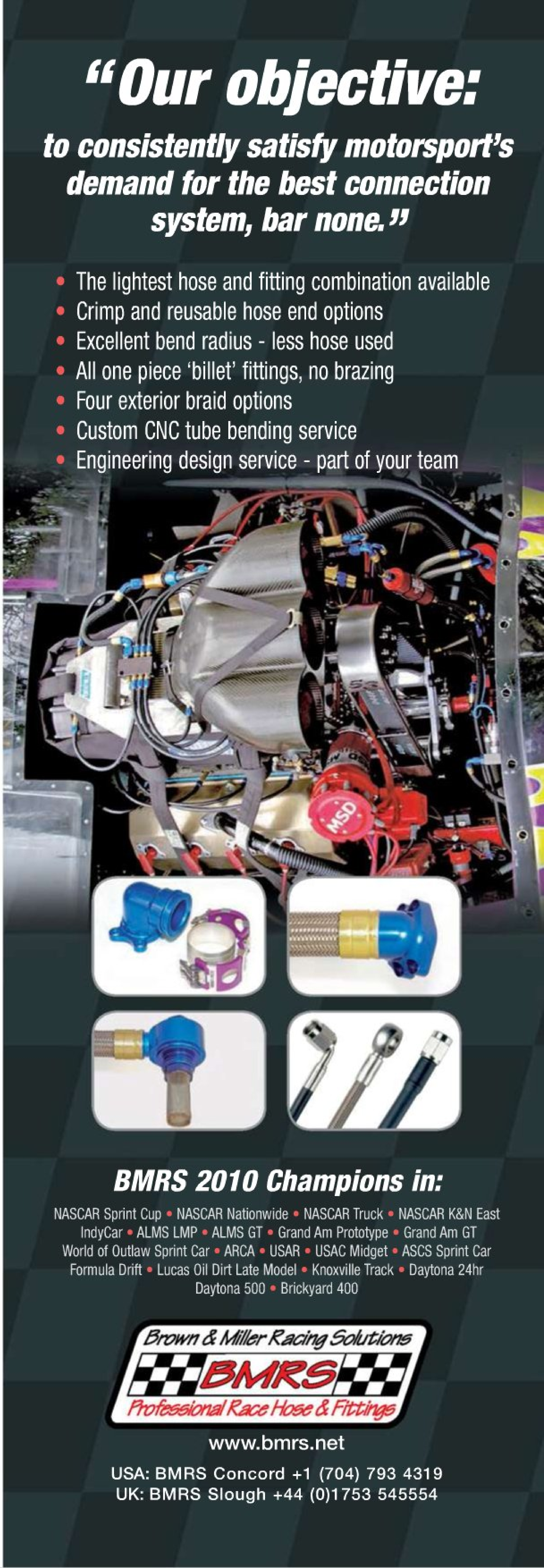

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# Air necessity

## Creative thinking at Toyota has produced an apparently legal aero update that offers improved downforce. Understandably, eyebrows were raised...

**BY ANDREW COTTON**

Toyota arrived at the fourth round of the World Endurance Championship at Silverstone with a controversial, double end plate rear wing on the TS030 that appeared to increase the wing to full width across the bodywork.

The rear wings for LMP1 prototypes were reduced from 2000mm to 1600mm for the 2009 season to reduce downforce after accidents afflicted manufacturer and privateer cars in 2008, but Toyota sought clarification of the rules from the FIA before introducing the new bodywork in the UK at the end of August.

Toyota claimed the end plates were an extension of the wheelarch, and that as a cheap solution offered an increase in downforce, and therefore more speed, on the short tracks in the second half of the season. The idea came to the designers at the tail end of 2011, but the team did not race at Sebring or Spa, and the package was not suitable for the low downforce Le Mans circuit in June.

'The first ideas were from the end of 2011,' said the team's technical director, Pascal Vasselon. 'If a loophole is when something happens that is legal but doesn't correspond with the original intention of the regulation, then maybe, yes, this is a loophole, but this is not trick. This is creative, considering the new regulations.'

**"Rules should not kill creativity"**

These new regulations include the opening of holes over the wheelarches at the front and the rear of the car. 'You would have had a high trailing edge for the wheelarch, which would have been very draggy,' continued Vasselon. 'Here the opening of the hole gives you a way to turn this into aero efficiency. It offers more downforce with a reasonable drag. The ratio is important.'

Audi could not understand how Toyota got away with the wing, but accepted the explanation of the extended wheelarch as, 'Very clever. Pascal Vasselon has given a clear explanation how it came together,' said Audi's technical director, Ralf Juttner. 'If it is clearly an advantage, and you can find another way of getting the same effect, you can do something of a copy. We won't be on the grid tomorrow [at Silverstone] with a second end plate, or in Brazil, or this year.

'Probably during the course


**Toyota's bid to win a World Endurance Championship race took several steps forward at Silverstone with a new aero package and its first finish of the year**

of the year you will see some copies, but I don't expect this to be a standard configuration of a Sportscar in 2013 and 2014.'

**ENTIRELY PROPER**

For Toyota, this was an entirely proper interpretation of the rules. 'I do not see why the rule should be changed,' said Vasselon. 'Rules should not kill creativity. You should only think about changing rules when it is costing too much money. What we found was cheap. As soon as you know what you are looking for, and it is not more expensive than a normal wheelarch, it is a cost-efficient development. It is very sad when all cars look the same.'

While the wing was the most visible part of the package, the increase in rear downforce had to be balanced out. 'It needed balance at the front for sure,' continued Vasselon. 'We have many details under the splitter and the front wheelarches. With the exception of the rear of the car, which is visible, like in Formula 1, the most important items are masked. This is an entire car package and includes a new splitter, new [front] wheelarch, rear wing and rear wheelarch.'


**The extended wheelarch that looks rather like an extension to the rear wing**

The front wheelarches are shorter, with a longer overhang of the splitter. There were some small changes to the dive planes to help balance it out and, with increased downforce, Vasselon also expected to have improved tyre wear. 'Tyres love downforce. For the same speed in the corners the tyre slides less. It is always good to save tyres. As soon as you can be faster in corners without sliding it is better. A tyre doesn't like to slide and it needs forces to warm up.'

'We had a really good pace, with a car that delivered what we expected with our new aerodynamic package,' said driver, Nicolas Lapierre. 'We were consistent and clearly on the pace of our competitors. Our fastest lap shows our potential and we hope to win a race before the end of the season. This will be the target.'

**DIRECT COMPETITION**

Meanwhile, a row has broken out in the GTE class, as Porsche was allowed to bring a new aero package to the WEC to the fury of Ferrari, but both Porsche and Aston Martin have called for a review of the regulations, as Ferrari has dominated on fuel consumption with its direct injection engine.

Neither Porsche or Aston Martin has a direct injection engine in their GTE cars, and during a six-hour race the Ferrari is able to complete the distance on just four fuel stops. Porsche expects to make one stop more, and doesn't have the pace on track to make up the difference, even with the new aero package that includes a new, higher rear wing moved further back, and a new, larger front splitter.


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# Dodge: NASCAR cash will not fund other categories

The head of Dodge's motorsport arm has confirmed that the money that would have been spent on its NASCAR Sprint Cup operation will not be re-directed to any of its other motorsport disciplines.

Dodge was forced to pull out of NASCAR after Penske decided to switch its allegiance to Ford from 2013, although the Penske Dodges will compete until the end of this season. Penske was responsible for the development of the Dodge cars and engines, and was the only team fielding Dodges full time.


**Dodge fans will be disappointed that the new-for-2013 Charger will not race with manufacturer backing in the Sprint Cup. A privateer entry is still possible**

Penske made its decision to drop Dodge in March this year, and since then Dodge has unveiled its 2013 contender. However, the company was unable to find another team to field its cars, and so the new car now looks unlikely to see Sprint Cup action.

Ralph Gilles, president and CEO of Dodge's street and racing technology brand and motosports, insisted the decision was not based upon any financial reasons, but also said the money saved on its 2013 NASCAR operation would not now be ploughed into any new or existing motorsport programmes.

'We are happy with our size [of motorsport involvement] right now,' Gilles said. 'We are about where we want to be. We also have introduced Rallycross and ALMS [this year]. But it's not a matter of taking the NASCAR budget and re-appropriating it. They were separate budgets to start with, so it's really a matter of going racing at the level and quality we are accustomed to, not necessarily budget management.'

Gilles also said he would not rule out a return to the Sprint Cup at some point in the future: 'We are going to keep our options open. It would be imprudent to try to predict the future right now.'

He also said there was the possibility that a team might run a privateer Dodge: 'It's relatively do-able. It's something that we are going to have to review and understand how we can make that work, but for now [there's been] no decision on that.'

NASCAR chairman and CEO, Brian France, said: 'Dodge has been a great partner to NASCAR for many years, and they have been part of numerous memorable moments throughout our history. They made a business decision not to return in 2013, as they did in 1977, before returning in 2001. We wish them well and hope they again will choose to return to NASCAR at a later date.'

Dodge's withdrawal leaves just three manufacturers in NASCAR's Sprint Cup: Ford, Chevrolet and Toyota.

## Red Bull to promote World Rally Championship

**The FIA was close** to signing a deal to install a new WRC promoter as *Racecar Engineering* went to press, with Red Bull Media House all but certain to take on the responsibility.

Red Bull Media House, the division of the energy drinks empire that deals with media content and promotions, won the contract a full six months after the FIA put it out to tender. This followed the termination of the previous contract with North One Sport, after its parent company, Convers Sports Initiatives (CSI), went into administration at the tail end of 2011.


