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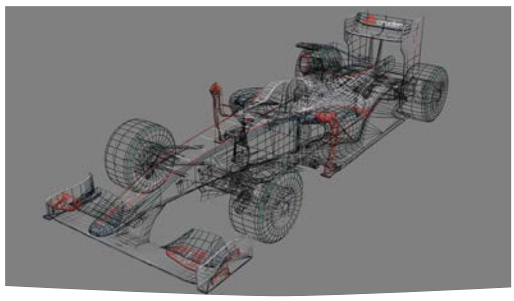

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Sex in motor racing

Women are still more likely to be seen in a bikini than a helmet on the racetrack. Why?

Anthropology teaches us that despite being nominally civilized, the bonobo primate behavior is very strong in humans. The sheer mention of sex in the title of this column activated some very primordial hard-wired instincts in your cortex. Reproduction is fundamental to the survival of the species, and the whole of society is based on its requirements, even if somewhat muted in general perception. But the main gist of this screed is to talk about gender in motor racing.

While some of us use the term 'sex' and 'gender' interchangeably, they are different concepts. Sex is both an act and a noun based on physical and biological rules. If you are born with testicles, you will be considered male, if you mature to menstruation and lactation you will be considered female.

Gender can be considered a social construct. Girls are not thought to be born with an innate liking of the color pink or a strong desire to wear high heels, nor boys to like blue and play with cars and guns. Male and female define biological sex; masculinity and femininity are designated gender roles, thus amenable to different activities in different societies.

Why do you work? Theoretically, to be able to find food and shelter, but fundamentally all behaviour revolves about status and the power to attract the best gene-bearing mate to further your line, even if you are not aware of this. The car you drive, the watch you wear, your clothes and style are linked with status symbols, and status is the ultimate ranking for reproduction. This is well understood in marketing and used to coerce you into buying products you don't really need, and celebrities touting any product try to convince you that you too can be like them. It's a case of monkey see, monkey do.

Physicality and drive

It can be stated that the competitive spirit, ingrained in motorsports as much as all others, comes directly from this hard-wired instinct, pushing us to show we are better than others. The fact is that a team sport does not change the reasoning; witness the fist-pumping and hoarse grunts when we win, the posturing that denotes that yes, we are the best tribe. This strong competitive spirit in racing is a way of asserting your superiority, and ipso facto showing the world you are best fitted to pass your genes on to any offspring.

Motor racing is a male oriented sport, and the behavior of its participants a bit of a throwback to earlier times, or a tacit bow to reality. The difficulty is that generally in these politically correct times the behavior of the drivers, teams and organisers cannot be as blatant as before, especially as most young participants haven't yet developed the cortical means to regulate their feelings.

As Hemingway said, 'There are only three sports: bullfighting, motor racing, and mountaineering; all the rest are merely games.' This probably stemmed from the immediate sanction for mistakes, where life was at stake, but is also linked to the aura that putting your life at risk gives off to the opposite sex. After all Eros and Thanatos were always good bedfellows…oops, I should rephrase that…

Testosterone driven pursuits tie in directly with the reproductive urge and messaging that you will kick butt when the chips are down.

Maybe the modern safety of racing keeps the groupies away? Or more positively women are more emancipated and have a better role to play now.

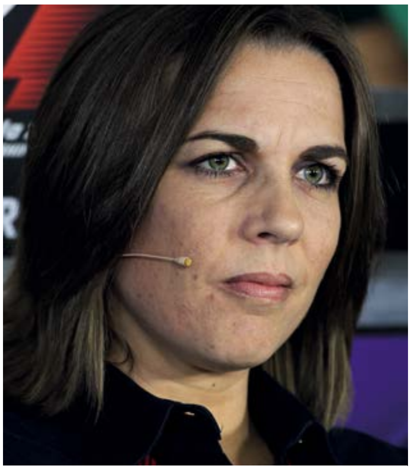
Coming back to gender and the sociological implications, one could postulate that racing would not have to be so male orientated because women could and can drive fast, master technology and be competitive, but gender roles channel them otherwise. Slowly the industry is beginning to have women working as designers, engineers, analysts and mainly managers, just as in the rest of society, although not in the same percentage, probably because the schedules and environment of racing not being convenient to reasonable human beings, as most women are, and the sexism being another downer for them.

Physicality (ie body mass and strength) is not so much of an issue on modern racing cars, taking out a previous constraint. Driving an F1 car is similar to running a marathon in physical requirement and women do it also. With power steering and driver aids it will be down to reflexes and ability.

Considering evolution has shaped the sexes over millennia in different roles it could be said that spatial perception and reflexes would be differently developed, but as any sporting endeavour is not based on the average capability but rather the exceptional, the far end of the Poisson distribution as to physical ability would cover this requisite.

Is it the lack of participation in the lower racing classes that keeps the exceptional from appearing? Given a big enough population, the number of sufficiently gifted individuals would grow to supply. This of course eliding the question of 'do we really need racing?' never mind gender equality. Let's not go there, as the can of annelids opened would greatly exceed the scope of this column.

Testosterone driven pursuits tie in directly with the reproductive urge



Women are being promoted to top jobs, including Williams deputy team principal Claire Williams

It seems that both the ambiance and society conspire against having females racing, it both being seen as not an occupation befitting women and by having assigned roles for them, mostly in the decorative or trophy side. The second point being the finances of it; promoting a female driver in terms of sponsorship puts forward an ambiguous message to a not very well defined demographic. Young men? Other women?

Which brings the question: why do we have grid girls? Far be it for me to suggest that one should restrict work opportunity for the women who would like to work as decorative items in this particular environment, much as the ones who grace auto show stands, trade shows and conferences, but the particular attire, mien and appearance at some tracks do not really suggest they are anything but the attempt to get interest by the use of the lower common denominator instinct, much as scantily clad women holding round-placards at boxing matches. Being a sex object can also be a career choice. I, for one, am actively considering it…

Laddish behavior is not restricted to individual cultures, it seems integral in all of humanity's pursuits, but again cycles back to the biological imperative, and I do not think it will change.

Meanwhile I welcome any female into the racing fraternity (Sorority?), we need more of you to have a more balanced environment, plus it will be that bit more civilized.


SUPERTECH

Half term report

Mercedes are dominant in F1, but it's all-to-play-for in Endurance racing

With the British GP over, F1 reaches the halfway point in the first season of its radically new technical regulations. WEC may have only three out of eight races under its belt, but in racing hours it, too, is at the halfway point of its first season of a similar, but significantly different set of technical regulations.

The combined FIA World Championships of F1 and WEC, with their two, new, efficiency-based formulae, have succeeded in attracting six of the world's major car manufacturers, with two more waiting on the sidelines to enter in 2015. The objectives of the two formulae are not the same: F1 takes a defined, manufacturer-preferred (after some arguing) powertrain configuration and sets the protagonists the task of achieving the greatest possible fuel efficiency. WEC allows each competitor to choose its own, preferred powertrain and fuel configuration, balances the technology and performance, and says: 'Go race; demonstrate what you can do.' Both formulae are based on instantaneous and average fuel consumption, the main difference being that F1 averages fuel consumption over a complete race, while WEC averages it on a rolling three-lap basis.

All those who have taken on these challenges have had around three years to prepare and six months to demonstrate what they have achieved. The results are fascinating, if fairly predictable, but have thrown up a few surprises. One factor that is more prevalent than ever before is the reluctance of any of the competitors to inform the public of what they are doing technically, and this leaves some interesting questions open to speculation. What follows are the issues that fascinate me the most.

Performance advantage

Why is Mercedes AMG Petronas proving so superior, even to the other three chassis powered by a Mercedes powertrain? Possible answers lie in two areas: powertrain (software, fuel and cooling), and chassis (aero, cooling, tyres and braking).

Once the flow-limited fuel has given up its energy to the wheels, the only source of further propulsion is the ERS. The energy flow to and from the motor generators is controlled by software, and while Mercedes will supply the core software, each customer must supply further codes to integrated the ERS with the chassis, and indeed the driver. Controlling the ability to harness energy is the key and this must be integrated with the braking system. Mercedes appears to have few problems in this area – at least when everything is working.

Mercedes' competitors have focused on Petronas providing them with a fuel advantage. The limited scope for fuel development provided within the regulations means that Petronas may have developed a fuel with a better energy/mass value, and better octane number and burning characteristics, which would allow Mercedes to run higher boost pressure. Whether it is the Petronas labs in Turin and Malaysia that have come up with this, or whether Mercedes combustion scientists have set the fuel specification is not disclosed.

Cooling systems bridge the gap between powertrain and chassis and Mercedes is one of the two teams where this key activity is fully integrated. Whether Mercedes has the best overall aerodynamics is not clear. Certainly Williams can deliver a lower CD, though it remains to be seen whether they can exploit this to be able to run more downforce on medium and slow circuits, and Red Bull's Adrian Newey still seems to excel at conjuring up downforce. Ross Brawn put in place a major effort to get on top of tyre science and Pirelli has improved tyre performance to give them more stable and predictable characteristics.

Why is Mercedes AMG proving so superior in F1?

The Williams comeback is a welcome surprise, and shrewd management is a key factor

The building blocks of Mercedes' success were put in place over the preceding seasons by Brawn, employing several of his successful but rejected Ferrari colleagues. The crumbling of McLaren and Ferrari's technical infrastructure since their most recent heydays has been just as apparent. However, the way Williams has popped up out of apparent ruin, to be Mercedes's closest competitor, was less foreseen. Williams, McLaren, and Ferrari are run by principals who emerged onto the F1 stage in the 1970s and are now collecting their pensions. While Ron Dennis and Luca di Montezemolo have stepped in to sort out their team's problems, Frank Williams has chosen people to run the company and team, allowing the Williams racing passion to continue to inspire. Mike O'Driscoll, Group CEO, is rebuilding the foundations of Williams and has selected two experienced technical personalities, Pat Symonds and Rob Smedley, who are building a technical team, creating performance and putting in place in the means of achieving results. Great to watch!

While we're talking about people rather than machines, the timing of Adrian Newey's step back from front-line involvement in the Red Bull car is unfortunate. Just as Red Bull stop their winning streak because Renault's powertrain is uncompetitive and unreliable, Adrian wants to go and play with something else.

WEC intrigue

WEC has, on the whole, unfurled as expected: Toyota is the fastest car; Audi the most consistent; and Porsche is learning fast. What is intriguing is how Toyota has managed to hang onto their speed advantage and avoid having it 'equalised' away. It always looked as if the two gasoline cars would be quicker than Audi's diesel, based on the March Appendix B figures, because of Toyota and Porsche's choice of 6MJ, against Audis 2MJ. What was not clear was whether Toyota would be quicker than Porsche. Their powertrain configurations are altogether different in most respects but only one gasoline engine could be the reference FTF in the EOT calculations, and it may be that the equations do not compute both configurations equally in practice. It is also possible that subtle ways in tuning and gearing the normally aspirated Toyota in the first two races resulted in the Porsche figure being used in the EOT to give the fuel flow figures compared to diesel. Toyota may have been able to tune and set-up the car to exploit it better. The other possible difference lies in the round-trip (charge-discharge) efficiency of their respective energy stores. The discharge energy is regulated, but if the harvesting is marginal at Le Mans to yield 6MJ, then, by way of example, an 85 per cent round-trip efficiency for batteries would require 7.06MJ to be harvested, while a 95 per cent for ultracaps (and flywheels) would only require 6.3MJ. Toyota's powerful ERS on each axle, plus a greater efficiency, may have contributed to their speed advantage. In the end, Audi with its simpler systems had problems that took less time to fix, and they won. And that is the difference between endurance racing and F1.

2014 so far, has proved technically fascinating, and even managed to provide interested observers with lots to ponder and deliberate over. Now, what are all the whingers on about?

McLaren fights back

After a disapppointing season in 2013, McLaren has changed its focus and is using the 2014 season as a development year

By SAM COLLINS

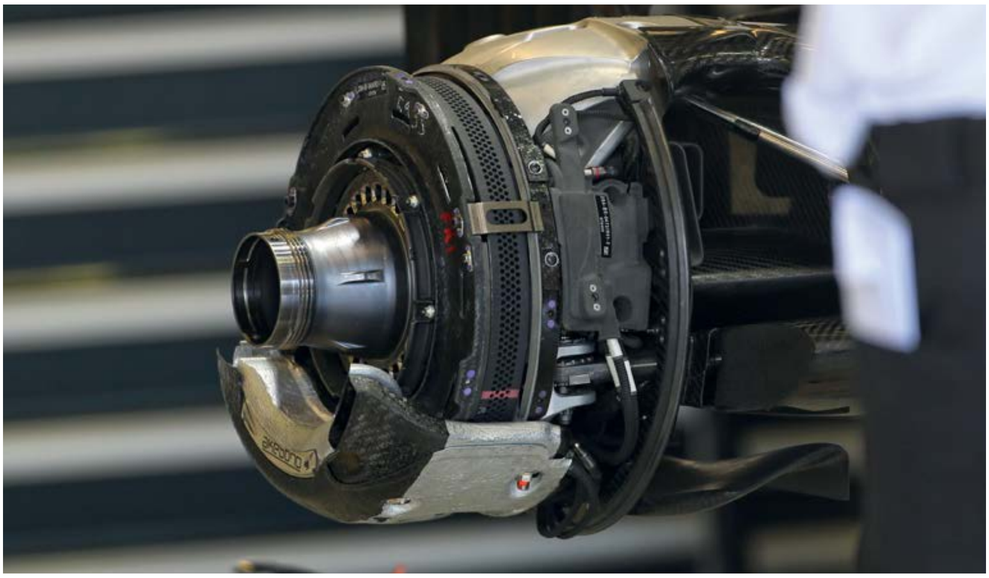
McLaren once came very close to being the constructor with the most wins in the history of Formula 1, but in 2013 it failed to get a single podium finish and trailed home fifth in the constructors championship. It was the worst season the team had experienced since 1980.

With rules stability between 2012 and 2013 things should have been much better. The 2012 car was at times the fastest in the field and a match for the otherwise dominant Red Bull. But the 2013 MP4-28 car represented a major change in car concept, adopting pullrod front suspension and a number of other major changes in design, and was a disaster. But it was a failure that McLaren believes that it has learned from and is now trying to repair the damage done with its new 2014 design.

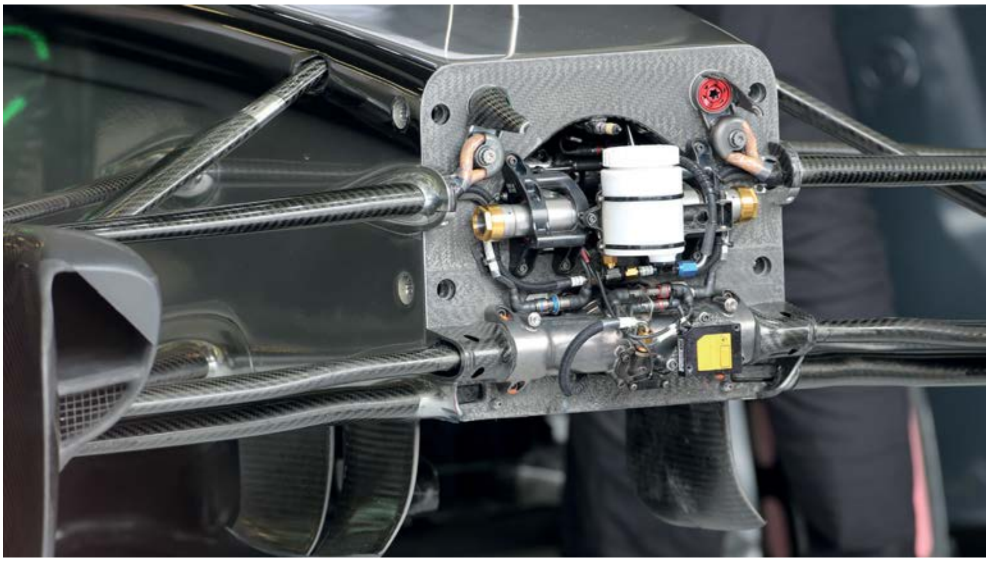
'Looking at car concepts, I would go back to the end of 2012, because what we did in 2013 was a mistake,' Jonathan Neale, chief operations officer and acting CEO of McLaren Racing admits. 'We picked an overly ambitious series of projects to bring together on one car. In trying to optimise those bits and pieces, the car became incredibly peaky in the way it delivered its performance; its sweet spot was very narrow and Formula 1 cars don't really work like that.' The MP4-28 also highlighted another major issue with the team's aerodynamic development, which had a huge impact on its performance.

'Also in 2013 we lost the correlation between track and wind tunnel too, and as the body of knowledge moved forward in Formula 1 we fell behind. So we were behind aerodynamically in terms of the way in which the airflows worked around the car and the delivery of downforce,' Neale reveals. 'The 2013 aerodynamic problems were nothing to do with the wind tunnel, they were everything to do with the car. As is the case with CFD, the wind tunnel is a model. It was a case of putting things on the car that worked in the tunnel but they were rushed on and there was not enough attention paid to the sensitivities of some things. A classic case of this was how you manage stall. Most of us want the car to stall as it goes down the straights so, as the diffuser gets closer to the ground, ultimately it stalls and chokes off that flow, losing you drag and making the car quicker. So, stall is helpful in that context but you have to ensure that the downforce comes back when the guy stands on the brakes. If you don't get it right the car can become incredibly hard to drive.'

"The car does not have any great flaw in it mechanically, it just does not have enough downforce"



Brakes feature Akebono calipers, but McLaren does not reveal the supplier, or suppliers, of their carbon discs



Bulkhead view shows the front suspension which ditched 2013's pullrod system in favour of a more conventional pushrod arrangement. Front-rear interlinked suspension system is mounted behind the fluid reservoir

The gearbox and driveline of the McLaren is designed and built in-house and has been one of the most satisfactory parts of the project. This part-assembled view is unobscured by the innovative 'mushroom' wishbones (see box page 12)

The whole McLaren team knew it had to improve and with the introduction of new power units in 2014, the MP4-29 was hoped to show that improvement, and after the first race where the McLarens came home third and fourth in the race things looked to have moved in the right direction (the two cars were later elevated to second and third after a Red Bull was disqualified). But the team knew by that point that the issues of 2013 were still disrupting the progress of the new car.

In-house design

'The car concept was basically simple: package the Mercedes engine tightly in the rear of the car, manage the heat and don't set fire to the bodywork with the turbocharger,' says Neale. 'And hope that the tyres that come at you are what you tested with Pirelli at the end of the previous year. Then it was just see what everyone else has got, and we saw that the car does not have any great flaw in it mechanically, it just does not have enough downforce. That is not trivial to fix, but we have done a pretty good job packaging the Mercedes engine - we hit our weight and compliance targets. Heat rejection was okay, but with the rapid development of the power unit the heat rejection is constantly changing as Mercedes tweak and changed things.'

Mechanically, one area of the car with which the team is happy is the transmission, which McLaren develops in-house. 'The gearbox casing is something for us that we are not going to give up, because we are quite good at it,' says Neale. 'Having invested in the know-how to do that, it's another one of those areas that continues to yield improved performance. The packaging at the back of these cars is crucial. We manufacture our own carbon case and design our own gears, we don't make the gears but we would if we could. We don't have any customers for our box at the moment like some others do and its not our intention to do so, in part because it does slow down manoeuvrability as a business. If you just have to make five in a particular space of time for yourself, that's quicker than having to do another five for a customer – and another five for a second customer. The manufacturing means that the lead time increases, and that means you have to design things a lot earlier. We don't want to do that as we want to have as much time for design and development as possible and the shortest time for manufacturing possible.'

Downforce wars

Having the best power unit in the field does lead to inevitable comparisons between the McLaren and the other three designs it is fitted to, namely the Force India, Williams and the works Mercedes. In the *RE V24N8*, Force India F1 technical director Andy Green reveals that he believes that his car has less downforce than the McLaren, something Neale disputes; 'I don't believe that Force India and Williams have less

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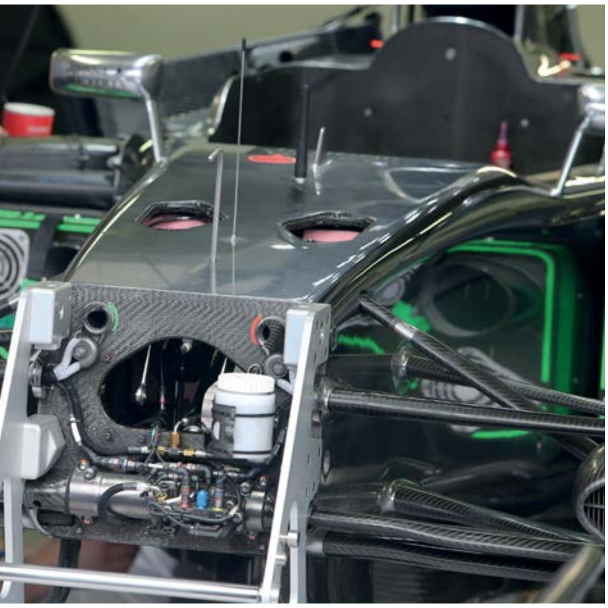


Partly disassembled, a pushrod end is visible through the bulkhead opening. This shot shows the front end without the FRICS hydraulics in place

downforce than us and my evidence for that is that, if you look at the Williams end of straight speed, they tend to be about 10km/h faster than the other Mercedes runners. Force India is not bad either, whilst perhaps not a downforce related issue they outperformed us on the super soft tyres.'

It is clear that the McLaren engineers feel that the major performance deficit on the 2014 car is an aerodynamic one, and that the problem is rooted in the problematic MP4-28. 'We have to fight our way back in aerodynamic terms, at a time when everyone from Caterham to Mercedes has exactly the same amount of time in the wind tunnel. It's just 80 runs a week. When you don't have a firm baseline you can end up firefighting,' says Neale, thoughtfully.

The McLaren has a fairly conventional aerodynamic package, using perhaps the most elegant variant of the less than pretty proboscis nose structures seen on many 2014 cars. While distinctive, it's an area of the aero package where Neale thinks that there is little to gain.

'At the start of the 2014 car project there was a lot of work done on noses by teams like Lotus and Mercedes. Everyone is trying to work out how much performance there is in noses, and after an initial scuffle during the opening races not really much has been done as it is not a dominant performance factor. There are two schools of thought out there and both seem to work: the high nose or the low nose. [FIA Race Director] Charlie [Whiting] was the person most exercised about nose shape as he did not get what he expected, so he has tightened up the rules and we won't have these designs next year.'

Fuelling rumours

The performance deficit experienced by McLaren compared to the other Mercedes runners may not just be down to the aerodynamics. One major difference between the cars is that the Mercedes, Force India and Williams all run on Petronas fuels and lubricants, and the engine was developed using that family of products while McLaren runs on Mobil 1.

MAGIC MUSHROOMS

At the rear of the McLaren there is an aerodynamic part of significant interest and unique to the MP4-29. Nicknamed 'mushrooms', these aerodynamic parts exploit a loophole in the technical regulations. The rear arms of the rear wishbones are fitted with large carbon fibre shrouds that look like the wings of an insect from the rear. From the front, though, it is clear that they are sculpted to give some kind of aerodynamic influence.

'I would imagine that they are trying to make the diffuser work better,' says Rod Nelson, chief test engineer of Williams when he first saw them in pre-season testing. 'One of the major functions of the lower rear wing (beam wing) was not to generate downforce on its own, but it helped you be more aggressive with the diffuser and stops it stalling at lower ride heights, so I would imagine that they are doing that.' This is something Neale confirms; 'One of the features of last year's regulations was the elimination of the lower element of the rear wing. It was one of a whole stack of elements that made the whole thing work. The rear arm shape is a concept that we chose early on and it works. But looking at other cars, it's quite clear that it's possible to generate the same levels of drag and downforce without them as we are clearly not a second-and-a-half up the road, so they are not a make-or-break feature of the car.'

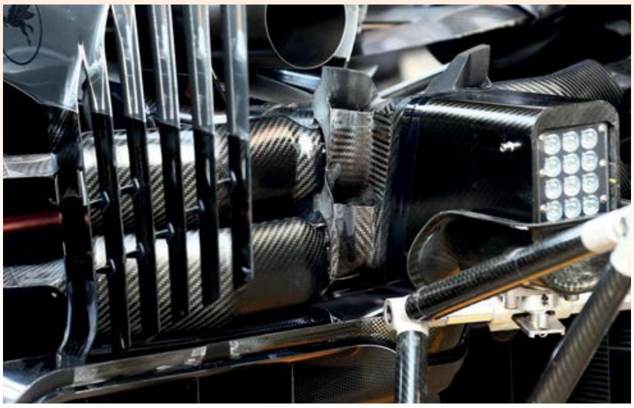
There was at one point a question of the legality of these parts as the 2014 F1 technical regulations relating to the suspension components states that non-structural parts of suspension members are considered bodywork. The F1 regulations also state that all bodywork must be rigidly secured to the entirely sprung part of the car (rigidly secured means not having any degree of freedom) and must remain immobile in relation to the sprung part of the car.

The 'mushrooms' being mounted to the wishbones are clearly unsprung and clearly move, but they are considered a structural part of the suspension. They are 'doglegged' to comply with another one of the technical regulations which says that:

'With the exception of minimal local changes of section for the passage of hydraulic brake lines, electrical wiring and wheel tethers or the attachment of flexures, rod ends and spherical bearings, the cross-sections of each member of every suspension component, when taken normal to a straight line between the inner and outer attachment points, must:

a) Intersect the straight line between the inner and outer attachment points
b) Have a major axis no greater than 100mm
c) Have an aspect ratio no greater than 3.5:1
d) Have no dimension which exceeds 100mm
- **The major axis will be defined as the largest axis of symmetry of any such cross-section. The length of the intersection of this axis with the cross-section must not be less than 95 per cent of the maximum dimension of the section**

The doglegs in the mushrooms mean that no dimension exceeds that 100mm limit and that all other parts of the rule are complied with. It is, in the words of a rival team, 'a very cute interpretation of the rules and worth investigating in the wind tunnel.'



Clever interpretation of the rulebook has led to these 'mushroom' shrouds incorporated into the rear wishbones of the McLaren MP4-29. It's thought that they assist in managing airflow around the diffuser and compensate in part for the removal of the lower element of the rear wing mandated by the 2014 technical regulations

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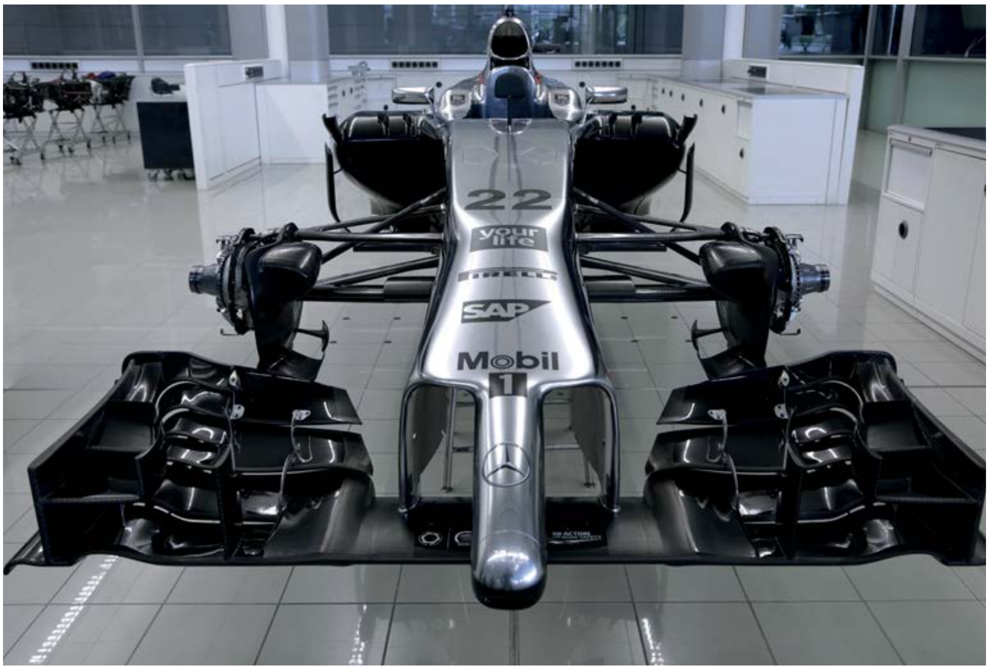


The various nose designs of the 2014 cars have been a major talking point, but the team doesn't think any of the configurations has shown a definite aerodynamic advantage on the track

'When you look at Mercedes, though, broadly we are running the same engine and hardware, yet they are a second and a half up the road. Formula 1 is still simply about power and downforce. Mercedes are good people to do business with, so I'm confident that we have the same hardware, but we run different fuels and lubes so our maps are going to be different. We don't have all the access to the things we would like to tune and play with in the power unit, but that's understandable as we are going to Honda next year and Mercedes for obvious reasons don't want all that knowledge getting out. So would it surprise me if Mercedes has some engine advantage in there? It would not surprise me at all,' Neale accepts. 'Fuel development is key to this generation of engines. The FIA are managing very closely what constitutes a reliability upgrade and what is a performance upgrade on the engine. But there is freedom on fuels and lubes.'

"Mercedes are good people, so I'm confident that we have the same hardware, but we run different fuels and lubes"

That switch to Honda power in 2015 could be the start of a new era for McLaren and it is instigating new working practices for the future which it hopes will allow it to regain its form. 'We are looking at changing the way we pick car concepts,' reveals Neale. 'There's reformation going on in many areas of the business and that's one of them. There is no longer an off season in Formula 1 and I think you will see teams becoming more ambitious in terms of changing suspensions, gearboxes and even whole back ends mid season. We will not always be relying on the new car to carry all of the new concepts but actually picking larger building blocks and having more regard for carry over. For example you could introduce a new back end for the first European race and the new front end for the first late season Asian race (currently Singapore). The restrictions on track testing and wind tunnel time have made the value of a unit of time so great, that the efforts that we go to validate our tools and correlate them has increased our confidence to have a go. So you will see a smearing out of development over a longer period of time rather than stop and go with a new car.'

To this end, McLaren appears to be using the MP4-29 as the clear basis for its 2015 Honda powered design. The engine installation in 2015 is going to be very different to what the team has developed with Mercedes. 'How Honda does things is different, so we are going through a massive repackaging exercise to accommodate the different requirements,' says Neale. 'The implication is that many aspects of the car – including how it works with the tyres – will carry over, and for that reason we will stay in development of this car right the way through until the end of the year. It's our underpinning aerodynamic knowledge going forward that we are developing. So it's really important for us this year to maximise the use of this season to maintain the correlation. But in terms of packaging for next year, there are some fundamental decisions to make with the Honda engineers at the moment about the airflows and where the radiators will be.'

TECH SPEC

Chassis construction
Carbon fibre incorporating driver cockpit controls and fuel cell

Front suspension
Carbon fibre wishbone and pushrod suspension elements operating inboard torsion bar and damper system

Rear suspension
Carbon fibre wishbone and pullrod suspension elements operating inboard torsion bar and damper system

Transmission
Carbon fibre composite case, epicyclic differential with multi plate limited slip clutch

Clutch
Carbon/carbon hand operated

Wheels
Enkei

Tyres
Pirelli
Fronts: 245/660-13
Rears: 325/660-13

Brake system
Akebono calipers and cylinders

Fuel system
ATL Kevlar-reinforced rubber bladder

Electronic systems
FIA SECU standard electronic control unit

Cooling system
Aluminium oil, water and gearbox radiators

Engine
Mercedes-Benz PU106A Hybrid , Internal Combustion Engine: Capacity 1.6 litres, Cylinders Six, Bank angle 90, No of valves 24, Max rpm ICE 15,000 rpm, Max fuel flow rate 100 kg/hour (above 10,500 rpm)

Fuel injection
High-pressure direct injection (max 500 bar, one injector/cylinder), Pressure charging Single-stage compressor and exhaust turbine on a common shaft, Max rpm exhaust turbine 125,000 rpm

ERS
MGU-K maximum speed 50,000rpm, max power 120kW, max energy recovery 2MJ/lap, max energy deployment 4MJ/lap
MGU-H Maximum speed 125,000rpm, max power unlimited, max energy recovery unlimited, max energy deployment unlimited. Energy store Lithium-ion battery

Lubricants and fluids
Mobilith SHC

Radio
Kenwood

Looking back over the 2014 season so far and the performance of the McLaren MP4-29, Neale is understandably rather pragmatic. It is clear that the car did not deliver the relative performance that the team really wanted, but that the problems have been identified and solutions developed. 'The MP4-29 is a good step forwards in our confidence in mechanical packaging, stability and correlation from last year, but it has revealed some underlying things about our organisation that we need to face up to. We are now making some lasting technical process culture changes and that can be quite painful, but we are going to get the job done,' Neale concludes.

E-numbers

Cooling issues with the Renault power unit have given problems. Lotus designers think they've solved at least some of them

By SAM COLLINS

"I'm not sure what Red Bull are doing, but I think they know what we are doing"

The Lotus E22 shows off its unusual, but effective, assymetrical twin-tusk nose design. It complies with FIA regs for 2014, but won't for next season

The winter of 2013 and 2014 was a tough time for the Lotus F1 Team. It had lost its star driver before the season had ended due to late payments, and the new car was falling behind schedule. The team boss Eric Boullier had left to join McLaren and James Allison the Technical Director had returned to Ferrari. There were even rumours in the press that the team would not make it to the 2014 season, but it did. And although it was the last team to actually reveal its 2014 Formula 1 car design, it was clear that the new Lotus E22 was not there just to make up the numbers.

The team's name, Lotus, is the hangover of a sponsorship deal that has largely come to an end, and is rooted in the legal dispute that saw two teams named Lotus on the grid at one point. Today, the team owns the rights to the 'Team Lotus' name, after an expensive settlement with Tony Fernandes but has, to date, chosen not to use it. The name of the car though reveals the team's real roots, E22, the 22nd grand prix car built in Enstone. This is the team that started life as Toleman, became Benetton, then Renault and eventually became Lotus. But, despite having no historic link to Colin Chapman's marque, its own innovative reputation has clearly had an impact.

On the nose

When the E22 was first shown off it was clearly an intriguing and highly distinctive design all round, but the thing that really stood out was its twin nose arrangement. In 2014 a new rule governing the height and side of the front impact structures on F1 cars was introduced and Lotus took advantage of a loophole in the rules, which has been closed for 2015.

