Leading-Edge Motorsport Technology Since 1990

Racecar engineering™

December 2014 • Vol24 No12 • www.racecar-engineering.com • UK £5.95 • US $14.50

Super GT goes global

'World Cup' plans taking shape for two-litre Class 1 cars

Williams FW36

British team returns to the sharp end of the Formula 1 grid

Damping technology

We examine suspension development in Formula 3 series worldwide

Peugeot 2008 DKR

French manufacturer launches full SUV-based Rally Raid programme

NEW

The Dry Sump Vacuum Race Hose

ProPLUS Xtreme

An engineered design with an externally wound stainless steel wire that provides great vacuum support and tight bend capability.

A high flowing, smooth bore, PTFE tube with external convolutions for flexibility. No internal convolutions that can cause flow restrictions.

A choice of lightweight braids:
XM - XtraTemp Mono or XK - Aramid

An exceptional achievement in race hose technology... Perhaps perfection.

The evolution in FLUID HORSEPOWER™ continues...

Go to www.xrp.com to learn more about the complete XRP ProPLUS Race Hose™ product line.

Like us on Facebook/XRPinc

Follow us on Instagram @XRPracing

USA	XRP, Inc. tel 562 861 4765	sales@xrp.com fax 562 861 5503
EUROPE	JLS Motorsport tel 44 (0) 121 525 5800	motorsport@lister.co.uk fax 44 (0) 121 525 4833

XRP®

THE XTREME IN RACECAR PLUMBING

CONTENTS – DECEMBER 2014 – Volume 24 Number 12

COVER STORY

COLUMNS

FEATURES

TECHNICAL

BUSINESS NEWS & PEOPLE

A symphony is no joke

The sound of a full grid at the start still stuns even the most jaded spectator

Having previously covered the topic of smells in the paddock, we can apply ourselves to the next sense, sound. My editor's steadfast refusal to print my stillborn column on taste in the paddock still hurts…and will leave a sense out of the compendium.

The cars are, of course, the lead singers in this symphony, bellowing lustily from the diaphragm of their engines. Obviously engine capacity also influences the note and volume, the deep rumble of American V8s are like summer thunderstorms approaching, but at a more frenzied pace, and the high-pitch screaming of the 1-litre F3 in days of yore sounded like rabid piccolos swarming in groups. Even the whistle and pop of blow-off valves on turbos was a musical passage, and crackling of lean mixtures on over-run accompanied with gouts of flame a staccato beat to preceding the wail as power came on for NA engines. The near 15000bhp of a full grid today is not as impressive as previous years, but the crescendo of sounds at the start will excite the most jaded listener.

Engine note is music to any aficionado's ears, with the possible exception of the Mazda rotary engine cars at Le Mans, and elsewhere. That thing screamed loudly, and after two hours of racing had the crew of every other car in the race praying for them to break down. After 12 hours of feeling that your tympanic membranes were having icepicks pounded into them there was a distinctly murderous tinge to your thoughts. This could also be the reason the ACO eventually banned rotary engines, a move that was heartily applauded by the whole paddock. Endurance racing, with different classes and engine types, is a full opera, with basses, baritones, tenors, contraltos and sopranos, while single-seaters tend to the Gregorian chant of Benedictine monks.

The clunk of gears being engaged in a dog-box, the whine of straight-cut gears and the chirp of tyres leaving pits, commentators on the track sound system, the juddering clunk and momentary locking of tyres that tells you how much the limited slip diff is working and what type it is when cars are being pushed around by the crews, down to the clink of tools, plaintive cries for coffee and the buzzing of neon lights during all-nighters are all part of the aural tapestry of racing.

The now-delayed ban on radio communication with the driver from the pits can be also conflated into sound. With the passage of time we went from screaming into the front of the helmet, easy when open helmets were the norm, to having plug-in intercoms (with coily-leads) that added an extra danger to being in the pit-lane.

Hasty drivers departing suddenly, before you unplugged, fostered the habit of always talking with one hand on the plug to forestall being dragged off down the pit-lane by your ears…

Also holding a pen, your clipboard and a stopwatch, you acquired skills that would enable you to find a job as a juggler when retiring from racing. The ear-cans also gave a modicum of protection to crew, previously exposed to noise that produced an early degradation of hearing ability but only in a restricted range of our ability to discern sound from 20Hz to 20000 Hz.

Race crew are deafer in the right ear from being on the pit wall at clockwise circuits

Cosworth V8s were slap in the middle of the typical adult female range from 165 to 255Hz, or at least that is my excuse when I miss what my wife is saying (don't try this at home, chaps, trust me, it doesn't work.)

There is a whole generation of racing crew who is deafer on the right ear, from being on the pit-wall in mostly clockwise circuits while Matra V12s wailed by, plus the rumbling gaggle of Cossies, BRM and Ferrari V12s and boxers playing the high notes...

Proper radio communications brought a new medium in which to hear drivers' excuses, sometimes while they were in the throes of having a whoopsie moment and greatly improved the noise-to-signal ratio. Well, at least for the sounds, the drivers' words being as vague as usual…Shannon-Hartley's information theorem not taking that in account.

Keeping your silence is a mark of the road-hardened engineer, only asking for illumination on important subjects when it cannot be gleaned from telemetry (if you have it…), and forbearing to micro-managing the driver. Raikonnen's 'Leave me alone, I know what I'm doing', at the Abu Dhabi GP is an iconic moment, demonstrating this foible.

Some drivers are taciturn, others chatterboxes. I once had a driver (who will remain unnamed for obvious reasons), while in Champ cars who gave a running description as he was racing, along the lines of 'just behind him, will try, ah, oops, goddamn, that was a close one, hoo-wee, nearly creamed the wall, go, go, go, shit, need more boost, how many laps to pit? Arghh he's closing, he's closing, hah, that showed him, bet he needs an overall change now…'

Music to her ears? Susie Wolff demonstrates old-fashioned noise-reduction techniques

The limitation of transmitter power enforced by the licensing authorities also restricts your radio-range on some tracks, despite the forest of high-rising telescopic antennae at the back of the pits, sometimes doubling as flag-poles, giving a dead zone where you cannot hear or speak, places like the Nordschleife and Le Mans being the obvious culprits. Or opportunities to ignore messages...

The first lap of any session is dedicated to having a radio check from driver at every corner exit to determine the coverage you have. Before the heavy enforcement we now have on broadcast frequencies and power I worked with a French team that had a 1000W transmitter, so our track-chat was probably eaves-dropped by the Antarctic weather stations. There was no chance of a dead spot...

The drop-out can be annoying; also the cut as the relay kicks in can truncate the transmission, forcing the speaker to wait until he hears the click that means he is on air – good for engineers, as it lets them engage brain before opening mouth, and is why they always sound calm and in control.

The delay in voice-actuated microphones drivers sometimes used is the reason Hiro Matsushita earned the nickname 'King Hiro' from Emerson Fittipaldi, who was complaining about Hiro when baulked lapping him. The radio circuit cut off the first syllable of the first word when he said 'F*cking Hiro!'

Different nationalities have different radio-modes, but English is a good, clear language to cut through the hiss and crackle of radio transmission. One has never been able to understand the difference between sousvirage and survirage or dessus and dessous, after all.

In the end it boils down to this: 'The single biggest problem in communication is the illusion that it has taken place.' – George Bernard Shaw.


FERODO
RACING
BALANCED BRAKING PERFORMANCE
All the way to the APEX
B ITE
D ECELERATION
M ODULATION
R ELEASE
THE DRIVER'S PAD
FERODO RACING BRAKE PADS
developed and engineered to perform in all four phases of the braking event.
In addition to the bite and deceleration expected from a world class race pad, Ferodo pads offer the superior modulation and instantaneous release for maximum exit speeds.
www.ferodoracing.com
FEDERAL-MOGUL MOTORPARTS
SELECTED RANGE NOW AVAILABLE THERMALLY BEDDED
WorldMags.net

Reflections in the salt

Bonneville retains its draw for those eyeing a wheel-driven 500mph run

One of the items on my bucket list was Bonneville and recently, I had the opportunity to tick it off by being there during the Mike Cook Shoot Out, a promotion put on by Mike Cook Events, which is the only time and place where the FIA provides sanctioning for World Land Speed Records. It does, of course, sanction individual attempts, but during this week anyone running is officially timed over precisely measured mile and kilometer distances.

One of the pleasures of being there was meeting Mike Cook Snr, the middle player of a three-generation dynasty of dragster and Funny Car racers and Bonneville speedsters. The years of experience show through in the organisation of this yearly event, in one of the most extraordinary environments on earth. The salt flats are at the same time one of the most beautiful places in the world and one of the most alien. No plants, insects, mammals or birds exist there, and if there are any bacteria, I didn't see them. Just being on the salt for the first time rings alarm bells about survival. Everywhere there are essential bottles of water, and I was warned that the sun can burn the bits that point downwards, like the inside of one's nostrils.

Because of late rains, there were doubts about whether an adequate course could be prepared, and the event was downgraded to a test session with the official speed event re-scheduled for October. In the end, a fine 11-mile course was laid out and smoothed, allowing full speed runs. Watching the fairly relaxed goings on and talking to participants provided plenty of food for thought about what it takes to go away with a world record from Bonneville. And just in case anyone might think it's easy, George Poteet, 63 years old, rolled his Speed Demon at 370mph the day before we arrived, but was fortunately up and about the next day to tell us about it.

Land Speed Records, LSRs, have historically migrated from tracks (Brooklands), to sand beaches (Daytona, Pendine), to salt pans (Bonneville, Lake Eyre), and finally to dry lake beds (Black Rock, Hakskeenpan). Salt pans are hard, flat and have a friction coefficient of between 0.5-0.6. The surface is like 80-grip sand paper, and works with rubber tyres, albeit very special ones. 400mph+ wheel driven records have been set on salt, but the higher speeds of the jet-thrust and rocket cars now require aluminium wheels to withstand the high centrifugal forces, but not the traction, and the competitors for the ultimate record have sought out dry lakebeds with their alkali playa surfaces. Salt, however, is the surface of choice for the wheel-driven record, and Bonneville welcomes those that chase it.

Currently the wheel driven LSR is held by the late Don Vesco, in his 3750 horsepower, turbine-engined, 4wd Turbinator. He clocked 458mph, with a 470mph highest recorded speed. The fastest piston-engined car is George Poteet, in Poteet and Main's 2wd Speed Demon, with a twin-turbo, 2200 horsepower small-block Chevy, having set a mile speed of 439mph, with 452mph the fastest recorded speed. 500mph beckons.

What does it take? If we look at a typical Bonneville course, the car must enter the 5-mile mark at around 480mph, and leave at about 517mph to cover the mile in 7.2secs at an average speed of 500mph. Taking a typical streamliner's characteristics, say Dieselmax, which are well documented, we have the essential parameters:

Weight:	**2500kg**
Frontal area:	**0.9m²**
CD:	**0.16**
Coeff of friction:	**0.55**
Air density:	**0.98kg/m3**

The key to the result is mass and coefficient of friction. The tractive force is nearly proportional to mass, and therefore acceleration increases with mass. Somewhat counter-intuitive, but:

Tractive force = $K.m.\mu$

(there is little load transfer thanks to a long wheelbase)

Total longitudinal force on the car = $K.m.\mu - \tfrac{1}{2}.\rho.C_D.A.V2$

Acceleration = $\dfrac{K.m.\mu - \tfrac{1}{2}.\rho.C_D.A.V2}{m} = K.\mu - \dfrac{\tfrac{1}{2}.\rho.C_D.A.V2}{m}$

Thus, the higher the mass, the greater the acceleration. But this needs more power. What is noticeable is that there are few exotic materials used in the construction of vehicles, and there is no skimping on safety structures. Also, every bit of spare space is filled with fire extinguishers. The only two things feared are fires and tyres.

At the terminal speed, only weight and friction matter. A Dieselmax configuration car will enter the mile at 458mph, using 2200 horsepower at the wheels, and exit at 492mph and 2370 wheel horsepower. Not fast enough, and simply more power is not the answer.

There are only certain ways to improve the matter to achieve the magic 500mph average:

1. Raise the weight to 4000kg. Now 3970 wheel horsepower are needed.
2. Reduce the CD.A by nearly 40 per cent – a tall order. Power needed is 2470 wheel horsepower.
3. Increase the friction by 10 per cent. Power required is 2700 wheel horsepower.
4. Fit 4wd, then only a 3 mile acceleration length is needed and about 4250 wheel horsepower.
5. Increase the run-up length by over 0.5 miles.

It looks as if Don Vesco did his sums right with Turbinator, and could achieve 500mph given slightly more installed horsepower (exactly what he was doing when he died from cancer in 2002).

Interestingly, only about 1050 wheel horsepower is needed to actually reach a terminal speed of 500mph, and a weight of 650kg would provide enough 4wd traction, or 1075kg for 2wd. Trouble is that it would need 15 miles.

Bonneville imposes its own set of conditions on wheel-driven LSR attempts, and as longer salt pans are not readily available, the earth itself may limit the ultimate speed attainable in a wheel-driven car. Some of the limitations are not obvious at first look.

In some ways the most fascinating vehicle at Bonneville was not a car, but a motorcycle-sidecar named KillaJoule. Yes, it's electric. And it was built and driven by a woman, Eva Håkansson. And it achieved 270mph. Eva, 33, is a PhD student in mechanical engineering at the University of Denver. KillaJoule was built by Eva and her husband Bill, who is also a mechanical engineer and research scientist. Although the design is a team effort involving family and friends, Eva has manufactured about 80 per cent of the vehicle herself in their two-car garage. It has taken five years to build KillaJoule on a shoe-string budget.

KillaJoule's real purpose is eco-activism in disguise. This 19ft, 400bhp, sleek, sexy motorcycle is to show that eco-friendly doesn't mean slow and boring. Eva is also on a mission to encourage girls and women to pursue a career in science and engineering…

George Poteet, 63, rolled his Speed Demon at 370mph the day before we arrived

Salt pans are hard, flat and have a friction coefficient of between 0.5-0.6 – the surface works with rubber tyres, albeit special ones

Clash of Titans

It started with pitching Honda, Nissan and Toyota up against BMW, Mercedes and Audi. Now a global plan is emerging

By SAM COLLINS

It all began in Bavaria. BMW wanted to change its motorsport involvement substantially. Instead of building a competition car that could only be used in one regional series, it wanted to build a car that could race globally. This desire was key not only to the manufacturer's return to DTM but also the introduction of a new rulebook in the largely German championship. That desire has also had a profound impact on Japan's premier racing category, Super GT.