**The energy drinks manufacturer continues its support of extreme sports by adding the WRC to its books**

WRC teams and the FIA were remaining tight lipped on the subject as *Racecar Engineering* went to press, but it's known that Eurosport and a partnership from South Africa have been informed their bids have been unsuccessful, leaving just Red Bull Media House in the running.

Meanwhile, it's believed the WRC manufacturers were told that Red Bull Media House was to be the new promoter at Rally Finland in August, at a time when the contract was going through due diligence.

Insiders have said the deal will probably be for three to five years, and not the 10 years North One Sport was signed up for.

Red Bull Media House was set up in 2007, primarily as a content provider, making its own films, running its own TV station and publishing its own magazine to showcase the Red Bull brand. The company would not comment on its involvement with the WRC.

If the deal goes ahead, the WRC's promotion should be on a firm footing, as Red Bull is a very successful company. Last year's financial reports shows it sold a staggering 4.631 billion cans of its energy drink worldwide, an increase of 11.4 per cent on 2010, while the company's turnover increased by 12.4 per cent from €3.8bn to €4.3bn. Interestingly, its sales increases were also in countries and regions with a WRC presence or history, such as Turkey (86 per cent increase), France (35 per cent increase) and Scandinavia (34 per cent increase).

# Motorsport valleys: new Welsh motorsport development on the horizon

**Plans for a £250m** Welsh motorsport complex, featuring an international standard race circuit and an automotive business park, have been unveiled.

Should it get the go-ahead, the motorsport complex, which will include karting and motocross tracks, as well as the 3.5-mile circuit, will host international events, including MotoGP and Touring Cars, it is hoped.

Circuit of Wales is to be developed over an 830-acre site in Ebbw Vale by the Heads of the Valleys Development Company. The company says: 'As well as the performance circuit, the project will include investment in industrial, commercial and leisure developments. It will also provide opportunities for the growth of advanced engineering, education, safety in motorsports and green transport-related businesses.' Should planning permission be forthcoming, construction should commence next year, with a view to opening the circuit in 2015.

The chief executive of the Heads of the Valleys Development Company is Michael Carrick, the founder of Aveta Capital partners – a company that focusses on infrastructure investments. He said: 'This is a major private sector-originated regeneration project, in partnership with the local authority and the Welsh Government, which will create significant job opportunities in a deprived part of the UK. We are currently in consultation with a range of stakeholders on our plans to create world class infrastructure and facilities that will allow us to attract and retain high-quality businesses and operate international motorsports events.'

The company says there could be as many as 9000 jobs created, 3000 in its construction, the others in the leisure industry and within the nucleus of companies around the circuit.

**A 'world class' facility that could have a profound effect on the surrounding Ebbw Vale area, and on Wales in general**

**A 3.5-mile racetrack, plus karting, motorcross and an automotive business park**

World-renowned automotive business expert, Professor Garel Rhys, chairman of the Welsh Automotive Forum, believes the project will be good for the principality: 'This is an exciting opportunity and will place Wales at the forefront of automotive innovation and sustainable growth – as well as providing an international track capable of hosting world class events. The term 'world class' is often wrongly used, but this project in all its various aspects – infrastructure, accommodation, events, and research and development – is worthy of such status. The knock-on effects will be profound, and show Wales can still attract big ticket projects.'

## BRES SAYS...

A long time before I was news editor for *Racecar Engineering*, I plied my trade as a business reporter on the *South Wales Argus*. It's my experience on that newspaper that tells me this might just work, though the promise of some 9000 new jobs seems optimistic. The project has the backing of the right people in Wales and the locals – some of my own family among them – are up for it. Gwent just does not do NIMBYs, you see. It's part of the reason why the area has always attracted inward investment, and also means the dreaded noise issue may not kill this one off. Anyway, it's been too quiet in the valleys since the steelworks and the mines closed.

**Mike Breslin**

## SEEN: MCLAREN 12C CAN-AM EDITION

If you've ever wondered what a GT car unencumbered by tiresome regulations might look like, then take a look at this startling concept from McLaren GT, the new racecar manufacturing arm of the McLaren Group. The one-off 12C Can-Am Edition, which shares the same carbon fibre MonoCell chassis as the 12C road car, certainly looks the part, all wrapped up in a skin of orange and black, redolent of Can-Am McLarens of years gone by. The car was shown off at the Pebble Beach Concours event and, at this stage, is said to be 'purely a concept', designed as the ultimate track car.

The revised version of the familiar 3.8-litre, twin-turbo V8 engine features a unique engine calibration and optimised cooling system, which allows a power output of up to 630bhp, making it the most powerful 12C derivative so far. The overall dry weight is 1200kg while the optimised aerodynamic package gains an extra 30 per cent of downforce. The aerodynamics have been honed by McLaren Racing and include a carbon fibre front splitter, dive planes, rear wing and diffuser.

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## PEELING BACK THE STICKERS NO 6: SANTANDER

**There was a time** when banks would not even consider an involvement in motor racing. It was seen as too risky, not quite respectable, and hardly the sort of place a bank would lodge its customers' money. These days, motor racing is seen as the respectable business.

Banks have certainly seen the possibilities of an F1 presence over the past few years, and the one which has made the best of it has to be Spanish company Santander.

Santander initially entered Formula 1 at the start of 2007. At the time it was re-branding Abbey National, a well-known UK high street building society, as Santander. An involvement with a British team was therefore an obvious move, especially when said team, McLaren, signed a Spanish superstar in Fernando Alonso. That didn't quite work out as intended, the human element coming into the equation to spoil the hopes and dreams of marketing men and number crunchers. Alonso's bust up with Ron Dennis generated plenty of publicity, but most of it was negative. Yet the bank stuck with McLaren, even without Alonso in the car, and ultimately did well in the UK on the back of its continued involvement.

**For every euro spent on sponsorship, there's another euro spent advertising it**

But, by 2009, Santander wanted to expand its coverage and have a more global reach, without alienating its UK customer base. Also, Alonso was known to be going to Ferrari the next year – and, although it would never admit it, the bank wanted Fernando. So, for 2010, the Santander brand was off the McLaren and on the Ferrari, although it remained on the overalls of British McLaren stars, Lewis Hamilton and Jenson Button.

At the time, the initial five-year deal with Ferrari was said to be worth €40m a year, €200m in its entirety, and the bank extended its deal with Ferrari until the end of 2017 earlier this year. Along with other F1 sponsorship deals, such as naming rights for a number of grands prix, Santander's spend across a Formula 1 season is now reckoned to be close to €54m a year.

There seems little doubt this has been money very well spent, too. The Spanish IESE Business School estimates that the return on the bank's investment during its first year with Ferrari might have been as much as €250m. But perhaps one of the most telling statistics, which comes from the bank itself, is that a staggering 96 per cent of Santander's employees thought the sponsorship was important to the success of the business.

A more telling statistic comes from a survey carried out by Spanish sports newspaper *Marca* during the first season of the Alonso, Ferrari and Santander triumvirate in 2010. It reckons that 96 per cent of those questioned thought the sponsorship was positive and strengthened the bank's image, while a staggering 65 per cent said they intended to open an account with Santander as a direct result!

But as sponsorship guru, Brian Sims, told *Racecar Engineering*: 'Sponsorship has been way beyond space on the car for a long, long time.'

And this is something Santander obviously understands, because for every euro it spends on the sponsorship, there's another euro spent on actually advertising the sponsorship: things like Ferrari-branded credits cards, and the long series of TV adverts featuring Santander-backed drivers. If the figures from Spain are correct, it's working very well.

# Nürburgring finances under further scrutiny

**The European Commission** has extended its investigation into the Nürburgring's finances to encompass a new €254m loan from local government, which was granted so as to guarantee payments on an existing €330m loan.

The approval of the loan by Rhineland-Palatinate state legislature was thought to have gone some way to saving the circuit from insolvency, but it has now resulted in the European Commission stepping up its existing investigation, focussing now on what it calls 'several additional financial measures aimed at avoiding an immediate insolvency of the companies concerned.'

The European Commission explained the reasons for the extension of its ongoing investigation in a statement: 'At this stage, the Commission has doubts that the measures were granted on market terms and that the companies are viable without continued state support. The extension of an in-depth investigation gives interested third parties an opportunity to comment on the additional measures under assessment. It does not prejudge the outcome of the investigation.'

The statement added: 'The Commission is concerned that Nürburgring may already have been a company in difficulties in 2008, when it received the previous aid. Because of its highly distortive effects on competition, rescue or re-structuring aid to a company in financial difficulties may be granted to a given company only once in a period of 10 years. The Commission will now investigate whether these repeated public interventions were in line with EU state aid rules.'

The Nürburgring, which hosts the German Grand Prix on alternate years, has been in difficulties since a major re-development operation, which was part of a push to make the venue more than just a popular motorsport destination. In all, the re-development project, which included a theme park and hotels, is said to have cost Nürburgring GmbH around €500m, which is not good economics when it turns out it has placed the facility in debt to the tune of €400m.

## BRIEFLY

### DeltaWing Light?

The team behind the DeltaWing Le Mans racer is in the running to build and supply a version of the radical racecar for Indy Lights, which is due to switch to a new spec chassis in 2014.

Project 56, which comprises the car's designer, Ben Bowlby, along with US racing luminaries, Don Panoz, Chip Ganassi and Dan Gurney, has now joined a list of constructors vying for the contract to replace Dallara as the IndyCar feeder series chassis supplier. Dallara itself, Swift and Mygale are also thought to have put forward concepts.