The rules regarding the nose size state that an impact absorbing structure must be fitted in front of the survival cell. This structure need not be an integral part of the survival cell but must be solidly attached to it. It must have a single external cross section, in horizontal projection, of more than 9000mm^2 at a point 50mm behind its forward-most point.

But what it does not say is that a 'single' impact absorbing structure must be fitted in front of the survival cell. In other words multiple structures could be used, it is an approach first seen on the Audi R15+ LMP1 car, but to ensure that the design stayed legal, the two 'tusks' at the front of the E22 are slightly different sizes.

'We looked at a lot of different solutions when the regulations came out for noses,' reveals Nick Chester, the new technical director at the Lotus F1 team. 'We looked at traditional low noses like those used by Mercedes, ones with a central prong like Toro Rosso, and we looked at the twin tusk and found that it was a reasonable amount better. So we did a lot of work at that point on getting it through the crash test. It's not an easy thing to test but we got it to work. One of the tusks is shorter, as the rules state

Looking to the future

A significant project to improve aesthetics of Formula 1 took its first major step when Lotus ran in the post British Grand Prix test at Silverstone using 18in wheels fitted with special low profile Pirelli tyres. The Italian tyre maker has stressed that the test is not about the performance of the tyres at this stage, rather the way they look.

'These are just a prototype concept, but if the teams decided that they wanted us to proceed in this direction, we have the capability to carry on development in this area and come up with a production-ready version in a comparatively short space of time,' Pirelli's motorsport director Paul Hembery explained at the test. 'We've heard a lot of opinions already and we look forward to canvassing other opinions in the coming weeks and months. Even though performance wasn't by any means priority here, the new tyres still behaved exactly in line with expectations, so we're potentially at the beginning of a huge development curve, with the wheel and tyre rules having remained unaltered for many years.'

The test is the first step in a project to improve the look of Formula 1 cars which for the last two seasons have been widely criticised for being very ugly. As a result a project has been instigated which could fundamentally change the look of F1 cars. 'Its pretty far-reaching and we expect to see the manufacturers working with their concept car designers on what the cars should be in future, these wheels are just the first step,' explained one insider.

Wheel and tyre sizes have been fixed for a long time in Formula 1, while fans have become used to the aesthetics of low profile rubber elsewhere. Any changes will mean a major rethink in chassis and aero design

It is thought the project, which has not been officially announced by the F1 Strategy Group, is in its early stages but could be a result of manufacturers wanting more brand identity in the cars similar to the NASCAR Generation 6 cars.

The test of the larger rims and low profile tyres went smoothly, although the car fitted with them was notably off the pace compared to the traditional 13-inchers. 'They seemed more reactive and more nervous,' said Lotus Test driver Charles Pic after running on the new tyres. 'But, we ran them in a very conservative manner as regards to speed, tyre pressures and avoiding the kerbs. I think that it is a tyre that will react quickly; the reaction you get in the steering wheel feels like it's more nervous and you get a snap, it's quicker.'

Fitting the new designs to the E22 required some changes to the car according to Chester. 'We viewed it as a shakedown run; simply a case of 'let's see' for Pirelli, rather than a performance run. We had to trim the floor and change the ride height to adapt to the different loaded radius of the tyres. Some of the suspension set up also had to be modified, such as the cambers. These were very basic revisions to enable Pirelli to evaluate the concept and see what the bigger wheels look like on the car,' he explains. 'Having 18-inch tyres would have a big impact on design. We would want to be testing in the wind tunnel for at least a year ahead of their introduction. The ride height and suspension packages would have to be changed and the tyre profile itself would be very different. It would be an interesting challenge.'

that there must be a single section 50mm back from the tip, but in the frontal crash tests both tusks are absorbing a good chunk of energy. We could not pass the test with one or other of the two tusks alone.'

Lotus has two versions of the nose in use on the E22, a standard version and a high downforce version which features a turning vane, or winglet, between the two tusks. It is a concept that other teams including Caterham and Toro Rosso have evaluated in the wind tunnel but have chosen not to use. 'We have heard people saying that this layout makes the car more sensitive, but we don't think that,' says Chester. 'We spent a lot of time looking at it when it is yawed and steered and we don't see an increase in sensitivity over previous years. Overall the layout gives us a bit more downforce.'

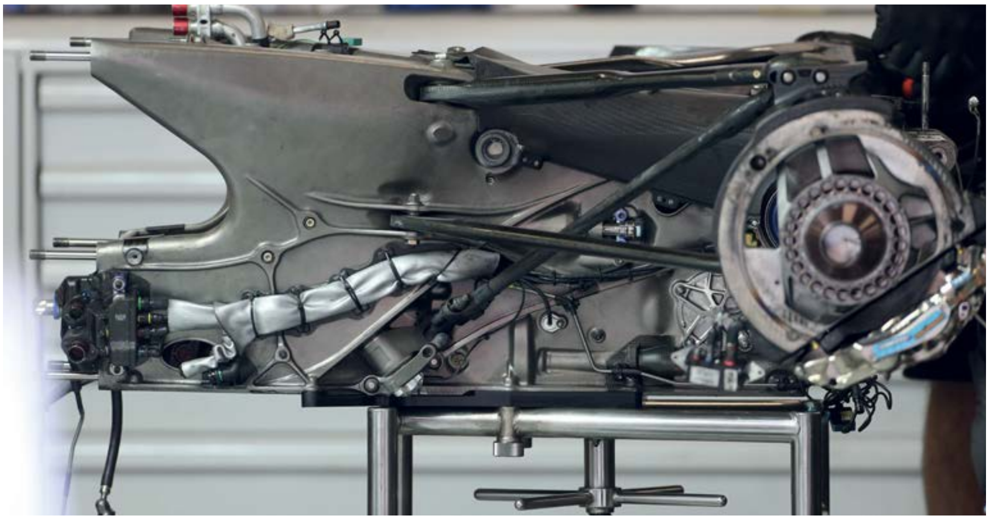
Weight issues

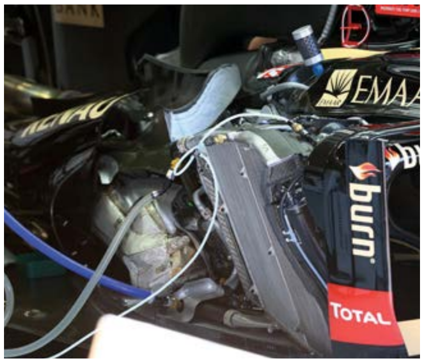
The chassis of the E22, is at first glance, relatively conventional, with push rod actuated torsion bar front suspension and a pullrod actuated layout at the rear. For the first half of 2014 the front and rear suspension was interconnected using a neat hydraulic system but that was removed ahead of the German Grand Prix (see P24).

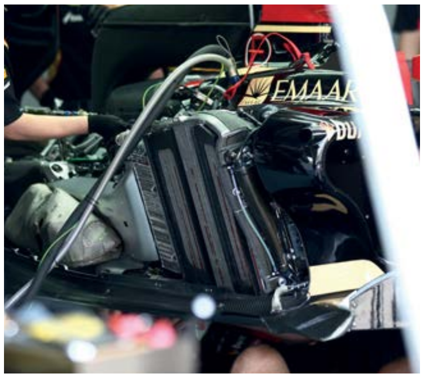
One of the major design challenges that all Formula 1 teams faced at the start of 2014 was getting the car down to the weight limit of 691kg while at the same time getting it within the mandated weight distribution of 314kg front and 370kg rear. 'There is some ballast on the car,' says Chester. 'We had a very strict programme in terms of developing the individual component weights because we have to hit that weight distribution limit. We knew we were going to be close on the overall weight limit; we did not have much of a range to play with. So, we had to make sure that we did not have to make the car overweight in order to meet the weight distribution limit. Even now we don't have the ability to move right across the 7kg range we are allowed but at the end we are where we want to be. As a result the wheelbase is a tiny bit longer, the extra length can be put down to getting the CG where we want and a bit of packaging too.'

At the rear of the car there is an interesting design that again shows a lack of symmetry, the rear wing has a single support structure but this is offset to one side with the exhaust tailpipe kinking around it. 'The layout was just quite efficient structurally,' says Chester. 'There's a lot of other things out there with Y-lons and the cascades that go with that. We are looking at that as some cars have really nice details there, so we may try that.'

Overall, the aerodynamics of the car seems to be an area that Chester and his team are relatively satisfied with and despite the trimmed down front wing mandated in 2014, he believes the car could be better than the race winning E21. 'If we had the exhaust blowing on this car as we did with the E21 then I think this car would be equal or better to that one. A lot of drivers







Above: Titanium-cased gearbox is unique to the E22. Full carbon fibre is a future option
Right: Experimentation with radiator and charge air cooler placement and ducting is continuing

are complaining about traction this year, I think some of it is that on one hand the cars have got a lot more torque, and and on the other the exhaust blowing has gone, so on corner exit it makes the car harder to drive.'

One aerodynamic concept that was used on the E21 but dropped for the E22 was known as 'The Device.' This was a way of stalling the rear wing and reducing drag on high speed sections of the circuit. Sometimes called passive double DRS, both Lotus and Mercedes attempted to use it in 2013.

'It was just too hard to make reliable, it was impacted by the wake of other cars and also if it did start to misbehave it would cost us downforce on the rear wing throughout the lap,' admits Chester. 'We raced it at Silverstone last year and it was neutral in terms of loss or gain, but when we ran it at Spa it was a loss, not a gain. We felt it was a really interesting system but required too much development for the returns it was giving. We are no longer pursuing it, and I imagine that most teams think its too difficult, maybe someone will do it some day.'

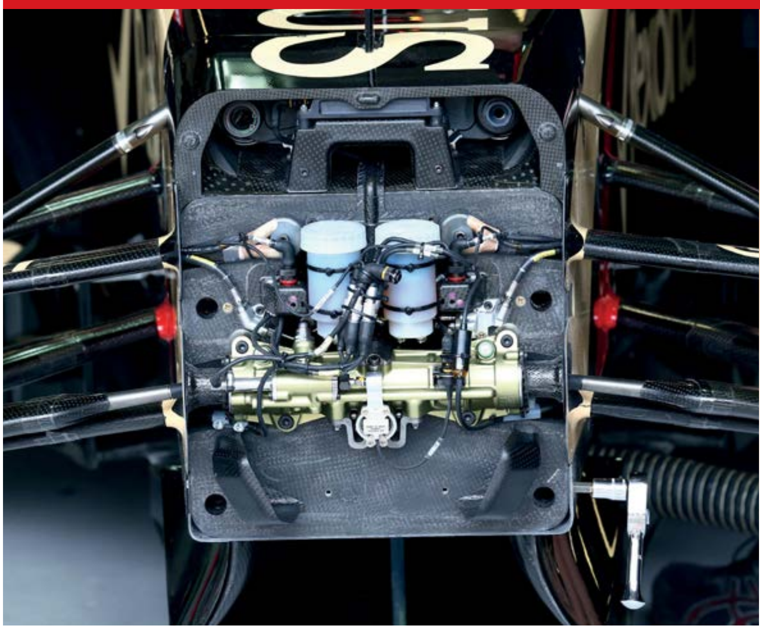
One of the less discussed rule changes for the 2014 season relates to the transmission of the cars, which now must have eight fixed ratios and last much longer, resulting in much larger gearboxes, but it has less of an impact on the car's aerodynamics than may be expected according to Chester. 'The increased size of the transmission has not really made it any harder in terms of aerodynamic packaging at the rear end. In fact the back of our gearbox is pretty thin. We are more driven in that area by cooling exits.'

Lotus is unique amongst the Renault powered teams in 2014 in that is uses its own bespoke transmission with a titanium case. The other three – Caterham, Toro Rosso and Red Bull – all use internals supplied by the latter, although Toro Rosso also manufactures its own casing.

'Doing our own casing gives us freedom on the suspension geometry, but for us it is also just a good way of developing a gearbox with the resources that we have got,' Chester explains. 'To do a full carbon fibre gearbox is a massive job, and while we are not ruling out doing one in future, we are quite used to the titanium casting method now. I think going to a carbon case may see a bit of a weight saving and we have run them in the past, but in terms of a design task it is pretty huge and we thought it was not worth it. One of the main reasons we did not pursue it for 2014 is because of the heat from the turbocharger. We thought it would be a risk to move to a carbon box when you are dealing with all of that.'

One of the advantages that Lotus feels it has with the E22 relates to the way torque is transferred from the crankshaft to the clutch,

The bulkhead



The front of the Lotus E22 reveals a fair bit about the car's overall design. Looking at the bulkhead you can immediately see that the torsion bars sit on top of the chassis underneath the 'vanity panel.' The bars are mechanically linked to one another and, somewhat curiously, the one on the left of the car regularly features a bolt in its centre while the right hand side bar does not. Nick Chester, Lotus F1 Team technical director is very cagey about this arrangement. 'The torsion bars are different to look at. It depends on what people think we are using the two bars for; they don't necessarily do the same thing,' he states when asked to comment on the 2014 design.

Also visible at the front of the car, sometimes hidden behind a Kistler control box, is the steering rack, mounted near the base of the chassis. 'The steering rack position is defined mainly by aerodynamic demands,' Chester explains, 'especially regarding where you want to put the track rod. We do a lot of suspension layout tests when designing the car and they pretty much define where the track rod goes in terms of height, so that fixes your rack, then you have to play a little bit with the geometry to ensure that the steer characteristics are right.'

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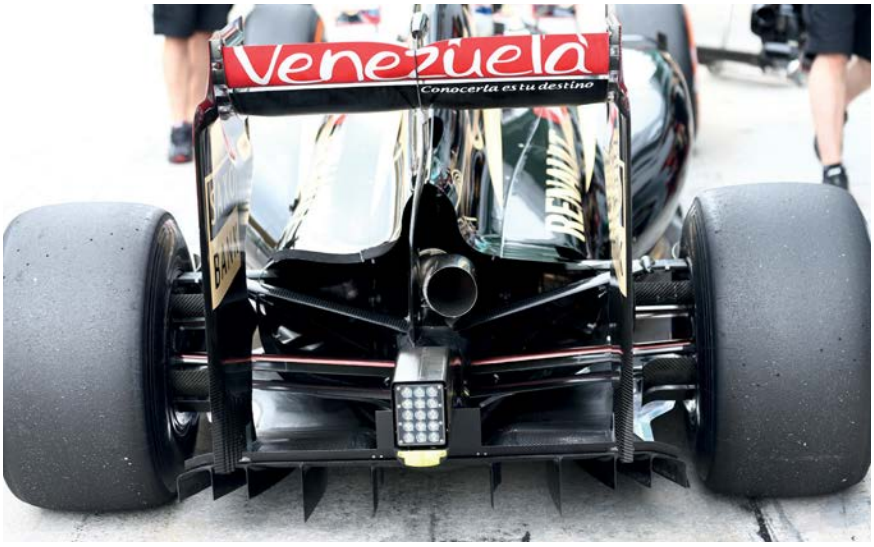
Reliability and power issues plagued the Renault V6 at the start of the season. Cooling problems are now mostly resolved



The slight assymetry of the wing strut and tailpipe arrangement is just as effective and lighter than other teams' more complex structures

something many struggled with initially with the high torque figures of the new power units. Chester will not be drawn on the exact details but is willing to admit that there is a system in existence. 'We have something different in the transmission, its not a trick really it is just something we did because we thought that it would give us more reliability in the clutch area. Its a purely mechanical solution between the crank and the basket that gets the torque into the clutch. I'm not sure what Red Bull are doing, but I think they know what we are doing. I'm not sure if they stuck with their original solution, or have switched to our concept.'

Installing the Renault power unit in the E22 has proven to be a major challenge for the team.

"The mapping got better and we got a lot more power by Barcelona, where the car was performing pretty well"

Initially there were well documented reliability issues, then there were some performance related setbacks, but overall the biggest issue with the RS34 power unit is its cooling demand. Here, too, Lotus has taken a different approach to the other Renault powered designs.

'There are a lot of different ways of cooling these turbo engines and on the grid there is a bit of a split between people who are using air to air cooling for the charge air and water to air cooling. We have gone for the latter solution,' says Chester. 'It's similar in concept to both Ferrari and Mercedes, though not in the installation. The reason we have gone down this route is for packaging. Red Bull has used an air to air solution which is quite big and has horizontal radiators. How you do it depends very much on how you are developing the bodywork on the back of the car. Red Bull differ to us there, but from our research both solutions work. We may change what we do in this area next year as we try to find the most efficient way to cool the car as it defines a lot of other parts.'

The radiators in the E22 are mounted longitudinally along the outer edge of the side pods, something that Lotus feel could give better flows under the bodywork. Additionally, the 1.6-litre Renault engine has not proven a major challenge to keep cool according to Chester. 'In terms of cooling we saved a little bit in terms of the combustion engine, so that saving is all on the right hand side of the car where all of the ICE coolers are housed. We achieved our cooling targets there quite easily but the charge air cooling has been more tricky. We have improved it through the season and have redesigned the radiators twice now to bring the charge air temperature down.'

This has at times resulted in additional ducting appearing on the E22 throughout the season, notably with a side cooling exit and some smaller openings in other areas of the car. 'Its such a different system to cool,' continues Chester. 'You can no longer just arrive at the track and have your temperatures perfect, so we did play with some additional exits to reduce our charge air temperatures a bit and we ran them in some races.'

Overall the E22 has not been as strong in races as many expected, which many put down to ongoing issues with the RS34 power unit, but Chester admits things are not quite as he would like in other areas too. 'Lots of things have improved; we were hurt at the start of the year as the car was late, and we had pretty poor reliability. At Melbourne we are in pretty bad shape, but through the following races leading up to Barcelona we improved in a lot of areas. Not just on the chassis side but on the power unit side too. The mapping got better and we got a lot more power by Barcelona, where the car was performing pretty well. We were not happy with the races that followed, as the car struggled with low speed corners and the way the power is delivered, but on tracks with high speed corners we should be better,' he concludes. However, his colleague Alan Permane, Head of Track Operations at the team is rather more blunt in his assessment. 'The suspension changes we had to make at the German Grand Prix complicated things for us,' he said. 'But it's clear we lack pace relative to our opposition.'

TECH SPEC

Chassis construction
Carbon fibre with aluminium honeycomb monocoque

Front suspension
Double wishbone, push-rod actuated torsion bar springs and dampers, anti-roll bar

Rear suspension
Double wishbone, pull-rod actuated torsion bar springs and dampers, anti-roll bar

Transmission
Paddle operated 8-speed semi-automatic

Clutch
Carbon multi-plate

Tyres
Pirelli
Fronts: 245/660-13
Rears: 325/660-13

Brake system
carbon carbon discs all round

Fuel system
ATL Kevlar-reinforced rubber bladder

Electronic systems
FIA SECU standard electronic control unit

Engine
Renault Energy F1-2014, 1.6-litre 90 degree 6-cylinder. Max rpm 15,000, 24 valves. Cylinder block in aluminium

Dimensions and weight
Overall length: 5088mm Overall height: 950mm, Overall width: 1800mm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Disconnected?

Every Formula 1 team was using one, but the FIA has discouraged interconnected suspensions. What were they hoping to achieve?

By SAM COLLINS

In recent weeks there has been a lot of discussion in the media about a ban on 'FRICS' in Formula 1, but many of these reports have been overstated or are generally inaccurate. The name 'FRICS' (Front to Rear Inter Connected Suspension) is simply the latest product of Formula 1's tendency to give every sub system of the car a new name, usually a complex sounding acronym, and the discussion of it being banned is simply incorrect.

Shortly before the German Grand Prix, the FIA issued a communication to all Formula 1 teams regarding interlinked suspension. It says: 'Having now seen and studied nearly every current design of front to rear linked suspension system we, the FIA, are formally of the view that the legality of all such systems could be called into question.' It went on to explain that the front to rear aspect of the systems, which can give some degree of pitch control may breach article 3.15 of the technical regulations, ie:

'Any specific part of the car influencing its aerodynamic performance must be rigidly secured to the entirely sprung part of the car (rigidly secured means not having any degree of freedom) and must remain immobile in relation to the sprung part of the car. With the exception of the parts necessary for the adjustment described in Article 3.18, any car system, device or procedure which uses driver movement as a means of altering the aerodynamic characteristics of the car is prohibited.'

It does seem difficult to understand quite how this regulation restricts a suspension system, but it was the same rule that saw the Renault F1-tuned mass damper outlawed in 2006. Interconnected systems do not clearly breach this regulation, and most teams feel that they are legal. 'The regulations are very stringent on what inputs a connection between the front and the rear of the car to work to, and in essence, that's limited to the vertical inputs through the tyres and that really restricts what you can do with them,' says Bob Bell, former Mercedes GP technical director. 'These suspension systems are complex and expensive but, because of those restrictions, they only have limited use. You still need a basically good car, using it will not get you out of a hole.'

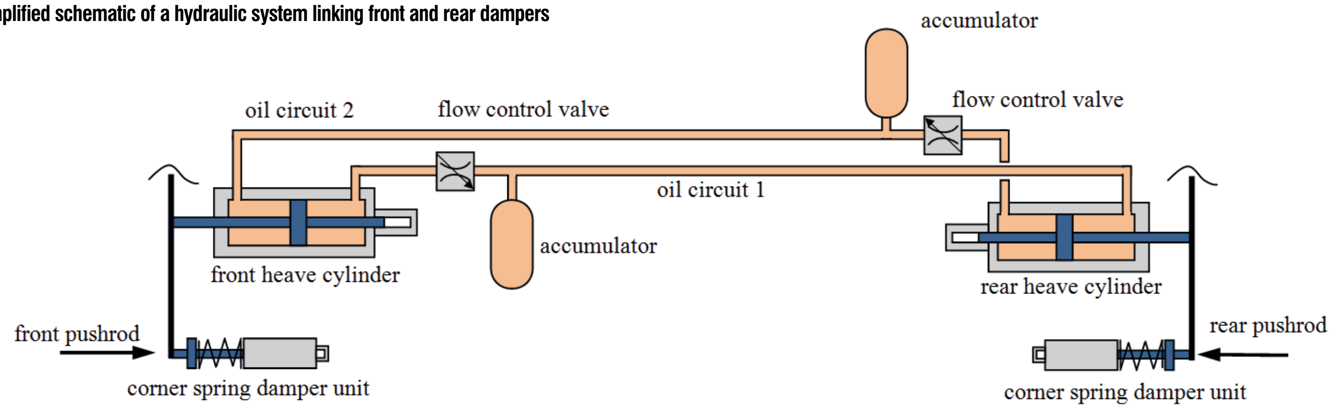
Lotus technical director Nick Chester adds that his team did not introduce it for aerodynamic reasons. 'We brought it into the sport in 2007 and the basic concept of the system has not changed,' he explains. 'We have obviously continually optimised it to improve the ride. We did it primarily for a ride benefit and it worked well.'

These systems are simple in concept and have been detailed in *Racecar Engineering* more than once, but notably by Sauber's aerodynamic design engineer, Manuel Greiner, in RCE V23N3 (March 2013). The layouts link the springs (torsion bars) and dampers to one another in order to cancel out bumps or give the car better more stable handling and aerodynamic performance. The exact nature of how the interconnection is done varies from team to team. In the case of Mercedes it is fully hydraulic, but purely mechanical and even electronic systems have been used elsewhere in the past.

> "It is no secret that everyone on the grid has an interlinked suspension system that incorporates Cambridge inerters front and rear"

Interconnected suspension systems have been used in F1 since 2007, but teams were encouraged to remove them for the German Grand Prix. Mercedes changed brakes after qualifying following a failure. Although it had FIA approval, other teams questioned the legality of such a change.

Simplified schematic of a hydraulic system linking front and rear dampers



'It is no secret that everyone on the grid has an interlinked suspension system that incorporates Cambridge inerters front and rear,' Marussia's Dave Greenwood explains. 'The way you get all of those elements working together is a way you can get performance. You find a spot where the car has the most downforce and that's where you want to run it as much as possible. Then you have the way the car shifts going through a corner, and the way you make the suspension work is to optimise where the car is in terms of ride height. That unit combines lots of elements that you would normally separate, it allows us to have something that gives us gains in ride and aero performance with as little weight as possible.'

Basically, what the teams are trying to do is keep the floor of the car, which generates substantial downforce, as flat as possible to give a consistent amount of aerodynamic load. This can also improve a car's handling and traction, though former Mercedes technical director Bob Bell downplays the impact of FRICS, as his former team dubbed it, and other similar systems.

'Although the suspension is hydraulically interlinked, and most teams have something similar, they do not do away with the concepts of springing, damping and roll stiffness. Those characteristics still exist, but how you achieve the changes physically on the car can be different, and that can enable you to have system that is more subtle and more adjustable. It's an enhanced tuning aid,' he explains.

In reality FRICS, or interlinked suspension, is nothing new at all, the Lotus team has run it for the last six years and claims that the increase in popularity in such systems is down to improvements in computer technology allowing teams to optimise it more effectively. Tyrrell used a similar concept in the 1995 season on the 023 design and dubbed it 'Hydrolink,' but the technology was not yet fully optimised and it was dropped and largely forgotten.

That system was only used on the front of the car and provided enhanced and separated bump and roll. Tyrrell felt that the having that additional control was of more importance on the front of the car due to the greater degree of suspension movement there and its fundamental influence on the air flow under the car. It had planned to fit it to the rear of the car but apparently never did.

False economies?

So, why did the FIA feel compelled to take action now? After all, the front to rear interconnection systems have been in use in F1 for the last seven years, or – if you go back as far as the Tyrrell application – almost two decades! Indeed, in 2014 every single car on the grid was fitted with a interconnection system of some description.

It seems that the FIA's communication was in response to a request from two teams wanting to clarify its legality for the 2015 season before integrating it into the new car designs. There was discussion in various F1 groups about banning the systems for next season as a cost cutting measure and possibly replacing it with fully active suspension in 2017. But some teams, including Lotus, argue that the costs of taking it off would be more significant than leaving it on. 'I think most teams, especially those that have had it for a few years are not developing it all that hard anymore,' says Lotus's Nick Chester. 'Some that are newer to it are arguing that they are developing it hard. For us, it is quite a lot of development hassle to remove it.'

For teams like Lotus, this will be a bigger challenge than it will be for some others. Force India is likely to be one of the biggest winners from the ban, though it will also be frustrated as it had just introduced an updated system to its car. 'We had an interconnected suspension system at the end of last year and we used the data from that to develop a new system for this car,' Force India technical director Andy Green reveals. 'We have used it in a couple of races (Shanghai and Barcelona), but it needed further refinement so we took it off and reworked it. We felt we could have raced it at Monaco, but we were not comfortable with the limits it was setting with respect to the tyres. Taking it off allowed us to explore a lot of different avenues.'

Ultimately, FRICS has not been banned in 2014 or 2015 (yet), but if found on a car after the German Grand Prix it would run a high risk of disqualification and lost points. With every point hard fought for in 2014, it seems that teams felt that it was not worth the risk and they all removed the systems from the cars for the German Grand Prix in July.

Interconnected suspensions remain legal in other forms of motorsport such as LMP1 where Porsche is using a highly advanced system on its 919 Hybrid. Toyota and Audi are also thought to have similar systems.

Brembo brakes break?

In qualifying at the German Grand Prix, the Mercedes W05 of Lewis Hamilton went out of control at around 160mph after its right front brake disc failed. Mercedes uses two suppliers of friction material on the W05, Carbon Industrie and Brembo, and the two drivers on the team regularly swap around the different products. At Hockenheim Hamilton had opted to use Brembo discs all round, while Nico Rosberg ran Carbon Industrie discs on the front and Brembos at the rear.

After Hamilton's crash, it was revealed that this was the second such failure the team had suffered. Mercedes consequently fitted Carbon Industrie discs to the front brakes of Hamilton's car and used the same products on the rear, and additionally switch Rosberg's rear discs to the French make. The trouble with this, especially the latter, is that while teams are allowed to make changes in *parc fermé*, it must be clear that any replacement part a team wishes to fit is similar in mass, inertia and function to the original.

Mercedes argued that the mass, inertia and function of the discs it fitted was similar to that of the newer discs, but not everyone in the paddock agreed, including Red Bull Racing, which interestingly also changed its rear discs but kept the same specification. 'It is a change of car specification,' said Team Principal Christian Horner. 'If you change it like for like that is one thing, but if you change it for something that is made by a different manufacturer that has a different characteristic, as described by the driver himself as something different. It is an interesting precedent.'

The day after Horner made this comments the team revealed that in fact Brembo discs had been fitted to the rears of both cars in the race. This contradicts most of the information coming out of Hockenheim on race day. Brembo introduced a new brake material for the 2014 season dubbed CER, which was an evolution of the CCR material used in 2013. CER was designed to reduce wear, and had more effective thermal conductivity, and is the material that failed in qualifying. It has been speculated that Red Bull fitted discs made from CCR.

The exact causes of the failures, and allegedly up to nine others this year, have yet to be revealed by Brembo.

Desert stormer

The American passion for brute force and rugged ingenuity translates into a serious contender for Dakar-style rally raid racing

By DON TAYLOR

As worldly and knowledgeable as they are, not all *Racecar Engineering* readers may be familiar with American Off Road racing, as contested in the southwestern United States and Mexico, under sanctioning bodies like SCORE (established in 1973 as Southern California Off Road Experience) or BITD (Best In The Desert), organisers of the Baja 1000, first run in 1967.

But they do know about Dakar, initiated in 1978 as Paris-Dakar, an international event stretching great distances across deserts and other rough terrain, and today dominated by a version of the Mini Cooper.

In many ways, the US off road events are similar to Dakar, but shorter in length and contested many times a year – typically over rougher terrain, meaning more rocks and more jumps, requiring more wheel travel.

While the Dakar (Paris-Dakar) event was initially being run across the pond from the US, a separate evolution of desert racing vehicle design was taking place in North America. The vehicles popular on the street in the US, super-sized pickup trucks, powered by their affordable, powerful V8 pushrod engines, were driving the structure of many US off road racing classes. In addition, and in contrast, a 'lighter is better' approach was also being taken, starting with the conversion of older VW Beetles into 'Dune Buggies', taking advantage of the traction benefit inherent in a behind-the-rear-axle engine location. This approach has resulted in creation of a range of classes for today's 'buggies', simply called 'cars' by the industry, running rear mounted engines ranging from air-cooled VW flat-fours to large V8s.

Along the way, some Americans acknowledged the importance of the far-away Dakar event. Perhaps the most well-known US driver to run the Dakar has been Robby Gordon, who has had success with his big V8 Hummer.

"It used to be, just get it down the road. Then it was, get it down the road in a hurry. Now, how that racecar performs and handles is critical"

With the Dakar event moving to South America in 2009, only a continent away from the US, a stronger connection is developing between the FIA-sanctioned Dakar event and US off road activities. SCORE's president Roger Norman, a Baja 1000 winner, has been negotiating with the ASO for more crossover opportunities for competitors both ways.

Featured in this article is a prominent US builder of off road vehicles, who has also had success at Dakar. This year, with Patrick Sireyjol, their vehicle took the T1 Class 3 win.

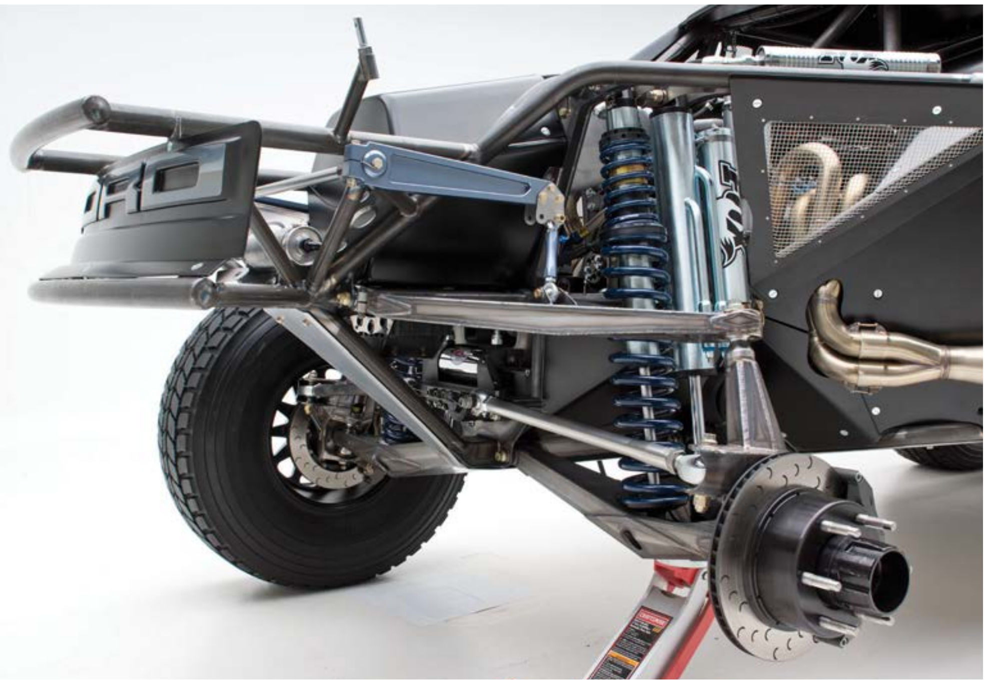
But their main business is in the US, producing winners in various classes of US off road racing, including those for the pinnacle, the Trophy Truck class.

To get a closer look at American desert off road vehicles, and in particular the Trophy Truck, *Racecar Engineering* visited the largest builder of vehicles for the professional off road classes, JIMCO Racing Inc. Headed by President Mike Julson, JIMCO's 16,000 sq.ft. facility is located in what could be considered the US off road equivalent of the UK's 'Motorsport Valley', the area near San Diego, California. Here one finds the shops of builders, component suppliers, and teams. Not to say it's all here; other prominent players in off road are spread around, closer to Los Angeles, Phoenix, and Las Vegas. All these locations have convenient access to the desert for testing, and are also close to where most of the race events are held. Still, the industry's nexus is around San Diego which makes it geographically strategic, being right next door to Mexico, home of the legendary Baja races.