As part of BMW's plan to see its car raced globally, negotiations about a unification of technical regulations between DTM and Super GT began in 2012. Many meetings were held in both countries, and after some fairly tough negotiations it was announced that a German-Japanese alliance had been forged and the GT500 class of Super GT would largely run to the DTM rulebook in 2014. Honda, Nissan and Toyota would in essence build DTM cars (RE V22 V6), so that they could go head to head with BMW, Audi and Mercedes. At least that was the initial idea.

The new generation of GT500 cars was revealed in late 2013 and they utilised the majority of the DTM package including the chassis, transmission, brakes and suspension. However, in the case of the chassis, those used in Super GT would be manufactured in Japan by Toray, rather than using imported German components, although in design terms the German and Japanese products are almost identical.

One of the reasons that Super GT agreed to the unification was a mutually held desire to cut

“If you give the Japanese the chance to reduce costs by reducing development they simply will not do it. It makes cost reduction really hard”

costs in the series, and according to Masaaki Bandoh, president of GTA – the organisers of Super GT – there have been some savings. ‘Like DTM there are three types of component in the cars, the single spec, single design DTM parts such as the chassis and crash structures, then a second group of single design parts, then finally a third group of open parts which in the case of GT500 are all made in Japan,’ he explains. ‘There is a cost reduction on the first two types of parts but the third has seen no reduction at all as the engineers want to develop things.’

In Japan the motorsport industry culture is somewhat different to that of the US or Europe, where marketing departments are largely responsible for funding and promoting manufacturer racing programmes, and this has created some issues in terms of bringing forward the unification of the two series.

‘Japanese motorsport is the preserve of the engineers,’ Bandoh continues. ‘So the budget and funding comes from the engineering department. It makes it difficult because the engineering departments do not like to spend money on marketing or promotion, they just want to spend it on development.

‘Also, if you give them the chance to reduce costs by reducing development they simply will not do it. It makes cost reduction really hard. I think the Japanese manufacturers need to follow the European model where marketing plays a key role.’

One of the clearest areas where this engineering-led approach can be seen in GT500 is the engine bay. Instead of adopting the 4.0-litre V8 formula used in DTM, or the

The idea was Toyota and other Japanese manufacturers would in essence build DTM cars, so that they could go head to head with BMW, Audi and Mercedes. This is the Lexus RC F

continuation of the 3.4-litre formula used previously in GT500 the manufacturers pushed for the introduction of a new turbocharged 2.0-litre four cylinder direct injection formula called Next Racing Engine or NRE.

'Developing the new engine has been a challenge, its almost half the size of the 3.4-litre normally aspirated engine we used in 2013,' says Matsumoto Masahiko, Honda's GT project leader. 'The number of cylinders has been cut in half but with the turbocharger the specific output has been increased significantly. The piston loads have almost doubled which makes reliability hard to achieve and, in addition to that, we are limited to just three engines a season. So you need to proceed with the design and development with the utmost care more than ever regarding durability of the engine.'

While both Honda and Toyota used their engines in the Super Formula series as well Nissan opted not to do so, however Honda was perhaps in an advantageous situation when the rules were introduced as it had already designed and raced an engine with a similar concept.

'Honda has been competing in the WTCC using a four-cylinder 1.6-litre direct-injection turbo engine series from the middle of the 2012 season, and from that we have extensive expertise, such as mapping of the throttle pedal and the elimination of turbo lag through its engine development,' Masahiko continues. 'One of the focuses for us was the elimination of turbo lag, because that is something very important to the drivers. If there is no linearity to the torque characteristics or the throttle response is slow then the driver struggles. So we have developed and anti-lag system, worked on mapping of the throttle pedal and the ECU to reduce the sense of discomfort felt by driver.'

But Honda's 2014 season did not get off to a good start, even with its experience of similar race engine design and development the distractions of the Formula 1 project seem to have disrupted NRE development and it seemed as though the Honda GT500s and its entries in Super Formula were simply down on power.

Commercial drive

'Honda R&D at Tochigi are developing the engine for SGT and Super Formula, and the results in both have not been great in either. But they have developed the engine hard through the year and it now looks much better, maybe they have a chance to win a race finally,' Bandoh adds. 'Honda's engineers don't really like these rules I think, they just want to race with a car that they can develop. Perhaps they are being antagonists to an extent but they have a policy that it must compete with a car that represents the commercial product and that means that it must be a hybrid. The hybrid means we must do a BoP for them.'

Honda uses the Zytek ZPH battery electric hybrid system on its NSX Concept GT which in its original form had a 50kW output. 'Our car, like the series production NSX, is a hybrid and on the racecar we have employed a larger version of the system used on the CR-Z GT GT300 car. Installing the system does increase vehicle weight so we have been making efforts to minimise this effect by optimising the layout of each component, but there is also a constraint that is used in the mid-engined layout on a chassis designed to be front-engined so it is not an ideal layout,' says Masahiko.

Honda's philosophy of developing a mid-engined car for GT500, because that is the configuration of the upcoming production NSX, was a major headache for its engineers and it has undoubtedly cost the manufacturer a lot of performance. As the DTM monocoque is designed to be used on a front engine, rear-wheel-drive car it is not well suited to be used in a mid-engined layout. Cut-outs have had to be made at the front of the monocoque to give the front wheels adequate clearance (when steered) which means the driver has

Lexus RC F. As with DTM there is design freedom below a certain line on the side of the car covering wheel arches and the space between them

Nissan opted not to use its engines in the Super Formula series. This is the GTR

Toyota teams are adopting 2.0-litre turbo formula – this could be the future for 2017

to be sat more centrally in the chassis than originally designed, and this cuts into the area meant to be used for the propshaft. It is said to have reduced the torsional rigidity of the chassis.

'It is not the only disadvantage,' says Bandoh. 'The GT500/DTM cars are meant to be front-engined and as a result they have struggled to cool the car, so have had to use a larger intercooler and general cooling layout. They are struggling to get air to where it needs to be and as a result they had a lot of overheating problems which hit engine performance.'

In aerodynamic terms the GT500 cars run to essentially the same rules as the DTM teams when it comes to the general bodywork, but the performance difference between the 2013 cars and the 2014 cars is substantial. 'Looking at the monocoque and new rules, depending on the circuit some cars are quicker, 1.5-3 seconds faster than the old ones,' claims Bandoh. 'The new cars have more downforce. That increase though may have come from the tyres, so you have to look at the gap to the GT300 cars, but thats all right I think.'

Not everyone agrees and many engineers in the Super GT paddock feel like they have their hands tied with the new cars. 'In the season development of aeroparts is a little restrictive,' says Masahiko. 'We can no longer change the bodywork to suit the track and all we are really now allowed to do is adjust the rear wing angle. But at Fuji Speedway we are allowed to run a special low-drag body. The aerodynamic efficiency of these cars is not that high. The new car has more downforce than the old car but the drag is also higher. So cornering speeds are higher but the straight line speed is similar to

"A focus for us was the elimination of turbo lag, something very important to the drivers – if there is no linearity to the torque characteristics then the driver struggles"

"The newly unified series will come under a new name and the idea is there will be joint races which will create a World Championship"

that of the 2013 cars. This has created a slight problem because it has become harder to overtake the GT300 cars on the straights, and that changes the racing – the racing GT500 class vehicles now have to overtake the GT300 class vehicles in the corner but this is risky.'

Notably the GT500 cars are thought to have a lower downforce level than the DTM cars, as the Japanese machines make much of their grip through the tyres which are open for development and have five competing suppliers. But aerodynamic changes could come to GT500 to reduce that downforce level even further, not because the cars are already faster than those in DTM, but because of the standard of Japanese circuits. 'One issue is that the circuits here in Japan are not as good as those in Europe in terms of run-off, so we have to be careful about safety. The cars are getting a bit too fast so we need to look at ways of keeping the straight line speed where it is but maybe reduce the cornering speeds,' Bandoh admits.

Slowing down the GT500 cars, which have more power than those in DTM currently, would make unification between the two classes somewhat easier and that is very much on the cards. 'Globalisation is important with these rules' Bandoh adds. 'There is a steering committee that has had three formal meetings. The idea is for a unified world championship. Now its a case of working out how that will work but we have agreed that in 2017 we will have the same technical regulations. That means DTM will use the 2.0-litre engines.'

The newly unified DTM/GT500 cars will come under a new name of Class 1 and the idea is that there will be a number of joint races which in essence will create a new World Championship for Manufacturers. But unifying Super GT, an endurance championship, with the sprint race format DTM is far more complex that just having the same technical regulations and there are key sporting issues that are still to be addressed.

'Its very exciting – we want to have joint technical regulations that allow us to race DTM cars in Japan, Super GT cars in Europe and both in the US but there are still some thing to look at,' Toto Wolff, Mercedes' head of motorsport admits. 'For example there is single tyre supplier in DTM and there is a tyre war in Super GT so we have to find a compromise with Hankook who supply DTM – they either have to step up the game or the others have to scale down.'

Tyre tender

Bandoh is also aware of the issue and suggests that the solution is not about increasing or reducing the performance of the tyres in either series, rather its is a matter of finance. 'There will be a tender for the tyres, whichever tyre maker offers the biggest money will get the deal. This is not just greed, its very important because GTA needs to have a larger portion of the money than ITR. Many of the GT500 teams have significant backing from tyre manufacturers, so if they cannot use their tyres so they would lose financial backing so the teams would need to be given starting money.'

Another major area of difference is the engines. While the DTM has already confirmed that it will also adopt a two litre turbo engine formula in 2017, there are some basic differences in the development philosophies of both series. 'The plan is to have a four cylinder turbo, but in GT500 the spec is pretty much open so you can develop the engine a lot more than you can in DTM,' says Wolff. 'We believe that is not an area we want to go in terms of spending, but if it happens that the DTM is fixed spec and the Japanese is open then we will

All DTM and GT500 cars share this chassis, including Honda although this has had to be modified significantly reducing stiffness to accommodate a mid-engined layout

"The Japanese think a homologation period of one year is about acceptable but the Germans want a minimum of three years"

probably use balance of performance. Firstly we want to have our cars racing in Japan. In terms of fuel flow the regulations are very different. There is a big balance of performance in the Japanese series, so you have ballast and after that point it's the flow restriction. But there is a big list of things we are looking at at the moment and working out how we can synchronise them.'

But many in Japan are highly reluctant to use either a BoP or reduce engine development, as engine work is paramount, and some firms, such as Honda, almost see it as a point of honour. 'Its a big problem with the engines,' admits Bandoh. 'There is a huge difference between the manufacturers, for example with the oil pan and crank. The Japanese think a homologation period of one year is about acceptable but the Germans want a minimum of three years. So we are having to make a lot of compromises before we can finalise the technical regulations. The globalisation of Super GT is really important. People must compromise. In 2016 or in 2017 that race will have to have equal conditions including the tyres and engines.'

DTM has also discussed the introduction of hybrids into the the German series using a spec system supplied by Bosch, and with Honda already using a hybrid in GT500 it would at first glance suggest that the Class 1 cars are likely to have hybrid power units, but Bandoh is firmly against that. 'Hybrids in Class 1? no way,' he says with some force. 'In Europe the aim of racing is generally cost reduction. Using the proposed single spec hybrid system you can boost performance from around 510bhp up to about 590bhp according to simulations. In Japan each manufacturer has developed its own hybrid system so you cannot demand they just use someone else's system, it won't happen. If Honda want to take part then the other five manufacturers would have to agree as that car does not meet the rules anyway.'

The Honda NSX GT500 features a mid-engined layout but in its orgininal trim (below) it suffered from serious overheating issues, so extra cooling had to be added in the season (above) further increasing drag

The final piece in the plan for this new world order is North America, and IMSA has taken an active role in the discussions about Class 1. However ideas of a DTM USA or Class 1 race in the US look more like an American dream than reality. 'For Super GT, if the USA DTM style race takes place without US manufacturers like Ford or GM then it has not value for us,' says Bandoh. 'You will never see Super GT cars racing in America if the American brands are not taking part too. Super GT in the US would be good for marketing, of course, but the series would have to have the three big manufacturers running cars too. The grid should be three Germans, three Japanese and three US manufacturers - thats the real idea for Class 1.' So far no US-based car manufacturer has admitted to showing any great interesting in the concept.

Collaborative event

The first big sign of the unification between DTM and GT500 was supposed to have happened in 2014 with a collaborative event in China following a DTM championship round there. But when the German series abandoned its Asian plans the idea collapsed. It would have taken the form of a joint test day featuring a demonstration race, although many of the German engineers were reluctant to put their cars up against the Japanese machines as they knew the European designs would be outpaced.

But there is still a chance the first fruits of the collaboration could come much sooner than expected via a BMW backed GT300 outfit called Team Studie. 'BMW have an intention to enter some race in Super GT next year with a GT500 car, but the problem is they hate balance of performance as a concept. So when we met with them in Tokyo even for a demonstration run they rejected the idea of having a BoP.

'The problem is they have no GT500 engine, so its hard for them to take part next year if they reject a BoP from us. We would really welcome them next year, but they would have to accept a BoP, but we want them to come so we would make the BoP really favourable for them,' says Bandoh in conclusion.

If BMW does show up in the Japanese series in 2015 then it will be fulfilling its initial target of one car racing in multiple markets. Will that be enough to satisfy the board that the annual budget was worth it?

SIN R1 GT

Engine
LS7 7.0L V8 – 500 HP
Dry sump
Motec M800 ECU, Drive by wire
Custom intake / Exhaust
Traction control system

Suspension
Fully adjustable pushrod system, Nitron 3-way adjustable shocks

Brakes
AP Racing 6 piston calipers
378mm discs – front and rear with fully adjustable pedal box

Gearbox
Albins sequential (optional paddle shift)
Tripple plate ceramic clutch

Wheels
Central lock
Front wheels 10x 18"
Rear wheels 12x 18"

Dashboard
Motec C125
Full carbon body

Dry weight
1200 kg

SIN R1 GT4

Engine
LS3 6.2L V8 – 400 HP
Dry sump
Motec M800 ECU, Drive by wire
Custom intake / Exhaust
Traction control system

SIN R1 Road

Engine
LS3 6.2L V8 – 450 HP
Dry Sump
Motec M800 ECU, Drive by wire
Custom intake / Exhaust
Traction control system

Suspension
Fully adjustable pushrod system, Nitron 3 way adjustable shocks

Brakes
AP Racing 6 piston calipers
378mm discs – front and rear with fully adjustable pedal box

Gearbox
Albins sequential (optional paddle shift)
Tripple plate ceramic clutch

Wheels
Central lock
Front wheels 10x 18"
Rear wheels 11x 18"
Front tyres 245 / 40 / 19 Michelin PS Cup 2
Rear tyres 305 / 30 / 19 Michelin PS Cup 2

Performance
Top speed: +300 km/h (+186.5 mph)
Acceleration 0-100 km/h (0-62 mph): 3.5 s

Optional
Full carbon body
Air conditioner
Navi / DVD / Radio

Dry weight
1200 kg

WWW.SINCARS.CO.UK

SIN CARS UK Ltd.
Wharf Farm, Coventry Road
Hinckley, LE10 0NB

Phone: ++44 (0) 1327 311660
Phone: ++44 (0) 7179 999 848
Email: office@sincars.de

Phone: ++44 (0) 1455 615 517
Phone: ++44 (0) 7870 601 672
Web: www.sincars.co.uk

Honourable mother

European influence is stifling GT300, and the Japanese have a plan to redress the balance

By SAM COLLINS

Super GT has always been two championships in one. The GT500 category was, and is meant to be, the preserve of the manufacturer teams, while the second tier GT300 class is meant to be a class for tuners and privateers. To increase the field and options for teams, FIA GT3 cars mainly manufactured in Europe were allowed to join the championship some years ago.