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## PEAK'S POWER

The running of this year's Pikes Peak hillclimb was a great fillip to businesses in an area that has been hit hard by well-publicised wild fires recently. The mayor of Colorado Springs, Steve Bach, said it showed the area was 'open for business'.

That it certainly did, with the event attracting reporters and broadcasters from 50 international news organisations, while despite the postponement until August 12 - the original date was July 8 - there were only 10 cancellations in the entry. Rhys Millen won the event overall in his Hyundai Genesis, setting a new course record of 9m46.164s, the pace significantly quicker as this was the first time the mountain road has been completely asphalted.

Pictured is the Toyota TMG EV P002, which won the Electric Vehicle class, setting a new category record on its way.


## CAUGHT

NASCAR Nationwide crew chief, Scott Zipadelli, has been fined and placed on probation after the no 9 RAB Racing Toyota was found with an improperly attached weight and failed to meet the minimum weight at post-race scrutineering. Car chief, Travis Young, was also placed on probation while driver, Kenny Wallace, and car owner, Robby Benton, were docked points.

**FINE: $10,000**
**PENALTY: six points**

NASCAR crew chief, Philippe Lopez, who tends the no 43 Richard Petty Motorsports Ford in the Nationwide Series, has been fined after the front of the car was found to be too low following the Iowa round. Lopez and car chief, Michael Wright, are now on probation until December 31. Driver, Michael Annett, and owner, Sandra Turner, have each been docked championship points.

**FINE: $10,000**
**PENALTY: six points**

# Forecourt-friendly NASCARS ready to rumble


**With aero testing complete, this is how the new NASCAR Sprint Cup cars look**

**The new-for-2013** street-styled NASCAR Sprint Cup cars have passed their final aerodynamic test, with all cars meeting the necessary targets.

New cars from Chevrolet, Ford, Toyota and Dodge were tested - although the Dodge will probably not race next year due to the withdrawal of the manufacturer - marking the closing stages of a two-year collaborative project between the car companies and the governing body.

The philosophy behind the new car is to field racecars that more closely resemble their respective manufacturer models on the showroom floor. Three of the four new models - Chevrolet's SS, Ford's Fusion and Toyota's Camry - will make their race debuts next February at Daytona International Speedway, with the first championship points event being the 55th running of the Daytona 500 on Feb 24 2013.

Robin Pemberton, NASCAR vice president of competition, said: 'We commend the manufacturers and our team at the R and D centre on all the hard work they've put into this new car. With all the designs and surface areas of the car now approved, manufacturers can now move forward with building the components needed to outfit their cars. The wind tunnel testing we've had with the manufacturers over the past several months has given us the timely and necessary data we needed to come to this confirmation. We believe the new car is going to be a milestone opportunity for our sport, one that our fans will embrace.'

# New Pilbeam LMP2 for African Le Mans onslaught

**Pilbeam is building** a new LMP2 for a South African race team, which harbours ambitions of competing at the Le Mans 24 Hours within the next two years.

The new car, which bears the milestone type number, MP100, is to be based on the monocoque of the company's last LMP challenger, the MP93. 'It's the original design of the carbon tub, but pretty much everything else has changed,' Mike Pilbeam told *Racecar Engineering*. 'The aerodynamics is the biggest thing. Our car was okay when it raced, it was as good as anything I think, given the right drivers and so on.'

Pilbeam says the car is scheduled to hit the track at the end of next year and he is hopeful of a Le Mans entry in 2014. 'We've been asked to do it. It's a South African-based team and operation. A chap called Dr Greg Mills is the man behind it. He's a tremendous enthusiast for motor racing, he loves it. His aim is to have as near as possible a South African car. Obviously it's our car and we're building it, and it will still be called a Pilbeam, but it will be run from South Africa ultimately.'

Mills, an amateur race driver, is well known in South Africa. He is a director of the Brenthurst Foundation, a body set up to help Africa's economic performance, and through which Mills runs advisory groups at a presidential level for countries such as Malawi and Mozambique. He joined the foundation after 10 years as director of the South African Institute of International Affairs.

The engine is likely to come from a manufacturer with strong South African connections, and Pilbeam says Toyota, which has a huge presence in the country, is a possibility. He also says that the new cost-capped regulations have helped to make the project viable: 'It's helped, definitively. The car only comes up to about £280,000, plus the engine, which is also cost capped. It's what LMP2 is meant to be but it got lost when they allowed Porsche and Honda to become effectively works manufacturers cars and they cost an absolute fortune. But this is good, it's really a privateers' formula.'

There is also a good chance the car will make it onto the grid at Le Mans, says Pilbeam: 'I've been over there and talked to the guys at Le Mans and they're happy with it.'

Pibeam has previously competed at Le Mans on five separate occasions between 2001 and 2007.

## INTERVIEW – PETER DIGBY

Peter Digby trained as an engineer with British Airways, before going on to work with the Williams Formula 1 team when he was 21. He also worked at Team Haas in F1, and completed a Masters degree before joining transmission manufacturer, Xtrac, in 1986. In 1997, Digby led a management buy out of Xtrac with all the employees,.

Xtrac, which was established in 1984, now employs approximately 275 people at Thatcham in the UK and Indianapolis in the US, and is one of the world's most successful motorsport transmission companies, with a turnover of around £40 million. It supplies gearboxes and gearbox internals to Formula 1, IndyCar, Le Mans, Touring Cars, rallying, Grand-Am and many others.

Peter Digby is a past chairman of the Motorsport Industry Association, an associate member of the British Racing Drivers Club, and a VP of Chelsea Football Club.

**Q. How important is it for Xtrac to have a presence in F1?**

Formula 1 has always been a real technology driver at Xtrac, it's the main one that helps us, or forces us, to bring out our new materials or processes. We love being involved with it, even though it's very demanding for timescales.

That said, the demands of putting a car out for a 24-hour race, especially with some of the high torque engines that are now in existence, can have some equally demanding – if not more so – challenges. We tend to be more involved in the complete supply of gearboxes there too, while most of our Formula 1 customers will tend to be buying internals and designing and supplying the gearbox casing themselves.

**Q. What challenges does F1 present?**

Formula 1 has been a very interesting sector, because obviously the regulations are such that the cars are testing a lot less now than they used to, and there's also the regulation on the amount of races the gearbox has to last. So we are finding that the volume is much less than it was, but the demand for higher quality is increasing all the time. And that plays into Xtrac's hands. We are experts at high quality materials, high quality heat treatment, high quality gear cutting etc. We're finding that we have to put more value added into the components and make them last longer, so it's a slightly different business model to what it was a few years ago.

**Q. How has the proliferation of spec series in motorsport changed the way you do business?**

It can bring a lot of benefits, certainly to someone in the transmission industry, as our business is all about volume if you want to get costs down. Our machinery is very expensive and it takes a long time to set up, so if you then only make four or five gearboxes, they do work out to be very expensive. But going to an organiser and saying we can supply 50 gearboxes, or even 100, to one specification can mean our costs are drastically reduced, so it cuts the costs of the gearbox and the spares.

But we're not a cut price gear manufacturer. So the model we've promoted is to go to the organisers and show them we can offer a cheaper gearbox to run in the long term. You might need to spend a little bit more on it, but it will offer you savings through its quality and durability.

**Q. What work is Xtrac involved in with newer automotive technologies?**

We've probably been involved in 20 different programmes for hybrid and electric vehicles, and they've all been incredibly successful. Some have been financed by the Technology Strategy Board, and we've done some for specific customers. But they're all the same thing: someone has had an idea, where they have some power they need to transfer to some wheels, or maybe a boat propeller or whatever, and Xtrac's engineers – and we've got a group of 65 very skilled engineers – can jump on that task immediately. The guys love using their skills, many of which they've picked up in motorsport, and through our long standing and award-winning apprentice and undergraduate sponsorship schemes.

**Q. The business model at Xtrac, with the employees owning shares in the company, is very unusual in motorsport. How did it come about?**

It's a major part of Xtrac's success. When our founder, Mike Endean, wanted to retire, we put forward various different business models. At the time, I had studied the National Freight Corporation, which was then owned by the government and was being privatised, led by Sir Peter Thompson. He wrote a book all about it, and I read this book and then gave it to Mike and

## OBITUARY – MIKE HEWLAND

**The man behind** one of the most well known and respected companies in the motorsport industry, Mike Hewland, has died at the age of 89.

Hewland left school at 14 and worked for many years in engineering, including a spell at Sykes and ML Aviation, before setting up Hewland Engineering in 1957. He had originally planned to concentrate on metal plating, but when this did not work out he went back to what he knew best – gear making.

The company started life in a leaky shed close to Maidenhead station with just four members of staff. In 1959, it did some gearbox alteration work for the UDT Laystall F1 team, and this proved to be the start of something very big indeed.

With the advent of Formula Junior in the early '60s, a major requirement emerged for improved gearbox internals to be fitted to standard transmissions. Hewland's choice, originally for Lola, was to use the VW Beetle gearbox as the donor. This move proved to be inspired and it established Hewland Engineering as a successful company, with thousands of Mk4 to Mk9 gearboxes sold over the coming years.