Mike Julson, whose father started JIMCO in 1975, took it over in 1991, and has grown the business to be a major force in US off road racing. Besides building winning Trophy Trucks, note that JIMCO also produces Class 1 (Unlimited Cars), Class 10 vehicles (Unlimited, lightweight Cars with a smaller displacement, sealed engine. See sidebar), Pre-Runner Trucks, and a Rally Raid Car. In addition, JIMCO also handles repairs and race-prep for many of its customers.

Julson owes his company's success, which includes years of championship wins by his vehicles in various classes, to focusing not just on having a well designed and built product. He has high respect for the products of his competitors, but he feels his difference is his follow-through. With his level of enthusiasm for the sport, and

Naturally aspirated V8s from Chevrolet and Ford make about 800bhp, but turbo motors are on the way



Massive suspension travel and huge tyres dwarf the Alcon 12-inch disc brakes. Surprisingly, two wheel drive is preferred

desire to win, he can't help but be out there. 'We don't stop with building the racecar,' says Julson. 'We're going to go out and test with the customer. I think we have a real good handle on what makes these vehicles click. My guys have ridden with everyone, from here to Australia. And to me, that is the critical thing. I have a million reasons why you should buy a JIMCO, but the reality is how they perform on the racetrack.'

JIMCO may produce vehicles in several classes, but in this sport, the fastest, most complicated, and most recognizable are the Trophy Trucks. As the top class in US off road, they are the overall winners in the major, multi-class events. Know universally as Trophy Trucks, they are also called 'Trick Trucks' in BITD parlance. They are the LMP1 cars of Off Road. JIMCO builds these vehicles for customers who pay upward of $500,000 US, depending on the selected component options.

When the class was formally introduced in 1994, manufacturer money was flowing into racing. With pickup trucks commanding a large part of the US auto market, and the marketers needing to demonstrate their truck's ruggedness, marketing dollars were spent on off road racing by nearly all manufacturers. The flagship event, and a name widely recognized by the public at that point, was the Baja 1000 race in Mexico. Factory supported teams tried lots of different technical ideas in this unlimited class. These efforts often wound up as noble engineering experiments in race truck designs that were not able to finish races, or failed to win.

Although OEM factory support has long departed from Trophy Truck, the class remains strong, and is now growing, thanks to flush privateer teams. 'I think most of the people in Trophy Truck are recession-proof,' claims Julson.

From a vehicle design standpoint, there is still the unlimited freedom in the rules today, not to be found in other professional racing series. Just how 'Unlimited' is Trophy Truck?

All options open

Let's start with the limits: it must have a body that looks (somewhat) like a production pickup, with the engine from that manufacturer's engine family, naturally aspirated (that will be changing in BITD). But going on from there, engine displacement: open. Engine modifications: open. Engine location: open. Engine electronics: open. Fuel capacity: open. Transmission/drivetrain: open. Chassis design: open (except for safety cage, etc). Suspension: open. Tyre choice: open.

Even with this freedom, most Trophy Trucks have evolved to a common configuration, with the differences now in the details. The basic description of a Trophy Truck is: steel space frame, fibreglass or composite body panels, front or mid-mounted V8 engine, automatic transmission, RWD with solid axle, independent front suspension, and plenty of travel. Getting into the specifics of today's Trophy Truck, the JIMCO version is fairly typical. A somewhat standard design has evolved, proven to work, and ready to win, with extensive component options if the customer has a preference.

The main criteria are reliability, repairability for when they do break down on-course, and speed. But it is reliability that has driven the builders' and teams' recent thinking. The chassis/roll cage structure is fabricated from 4130 steel tubing, as required by the rule book. Tubing for each vehicle is CAD designed for CNC laser cutting, providing an accurate fit as the frame members are TIG welded into place.

Engine rules allow any displacement, number of cylinders, but engine must be from the production family of the pickup truck body, and naturally aspirated. Note that BITD has now opened up its series to turbos, which may kick off new developments. The fuel cell has no capacity limit, with some carrying up to 100 gallons. The tank is mounted behind the rear axle to get weight for traction.

Transmission options are open, with most teams preferring an automatic as there is so much violent loading/unloading of the drive train. The most common unit is based on the General Motors, Hydra-Matic HMT 400, 3 speed, with the torque converter acting as a cushion for the engine. Sequential shifting 5-6 speed manual transmission development is moving along, with or without a fluid coupler. These have shown some performance advantage, but reliability is still the challenge. Xtrac had ventured into this arena earlier with uneven results.

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BITD has now opened up their series to turbos, which may kick off new developments in power plant thinking

One may ask, if the desert race course is mainly loose sand and dirt, why not use four wheel drive? It is used in some other classes, and in theory has some advantages. Trophy Truck teams that have tried it have faced challenging development programs. In general, it is felt the extra complexity, extra weight, limited front wheel travel, and the vulnerability of the front wheel drive shafts to damage, are not worth the performance advantage shown in certain types of terrain.

The independent front suspension consists of double A arms, and a fabricated steel spindle. The springing medium is coil springs, with dual shocks. The arms are rugged steel fabrications, whose inboard mounting points come close to the vehicle centreline to maximize their length. JIMCO employs a front sway bar. Front suspension travel is an extraordinary 26in in total. At the rear, the sturdy live axle housing, located by trailing arms and track rods in a 4-link arrangement, can travel a total of 36in. Coil springs are used, in conjunction with shocks.

The biggest enablers for racing at high speed through the desert have been generous wheel travel, and ever-evolving, modern shock design.

The development and sale of specialized, off road shock absorbers has become a business in itself for companies like King Shocks and Fox Shox. They have kept pace with the demand for more wheel travel and tunable control, with longer strokes and larger tube diameters. Remote fluid reservoirs with elaborate cooling are the norm.

Forged aluminium wheels are 18-22in diameter, with available tyres currently maxing out at a 42in diameter. JIMCO's Trophy Truck typically comes with 39in diameter, BFGoodrich KR tyres. The competing tyre brands, including BFGoodrich, General, Toyo, and Yokohama have done a great job in producing tyres capable of taking the abuse of repeatedly landing on sharp rocks and hitting boulders, as have the wheel companies. But the price is weight. The big wheel/tyre combo can come in at 140-150 lbs a corner. Alcon brakes with one piece, 6 piston, light alloy calipers are used, with steel discs.

Steering is via Howe rack and pinion with full power, hydraulic assistance.

The two-man cockpit is surrounded by a roll cage, built to specifications loosely defined by the sanctioning bodies. Right behind the drivers are located the engine cooling radiators in what would be the rear window. As there is no windscreen, air moves through the cockpit, assisted by electric fans, to one of the safest areas for the radiators. Not the best low drag solution with top speeds approaching 140mph, but it works.

Instrumentation has evolved to just a digital dash, supplied by MoTeC or others. It is located within sight of both the driver and co-driver. But the bigger and more important cockpit screen belongs to the navigation system. A Lowrance GPS system is used by the co-driver to plot the race course. Notes added during the pre-run are triggered to warn of upcoming hazards.

As per the rules, the body must resemble a production pickup truck, but not that it has to actually follow any of the stock dimensions of such. The material? Fibreglass, generally.

JIMCO CUSTOMER: Jason Coleman Motorsports

During our visit to JIMCO, we met one of their first time customers, there to check out his off road vehicle build. Jason Coleman is a young driver/team owner, not ready for a Trophy Truck, but ready to take the next step for him. After great deliberation and analysing his options, he had decided to commission the build, out of his own pocket, of a JIMCO Class 10 race car.

Class 10 cars are open wheel, tube frame, one or two passenger machines, built to a lighter-is-better philosophy. All components are built purely for racing, except the engine. Requiring low cost, sealed spec engines in 2010 really ignited interest in Class 10, such that 25-40 cars may show up for an event.

Jason had started out with a Class 1/2 - 1600, a tube frame vehicle with early VW Beetle suspension and the air-cooled VW four cylinder engine. Jason was able to make his mark in that class by winning championships in 2010 and 2012, plus events such as the Baja 500.

Although interested in other forms of racing – he almost went formula car road racing – off road racing is under his skin. From a driver viewpoint, off road offers lots of seat time (hours and hours of it), unlimited testing opportunities, and a new challenge to your skills around every corner. All at a fairly reasonable cost.

Jason has made many visits to the JIMCO shop over the last eight months, and now to see his car getting close to completion, he has even more appreciation of JIMCO's attention to detail. To his discerning eye, each weld and bracket is a work of art. Mike Julson, JIMCO President, spent time with him, discussing what's next. Testing will have to be done before the targeted first race in mid August, at the BITD 'Vegas to Reno' event. Mike was quick to add '…and we'll go out to that test with him. I will not be satisfied until he wins a race. It may take a while, but I know Jason's got the talent; he's got it in him.' Now that's encouragement!

For the other components, Jason describes his process of evaluation in the selection of each one, such as choosing the newer GM EcoTec engine with direct injection. It costs more with the electronics than the also legal, older non-DI engine. Even though power is regulated to be the same for all eligible engines, the newer EcoTec is going to have the latest internals for friction reduction, oiling, and cooling. And speaking of oiling, even with the sealed engine, Jason can use his sponsor's product, LAT Racing Oil.

He has selected the Fortin sequential shifting, six speed transmission. 'I could get by with a four speed, but I like having more ratio options,' says Jason.

The choice of shock absorbers is also carefully considered: 'We are sponsored by King Shocks, and they're 20 minutes away. But beyond the sponsorship, I know they will be at the events and help me.'

For brakes, Jason has selected a company with whom he has had a long relationship: 'Jamar has been around for decades, but in last three or four years they have committed to a competitive racing product…..they'll go to the tests and races with you, and want to make it better.'

And when he does test, like any good racer of his generation, Jason will continue to update his suppliers and fans via social media, on facebook, twitter, and through his website, ColemanMotorsports.com.

As he advances in his driving career, and is ready to move up again, he will likely stay loyal to the component suppliers with whom he has grown relationships. Going on to Trophy Truck is his dream. And at this rate, that Trophy Truck could be a JIMCO.


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Jason Voss has piloted his JIMCO Trophy Truck to multiple wins in the toughest races on the US off road calendar

As the body work, particularly the front and rear fenders, is vulnerable to damage by stray cactus, tumbleweed, other competitor's vehicles, or rocks, it faces frequent replacement, and fibreglass is relatively cheap.

However, carbon fibre is making inroads as body material. Reinforced with Kevlar, it has a fair chance of taking a thump and staying in place.

Accessories

As for aerodynamics, some wind tunnel work had been done historically on off road bodies, primarily by the auto manufacturers, and well-heeled teams. It is a factor in drag and downforce, primarily in the hood and front end area. However, with the enormous wheel openings required for travel, lack of windscreen, and the body's vulnerability to damage, finding benefits from better aero may not be possible.

As many US/Mexico off road events run into the evening, or through the night, good lighting is critical. Hence an array of long range and short range lighting units adorn the front grill area, the A pillars, and perch on the roof. LED units have quickly made their way into this arena, available in a variety of arrays, replacing HID, requiring a lower power draw, and offering smaller packaging dimensions.

To be prepared for whatever happens in the desert, the truck carries a wide collection of parts and tools. A vehicle may break down, or have an accident, miles from the nearest pit area or support vehicle. It is up to the driver and co-driver to deal with it.

For every event, competitors must ask the same question as you ask yourself when packing for a family holiday: what should I take along? To start with, Trophy Trucks often carry two spare tyres, or only one if they are very optimistic. Despite the current tyre design's proven durability, failures are still fairly common. The 140-150 lb. spare tyre can be a chore for the co-driver to change in the desert's day time heat, or night time cold. But with practice, they have the routine perfected to quickly do it alone. Handily enough for the drivers, they typically stay in their seat during tyre changes to not break focus and avoid re-buckling their belts. The truck may be jacked up by a platform powered by the steering pump, made flat to not sink into the sand. Or to save weight a lightweight floor-jack, weighing around 200lbs, is used instead. Other spares include a driveshaft, fan belts, alternator, starter, battery, and ECU. Plus there is a first aid kit, fire extinguishers, and tools.

TECH SPEC

JIMCO Trophy Truck

Engine
Type: Chevrolet or Ford, push-rod V8
Cubic capacity: 454cu.in
Number of valves: 16
Position: front
Number of cylinders: 8
Maximum power: 800bhp
Torque: 665lb.ft
Maximum revs: 7000 rpm
Top Speed: 140mph

Transmission
Type: GM Turbo Hydra-Matic TH400 Automatic with converter
Gearbox: 3 speed automatic, planetary gearset

Chassis
Frame: 4130 steel tube frame
Bodywork: fibreglass, or carbon/Kevlar composite

Suspension/brakes/steering
Suspension front: double wishbones
Suspension rear: solid axle, trailing arms, track rods
Rear end: Tubeworks or ID Designs
Springs: coil
Dampers: pressurized dampers, Fox Racing Shox's Full Bypass Technology
Anti-roll bars: front and rear
Wheel travel front: 26in
Wheel travel rear: 32in
Jacking system: optional: AGM or Howe
Steering: Howe rack and pinion with full power assist
Seats, nets, and belts: Mastercraft Safety
Brakes: Alcon - hydraulic double circuit brake system with one piece light alloy calipers
Brake discs: ventilated steel discs
Diameter: 12in
Wheels: forged aluminum
Tyres: 39in diameter, BFGoodrich KR racing tyres

Dimensions
Length: 220in **Width:** 84in **Height:** 72in
Wheelbase: 128in **Track:** 92in **Fuel tank:** 80 gallons
Weight: 5800lbs. wet

Add it all together, and the weight quickly adds up on these trucks. Although a minimum weight may appear in the rulebook, today's trucks are not in danger of showing up too light. Trucks typically hit the scales at between 5500 and 6500lbs, ready to go. Some trucks have reportedly exceeded 7000lbs.

Weight is not necessarily seen as a bad thing; some claim that the heavier truck, once it gets going, has more momentum to carry it straight, while the wheels and suspension have the task of reacting to the uneven holes, ruts, and dips of the course. The low unsprung to sprung weight ratio helps even out the ride for the driver. Not that the unsprung weight items don't look very light. The suspension arms and rear axle appear massive. They make NASCAR parts look like match sticks. And don't forget the weight of the wheel and tyre. It's all relative.

Losing weight

In fact, all of the truck's pieces have been made beefy to survive. The general approach has been to keep making the failing bits stronger, and if the vehicle gets heavier, just add more horsepower! Remember, there's no displacement limit. That's fine, until the vehicle has to slow down, or corner.

There is the start of a movement to reduce Trophy Truck weights, and the Trophy Trucks will continue to be more technically sophisticated. 'Off road racing and road racing are completely different forms of motorsports, but the similarities from an engineering standpoint, especially today, those similarities are coming closer and closer together,' says JIMCO's Mike Julson. 'What I mean by that is that years ago I would say that off road racing was bunch of good old boys out here, but we're not just out here laying pipes on the floor anymore. We really need to do our homework; because that's the level it's at. That's why are we constantly looking at different brake systems, electronics, and so forth.

'It used to be, just get it down the road. Then it was, get it down the road in a hurry. Now, how that racecar performs and handles is critical.'

Some say, with the similarity between today's Trophy Trucks, that it is more of a driver's race, with the glory of men, and many women, challenging each other and all that Mother Nature can throw at them. But the engineers and builders still see advantages to be gained in engineering the vehicles. Adds Mike, 'I'm amazed right now, that somebody has not thought further outside the box, like high travel, independent rear suspension. Almost all the new trucks are front engine, Turbo 400, with a solid axle.'

There are many risks associated with trying something completely new but, as long as the Trophy Truck rules remain 'unlimited', someone will be tempted to break through and think outside of the box. Don't be surprised if it is Mike Julson and JIMCO.


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Time machine

Honda's WTCC Civic was rushed through the design phase, but a summer development programme should see them challenge on speed alone in the second half of the year

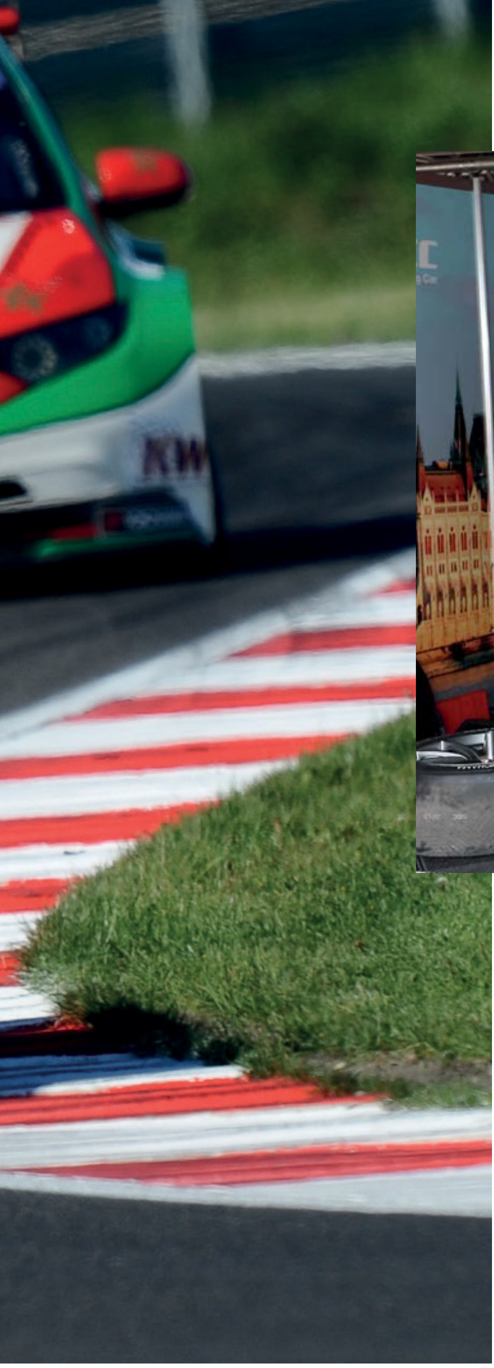
By ANDREW COTTON

Honda's World Touring Car Championship programme has seen a huge investment, with three different cars in successive years, and in 2014 a commitment not only to build a car to new regulations, but also supply customer teams. Honda remains the only manufacturer to run a factory team against its own privateers, yet provides all the updates to everyone, offering equal opportunity to win in one of the most hotly contested touring car series in the world. Following a short design process and gestation for the Civic, there's been a large development programme over the summer with a view to scoring victories in the second half of the season.

Led by team principal Alessandro Mariani, the team accepted the proposal to bring forward the new regulations from 2015 to 2014 to allow Citroën to enter the series and rushed through a series of changes before being able to test them properly. With a lower ride height and new 18-inch tyres, the team needed a new suspension system; with a wider body it needed a new aerodynamic package and with more power, the team needed new engine maps, which were finalised in Japan.

The delay came about because Honda was waiting for confirmation of Citroën's entry into the championship. Once that arrived, Honda could begin to design in earnest, so the decision was taken to compromise the development work on the 2013 car, concentrate on the 2014 car instead, and hit the track for the first time in January, less than four months after reaching board-level approval.

'Citroën started [designing] immediately at the beginning of January; they had the decision of the board to enter the championship, but we had to wait for the because if Citroën say no in June, then they hold the regulation to 2015,' says Mariani. 'We were also busy with the championship while they were free [to test]. They had a big budget for testing, so we started with a big disadvantage, but it is important to have a strong championship.'



Cooling design involved some guesswork, but came good relatively quickly. This is Norbert Michelisz's Zengo Motorsports Civic WTCC in the pits at Marrakech

The new regulations give the World Touring Car Championship a new problem; not only are the cars more expensive to buy, but after three years there is nowhere else to sell them as no other series in the world runs the same regulations. Mariani counters that the costs are 15-20 per cent more than in 2013, but that the spare parts are almost the same, and therefore the costs to privateers is not much higher. 'The new WTCC overall with the new rules is the perfect combination of production car and sporty car,' he says. 'The DTM is too much, and the old touring cars look not so attractive. These regulations are very good, but we knew that it would be difficult, it would be tough at the beginning, but we have plan for recovery, a lot of ideas, so for sure we will recover and I am very confident. I don't see any reason why we cannot be more competitive.'

Rush job

The team used its experience to develop a new car from a clean sheet of paper. It is the only 'two box' design, which leads to some limitations aerodynamically, and it has had some issues around the front structure. At the end of April the team used its first 'joker' to strengthen the front subframe, which helped to prevent the unpredictable steering lock that affected the drivers in the first race at Marrakech and caused Gabriele Tarquini to crash in practice. That meant that the team's test car was put into use for the second race, which caused further delays in early season testing. 'We had to put the car on tarmac, and made some decisions based on past experiences. Based on judgement from past experiences, rather than what was solved,' said chief designer Andrea Adamo. 'So, we had to make the car according to the planning. How much time does Pankl take to deliver a driveshaft, for example? We started the car, did eight days of testing, but the first three months were tricky because we had some reliability issues. We never got deep into the setup. We did some aero testing but we have only a basic shape. We have not done a full aero map so there are windows on the car's behaviour that are grey areas.

'We had to solve the reliability issues first. We tried to understand the subframe and the arm, and now we have a plan – by the end of the year races we might have new parts to homologate.'

With the car on track for the first time in January, and the first race in March, Honda was forced to accelerate its production plan to produce customer cars.

'Everyone says that the rules are not open, but in my opinion that is not true,' says Adamo. 'From one side, it looks as though there is more freedom, but on the other, everything is homologated. And once it is homologated, it is done. You have some jokers, but you have to homologate the parts during the year. I have to have the idea by the end of August to present to the FIA by December 1.'

Civic skin

One of the main concerns for the team was Tarquini's crash in Marrakech, where the steering locked. It was a different system than the electronic one used in 2013, which the team considered was not robust enough to cope with the higher loads through the larger tyres and more aggressive aero. 'Last year we were using an electrical system, but we knew that it wasn't powerful enough to work with the bigger tyres, aero, more aggressive suspension geometry, so we had to swap to our current one,' says Adamo. 'We have already started working to improve it. We had some problem with the subframe so we modified it.'

The programme was not developed enough to run the car at full speed in the early tests, and so more problems were emerging throughout the first races of the year. 'We started testing

"We never got deep into the setup. We did some aero testing but we have only a basic shape. We have not done a full aero map"

Tiago Monteiro's Castrol-sponsored Honda Civic WTCC during the fifth round of the World Touring Car Championship, held at the Salzburgring in Austria back in May

in winter, and we were not exploiting 100 per cent the car, so not all of the issues came out,' says Adamo. 'Now we are going faster, and that means that they come out, and we have to face that. We didn't have time to solve that before. I had to homologate parts that I was not 100 per cent sure would work, but I had to homologate them if I wanted to be at Marrakech.

'It was totally different [to 2013]. We had to understand how to design the front and rear suspension and match them with the aero. We had no previous data. The shape that we are obliged to use is a tricky one. We need to have a constant thickness, so the leading edge of the splitter has to be 10mm radius, no diffusers, and the only thing that I knew from my past experiences as an aero guy is that the ride height would be a nightmare. As long as you have too much ride height, or you have a problem with the radius, you can have a detachment to the floor. I tried to understand these things, then I had to match that to the suspension, so anti dive, anti lift and all of that, but we were guessing. Also, Yokohama had to have a rush to develop the tyres, so we had to have data by the end of November, and when you have the tyre data at the end of November it gets tricky.'

Not only did Citroën have more time to develop its car, but according to Honda it also had the advantage of working with a known shape in the C-Elysée. 'If you have a car that resembles the other one, like Citroën, you can work on brakes, cooling, when you do not, you have to put all the things together. Our car has the biggest greenhouse of everyone, so I have also to make the wing work properly, we have had to properly shape the front and find downforce elsewhere, particularly the floor without compromising the mechanical aspect of the car. We have to guess a bit to match the two things. Cooling was a bit of a guess. We have bigger restrictors, so we had to guess how much heat rejection we had, to play with the inlet, the radiators and drag. Now we know cooling is not on the list, so something was good.'

The engine is a development to that used last year, with a modified inlet, exhaust, electronics and the turbo, which has meant a crash course in turbo management. 'Our competitor comes from a huge experience with turbo engines,' says Adamo. 'We are new guys. We have to do things better, but give me the time to do it. The front and rear suspension is totally free as long as you are designing a MacPherson. We have designed it, homologated it, made a simulation, raced it, changed it a bit, made a K&C study and then we race it again next year. It is not like a timing operation. Things have to be done properly.'

For Mariani, the summer will be full of testing, in Japan for the engine and in Europe. The target is to be able to challenge Citroën by the second half of the year on outright pace. 'We have a base, so we know what we have now,' says the Italian. 'Then, we have engine side, electronic management, chassis and suspension, in other words, all the parts of the car! Now we have solved the reliability problems and we can look for pure performance.'

"I had to homologate parts that I was not 100 per cent sure would work, but I had to homologate them if I wanted to be at Marrakech"

TC3: an affordable Touring Car series for 2015

Following the recent announcement that the TC3 International Series will be taking to racetracks worldwide in 2015, the experienced Touring Car racing promoter Marcello Lotti will join the company for the opening season. Lotti was the promoter of the World Touring Car Championship between 2004-2013, but left at the end of last season with a view to starting a new series and forming the base of the touring car pyramid targeted by the FIA. The highly-respected Italian is clearly excited at the prospect of being involved in the first year of the new series and gave his view of how it will look.

Q: What is the idea behind the TC3?
ML: 'This new concept has come about as a direct result of the experiences faced by the different national Touring Car championships. There is a strong demand for competitive cars that can be purchased and run at reasonable costs.'

Q: What sort of cars are we talking about?
ML: 'There is one car that already meets all criteria I've mentioned: the single-make trophy SEAT León. It has already proved to be the perfect customer racing car, launching a number of young drivers to successful careers in national, regional and even world championships. A number of manufacturers have cars that are potentially eligible for TC3; to mention only a few others, there are Alfa Romeo Giulietta Quadrifoglio Verde, Ford Focus RS, Honda Civic Type-R, Mercedes CLA 45 AMG, Opel Astra OPC and the Volkswagen Golf GTi. All these models are, by their very nature, suitable to answer the need.'

Q. What are the aims of the series?
ML: 'TC3's biggest aim will be to reinforce the Touring Car category, recreating the basis of the 'Touring Car Pyramid' through a worldwide racing product. The Technical Regulations have been conceived to provide close, exciting racing and these Regulations will be further leveled by a Balance of Performance system. As a result, I think manufacturers and tuners will be able to reinforce and enlarge their customer racing communities and teams and drivers will be given the opportunity to grow and gain experience within Touring Car racing.'

Q: Can you go into detail about the 2015 TC3 International Series yet?
ML: 'The TC3 International Series will be awarding one Drivers' title and one Teams' title, whilst participation will be limited to eight teams, in order to achieve a maximum of twenty-four cars. Further details will be given in due course.'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The legend continues. . .

McLaren has introduced a dramatic upgrade kit for the already successful 12C GT3

By ANDREW COTTON

"This car will be cheaper to run than the 12C, which is already in line with the other cars"

Few could have predicted the extraordinary success of the McLaren 12C GT3 car, with 42 cars sold, three championships won, and almost 80 race wins around the world. The company has now moved the car on and in June this year, introduced the 650S GT3.

Built to contest the GT3 series, once the car is homologated it will be available as an all-new machine, but can also be built up from an existing 12C, using the same tub, dashboard, ECU, wiring and looms as the old car, but adapted to run with new, taller front tyres that are becoming standard across the board in the category. That required a new suspension, new bodywork and a new wheelbase. McLaren has targeted making the car easier to drive for the gentleman driver, easier to work on for the teams and mechanics, and managing director Andrew Kirkaldy says that the target is to significantly reduce the running costs compared to the 12C GT3.

Boost control

When the 12C first arrived on the scene, it was the only GT3 car with a turbo engine and, in a series that solely relies on balance of performance, that created

problems for the balance of performance team – and for rivals who feared its performance. However, after a bedding-in process, the car has run competitively, although there have been developments within the engine.

The 650S GT3 runs the same engine as the 12C, but already there are big changes, particularly to the turbo wastegate functionality.

'When the 12C started, it was running road-going boost control, running on a vacuum system that evolved into a hybrid of that to try to get better control, and then we went to a pneumatically controlled system with its own ECU,' says Kirkaldy. 'That was a push to open system, applying pressure to open the wastegate. We are now looking at a push to close system, because that gives us better characteristics in dumping boost, over shoots are what everyone gets excited about, and now we are looking at an electric wastegate system. We are only just putting it on the engine now.'

The 3.8 litre engine enjoys better cooling thanks to the changed aero, while the gearbox oil cooler has been relocated, now incorporated into the larger side intakes, giving the rear of the car a cleaner, more aerodynamic flow.

Cost control

While the cost of the upgrade has yet to be finalised, the proposed £150,000 tag has made some eyes water. One of the key changes that had to be made was the change to the larger front tyre, which was not possible in the 12C. The change was not as simple as first thought, with a new aero kit needed, new driveshafts, suspension system widening the track by 52mm, and crucially a need to change the weight balance forward to work the tyre better. Doing that within the confines of a current tub was not the work of a moment. The oil tank has moved in front of the engine, the doors are all carbon making them much lighter.

'It is a carbon tub, and you can't just cut it,' says Kirkaldy. 'You have to move the front wheels 20mm forward and out a bit, so therefore the car becomes wider, the wheelbase moves and so when that happens everything else moves forward, and that's a big engineering job.

'Then, the other thing that we have concentrated on is getting the cost of running it down. The cost of GT3 is running away, and it has gone mad. At the minute, to our estimations, this car will be cheaper to run than the 12C, which is already in line with the other cars. One way we have done that is to go to an LMP or single seater type upright system where you have a hub going through bearings. A lot of GT3 cars use a hybrid road going bearing system where the hub and the bearings are one unit, which is very expensive, especially when you run out of life on the bearings. You have to change the hub and the bearings. With this system, the hub should last, it is a Pankl part, but on lifing you only need to replace the bearings.

'We have switched transmission to Xtrac largely due to cost. The main reason is to get the mileage of the unit up - we want to do 8,000km between rebuilds - and we have done a lot of work on the engine to bring the mileage up between rebuilds. When you couple all that together, it makes a massive difference to the running cost of the car.

Wider body, longer wheelbase and bigger tyres make the 650S GT3 look ready to race. Engineering improvements give new levels of durability

'This kit is a conversion to a 650S GT3-homologated car which gives you another three years with the same car. You can buy a new GT3, a new McLaren or whatever, but you are going to spend £300-350,000, or you can spend less than half of that on the kit. [The 650S GT3 uses] the same chassis and the same engine, so therefore we can upgrade, which is a big deal. What makes that slightly difficult is that you need to be able to do that within the confines of what you have.'

As it is, the car has almost every panel new, as well as a new gearbox, uprights, bearings and wishbones, all designed to make the car easier to work on and better to drive. By contrast, in order to keep costs under control, the wiring harnesses, ECU, dash, steering wheel and tub is all the same as the 12C. The rear diffuser is the same concept, just trimmed, and the rear wing is the same profile, but wider. 'What has moved on dramatically is that the 12C was not the easiest car to work on, and none of the GT3 cars are because they are essentially road cars,' says Kirkaldy. 'At the moment, you can get the front bumper and splitter off in under a minute, and the same for the rear bumper and diffuser. You need only one tool to take off a wheel house. We have done things that the teams have brought up, and do what the teams would like. It makes a big difference, because they feel that they have had input to it.

'Aerodynamically it is an evolution. It looks different because it is wider and the aero has changed. On the 12C, we looked at the cost aspect; the rear bumper looks great, has louvres and so on, but it is expensive. With this one we have cut the bumper away, and it makes the rear bumper cheaper, and easier to work on.

'The car is a big step forward, but by big step forward I don't mean performance, I mean in driveability, ease of maintenance and cost of ownership. It is going in the right direction, and we are trying to drive the cost of this down, not up, and to be fair to the FIA, they are trying to keep the costs down, and if they don't we won't have customers. We have improved it, but for our customers and for the sport.'

Every body panel is new, but improvements include maintenance accessibilty as well as aero and cooling considerations. Cut away rear bumper replaces complex road car-derived design

Le Mans bound?

For years, McLaren has been looking to return to Le Mans, the scene of a famous win in 1995 with the F1 GTR. It was all set to contest GTE before convergence talks began, including spending more than a £1million on engine development for the category, but the talks caused enough uncertainty that the project was put on ice. With the launch of the 650S GT3, the rumours have again surfaced, but McLaren is keen to see a rule book before any decisions are made.

'This car is adaptable for GTE,' confirms Kirkaldy. 'We are left in a difficult place for GTE in that convergence fell apart. The first thing that we looked at [when designing the 650S GT3] was GT regulations today, GT regulations that are being proposed and convergence, and the car is close to all of them. If you owned one of these, it could be upgraded to GTE at some point in time.

'We want to do it, but we need clarification on engine rules. We have an engine that we designed for GTE, it is not secret, we dusted it off of late to have a look at, and it is there. There will be aspects of that which will work. I like some of the noises coming from the ACO and FIA that they are going to look at controlling turbo cars purely on boost. One of the things we had before was that the restrictor that they wanted to put us on gave us a lot of problems. All it does is pull on the turbo, and can cause problems. We have to have a restrictor, but as long as it is not breaking the turbo, that is not a problem. If they go in that direction will make it easier for us.'

One of the problems with the turbo engine is that it uses more fuel, and to compete in GTE Pro the McLaren would need to have waivers on the fuel allocation before it can compete. 'It's tough getting people to understand that a turbo car uses more fuel, so how do we get a fuel balance?' says Kirkaldy. 'We can't go to Le Mans and go two laps less. We want to be there, and have said that for years, we just want a set of rules.'

McLaren sold six 650S GT3s on the first day when it was launched, and expects to deliver 15 new cars by the start of the 2015 season. It also expects to sell 15 upgrade kits to existing customers in time for the start of the season, and more during the year. The McLaren GT legend looks to have a secure future.