By 2014 there were two options for teams, to develop a GT300 car to the Japan Automobile Federation (JAF) GT300 regulations or to simply buy in a GT3 car from Europe. Most opted for the latter, significantly changing the feel of the series, and the only teams opting for the bespoke JAF rules cars were manufacturer backed.

This boom in GT3 cars has caused deep concern among many in the Japanese motorsport industry who feel that the increase in the number of European machines means that Japanese engineers have nowhere to hone their skills, so it was felt that a new type of GT300 car was needed.

"There is a big difference in price to the GT500 chassis which uses honeycomb and different composites"

'In the GT300 class there are more GT3 cars today,' Masaaki Bandoh Super GT President and former GT300 team boss claims. 'But the class is meant to be for JAF GT300 cars, for tuners. The problem is that the GT3 cars are very good and cheap. To make the JAF GT300 cars to compete with them is very expensive which is why only teams like Mugen and R&D Sport can do it. So the idea was to get a common chassis and use it as a basis for all of the cars.'

This mother chassis concept is not that dissimilar in basic concept to that seen in the GT500 class and DTM, but in detail the idea is to give tuners a new outlet in top level racing. But to produce a competitive and flexible new chassis was not straightforward, as the DTM chassis was far too expensive.

Monocoque design

Bandoh turned to his friend and Dome president Minoru Hayashi for a solution. 'Our president was planning to build his own sports car, his Isaku project, and Bandoh saw the design for the monocoque he was going to use for it.' Dome head of project Takuya Nakamura reveals. 'He asked to use it in GT300 and Hayashi agreed, so we modified the design and used it for the new GT300 concept.'

The monocoque was designed using the innovative Dome UOVA technique that was first seen on the JMIA F20 concept cars in 2009. It does not use any honeycomb in the core of the structure, instead using solid carbon fibre sheets. The chassis is made by laying pre-preg carbon fibre sheets over a male mould, a special and still secret method ensures that the external surface is smooth as well as the internal surface. Dome claims that the technique lowers the cost of the chassis construction significantly and reduces the construction time by 70 per cent.

Partly because of this construction technique, and partly for cost reasons, the mother chassis, as the new GT300 design has become known, is not crash tested. 'The chassis should not be seen like that of the DTM car – it is not a survival cell, it is a chassis. The roll cage and seat and those type of components all meet FIA specifications. The tub itself meets the regulations of GT500 cars from 2009,' Nakamura adds. 'There is a big difference in price to the GT500 chassis which uses honeycomb and different composites. The actual chassis is stiffer than the DTM chassis because of how it is made, but it is heavier. To keep the stiffness good we have to add a lot of material.'

The reworked chassis was made as flexible in design terms as possible so that teams could develop a wide range of cars around it. Indeed it has been specifically designed so that it can be configured for either front or rear engined cars.

'There are housings in the chassis for starter, propshaft, and air conditioners. There is a steel extension plate to carry the engine, the suspension picks up on that too. That then links

The mother chassis can be configured to be front- or rear-engined. In the front-engined setup here the transmission is off-the-shelf GTA component

The prototype car which is fitted with the off-the-shelf spec GTA V8 engine – which in reality is a Nissan V8. Other engines can be fitted

At the front of the mother chassis prototype, a steel structure mounts to the front of the monocoque which carries the engine and suspension

The mother chassis – designed to provide tuners with a new outlet in top-level racing

to the crash box. The teams who buy the mother chassis can opt to use it or not, they are also free to do their own design. Any engine can be used and it can be mounted at the rear of the chassis.

'We designed the chassis to have many fixing points, so we can fit options in future,' Nakamura says. But some elements, mostly safety related are fixed such as the steel roll cage and the Fuel Safe FIA specification cell.

The first car developed using the mother chassis was a Toyota GT86 funded by Super GT's governing body, GTA. It is seen as a demonstrator for a wider mother chassis concept that, like the British Next Generation Touring Car idea, features a number of off the shelf components that the teams can pick and choose. Immediately evident is the installation of a GTA badged Nissan V8 engine where you'd expect to find a Subaru flat four in a GT86.

'The GTA engine is the same basically as the ones used by ORECA in LMP2, but we cannot call it a NISMO engine as the manufacturers like Toyota and Honda would never agree to having a NISMO engine in their cars. So it is now a GTA engine,' Bandoh admits. 'The reason we are doing this is because some teams cannot develop engines but can do the chassis. Now they can use the GTA engine. Then, if they leave the series that engine and chassis still has value, which is not the case with the JAF GT300 cars.'

Freedom of choice

Other 'GTA' parts include the transmission, dampers, clutch, coolers and safety equipment, but teams are free to pick and choose which elements they include and which they do not. This is especially true with the engine where almost any design can be fitted (GTA then balance the performance with air restrictors). Under the JAF GT300 rules hybrid power units can be used and both Honda (via Mugen) and Toyota (via apr) opt for this approach but it is one that Bandoh is not keen on. 'We will never have a hybrid in a mother chassis car running in GT300 as long as I am around. I don't like hybrids, I will not allow it,' he says unequivocally.

The GT86 bodywork on the prototype car was developed by the Dome engineers, but working in a way that a smaller team might operate. 'There was no wind tunnel or significant CFD used developing 86, we just relied on our experience. Once the car has done some more running we will start to develop the body more as there is freedom for aerodynamic development. While the total aero forces are similar to a JAF GT300 car like the CR-Z. We expect that the new car will be faster than them. But we are still developing this car so its still uncertain. Compared to the DTM cars though it is much lower in terms of aero,' says Nakamura.

The mother chassis prototype made its race debut at the new Chang circuit in Thailand where Toyota Team Thailand ran it. Although it finished two laps behind, Bandoh was satisfied with the debut. 'It was not fast because it had a very small restrictor, but I was satisfied. It is worth noting the car in Thailand looked like a Toyota 86 but is not endorsed by Toyota.'

The debut was enough though to impress a number of customers and already orders for new mother chassis cars are being placed.

'Next year Mooncraft will run a Lotus but that car will be mid-engined, like a real Lotus,' says Bandoh. 'There are other serious enquiries too, one from Thailand where they want to develop the mother chassis into a Toyota Corolla to race in the Thai Supercar Challenge.'

The mother chassis car in full GT86 configuration is thought to cost around the same as a GT3 specification Nissan GT-R but the kit of parts can be acquired for less.

Re-building the teamwork

By mid-2013 the Williams F1 team was not performing and they knew it – but against the odds they have bounced back

In 2014 the Williams FW36 has been a regular sight at the front of the Formula 1 field regularly challenging the likes of Red Bull and Ferrari, and on occasion even the otherwise dominant Mercedes W05s. It is something that in recent years would have seemed highly unlikely.

In mid-2013 the Williams F1 team was enduring one of the worst periods of its existence; with half the season gone it had failed to score a single point. While the paintwork of the car harked back to the former glories of the Rothmans era, the logos on the car were few and far between – the biggest of them related to one of the team's drivers, Pastor Maldonado who looked likely to leave the team at the end of the season as the relationship soured.

Financially and technically the team was underperforming and everyone knew it. 'If I had been in charge of that I would have been fired,' a former Williams technical director admitted ruefully. It was into this environment that Pat Symonds arrived from Marussia to take up the post of technical director.

'When I really got into the team I saw a lot more than I had expected, and I was a lot more worried than I thought I was going to be – there were a lot more things to do than I realised,' he admits. 'There was a bit of an air of panic, the car was not good, and everyone was blaming aerodynamics which was partly true but they'd also sort of given up on other areas which was a shame because they should have done better.

'The pressure then was on the aero guys – a sort of "here's a new front wing, oh that didn't work, here's another." I think the trouble was that the results were so bad and there was no sort of direction of: "This is how we're going to get out of it." The idea seemed to be, "Well, if we just put more parts on the car, sooner or later we'll get something that's good."

'So we calmed that, thought our way through it. I hope I took away the blame culture and allowed people to innovate a bit.'

Symonds knew that things needed to change across the organisation, the team was clearly not functioning to its potential. 'I could see there were some damn good people there – they just didn't know quite what to do to make a winning team. There were some deficiencies, so I set about analysing what we had, where we needed to fill in – that's a process that takes some time.'

Working with the team's management – team founder Frank Williams and his daughter Claire, the deputy team principal and commercial director – Symonds restructured the whole team to become more effective.

Talent pool

'We made a conscious effort to go out and recruit some senior technical figures last year to complement the great talent pool we already had in house. These people have come into a variety of different departments – Rob Smedley (head of performance engineering), Rod Nelson (chief test and support engineer), Pete Vale (race team manager), Greame Hackland (IT director), Jakob Andreasen (head of engineering operations), Craig Wilson (head of vehicle dynamics), Shaun Whitehead and Dave Wheater in aerodynamics to name a few,' Claire

"The pressure was on the aero guys – a sort of 'Here's a new front wing, oh that didn't work, here's another'"

Williams adds. 'The restructure was to make sure that the right people are in the right places doing the right things.

'The impact of those changes we will see going forward as they continue to develop this year's car and then moving on to the FW37 project which has already commenced.'

With the new structure coming into place Symonds then had to turn his mind to the 2014 car design. 'The basic architecture was done when I arrived,' he says. 'The monocoque was completely laid out, a lot of the engine was too, but we made changes on the transmission and rear suspension, and then just concentrated on aerodynamics because there was only a basis laid out. That was where I spent most of my time in the first few months. I felt the design group were very functional, were very good indeed, so really we wanted to concentrate on aero – as always performance comes from there.'

One of the biggest challenges for Symonds with the aerodynamic programme was to work out exactly where the shortfall was coming from on the 2013 car. By understanding that he felt that he could then improve the 2014 design before the season had even started.

'The fact is that an awful lot of the performance of last year's cars came from the blown diffuser. It wasn't everything, and the basic aerodynamics of the FW35 were pretty poor anyway, but the blown diffuser was a disaster, so elimination of that definitely made my job easier. But I looked at the car when I arrived and knew there wasn't a quick fix. We had no chance of catching Sauber in front of us, and we knew that for someone to overtake us it would be a freak result – so to me the concentration was always on the FW36,' he explains. 'As a result, the aerodynamics of the FW36 are good. And that wasn't because I came along and said, "Well I think if we change this bit and this bit and this bit here it'll be better."

'It was much more because I said, "Look, just think about the way you're looking at your test results, think about what you need to do next. Don't be afraid to say you've got something wrong. Understand what went wrong and understand what went right and why they both have." With that sort of approach to things almost the same guys are producing a very, very effective car.'

Immediate improvement

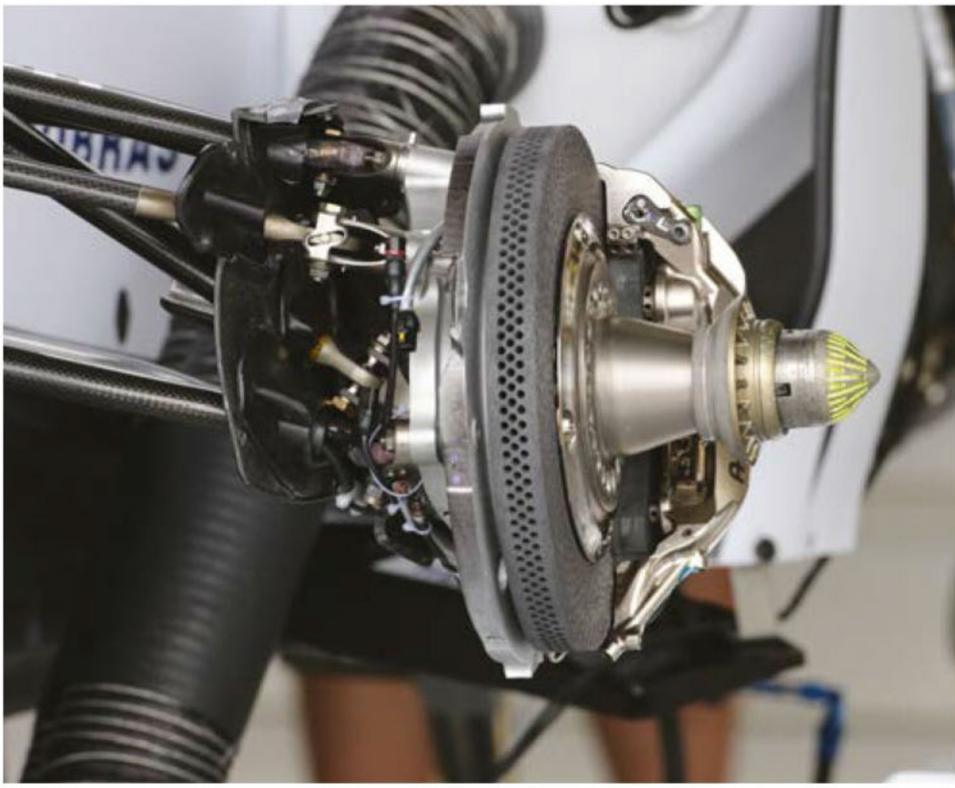
Indeed, when the FW36 first rolled out at the Jerez Circuit in Spain during winter testing it was apparent almost immediately that the team had made a step in the right direction. The design itself seemed fairly conventional among the 2014 F1 field with push-rod-actuated dampers with torsion bars on the front suspension and a pull-rod-actuated layout at the rear. Williams had struck a deal with Mercedes to supply its power unit in 2014, which has since been firmly established as the class of the field.