Hewland transmissions such as HD, LG, FT200, DG300 and FG400 were to become ubiquitous in world circuit racing for a quarter of a century and beyond. Between the mid-'60s to the mid-'80s, almost all F1 cars, except BRM and Ferrari, used a standard Hewland transmission, usually allied to a Cosworth DFV engine. During the '70s, Hewland Engineering had well over 100 staff at its premises in Boyn Valley Road in Maidenhead and had become a cornerstone of the motorsport industry, with Mike Hewland being awarded the prestigious Ferodo Trophy in 1970.

Alongside all this, Hewland kept up his passion for engines as an almost constant sideline and, in a small development department run by engineer John Hogan, his designs each made a mark. Firstly, there was a fuel efficient, sleeve-valve engine said: 'Look, this is what I want to set up. Something where the employees have a big part of the business, so that if we do well they can share in that success.' He agreed to it and allowed us to pay him off over time, which we did by 2000, and it has been fantastically successful, with the employees the biggest shareholders in the business.

**Q. What does the future hold for Xtrac?**

We will certainly be making sure we look after all our existing motorsport markets, and we will be consolidating them. For instance, every year there are more and more cars at Le Mans running Xtrac transmissions – I think it was well over 30 this year – and we are expanding our markets in Sportscars, and also in Touring Cars.

But we're not just a gear and gearbox manufacturer now. We are becoming systems suppliers, too. So we are supplying the gearbox with its assisted gearchange system, and paddleshift system, for instance. We're also a lot more involved in the maintenance of the gearbox, so we can actually offer a cradle-to-grave approach to anyone who uses Xtrac's gearboxes.

But probably the biggest growth area is going to be our automotive and engineering on our non-motorsport side.

research project, which still attracts attention today. Also, a 100cc kart engine won numerous British championships between 1977 and 1982, while a 750cc, two stroke, three cylinder aircraft engine was CAA certified and used in the ARV Super 2 aircraft, amongst others.

Hewland's last two design projects were the famous LD200 gearbox, used in top level Formula Ford until very recently, and the SGT gearbox, used by the Prodrive BMW BTCC team in 1992 and beyond. He retired from the business in 1991, handing over the reins to his son, William.

**Mike Hewland 1923-2012**

# General Motors marketing boss steps down

**In a move that** could have repercussions for General Motors' motorsport programme, its global chief marketing officer, Joel Ewanick, has stepped down from his post. The US motor giant has appointed a temporary replacement while it searches for a successor.

The American car company would not comment on the exact reason for Ewanick's departure, although a spokesman did say: 'The resignation is disappointing, but he failed to meet the expectations that a company has of an employee.'

Ewanick joined General Motors in May 2010 as head of North American marketing, and was named as global chief marketing officer at the end of that year. Before he joined GM he was vice president of marketing and chief marketing officer for Nissan North America. Recently, he is known to have been involved in the brokering of Chevrolet's sponsorship deal with Manchester United Football Club, and there is speculation his departure might have something to do with details of this deal, thought to be worth $100m.

GM's marketing strategy has been in the limelight of late, with the company decreasing its advertising spend by 16 per cent since 2010 and even electing to drop its TV advertising at this year's Super Bowl – a move that gave rise to much comment in the US. It also announced that it would be reviewing its $4.5bn media and marketing budget in an effort to slash $2bn off costs within the next two years. All this is against a backdrop of dwindling market share in the USA for the Detroit-based motor manufacturer.

At the time of writing, no successor had been found for Ewanick, but Alan Batey, vice president US sales and service, has taken on his duties in the meantime. Batey started his GM career as a mechanical engineering apprentice with Vauxhall in the UK in 1979.

## RACE MOVES

McLaren team principal, **Martin Whitmarsh**, has said he does not intend to stand for re-election as chairman of FOTA (Formula One Teams' Association), a body he has headed since replacing Luca di Montezemolo in the position three years ago. Whitmarsh has said he thinks it's time for someone else to take the reins, and Mercedes' boss, **Ross Brawn**, and Lotus chief, **Eric Boullier**, are favourites to replace him.


LAT
Chad Norris

**Chad Norris** is now crew chief for **Carl Edwards** in the NASCAR Sprint Cup. Norris takes the place of **Bob Osbourne**, who has stepped down from tending the Roush Fenway Racing Ford dues to health issues. Osbourne had been Edwards' crew chief since 2007.

**Don Taylor** is now the MIA (Motorsport Industry Association) development director for the West Coast region of the USA. Taylor joins fellow US directors **Jeremy Byrne** (north region) and **Michael Bailey** (south east). Taylor has had a varied career in motorsport, including working for GM as a group manager, where he guided its motorsport safety programmes in America.

**Toto Wolff** has taken up an executive director position at Williams, a role that will see him directly assisting team boss, **Frank Williams**. Wolff's influence in the team has grown since the departure of former chairman, **Adam Parr**, earlier this year, and he has been a major shareholder in the business since 2009.

**Tony Dowe** has resigned from Australian V8 Supercars team, Kelly Racing, to take up the position of engineering and development manager at rival outfit Walkinshaw Racing. Dowe already has quite a connection with the Walkinshaw name, as he was once the managing director at Tom Walkinshaw Racing's Jaguar IMSA programme in the '80s and '90s and also ran the Le Mans-winning Jaguar for TWR in 1990. Dowe also has extensive experience in F1.


LAT
Tony Dowe

**Craig Spencer** has left the Mercedes Formula 1 team, where he had a senior engineering role in hydraulic systems, to take up a position with the Kelly Racing V8 Supercars team in his native Australia – essentially filling the gap left by the departure of **Tony Dowe** (see previous story).

Veteran race engineer, **Ian Walburn**, has joined Australian V8 Supercars outfit Team Norton DJR, where he will look after driver, **James Moffat**. 30 years ago he filled the same role for James' father, **Allan Moffat**, a legend in Australian Touring Car circles.

Rally driver and, more recently, rally team boss, **Philippe Bugalski**, has died after a fall at his home in Vichy, France. Bugalski, affectionately known as 'Le Petit Bug' was a test driver for Citroën and was also the first man to win a WRC event for the marque. In recent years, he was active in historic rallies, while he had also just taken control of the Automeca rally team. He was 49.

**Greg Downey** is now senior director brand and consumer marketing at NASCAR. Downey was formerly group director of entertainment marketing at Coca-Cola, where he oversaw the company's North America entertainment marketing efforts. Prior to this, he worked at NBC Universal. Downey's appointment, as well as that of **David Zane** and **Joseph Machin** (see below), is part of a concerted effort to help increase the sport's appeal to youth, Generation Y and Hispanic fans.

**David Zane** has also joined the NASCAR Brand Consumer and Series Marketing department. Zane, who has taken the role of director, multicultural marketing, comes from ESPN, where he was an associate director of sports marketing. He led the development and implementation of marketing strategies to attract viewership for ESPN's motorsports (NASCAR, IndyCar, NHRA) products across all of the media company's platforms.

NASCAR's Brand Consumer and Series Marketing team has also announced the arrival of **Joseph Machin**, who has assumed the role of director, multicultural marketing. Machin will oversee NASCAR's marketing efforts to key multicultural segments with a focus on reaching potential Hispanic fans. Machin has previously


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## BRIEFLY

### Two bids for A1GP

Two bidders are hoping to scoop the assets of the defunct A1 GP formula, with each of them interested in re-launching the so-called 'World Cup of Motorsports' in some form. The assets include the fleet of 'Powered by Ferrari' single seaters used in the fourth and final season of the series in 2008 and 2009 and, at the time of writing, the administrator was waiting to see which of the bidders would complete the deal first. One of the bidders, which has backing from Australia, is believed to be planning on re-launching the series as A10 World Series, competing predominantly in Asia, while the other, thought to be a Netherlands-based company, hopes to run a series called A1 World Cup.

### Roush job

Penske will not build its own engines when it switches to Ford for next season's NASCAR Sprint Cup. Instead, it will source them from Roush Yates, which will mean all the Blue Oval teams will again be running the same engine. The same is the case with Toyota, after Joe Gibbs Racing started to source its engines from Toyota Racing Development (TRD) earlier this season, but Chevrolet continues to run multiple engine strategies.

### Street machines

Hartmut Beyer, the man behind the FIA GT and British F3 races in Bucharest in 2007-'08, is planning on launching a street racing series for GT3s, with five international events pencilled in for the winter of 2014. There will be an initial race in the streets of Baku, the capital of Azerbaijan, in October this year, before a five-race series, called the City Challenge, will be launched at the beginning of 2014, running until the start of the racing season proper in the spring. Races will be held at Baku and at as yet unannounced locations in the Middle East, Africa and the Caribbean.

## SPONSORSHIP

The Mercedes F1 team has inked a one-race sponsorship deal with Indian telecoms company, Bharti Airtel, for the Indian Grand Prix. The company's branding will feature on the airbox and headrest of the Mercedes, and on the drivers' race suits and helmets. Bharti Airtel is also the title sponsor of the Indian race, as it was for last year's inaugural F1 event at the Buddh circuit. The New Delhi-based company is one of the world's top five mobile service providers.

Red Bull Australia has agreed a multi-year title sponsorship deal with Australian V8 Supercars' team, Triple Eight Race Engineering. The energy drinks company will plug the hole left by telecoms giant Vodafone, which recently announced it is to stop sponsoring the Holden team at the end of this season after a five-year partnership.

The US National Guard is to continue as a primary sponsor of the no 88 NASCAR Sprint Cup Series car and its driver, Dale Earnhardt jr, after extending its relationship with Hendrick Motorsports through the 2013 season. The National Guard will receive primary paint schemes in 20 Cup races, and prominent brand placements at other times.