TECH SPEC

McLaren 650S GT3

Cost: £330,000 ex works, plus tax

Chassis/Body: McLaren carbon fibre MonoCell with aluminium front and rear sub frames
Bespoke lightweight carbon fibre/composite body panels
Left hand drive
FIA approved safety roll cage
Air-jacking system
Colour – customer choice

Aerodynamics: Front splitter and dive planes
Rear wing – fully adjustable with gurney
Front and rear diffusers

Engine/Management: Race prepared 3.8-litre V8 twin turbo McLaren M838T
McLaren Electronics ECU incorporating turbo boost and transmission shift control

Transmission: Six-speed sequential motorsport transmission pneumatically actuated via steering wheel mounted paddles

Electrical System: Lightweight motorsport specification wiring and connectors
Electronic power management system
Membrane type switch panel
Auxiliary power supplies for fitment of team equipment (radio etc)

Data System: McLaren Electronics 'ATLAS' data system
Motorsport digital dash display

Front/Rear Suspension: Double wishbone adjustable for ride height, camber and toe
4-way adjustable dampers with coil over springs
Motorsport axles with single wheel retaining nut
Adjustable anti-roll bars
Forged aluminium wheels: Front 12.5in x 18in, Rear 13in x 18in

Steering: Electro-hydraulic power assisted steering
Unique McLaren GT composite steering wheel incorporating key driver switch controls and map settings

Fuel System: Motorsport 'bag tank' system with 125 litre capacity
Motorsport 'quick-fill' system

Brake System
Monoblock calipers with ventilated discs:
Front – 6 piston caliper, 380Ø x 35mm disc
Rear – 4 piston caliper, 355Ø x 32mm disc
Bosch motorsport ABS adjustable brake bias

Cockpit: McLaren GT bespoke composite seat shell
Six-point racing harness
Motorsport pedal box – adjustable position
Lightweight carbon fibre dash with integrated driver display and switch panel
Motorsport fire extinguisher system

Rebuilding the McLaren M8A

We chart the technical development of one of the most iconic Can-Am cars of all time and the tortuous history of its restoration

By **CHARLES CLARKE**

We all know that old race cars are reborn several times, but this McLaren M8 featured has been through several very interesting incarnations. To start the story we go back to 1967. This was the year of the McLaren M6A, the first of the orange elephants, as they were affectionately known and of course, the first year that Bruce McLaren and his team won the highly coveted Can-Am Championship.

After winning the Can-Am series in the all-conquering M6A, Bruce McLaren set about designing an even quicker car. Why? Because at the Riverside race, Jim Hall's Chaparral had proved to be competitive and McLaren knew he needed a better car for 1968.

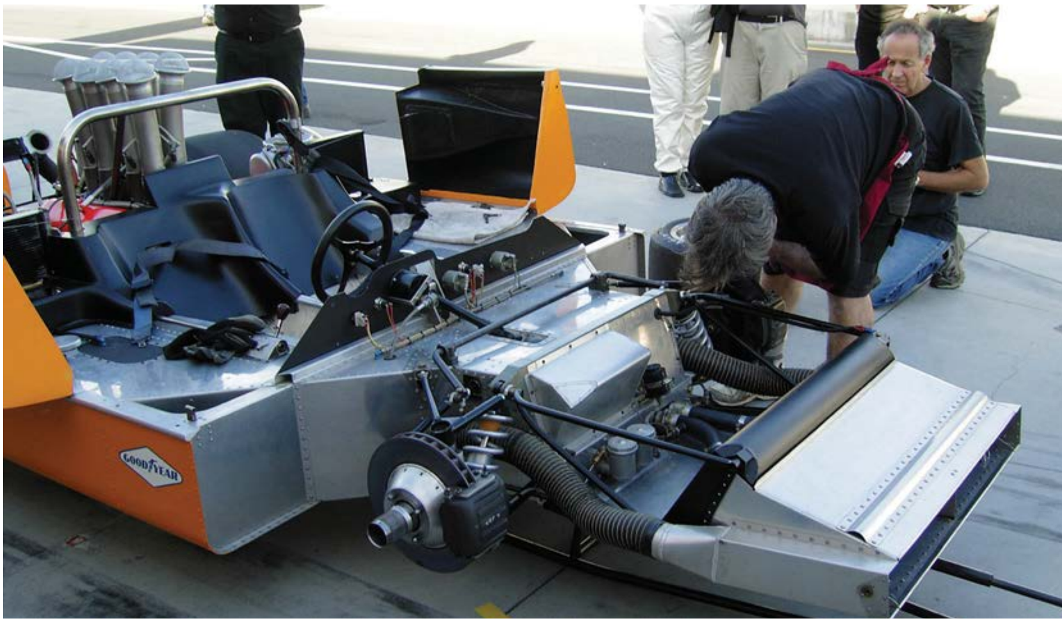
The monocoque chassis M6A was hugely successful in 1967. At the season's end, the McLaren factory took Denny Hulme's M6A, which had run a small block Chevrolet engine, and mounted a big block 427 cubic inch Chevy motor to create the first M8A, with the engine as a semi-stressed member. Power was increased from 516bhp to 640bhp with the new engine, although in McLaren's shop it increased further, to 650bhp, almost 100bhp more than the 1967 car! With wider tyres and better body aerodynamics, the new M8A was expected to lap about three per cent faster.

The M8A (the Formula 1 car was the M7A) weighed in at around 1440lb (645kg), which was 25lb (11kg) lighter than the '67 car. Suspension and general styling were similar to the previous car, although the body was wider and lower than the M6A. Because tyre profiles were lower than before, the wheel arches were less pronounced for better forward vision.

Slots above the front guards relieved the high-pressure area beneath and NACA-type triangular ducts fed air into side-mounted aluminium engine oil-coolers. A separate oil cooler for the gearbox was mounted in the swept-up lip of the tail as it was on the 1967 car. A larger air-intake slot in the nose fed a wide aluminium radiator, and careful interior sculpting inside the nose ensured that the air rushing through the radiator created down force on the front wheels.

The body was in four pieces: nose, tail section and two doors which carried the side-screens. The screen was moulded up around the driver, almost like a single-seater, making it impossible to carry a passenger. The regulation passenger seat was almost covered by a perspex 'tonneau cover'. McLaren wasn't sure whether this was legal, but reckoned he would try it out anyway.

The chassis was monocoque but, unlike the M7A Formula 1 car with its four fabricated steel bulkheads, the M8A had only two bulkheads. The broad monocoque was aluminium sheet on the inside and magnesium on the outside, with two rubber bag tanks carrying 30 gallons of fuel per side.



The Lockheed 11" ventilated discs were state of the art for the time

Sir Jack Brabham reunited with the McLaren M8A

The 7-litre Chevy V8, like the Ford Formula 1 engines of the time, was a stressed part of the car's chassis. The forward face of the engine bolted to a sheet of magnesium, and A-frames running back from the rear of the chassis (it stops abruptly behind the cockpit) bolted to the rear of the engine.

A fabricated sub-frame was mounted over the bell housing and carried the rear suspension, while long radius arms ran from the rear uprights to the back of the monocoque. Although the monocoque appeared to extend back past the cockpit, this extra 'shelf' on either side housed the oil tank for the dry-sump set-up and the various pumps and electrical paraphernalia needed to keep the engine sparking. The magneto was mounted vertically behind the inlet manifold and the metering unit poked back horizontally above the engine.

The high stacks of the McLaren-modified fuel injection looked like eight shot-blasted stainless steel lilies curving a full 12in (30cm) above the engine. The exhausts ran into a pair of big-bore stove-pipes that ran out on either side of the gearbox below the body.

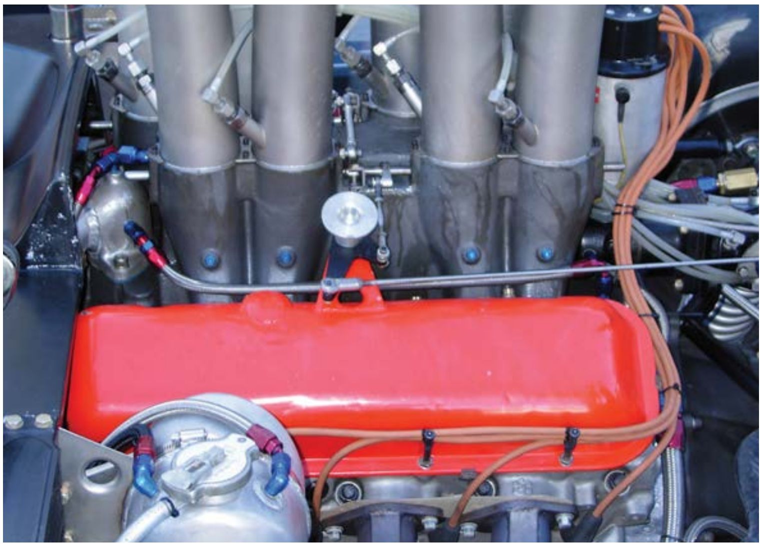
A Hewland LG500 gearbox with specially tailored internals for the McLaren completed the drivetrain. Instead of the normal five cogs, this new box had only four special gears (and reverse) with a relatively high first gear for Can-Am rolling starts.

The McLaren wheels got wider too and became knock-ons for ease of changing. As tested at Goodwood, the M8A had rear wheels 15in diameter and 15in across the rim and they planned to take a set of 16in rims with them to races as well. Front rims were 9in x 15in.

The stopping department was catered for with a set of the biggest disc brakes and callipers seen at that time. Made by Lockheed (who also made brakes for McLaren's Formula 1 cars) the big ventilated discs measured 11½'in (29cm) across on the rears, and 11'in (28cm) on the fronts. The discs were 1 1/16in (27mm) thick.

M8A-2, Denny Hulme's car, was constructed at the McLaren factory in England in early 1968

Tall stacks on the mechanical fuel injection. Magneto ignition



Aluminium 427 Chevrolet replaced by a durable iron block for restoration

by the team, which included New Zealander's Colin Beanland, Cary Taylor, George Begg and Chris Charles. The two M8As were only just ready in time for the opening round of the 1968 Can-Am series in North America. The 1968 Can-Am proved a very successful year for McLaren, with M8A-2 winning the series with Denny Hulme driving and Bruce McLaren coming in second.

For 1969 the M8 was developed further with a high wing, cut-away front fenders and a 430 cubic inch, nearly 700bhp, screamer of a big block engine. Hulme's M8A-2 was upgraded and modified to the 'B' specification to become the team's spare car.

At Riverside, McLaren crashed the M8B, when a rear wishbone broke and damaged his car badly. He took over the spare car for the final round in Texas and secured the 1969 title in M8A-2, hitting 210mph on the banked circuit. During the 1969 Can-Am season the spare car was also driven by Jack Brabham, Chris Amon and Dan Gurney.

approached for advice and suggested they talk to Motschenbacher about his crashed chassis.

Motschenbacher had accumulated various McLarens, including Denny Hulme's M8D-1 and it was agreed that he would 'put together' an M8D show car, based on the old damaged M8A-2 tub and so the next part of the story begins. The damaged tub and bulkheads were 'dollied up,' a 'grenaded block' formed the basis of the dummy engine and an empty Hewland gearbox was attached at the rear. With a fine set of induction stacks, a collection of all sorts of genuine McLaren parts, new wheels and tyres and a genuine M8D body from Hulme's car, the M8A-2 rolled out in all her newfound glory and became the Goodyear Show Car. However, show cars also pass their 'use by date' and, after it had finished its promotional tours, Goodyear's publicity team gave the car back to Hulme.

In conjunction with Hulme, Goodyear and MOTAT (the Museum of Transport and Technology in Auckland, New Zealand), it was

Of prime importance was the fact that the original works McLaren tag was still riveted in place

When the team offered M8A–2 for sale, it was very quickly purchased by Lothar Motschenbacher. Motschenbacher's first race of the season was at Mosport on June 14th 1970, where he came in second to Dan Gurney in the works McLaren M8D.

At Elkhart Lake in Wisconsin, Motschenbacher went off through the trees, and effectively wrote off the M8B. Investigations showed that a left rear wheel spindle had snapped and the two year old, badly damaged M8A/B was parked at the back of the workshop.

With McLaren dominating the Can-Am Series Goodyear, as one of the major sponsors, decided in the early 1970s that they needed a show car for advertising purposes. Denny Hulme was

agreed that the M8A-2 should come to the home of its driver and builder and arrangements were made. In March 1978, the M8A-2 was officially presented to MOTAT by the Goodyear Tyre & Rubber Co. The McLaren created a lot of interest and formed the basis of many special displays. In time and in line with MOTAT policy it was decided that some work should be done on the M8 to improve its presentation.

In 1979 the restorer of the car saw an advert from the Northern Sports Car Club, looking for exhibits in a large car show. He telephoned the Club and they collected the car for the show. They spent some time cleaning up the car and after the show decided to store it indoors at the clubrooms for better preservation.

In 1995, with the formation of the Bruce McLaren Trust, Jan McLaren (Bruce's younger sister) decided to try and resolve the car's ownership dispute with the help of other Trustees and, after 18 months negotiation, all parties agreed to relinquish their ownership claims in favour of the Bruce McLaren Trust.

When the M8A was gifted to the Trust it was in a major state of disrepair. Its reconstruction as a Goodyear show car included many severely damaged and incorrect parts. Added to this, it had also been fitted with an incorrect fibreglass body and a 'dummy' engine and gearbox made up from a collection of old and damaged parts.

During its early time in New Zealand it unfortunately suffered deterioration by being left outside. While under the control of the Northern Sports Car Club it was kept in a secure dry room, but as no work was done on it, due to the ownership dispute, further natural deterioration also occurred.

Very little of the original car was salvageable or could be used in the reconstruction, but all parts were invaluable for patterns and for visual display in their deteriorated condition. Of prime importance was the fact that the original works McLaren tag was still riveted in place.

The tub section, which forms an integral part of the construction of the chassis, was thought to be reusable but, on further examination, deterioration of the inner strengthening bulkheads meant that the tub was unsafe and a decision was taken to totally reconstruct it.

Work begins

The aluminium tub has been painstakingly dismantled by hand grinding out over 1000 steel centred aircraft quality rivets and the many original pieces were used as patterns in conjunction with original line drawings to reconstruct the new tub section.

While the Trust had inherited M8A-2 as a 'complete' looking car with bodywork, the actual old bodywork on the car was from an M8D – a very different model that had seen two years of

Restoration of the monocoque tub was required due to the deterioration of the inner strengthening bulkheads. Each of the 1000 rivets used in the construction were sourced from the UK to maintain authenticity

development, alteration, widening, wings, etc, and in no way could any of this bodywork be used for an M8A restoration project.

So it was back to the drawing board and hours and hours of research and a challenge that had plagued the restorers from the very beginning – where would they find any parts of the original body to at least give them a starting point? The buck for the body was finally finished after nearly five months of painstaking work and it was composed of about 18 different sections.

'We had a 1968 chassis with 1970s bodywork, made out to look like a 1971,' says Duncan Fox, chief restorer and owner of Group 7 Sports cars who did most of the work. 'I studied all the existing bodywork so that I could basically reverse-engineer a modified piece of 1970 customer bodywork back to an M8A. From moulds of the old Trojan customer cars that Group 7 have bought and own in England, I started with an M8C front and an M8E rear and we made a panel out of each of them and then started modification.'

The front upper section of the buck was M8C, the next section piece was from an M8D and then the other section was from the M8F. 'It is just a matter of identifying the componentry and using it with unmolested pieces of various bodies and putting them all together,' says Fox. 'Finding pieces of the body work became a saga in itself. It would have been unexpected that we would find any M8A panels in America because both the A cars went back to England. If we were ever going to find A bodywork it should have been in England and not in America.'

However, after two trips, Fox located a piece of M8A bodywork that had been sold in the San Francisco Bay area. 'It was a case of finding old timers who ran a car that looked like a McLaren,' says Fox. 'I came to a dead end, only to find one piece of body work but not recognising it.' On his second visit, Fox found the piece of bodywork sold in 1973. The McLaren team had figured Motschenbacher might be able to sell it in California, rather than taking it back to the UK.

The rear wings on an M8A were unlike anything used on any other car, either a works or a customer car. 'It was one of the things where we knew what it looked like from the pictures but we didn't know how to make them,' says Fox. 'It turned out that the wings were one of the first pieces of bodywork that we actually acquired.'

"I basically reverse-engineered a modified piece of 1970 customer bodywork back to an M8A"

Fox managed to track down the fire blackened and burnt wings after they had been rescued from a dumpster following a fire at the Motschenbacher workshop.

'These two pieces of wings and sides were quite charred in some places but if you study them hard enough you can almost see the plywood - and that's how they were made, on a plywood buck,' says Fox. 'By a bit of 'carcheology' I decided that these particular two pieces of wing probably came off another body panel. We know it didn't come off the body panel we had as the holes didn't match. However, we do believe that they came from Bruce's car rather than Denny's because they were in two pieces, as carried from the UK as hand luggage on the plane.'

The bodywork alphabet soup gets a bit complicated. The M8C front, the upper portion was the same as the M8A but the radiator duct opening was different because the C body went on an M6 chassis and not an M8, so that portion had to be altered as the M8A radiator was narrower. 'The C dashboard has a large hump in it, so we had to get rid of that and this all took hours of studying pictures, reading books and just looking at the body and absorbing it all,' says Fox. 'I knew that an M8E front was made from an M8B, so it was a natural progression, but because it was an understeering car, they quickly modified it before they sold the customer cars. One bit of information I got was that the front of the dash was always going to be constant, whether on a B, A or E. So I knew that by cutting the front off the dash, I had the front of the dash for our M8A.

'The front alone tells a huge story. We made moulds of the B body, then made the A fenders by basically cutting, fiddling around, and adding pieces on. You have to ask, 'why did they do that?' And then reverse engineer it.' Group 7 used a set of original McLaren factory drawings to ensure the restoration project was completed to produce a safe and authentic McLaren M8A. Engineers and mechanics who worked for McLaren Racing are now resident in New Zealand and volunteered their services and knowledge to assist with the rebuilding.

Extensive research has ensured that the project maintains all surviving evidence of the car's provenance, its pictorial history, procurement of original plans, detailing the availability of components, body moulds and attention to detail. For example, the aluminium for the monocoque was specified to precisely match the original material and sourced from the USA, original rivets were sourced from the UK and new steel bulkheads have been built. Once the monocoque was reconstructed, a number of mechanical components were replaced. These included replacement of the magnesium suspension uprights, wheel rims, etc. Replacement was unavoidable because the magnesium alloy has a finite working life and then becomes prone to stress failure. Moulds were produced using the original pieces and these components have been remanufactured.

The engine and gearbox required complete replacement, as the 'dummy' gearbox and engine in the display car was not in working order. A number of vital small missing components were also manufactured from original factory drawings. As for the engine choice, the Trust had the option of installing an aluminium or cast iron 427cubic inch Chevrolet engine of approximately 600 bhp. For the time being, the cast iron option has been chosen in the interests of reliability.

The Bruce McLaren Trust now hopes the restored car will join the ranks of surviving McLarens and will be a monument to that famous name.

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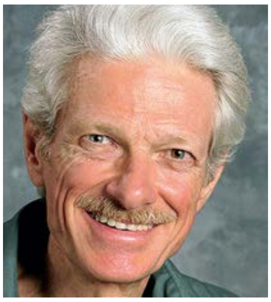


Pin lead or trail in steering geometry

Agility or stability? How to find the perfect compromise

Question

What's the thinking behind the Porsche 919 at Le Mans? The front wheel bearing is ahead of the ball joints. Indy cars have been doing this for years. Chapman did it on Jim Clark's Lotus 35 Indy car. This doesn't make sense to me.

The consultant says

I call that pin lead: the spindle pin is ahead of the steering axis in side view. It is also quite possible to have pin trail: spindle pin behind steering axis.

When the amount of pin lead or trail is small, it may be difficult to see whether it's present. Therefore, more cars may have some pin lead or trail than is commonly supposed. When dealing with production cars, in most cases we don't even think to try to measure it. It only gets attention when we are designing, making, or modifying uprights or spindles, or possibly if we are checking them for damage.

However, some common devices that we're all familiar with have obvious pin lead or trail. Bicycles and motorcycles almost always have the steering axis behind the axle: pin lead. Swivelling casters on shopping carts and furniture have really dramatic pin trail.

Ball joint application

We most often see pin lead in independent front suspension with conventional ball joints or sphericals used as conventional ball joints, but it is also possible to design a spindle for a beam axle that has a little pin lead or trail. We need to make sure we still have adequate steering movement. The same applies to an independent design that uses a kingpin as in a beam axle. MacPherson struts can easily have pin lead or trail. With a dual ball joint design (meaning two uppers and/or two lowers), we can adjust the effective pin lead or trail without any need to change the spindles or uprights, although some change in wheelbase may occur. Different uprights may still be required to obtain desired wheelbase when changing pin lead.

So there is no law of nature that says the steering axis has to intersect the wheel axis. We can lead or trail the wheel axis with almost any kind of suspension. The question is: what are the effects of doing that, and when might we want to use pin lead or trail, or avoid it?

The main reason for using pin lead is to get a lot of caster without a lot of trail at the ground plane. Caster is the side-view inclination of the steering axis. Caster makes the front wheels lean into the turns when we steer. Depending on how much scrub radius (or front-view steering offset) we have, it also de-wedges the car when we steer: it jacks the inside front corner up and the outside front corner down, adding load to the inside front and outside rear and reducing load on the other two wheels. That makes the front wheels more equally loaded when cornering, and the rears less so, which reduces understeer.

This effect is particularly useful on street circuits and slow, tight road courses. It's generally good for autocross. It is less desirable on a high-speed oval, where we can use asymmetrical static camber and are more concerned with making the car steady and stable and less concerned with making it turn in quickly.

Unless otherwise indicated, trail is the side-view distance from the point where the steering axis meets the ground plane, back to the contact patch centre. This is approximately the moment arm on which lateral forces at the contact patch act about the steering axis. That determines how forcefully the steering tries to centre itself when cornering, and also how much force the driver has to exert to keep the car running straight on a laterally sloped surface. If trail is insufficient, the steering will feel numb. If trail is excessive, the steering will wear the driver out, especially with unassisted steering. Driver preferences with regard to these effects can vary quite dramatically.

Porsche's suspension assembly for the 919 Hybrid Le Mans car, including the brake shroud and peripherals

If trail is insufficient, the steering will feel numb. If it's excessive, the steering will wear the driver out, especially with unassisted steering

For a given tyre diameter and pin lead, caster and trail are inextricably related. More caster implies more trail. If we want the benefits of added caster, without making unassisted steering intolerably heavy, the only way to get what we're after is to use pin lead.

Pin lead issues

Are there downsides to pin lead? There can be. Not all forces acting on the upright can be considered to act at the ground plane. Some can be considered to act at the pin. Any time there is thrust but no torque on the upright, we have a force that can be considered to act at the pin. A rearward force acting this way will create a de-centring force in the steering if there is pin lead. This can lead to instability, and in some cases oscillation, in the steering.

One common source of that kind of force is the drag the tyre makes just by rolling down the road, as opposed to the induced drag it makes when running at a slip angle and generating lateral force with respect to itself, which is partly rearward with respect to the car's direction of travel. The drag that comes purely from the tyre's own internal resistance to rolling straight ahead does not produce a torque at the front spindle. It only produces a rearward thrust at the pin.

Another source of thrust at the pin without torque on the upright is braking or drive force exerted through a jointed shaft: propulsion force for a driven front wheel, or retardation force for a front wheel with an inboard brake. Propulsion force with pin lead can be expected to produce an increasing self-centring force with power application. Retardation force from an inboard brake can be expected to produce steering instability if combined with pin lead.

Therefore, pin lead with driven front wheels and outboard brakes is not necessarily awful, but pin lead with inboard front brakes is probably a combination to be avoided.

Pin trail makes sense for cars that need to run straight, particularly if they have very small front wheels. A dragster with small front wheels would be an example.

FRIC suspension ban

Is the latest FIA ruling really in the interest of the sport?

Question

Your recent article on hydraulic interconnection of suspension systems was certainly timely. I see that the FIA is now going to impose a mid-season ban on interconnection of front and rear suspensions in Formula 1. What do you think of that?

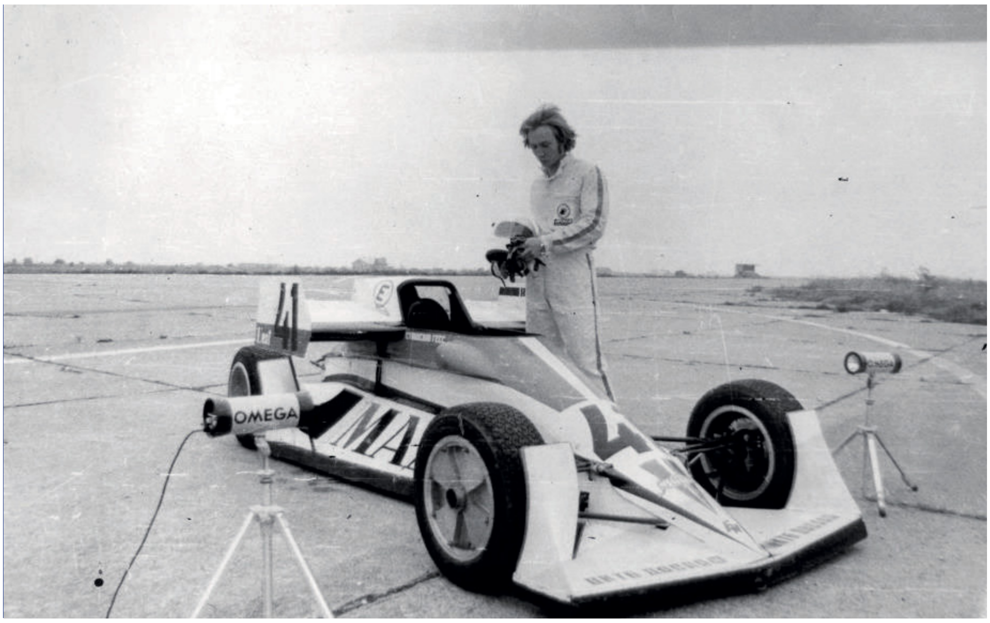
The consultant says

From what I've been able to read, this is supposed to be a cost reduction measure. Detractors say it's the result of lobbying by smaller teams that are hoping to suppress innovations mainly used by the bigger teams. My take is that in a series with mandatory turbochargers and complex energy recovery systems, the suggestion that a mid-season ban on passive suspensions involving front/rear interconnection is needed for cost reduction rings pretty hollow.

With or without front/rear interconnection, suspension systems can be made complex and expensive. Is front/rear interconnection of any kind intrinsically expensive? I don't think so. How expensive, for example, is a Citroen 2CV? That has interconnected front and rear suspension. How expensive is a Hydrolastic Mini or Austin 1100?

For future seasons, I would suggest considering limitations on number and type of suspension components, rather than a ban on front/rear interconnection of any kind, if it is decided that such measures are really needed for cost containment – which, as I've said, is in itself a bit of a reach when applied to passive suspension of any kind at the F1 level.

If the objective is to equalize competition, and perhaps justify racing as a means to 'improve the breed,' how about requiring the teams to tell the public what they're doing with interconnected suspension? That would be refreshing, and certainly more informative than the confused blather I've been reading on the subject from my fellow journalists.



The MADI-Moskvitch had cable-linked suspension which interacted with resilient elements to control body roll

CONTACT

Mark Ortiz Automotive is a chassis consultancy service primarily serving oval track and road racers. Here Mark answers your chassis setup and handling queries. If you have a question for him, get in touch.

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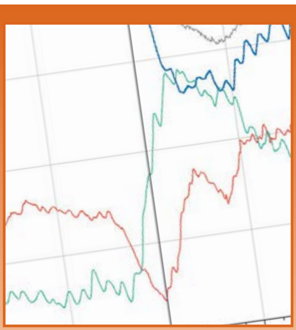


Databytes gives you essential insights to help you to improve your data analysis skills each month, as Cosworth's electronics engineers share tips and tweaks learned from years of experience with data systems

Is it time for active suspension again?

Complex and expensive? Or the simplest answer to rules confusion?

Suspension systems are the talk of the town at the moment with interlinked front and rear suspension components being the latest tool used to gain an advantage. This technology has been seen in top level racing in Formula 1 and WEC lately and a debate has risen as to whether it is legitimate or not.

At the moment the suspension systems in question revolve around a mechanically linked front and rear components which helps to control the movements between the sprung and unsprung weights of the car. The grey area here is whether this system falls under the rule of a moving or active aerodynamic device, a question seemingly few would actually like an answer to at the moment, but this remains to be seen. This reluctance to take it to the courts is understandable as, if any form of ride height control is deemed illegal based on the active aero component rule, then we might be in trouble. Conversely, if ride height control is deemed legal could we then go back to the future and bring in truly active suspension?

Most people will remember the days when the most advanced Formula 1 car ever sat in its garage and appeared to 'breathe' as the active suspension was put through its travel for calibration (or just to show off!) If active ride height control was brought back in and with FRICS being criticised for high costs, it is possible that we could see this again. Electronically controlled suspension has been around for many years now and is used in many luxury and high performance road cars so the components are well known and the theory well understood. It all starts with the classic quarter car suspension model, but with a small component added.

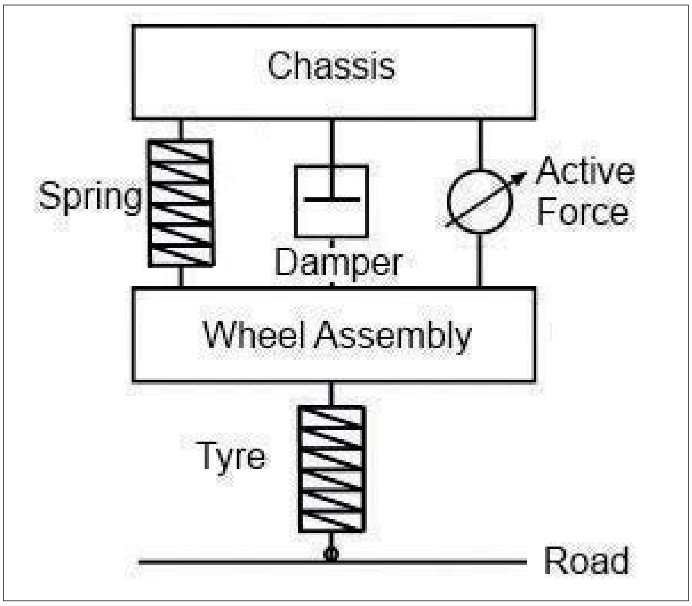
History lesson

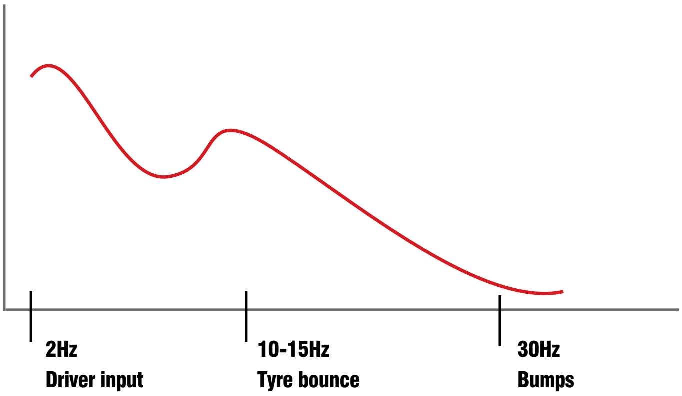
Active shocks were pioneered by Penske in the early 1990s for use in Indycar, and have become very popular in NASCAR in recent years. They allow teams to go through a wide range of ride heights and setups without having to pit for changes. Such systems are common place on rigs and are often used in track tests. Only two firms are known to offer systems off the shelf, Penske and JRi. Both also have F1 specification dampers available. The tight restrictions on Formula 1 testing saw at least one team resort to using a banned technology to accelerate development. In 2011, Force India used a form of active suspension to try out alternate setups during its straight line aero tests. However there was no suggestion that the teams was breaking the rules, as these do not cover testing.

In terms of data values, the force component Fs represents a method for controlling the movement between the wheel and the chassis. In the FRICS system this component is purely mechanical, but in an active suspension this component could be electronically controlled. There could be a cost saving argument here as it could be possible to use simpler mechanical components in an electronically controlled system and

Nigel Mansell was dominant in 1992 in the active suspension Williams FW14B. The techology is now commonplace, but remains banned in Formula 1

WILLIAMS F1





Above: High frequency control loops can respond to more complex track inputs
Left: Hydraulic or electromagnetic actuators work with springs and dampers

in most cases, the cars' current control systems could be used to handle the processing.

In the era of active suspensions in Formula 1 there were two approaches, a semi-active system that controlled ride height based on speed, and a fully active system that controlled ride height using laser ride height sensors and distance. The former option is probably not far from what is possible with today's mechanically linked systems and when Tyrrell tested the semi-active system, it was said to have been worth half a second around Silverstone. These systems were controlled either by the cars' logging system or other control system on the car and the output was used to control motors that pushed hydraulic fluid that in turn applied a force to control the suspension. The main difference between those two methods is the reaction time. The semi-active solution works in the 1-2Hz frequency range which is the same range as any driver input, so it is unlikely to upset the car or cause any unwanted disturbance. The fully active system is capable of a much faster response and as such can deal with larger bumps, dive and heave. This faster response then allows the suspension to be used to control not just the ride height but also the rake of the car which can be used to give aerodynamic assistance under braking. The bump control here is also very interesting as the current Formula 1 tyre is very much an active spring. If the proposed 18in wheel proposal goes through, then having active suspension could make that transition much easier.

The active suspension system's main advantage comes from aerodynamics, taking variable ride height out of the equation allows the aerodynamics map to be much more precise and allows the aero designers to really focus on details. This is why there is so much focus on suspension systems at the moment as it is an area where large gains can be made, even if it is at a huge financial expense.

Looking beyond just replacing the mechanically linked front and rear suspension system, the fully active suspension can be controlled based on any chosen value available in the cars control system. One value of interest is distance. This is where the active suspension really could come into its own, where the ride height is not only maintained but also adjusted according to the cars' position on the track for optimum settings in any condition. This is how the best active suspension systems worked in the past, but in those days they only had wheel speeds to calculate the distance travelled, which could pose problems if there were any hiccups during a lap. A missed beacon trigger or a spin had to be accounted for in the distance map. In today's world of high accuracy GPS this would no longer be a problem, and with differential GPS it is possible to pinpoint the location of the car with centimetre accuracy.