Even with the experience the team had of developing and installing hybrid technology into competition cars having developed its own systems in 2009 and 2011, integrating the Mercedes power unit was still a challenge. 'It wasn't difficult because it was a Mercedes or anything like that, although there is a certain

Roll hoop of the Williams FW36 with cooling slots evident. Note the engine air intake with its hybrid safetly light

The team has experimented with the cooling system, but the only real change was pre-season between tests in Bahrain and Spain

Front bulkhead showing torsion bars and master cylinders



Left front brake setup with shrouding removed so that outboard front suspension pickups are visible

amount of challenge involved with just working with a new partner at that sort of level.

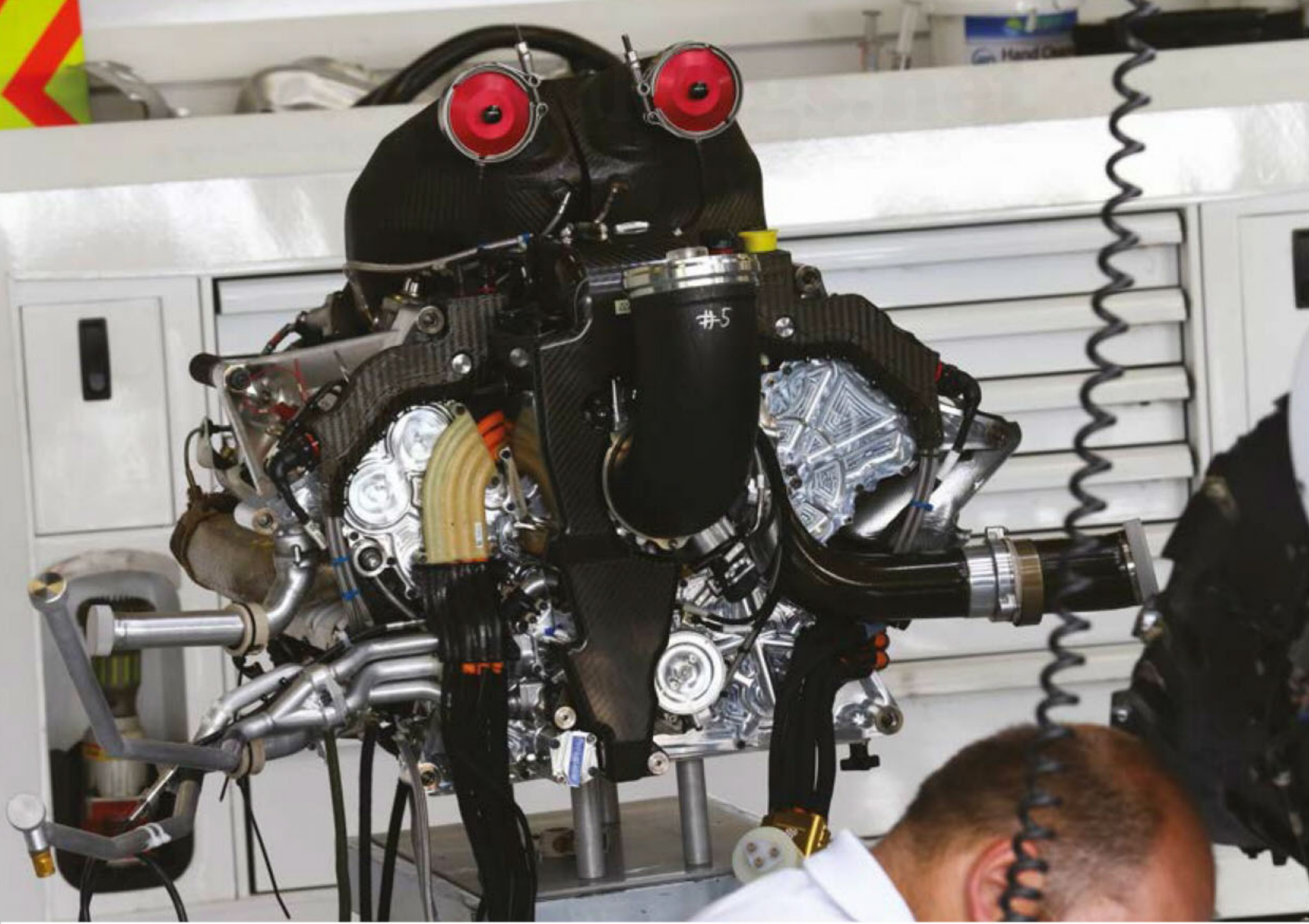
'But I think the main thing was the hybrid power units this year are so different to anything we have dealt with before that we really had to go back to square one and consider every aspect,' Symonds explains.

'Now I think that, generally speaking, to install a new engine is pretty much an engineering/design exercise if you like. What can become difficult is two things – understanding the duty cycle of the engine and also understanding how your engine supplier partners work. Of course we had to cope with both of those for the 2014 car. So the duty cycle of the engine was obviously going to be very very different to what we've experienced before. It took an awful lot of simulation to do and the understand the effects of that, particularly on heat rejection.

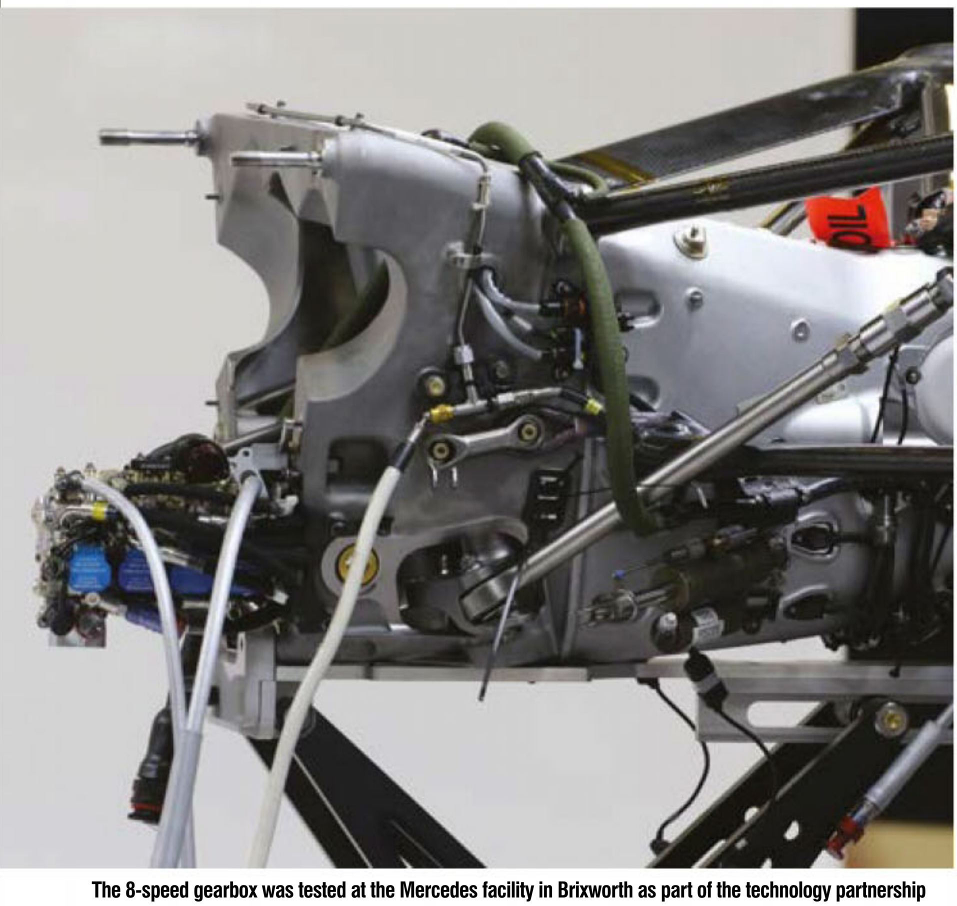
'Heat rejection is one of the banes of a chassis designer's life and for the 2014 cars there was an awful lot of additional work to do in that area, because although the heat rejection to water and heat rejection to oil were reduced, we now had charge air cooling to deal with and a lot more work to do on the ERS cooling so that was pretty difficult. And at the same time we had to get to know the people from Mercedes HPP and understand how they expressed things like heat rejection, so it was quite a challenge.'

To improve the integration Mercedes HPP at Brixworth allowed its partners not only to use some of its facilities (the Williams transmission was tested on the rigs at Brixworth for example) but it also embedded some of its staff in each of the teams. They work with the car designers looking at every element that could impact the power unit's operation and performance.

'We have a number of dedicated people so on the design side we have a dedicated contact point within HPP at Brixworth and he is our sort of immediate point of contact for anything we need, whether it's CAD models, engineering information or discussions. We obviously also have now, a dedicated trackside team who work with us all the time at the circuit but behind our



Mercedes has the upper hand in terms of performance, but the turnaround of Williams' fortunes have had more to do with the restructuring than solely engine performance, notably the Mercedes powerunit features a split turbocharger with the compressor and turbine at different ends of the engine block, as above



The 8-speed gearbox was tested at the Mercedes facility in Brixworth as part of the technology partnership that Mercedes initiated with its customer teams. Note hydraulic block at front of gearbox

dedicated design contact of course there is the entire services of HPP at Brixworth that we can call on,' Symonds continues. 'I don't think helpful is the word for this, I think the word is essential, we couldn't work without having someone we could talk to on a daily basis and of course we have face-to-face meetings every couple of weeks as well. We still, however, need someone who can filter all of our requests throughout the organisation.'

And this approach has not prevented Williams from taking its own approaches to the installation of the power unit in some areas, notably the positioning and design of the intercooler in the left-hand-side pod of the car.

A different solution

'Mercedes will tell you what the heat rejection is, what the maximum temperatures are that you can operate at, and how you achieve those is entirely down to you as a chassis team. Our solution is different to that which works for Mercedes but one I think has worked very well for us. We use an air-to-air intercooler. Some teams, certainly the Ferrari teams and some of the Mercedes teams, do use a water-air intercooler and then an air-air, but I think our solution is the most efficient. We've run basically the same cooling configuration since day one. The only change we've made to the

The exposed rear end of the Williams FW36 – the metal transmission casing evident as is the composite rear crash structure. Note the neat rear upright designs

"plumbing" if you like is in Spain. There we resized the cooler slightly because we were able to actually get good heat rejection information from the Bahrain tests, and by the time we had made that and designed the parts, it was actually for fitment in Spain so we did a pretty major cooling system upgrade and we've done nothing since other than bodywork changes.'

One major change to the layout was tested at the Austrian Grand Prix where the intercooler was mounted behind the fuel cell, but according to the team that was a test of the 2015 cooling concept rather than a development for 2014.

"We did a pretty major cooling system upgrade for Spain and we've done nothing since then other than bodywork changes"

From the first race of the year, the FW36 proved to be a very strong package indeed, and as *Racecar Engineering* closed for press had finished on the podium six times, but the top step has proven elusive. The Williams unable to quite match the pace of the works Mercedes, Symonds feels that while the works team is much better funded and able to do more development there are still areas of the car which are weaker than that of the front runners. 'I guess two main things are aerodynamics and tyre usage. I think we have an aerodynamic deficit to Mercedes and I think they're very very good at the way they use the tyres both in qualifying and in the race,' he admits.

Despite heading for the team's best finish in the constructors championship in over a decade, Symonds is not satisfied and feels that there is still much more to do. 'I am surprised by the speed of the turnaround, that's true. I didn't expect we could get this far up. Realistically I hoped we could get to sixth in the championship or something like that this year. But I know where I want to get to and that is a long way further ahead from where we are now. It's never one person: what it shows is that there was some quality there, it just needed direction as to how to turn that quality into performance. Each department was doing it individually but everyone was in silos and there was very little communication. The design department, the operations, the trackside operations, the aero and even to some extent the production, although production was, to be honest, a lot better. I really wanted people talking together more openly and while I haven't got as far as I wanted to go with that yet – I'd like everyone in one office. But what I have got is people who now like to talk to each other about what they're doing and they're not trying to score points over their colleagues or blame their colleagues, they're just getting on just trying to make everything better but there's a way to go yet,' he concludes.

Claire Williams has set a clear goal for the team moving forwards. Even with its Martini branding the team is still not the best-funded operation at the front of the grid by any stretch. 'Williams has always been a great example of a team that has not always had a huge budget and we have won championships.

'You only need to look at the 1990s when we had significantly smaller budgets than other teams and we were winning championships. I think it is a dangerous mindset that it is always about money, it would be great to prove again that you can win races in Formula 1 without big budgets,' says Symonds.

Work is well advanced on the 2015 Williams FW37, and it will be the first car that Williams has developed fully under the technical management of Symonds. The proof of his restructuring and influence on the team will only really be shown when, and if, that design reaches the podium for the team's first win since 2012.

TECH SPEC

Chassis construction
Monocoque construction laminated from carbon epoxy and honeycomb surpassing FIA impact and strength requirements

Front suspension
Double wishbone, pushrod activated springs and anti-roll bar

Rear suspension
Double wishbone, pullrod activated springs and anti-roll bar

Transmission
Williams eight speed seamless sequential semi-automatic shift plus reverse gear, gear selection electro-hydraulically actuated

Clutch
Carbon multi-plate

Dampers
Williams

Wheels
RAYS forged magnesium

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

Brake system
AP six piston front and four piston rear calipers with carbon discs and pads

Steering
Williams power-assisted rack and pinion

Fuel system
ATL Kevlar-reinforced rubber bladder

Electronic systems
FIA SECU standard electronic control unit

Cooling system
Aluminium oil, water and gearbox radiators

Cockpit
Six point driver safety harness with 75mm shoulder straps and HANS system, removable anatomically formed carbon fibre seat

Engine
Mercedes-Benz PU106A hybrid
ICE capacity 1.6 litres, six cylinders, 90deg bank angle, 24-valves
Max rpm ICE 15,000rpm
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 125,000rpm

ERS
Mercedes AMG HPP

Dimensions
Overall length: 5000mm
Overall height: 950mm
Overall width: 1800mm

Back in the mix

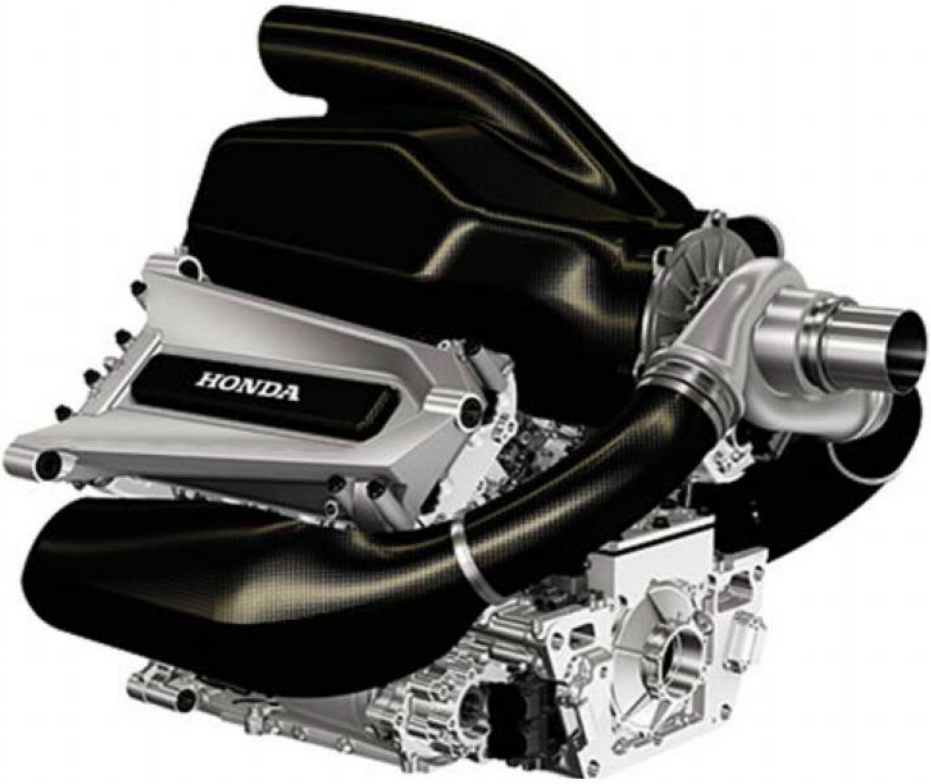
Honda is on the brink of its F1 2015 return and the firm has a clear eye on a long-term future this time around

By SAM COLLINS

Honda's return to Formula 1 in 2015 is a project that has a long-term future, with the company's chief officer of motorsports promising that there is no exit strategy under consideration.