British Touring Car Championship and VW Racing Cup outfit, Team HARD, has gained sponsorship from Lucas Oils. Team HARD runs a Civic in the BTCC and a fleet of four Golfs in the hard fought one-marque VW championship.

Camera brand, GoPro, well known in motorsport for its on-board cameras, has signed a three-year title sponsorship agreement with Sonoma Raceway for its annual IndyCar race. GoPro will receive signage and hospitality packages from the circuit, as well as the right to use the track's name and logo for promotional purposes.

## RACE MOVES

advised brands such as KFC Foods, Telefonica Movistar Latin America, Terra Networks, Bank of America Home Loans, Nissan North America and Chevrolet on their multicultural marketing efforts.

**Giorgio Ascanelli** is no longer technical director at F1 outfit Toro Rosso and is now seeing out his contract with the team while 'on holiday'. **James Key** is expected to replace the Italian, who is rumoured to be eventually moving to Ferrari.


LAT
Giorgio Ascanelli

The British Racing and Sports Car Club (BRSCC) has launched a recruitment drive aimed at attracting more volunteers into race meeting management and administration. The primary purpose of the initiative is to find new clerks of the course, of which there is a shortage.

**Bernie Ecclestone** visited the Olympic Park during the London Games, where he talked about the possibility of a grand prix at the site. A company called Intelligent Transport Services is one of a number of concerns bidding to use the venue, and Ecclestone said its F1 track plan includes driving in and out of the main arena. A decision on the future of the Olympic Park is expected in the autumn.

A 42-year old NASCAR fan died after being struck by lightning at the Pocono round of the Sprint Cup Series in August. At least nine other people were also injured in the strike.

**Peter Metcalfe** has been appointed as the MSA's Go Motorsport's Regional Development Officer (RDO) in the north east of England. He is now one of 10 RDOs in the UK, each of which is tasked with developing local motor clubs and promoting motorsport to youngsters. Metcalfe replaces **Anthony Dunn** in the position, who has stepped down after three years of service.

The FIA has hosted its first Women in Motorsport Seminar in Paris, with representatives from 47 countries taking part. Attendees included competitors and those working in the organisation of motorsport.

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## Eek, Greek GP proposed

The government of Greece – the European nation facing the most severe economic challenges in the ongoing 'Eurozone' crisis – has surprised much of the population, and the staff of *Racecar Engineering*, by endorsing a plan to stage a Formula 1 race in Piraeus, 10 miles from the capital, Athens.

Sports minister, Kostantinos Cavaras, confirmed that the government was supporting an initiative by the municipality of Drapetsona, an area of Piraeus, to create a circuit there, but stopped short of committing the government to any financial input. 'We have to support all projects that market Greece,' he said. 'The possibility of having Drapetsona host a Formula 1 race would be very important for the development of Piraeus.'

The project was initiated in June last year by a group trading as DIELPISFormula1, including an Athens-based architect who has designed the circuit and its associated infrastructure. Thanasis Papatheodorou put the idea for a grand prix to Lukas Canis, the mayor of Drapetsona, and a formal proposal was lodged with the FIA in November via Vassilis Despotopoulos, the president of ELPA, the national motorsport body in Athens. In May this year, Despotopoulos, a long-serving member of the World Motor Sport Council, presented FIA president, Jean Todt, and Formula One's Bernie Ecclestone with venue details.


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## OBITUARY – WILLIAM F MILLIKEN by Peter Wright

Bill Milliken – scientist, adventurer, daring flyer, analytical brain, canny businessman, *bon vivante*, engineers' confidante and inspiration, innovator, dedicated family man, friend and, above all, a racer, died peacefully on 28 July 2012, aged 101.

To describe how he filled those 101 years took Bill over 600 pages of fascinating, exciting, philosophical and humorous stories of adventure in aircraft and automotive science and engineering. His autobiographical book, *Equations of Motion – 80 years of Adventure, Risk and Innovation,* is the story of his life, from his earliest days building ever-more daring vehicles; his design, construction, flight and crash of the M-1 aircraft at the age of 22; his desire to discover the science behind stability and control (the absence of which lead to the crash of the M-1); his pioneering work developing the science of flight testing in the pre-war aviation industry – including an intense and harrowing period with Boeing working with the legendary test pilot Addie Allen to develop the B-17 to fly at altitude – his post-war transition to flight research, including work with Northrop on flying wings; his daring trans-continental solo flight in a small single-engine, open-cockpit aircraft; and the formation of the Flight Research Department at CAL, where research into variable stability was started. When he presented a paper to the Royal Aeronautical Society in 1951, suggesting that the stability and control of aircraft in the future would be augmented by computers, he was 'booed out of England'.

The transition to vehicle dynamics research was born out of Bill's love of fast cars and racing. His racecars included Bugattis – a T35, a T51 and a T54 – the 4WD Miller and the Butterball Special. He raced notably at Watkins Glen (the corner at which he rolled the T35 is now named after him) and at Pike's Peak, with preparation and development carried out at CAL by the enthusiastic aircraft engineers and mechanics. To formalise what was going on, the Vehicle Dynamics Department was formed, so Bill set out to sell the new department, and was fortunate to meet with Maurice Olley at GM. Pitching CAL's flight control work to a group of engineers, led by Olley, Bill was surprised when Olley suddenly stood up and said 'We should do it!' This led to a multi-year relationship that funded the work to put vehicle dynamics onto a scientific basis, and built the department into the world's premier vehicle dynamics research facility. Crash test and tyre test facilities were added to the development of test standards for manoeuvrability, and analysis and simulation software. When Bill led a group to a special session of the Institute of Mechanical Engineers to present their work, this time England treated him like royalty, applauding his pioneering work.

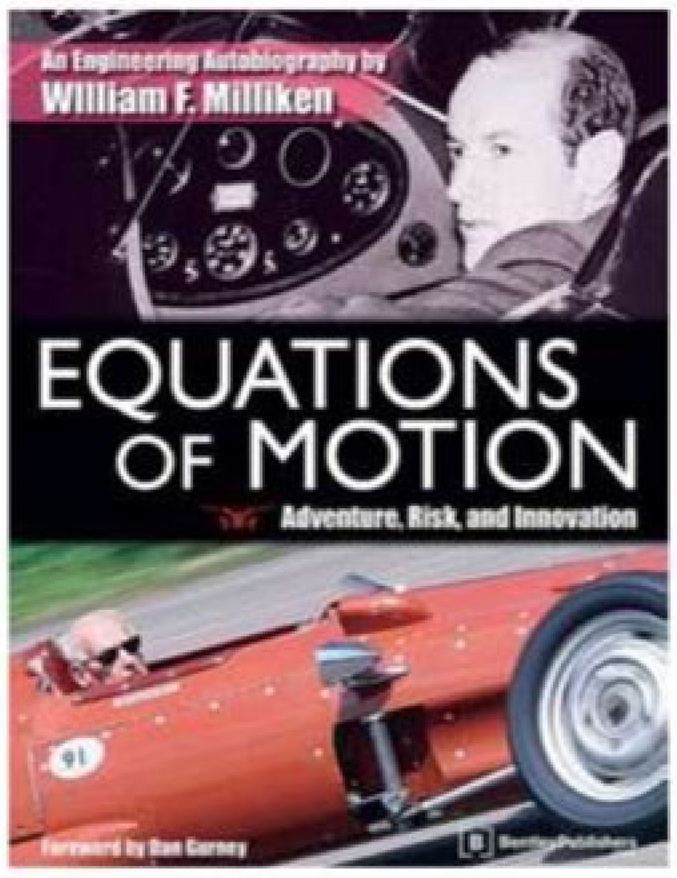
The last part of the book is devoted to the concept and construction of the Milliken Camber Car, spiritedly driven by Bill, aged 91, at the Goodwood Festival of Speed in 2002, and his work in independent consultancy – Milliken Research Associates – bringing together the expertise of the CAL scientists and engineers.

He has left behind the seminal work on his subject and his passion: *Race Car Vehicle Dynamics*, written with his son, Douglas. No racecar engineer can survive without it – a recent audit at Ferrari found 14 copies of the book. Also co-authored with Doug is *Chassis Design: Principles and Analysis*, based on the work and writings of Maurice Olley, who encouraged Bill to write down the equations of motion of the automobile, the science that forms the basis of all vehicle dynamics simulations and simulators.

Bill will be missed by his family, and his many colleagues and friends, but will remain an inspiration to every race engineer in the business. Someone recently said of Bill: 'Of all the things he shared with us, I think his example of how to live a full and incredible life is perhaps the greatest.'

**William F Milliken 1911-2012**

**Bill Milliken took stability and control studies to new levels**

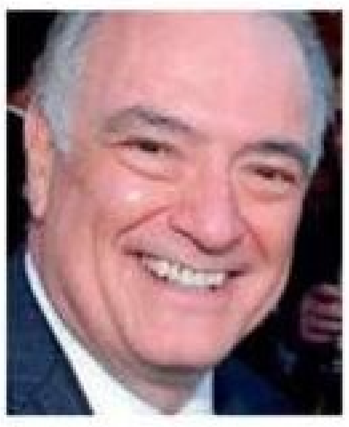



**If, as an engineer, you only read one book in your life, make it this one**

**The Camber Car, built by Milliken in 1960 to test his theories on lateral stability**

**Milliken's car languished in his garage until it was recomissioned in 2002 by E Dean Butler so Bill, aged 91 at the time, could drive it up the hill at Goodwood**

BUSINESS TALK – CHRIS AYLETT



# Olympics, motorsport and an international legacy

## How the 2012 London Olympics can improve motorsport business

I write this, immediately following one of the greatest international sporting events I have ever witnessed, the London 2012 Olympic Games. Simply magnificent, a credit to all involved, which energised and enthused everyone who came into contact with it. While watching it, I wondered what relevant value or legacy could be enjoyed by motorsport, and whether any lessons could be learned.