If active suspension is allowed, a new arms race would begin in components that respond faster

As the main benefits of constant ride height are in stabilising aerodynamics, it is understandable that the governing bodies of motorsport are looking closely into the way the suspension systems are used today and it is possible to argue the point that any suspension system that is able adjust the ride height during running is an active aero device. The fully active race car also makes aerodynamic testing much easier as, if taken to a full scale wind tunnel with a rolling road, the car could be made to run multiple ride height scenarios without ever having to turn the fans off. Similarly, during straight line testing, it is beneficial to maintain constant ride height and also being able to adjust the ride height very fast.

Control systems

If active suspension is allowed, a new arms race would begin in the realms of components that respond faster and hoards of simulation engineers running every scenario possible in order to get closer and closer to control the movement of the tyre over every single wrinkle in the tarmac.

In order to achieve ride height control it is necessary to measure ride height for each corner and suspension movement. For each corner, additional values of interest could be, accelerations, pushrod load, tyre pressure along with speed and distance. In traditional systems the output drives a hydraulic servo that applies a force to control the suspension. If active suspension was allowed back into motorsport the hydraulic part would probably be replaced by more efficient and faster working electromagnetic motors, which could also be used to recover energy from the suspension system.

The control loop could even be made to account for braking, steering or even wind speed and direction given the right inputs. This however would probably be very borderline, if not over the limit, when considering the active aerodynamic implication. Another interesting point to develop would be the way the suspension reacts to apex kerbs. Using a fast acting electromagnetic system it could be possible to control the way the wheel bounces off kerbs.

Instead of setting teams on a ruinous programme of technological research and testing, active suspension could be used to save costs, as the moving parts might prove to be less expensive than current favourite designs – assuming, of course, that hardware limitations put in place. However, if active suspension is allowed we know that teams and manufacturers will always find ways to spend money in order to make the car go faster.

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How low can you go?

We round off our most recent study of Group CN cars with an in-depth analysis of rear wing height and location

Our latest MIRA wind tunnel session featured a pair of CN cars that could not have been more different, courtesy of Mike Newton at Tiga Racecars, Dave Beecroft at Orex Competition and aerodynamics consultant James Kmieciak. 'Tiga CN12A', based on an earlier Chiron design, in blue, red and white (see **Picture1**), and 'Tiga CN12B', an update and evolution of a WFR design, in orange (see **Picture 2**), differ strikingly in the location of their rear wings, Tiga A's being very low. Dimensionally the cars are also very different, Tiga A being 220mm narrower and 115mm shorter. Last month we studied Tiga B in detail; this month we'll focus on some very interesting rear end changes to Tiga A.

Fencing

Let's recap first on the aerodynamic coefficients on Tiga A in baseline configuration, and after a change of nose section from a mildly convex to a mildly concave one (see **Table 1**).

So, as it arrived in the wind tunnel, Tiga A showed between 20.4 per cent and 21.6 per cent of its total downforce on the front axle, some way short of the middle to high 30s per cent that would provide an aerodynamic balance in steady state cornering, given the static weight distribution of 40 per cent front, 60 per cent rear. The change of nose section made a slight improvement to balance, as **Table 1** shows, although interestingly dive planes did not (see July issue for full details).

The next configuration change involved the fitment of fences at the rear that connected the outside face of the rear wheel pods to the wing end plates (see **Picture 3**). The results, compared to those with the concave nose above, are in **Table 2**.

The fences made a significant difference then, with 101 counts more total downforce for just 22 counts of drag, an incremental efficiency gain of 4.59:1. The gains were probably down to the extra depth the fences gave to the wing end plates, but as the fences also extended below the wheel pods there may also have been gains from the diffuser region as well. However, the gain was at the rear and as such the balance shifted 2.6 per cent off the front end.

Wing height

There are a number of other sports racers around the world competing with low mounted rear wings, and your writer has heard claims of 'high –L/D ratios' for this configuration. So the chance to take a glimpse at a car with just such a low rear wing was exciting indeed.

The two cars we had available for this session were different in more than just wing location though, so it is perhaps not entirely fair to compare their data, but inevitably we did (see **Table 3**, with coefficients multiplied by frontal area to enable comparison). And in similar '%front' balance states it was clear that Tiga A with the low wing generated less total downforce and had a lower –L/D figure. But Tiga A had 15 per cent less plan area with which to develop downforce, so it was probably too much to expect it to match Tiga B.

To achieve the 35.2 per cent front figure in **Table 3**, the wing on Tiga A was lowered by 100mm to the position in which it actually raced in 2013, from the higher position in which the car was baseline tested at the start of our session. The direct comparison between the high and low position is shown in **Table 4**.

Clearly this adjustment had a big effect, with a 21 per cent reduction in downforce and 8.8 per cent less drag but, because of the large decrease in rear downforce, it also produced the best aerodynamic balance the car showed during the session. Orex Competition team principal Dave Beecroft stated that the car was 'balanced, just slow' on track with this configuration. To be fair, suspension issues restricted meaningful aerodynamic development mileage during 2013. But our

Picture 1: Tiga A, compact dimensions and low wing location

Picture 2: Tiga B, with conventional wing location

Table 1: baseline and first modification coefficients on Tiga A

Nose	CD	-CL	-CLfront	-CLrear	%front	-L/D
Convex	0.719	1.427	0.291	1.135	20.4%	1.985
Concave	0.720	1.433	0.310	1.123	21.6%	1.990

Table 2: the effect of fitting rear end fences, changes are in 'counts', where 1 count = a coefficient change of 0.001

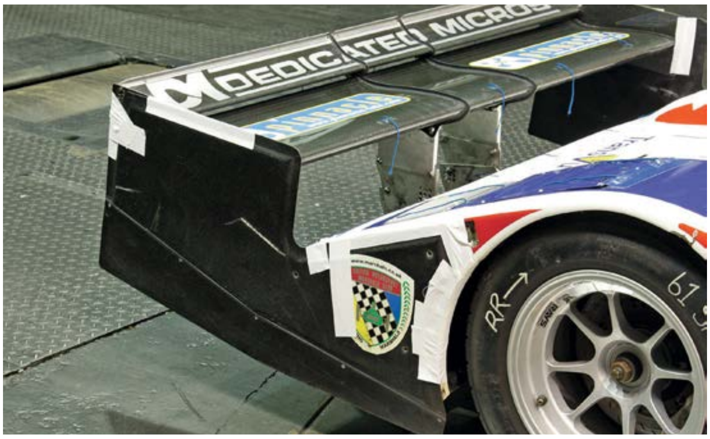
	CD	-CL	-CLfront	-CLrear	%front	-L/D
Without	0.720	1.433	0.310	1.123	21.6%	1.990
With	0.742	1.534	0.291	1.242	19.0	2.067
Change	+22	+101	-19	+119	-2.6%	+77

Table 4: the effect of lowering the rear wing by 100mm on Tiga A

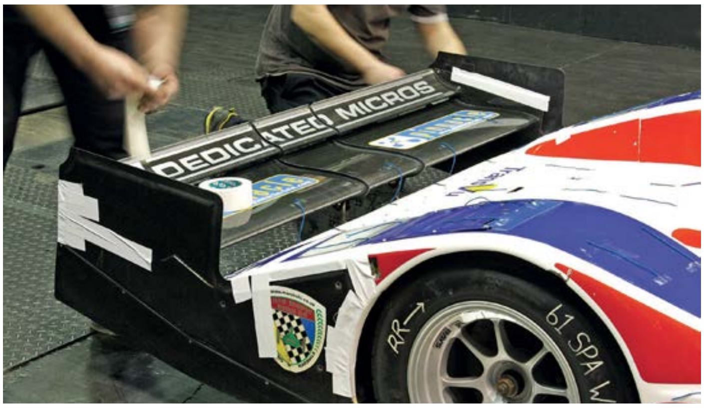
	CD	-CL	-CLfront	-CLrear	%front	-L/D
High	0.742	1.534	0.291	1.242	19.0	2.067
Low	0.677	1.210	0.426	0.784	35.2	1.787
Change	-65	-324	+135	-458	+16.2	-280

Table 3: comparing Tiga A and Tiga B in similar balance states

Car	Balance	CD.A	-CL.A	-CLfront.A	-CLrear.A	-L/D
Tiga A	21.6%front	0.785	1.562	0.338	1.224	1.990
Tiga B	21.5%front	0.740	1.833	0.394	1.437	2.477
Tiga A	35.2%front	0.738	1.319	0.464	0.855	1.787
Tiga B	34.0%front	0.789	2.079	0.706	1.372	2.635



Picture 3: Connecting the wing end plates to the wheel pods with these fences produced fairly significant data shifts



Picture 4: Lowering the wing to its normal position made a substantial difference to downforce and balance

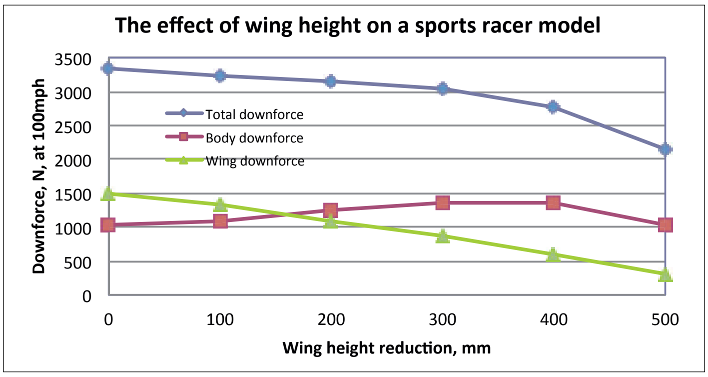


Figure 1: CFD-derived forces on a hillclimb sports libre model versus reduction in wing height

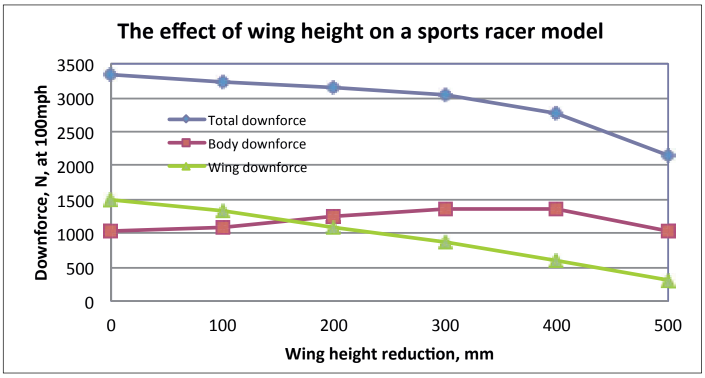


Figure 2: CFD-derived '%front' value on a hillclimb sports libre model versus wing height reduction

data showed that, although balanced with the wing at this low position, the car was short of downforce relative to Tiga B and, by extension, other similar cars.

The low wing position (see **Picture 4**) located the leading edge slightly above the body's trailing edge, but the vertical gap between the bodywork and the wing was quite small. Although the car's tail section was gently tapered down towards the rear to ease the airflow towards the wing's leading edge, there was no escaping the numbers. Rear downforce dropped by some 36.9 per cent, suggesting the wing was not getting an adequate feed to its suction (lower) surface.

Does this mean a low wing location doesn't work? In short, no. For example, we saw in our August 2011 issue (RCE V21N8) that vertical and fore/aft movements of the wing on the ADR3 sports racer yielded best results when the wing was lowered and moved forward from its stock location, and it was clear from the data that body downforce had increased in the 'best' wing position, although time again prevented more options being explored.

In the absence of a more complete 'map' of wing height from the wind tunnel, a brief CFD exercise was carried out using ANSYS on a hillclimb sports libre model (see **Picture 5**) to gain a little more insight, and the plots in **Figures 1** and **2** show the changes that occurred as the wing was lowered in 100mm increments from the maximum permitted 900mm. A 400mm reduction in wing height was roughly analogous to the lower position on Tiga A. This plot is obviously not definitive but does suggest that, with a better optimised body, peak downforce could indeed be generated with a low wing height. Fore and aft location will, no doubt, also be a crucial parameter. But we will have to await another opportunity in the wind tunnel to explore this more fully.

NEXT MONTH we'll start another new and exciting project.

Racecar Engineering's thanks to Mike Newton at Tiga Racecars, Dave Beecroft and crew at Orex Competition and James Kmieciak at Percam Engineering.

Picture 5: Sports libre model with analogous wing location to Tiga A's standard wing

CONTACT

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In these pages he uses data from MIRA to discuss common aerodynamic issues faced by racecar engineers

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Dutch success in UK

The TU Delft entry's all-round performance clinches victory in another tightly competitive Formula Student shoot-out

By GEMMA HATTON

The TU Delft electric entry was dominant in the tight and twisty Sprint event and held on to their points advantage to win overall, despite a slow Endurance race

Last year saw the first electric car to win the UK Formula Student event at Silverstone and the trend continued this year as TU Delft claimed the overall top spot with their electric, all wheel drive, centreless wheel concept.

Surprisingly, although Silverstone's microclimate varied from a blistering hot 23degC on the Saturday, to a chillier 16degC during some parts of Sunday with the continual threat of rain, the Acceleration, Sprint and Endurance events were barely affected by the weather.

Saturday saw the top five design finalists fighting for position as judges scrutinised the design, manufacture and engineering of every area of the cars. Oxford Brookes finished top, followed by Stuttgart, Zurich, Delft and Karlsruhe – a good indication of the teams to watch out for throughout the weekend.

The dynamic events start with acceleration, and unsurprisingly the electric cars dominated, with the top six run-off becoming a battle between the electrics. ETH Zurich took the top time of 3.441 seconds for the 75m standing start – two tenths quicker than last year's effort.

The next major dynamic event is the Sprint, which comprises of an 800m long tight track and pushes the cars manoeuvrability and handling to the limits. Delft secured top with an excellent time of 48.748 seconds, nearly 6.5 seconds ahead of second place Karlsruhe and that turned out to be a turning point in the competition. Third was Monash with its front and rear DRS proving effective. To avoid the unpredictable Silverstone weather playing havoc with the results, the top five teams from the Sprint event all started the Endurance event at the same time, resulting in a grand prix style finale to the competition.

Team Bath Racing opened the event, but problems emerged towards the end of their race when a fault led to the loss of the front brakes. Meanwhile their UK rival, Oxford Brookes, had their own worries to deal with; a slow Zwickau car, three engine restart attempts at the driver changeover and then a connector breaking from the pneumatic valve block resulting in the driver being unable to shift down through the gears. Oxford Brookes finished 20 seconds ahead of Team Bath Racing. Last year's champions, ETH Zurich had three motors dropping out due to electrical drivetrain problems in the first stint, and although their pace improved, they began to lap slowly and held up triple champions Stuttgart, who lost 13 seconds in one lap. The Germans, who were competing against Oxford Brookes for first, then found themselves stuck behind another electric car from NTNU on their final lap and had to hope that none of the teams from Munich, Chalmers, Monash, Delft and Karlsruhe could beat them.

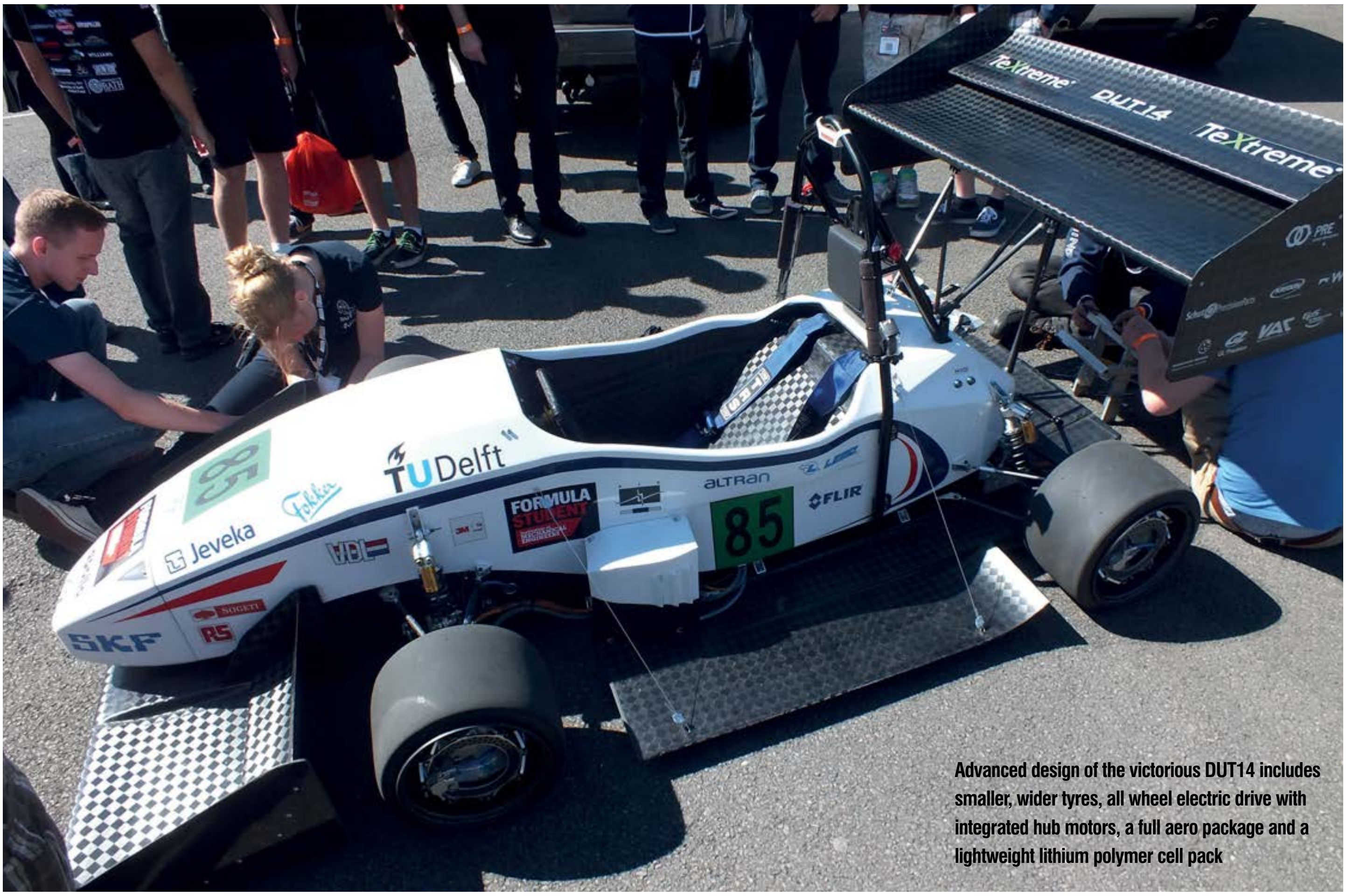
The first of the top five to face problems was Chalmers, which had brake issues after only two laps. Next to suffer was the Munich team which, after six laps, had a jubilee clip failure resulting in the silencer hanging off. Delft's strategy was to race to a specific lap time. However, each stint is essentially a sprint, and the Dutch team's pace was slow. Monash was the first to cross the line and topped the times, while Karlsruhe had gearshift problems but managed to take third place. The Delft car completed the race in a disappointing eighth place. Crucially however, they remained ahead of their main rivals ETH Zurich by 1.7 seconds and therefore the point difference between them was minimal.

The final results were announced at the closing Awards Ceremony, and TU Delft's successful sprint time over their rivals helped them to become the 2014 Formula Student UK Champions with a total of 855.5 points. In second place, 18.7 points behind, was three-time champion Stuttgart and third was Karlsruhe's combustion car. Last year's winners ETH Zurich came in fourth due to several electrical problems disrupting their weekend and fifth was Oxford Brookes, snatching the top UK title by 1.2 points from Team Bath Racing who finished sixth.

Dominating Delft

Six-time victors TU Delft brought a car packed with new ideas, clever design and effective engineering to take the win

By GEMMA HATTON



Advanced design of the victorious DUT14 includes smaller, wider tyres, all wheel electric drive with integrated hub motors, a full aero package and a lightweight lithium polymer cell pack

The TU Delft Formula Student team has enjoyed a rich history of success since it was founded back in 2000 by two students. With six overall competition wins under their belt since, the 2014 Silverstone event saw the TU Delft team and the DUT14 car add another overall first place trophy to their cabinet. Renowned for being one step ahead of the game, with their 2012 car being the first to feature four wheel drive, traction control and torque vectoring at the UK competition, this year's car did not disappoint.

The most astonishing innovation in the pitlane was undoubtedly TU Delft's effectively centreless wheels which played a big part in getting them to the design finals of the competition. A trend that we began to see last year was teams not only downsizing their wheels from 13in to 10in, but also making the tyres wider for increased grip. This was the first step of TU Delft's 2014 car; self-designing the tyres in collaboration with Apollo to be smaller and wider. The next issue to overcome was the transmission; the team wanted to continue using the same motors as last year but because the tyre size was smaller, this meant that a smaller gear ratio was required and prompted the move to a one-stage planetary transmission, which resulted in a 50 per cent weight saving compared to last year. 'We thought to ourselves; wheels have spokes – why do they need spokes? We can just put the gears in the middle of the tyre and connect the ring gear directly to the wheel,' explains chief engineer Marinus van der Meijs. 'We then had the transmission inside the wheel, so why not the motors and the brake discs too? I think it's like a lady's handbag – you can fit more inside then you think.' All of this weighed in at just 10kg, which is 2kg lighter per wheel than the 2013 car, the DUT13.

'Our brake design is really special because we have our hubs so big due to the large ring gear, that the brake disc would not fit on the inside of the hub, so we had to fit it on the outside. As the disc is so large, we could have many holes which allow us to brake harder and also as it is on the outside, the air can flow around it so we have better brake cooling,' explains Tim Houter, Delft's chief of vehicle dynamics. The brake discs are made of an aluminium matrix composite developed for the aerospace industry.

Of course, the wider tyres came with new challenges, such as fitting the pullrod suspension to the uprights and resulted in over 55 design iterations to determine the location of the arms which optimised the design without the parts colliding.

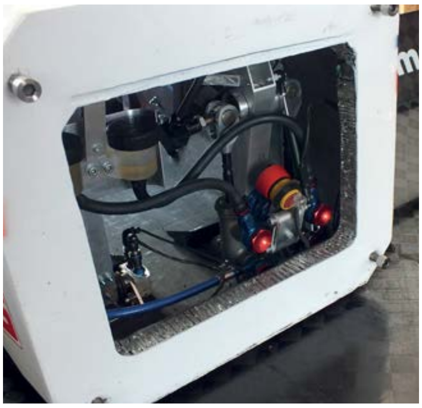
'Unfortunately, we couldn't fit the driver in the wheels too, so we had to make a chassis,' jokes Meijs. 'We were at lunch and decided that

Suspension arm design took 55 iterations before optimisation with the smaller tyre package was achieved

we needed a material similar to a sandwich; two strong materials on the outside which are not so good in bending such as carbon fibre and then a lightweight 'filling' such as aluminium honeycomb.' The result of this was a chassis that weighs as much as a crate of beer and is 3kg lighter than the DUT13's foam core design.

Last year, the TU Delft team had developed their first attempt at an aerodynamics package, but the design and manufacturing challenges of making successful wings meant that they decided to run without it. This year however, the team started the design process much earlier, allowing prototypes to be made and tested before being included in the cars final design as well as improving the assembly and production procedures. This resulted in the successful implementation of front and rear wings as well as a diffuser. To address the issue of the front wing blocking undisturbed air to the diffuser and the cooling, the nose height was increased, creating a slot for smooth air to flow through. For electric cars in particular, reducing drag is vital because the higher the drag, the more energy required to accelerate and therefore larger and heavier accumulators are needed – the exact opposite to Delft's 'lightweight' motto. Thus the rear wing was one of the smallest in the paddock, featuring two elements but still produced just enough downforce (75kg at 60km/h) to ensure the aerodynamic forces act in the centre of the car.

'The whole electronic system has been completely redesigned, there is nothing taken from last year's car. We now also design our own battery management system (BMS) which gives us much more opportunity to really integrate all the systems together,' points out Marinus Geuze, chief of electronics. The idea behind this redesign was to be as simplistic and as lightweight as possible, so components that needed to communicate closely were placed together, reducing wiring and thus interference. Using this philosophy in the BMS meant that



Carbon fibre and aluminium honeycomb sandwich results in a light but rigid chassis structure

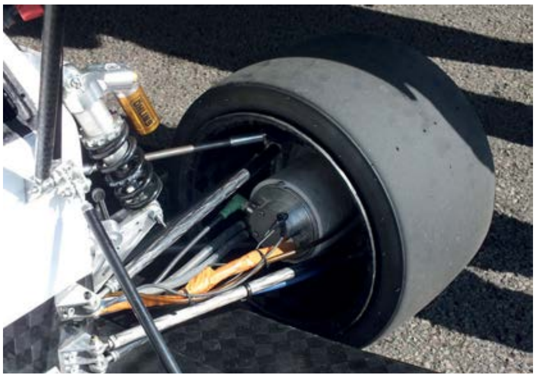
the number of wires per battery package was reduced from 40 to two. Another example is found in the sensor node design. Unlike previous cars that had a unique design for each part, a shared a common sensor node was developed that could be used anywhere on the car; increasing data reliability.

Battery efficiency

The energy of the car is stored in an accumulator made of lithium polymer cells and (you guessed it) is extremely lightweight. 'If we made our accumulator out of batteries found in a normal car it would weigh around 200kg, whereas ours only weighs 40kg because of these lithium polymer cells,' highlights Meijs. 'It is also extremely efficient, with a 6.4kWh output. Usually my iPhone lasts for a day without recharging, but if I could somehow connect it to this accumulator, my iPhone would be powered for three years without needing to recharge. Despite this, we cannot power our car throughout the endurance on an accumulator

Aero design focuses on balancing drag and downforce. Last year's car ran wingless after aero development time ran out

Radical rethink of wheel and hub design looks inside-out but is light and functional. Exposed brake disc gets maximum cooling



Regenerative braking combines with lightweight lithium polymer batteries to provide efficient energy management

alone which is why we have regenerative braking. When we brake, energy is put back into the accumulator and this generates around 30 per cent of our total power.'

After spending time analysing the car, it was clear that every aspect of the car was not only innovative and well designed, but manufactured effectively and properly finished. It is no wonder then, that the entire paddock was talking about their car and it will be interesting to see how the winners of the UK event will do against a whole host of German rivals in the next round of Formula Student at Hockenheim.

"We had the transmission inside the wheel, so why not the motors and the brake discs too?"

Keeping it simple

Resisting the temptation to rewrite the textbooks, OBR topped the British teams with shrewd engineering and clear planning

By GEMMA HATTON

Oxford Brookes Racing (OBR) have been one of the top UK Formula Student teams for many years, along with Bath and Hertfordshire. This year, the team came to Silverstone armed with a reliable single cylinder car which won the design final and snatched the UK top spot by 1.2 points from Bath, finishing sixth overall.

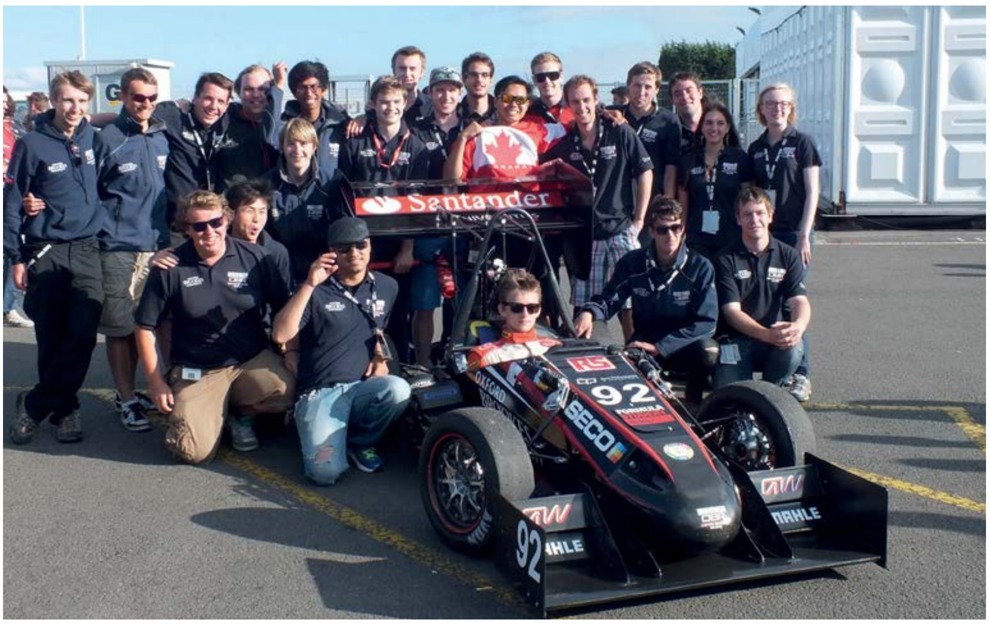
Cost effective folded aluminium monocoque was combined with carbon fibre elements for a significant weight reduction

'Last year our team struggled in the competition, so I learned a lot of lessons and sometimes it's good to have a big learning experience because it makes it very clear the areas you need to focus on,' reflects George Simmons, team leader of OBR 2014. 'The first thing I did when I became team leader was go through a list of all the competitions and work out exactly what we needed to do. Last year we threw away 1000 points over the competitions through failing endurances, yet we did much better in the static events. That told me that we had a good concept but just struggled with the execution, which is why we stuck with a very similar concept this year, without trying to overstep the mark anywhere. We decided to build a good car, which we could execute well in the time that we had and focus on the delivery, rather than trying to take two steps forward and ending up going one step back.'

Chassis

OBR have been famous for their folded aluminium chassis since 2011 but this year's new development was the use of carbon fibre to reduce weight. 'We did a complete mass analysis of last year's car and our monocoque weighed 38kg – other teams could probably fit two monocoque's in that, so we improved the use of materials,' says Simmons. 'We don't have the money or the expertise to do a carbon fibre tub so we tried to get that similar weight with a different concept.' This was achieved by maintaining the aluminium skins on the outside of the chassis but switching to carbon fibre on the inside, and flat parts of the sandwich panels. By laying up the skin material themselves, the team have been able to vary the number of plies, rather than a standard thickness with the aluminium. 'It gave us complete control and saved us 8kg,' says Simmons. 'By using the folded concept we can still get the low density of carbon fibre into the monocoque without having all the expensive tooling costs. We're maybe 3-4kg heavier than the efficient carbon fibre monocoque of our competitors, but we have spent thousands of pounds less.'

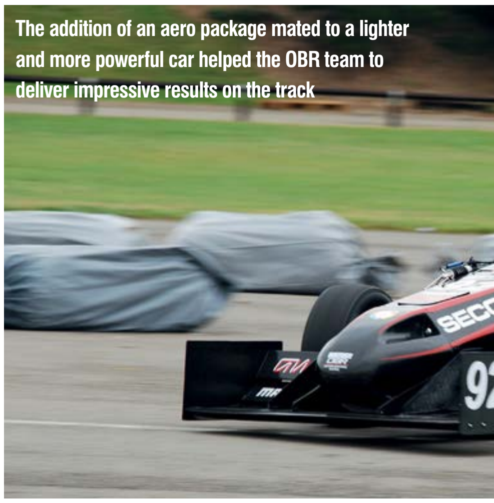
As always, the implementation of new methods, materials and designs often lead to unexpected problems. Simmons reveals: 'when we bonded the aluminium and carbon fibre chassis together, we used a hot press, and the coefficient of thermal expansion of the two materials meant that we actually ended up with a banana shaped chassis for a while which set us back about a month.' Overall, the manufacture of the monocoque was completed in under two months and due to OBR's efficient use of materials to achieve a cost effective solution, they received an award from event sponsor GKN.



Along with the new lightweight monocoque, organisation and planning allowed the team to deliver the project on schedule. As a result, they reaped the benefits of track testing time to finish the event as top British entrant

Suspension

The suspension system saw the introduction of carbon wishbones which the team ensured



The addition of an aero package mated to a lighter and more powerful car helped the OBR team to deliver impressive results on the track went under rigorous fatigue and tensile testing of the bonding techniques and insert designs. The team managed more than 50,000 maximum load cycles on the fatigue test with the bolt breaking before the actual wishbone or insert. Furthermore, the bearing sizes have been reduced in more than 50 per cent of the suspension components; decreasing weight and improving dynamic performance further.

Maintaining their 'keep it simple' approach OBR decided to stick with the one cylinder 510cc KTM 530 EXC motorbike engine, but raise the cylinder size to 570cc for a better performance boost, which helped them achieve tenth in the Sprint event and first UK team. The car also featured an aerodynamics package for the first time, composed of a front and rear wing.

It is clear that OBR's success was all down to preparation. 'What really helped us in the design competition was gaining data throughout all of our testing and ensuring that we were recording everything,' says Simmons. 'For the first time in a long time we did a chassis torsional stiffness test for example.' As well as individual component testing, the car itself had run 250km before competition, five times more than OBR had ever managed before. 'Overall this year, we have managed to keep a steady rate of progress. Generally you find that in the weeks before competition, you have to stay and work all nighters, whereas we actually completed the whole year without a single one. We focused on having really good progress tracking methods to ensure that we got the car finished one month before competition. I'm surprised with how well the team is doing if I'm honest. We are now running with competitive times in the sprint event, even against some of the electric cars.'

"Last year we had a good concept but just struggled with the execution"

The 570cc KTM single-cylinder bike engine was familiar technology, but the carbon wishbones are all new

What spaceframe?

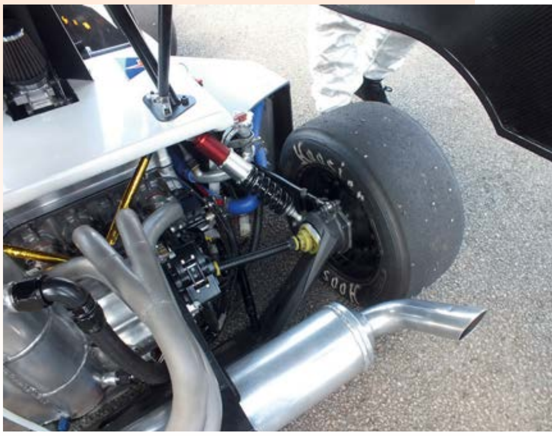
The Australian team from Edith Cowan University (ECU) arrived with a 4 cylinder, 10in wheel concept, including aero. But what really got the teams and judges talking was their innovative rear suspension and their custom built engine.