The engine, currently under design, will be tested for the first time over the winter, in the back of a McLaren MP4-30 as the company chases track time compared to its rivals. While Mercedes, Ferrari and Renault all have a season of data under their belts, Honda is starting from scratch. Some may say that puts them at an advantage, with performance targets already established, particularly in the tricky area of cooling, but the company itself says that the 2015 season will be one of catching up.

'I don't think coming late gives us an advantage having seen the others, in fact I think it's a disadvantage,' says Yasuhisa Arai, Honda's chief officer of motorsports. 'We don't have any kind of track test data. Just imagine the difference between track and dyno, all those tiny things. We need that race track data. It is a big disadvantage for us.'



Honda's new power unit. Like all of the current F1 generation it is a turbocharged 1.6-litre V6 engine with direct injection, with a pair of motor generator units and an electrical energy store

"It is a new F1 era for Honda, but we never refer to it as a Fourth Era... this suggests that it will end at some point but we will never stop"

For Honda, its return to Formula 1 means much more that perhaps it did in the past where it was primarily a technical exercise to improve the understanding of the firm's engineers. This time round it is a key part in attempting to restore faith in a brand that has lost its sporting reputation. 'In Europe fans believe that Honda is a sporting brand and with the launch in 2015 of some very sporting road cars they will tie in perfectly with Honda's engagement with Formula One. We will use Formula 1 as a catalyst to deliver the message that Honda is building very sporting cars again,' Arai concludes.

Fourth era?

Honda's return to Formula 1 was first revealed on the *Racecar Engineering* website in late 2012, and, when the project was formally announced the following spring, the provisional projects started some time earlier took on new impetus. 'We announced the project in May 2013, and the real work started just before that,' explains Arai. 'We have only had one year and a half of work on the project, we have really been pushing, pushing, pushing. It is always the Honda way.'

The 'Honda way' has been a part of Formula 1 since 1964, when the Japanese marque entered its first grand prix. When that project started the engineer appointed to head it did not even know what F1 was. Over the next five seasons the Japanese engineers learnt a lot and the brand took two grand prix victories before withdrawing following the 1968 season.

That period became known internally as the 'First Era Formula 1 activity'. It was followed in 1983 by the 'Second Era' where Honda returned to the sport as an engine supplier, eventually leading to that famed partnership with McLaren and four back-to-back world titles, to add to the two it already had with Williams. During this era, Honda built a number of its own Formula 1 cars in secret but never raced them and has only shown them off in public in recent years. Honda again left the sport at the end of the 1992 season, drawing the era to a close.

Honda kept its toes in the water via its founder's son's concern Mugen, which supplied engines to a variety of teams, notably Ligier and Jordan in the 1990s, but its return proper came in 2000. It should have come in 1999 with a Harvey Postlethwaite penned Dallara chassis but that project collapsed following the designer's death. Honda then partnered with, and later acquired, the BAR team but after years Honda only had a single win to show for its substantial investment, and in the economic downturn of 2008 it decided to quit Formula 1. This period is known as the 'Third era', and the development of the engine is covered in RE V24N10.

The firm's return to Formula 1 in 2015 could then be considered as the 'Fourth Era' but Arai strongly rejects that title for his group's new activities. 'It is a new era for Honda, but we never refer to it as the Fourth Era,' he says forcefully. 'After 2015 we are continuing our Formula 1 race activity forever. To call it fourth era suggests that it will end at some point, but we will never stop.'

Honda revealed the first renderings of its new power unit shortly before the 2014 Japanese Grand Prix. Like all of the current generation it comprises a turbocharged 1.6 -litre V6 internal combustion engine with direct injection, along with a pair of motor generator units and an electrical energy store. Arai admits that some of the technology featured on the new power unit has been developed over a number of years. 'After 2008 we did not focus directly on Formula 1 technology but we did work on developing the high pressure direct injection technology for racing and worked hard on turbochargers. We also looked at building small-displacement, high-output engines. So yes we continued after we stopped Formula 1 activity in 2008 but the work was not specifically focused on Formula 1.'

Using some of that learning, Honda rolled out a World Touring Car Championship engine (which was never meant to be used in competition) and its new GT500 power unit. Both feature elements of the current grand prix power unit concept, the latter of course, being a hybrid.

Hybrid secrets

The unit bolted to the back of the McLaren MP4-30 (or if some proposals go ahead the MP4-29) will not be Honda's first hybrid Formula 1 design. Right at the end of its so-called third era activities Honda designed and built its first hybrid Grand Prix car. Based on the 2006 Honda RA106 chassis the first test mule took to the track in an open test at Jerez in 2008, data from that was used to improve the hybrid system both in terms of the energy storage and MGU-K.

A near complete hybrid system was fitted to a 2008 spec RA108 chassis and was on the way to its first full test session (after limited shakedown runs) when Honda announced its withdrawal from Formula 1. At this point the Honda RA109 had been subjected to its mandatory crash tests, something that was a major undertaking as the car had an unusual energy storage layout with the batteries mounted at the front of and underneath the front of the monocoque. The RA109, which had been designed to be a hybrid from the outset, was never officially completed or tested on track, though some of the design and aerodynamic data was used to create the Brawn

“Some of today’s staff don’t have that racing experience. It’s sort of half and half between those who have F1 experience and those who do not”

Some say that in starting again from scratch in F1 Honda – with performance targets already established, particularly in the difficult area of cooling – has the advantage over other teams but the company denies this

In Honda’s second F1 era it had no major involvement in chassis development. This is something it hopes to repeat in the current era, leaving chassis work to its partners and focusing on integration

BGP001, which dominated the opening races of the 2009 world championship, and took both titles at the end of the year.

Since then Honda has not attempted to race a hybrid of its own design at international level, despite the substantial investment that it made in 2008. The GT300 and GT500 specification cars racing in Super GT as well as the Super Formula hybrid prototype all use systems supplied by Gibson (nee Zytek) rather than technology developed in-house.

But the skills gained during the Honda F1 hybrid research project of 2008 have not been forgotten according to Arai, and they have been employed in the development of the new power unit. ‘Some of the people from the old Formula 1 activity came back but the new regulations required very different skills. It was not just about internal combustion engines but also hybrid technology too. Some of the staff today don’t have that racing experience. Its sort of half and half between those who have Formula 1 experience and those who do not,’ he admits. ‘I think there is a big difference between the 2009 car and its hybrid system and today, the technology has moved on but we do have some staff that worked on that so they have some idea of how the integration works. But the technology now is quite different and the new system is far more sophisticated.’

Return reasoning

The new regulations, which are focused on efficiency, are one of the major reasons that Honda returned to Formula 1, along with the fact that a brand built on its racing heritage needs a major international racing programme. But it also hopes that some of the lessons learnt in its F1 activity will feed back to the cars in the showroom. ‘The power unit technology is not something we can immediately transfer to production,’ Arai admits candidly, ‘but maybe the experience we gain with things like the MGU-H can feed back to production cars in the future. However, looking at it the other way round we have good experience in the production car hybrid technology area and we are feeding that into the racing programme. That is a big advantage for our F1 programme.’

To facilitate its new operations Honda has constructed two new facilities specifically for the development of its new Formula 1 power unit. The design and manufacture will be moved from Honda R&D’s well-established headquarters at Tochigi, Japan to a new base nearby at Sakura City. A second, smaller facility has been constructed in Milton Keynes, England, which is shared with Mugen Euro.

‘We have not moved yet, we are just starting to move now. We have had to build up new techniques, and new tools for development at Sakura City, but its something of a secret exactly what,’ Arai continues. ‘We do have engine dynos as you would expect, there is a wind tunnel there but its not for racing, more for mass production work. We also have a design room there and machine shops but it is not that big.

‘Everything on the power unit will be made at or near Sakura City, all the design work and testing will be done there. The Milton Keynes facility is small, it’s just some dynos and offices, its for the people who go to the track to support the power units really, just to do document work. The complete power units will generally be shipped from Sakura City direct to McLaren, only if something happens at the track, something goes wrong, will the power units go to Milton Keynes to be checked over.’

Honda’s most successful era in Formula 1 was its second, in partnership with Williams and McLaren, when it had no major involvement in chassis development. This is something it hopes to repeat in this new era, leaving all the chassis work to its partners. ‘We have no plan to do chassis things again, but we work closely with McLaren, and there’s a lot of discussion going on. The integration of the chassis and power unit is the most important thing, because you need good aerodynamics,’ Arai says. However with the futures of a number of grand prix teams far from certain, rumours of a second Honda-backed team refuse to go away.

‘It is a good question whether or not we will have a second team in Formula 1, but unfortunately it seems that nobody is interested in our power unit,’ Arai reveals. ‘The reason for that I guess is that its an unknown, they don’t know the performance it has, so they are cautious. I don’t have any kind of offers at the moment, we are open to a second team. Our contract with McLaren means that the power unit is exclusive to them in the first year but in 2016 we are open.’

A lot of attention is focused on the potential performance of the new Honda power unit. Arai and his engineers are playing their cards fairly close to their chests, but there is no sign of any panic, rather a perhaps not so quiet confidence. ‘Maybe after Melbourne many teams will want our power unit, that’s what I expect,’ smiles Arai. ‘Overall the development is on schedule, the numbers we have achieved are what we expected and there is much more to come before the homologation deadline.

‘We are really pushing hard and I hope next season the performance we have is much more than the other top teams and at Melbourne I hope we are sitting at the front of the grid. We are confident.’

our vision

For a viewing and further information, please contact:

DTRE
020 3328 9080
www.dtre.eu

James Watson

MEPC

World challenger

Peugeot has begun a three-year off-road programme to promote the 2008 SUV. This is the first draft of its ultimate off-roader

By ANDREW COTTON

"This is no ordinary factory effort. The 2008 SUV has already been launched in Paris, South America and China, all of which have well-established rallies"

It has been nearly three years since Peugeot abruptly ended its factory racing programme amid a financial crisis that almost crippled the company. Against the backdrop of job losses, countenancing a high-spend Le Mans programme was not an option and so the manufacturer made the decision overnight.

Since then, Peugeot Sport has been involved in rally programmes and in 2013, tackled the Pikes Peak hill climb with Sebastien Loeb. To do so, it raided its spare parts bin from the 908 Le Mans programme and specced up a 208 for an incredible run into the clouds in record time. Now, however, the company begins a new chapter with the launch of the 2008, and the first sustained racing programme since the 908.

This is no ordinary factory effort. The 2008 SUV has already been launched in Paris, South America and China, and these countries have well-established rallies. The 2008 will compete in the 37th Rally Dakar, named in 2015 as the Dakar Argentina – Bolivia – Chile. The 2008 features a 3.0-litre V6 turbo diesel, capable of running 800km between refills (although the fuel tank is a rather impressive 400 litres). Unusually, It is two-wheel-drive, which means that it is much lighter than the four-wheel-drive alternative, has bigger wheels and more suspension travel. This, it seems, is an adequate trade-off against 4wd which would give better traction in unpredictable terrain.

A motorsport plan

'The one main reason for this programme is to give sense to our sporting activities, or motorsport activities,' says Director of Peugeot Sport, Bruno Famin. 'The Peugeot brand is developing itself all around the world, particularly in South America, Russia and China, and it is clear that we need to build a motorsport plan around those areas and there are cross-country activities in all of them. A key model in our range is the 2008 which is an SUV, and to help to promote the 2008 we have a cross-country version. It has the SUV image, and it gives a lot of sense to the programme.'

The 2008 has been launched in all of the major markets now, at the Russian and the Moscow motor shows, as well as in China and the plan is for the brand to use the new cross-country programme to promote the standard vehicle in all those countries.

Unlike Pikes Peak, which was a one-shot assault, this is a three-year programme, in deference not only to the marketing plan around the 2008, but also to the difficulty that the team will face in winning some of the toughest rallies in the world.

'For Dakar you need experience,' says Famin. 'It is an endurance race, not a 20km race on a paved road! It is a bit more complicated than that. With all the conditions you can imagine, the competitors are strong… and we are going to be here for three years.'

By regulation, the engine block, crankshaft, con rods, pistons, valve train and cylinder heads all have to be original: 'For the internals you cannot do anything'

The engine comes from the PSA range and by regulation must be based on a production unit. Peugeot has linked with Ford, with four-cylinder engines going to the American brand, and six-cylinder engines coming the other way. The 340bhp 3.0-litre V6 that is used in the 2008 DKR is based on an engine that is used by both Citroën and Peugeot production cars. By regulation, the engine block, crankshaft, con rods, pistons, valve train and cylinder heads all have to be original. 'For the internals you cannot do anything,' says Famin. 'The only thing that is allowed to be changed is the turbo, provided it is a homologated turbo, or potentially homologated with 2500 parts per year. We are working on the exhaust line and pretty much that is all you can do.