New business was created by motorsport suppliers bringing innovative solutions to cycling, sailing and rowing. Any concept that gave a small gain in weight saving, or aerodynamics, or energy efficiency was valuable. Several MIA members' products helped to win gold medals. The well-known reliability and performance of motorsport in competition was embraced by Team GB to full effect. UK Sport are now looking to the 2016 Rio Olympics, and including even more technological innovations, so make contact now.

I personally experienced the genuine and friendly welcome from staff and volunteers at the Olympic Park, and admired the outstanding management skills that delivered this major sporting event. The reception for spectators was happy, smiling and welcoming. I reflected on how much some motorsport venues and events could learn from this experience, and add to their customer enjoyment and future business growth.

Finally, I was impressed that BBC TV created 24 new TV channels for live sport. Just one legacy for motorsport would be good, and could the BBC retain even one live sports channel for a 'wide world of sports', it could be enjoyed by so many. So much live TV sports coverage focusses on football and Formula 1, and the BTCC, yet the UK has such a diverse range of motorsport – from karting to hillclimbing, through auto tests, to some great track racing – none of which gets any live BBC TV coverage whatsoever. What a genuine legacy a dedicated BBC UK sport channel would be – in which motorsport could feature - and deliver a boost to business and the popularity of sport in general.

Away from the fun of the Olympics, the news reminded me of the troubled times in the major markets of Europe and the USA, and this made me think about the international market for motorsport. All developed countries must work hard to grow their international trade, and the future for the business of motorsport is no different.

Much of the world remains under-exploited for motorsport – very few events take place in Russia, China and India, let alone the developing markets surrounding these. The largest markets remain in the USA, Europe and South America, where Brazil, Argentina, Venezuela and Columbia have a fast growing motorsport following. It's clear there are plenty of new international trade opportunities for motorsport over the next five years.

**McLaren's Venge takes race engineering to a wider application**

Many Motorsport Valley UK companies rely on the UK Trade and Investment for grant support. UKTI are determined to see international trade in high-performance engineering and motorsport grow, and have agreed to work pro-actively with the MIA to achieve this. Lord Green, our UK Trade Minister, recently launched a 'National Export Challenge' aiming to double – to 50,000 – the number of SMEs it helps by 2015.

UK motorsport already exports over 65 per cent of its sales, but it can do better. Companies throughout the world want to sell to, and buy from, the UK, which is the centre of the global industry. Boosting international trade is vital for the health of our whole sector.

The MIA has launched a new Motorsport International Trade Exchange (MITEX) programme, aiming to create new business for all in motorsport. At PMW in Cologne, PRI in Orlando and Autosport International in Birmingham, we will have a 'Business Matchmaking' team, ready to help arrange meetings, at no cost, between international buyers and sellers, at our UKTI-supported MIA business lounges.

Experience shows that small engineering companies find it hard to meet 'the right guy' with whom to discuss their product or service. The MIA wants to change this and drive growth in trade, and, with the help of UKTI, we are going to fix it for them. Using our vast, global motorsport business network, and that of UKTI, together with these three top class business shows, we are determined to initiate new international business meetings. And we are starting right now. I encourage all *Racecar Engineering* international readers to contact our experienced 'motorsport matchmaker', Alicia Warden, on Alicia.warden@the-mia.com, and explain the product, or service, you wish to buy. The MIA, working with UKTI, will arrange for you to meet a relevant UK company at PMW, PRI or Autosport International. No charge, no fee, and the meeting arranged for you. Now there's no reason not to grow your international trade now, just sign on to the MIA's MITEX programme and get started.

I am sure other motorsport countries will create their own schemes and so boost trade between the USA, Europe and the UK, and open up new, developing markets, too. Now is the perfect time to kick start international trade. Make this your next business objective, get involved with the MIA and let's win a 'gold medal' together – new international motorsport business and partnerships will be the real legacy from the 2012 London Olympics.

MACHINE TOOLS


# Mazak Integrex i-630V

**Yamazaki Mazak** has extended its range of multi-tasking products with a new, space saving machine specifically designed for the machining of heavy duty applications. The new Integrex i-630V is a vertically configured machine capable of machining large work pieces, with dimensions up to 1050 x 1000mm and up to 1750kg.

With a column-type design and improved rigidity, plus a compact, five-axis tilting head and a 630 x 630mm pallet, it reduces the installation area to 4960 x 6500mm, while retaining cutting performance with the utilisation of a new milling spindle, capable of delivering 10,000rpm (37kW, 343Nm, 40 per cent ED rating) as standard, with options for 5000rpm (37kW, 715Nm, 40 per cent ED rating) and 15,000rpm (56kW, 143Nm, 40 per cent ED rating). The rotary table has a turning function and is equipped with a direct drive motor and high rigidity bearings, improving heavy duty machining performance on difficult to machine work pieces. The combination of direct drive motor and rotary scale configuration also ensure that indexing performance is maximised, whilst delivering enhanced surface finish and high part accuracy.

**See www.mazak.eu for more information**

HARDWARE

# Jenvey LS3 throttle bodies

**The Chevrolet LS3** engine is popular with racecar manufacturers looking for low cost, high reliability horsepower. To cater for this market, UK fuel injection specialist, Jenvey, has released a complete individual throttle per cylinder conversion kit to replace the standard single 90mm throttle body. The resulting gains in throttle response and performance are claimed to be considerable compared to the factory single throttle body system. The conversion kit includes throttle bodies, manifolds and fuel rails - cast in Jenvey's own foundry - air horns, carbon airboxes, a new solid linkage, breathers and various brackets needed to complete the installation. The carbon airboxes fit most applications, but may be problematic on some, such as the Z06 Corvette.

**See www.jenvey.co.uk for more information**

MACHINE TOOLS

# Centroid A560

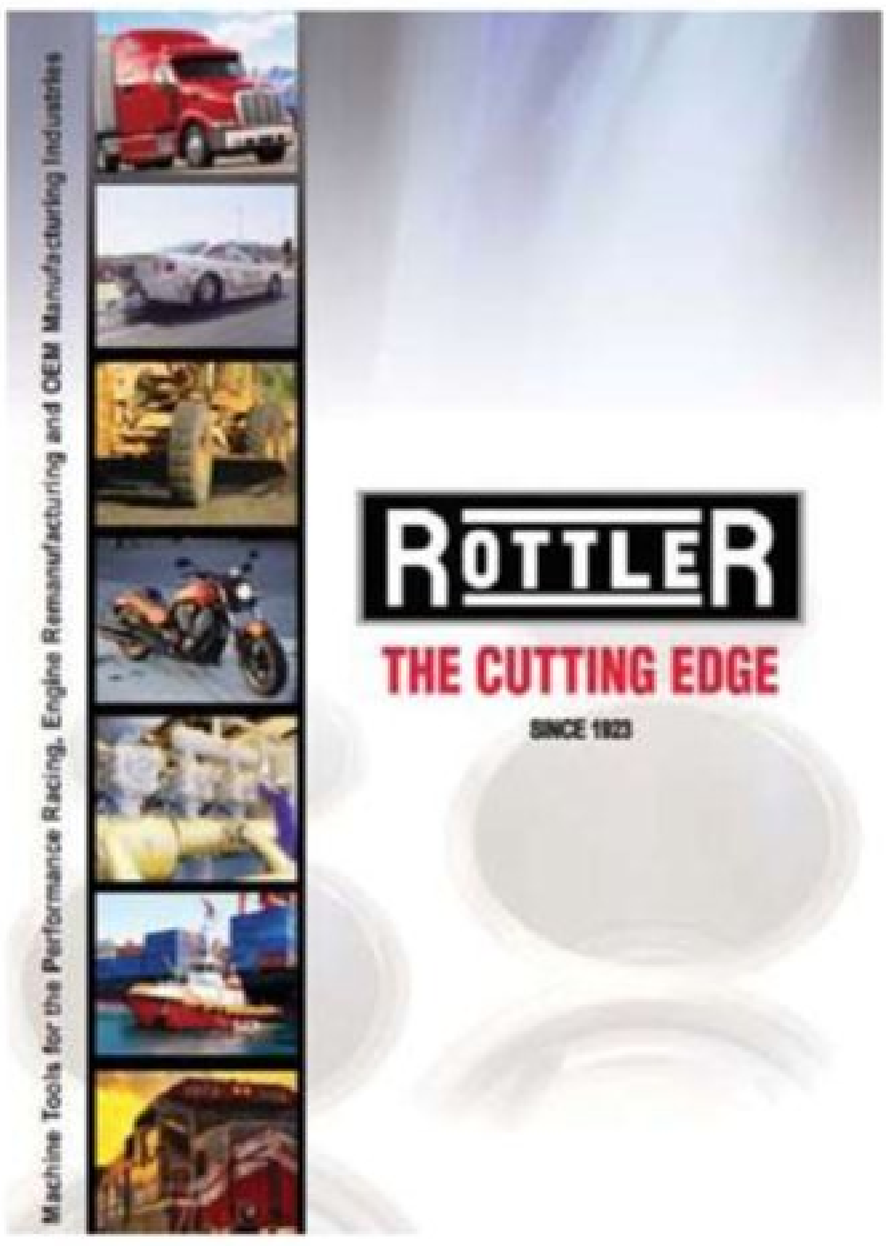
**The new Centroid A560** five-axis machining centre means engine builders can now CNC port cylinder heads or blueprint and machine engine blocks on the same machine without having to alter their work holding fixtures. The new tool features a patented ball screw-driven fifth axis articulating head, designed specifically for engine rebuilding and development work.