'The rear suspension is a De Dion axle with Satchell links and has many benefits,' explains Phil Le, the team's technical director. 'We have been able to remove the rear spaceframe as all of our suspension loads are fed straight back into the carbon chassis, so we have lost around 10kg when compared to previous years. Using the Satchell link as a form of triangulation over the Watts link or Panhard bar means that we do not need an extra suspension point on the engine or chassis.'

The engine is based on the Honda CBR600RR, and has been in progress since 2010 with the manufacture commencing last year. 'The block is a machined billet casing that weighs under 13kg,' says Le. 'We have used a standard Honda CBR head. Internally, the rotating parts are all from the CBR but we have reduced the gears from six to two, and made our own final drive to suit the FSAE tracks. The final drive is now running off a spur gear and is mated to a spool that is located within the gearbox side of the block.' One of the main advantages of this design was being able to flip the head around so the exhaust can exit out of the back, while the intake is towards the front. 'We have been able to drop our crank centreline by some 120mm compared to the standard Honda CBR, which decreases the CoG height.' Overall, the rear could be tightly packaged resulting in a low yaw moment of inertia. However, as the engine was originally designed to run with 13in wheels, ECU have had to run extreme driveshaft angles. This will be changed in future designs by lowering the gearbox height, as well as making it narrower.

The team is also famed for its 'cut and fold' technique used in the manufacture of their chassis since 2010. 'Our chassis is made from two sections, front and body with a bonded front roll hoop between the two sections,' says Le. 'The construction technique begins with flat aluminium honeycomb and carbon skin panels which are then cut by CNC machines. The cut line dimensions are determined by what angle we choose to have the bend at. Once the panels have been routed we begin construction of the chassis and each bend and joint is reinforced with a microfiber and wet lay-up carbon. All hard points feature a bonded aluminium insert to take any loads and others feature a threaded insert for parts that need to be retained.' The resulting weight of the chassis is 20kg with a bonded front roll hoop and the entire process took an impressive two weeks.

Such an ambitious design led to many problems, but the end result was an innovative car that is exactly what the Formula Student judges wish to see. In addition, their custom built engine completed all of the dynamic events, proving the reliability of the concept.



Machined billet block holds Honda CBR internals. De Dion axle with Satchell links removes need for rear subframe

Advancing aero

Despite comparatively low speeds, Formula Student cars now display some sophisticated aerodynamic thinking

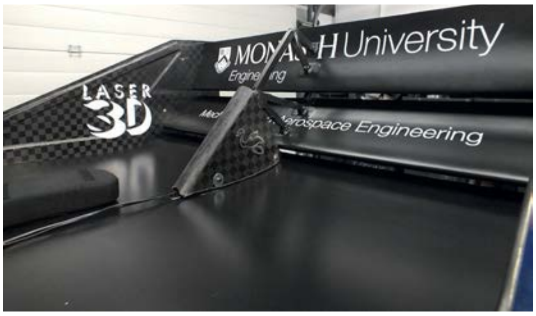
By GEMMA HATTON

'Like them or not, they are faster' says Oxford Brookes' team leader, George Simmons summing up the general consensus around the pitlane regarding the multitude of wings and aero systems. This year saw new debates surrounding Drag Reduction Systems and wing size. With 85 per cent of the top 20 and around half of the grid now featuring aero, more and more teams are switching to such designs, even if they don't have quite the right amount of time or resources to do so. The governing bodies are stepping in to regulate the use of aero to reduce costs, close up the competition and to ensure that teams actually understand the concept of aerodynamics to optimise performance.

Rear wings and DRS

Last year's event at Silverstone saw the introduction of a Formula 1-style Drag Reduction System (DRS) for the first time on both the combustion and electric cars of Karlsruhe Racing, which caused quite a stir. Previously, other teams had manually adjustable wings, where the middle element of the rear wing would be pivoted downwards, reducing drag for specific events such as acceleration. A few more of the top teams featured DRS this year, with Monash university utilising the most advanced system which included both front and rear DRS. The team from Melbourne are renowned for their aerodynamics, first featuring wings in 2002, and their aero philosophy has helped them to win the Australian competition for the last five years and become one of the world's best Formula Student teams.

'Large wings are part of Monash motorsport, but we started hitting the point where making it larger was really limiting us due to drag,' explains team leader Ed Hamer. 'Therefore, we incorporated a DRS system to allow us to be more aggressive with our aerodynamics whilst maintaining a low drag number, so this design gives us the best of both worlds; a large amount of downforce without so much of a drag penalty.' Monash's aero package is a three element front and rear wing, and down the straights with DRS activated, the top flaps on the front wing and the middle and top flaps on the rear wing all open to reduce drag. 'We looked at having an adjustable system with cornering, but the time delay in needing max downforce isn't really there so it's not worth going partial,' Hamer continues. 'If you suddenly lose downforce at the rear going into a corner, you want to ensure that you are removing a similar amount of downforce from the front to guarantee balance during cornering. For instance, we can do a lane change with the DRS open because we are still producing the same amount of downforce that we were in 2010, even with the DRS activated.'



Monash University's entry featured DRS front and rear. The middle and top flaps on the rear wing open for straight line speed

Sweden's Chalmers University used full scale wind tunnel tests to create their innovative design

Overall second place finishers Rennteam Uni Stuttgart went with a comparatively simple yet effective aero package

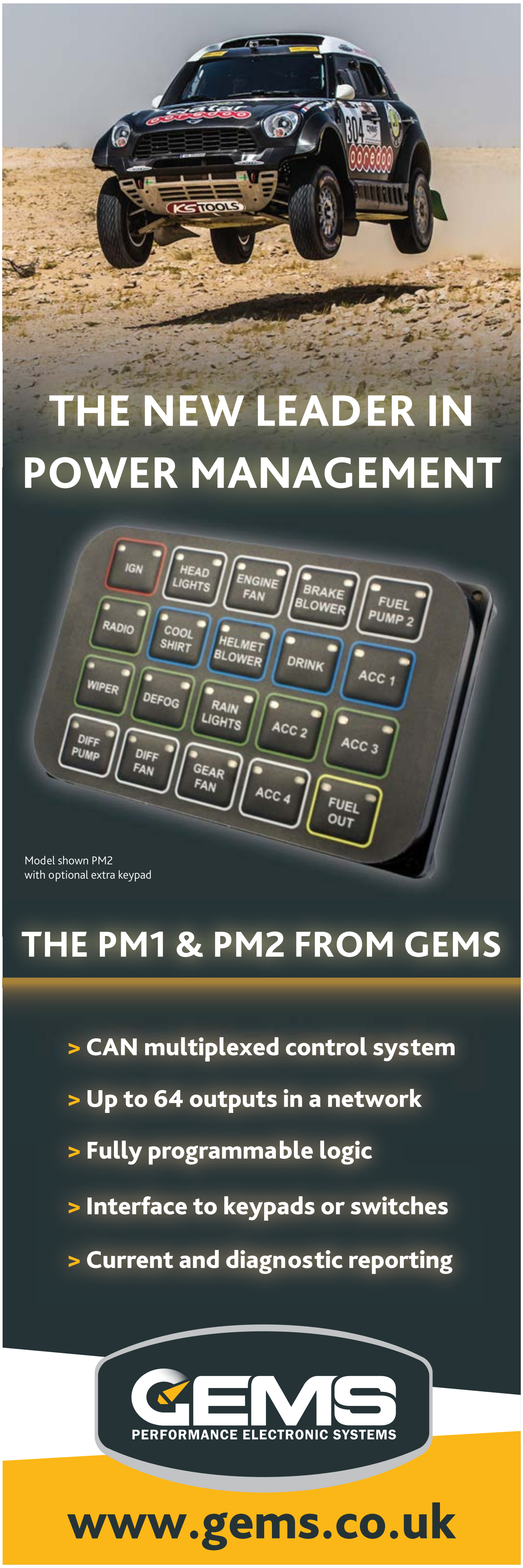
Other teams are not so certain about the benefits of DRS, such as this year's UK competition winners, TU Delft. 'At the start of the year we looked at DRS, and it is a system we would like to implement,' explains Marinus Geuze, chief of electronics. 'The problem we saw with DRS is that it takes too long for the air to re-attach to the wing again. In Formula Student there are such short straights and many corners so the DRS would have to be on and off quickly, so the time when the air is actually attached is too low to really gain anything.'

However, these conclusions were largely based on CFD simulations so it may be that only the true effects of DRS can be demonstrated in a full scale wind tunnel, something that Monash have regular access to. The real question is just how effective is DRS on Formula Student applications? It will be interesting to discover the answer at next year's event and see how many teams are running such a system.

Front wings

Arguably the most impressive aerodynamic device was Team Bath Racing's front wing, and was a talking point amongst most of the other teams. 'We are quite proud of our intricate front wing, which only weighs 3.5kg – the same weight as last year but double the size,' highlights Dave Turton, Project Manager.

The wing is essentially an exercise in vortex management as Francisco Parga, head of Aerodynamics explains, 'The wing design seeks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The University of Bath's entry featured an impressive front wing that uses vortex management to improve efficiency. Structure weighs only 3.5kg, but drag would be punitive at higher speeds

to take use of the vortices shed by the footplate to improve overall performance of the wing. The vortex in the footplate channel is 'captured', allowing the vortex to grow and 'power up' which helps to seal the low pressure area on the underside of the wing from the higher pressure around the wing. This can also be achieved with big endplates that extend close to the track, but this creates problems during pitch under braking which could result in the wing hitting the ground, and a potential disqualification. As the vortex increases in strength, it grows and therefore the channel needs to grow with it, so initial iterations expanded this channel by a simple curved endplate design. During development, we noticed the flow would detach itself on the outboard side of the channel, which is clearly detrimental. Therefore to keep the flow attached, the endplate had to be 'flapped'. It then made structural sense for the wing flaps to blend into the endplate and the turning vane on the top essentially prevents air spilling over and off the wing.' The overall curved shape was down to CFD simulation results and the rear wing was designed to balance the front wing. 'Unlike most race cars, a Formula Student car is front limited. Usually drag is a major issue, and the rear wing is the largest drag producing aero surface on the car and the front wing generates little drag in comparison. Therefore, generally a rear wing is designed to be as efficient as possible and then the front wing is used to balance the rear. With the low speeds in Formula Student, we don't really care about drag, so I designed the front wing to be as big as possible, while keeping the driver happy, and then designed a more conventional rear wing to suit.'

Negative impact

The Swedish 2012 FSUK winners, Chalmers, managed to complete full scale wind tunnel testing for the first time and the result was an innovative aero package. 'Last year the aero was over-adjustable; the rear wing was mounted using several struts, whereas now we have two carbon fibre plates with a fixed pivot point, which we used CFD to determine the effective height,' says Raman Yazdani, aerodynamics engineer on the Chalmers team. 'The plates also shield the clean flow from the highly turbulent flow caused by the headrest which we validated in the wind tunnel. A big change in the front is that we have integrated the nosecone design with the midpart of the wing. Usually you would have a negative angle of attack to get downforce. However, we have a positive angle because we raised the nosecone to allow more air to feed the diffuser and provide cooling for the sidepods. During wind tunnel testing we learned that when you have high angles of attack at the front (which we need to balance the car) it has a negative impact on the yaw inertia. This is because the faster the car goes, the more upwash we get which starts to effect the rear and so we actually lose some grip in at the rear when we go fast.'

Another notable design feature was Monash's wings, which are unsprung. 'This means that the downforce they produce goes directly to the tyre, or through the uprights at least,' says Hamer. 'The front is probably 60 per cent unsprung and the rear is fully unsprung. This allows us to have softer suspension, rather than having the design determined by the aero loads. And it also allows stability in our wing during cornering as it doesn't pitch with the chassis. A lot of teams don't quite get the wing mounting right, but if done in the right way it is safe to do unsprung.'

Like any form of motorsport, the boundaries are constantly being pushed by the teams to discover that performance advantage over their competitors. With DRS now front and rear, underfloors and diffusers, it looks like the 2015 regulation changes will be a major factor in future aerodynamic designs.

"With the low speeds in Formula Student, we don't really care about drag"

Spaceframe vs Monocoque

Several teams switched to a full carbon fibre monocoque design, while others stuck with an aluminium rear spaceframe - and the debate over whcih is better continues.

Team Bath Racing (TBR) was one of the teams that invested in manufacturing a carbon composite chassis to increase its competitiveness alongside the top European teams in competition. The main advantage of such a design is the significant reduction in weight, with TBR's chassis shedding 8kg compared to last year. Of course, such an advantage doesn't come without compromise as TBR project manager Dave Turton explains: 'It is a very long lead-time component. We started making the patterns for the chassis back in August last year and have been flat out with SES testing. Working out all the details of the different laminates, the rotation of the fibres and using completely new materials was a really steep learning curve. Whatever you think will take one month takes about three.' Luckily for Bath, they have their own autoclave within the University, which allowed samples to be quickly turned around and enabled them to make the entire chassis in house. 'The technical challenge came in two parts; firstly you have to do your design using materials you have never used before but you also have to source the materials in parallel with your design. It's a bit of a chicken and egg scenario, because your design depends on your available resources, but the resources you want are determined by your design.' Another limiting factor of a carbon composite monocoque is the sheer expense – around £60,000 worth of resources went into TBR's chassis and probably explains why many teams, including Monash, run a spaceframe. 'The big difference between us and the higher level European teams is we still run a steel spaceframe,' says team leader Ed Hamer. 'Although it is a hybrid spaceframe as we do use composite panels, our philosophy is 'points per dollar' so for the amount of points in the competition for the amount we spend, a spaceframe is a much better solution.'

Huge challenge

A dark horse in the competition was the team from the Norwegian University of Science and Technology (NTNU) which not only switched to a carbon monocoque for this year, but featured an electric powertrain, a self-developed accumulator package and carbon rims for the first time. This is a huge challenge for any team regardless of budget or manpower. However the Swedes made it look easy, finishing eighth overall and fifth in the Acceleration and Endurance events. 'The main challenge with a monocoque is having everything ready very early and once made you cannot change anything,' says chief engineer Henrik Meland. 'Switching to electric, we had a lot of new components which was difficult to integrate into the car, so we used a computer assistant design which created a 3D assembly to ensure that everything fits. We are really happy with our monocoque. It weighs about 18.5kg which is a very good weight for our first year.'

Overall, a carbon composite monocoque clearly does have a performance gain which is why it is seen in championships such as Formula 1. However, the expense, time and resources required mean that only the top teams can afford to do it. So, will regulations try to force teams to more cost effective solutions? Or would that just distance Formula Student from the real world motorsports industry?


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What's ahead for 2015?

In Formula Student, as in all motorsport, rule makers have to balance fair competition against restricting innovation

By GEMMA HATTON

Since electric cars were introduced into Class 1 in 2012, it is fair to say that rapid development has made them a dominant force in the competition. With the last two years seeing electric champions (ETH Zurich in 2013 and TU Delft in 2014) and the top six acceleration 'shoot-out' consistently made up of electric cars, it is time for change and, as ever in motorsport, that change is decided by the regulations.

'We are talking about a 5kW decrease for all electric cars, but that is still to be confirmed,' explains Andrew Deakin, Vice Chancellor of Formula Student and Chairman of the International Rules Committee. 'At the moment we believe that, three years ago when the rules were written, there was parity between the best petrol cars and the best electric cars. However, electric car efficiency has improved. Bringing it down 5kW would make the average power between the two much closer.'

Another innovation that electric cars have been developing is four wheel drive. TU Delft, arguably the most successful Formula Student Team ever, have been running such a system since 2012. Not only does this mean extra grip, but it also allows the team to implement regenerative braking systems, boosting their overall efficiency. 'It is very easy for a four wheel drive car to get lots more grip, resulting in approximately 20-30 per cent more acceleration achieved at low speed when their car is grip limited. If you do the calculations, it's around 40mph where the car no longer becomes grip limited so up to that speed they have a massive advantage on acceleration,' explains Deakin. 'The problem with that is these systems are expensive, complicated and not all teams can compete fairly, so if we can peg the four wheel drives back a little bit, they will still have all the advantages but the overall performance should reduce a little.' In fact, maximum power is very rarely reached on the endurance track and in only a few places in the sprint event do cars ever use more than 50 or 60kW, so the big hit will be in acceleration, but this will result in a fairer battle between combustion and electric.

Aero reductions

With nearly 50 per cent of the grid now running an aerodynamics package, including the top 18 cars, there is little dispute that the way to go is aero. 'We opened up the regulations about five years ago to allow much bigger aerodynamic wings, but they are probably getting too big now. Quite a few teams just have a big wing without understanding how efficient it is,' says Deakin. The rules are likely to favour smaller packages, and the definition of the different areas of aerodynamics could also slightly change. 'One possible alteration is to have the rear wing narrower than the rear tyres which gives the teams an interesting compromise – wide tyres or wide aero?' Diffusers, underfloors and DRS (Drag Reduction Systems) will remain unrestricted with the only concern being the safety of the wing mounts and DRS flaps. 'Changing the regulations occasionally in this area should make teams think again, go back to first principles and understand how to optimise the use of aerodynamics properly.'

Negotiating noise

The 2014 competition saw a quarter of the combustion grid running single cylinder engines and, with the continual trend for downsizing and lightweight vehicles, the increasing dominance of screeching bike engines is set to continue. 'It has not been decided yet, but there is discussion about going to a dBC weighting rather than dBA when scrutineering the noise level of the cars. In theory, that should reduce the noise of the singles more than it will reduce the noise of the four cylinders because of the way the signal is filtered.' Formula Student scrutineers are currently using both dBA and dBC scales and a decision will be made once all data is assessed.

Electronic throttle control

'This is something we have wanted to do for a long time,' says Deakin. However, the judges task of actually looking through all the software is a challenge. 'The additional brake device will use analogue electronics to measure the brake and throttle signal as well as the current delivered by the battery. If those three parameters go out of sync, for example if the driver asks for a lot of brake and no throttle, resulting in a large amount of current being delivered to the electric motors, then the device will kill the electrics acting as a back up to their electronic throttle control system. It is similar to the petrol cars where they have two throttle springs, so if one breaks, there is always a second one there – there are two systems working. But we are just developing the details of that at the moment.'

Other changes include the option of rear wheel steer as well as front wheel steer, rationalised battery regulations, and changes to restrictors, compressors and throttle bodies for turbo or supercharged cars. The final version of the 2015 regulations will be revealed at the end of August or early September.

'The danger of not adapting the regulations is that as the top teams get so much quicker, the smaller teams feel that they have no chance, and we end up putting teams off before starting their voyage into Formula Student.'

"Three years ago, there was parity between the best petrol cars and the best electric cars"

Electric cars, particularly those with four wheel drive, are proving more able on acceleration and can use energy recovery systems, but the acceleration advantage is set to be reduced by proposed rule changes to power outputs

Springing ahead

Advances in metallurgy, carbon technology and hydraulics are opening up tremendous possibilities for chassis designers

By GEMMA HATTON

Despite appearances, the gossamer-light front suspension of a Formula 1 car is able to withstand incredible amounts of pressure. Today's teams are facing a different type of pressure as the controversy surrounding FRICS resulted in the entire F1 grid abandoning the technology for the German Grand Prix in July.

FRICS stands for Front and Rear Interconnected Suspension and essentially connects the springs and dampers between the two wheels on each axle, and the front wheels to the rear wheels. The principle behind this is to maintain a constant ride height at all four corners of the car during braking, acceleration and cornering. This results in the floor of the car remaining as flat as possible, keeping a constant aerodynamic balance which ensures maximum downforce. Cancelling out bumps also improves stability, handling and tyre management.

Such systems have been run by Mercedes and Lotus for more than five years. Every team on the 2014 grid utilised this technology in the first half of the 2014 season with varying degrees of success, so it is by no means 'new'. The reason why it has been allowed in the past is because it is a passive system; it uses hydraulics instead of a mechanical input from the driver or being electronically controlled and is thus legal. However, FIA Race Director Charlie Whiting has raised the issue as it is now believed that teams are running FRICS mainly for aerodynamic advantages, and therefore could be in breach of the regulations banning moveable aerodynamic devices. The FIA's involvement in this was initially due to reduce costs, which is why it looks as though active suspension systems will be making an F1 return in 2017 as it is a more cost effective solution. In the meantime however, rumours of significant FRICS developments could be expensive and prompted the FIA to investigate further.

To avoid the risk of a protest all of the teams decided to remove FRICS from their cars in a non-protest pact. The effect during the German GP was deemed minimal, even for the likes of Mercedes who arguably had the best system; 'finding the sweet spot with the car is just in a different place now,' explained Mercedes driver Lewis Hamilton. FRICS is even more effective in mid-speed corners which are more common at circuits such as the Hungaroring, where it is estimated that the system could be worth up to three tenths of a second for a team running an established system.

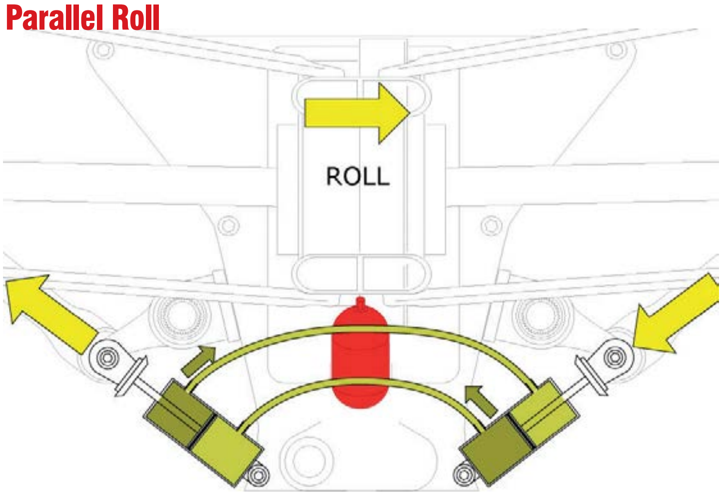
So how does FRICS actually work? Well, at each end of the car there are three hydraulic elements; a double acting hydraulic cylinder mounted to a pull or pushrod rocker on either side and a centre element or valve block which links the two cylinders. However, these cylinders are not like dampers, where the piston forces fluid to flow from one chamber to the other within the cylinder; instead the fluid flows in pipes through the valve block and into a chamber in the opposite cylinder. There are two modes to this design, parallel and crossover which are explained below.

Parallel Roll

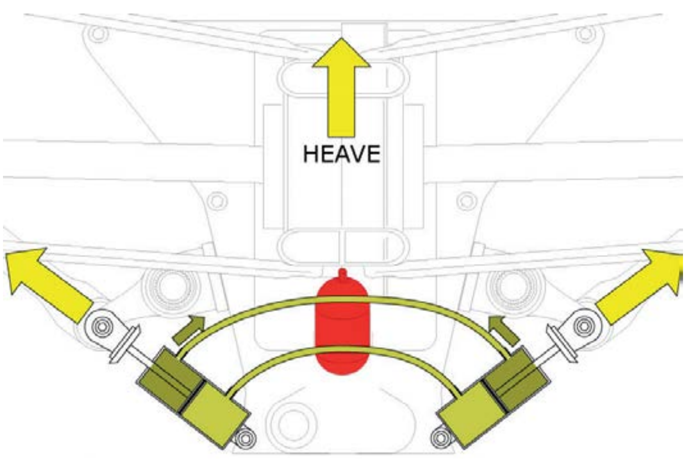
When a car turns a corner, the weight is transferred to the opposite side (defined as roll) and this compresses the outer hydraulic cylinder and rises the inside hydraulic cylinder. This then forces the outside cylinder piston downwards and the inside cylinder piston upwards, creating high pressure in the lower chamber of the outer cylinder and the upper chamber of the inner

FRICS systems have been running for over five years. Every team on the 2014 grid utilises this technology, so it is by no means 'new'

Parallel Roll



Parallel Heave



cylinder. Due to the piping connecting each high pressure chamber to the low pressure chamber on the opposite cylinder, the fluid is displaced with minimal resistance and therefore the cars roll stiffness is not increased. The precise amount of fluid flow is determined by the valving setup within the valve block and can be tuned to a team's requirements.

During heave – when the car is moving up and down vertically – both pistons rise, creating high pressure in the upper chambers of both the hydraulic cylinders. As these chambers are connected, this generates high resistance and the overall heave stiffness is increased. In contrast to the parallel design during roll, this crossover mode increases the cars roll stiffness as the two high pressure chambers are connected, generating high resistance.

Crossover Heave

Once again, this design creates the opposite outcome of the parallel design, and has no effect on the heave stiffness of the vehicle as both high pressure chambers on each cylinder are connected to the low pressure chambers on the other, so the fluid is easily displaced.

In summary then, the parallel and cross over designs are utilised depending on whether the roll stiffness or heave stiffness needs to be increased, which only happens if the high pressure chamber of one cylinder is connected to the high pressure chamber of the other cylinder for maximum resistance. As well as the piping connecting the hydraulic cylinders on either side of the car for antiroll, a similar system is implemented to link the front and rear cylinders to control dive under braking.

No one yet knows the true effect of abandoning FRICS, but teams running sophisticated and established systems, such as Mercedes, could lose out more than most.

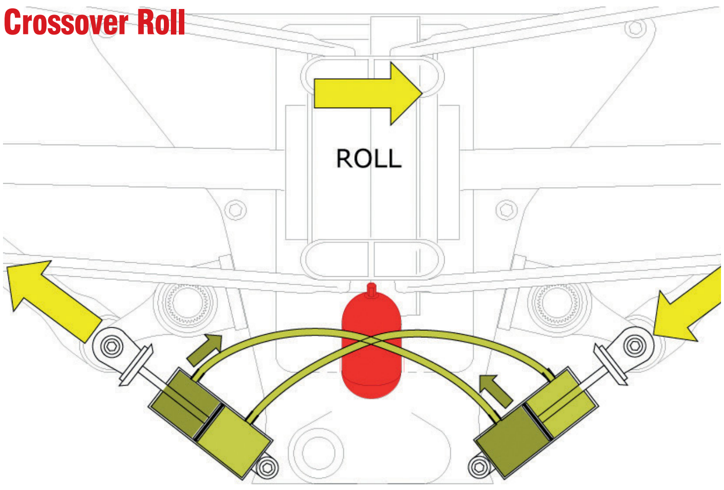
Supplying suspension

British company Kaiser is Formula One's top suspension supplier and manufactures hubs, wishbones, rockers, torsion bars, steering racks and damper housings to the highest level of performance. 'The main challenge in the design and manufacture of these parts is to maintain the strength and reduce the sizes of the components to make the aero improvement possible,' explains sales director Ragnar Bregler. This philosophy can be seen in the wishbone design which utilises carbon fibre and aerodynamic profiles – essential for one of the most highly stressed components in a race car.

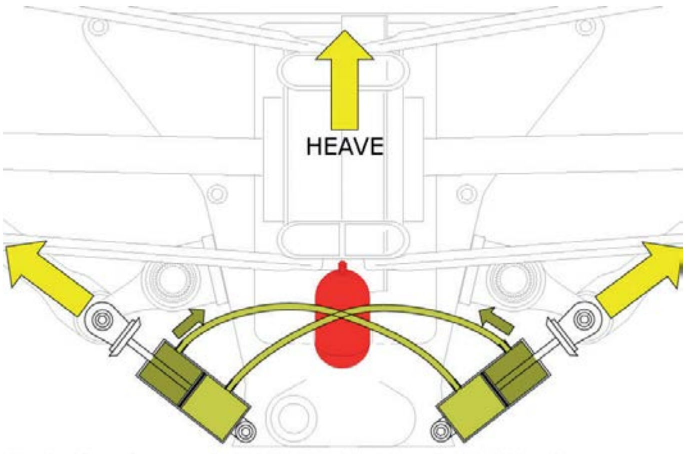
There are two techniques for the joints, the first uses solidly mounted metallic flexing ends mostly made from titanium that are bonded into the carbon. The second employs a fully integrated flex area made from carbon which is reinforced around the fixing areas by top hats as shown. 'The future of motorsport suspension systems will be the continued challenge of reducing size and weight, supplying a stable aerobalance and ensuring mechanical grip.'

The scragging, or preconditioning, of torsion bars improves the material properties and is now a sophisticated manufacturing process for high spec materials.

Crossover Roll



Crossover Heave



Advanced spring technology

A complete carbon composite bellows spring stack on a damper

The spring rate of a suspension system is a crucial factor in how the sprung mass of a racecar behaves, and thus affects handling and stability. One worldwide company specialising in high performance suspension coils is Hyperco/MW Industries which works with race teams to design, innovate and manufacture the worlds leading designs.

A recent example of a Hyperco/MW Industries 'breakthrough' is the Dynamic Travel Response (DTR) concept on the Conventional type of springs, which are used in NASCAR and drag racing. 'Typically, high performance springs are built to deflect to solid without overstressing and taking a set (i.e. losing free length and loaded height)' explains Mark Campbell, Manager of New Product Development of Hyperco/MW Industries. 'These Conventional springs with a high rate (approx. 600lb/in and higher) will usually reach the maximum load of an application well short of the springs maximum travel. When a spring is built to withstand a load at solid far higher than the application, it is heavier than it needs to be. Therefore through evaluating real-world loading of conventional springs, we discovered that most higher rate springs were never being used past 60 per cent of their overall deflection and most springs 900lb/in and higher never even saw 40 per cent deflection.'

Hyperco's Optimum Body Diameter spring. See how the body diameter increases down the length of the spring, which optimises the applied stress and so the number of coils can be reduced; saving weight

The individual carbon fibre elements that make up the carbon composite bellows spring

Naturally, a redesign process followed to minimise the weight without compromising the required load. 'The DTR Conventional springs feature smaller wire diameter, fewer coils, and weight savings of up to 5lbs per spring. And the lower inertia improves the spring's dynamic response and positively impacts handling and damper response.'

Another unique design concept is the 'Optimum Body diameter' where the body diameter of the spring adjusts relative to the end coils. This optimises the applied stress to take full advantage of the high tensile material that Hyperco/MW Industries offer, and has resulted in removing a coil or more wire in some designs; reducing weight, allowing more travel and improving linearity. 'The response has been so overwhelming that we have continued to update spring designs using the OBD approach - even six years after its initial introduction. Doing so has allowed our springs to be used in a wider range of applications and with a higher level of customer satisfaction,' explains Campbell.

However, the latest advance in Hyperco's spring technology comes in the form of Carbon Composite Bellows Springs (CCBS) which is a system of carbon fibre elements that combine to effectively work as a lightweight, high performance compression spring. This spring is made from several individual 'rings' or elements which are paired in sets and joined to make a stack. The number of elements, the base rate (spring rate of each individual element) and the orientation of each element determines the overall spring rate.

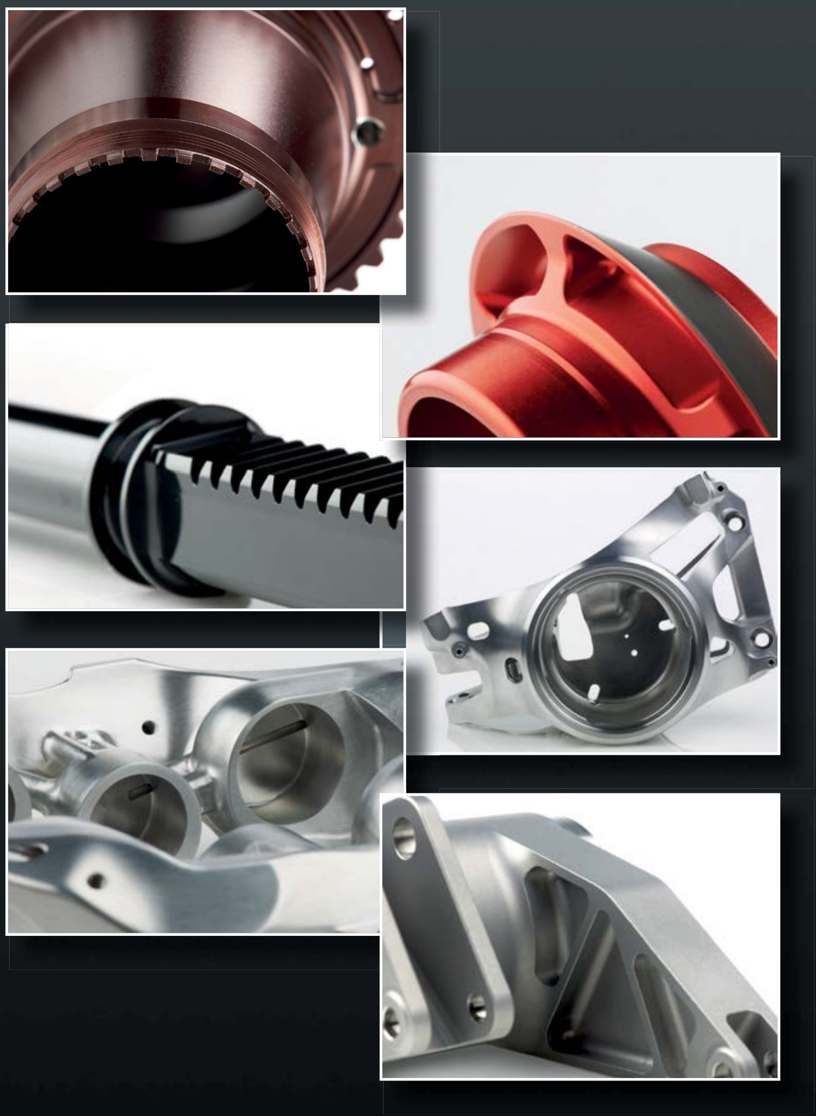
Although using carbon fibre results in a 60-70 per cent weight reduction per spring,

A carbon composite bellows spring stack constructed by pairs of carbon fibre elements. The use of carbon fibre reduces the weight by 60-70 per cent

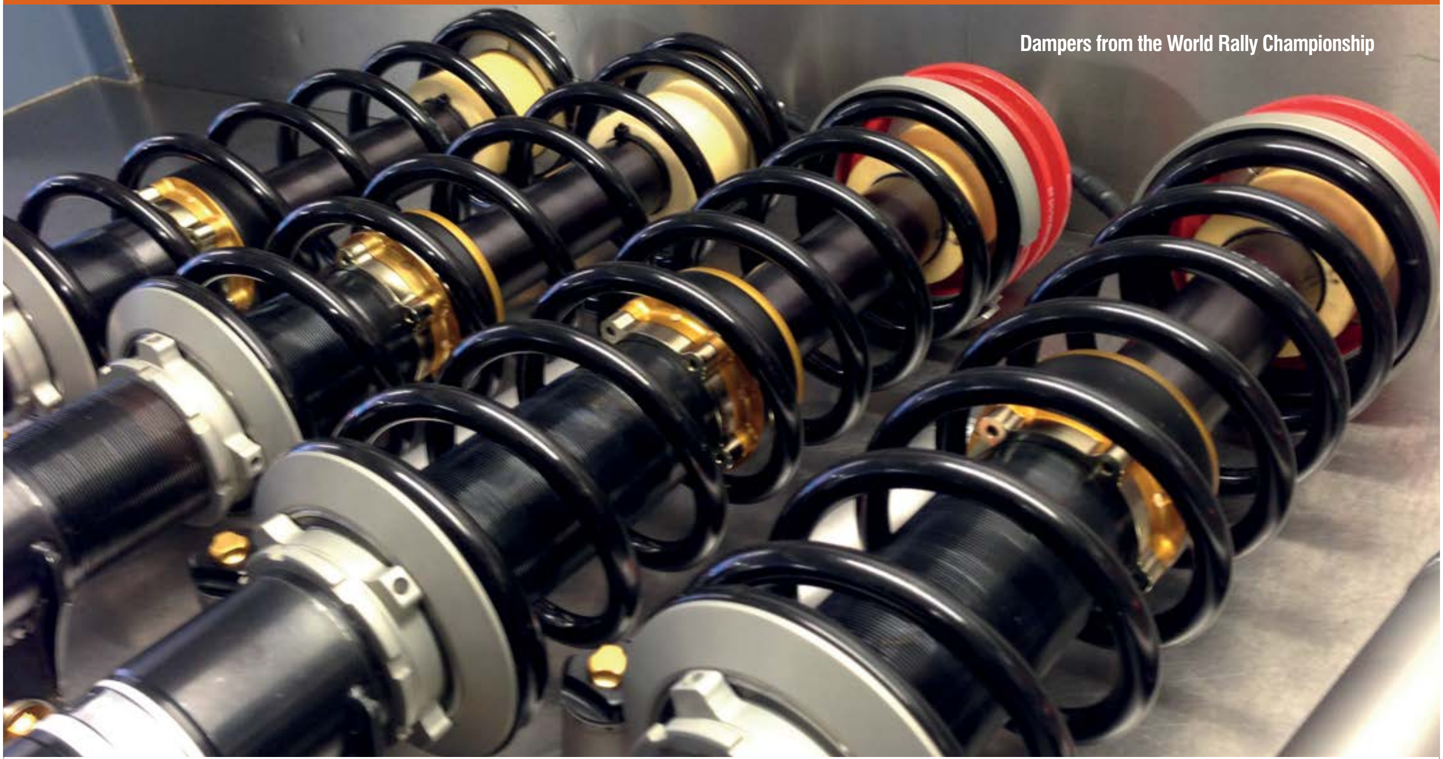
the advantages are not just weight related. By manufacturing carbon fibre through molds, intricate designs can be achieved in a single operation, rather than simplistic stamped metal springs. The laminate construction allows steeper pitch angles for more deflection without overstressing and because the base rate of each element is determined by the thickness, custom designs can be produced quickly without specialised tooling. Furthermore, due to the optimised interface between each element and the reduced friction at the spring seat surface results in low hysteresis – it is as efficient at releasing energy as it is at storing it.