'It is about the management of the engine, and the management of the turbo, particularly in terms of response time rather than the full power. We need a good use of the engine, which is required in these activities. We have to use standard parts, and we are trying to find the best possible parts.' One option is to use a variable turbine geometry turbo, which increases the response at low levels and has been used extensively in Audi's Le Mans programme although Peugeot says that it is too early to discuss the turbo.

The choice of diesel engines was not an easy one, considering the team had also opted for two-wheel drive, the wheels driven through a bespoke gearbox designed by Peugeot Sport and built by an external company. The two-wheel drive arrangement allows for larger wheels – with a diameter of 940mm compared to 810mm for the four-wheel drive cars, longer suspension travel, up from 250mm to 460mm, and the tyre pressures may be adjusted remotely from inside the cockpit. However, the switch to two-wheel drive also had a significant impact on the weight of the vehicle. For a two-wheel drive car, a weight saving of almost 600kg could be seen as an advantage…unless you consider that the team is struggling to get down to the weight limit. Such is the struggle that a carbon and Kevlar body has been constructed, although Famin admits that there is no chance of hitting the minimum weight limit.

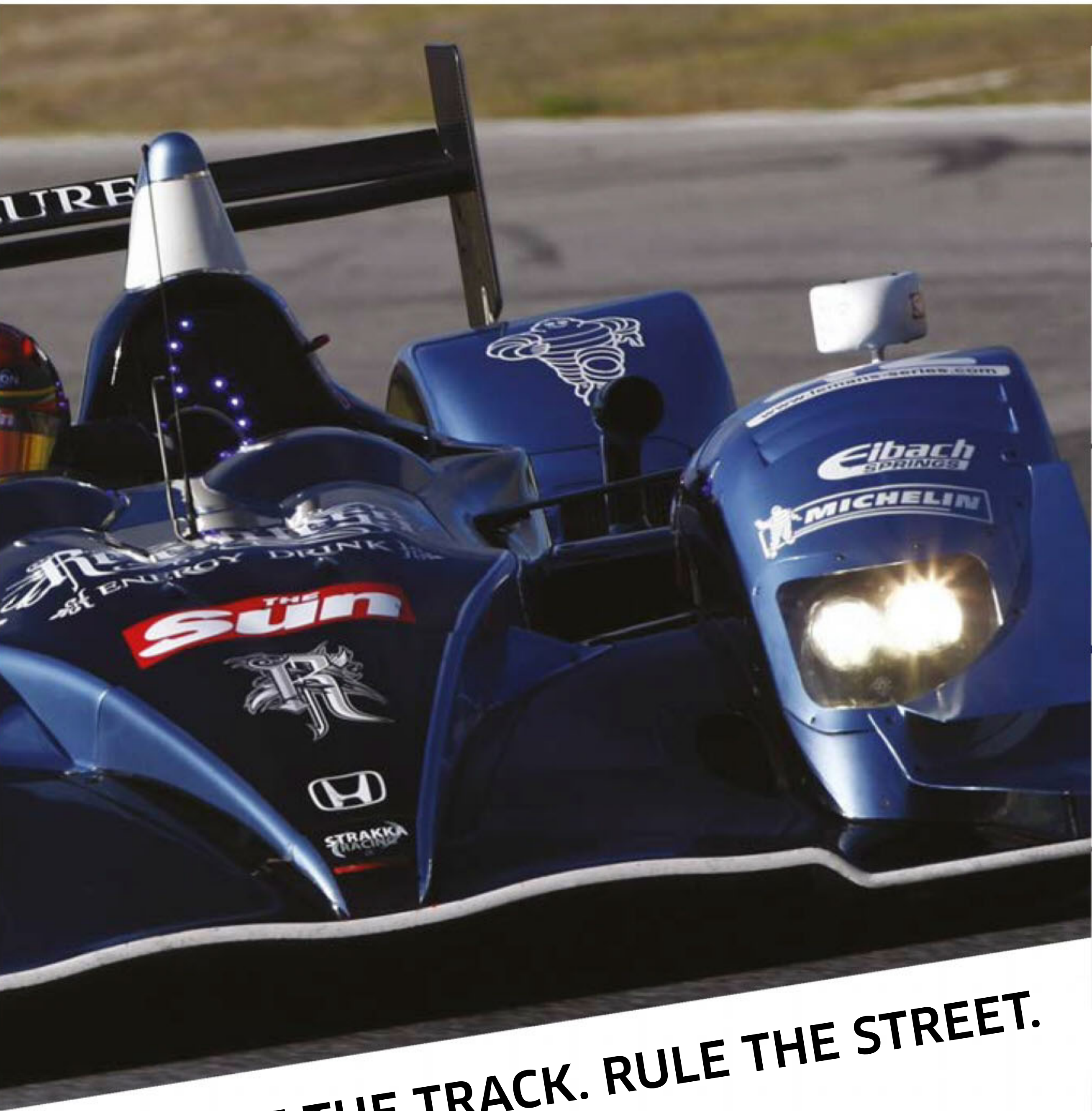
'The chassis is a full tubular chassis with a central rear engine, and the bodywork is almost full-carbon but with Kevlar,' says Famin. 'Weight is always a problem! The minimum weight of the two wheel drive car is very low. It is very difficult, almost impossible to be so low, and everything that we can save in weight is good. The minimum weight for 4wd is 1950kg, but we still believe that we can be significantly lower than that and then it is still interesting to be two-wheel-drive.' The weight of the car is not helped by the huge fuel tank, 400 litres, that must be carried from the first kilometre.

Weighty matters

'The sporting rules require the cars to have 800km autonomy,' says Famin. 'With the diesel engine, we have a lower fuel consumption than a gasoline engine, and that will compensate the fact that the engine is heavier than a gasoline engine as a turbo diesel is much heavier. The main thing that we are working on is to make the engine easy to use at low revs. You have to go into some places that a car should not go, and the drivers need to have a very easy-to-handle engine. The fuel tank is at the centre of gravity. The weight distribution at the end of the stage is the same as at the beginning of the stage.

'There is a big disadvantage with two-wheel-drive. If the track conditions are very poor, with a lot of rain (we have some stages close to the WRC stages) then we will have less traction than the four-wheel-drive. The advantage of 2wd is the big wheels and big travel of suspension is much more competitive in open stages. With the weight, it can compensate. In cross country races, you have another balance of performance. You have the technical BoP with two and four wheel drive, and you have the route of the rally. Depending on the organiser, if he makes more WRC stages, or more desert stages, he can balance the rally as he wants and give advantage to two wheel drive or four

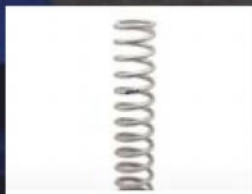
"It is about the management of the engine, and the management of the turbo, particularly in terms of response time rather than the full power"



IMPERIAL RANGE

METRIC RANGE

TENDER | HELPER



OFF ROAD

COIL SLEEVE

BUMP STOPS

DOMINATE THE TRACK. RULE THE STREET.

ERS | Eibach Race Spring System

- Over 1,300 single components – main and tender springs – metric and imperial, various auxiliary race suspension accessories, ready and in stock on 5 continents
- Comprehensive Program of single components
- Single Main Springs with highest rate-linearity and lowest rate tolerance
- Progressive Characteristics via set-up of different springs serially – double or even triple spring combinations
- Extreme Low Weights achieved through Super Hi-Ten materials and manufacturing technology
- Smallest Solid heights, maximized spring travels and higher maximum loads
- Spring Surface Stabilization through specialized shot peening
- Every ERS Spring preset to block
- Block and Sag Resistant
- Smallest Tolerances and precise plane parallelism of spring ends
- High Dynamic Durability – under Motorsports conditions
- High quality corrosion protection by phosphating and epoxy coating
- Springs Printed with part-number (speaking code = rate and dimensions)
- Individual protective single box packaging

Eibach UK | Phone: +44 14 55 - 28 58 51 | eMail: sales@eibach.co.uk

eibach.com

Opting for two-wheel-drive means that the team can run bigger tyres and more suspension travel, although handling is a little livlier than the drivers expected

wheel drive very easily. We have to work on the technical side, and on the lobbying side too. We are on it.'

So, with less traction available, an unachievable weight limit, and all the competition choosing 4wd, why choose two-wheel-drive at all? 'We carried out an in-depth analysis of what already existed in the world of cross-country rallying and weighed up the benefits of the different solutions,' says project leader at Peugeot Sport, Jean-Christophe Pailler. 'In the end, we opted for an approach that was quite different to that of the competition. Given the off-road capability of two-wheel drive transmission and its ability to run on sand, that's the choice we ultimately went for. It enabled us to fit bigger wheels and also benefit from more suspension travel. With the larger wheels, and very short front overhang, the car is extremely capable with steep climbs, for example.

Bespoke parts

These considerations had a significant knock-on effect for the car's stylists, and not only around the front overhang. 'The chief difficulty resided in adapting the model's styling cues to the different technical constraints dictated by the hostile terrains visited by the discipline,' notes Giovanni Rizzo, the 2008's exterior designer. 'There were two ways we could have approached this task - either by taking a standard 2008 and grafting on bespoke parts, or else by drawing inspiration from the 2008's defining overall forms to design a car that covered the constraints inherent in its mission. We eventually decided to go down the second path to produce a fresh take on the 2008! For example, the 2008 DKR doesn't have rear doors, so it's more like what a coupé version of the model might be.'

Carrying over the road car's styling cues to the rear of the new Dakar challenger turned out to be relatively straightforward, but the front proved more taxing for the design team, as Michaël Trouvé, Peugeot design manager, relates: 'Due to the off-road capability needed, the approach angle had to be very high. This meant a very short overhang, which in turn resulted in a front-end design that was quite different to that of the production version.

'Happily, the technical team didn't hesitate to listen to our arguments and accepted repositioning certain parts, which could have been a problem for us. That gave us a little freedom to design a front end that resembled the look of the road car as closely as possible.'

With the car launched in all the key markets and the racing programme set, testing has been ongoing. Peugeot denies rumours that the drivers are struggling with the handling of the car, and that this was the reason that it missed the most recent Morocco Rally.

'We were not supposed to do the Morocco Rally,' argues Famin. 'We said that if we were in a condition to make the rally, it would be much better for the Dakar, but we never said that we would do the rally. As we needed to do a lot of kilometres, we preferred to make more tests as the Morocco Rally is interesting, but it is one week or ten days for a very low number of kilometres in stages and we preferred to test the car over as many kilometres as possible.

'The drivers are happy with the car. We never tried to compare the performance of the car with the Mini or the competitors. Our main concern is reliability and this is where we have to work. The Dakar race is very difficult, and we have to do the kilometres to see as many problems as possible before the race.

'When you have never raced in Dakar, you never know what sort of conditions you might encounter. For example two years ago there was a lot of water on the track and some buggies were diverted around rivers.

'The main thing is to test the car in almost all conditions. We are doing our best to test the car in this range of possible conditions.

'The drivers do their best to break the car during the tests to see the weak points and there is no major problem.'

The Dakar Rally starts on 4 January and runs to 17 January, 2015.

Driver's eye view

Stéphane Peterhansel is a multiple Dakar champion, but the 2008 presents the Frenchman with something of a culture shock – this is the first two-wheel-drive car that he has driven in this competition. 'I've never previously driven a car with so much suspension travel,' he says. 'The first big surprise is the manner in which the 2008 DKR soaks up potholes and compressions. I've always been accustomed to getting thrown around like a rag doll inside the cockpit, but the behaviour of the 2008 DKR is infinitely more efficient and smooth. Whenever you fear an impending impact, the suspension and large-diameter wheels absorb it. That is a reassuring feeling, which allows you to pass over potholes at 120kph or 130km/h rather than just 80km/h. I'll need to adapt my driving style accordingly…

'Being two-wheel-drive, the 2008 DKR is a bit livelier and as such, demands a defter and more precise touch behind the wheel since it is not quite as easy to control. You really need to always be at the point of sliding.

'Apart from that, the engine and gearbox both feel good, and while we are still inevitably a long way from finding the ideal setup, initial impressions are excellent – there is plenty of potential here.'

TECH SPEC

Engine
Type: V6 bi-turbo diesel
Cubic capacity: 2993cc
Number of valves: 24
Position: Mid-rear
Number of cylinders: V6 ('vee' angle = 60 degrees)
Maximum power: 340hp
Torque: 800Nm
Maximum revs: 5000rpm
Top speed: 200km/h
Lubricant: Total Quartz 10 W 50

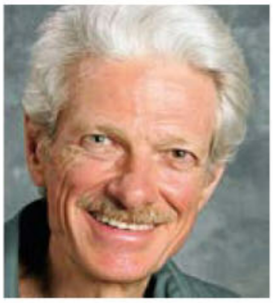
Transmission
Type: Two-wheel-drive
Gearbox: Longitudinally mounted six-speed manual sequential gearbox
Lubricant: Total 755 HPX 80 W 140

Chassis
Type: Tubular steel
Bodywork: Carbon

Suspension/Brakes/Steering
Suspension: Double wishbones
Springs: Coil springs (two per wheel)
Dampers: Adjustable (two per wheel)
Travel: 460mm
Anti-roll bars: Front and rear
Steering and brakes: Hydraulic power steering
Hydraulic dual circuit, one-piece light alloy four-piston callipers
Discs: Front and rear-vented discs front and rear
Front discs (diameter): 355mm
Rear discs (diameter): 355mm
Rims: Aluminium two-piece wheels (17 x 8.5)
Tyres: Michelin 37/12,5x17

Dimensions
Length: 4099mm
Width: 2033mm
Height: 1912mm
Front overhang: 641mm
Rear overhang: 658mm
Wheelbase: 2800mm
Fuel tank capacity: 400 litres


What's the
secret
about the new 911 GT3 Cup's
new brakes?
Mobil 1
GT3
adidas
It's Quicker.
PFC
PORSCHE
OFFICIAL PARTNER
PORSCHE
MOTORSPORT
PFC
BREMSE
www.pfcbrakes.com
1.800.521.8874



Shocks, suspension and a trade-off

Mark Ortiz considers two related questions this month

The questions

1. What are the pros and cons of using dual shocks – meaning two of them acting in parallel on a single wheel?
2. We are involved in designing a front and rear suspension for a small-formula vehicle. Both suspensions will be push or pull rod (still to be decided) with coil-over spring/shock absorber. The motion ratio wheel/spring will be higher than one. Due to some budget concerns, we have to use another shock absorber coming from a previous vehicle that was heavier; we have the budget for new springs. Preliminary calculation shows that to keep these shocks, the new motion ratio will be around 1.4 to 1.5. This seems a little bit high based on similar vehicles, which are around 1.3. Apart from manufacturing tolerances – we know the higher the motion ratio the closer the tolerance has to be – we do not see any other drawback for this motion ratio. What do you think?