The machine is supplied as a turn-key package to minimise set up times and increase productivity. Both local and factory support is included as well as machine set up, tooling, software and comprehensive training. The A560 is available in two sizes – regular and XL – XL being intended for work on oversized engines. Both machines have similar features and are equipped with digitising and part probing, which is used to copy 2D or 3D shapes.

**See www.centroidcnc.com for more information**


MACHINE TOOLS

# Rottler online




**Rottler's new 2012** brochure is now available online, with details on the company's full product line, from multi-purpose CNC machining centres, seat and guide equipment, honing machines, valve re-facers, surfacers, digitising and porting machines and boring and sleeving machines.

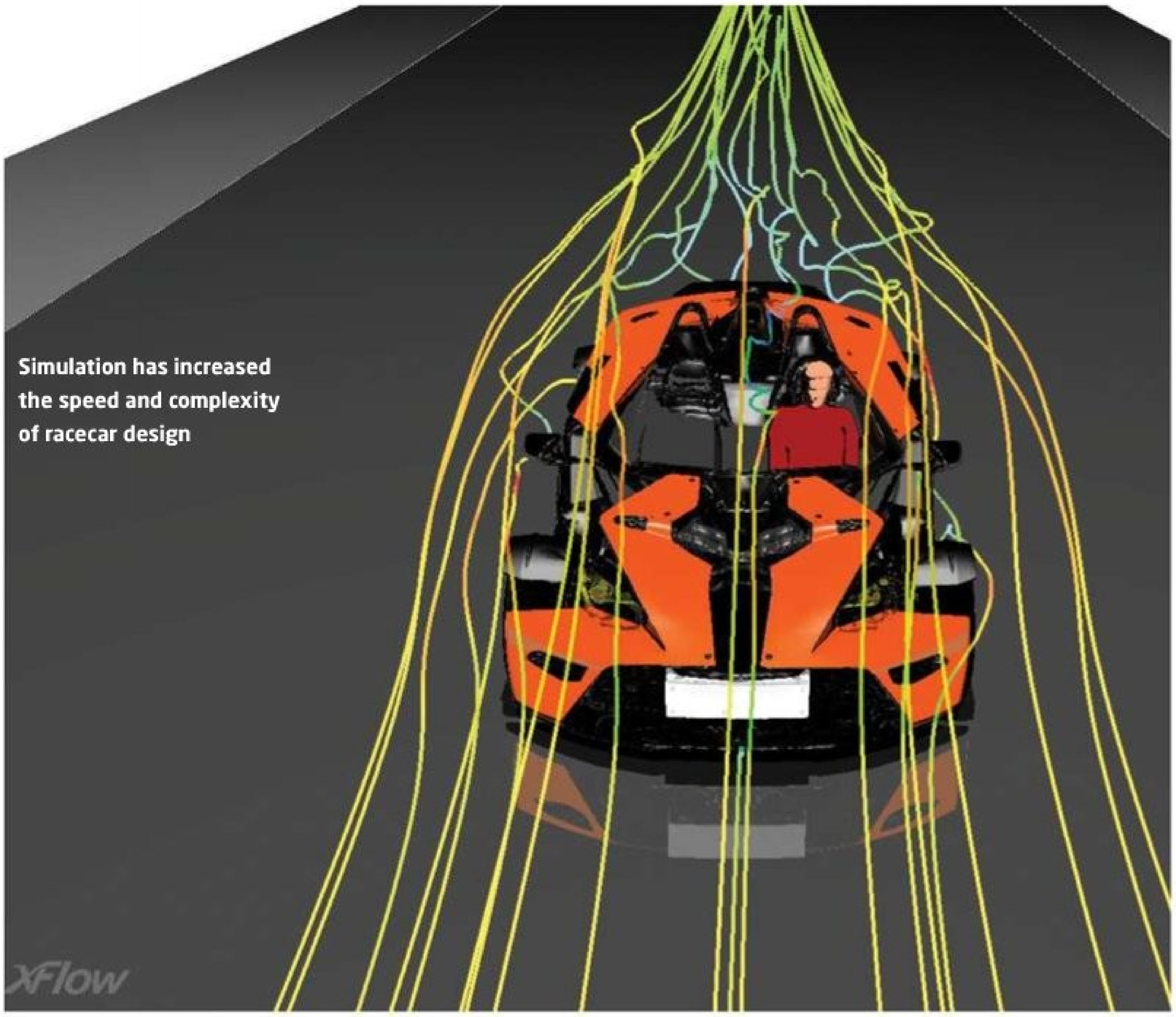
**See www.rottlermfg.com for more information**

# Technical Excellence

**_Racecar Engineering_ asked six leading motorsport engineers their opinion for the single greatest technical innovation in motorsport. Over the next five issues, we will present each of their suggestions and ask you, the reader, to vote for the one you agree with. The _Racecar Engineering_ Technical Excellence award will then be presented at the Autosport International Show in January. For this first installment, we refer to our technical consultant, Peter Wright**

Of all the technologies developed or adopted by motorsport, I believe simulation has had the biggest influence on design, engineering, development and possibly even driving. It has steadily replaced intuition as the deciding influence on the design of racecars. In its broadest definition, simulation includes CFD, FEA, lap simulation, driver simulators, hardware-in-the loop test benches, race-distance engine and transmission dynamometer testing, race strategy analysis, combustion simulation, tool-path analysis... The list is almost endless. No part of a racecar these days is specified and designed without intense analysis in simulations.

Of course, the key technology that underpins simulations is the computer. Without the ability to make millions of calculations per second without human involvement, simulations are too hard, and so inspiration, intuition and experience are needed. As computer power increases according to Moore's Law, simulations are taking over from actual testing to complete the process of the development of effective racecars. This goes on in the workshop and the laboratory, while the drivers hone their skills, experiment with driving techniques and assess design changes and concepts in ever more functionally accurate simulators.




**Simulation has increased the speed and complexity of racecar design**

One, or even the first, simulation of the performance of a racecar was by GM Research, while working with Jim Hall's Chaparral team. By making measurements of the lift / downforce and drag generated by test cars on the track, and keying the results into a simple lap simulation, they determined that, on the circuits prevalent after the war, the lap time benefits of downforce outweighed the penalties of the associated drag. That started the whole wing / ground effect development that now dominates performance in motor racing. Simulation has never looked back.

Simulations do not have to involve computers. Wind tunnel testing is a simulation and, in many cases, an imperfect one. Today, of course, they and the test model are controlled entirely by a computer during the test sequence, and the results processed and displayed by another. When I started tunnel testing in F1, the model was adjusted by hand between runs, and the results read off dials and calculated by slide rule. These days, wind tunnels, and the immense costs of construction, maintenance and running, are being superseded by CFD. As the knowledge of aerodynamics at the molecular level improves, and computing power increases, CFD provides a faster, cheaper and deeper insight into the complex aerodynamic characteristics of a racecar.

Would exhaust blowing and its effect on engine fuelling, the f-duct or the double DRS have been developed without CFD?

Another innovation that would probably never have seen the light of day is the zero-shift gear change. Without simulations, sorting out the interactions of driver, engine, transmission, tyres, hydraulics, sensors, electronics and software would have destroyed so many engines and transmissions that it would have exhausted the budget before success was achieved.

Engineering first degrees are dominated today by learning simulation techniques, and higher degrees by the use of them. Quite simply, without simulation, motorsport engineers would have to return to the dark ages of the 1960s and '70s.

# Europe's largest motorsport show returns in January

It's six months and counting until Autosport International returns to the NEC, Birmingham, for its 23rd annual show, with the show's doors open from 10-13 January 2013.

As Europe's largest motorsport trade show, Autosport International attracts some of the industry's biggest companies. Returning exhibitors already confirmed include brakes specialists AP Racing, Brembo and Bremsen Technik, racecar marque Ginetta and Japanese tyre manufacturer Yokohama, while an engineering perspective is provided by drivetrain and transmission specialists Xtrac, Quaife Engineering, Sadev, Drenth and Elite Transmissions.

Eibach and ThyssenKrupp Bilstein will be showcasing their latest springs, dampers and suspension technology, as will Sweden's premier suspension provider, Öhlins.

Cruden will also be back. Last year it revealed upgrades to its professional motion simulation software with a new set-up tool and telemetry analyser, as well as updates to its GPS Tracker.

With the UK motorsport industry and performance engineering industry's annual turnover worth £6 billion, Autosport International plays an important role in keeping up to date with the latest advancements in the sector.

Autosport International show director, Ian France, commented: 'Autosport International has established itself as one of the highlights of the motorsport industry calendar, and continues to attract the biggest names and the latest products, making it Europe's leading motorsport show.'

Autosport International runs from 10-13 January 2013, with the opening two days dedicated to trade visitors. Adult tickets are available from £26, with discounts for group bookings. To register call +44 (0)845 218 6012, or visit www.autosportinternational.com.