'A helical coil spring has been around for a long time, essentially unchanged,' Hazard highlights. 'It takes fresh thinking to buck tradition and take spring design to the next level. We see this direction hinging on a more efficient use of the physical properties of spring steel and alternate materials, with the latter requiring a different approach to spring design; leaving the door open for application we are not even thinking about now. However, steel as a coil spring material is not going away.'

Because the base rate of each element is determined by the thickness, custom designs can be produced quickly without specialised tooling



Damping duties


Dampers from the World Rally Championship

When a racecar hits a bump, the suspension springs will compress and this kinetic energy causes the piston situated in the damper to move through oil, so essentially the kinetic energy of the spring is converted into heat energy which is then absorbed by the oil. The rate of fluid flow in the damper is determined by the size of the orifices which restrict flow between the upper and lower chambers of the damper. By adjusting the behaviour of the dampers, load variations in the tyre at the contact patch can be minimised, allowing the tyre to have maximum contact with the road at all times; resulting in high mechanical grip. The best performance dampers need to deal with the largest inputs at the highest frequencies – an environment specific to the world of rallying.

Exe-Tc has won seven WRC titles with its dampers and apply its design philosophies across the entire spectrum of motorsport. For instance, manufacturing dampers for a two tonne rally raid built for endurance where reliability, heat management (particularly in the desert stages) and a good balance between comfort and performance are key factors compares to designing for the new Porsche 991 Cup car, which is a machine built for going around a track as fast as possible.

'One of the most important roles of a racing car suspension system as a whole is to maintain a constant tyre face loading. This will ensure good tyre life, less fluctuations in available grip and ultimately faster lap times,' explains Rob Biggs, design engineer at Exe-Tc. 'Friction at any point in the system detracts from this ability and has to be overcome before movement can occur. One of the biggest issues with a MacPherson strut in a rally application is the friction in the DU bush guiding system. In our top end systems we use our own design needle roller bearing guides to replace the DU bushes.' These rollers have a specific profile that interacts with the tubes which changes with loading so there is more support at high loads, but at low loads friction is reduced by a factor of 10.

'On rally car systems the input loadings to the car are very high due to potholes, debris strikes and jumps. Our general setup philosophy entails the use of low rate springs to maintain traction over rough terrain but obviously this puts a lot of strain on your usual rubber bump stop when wheel movements reach the limits of available travel. Our 'End Stroke Absorber' (ESA) is a secondary piston that only engages towards full bump conditions. Once engaged, the damper fluid can only escape through progressively smaller outlet holes so that the end rate damping loads can ramp up to significant levels controlling the impact. There is a check valve in this system so there is no recoil as in a conventional bump rubber,' Biggs explains.

A continuous issue throughout every avenue of motorsport is the lack of testing, which makes optimising car set up difficult and typically changes are made when the car is stationary either in the pits or at the end of a stage. 'To improve this process and make it faster we are looking at an electronic component of damper control. This can vary from a remote adjuster system that would give the driver control of the click settings in the damper on the fly without the need to stop, to a damper that has an electric motor generator to add another dimension of control. This could allow for the ability to put in or take out energy in electrical form, possibly for regenerative purposes.'


The Citroen WRC roller bearing system, with a specific profile that interacts with the tubes in response to changes in loading

"One of the most important roles of a racing car suspension system as a whole is to maintain a constant tyre face loading"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Simulation and design

ChassisSim software has proved invaluable for tweaking an existing setup, but it also has huge potential for designing from scratch

By DANNY NOWLAN

A couple of months ago, I posted a video on the ChassisSim blog and YouTube channel that generated a lot of interest. It was about how to use racecar simulation in designing a racecar. Traditionally, tools such as racecar simulation (ChassisSim in particular) are often thought of as more for racecar engineering than for design. This is understandable because, sadly, in the modern motorsport environment race engineering is where the bulk of our technical effort goes. This reflects the fact that, apart from isolated pockets of motorsport, teams don't build racecars any more.

One of the untold stories of ChassisSim is how it's been used in the racecar design process. The focus of this article will be on how to apply racecar simulation to any racecar design exercise you might be faced with. We'll look at some tips, tricks and processes that you can follow that have been applied with great success in the past. This is something we can all benefit from.

Before we get into the technical nitty gritty it would be wise to reflect where ChassisSim has been applied in the racecar design process. The ChassisSim European distributor, Pilbeam Racing Designs, has been using ChassisSim for their racecar projects since the late '90s, starting with sanity checking of the MP84 Sportscar. However, it was used extensively to explore aero targets of the VdeV MP98 car and the recent LMP2 design effort, the MP100. ChassisSim was also used extensively by ORECA in exploring the ramifications of 2014 Le Mans regulations in their LMP1 Rebellion racing project. This article will reflect the lessons learned in projects like these and others I have worked on.

Baseline the project

To kick things off, it would be wise to reflect that nothing happens in a vacuum. The practicality of this is that even if what you have is complete rubbish, it's actually a really good idea to understand why it's complete rubbish first. What this means is that, before you start, you want to make sure your simulated models are getting correlation like this seen in **Figure 1**.

As always, actual data is shown in colour and simulated in black. Note that, in terms of speed and damper travel and steering, we already have a very good handle on what the tyres are doing and the downforce and drag we are running. This translates to an excellent basis not just to race engineer the car, but also for our design activity, since we already have a good working baseline.

The other point that I would like to reflect on is that motorsport is about evolution and not revolution. You see it all the time with Formula Student teams who think they are going to revolutionise the world. In reality, they take a good design and throw it away and then build the latest and greatest – and it's a complete train wreck. I had a ringside seat of this in the mid '90s. I'm not going to name names here, but a new start up team was designing their own touring car. They built the 'latest and greatest' and it nearly destroyed the operation. The moral of the tale here is that you may not like what you have but – if it's half competitive – understand why first. You don't get brownie points for proving how utterly brilliant you are. You only get the kudos from results.

One of the biggest holes I see people fall into is increasing the wheelbase and track of the vehicle

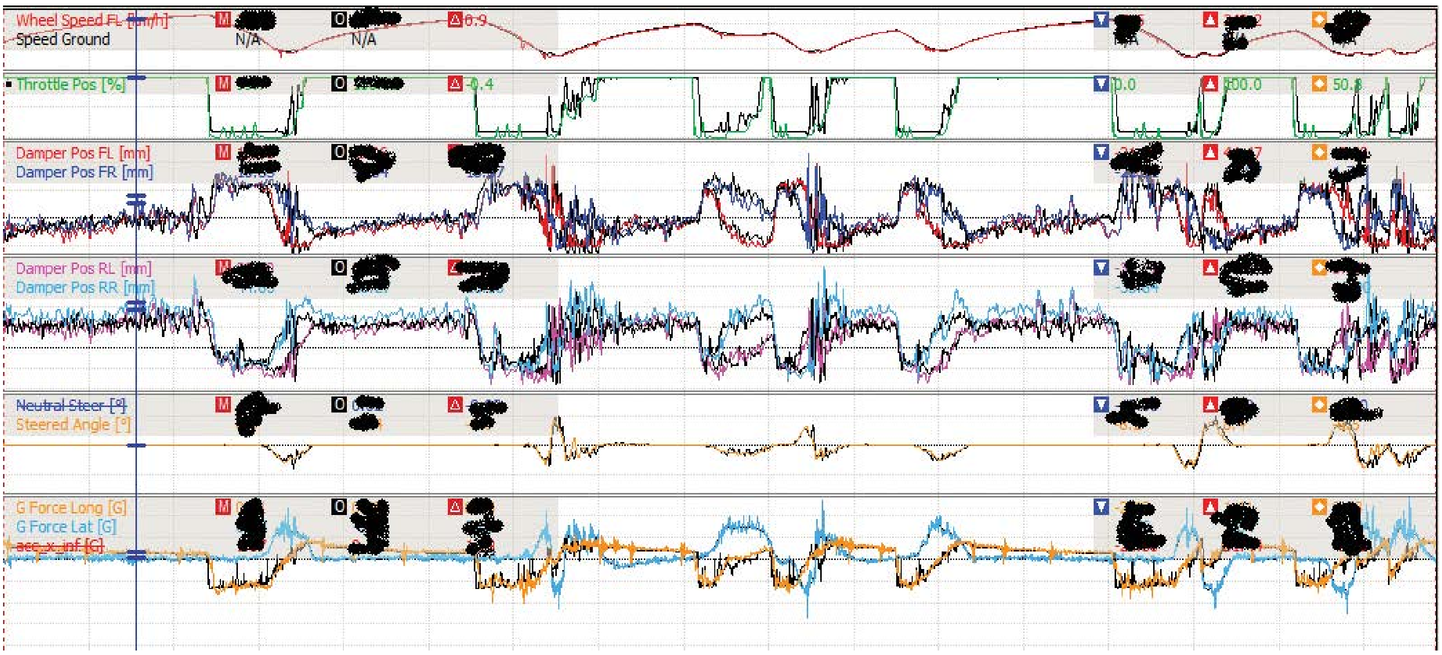

Figure 1: ChassisSim correlation from a current customer car

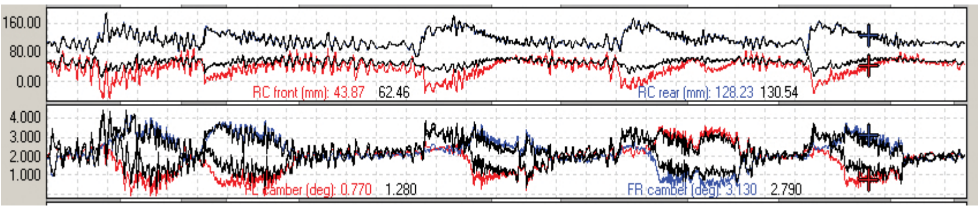

Figure 2: Baseline suspension geometry vs standard geometry

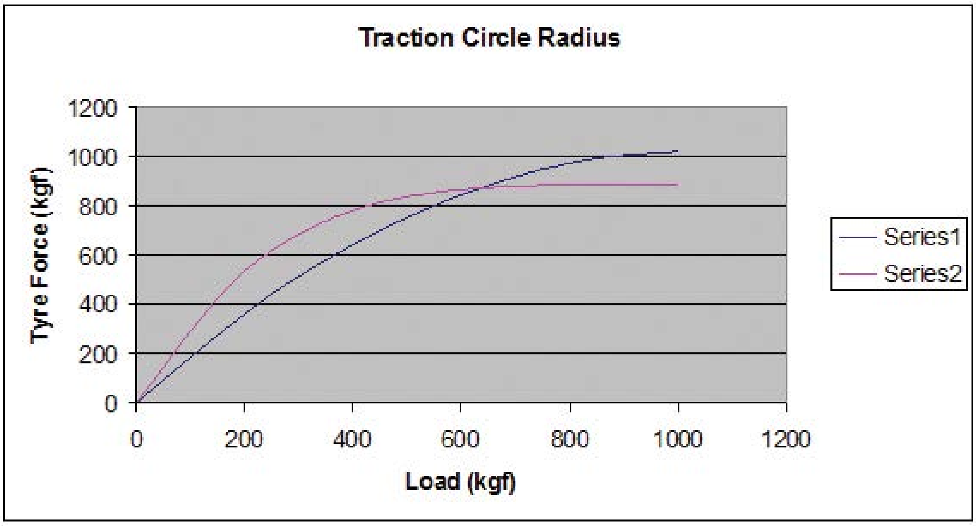

Figure 3: Plots of traction circle radius vs load

EQUATIONS

EQUATION 1

$$I_x = \iiint (y^2 + z^2) \cdot \partial m$$

$$I_y = \iiint (x^2 + z^2) \cdot \partial m$$

$$I_z = \iiint (y^2 + x^2) \cdot \partial m$$

EQUATION 2

$$I = I_{CM} + m \cdot r^2$$

EQUATION 3

$$I_{x\_new} = I_{x\_base} \left(\frac{tm\_new}{tm\_base} \right)^2$$

$$I_{y\_new} = I_{y\_base} \left(\frac{wb\_new}{wb\_base} \right)^2$$

$$I_{z\_new} = I_{z\_base} \left(\frac{tm\_new^2 + wb\_new^2}{tm\_base^2 + wb\_base^2} \right)$$

Here we have,

I_{x_new} = New moment of inertia about the x-axis (kgm²)
I_{y_new} = New moment of inertia about the y-axis (kgm²)
I_{z_new} = New moment of inertia about the z-axis (kgm²)
I_{x_base} = Current moment of inertia about the x-axis (kgm²)
I_{y_base} = Current moment of inertia about the y-axis (kgm²)
I_{z_base} = Current moment of inertia about the z-axis (kgm²)
tm_base = Current mean track (m)
wb_base = Current wheel base (m)
tm_new = Current mean track (m)
wb_new = Current wheel base (m)

Before diving into the design process, it would be wise to discuss some preliminaries. The first point about design (particularly if you are exploring it from an existing platform) is to quantify what happens with the moments of inertia of the car. I realise this might seem a weird place to start, but one of the biggest holes I see people fall into is increasing the wheelbase and track of the vehicle and seeing the simulated results get better and better. You have to remember that as we change the geometry of the car, we need to adjust the inertia to suit. Here are the equations of the second moment of inertia. See **Equation 1**.

What this means in plain English is that the angular momentum of the car is the sum of the mass components multiplied by the square of the distance from the centre of gravity. If you are also adding new components to the vehicle **Equation 2** is a very handy tool.

This equation establishes that the moment of inertia of any component is given by the inertia of that component on its own, plus the mass of that component multiplied by the square of the distance from this from the centre of gravity.

On the basis of this, we now come to the meat of this discussion, which is a rough rule of thumb of how inertias change as the tracks and wheelbases change. This is summarised in **Equation 3**.

I realise that this equation isn't going to win any prizes for elegance or subtlety but it will help to ensure you don't go down any blind alleys as you start changing wheelbases and tracks. It will certainly allow you to adjust your inertias to suit which will add sanity to the sim results you'll get back.

Secondly, don't get carried away with specifying spring and damper rates too early in the design process. The reason you don't want to get bogged down too much with this is that spring and damper rates are primarily race engineering tools that you need to adjust on track. This comes down to the way the tyres are loaded on the circuit and how they build up temperature. The ultimate test of this is how the car runs on the circuit. Software like ChassisSim will greatly assist you in this endeavour but it is no replacement for testing. Consequently focus on small and sensible changes from a known platform. If you are designing for a platform you haven't competed in and need a start point, go to an equivalent race and talk to the data and race engineers and find out (Hint – good wine/beer will greatly assist in this process).

To start the discussion on the design process let's address how you go about designing suspension geometry. This was a question I had to face directly when I was involved in designing a time attack car back in 2007. It's actually a bit more complicated than you think, but here are some good rules of thumb:

- **Focus on minimising roll centre migration**
- **Minimise camber change**
- **Build in wiggle room for changing roll centre location**

They were pretty much the tenets I worked from for this project and they served me well. The first two points are quite self explanatory. However, the reason you want wiggle room on roll centre migration is that, like springs and dampers, roll centres are something that you'll tune on circuit. As a rough rule of thumb I'll go for a delta of +/- 50mm.

Also when using a tool like ChassisSim at this point in the game lap times are irrelevant. What you are focusing on is looking at suspension movement and the returned cambers and roll centres. It was actually one of the variables I insisted on returning from ChassisSim very early on in the process. When you are done, you should have a plot that looks like **Figure 2**.

Again the baseline is coloured and the new design is black. Notice the significant improvements in both roll centre migration and camber variation. When you see something like this, you know you are on the right track.

Another application for racecar simulation is specifying downforce, drag and aero balance targets. This is where lap time simulation and ChassisSim in particular excels. That being said, there are still some tricks of the trade that you need to be aware of.

Firstly, if you are designing from a clean sheet of paper, start from a template that most closely resembles your car. I realise that this borders on the obvious, but the last thing you need at this point is any unknowns that are going to lead you down the wrong path.


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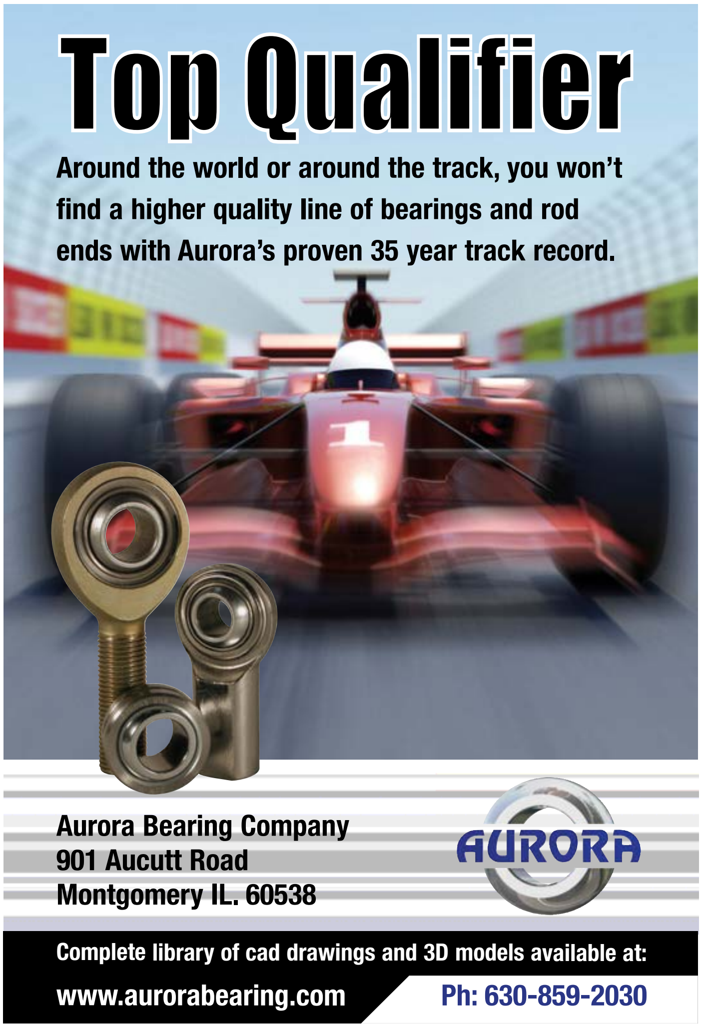
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The next thing is making sure you have a solid tyre model underneath you. Make sure it comes from race data, preferably using either the ChassisSim tyre force modelling toolbox or a proper tyre rig such as the SovaMotion tyre rig. In particular you are looking to make sure the high load part of the tyre curve is not too optimistic or the traction circle radius doesn't flat line. These are illustrated in **Figure 3.**

Here we have two plots. The dark blue plot illustrates when the tyre force doesn't bleed off at high load. What will happen here is the tyre wants more and more load. This will produce overly optimistic results for downforce. The other extreme is where we have underestimated the peak load and in the high load region (in this case 600kg plus) as we drop downforce there'll be no change in tyre force producing overly optimistic results as we take downforce off. Also **Figure 3** illustrates we need to get the load range of the tyre right.

With that sorted, you then start playing with overall downforce, drag and aero balance offsets. If you are using ChassisSim you play with the rear adjustments only. These control the global levels of downforce, drag and aero balance. Provided the tyre model is reasonable this will point you in the right direction. Racecar simulators of all descriptions will inevitably favour less downforce and more forward aero balance. When you do your analysis as a rough rule of thumb, add more downforce (say 10 per cent from the simulated results) and trim the aero balance rearward by 5 per cent. Once the car is further improved in testing then we can chase the simulated ideals. The last thing you want to do is freak the driver out the first time the car hits the circuit.

Once the aero platform has been established then you can move on to engine/energy recovery systems. Again, as with everything else, tread carefully. The simulated numbers will point you in the right direction. With KERS, simulation will prove invaluable in showing at what points on the track you should be saving energy and strategies to release the energy. Everything must be validated on track. Never forget that.

While tools such as ChassisSim are a great help, they are no substitute for track testing

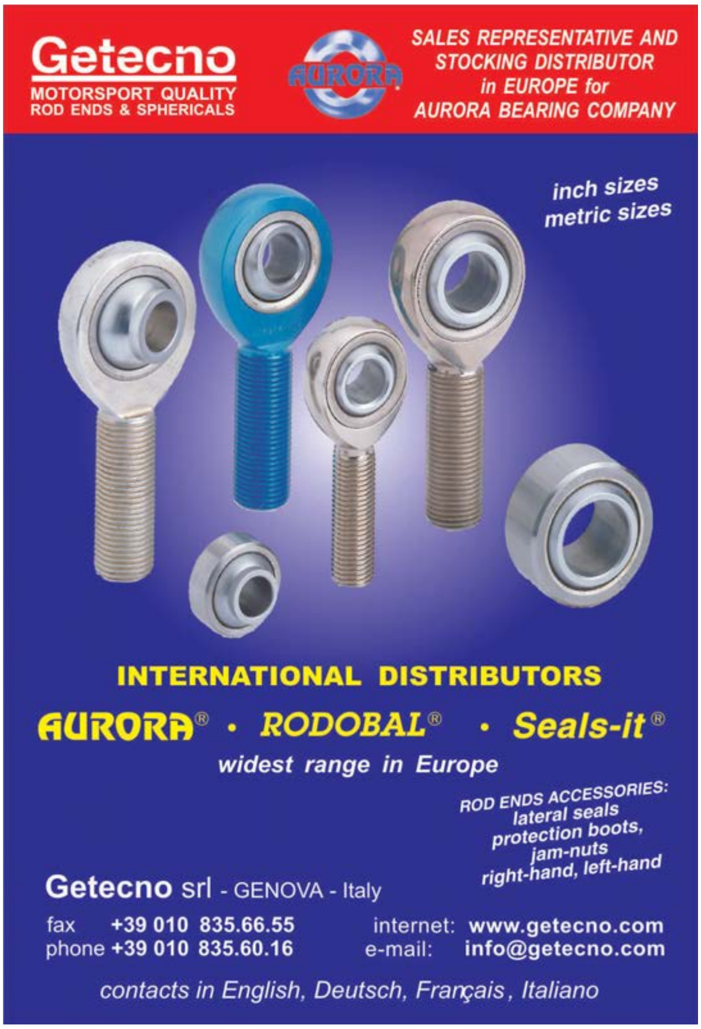
There is a distinct process in which simulation should be adopted in the racecar design process. This procedure is:

- **Start from a solid baseline as close to the target car as possible**
- **With a representative engine, establish the aero targets**
- **Fix the roll centres and establish tracks and wheelbases**
- **If needed, investigate KERS and engine properties**
- **Work on suspension geometry**
- **Establish spring and damper specifications**

What you are seeing is the master list that ChassisSim has been using in racecar design. This has proven to be a very effective guide.

That being said, while tools such as ChassisSim are a great help, they are no substitute for track testing. One of the greatest myths I see in this business is the assertion that computer aided engineering tools can replace actual testing. Computer aided engineering software packages are tools. Consequently, treat them as such. They are there to get you ready for track running and not replace it. Always keep that in mind. Just remember, F1 teams would accept testing back in a heartbeat, so why do you think you should be any different?

We have discussed what a useful tool simulation can be in racecar design. Based on how ChassisSim has been used in the field we have seen some useful pointers about how to fit this into the design process. The key is to start on a known baseline, establish the aero targets, move on to track and engine and KERS properties and then finish the process off with tuning suspension geometry and spring and damper properties. However, bear it in mind to be sensible in interpreting the results and always validate on track. If you do that, racecar simulation will prove invaluable.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New owners to invest heavily in Caterham points chase but staff lose their jobs

New owners of the Caterham Formula 1 team have authorised significant investment in car upgrades as the team strives to secure a financially vital tenth place in the championship this season. However, lawyers have been appointed to represent what is believed to be up to 40 staff who lost their jobs. It is understood that the employees have asked the FIA to investigate the conduct of the team.

Caterham was bought from its founder Tony Fernandes in July by a consortium of Swiss and Middle Eastern investors, and a three-man team was parachuted in to run it. This comprised of Colin Kolles, former HRT, Midland, Spyker and Force India team principal, ex-F1 driver Christian Albers, and Manfredi Ravetto, who was last involved in F1 with HRT. The identities of the investors remain a secret, but it's known that they are intent on scoring the point, or points, that could clinch tenth place at the end of the year, securing the £20m of commercial rights money.

XPB

New investors have secured Caterham's short term future but the team still needs to score points before season's end

According to team principal Albers, the new owners have green-lighted a spending programme to update the CT05 before the Belgian Grand Prix at the end of August. It is hoped that these upgrades will help the team to pass both Marussia and Sauber, who currently sit ninth and tenth in the championship. Achieving this result in the remaining grands prix qualifies the team for Column 2 payments, which reward results over several seasons and as Caterham finished 11th in 2013, such improvement is critical.

Gerry Hughes, head of track operations at Caterham, said: 'They [the new owners] have given us a direction and a remit and certainly our goal for the remainder of the season is to finish 10th in the championship. The design of the new car is going ahead and is on schedule, so we are looking forward to 2015.'

Kolles' place on the team is thought to be temporary, as he is already committed to another F1 operation, Forza Rossa – a planned new team with backing from Romania. It is thought Kolles was brought in to help sort out the financial problems that the team has.

Four door hybrids and fuel flow meters for new look WRC?

The World Rally Championship is set to undergo an overhaul of its technical regulations for the 2017 season. Larger cars look likely to be used as the base models, instead of the current generation of small cars (B segment) such as the Hyundai i20 and Toyota Yaris. The new cars will be based on larger models (D segment) such as the Hyundia i40 and Toyota Corolla Altis. There will be much greater freedom in terms of the power units in the cars.

The WRC will follow the lead set by LMP1 and control performance by fuel flow rather than by limiting engine configuration and capacity. Hybrid cars are also expected to be permitted.

The proposed changes have surfaced at a time when many in the sport – apparently including WRC Commission President Carlos Barbosa – feel that the current cars are too dull and lack technical variance. The full rulebook will be released before the end of 2014.

Smaller cars such as the Fiesta seem likely to make way for midsize models in a WRC rule reshuffle for 2017

XPB

NASCAR TV decline not a concern says France

NASCAR chairman and CEO Brian France has downplayed the significance of a noticeable recent drop off in TV viewing figures for the Sprint Cup, saying that the audience has other ways of watching the sport including digital media.

Viewing numbers for NASCAR's premier series have been showing a downward trend and according to *Sports Media Watch*, of the 15 Sprint Cup races that can be compared to last year (at the time of writing) 12 have seen reductions. For example, the NASCAR Sprint Cup race at Kentucky pulled in 3.6 million viewers, down 10 per cent on the 2013 season (4m).

However, France says the decline is largely due to a shift to viewing on different media. 'When you really look at it, and look at all the digital interests that we have today on devices, that's not scored currently,' France said. 'When you combine it all, we're actually not off that much, even with our challenges.'

He added that the ratings, which measure the sport against other broadcasts, have actually been satisfactory: 'I think seven or eight times we were number one coming in and out of the weekend on television, seven million viewers a week on average,' France said. 'We're never pleased when our ratings aren't growing at the rate we would like, but we understand that circumstances will always have us going one way or the other from time to time.'

Yet while NASCAR has seen its TV popularity take a dip, there has been better news for single seaters in the US. NBC Sports Network has reported that it has averaged 390,000 viewers for IndyCar coverage thus far in 2014, which is an impressive 34 per cent up on the comparable point last year (291,000).

Haas moves closer to Ferrari technical partnership

A technical tie-up between Gene Haas's planned US-based Formula 1 team and Ferrari now looks all the more likely after a sponsorship deal between the two was announced.

Haas, who will be entering a team in Formula 1 in 2016, has said he is looking for a technical partner after discarding the original plan of using a car built by Dallara. Relaxed customer car regulations from 2015 will allow far more technical transfer between teams. Haas has said he hopes to purchase many components from an established constructor, and then concentrate on producing his own chassis at his US base in Charlotte, NC.

While the new sponsorship deal with Ferrari, which sees Haas logos on the lower edge of the side pods, does not guarantee a technical tie up, it does strongly suggest that commercial negotiations are progressing, and Ferrari team principal Marco Mattiacci admitted as much: 'Over the past few months, we have been exploring with Haas a number of potential areas of collaboration, and this [the sponsorship] agreement is an immediate opportunity that we are pursuing, which proves Haas's interest in Formula 1. Haas is committed to entering Formula 1 with its own team, a testimony to the growing appeal of our sport in the USA and on this front, technical discussions are ongoing between us.'

Haas himself said: 'Haas Automation is a premium brand, and there's no better way to drive that point home than to connect it with Scuderia Ferrari on motor racing's biggest stage.'

XPB

Haas logos on lower edge of side pods hints at strengthening links with Ferrari

Haas Automation is the largest CNC machine tool builder in North America. Haas's other motorsport interests include the Stewart-Haas Racing NASCAR Sprint Cup team.

While Haas will be running his F1 operation from the organisation's Charlotte HQ he has said it will also be setting up a European base to help with logistics.

NASCAR Sprint Cup teams form business alliance

Some of the top NASCAR teams have joined together to form a body to protect their interests, strengthen their buying power, and work on improving and promoting the sport.

Nine Sprint Cup operations have signed up to the new body, the Race Team Alliance (RTA), while membership will be open to all full time teams in NASCAR's top level series in the near future.

At the time of writing, the group included NASCAR heavy hitters Chip Ganassi Racing, Hendrick Motorsports, Joe Gibbs Racing, Richard Childress Racing, Michael Waltrip Racing, Richard Petty Motorsports, Roush Fenway Racing, Stewart-Haas Racing and Team Penske.

The establishment of the RTA marks the first time that NASCAR teams have banded together in such a way.

Rob Kauffman, the co-owner of Michael Waltrip Racing and the chairman of the RTA, says its formation is simply a matter of giving a structure to a group that in many respects already existed: 'The teams have met in various forms and forums over the years to explore areas of common interest,' Kauffman said. 'This simply formalises what was an informal group.'

Kauffman added that the group will be focused on helping the teams operate collectively on sporting, technical and business matters. 'We all have vested interests in the success and popularity of stock car racing,' he said. 'By working together and speaking with a single voice, it should be a simpler and smoother process to work with current and potential groups involved with the sport. Whether it be looking for industry-wide travel partners or collaborating on technical issues – the idea is to work together to increase revenue, spend more efficiently, and deliver more value to our partners.'

Some reports stated NASCAR was not happy about the formation of such a potentially powerful new organisation, but the sanctioning body's president, Mike Helton, has made it clear that it does not have a problem with the RTA. 'First of all, we've got great respect for all of our stakeholders in the sport,' Helton said. 'As their business models would evolve from time to time, ours has too. But we've got great respect for all of our stakeholders; so any perception that there could be animosity based on this topic is incorrect and very unfortunate, and we should set that straight very quickly.'

XPB

Strength in numbers: some of NASCAR's top teams have formed new business grouping

LMP3 is (almost) go!

LMP3: a competitive but cost-controlled gateway to top level sportscar racing

The Automobile Club de l'Ouest has launched a new category called LM P3 (Le Mans prototype 3), which will be part of the Asian Le Mans Series and European Le Mans Series continental championships in 2015. This formula is the latest gateway to Le Mans-type endurance racing and follows in the footsteps of Formula Le Mans (aka LMPC) and IMSA Lites.