The consultant says

To take the simplest bit first, probably a change in motion ratio of the order of 10 per cent isn't going to dramatically hurt performance. That's a fairly small change. Shocks are sometimes run with wheel/damper motion ratios of two or more (damper/wheel motion ratios of 0.5 or less).

There are both penalties and benefits when we do this. The main benefit is that the shock can be shorter. This will generally make it lighter and easier to package. It will also reduce shaft and piston accelerations, which could be good, bad, or largely inconsequential depending on the nature of the valving and the desired properties.

The penalties when we shrink dampers are considerable, however – at least if we shrink them a lot. The pressure required to get a given damping force at the wheel varies directly with the square of the wheel/damper motion ratio, or inversely with the square of the damper/wheel motion ratio.

To reduce the stroke by a factor of two, we have to quadruple the working pressures in the damper. To reduce the stroke by a factor of 1.10, we have to increase working pressures by a factor of 1.21.

This increases stresses on all the parts of the damper, particularly the seals. Not only is unintended bleeding past the piston more likely, but since piston velocity is lower, a given size bleed may have a greater effect on force produced.

Higher pressures and lower shaft velocities increase elastic effects in dampers. These effects have not been adequately researched, to my knowledge. In fact, these effects are so little recognised that the entire subject probably requires some introductory explanation.

A damper is intended to produce a force opposite in direction to shaft velocity, and dependent only on shaft velocity. However, actual damper behaviour deviates from this, most noticeably near a reversal of motion, or the end of a stroke. Often, for a short period after piston motion reverses, the damper will actually exert a force on the piston in the same direction that it's moving. While this is occurring, the damper isn't damping at all. It is acting more like a spring.

This can be observed on a shock dyno, when doing the most common type of test, a sinusoidal test. When we measure the gas spring force at the top and bottom of the stroke, we will see a small spring rate. The gas force will be slightly greater at the top of the stroke than at the bottom, but only a little. Normally we will zero the dyno reading to subtract the gas force from the readout, most commonly at mid-stroke.

The most common form of shock dyno uses a scotch yoke mechanism to cycle the shock. We have the choice of a few stroke lengths and rpm settings. The most common for car shocks is a 2in stroke at 100rpm. This gives a peak velocity just under 10in/sec.

When we cycle the shock through a 2in stroke at 100rpm, and plot force versus absolute velocity for the entire cycle, we get a trace that looks like two Vs lying on their sides. The Vs meet at their spread ends, at the right side of the graph. These are the points of maximum absolute velocity, at the midpoints of the upward and downward strokes.

The points of the Vs are at the *y* axis, one higher than the other. These show the force at zero velocity, the points where the piston is instantaneously motionless at the top and bottom of the stroke. These points will be spread by a greater amount than when checking gas forces. This is due to other things than the gas reservoir acting like springs.

When the piston is moving down, the fluid below the piston compresses, and the body of

Twin dampers reduce the operating temperature and improve damper performance in severe conditions

Standard Formula 3 layout is a twin damper system on the two rear wheels, rather than just one

the damper below the piston stretches a little. When the piston stops and begins moving upward, the body and fluid below the piston briefly act like an accumulator, and force fluid upward through the piston despite the fact that the piston is beginning to move upward.

Until the piston has moved a bit and picked up some speed, the damper doesn't damp. The graph shows the shock trying to hasten the motion of the suspension rather than retard it.

Suppose we built a dummy shock – no shims on the piston; essentially no damping effect – and put a spring on it and dyno-ed that. What sort of trace would we get? We would get reversed Vs: big spread between the left points and very small spread between the right points. Shock dynos typically also allow us to set the stroke at 1in and the rpm at 200. This gives us the same velocity range as a 2in stroke and 100rpm. This setting is often used for small dampers such as mountain bike shocks that don't have two inches of stroke. These are often used on Formula SAE cars as well as bicycles. It is also possible to test full-sized car shocks this way, and compare the plots to tests at the more customary 2in at 100rpm.

When we do that, we generally find that the points of the Vs, at the *y* axis, spread apart more at the higher rpm and shorter stroke. This means that for similar velocities, the shock is failing to damp over a larger percentage of the stroke when the frequency and acceleration are greater. This appears to be so even when peak velocities, and hence peak pressures, are similar. This could be explained by the fact that the pressure in the "accumulator" needs time to bleed off. The piston will therefore have to accelerate to a higher velocity after reversing direction before it will start to generate damping force. This would relate well with popular thinking that it's harder to make a shock damp with small, fast suspension motions than with large, slow ones. We also see the points of the Vs, at the*y* axis, spread if we stiffen the valving. This is logical because we will see greater compliance when the pressures are greater.

All of this means that there are penalties in damping performance when we raise working pressures to attempt to shrink the dampers, and these cannot be entirely overcome by minimising leakage inside the damper. The performance penalties will be particularly noticeable on chatter bumps.

There are penalties in damping performance when we attempt to shrink the dampers…

But wait – if we make the damper bigger, doesn't that by itself make the damper more compliant? If the body has more diameter or length, doesn't it have less stiffness? If a column of fluid is longer, isn't it more compliant? When we make a shock bigger to reduce the working pressures, are we tricking ourselves? Do we lose on the swings what we gained on the roundabouts?

Partly we do, but not entirely.

Consider what happens if we double the length of the damper, and adjust the motion ratio accordingly. The shock now only has to make half the force at given wheel velocity. When the velocity reverses, the pressure will be half as great, but the column of fluid will be twice as compliant, so it will deflect the same amount. However, the piston will accelerate away from its point of reversal twice as fast, so it will start damping sooner.

Suppose we leave the length and motion ratio alone, and double the piston area, meaning we increase the diameter by a factor of the square root of two. That also cuts the pressure in half, and does it without increasing the length of the fluid column. However, it does increase the surface area of the body, and correspondingly its compliance in terms of radius and circumference, and the hoop stress acting on it. The hoop stress goes up by a factor of the square root of two, and the wall stretch per unit of hoop stress also goes up by a factor of two, so the diameter increase for a given rod force doesn't change.

So, *macht nichts*?

Not quite. The changes in diameter and circumference are the same in absolute terms, but smaller in percentage terms, for the larger diameter. For identical small absolute values of diameter change, the larger diameter sees a smaller percentage area increase. For example, if a 1in cylinder grows to 1.01in, its cross-sectional area grows by a factor of 1.01 squared, or 1.020. If a 1.4in cylinder grows to 1.41in, its cross-sectional area grows by a factor of 1.014. So there is a little gain in terms of the effect of wall stretch, and a reduction of fluid compression by a factor of the square root of two.

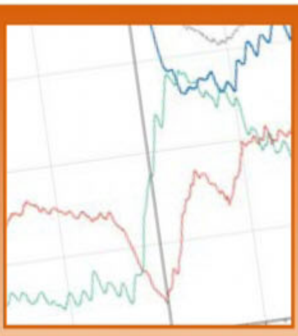
Thus, we do reduce compliance effects in a damper by increasing its size, either by making it longer and adjusting the motion ratio to suit or by making it fatter.

Now, what about using two dampers? Other things held constant, we reduce working pressures by a factor of two, and we don't increase fluid column length or reduce radial rigidity. Then there's the question of heat. Regardless of size, if the shocks are similarly effective they must generate similar amounts of heat, in calories per unit of time. This must be dissipated through the surface of the units. Other things being equal, greater surface area will translate to lower operating temperatures and improve damper performance in severe conditions. Using multiple dampers is best for this, followed closely by using longer dampers. Using fatter dampers helps, but not as much.

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.

E: markortizauto@windstream.net
T: +1 704-933-8876
A: Mark Ortiz
155 Wankel Drive, Kannapolis
NC 28083-8200, USA

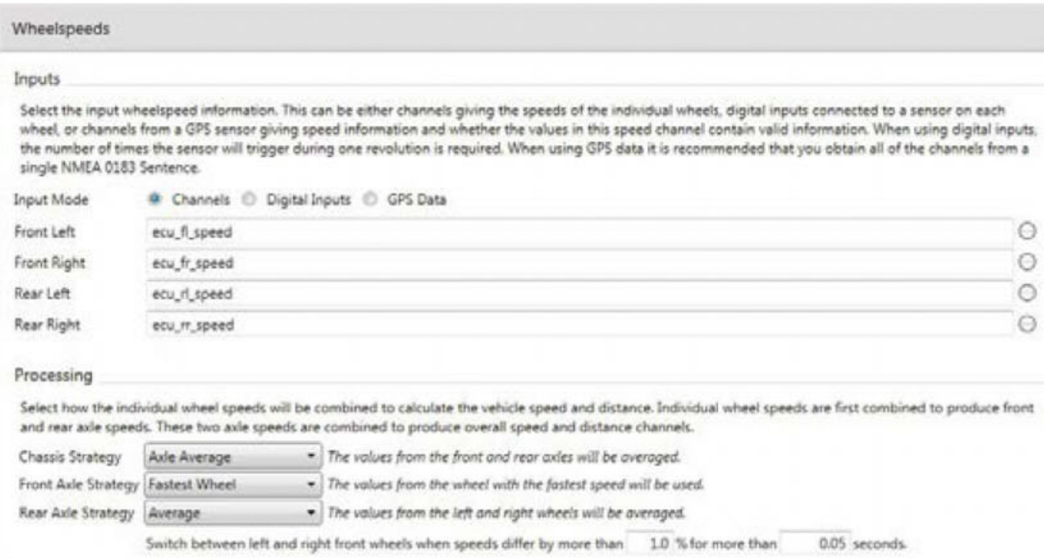


Databytes gives you essential insights to help you to improve your data analysis skills each month, as Cosworth's electronics engineers share tips and tweaks learned from years of experience with data systems

First select your wheel speed plan

Indicated values of wheelspeed will let you get true vehicle speed

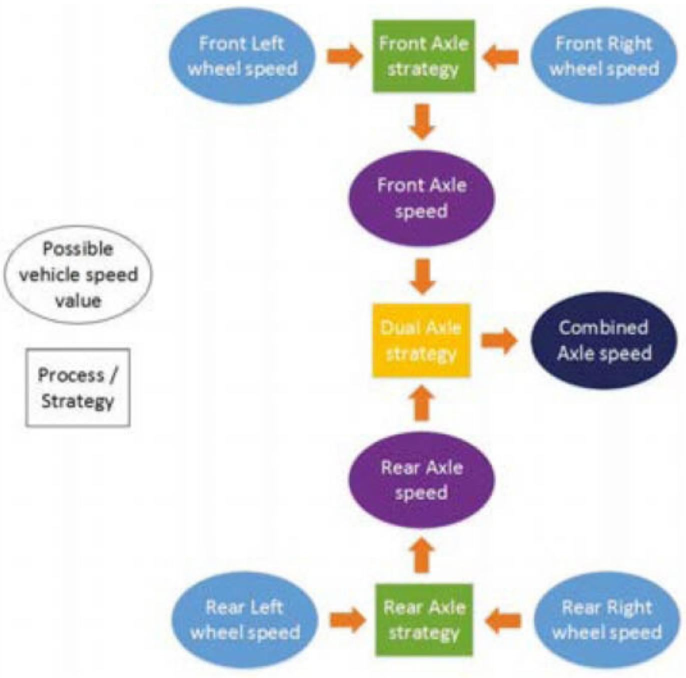
In motorsport, speed is everything. Whether you are looking for the final tenth on a qualifying lap, or for some extra mileage on an endurance stint, speed will be one of the most important channels a data engineer will analyse. Speed is also necessary to generate a value for distance, another fundamental channel essential for proficient data comparison and analysis. Speed is a value often taken for granted, however. Generating an accurate and reliable speed trace is actually quite a fine art. For a vehicle with four wheels, and four wheelspeed values, a multitude of strategies can be used which combine these values, in order to generate an estimate for true vehicle speed. This may seem trivial. However with events such as wheel lock-ups, kerb strikes, wheel spin and jumps, individual wheelspeeds may rise or fall to values not representative of the true vehicle speed. This article will investigate some of the strategies available for calculating true vehicle speed from indicated values of wheelspeed, highlighting some of the areas which need considering when selecting a strategy.



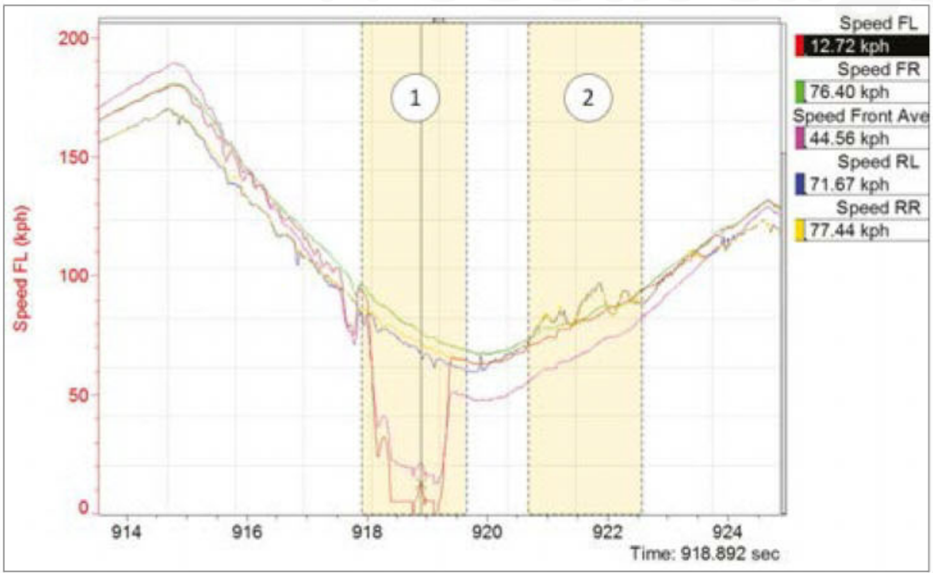
Professional datalogging software may have the ability to select different wheelspeed strategies for generating vehicle speed.