The schedule for the third annual International Motorsport Business Week has been announced, with the seven-day event taking place between 7-13 January 2013. International Motorsport Business Week comprises a series of events that bring together key figures and experts in the motorsport industry. The week begins with the *Race Tech* World Motorsport Symposium on 7-8 January, a technical forum attended by leading motorsport engineers and designers. International Motorsport Business Week continues with initiatives such as the UKTI Business Exchange and the MIA International 'Low Carbon' Racing Conference, which offers a perfect platform to network and discuss the developments in the industry. The week culminates with Autosport International, Europe's largest motorsport exhibition, between 10-13 January 2013.

### Motorsport Business Week Schedule

| | |
|---|---|
| 7-8 January | *Race Tech* World Motorsport Symposium |
| 9 January | MIA International 'Low Carbon' Racing Conference |
| 10 January | MIA Business Awards Dinner |
| 10-11 January | UKTI International Business Exchange (IBEX) |
| 11 January | Motorsport Safety Fund 'Watkins Lecture' |
| 10-11 January | Autosport Engineering in association with *Racecar Engineering* |
| 10-13 January | Autosport International |

### AUTOSPORT INTERNATIONAL TESTIMONIALS

'We launched a number of new products and the feedback has been positive. Also a video detailing our production process has attracted a lot of interest. All of us have been working non-stop, which illustrates how important this excellent show is to us.'
**Terry Graham**
Managing director, Zircotec

'We've been coming to Autosport International for 23 years. In my opinion it's the most important motorsport show in Europe. The organisers always provide us with a great show, and the UK is very important to us. Autosport International is where we always start the year.'
**Wilfried Eibach**
President, Eibach Group

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**Contributors** Stefan Batholomaeus, George Bolt jr, Lawrence Butcher, Charles Clarke, Ricardo Divila, Simon McBeath, Danny Nowlan, Mark Ortiz, Marshall Pruett,
**Photography** Mark Horsburgh, LAT, Dave Miller, 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
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**Managing director** Paul Dobson
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# Snakebite

Our cover story this month is the Dodge Viper, built by Riley Technologies, and currently running in the American Le Mans Series. It is the second time the American manufacturer has become involved in endurance racing and, as Marshall Pruett points out, it is going to take a lot of work to reach the same level as ORECA, now running Toyota's LMP1 cars, achieved between 1996 and 2000.

Then, the Viper faced competition from a fledgling Corvette team in the US, and cars such as the Lister Storm and the Porsche 911 GT2 in Europe, and the pickings were rich. This year in the ALMS, they face the factory Corvettes and BMWs, and Ferraris and Porsches in customer hands. The car requires waivers to compete - never a popular move, particularly when the new Viper features an 8.0-litre engine, racing within regulations that permit a maximum displacement of 5.5 litres.

ORECA's first Viper, in 1996, was as a GT1 in the BPR series, but it was not up to the speed of the Porsche and Mercedes and the parent company was not willing to make the investment to compete. Dodge, or Chrysler in Europe, took the decision to drop down to GT2 for the 1997 season, and dominated the class for the next four years. With drivers of the calibre of Olivier Beretta, Karl Wendlinger, Dominique Dupuy and Jean-Philippe Belloc in Europe, as well as Wendlinger, Beretta, Tommy Archer and David Donohue in the US, the team won the FIA GT Championship in 1998 and 1999, and Wendlinger and Beretta the ALMS title in 1999 and 2000, after winning 10 races in a single season.

**"Even the hot races at Le Mans saw drivers collapse after a long stint"**

The engines were, of course, front mounted, and feature a side-exit exhaust. With races run in Texas in the summer, the drivers suffered from a lack of air conditioning. Even the hot races at Le Mans saw drivers collapse after a long stint.

Customer teams were run by the likes of Hugh Chamberlain and Paul Belmondo Racing, but against the factory-run cars they were often beaten. Toine Hezemans refused to accept that he could not engineer the car better, and worked his magic on his own Viper. It worked, sometimes. At Silverstone, however, a new Toine-designed front splitter fell off because it generated too much downforce and the team couldn't secure it properly. They moved the oil tank, the engine, and updated the car so much that, years later, a private collector wanted to put the car back to ORECA spec. 'They 'phoned me and told me how much work they had to do, and how much it cost them!' laughed Hezemans.

In 2000, the ORECA Viper, driven by Wendlinger, Beretta and Dupuy, also won the Daytona 24 Hours outright, beating Corvette by little more than 30 seconds after the prototypes broke. The following year, after the Vipers had gone, Corvette took its own well-earned overall win at Daytona.

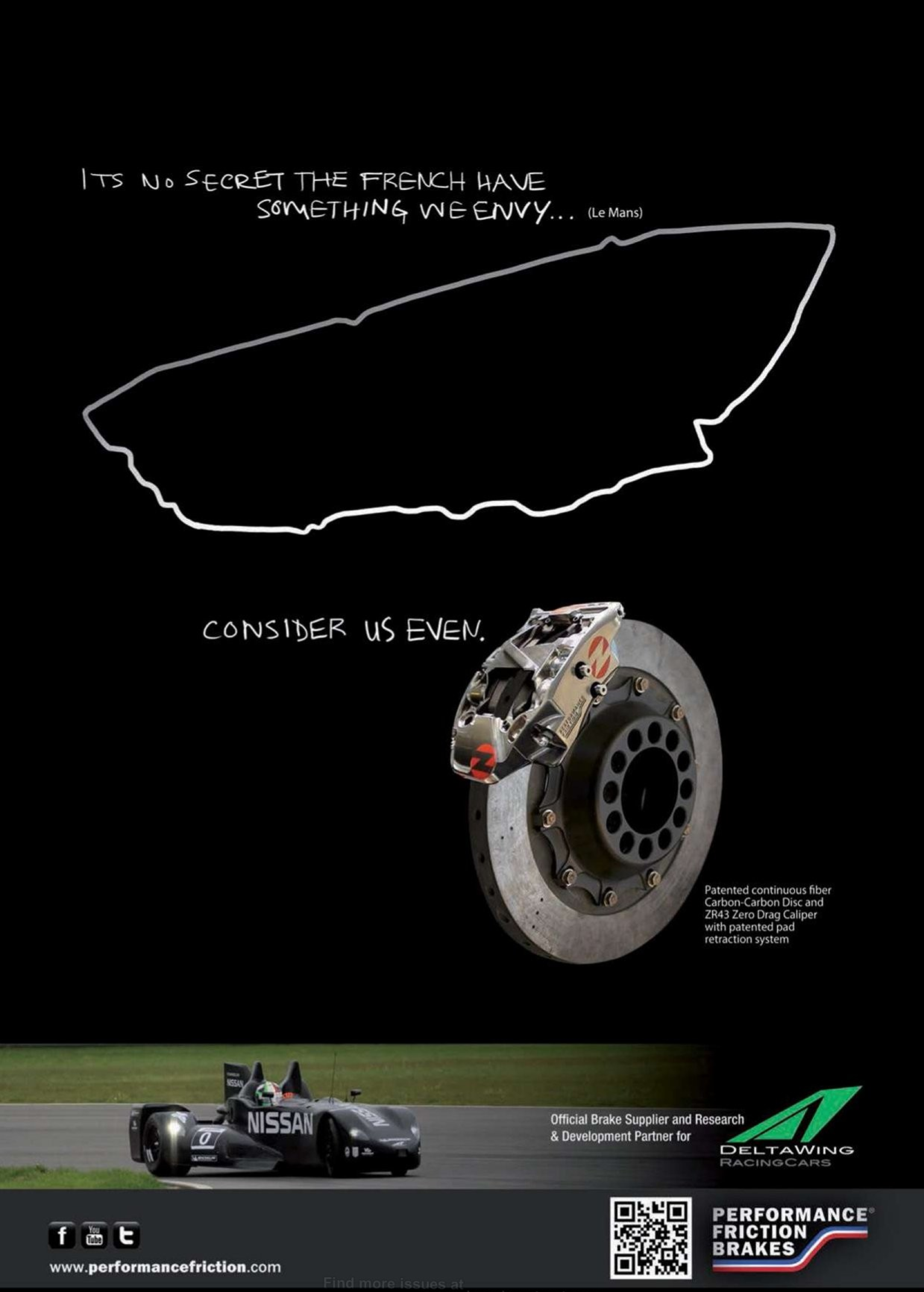
It was a time of change in Sportscar racing. The ALMS was considered to be the strongest series, the FIA GT Championship had received a body blow with the withdrawal of the Mercedes and Porsche factory teams at the end of the 1997 season, and the 2001 European Le Mans Series was a single year affair.

The ELMS had potential for 2002, but was killed off by the ACO, and replaced with the Le Mans Endurance Series, then re-named the Le Mans Series. In the US, golden years were to be had again with the Porsche, HPD and Audi battles, but they were all flashes in pans, and there was never real substance, as manufacturers came and went. The LMS is still going, just, but has cancelled its final races due to lack of entries and will instead partner the ALMS at Road Atlanta in October as a season finale. A management shakeup of the LMS was announced in August.

The World Endurance Championship is the next bright thing, but with races in Bahrain and Shanghai in 2012, and with the rumour that the Sebring 12 Hours will not be part of the possibly 10-race calendar in 2013, it seems to have got its calendar all wrong. The GT World Championship could die at the end of this season unless another promoter is found, and what is left for Sportscar racing? The only series with any credibility is the WEC, although that is fabulously expensive for the teams and reliant on the manufacturers remaining loyal - not a trait witnessed so far this year - and the American Le Mans Series.

Could it be that one of the original hunting grounds of the Viper, the American Le Mans Series, will become Sportscar racing's premier category again?

**EDITOR**
Andrew Cotton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