The new category, first suggested by *Racecar Engineering* in 2005, is aimed at allowing teams, drivers and constructors to learn the specific aspects of endurance racing before moving up to the top level.

The LMP3 car concept is designed to resemble a LMP2, but with slightly smaller dimensions (it is 15 cm shorter but has the same width). The chassis must be a coupe with a carbon chassis and a metal rollbar, crash tested to undefined FIA safety standards as well as featuring LMP2 style aerodynamic safety parts such as openings in the wheel arches and a shark fin.

Cars will have a single V8 engine supplier (to be confirmed before end of July), putting out around 420bhp. The engine management system will come from Magneti Marelli and this ensemble will be sold by ORECA, which will provide a back-up service to help the teams at all the circuits. A single engine will be allowed per car per season and each one must last 10,000 km without maintenance. The total car weight will be between 870kg and 900 kg, more than the current LMP1 lightweight and hybrid cars.

While it is an open formula, there will be a number of control parts including the transmission from Sadev, wheels, brakes, fuel tanks, and some safety elements. Tyre sizes will be similar to those used in the Porsche Cup. Each championship can call on the manufacturer of its choice and the entrants in the series will have to use these tyres. The sales price of these cars by the constructors to the teams cannot exceed €195,000, including the chassis (€135,000, $100,440 and engine (€60,000/$44,640). The running costs of a car over an ELMS season should be between €350,000 and €400,000. Thus, for a car with three drivers the budget per driver for a full season will be in the region of €120,000.

There are a number of companies considering building LMP3 cars including Onroak Automotive (Ligier), SORA/Sébastien Loeb Racing, Tatuus, Riley Technologies, Norma and Juno.

BRDC changes management structure at Silverstone

The British Racing Drivers' Club (BRDC), the owner of British Grand Prix venue Silverstone, has announced a major shake-up of the management structure at the historic circuit.

Silverstone Holdings Limited (SHL), a subsidiary company, has had its board dissolved as part of the changes, while SHL chairman Neil England is no longer part of the business.

The decision comes in the wake of the investment deal with commercial property company MEPC, signed in September of last year, which saw the British company acquire a long lease on the existing Silverstone Industrial Estate and development land around the outside of the circuit. Following these changes, the BRDC reviewed its corporate governance arrangements, which has led to the dropping of the SHL board.

The Silverstone Circuits Limited (SCL) management team will continue to operate and promote the track under the leadership of managing director Richard Phillips, who will now report directly to the BRDC board.

Meanwhile, Neil England, chairman of SHL for the last six years – who has been instrumental in recent investments in the circuit, most notably the dramatic Wing pit and paddock complex – has resigned.

John Grant, chairman of the BRDC, said of England's resignation: 'The BRDC Board wishes to thank Neil for his hard work, tenacity and commitment to Silverstone during his six years as chairman of SCL. He should be proud of everything he has achieved during that time and the significant contribution he has made to Silverstone.'

The BRDC says its future plans for the circuit will be directed towards continuing to build on its wide range of activities to ensure the group's substantial assets are fully utilised, and to work with partners to pursue major new projects, which include a heritage centre and a hotel.

XPB

Silverstone has made major changes to the way it manages famous track

BRIEFLY

Slow boat to China

The World Touring Car Championship has been forced to drop its US round at Sonoma and replace it with an event in Beijing, China (on 5 October), due to logistic issues caused by the cancellation of a ship that was scheduled to leave Oakland harbour in California for Shanghai on September 17. The next vessel, leaving on September 21, would not arrive at Shanghai until October 9, which wouldn't allow enough time for teams to prepare for the Shanghai race on October 12. WTCC's logistic partner and its promoter Eurosport Events could not find another suitable sea freight solution. Francois Ribeiro, director of operations at Eurosport Events, said: 'We came to the conclusion that keeping Sonoma on schedule was not viable.'

BRC sabbatical

The British Rally Championship will not take place in 2015, after a tender to find a company to run the 56-year-old championship was unsuccessful. The Motor Sport Association (MSA) now intends to run the BRC itself from 2016, and has pledged to spend next year consulting with the UK rallying community over what direction the BRC should take in the future. This could mean a shift of focus from the front-wheel-drive machinery – such as the Citroën DS3 R3 – that is currently dominating the championship. The only other time the BRC has not run since its inaugural season in 1958 was during the foot and mouth disease outbreak in 2001.


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Williams Advanced Engineering opens new £8m base

Williams has opened its impressive new Advanced Engineering facility at its Grove, Oxfordshire headquarters.

The 3800sq.m building, which will be the base for the part of the group that harnesses F1-derived technology for other sectors, was opened by the UK Prime Minister David Cameron and is said to be the result of £8m of investment over the past two years.

The new Williams facility features a ground-floor workshop with Formula 1-inspired build-bays that can be used for one-off projects or low-volume production. The building has been designed with the capability to accommodate up to 250 design engineers and it also features a number of confidential rooms where projects can be worked on in complete secrecy – which the company says is vital given the nature of its client base.

Meanwhile, Williams Advanced Engineering has also won a prestigious award for the application of its work in the renewable energy field. The company won the Pioneer Award at the 2014 British Renewable Energy Awards, said to be one of the most important events in the nascent industry's calendar. The Renewable Energy Association's Pioneer category is designed to honour an organisation that is traditionally outside of the sustainable energy industry yet has broken new ground in the use of renewable fuels, heat or power.

Williams Advanced Engineering has a new hi-tech headquarters

Williams won the award for its work in taking high efficiency flywheel energy storage technology, first developed for the 2009 Formula 1 car, and bringing it to market in the renewables and transport sectors. A case study that was of particular interest to the judging panel was a recent project that sees the Williams flywheel technology installed on two microgrid generation systems in the Scottish highlands.

Craig Wilson, managing director of Williams Advanced Engineering, said: 'The fact that in less than five years a technology first developed for a racing car is now being installed on a renewable microgrid is testament to the ability we have to accelerate technical innovations that help address important issues such as global warming. It's a real honour to be acknowledged for our R&D work at such a prestigious awards ceremony.'

BRIEFLY

Simmers world

French design software giant Dassault Systèmes has snapped up German simulation company Simpack for an undisclosed sum. Dassault Systèmes – which describes itself as a world leader in 3D design software, digital mock-up and product lifecycle management – tells us it will now be able to expand its Simulia simulation technology portfolio to improve its virtual concept validation and add more real-time experience. Specialising in real time multi-body simulation of friction and flexible structures, Simpack, based in Munich, has an impressive customer base of more than 130 names in the energy, automotive, and rail industries, including BMW, Daimler, Honda and Jaguar Land Rover.

OBITUARY – Stephanie Kwolek

The chances are you have never heard of Stephanie Kwolek who died recently aged 90, but it's certain that if you are reading these pages you are more than aware of her best known invention. The native of Pittsburgh, Pennsylvania joined the DuPont company in 1946 where she worked as a research chemist. During her time there she came up with many innovative concepts including a way to make Nylon in a glass beaker at room temperature, but it was in 1964 while looking at potential materials to use in automotive tyres that she almost by accident when experimenting with aramid fibres created a new strong polymeric fibre (a para-aramid). It went on to be released commercially as Kevlar, and now can be found on almost every modern top level competition car in the world.

Perhaps the reason that Kwolek is so little known in the motorsport industry is that she had little involvement in developing its applications. She also did not profit from the invention, with the patent being owned by her employers DuPont. She died on 18th June 2014.

Stephanie Kwolek: 1923-2014

CAUGHT

The No.41 Stewart-Haas Racing Chevrolet, driven by Kurt Busch, was penalised in the wake of the Daytona NASCAR Sprint Cup round in July after a track bar, or panhard bar, was found to be out of position, altering the car's handling characteristics. As a result Busch was docked 10 championship points while team boss Gene Haas lost the same number of points in the owners' standings. Crew chief Daniel Knost was fined $10,000.

FINE: $10,000
PENALTY: 10 points

Eric Phillips, crew chief on the No.51 Kyle Busch Motorsports Toyota in the NASCAR Camping World Truck Series, has been fined $5000 after the truck failed to meet the minimum height limit at the Kentucky Speedway round of the championship. Team owner Kyle Busch was also docked six points in the owners' championship.

FINE: $5000
PENALTY: 6 points

INTERVIEW - David Richards

On the move

Prodrive might be moving home, but its winning ethos stays in place. We talked to David Richards about his company's past glories, rare failures and future plans

By MIKE BRESLIN

"It's got to be aspirational; it's got to be exciting; it's got to be something you want to watch"

Since the 1980s a gleaming white edifice has stood alongside the M40 in Banbury, its walls a polar expanse broken by just one word: Prodrive. Sight of this building has always enlivened a boring motorway journey, if for no other reason than the yumping Subarus, fire-spitting Le Mans Astons, and door bashing BTCC BMW M3s it brought to mind. But now Prodrive is on the move.

The relocation is commercially driven, the prime site having been sold to retail giant Marks & Spencer, but then this has always been an overtly commercial base – the fact that the building faced out on to the motorway and not the business park is no accident, it was always seen as part billboard, Prodrive founder and chairman David Richards tells us.

'It's a fairly big upheaval,' Richards says of the move. 'But it only really affects the motorsport side, not the other aspects too much. We will be in new premises by next March, still in Banbury, but not quite so prominent alongside the motorway. But we've got some plans for the new site which I think will be equally high profile.'

In the meantime those shopping for lingerie and lettuce in the new M&S might not be aware of the motorsport heritage of the site. Yet heritage there surely is, for Richards set up Prodrive in 1984 and in the 30 years since it's done just about everything there is to do in the motorsport world, from touring cars to WRC, via GT and LMP.

Richards himself comes from a rallying background, he was co-driver to Ari Vatanen when the Finn won the WRC in 1981, and it is with rallying that Prodrive's found its greatest success, not just in terms of results, but also with what is perhaps one of the greatest demonstrations of how motorsport can change the perception of a brand.

Back in the 1980s Subarus were known as farmers' cars, if you saw one on the road chances are it would have been a pickup version with a border collie barking in the back. Then along came Prodrive. 'It was one of the best examples of how to use motorsport in a transformational way for a brand,' Richards says. 'Subaru took what was a farmers' car and made it into an iconic vehicle for petrolheads. And that's something we should all be proud of here.

'It came about because of a couple of key things,' Richards adds. 'The most important of all was an individual at Subaru called Ryuichiro Kuze, who just had total confidence in Prodrive. Because they weren't very active on the marketing front they gave us a free rein. Which meant we had a consistent approach to it. We got the colour scheme right from the word go, we didn't deviate from it; we got the [Colin] McRae factor that raised the game for everybody. Sometimes everything aligns, it works well, and that's what happened.'

In 2008, after three drivers' and three manufacturers' titles, Subaru pulled the plug on its WRC programme. Reasons for this were manifold, explains Richards. 'Firstly Toyota had taken a stake in the company and the company was changing. The technical regulations were going against us at that point in time, too, and it came at a time when the whole of the Japanese motor industry was pulling out of motorsport: Honda and Toyota withdrew from Formula 1, and it was the thing to do at the time, unfortunately.'

Since then Prodrive has embarked on another WRC adventure, this time with BMW, which is well-known for its motorsport heritage. With its brand, Mini, the programme launched with, in its earliest BMC incarnation, a rally legend. It seemed like the dream deal. So what went wrong? 'The problem was due to the championship itself at the time,' says Richards. 'Basically the promoter went into administration and there was no promoter just at the time we were about to launch the programme [in 2011]. BMW lost confidence in the championship, so the finances weren't there from them, and nor were there any commercial sponsors out there given the circumstances around the championship, which to a great extent still prevail today.'

Besides the promotion of the sport, Richards also sees a more fundamental problem with the WRC. 'I think at the centre of every sport, particularly motorsport, if you want to gain the public's interest the product has got to be appealing; it's got to be aspirational; it's got to be exciting; it's got to be something you want to watch. Now, with all due respect to the great products these car manufacturers make, you're not going to get too excited about a Polo or a Fiesta, are you?'

But you are going to get excited about an Aston Martin, the marque that Prodrive and Richards has been closely associated with for years – he was its chairman until 2013. Prodrive and Aston has enjoyed great success in sportscars, with three Le Mans GT wins. But it's not all been plain sailing and a move to an entirely in-house built LMP1 in 2011, the ill-fated AMR-One, proved character building to say the least.

'That was a project we took on too late and with too little resources,' says Richards. 'It's a truism in most forms of motorsport: you'd rather have double the time and half the money. I think the concept was sound. But I think we tried to rush it. If we were going to do it again I'd give ourselves double the time to do it, and probably do it at the same budget.'

It's a lesson Prodrive is sure to take into its next projects. It's currently looking at Formula E (though only in year two when powerplants are free and it can use its engineering expertise) and the Dakar, the latter of which Richards says will be with a manufacturer, although he is not saying who just yet. As far as other programmes are concerned the company is actually in a fairly unusual position. 'Twice a year we have a review internally, into what is out there, what formulas are growing. But with a company of our size it can be a problem. If a motorsport programme is fairly modestly priced there are so many people out there doing it so cheaply we just can't be competitive on a commercial level.'

Prodrive might be seen as too big for its own good (it almost got to F1 on two occasions, 2008 and 2010) as far as motorsport projects are concerned. But then Prodrive doesn't really need the sport these days, and some might be surprised at the extent to which it has embraced non-motorsport business. Motorsport now accounts for just 30 per cent of the work the company undertakes – it is also involved in automotive, aerospace and even the European Mars Rover space project. Yet Prodrive is still a motorsport company at its core, insists Richards. 'I think that's the beating heart of the organisation, and that's the way we behave in terms of the approach. Everything we do, we go about it with a motorsport spirit. That's why car manufacturers and other companies come to us, because we apply that same philosophy that we've always applied in succeeding in motor racing.' While the drive up the M40 to Silverstone might not be quite the same, Prodrive will continue to do what it does best; be it at Le Mans, in the deserts of the Dakar, or even on Mars.

Prodrive's rally programme helped to open up new markets for Subaru, expanding beyond the utility sector with a serious performance car image

RACE MOVES

Jean Michel Jalinier, the president and managing director of Renault Sport F1, has resigned from the role, citing personal reasons. **Jerome Stoll** has now taken over the duties of president, alongside his position as chief performance officer and group sales and marketing director at Renault.

Tom Stallard is now **Jenson Button**'s race engineer at McLaren, taking over from **Dave Robson**, who had worked with Button since he joined the team in 2010. Stallard was previously Button's performance engineer, while he also won an Olympic silver medal for canoeing in Beijing in 2008.

Cyril Abiteboul has been appointed managing director at Renault Sport F1, reporting to **Jerome Stoll** (see above). Abiteboul comes from the Caterham F1 team, where he has been managing director since 2012. He previously worked in senior roles for Renault from 2001 to 2012.

Mercedes motorsport boss **Toto Wolff** has sold some of his shares in the Williams F1 team to **Brad Hollinger**, an American entrepreneur known for his work in the healthcare field. His company, Vibra, owns 90 hospitals in the US. Hollinger has bought a five per cent stake in the team from Wolff, with the option of purchasing the Austrian's remaining 10 per cent later in the year.

Dr Frank-Steffen Walliser is to take over the role of vice president of motorsport at Porsche at the start of October, succeeding **Hartmut Kristen** in the position. The latter is moving on to take on an advisory post in Porsche R&D. Walliser will now be responsible for the company's GT racing activities, though he will also keep his position as 918 Spyder project manager.

At the FIA's recent World Motor Sport Council meeting in Munich it was decided that the Formula 1 Friday night curfew, which limits overnight work on cars, is to be extended from six hours to seven hours in 2015, and then to eight hours in 2016.

Chris Murphy is now the technical director of the BRDC Formula 4 Championship. Murphy has a wealth of motorsport experience, including spells at F1 outfits such as Lotus, Zakspeed and Lola, as well as working in sportscars, DTM, and more recently GP2. In his new role Murphy will provide liaison between the F4 teams and MSV's technical department.

Red Bull aerodynamics boss **Peter Prodromou** will start work at McLaren in September. Prodromou signed with McLaren at the end of last year but Red Bull insisted he saw out his contract, although the news that he will now join some months earlier than expected suggests an agreement between the two teams has been reached.

Tom Campbell, the president and CEO of SCCA Pro-Racing Ltd., is to retire later this year. He will be replaced by **Robert Clarke**, the former boss of HPD (Honda Performance Development). Clarke was at the helm at HPD from 1993 until 2008.

Former Jordan technical head **Gary Anderson** has been awarded an honorary degree by the University of Ulster. Anderson was made an honorary doctor of science in recognition of his work in motor racing. The Northern Irishman has also worked for Stewart/Jaguar, Ensign, Brabham and McLaren in F1, and is currently a motorsport media pundit.

Well-known NASCAR engine builder, car owner and crew chief **Ray Fox** has died at the age of 98. Fox was a native of New England but he moved to Daytona to begin working as a race mechanic following service in the US Army during World War II. He went on to become an engine builder of repute and in 1962 he became a team owner, his cars winning 14 races from 200 starts in NASCAR's top division.

Colin Smith, managing director of NASCAR Digital Media, has now assumed responsibility of managing day-to-day

Infiniti engineering talent search winners announced

Engineering student William Priest, pictured with Adrian Newey, will begin his Formula 1 career in September

Three engineering students from the UK and the USA have landed dream jobs with the Red Bull Formula 1 team after coming out on top in a global talent search.

After an intensive three-day world final event in the UK, which saw 12 hopefuls from around the world competing for victory in the Infiniti Performance Engineering Academy, William Priest from Chesham, Buckinghamshire, Eric LaRoche from Hamilton Square, New Jersey and Jason Zilde from Laguna Beach, California were announced as the winners.

All three will now take up a 12-month engineering work placement with the team, beginning in September. They will receive accommodation in the UK, an Infiniti company car and full salary as part of their prize.

UK winner Priest studies mechanical engineering at the University of Exeter and has gained motorsport work experience as a race engineer with the TH Motorsport British Touring Car squad. He is also familiar with Red Bull Racing, having spent two weeks working in the design department.

La Roche studies mechanical and aerospace engineering at the University of Maryland and gained engineering experience working at Chrysler's Viper GTS-R team in the American Le Mans Series, as well as aviation giant Boeing.

Zilde studies mechanical engineering at the University of Southern California and his experience includes being team captain of a Formula SAE effort. He is familiar with Infiniti having completed work experience at its North American Technical Centre.

The 12 finalists were selected from over 1500 entrants at 100 top engineering universities worldwide.

Red Bull technical chief Adrian Newey said: 'It's an incredible achievement for the winners to have made it through this process and I was extremely impressed with the calibre of all 12 of the finalists.'

Newey added: 'For the winners though, the work really begins now, and we look forward to bringing them into the team in September.'

SPONSORSHIP

Japanese electronics giant **Panasonic** has extended its relationship with NASCAR Sprint Cup outfit **Hendrick Motorsports**. It will now be the primary sponsor of Jeff Gordon's Chevrolet for two races each season until 2016, advertising its Toughbook brand on the car. It will also be an associate sponsor for all other races.

The FIA Formula E Championship has entered into a partnership with the **Albert II of Monaco Foundation**. The Foundation, created by Prince Albert II of Monaco in 2006, is dedicated to the protection of the environment and the promotion of sustainable development. The Foundation's efforts focus on three main sectors: climate change and clean energies, biodiversity, and integrated and sustainable water management.

RACE MOVES – continued

M-Sport boss **Malcolm Wilson** has been given the award for Outstanding Contribution to the Motorsport Industry by the MIA (Motorsport Industry Association). Wilson has had rallying success as both driver and team owner, and his Cumbria-based organisation won the World Rally Championship for Ford in 2006 and 2007.

operations for the sanctioning body's digital platform. Smith, who joined NASCAR in 2012 after a 17-year career at Raycom Sports, will be responsible for the entire digital operation, which includes NASCAR.com as well as the tablet and mobile side of the business.

John Martin, managing director, digital and business operations for NASCAR Digital Media (NDM) is to take on additional responsibilities, and will now report to **Colin Smith** (see above). Meanwhile **Brian Herbst** has been promoted to senior director, content rights and partnerships at NDM, **Mike Sales** has been promoted to director of design, and **Donald Baal** has been promoted to senior manager database marketing.

NASCAR has announced a raft of promotions in its communications departments. **Patrick Rogers** has been elevated to senior director of driver marketing services, **Evan Parker** becomes senior director of brand platforms and **Scott Warfield** has been promoted to senior director of social media and broadcast communications.

Simon Blunt has been appointed general secretary at the Motor Sport Association (MSA), the body that oversees UK motorsport. Blunt replaces **Rob Jones** in the role, following the latter's promotion to chief executive. Blunt originally graduated as an engineer but went on to work as a solicitor, while he is also a race licence holder and classic car enthusiast.

Tom Higgins, once a reporter on *The Charlotte Observer* has been named as the recipient of the 2015 Squier-Hall Award for NASCAR Media Excellence. Higgins was the first mainstream journalist to cover every event on the NASCAR schedule, reporting on the sport from 1980 until his retirement in 1997.

Mercedes-Benz awarded the winners of its Apprentice of the Year competition in the UK with a week of work experience at the F1 team's base. The winners were **Ben Allcorn**, **Ashley Donnithorne**, **Lan Dempsey** and **Dominic Drury**.

Veteran NASCAR radio broadcaster **Barney Hall** has hung up his microphone after commentating on stock car races for 54 years. Hall (82) is not retiring from the sport entirely, though, and he intends to take on some feature-led projects with Motor Racing Network, the channel he has been with since 1970.

Prior to the British Grand Prix the Motor Sports Association (MSA) released figures for the number of volunteers involved in the event: there were 1032 in all, including 105 medical personnel, 86 flag marshals, 20 rescue personnel, and 325 spectator marshals.

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


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This new range of torque wrenches from Laser Tools are of a strong and robust design, and offer three sizes: 1/4in-drive (part no: 5865), 3/8in-drive (part no: 5866) and 1/2in-drive (part no: 5867). Dual scale, with a separate easy to read unit graduation the wrenches feature a locking ring to maintain the setting.
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Sensors
Variohm linear range

Variohm EuroSensor has introduced a new version of their well proven VLP linear potentiometer sensor. The new VXP offers improved sealing, longer life and higher temperature capabilities. These new design changes are aimed specifically at the demanding motorsports industry and has already been tested and approved by a number of existing motorsport customers.
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The new VBOX LapTimer from Racelogic is a 20Hz GPS data logger and display, recording your on-track performance for later analysis and outputting predictive lap times and Delta Velocity. Instant feedback: Delta Time tells you if you've made a mistake; Delta Velocity lets you know if you're about to!
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Wall to wall racing

There are serious proposals to make racing a year-round activity, but what does this mean to supply companies and how you use the established trade shows to maximum effect?

There is no such thing as the 'off-season' in motor racing anymore. It used to be that the monotony of being at home in winter was punctuated first by Christmas, then by the Autosport International Show in Birmingham, and then the Daytona 24 hours at the end of January. The latter two were the perfect way to see in the new year, with the ASI show the place to do business, secure deals and gear up towards a new season. The second was the first of the endurance racing classics, an historic event that got everyone out into the sunshine for a bit.

Today, the off-season has moved towards the month of August. As this is written, Formula 1 is going through the enforced two week lay off period followed by a re-start to prepare for the Belgian Grand Prix. For those looking further ahead to show season, there is a bit more planning to be done, as not only do new products and new ideas need to be finalised and ready to sell at trade shows, but races need to be catered for too.

The Grand Am series was one of the first to dramatically change its schedule to finish early in September, before the college football season started and soaked up the television air time (not to mention the family hours that are used watching sport). They didn't want to compete with the more popular sports in the cross-over period, so crammed in the races as best they could, and delivered a fast-paced series with racing virtually every weekend.

The results were encouraging, so now organisers are looking to repeat that model and introduce more races through the winter. The Dubai 24 hours was held on January 10-11 this year, and teams and personnel were stretched between that, and the 'Roar before the 24' in the US, a test session ahead of the Daytona 24 hours.

New calendar

Yet it is about to get worse, if plans for the World Endurance Championship reach fruition. With Le Mans in June being the largest race of the season, a double point scorer (due to its duration in a series of six-hour races), and with the August layoff not long after, it is the perfect place to finish the year. There are problems with that – not least with homologation of cars and parts, the introduction of an entirely new calendar and so on. Audi's motorsport boss, Dr Wolfgang Ullrich, confirmed that the idea was being looked at, but that the pros and the cons have to be weighed up before a final decision is made. What is the point, he says, if the two don't balance out? What it would mean, of course, is that the whole supply chain to motorsport would have to change, lead and delivery times for new cars would be different, and actually in the UK, racing would compete for air time and space on the sports pages with soccer, almost a way of life here (not that you would notice it given our performance this year in the World Cup, a competition which coincidentally keeps soccer on our screens almost year-round once every four years). No longer would the focus be on racing through the traditional months, from March to October (or stretched to December as in 2013). Now, the focus would be on year-round supply to various series.

The whole supply chain to motorsport would have to change, including lead times

And that leads to a need to plan very carefully how an exhibiting company schedules its work. The shows will always be used as sales tools to the industry, as well as to show off the sport to the public and give them greater access to the cars, and the drivers. Through the different halls at the Autosport Show, the public is treated to a variety of sport, cars and history that cannot be found anywhere else. From the newly-created Low Carbon area within the Engineering show to the established Formula 1 pit lane and the Piston Heads show, there is plenty to hold the attention of the public.

So, if the racing season moves to become a year-round activity according to which series you contest, when do you bring out your new products? When do you sign your year-long contracts? Would it be easier to create rolling contracts? The Autosport International Show will always provide an arena for the industry to mix with suppliers, buyers, teams and public, regardless of the scheduling of the race series. All companies have to do is make sure that you are ready to support the shows, as well as the races, to make sure you don't miss out on a golden opportunity.

The motorsport calendar is under pressure to stretch into the 'off season' to avoid competition between categories rather than other sports

Q&A WITH ZIRCOTEC

Zircotec's coatings experience in the nuclear industry led to an involvement in motorsport that began in 1994. Peter Whyman, sales and marketing director at Zircotec, discusses the industry and what the future holds.

Q. Zircotec has been in the motorsport industry for a number of years. What has been the most significant change over that time?
A. The main change has been in the rise of composites from being a niche coating application when we first looked at this in the late '90s in F1, to now being a major element of our motorsports business. It is not just in F1, as we are coating parts in the FIA World Endurance Championship, touring cars and club motorsport.

Q. Autosport International is celebrating its 25th anniversary. What has been the most notable anniversary for your business?
A. Zircotec's involvement in motorsport stretches back 20 years to 1994, when the thermal barrier coating was applied to the exhausts and manifold of Subaru rally cars to lower in-cabin temperatures. 2015 will also mark five years since we moved from the secretive Harwell Site to our facility in Abingdon, which enabled us to bring in new finishing processes and significantly higher capacity.

Q. What are the main challenges that you currently face working in the motorsport industry?
A. Our biggest challenge is time. The motorsport industry wants parts returned immediately, something that is a challenge with a specialist process. After this winter we increased capacity with the ability to run a night shift and also took on and trained more staff. This was necessary as our thermal barriers were highly sought after by F1 teams as it provided protection in the more tightly packaged engine bays we have in 2014. Seasonality is also a challenge but with championships such as WEC considering a winter schedule we could see some flattening out of demand during those winter months when everyone wants everything yesterday!

Q. What can we look forward to seeing from Zircotec in 2015?
A. You can expect to see more new products and derivatives of existing products from us. We've been doing a lot of motorbike work and we enjoy a technical partnership with MOTO2 leaders MarcVDS, who have been assisting us with development and testing in 2014. We've already launched a tougher road bike coating that is extremely successful and we are always looking for more technical partnerships and plan a further one in sportscar racing. This will join our work with Andrew Jordan in the British Touring Car Championship and JMW in the European Le Mans Series.

Q. What is the most significant industry issue for your business at the moment?
A. Zircotec is growing very quickly at present and we are looking for good people to join us and we have taken on six people in the last six months. As we grow and diversify we need these people to support the new customer groups and sectors.
Q. Many people in the industry talk about a lack of skilled talent and graduates in the engineering industry, what are your thoughts?
A. We have had success with a number of school leavers joining our manufacturing team, as they are motivated and keen to show what they can do. We haven't needed to recruit from the graduates.

Q. What are your hopes for Autosport International 2015?
A. Autosport International continues to offer Zircotec the best method of meeting motorsport customers from all levels and from all over the world. Last year we had everyone from a short circuit driver through to an Formula 1 engineer on the stand and crucially we also met a good number of people from outside of motorsport, which included car manufacturers and even engineers from aerospace businesses.

Q. The motorsport industry has changed considerably over the past 25 years, what one element do you feel will change most over the next 25 years?
A. There is a considerable swing towards efficiency and we expect this to continue. That bodes well for Zircotec as our technology enables the use of lightweight composites in high temperatures where previously heavier metals had to be used. Efficiency is also about packaging and we allow engineers to put sensitive components closer to heat sources, which we have seen a lot in F1 this year. On a sporting level, we think there will be more focus on the entertainment side, which will include double points, reverse grids and shorter races.


Zircotec technology is providing high temperature protection for lightweight materials

Tickets are on sale for the show, held at the Birmingham NEC, on 10-11 January 2015. Advanced Adult tickets cost £32, children £21 (under fives go free). Group tickets are available. Paddock passes cost from £42, VIP from £120.

Paddock passes include general admission plus access to Driver Signing Area, the backstage Paddock Area and a paddock guide.

VIP tickets include: access to the VIP enclosure at the Live Action Arena, complimentary champagne and canapés, a Club Lounge, complimentary parking, access to Driver Signing Area and dedicated VIP signing sessions, fast-track entry to the Live Action Arena and access to the backstage Paddock Area.

For more information call +44 (0)844 581 1420 or visit www.autosportinternational.com

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Spin avoidance

There is, it appears, no room for criticism anymore in racing; the message from press and PR must always be positive yet the sport, particularly Formula 1, is searching for new ways to attract an audience. There can be no better way of generating coverage than to manage a fight between drivers or manufacturers, have accusations of pushing boundaries too far and push technology to its limit, but racing is headed onto a different path.

DTM boarded the 'Good News Gravy Train' years ago, burying bad news or criticism. This tactic has led to established magazines ignoring the series, yet others appear to be adopting this self-defeating philosophy. Good news doesn't necessarily sell; gossip, and if possible scandal, is a God-send. Who looks back at the Senna-Prost years and thinks; 'that wasn't racing'? It was competition, pure and simple. Who looks at the imposed love-in between Hamilton and Rosberg, and thinks; 'awww.' I preferred it when they were at loggerheads. Much coverage has praised Mercedes' decision to let them fight, as long as thev bear in mind that they drive for Mercedes, not for themselves. That, to me, is a respectable limit. Yet there are others who are going a step further, and here I am looking at Le Mans, and the World Endurance Championship.

Racing is not a corporate message facility

At Le Mans this year, questions were raised about the legality of Porsche's bodywork, and Toyota's braking system and rear wing. Manufacturers referred journalists to the FIA – we present our opinion, they said, and it was then up to the governing body to sort out legality. Normally if there is a question of legality, teams can't wait to highlight the issue. Pressure is applied, column inches are filled, airtime is devoted and eventually it all blows over until the next drama. According to sources, teams were later told not to repeat the airing of dirty washing in public. This looks suspiciously like a move to bury bad news, and that is not how you endear yourselves to the media or fans. I loved the fact that the manufacturers were pushing the boundaries, that arms were waving, accusations were flying and questions were being artfully dodged. That's part of the game, and the teams love to play it too. When Audi introduced its blown diffuser at Sebring in 2013, they took bets on how long it would take the media to work it out. Answer; until Silverstone in May. They were disappointed in us.

Instead, a three-page list of dos and don'ts was issued by one GT manufacturer to its drivers. One of the rules told its drivers what to tweet if a car retired from the race. Watch the ratings plummet – racing is not a corporate messaging facility. Fans want to hear about the pre Le Mans testing crash at Aragon between the LMP1 Porsche 919 and the GT Porsche RSR when they were the only two cars on track.

Before the curse of the safety car arrived in Formula 1 in 1992, yellow and red flags were considered to be sufficient for any eventuality. The safety car was introduced to neutralise racing while work was carried out. These days, the safety car can now be a race decider. So, regulators have spent years trying to figure out how to make it fair. The latest from Le Mans was to introduce a slow zone. This caused new problems as some approached the slow zone at full tilt, and then dropped anchor, some eased up gradually, others slowed down quickly at the start of the zone and the traffic backed up unexpectedly behind it. This was all manageable, yet following heavy accidents on Wednesday in qualifying, there was no appetite for a full-blown run for pole on Thursday and as the top LMP1 cars were rolled onto pit lane with low fuel and fresh tyres at 11.30pm, it was announced that selected slow zones would be in place until the end of the session. The cars were packed away again, a perfectly good qualifying battle ruined.

Now, Formula 1 has taken the safety car concept to a new level, and introduced a standing restart in an attempt to make the sport more appetising for the global television audience. The standing start is, according to FIA Race Director Charlie Whiting, the most exciting part of a Formula 1 race, and so the FIA has worked out how to introduce such a phenomenon. With fast degrading tyres to force pit stops, DRS to help overtaking, double points for the last race to maintain interest in the championship, and now artificial standing starts, it's hard to take this seriously any more. We're losing the purity of racing as a high-speed game of tactics. Reach that flag first, be a champion.

Incidentally, standing starts present new options for teams. Do you pit under the safety car for fresh tyres and give up track position? Do you leave the number 2 driver out on cooling and worn tyres, and then go into the first corner from the front row? Is a standing start safer than a flying start? Is this a safety measure for a safety car procedure?

Motor racing's format should be consistent – a green light to start, a pre-agreed duration, and the chequered flag to finish. Whoever has completed that distance the fastest, or completed the greatest distance in a pre-agreed amount of time, shall be the winner. Recent measures have made a mess of the bit in the middle, the actual racing.

The old adage of 'when the flag drops, the bullshit stops,' will no longer apply unless the media ups its game and stops swallowing the persistent positive news. Scandal is bad, apparently, and gimmicks are good. I humbly suggest these may have got confused.

ANDREW COTTON Editor

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