Professional datalogging software may have the ability to select different wheelspeed strategies for generating vehicle speed. The flow chart (left) shows the strategy process, with each elliptical shape representing a value which could be used as the true vehicle speed, and the rectangular shapes representing some form of numerical processing or calculation. There are varying complexities to the speed values generated, depending on the number of processes required to generate them. The most basic values would come directly from one of the individual wheel speeds, where, for example, the front left wheel speed would be taken as the value for true vehicle speed. The next level would come from an axle strategy, where the values of the two wheels across an axle would be processed to give an axle speed. This could be, for example, selecting the fastest wheel on that axle to give the speed value. The final level of complexity comes from a dual axle strategy, where the front and rear axle values of speed are combined to produce another value for speed. This could be, for example, using the front axle value under braking only, and using the rear axle at all other times. Some possible axle and dual axle strategies are summarised in **Table 1.**

It is important that the speed strategy is carefully considered. There is no perfect solution for all cars and tracks, as vehicle and setup variables, such as drivetrain (Fwd, Rwd or 4wd), weight distribution, ABS and traction control, as well as track variables, such as kerbs or surface quality, can change the way the wheels behave. On a rear wheel drive vehicle, with no traction control, low grip tyres, a lot of torque and a rookie driver, it may not be appropriate to use the rear wheels, on power at least, to give a representation of true vehicle speed, as there is likely to be some wheel spin. Similarly, on a different rear wheel drive car, with traction control, a professional driver and a very rearward weight distribution on a dusty track, it might be better to use the rear wheels for the speed strategy, as there may be some front wheel locking and the traction control should limit rear wheelspin.



Each ellipse represents a value which could be used as the true vehicle speed, and the rectangular shapes represent some form of numerical processing or calculation



Specific behaviour of the wheels in the two areas of braking and acceleration gives engineers a strategy indicator

Table 1: Some axle and dual axle strategies

	Strategy	Description
Single axle strategy	Left Wheel	Takes the value of the axle left wheel only
	Right Wheel	Takes the value of the axle right wheel only
	Fastest Wheel	Takes the axle fastest wheel
	Slowest Wheel	Takes the axle slowest wheel
	Wheel Average	Takes the average of the two wheels
Dual axle strategy	Front Axle	Takes the value of the front axle only
	Rear Axle	Takes the value of the rear axle only
	Fastest Axle	Takes the fastest axle value
	Slowest Axle	Takes the slowest axle value
	Axle Average	Takes the average of the two axles
	Front Wheel Drive	Takes the front axle value under a specified condition (braking) then the rear axle value at all other times
	Rear Wheel Drive	Takes the rear axle value under a specified condition (braking) then the front axle value at all other times

The data here shows five speed traces, including the individual wheel speeds, front left, front right, rear left and rear right, and also the average of the front wheels. Two areas are highlighted, area 1, under braking, and area 2, under acceleration. Each of the areas show some specific behaviour of the wheels, which data engineers need to be aware of while selecting a speed strategy. Area 1 shows a wheel lock-up of the front left wheel. It can be seen that this trace drops away dramatically for a short period of time. It should be noted that the front average trace is heavily influenced by this event and also reads low. The average front strategy, therefore, may not be a particularly good choice for a car which suffers from front wheel lock-ups a lot.

Area 2 shows some slight rear wheelspin, signified by the undulations in the rear speed traces. The rear speeds or rear axle trace, therefore, may not give a good representation of true vehicle speed in this area.

For this small snippet of data, a recommended strategy may be to use the fastest front wheel, or perhaps the average of the rear wheels under braking and then the average of the fronts while accelerating. Both of these strategies, albeit stronger for this snippet of data, also have weaknesses. For example if a dual wheel lock-up is seen, the fastest front strategy will be poor, or if there is rear wheel lock-up while changing down the gears under braking, the second strategy may also be poor.

In summary, the wheel speed strategy selected needs careful consideration as different cars, driver styles and tracks may play to the strengths of one strategy more than others. Professional datalogging software can provide many different strategies for calculating speed. However, selecting the best one is up to the engineers involved and is not quite as straightforward as it may initially seem.

Different cars, driver styles and tracks may play to the strengths of one strategy more than others so wheel speed needs careful thought

Challenge

See if you have understood how the wheel speed sensors and strategies work by answering the following brain teaser.

A car is set up to use the speed strategy of a dual axle, axle average. The individual axle strategies are both set to fastest wheel. It uses standard Hall effect wheel speed sensors with equally sized trigger wheels on each wheel. It can be assumed that, initially, the sensors are calibrated correctly for the wheel diameters and the wheel speed readings are valid.

The team suspects rain. However they only have two wet tyres. The car comes into the pits and the team pre-emptively fit wet tyres, which have a larger diameter than the slick tyres, to the rear of the car. Assuming that the on track performance of the wets is the same as the slicks (no extra wheelspin or lockups than previously), and the driver sets the same lap time, how would you expect the speed traces to differ before and after the stop. NB the trigger wheel and wheel diameters are NOT adjusted in the datalogging software during the stop.

A **Rear wheel speeds higher, front wheel speeds unchanged, overall speed trace higher**

B **Rear wheel speeds lower, front wheel speeds unchanged, overall speed trace lower**

C **Rear wheelspeeds higher, front wheel speeds higher, overall speed trace higher**

For the answer to this question, please visit: **www.racecar-engineering.com**

COSWORTH

Produced in association with Cosworth
Tel: +44 (0)1954 253600
Email: ceenquiries@cosworth.com
Website: www.cosworth.com


Racing connections
UPGRADE YOUR FLUID SYSTEMS WITH
HYDRAFLOW 14J21
LOW PRESSURE CONNECTOR
FOR OIL, AIR, WATER
Locks automatically
Gloved hand operation
Lightweight and flexible
Integral bonding wires
Aerospace standard spec
Safety strap
RACING WITH AeroCatch® SHEAR PIN GENIUS
RACING WITH AeroCatch® XTREME NEW
THE PANEL FASTENER FOR THE 21ST CENTURY
WITH STEEL STRIKE PIN FOR XTREME RACING
SPECIALTY FASTENERS & COMPONENTS
Quarter Turn Fasteners
Their quick opening action makes them ideal for applications where fast and frequent access is required.
Livelock Panel Fasteners
With low profile and light weight, they lock within two turns yet take high shear and tensile loads.
Quick Release Fasteners
Hand operated and non-threaded means they offer fast and easy removal of panels such as racecar bodywork.
HYDRAFLOW 14J21
Fully interchangeable with Wiggins-style connectors, in any installation.
Speeds up radiator/ turbo/engine changes – no hoses or jubilee clips to fiddle with.
Integrated locking strap - so no lock wire or ty-rap, saving weight and time.
Meets performance requirements of AS 1650.
For full information and technical spec, please check the QR code, or call +44 (0)1803 868677
AeroCatch®
Bonnet, Boot, Hood, Trunk, Tailgate, Street, Race & Rally, Plus Flush & Flush Options, Black, White, Carbon Look, Locking, Non Locking Options.
Aerocatch 2 Deck Hatch, Engine Cover, Hood, Bonnet, Tailgate, Trunk
AeroCatch 3 Shear and tension latch; fastens panels together; shear engagement tongue; carries loads in 3 axis
AeroCatch Xtreme With its steel strike pin, is set to make rallying and xtreme offroad events safer
For full information and technical spec, please check the QR code, or call +44 (0)1803 868677
SPECIALTY FASTENERS & COMPONENTS
the right connection
SEE THESE PRODUCTS - AND MORE - AT PMWE, PRI and AUTOSPORT INTERNATIONAL

Balancing act honed in the tunnel

Monitoring the effect of rake changes on overall balance

The Formula Student UK competition at Silverstone in July saw *Racecar*'s editorial team taking its first close look at the 2014 entries, and Bath University's TBR 14 entry caught the editorial eye. So, Team Bath Racing was this year's Formula Student invitee to a half-day session as *Racecar*'s guests in the MIRA full-scale wind tunnel. In this third instalment (of four), we take a look at the best way of balancing out the aerodynamics.

Team Bath Racing had only been exploiting a wing package on its cars since 2012 and as a result it was still putting a lot of development effort into this aspect of the car's design. Indeed, particular emphasis went into the wing design on TBR 14, especially at the front, which featured a number of intricate details as is evident in our photos. Overall, the quest was clearly for maximum downforce without much concern about drag. For readers who have missed the previous two *Racecar* instalments on TBR 14, the car set new Aerobytes records for CD and -CL (as measured in the MIRA stationary ground wind tunnel), meaning in simple terms 'mission accomplished' on the overall aerodynamics target! The baseline aerodynamic data at 60mph is shown in **Table 1** for reference.

Evidently then, TBR 14 produced high downforce with the expected high drag penalty, but the team's simulations showed that downforce at these levels of efficiency (-L/D) would yield gains in lap time. The balance (percentage front) looked not unreasonable as a starting point in the session, but with a weight distribution with driver aboard of around 50 per cent front, a bigger proportion of the total downforce was needed on the front end. After investigating rear wing adjustments which reduced total downforce but improved balance, the team moved on to some tests to find ways of obtaining more front downforce.

Balance transfer

The construction of the front wing meant that there was little inherent adjustability available, so the first and most obvious modification to evaluate was fitting different height Gurneys to the upper surface of the top flap's trailing edge. The results of two different Gurney heights are shown in **Table 2** compared to the previous configuration (not the same as the baseline in **Table 1**), with changes reported in 'counts' where 1 count = a coefficient change of 0.001.

So both small and large Gurneys proved to be useful if modest balance shifters, the larger ones being more potent. It's interesting to compare the other effects of the two different Gurney heights though, with similar modest additional drag increments and not totally dissimilar, minimal effects on downforce. In both cases the effect was to generate a small amount of extra front downforce and knock off some rear downforce, with the percentage front value heading closer to where the team felt the balance needed to be. The losses at the rear may have been aerodynamic but were more likely the mechanical result of more front downforce overhanging the front axle, so offloading the rear tyres.

In simple terms the records meant 'mission accomplished' on the aerodynamics targets

Table 1 – baseline data at 60mph

	CD	-CL	-CLf	-CLr	%front	-L/D
Baseline data	1.401	2.409	0.946	1.463	39.26	1.719

Table 2 – the effect of front gurneys

	CD	-CL	-CLf	-CLr	%front	-L/D
Previous confign	1.275	2.258	1.034	1.224	45.81	1.771
+6mm Gurney	1.291	2.262	1.048	1.214	46.34	1.852
Change	+16	+4	+14	-10	+0.53	-19
+18mm Gurney	1.293	2.257	1.052	1.206	46.61	1.746
Change	+18	-1	+18	-18	+0.80	-25

Table 3 – the effects of front ride height changes

	CD	-CL	-CLf	-CLr	%front	-L/D
Previous config	1.275	2.258	1.034	1.224	45.81	1.771
+3mm FRH	1.271	2.212	0.985	1.227	44.52	1.740
Change	-4	-46	-49	+3	-1.29	-31
+6mm FRH	1.273	2.191	0.964	1.227	44.01	1.722
Change	-2	-67	-70	+3	-1.80	-49

Figure 1: Team Bath Racing's TBR 14 is set up in the MIRA wind tunnel. The boundary layer 'trip fence' is clearly visible in the foreground

Figure 2: TBR 14's aerodynamics were dominated by its large, aggressive wings; the front wing incorporated some intricate detailing

Figure 3: Small front Gurney

Figure 4: Large front Gurney

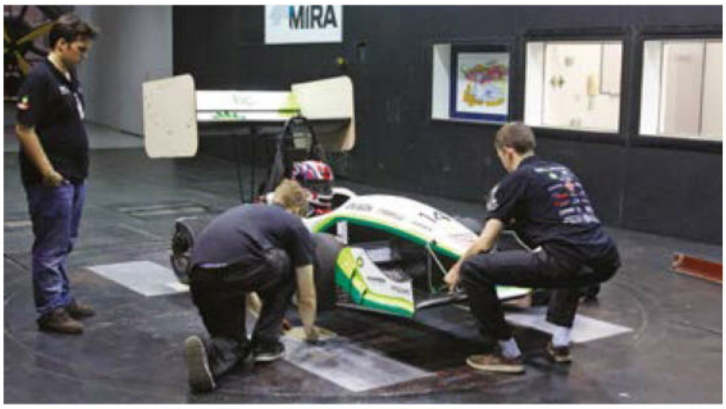


Figure 5: Project manager Dave 'Quick Lift Jack' Turton does the hard work while aerodynamics leader Francisco Parga supervises the placement of front tyre shims

Figure 6: Re-checking the car's alignment after installing tyre shim plates

Table 4 – the effects of raising the rear ride height

	CD	-CL	-CLf	-CLr	%front	-L/D
Previous config.	1.293	2.257	1.052	1.206	46.61	1.746
+19mm RRH	1.320	2.385	1.165	1.221	48.83	-1.807
Change	+27	+128	+113	+15	+2.22	+61

Raising the rear added a significant total downforce increment at the front end

Ride heights

As configured for this wind tunnel session, TBR 14 had a low ride height and solid spacer in lieu of the damper units. This allowed ride height increases only (using shims on the load cells pads under the tyres), which of course would likely not increase the percentage front value but would at least enable the car's response to ride height changes to be gauged. Two changes of front ride height were evaluated, with the results in **Table 3**.

The effects, then, of even small front ride height changes were quite potent. There was a significant though non-linear loss of front downforce as front ride height was raised, with little change in rear downforce (drag), equating to a loss of percentage front and efficiency with each front ride height increment. The front needs to be run at the lowest ride height possible, commensurate with avoiding excessive ground contact in worst-case pitch and roll combinations, to obtain the best percentage front possible.

Next, the rear ride height was increased, and as only one sample was scheduled for brevity, a bold change was made in order to gauge the response with the rear tyres being raised by 19mm. **Table 4** shows the data relative to the immediately previous configuration.

So raising the rear added a significant total downforce increment, most of which was at the front and this in turn provided another useful increment of percentage front. The gain was quite efficient too. With the front wing overhang (to the leading edge) corresponding to almost 54 per cent of the car's short wheelbase, a 19mm increase at the rear axle would have caused the wing's leading edge to drop by 10mm. In addition, that 19mm increase over the 1540mm wheelbase represents an angle change of 0.7 degrees. So, at the front, the wing's height was reduced by 10mm and the wing angle was increased by 0.7 degrees, both of which would add downforce. The rear wing's angle would also have increased by 0.7 degrees, which would have generated additional downforce that would mitigate the aerodynamically induced mechanical losses at the rear axle arising from the front downforce gain, and so the rear also gained downforce. Thus, although TBR 14 featured no aerodynamic underbody as such, rake changes still proved to be potent tools in establishing total downforce and balance. And providing the raised rear ride height didn't compromise the suspension kinematics or cause excessive ground contact at the front end, it looked like a helpful balance adjustment.

In **next month's** final episode on TBR 14 we'll look at some curious results found when applying yaw angle.

Racecar Engineering's thanks to the staff and students at Team Bath Racing.

CONTACT

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

Produced in association with MIRA Ltd

Tel: +44 (0) 24-7635 5000
Email: enquiries@mira.co.uk
Website: www.mira.co.uk


180 MPH WITHOUT MOVING AN INCH

Damping dilemma

Formula 3 has been a fertile field for suspension research but regulatory changes have forced some re-thinking – and more developments

By SIMON McBEATH

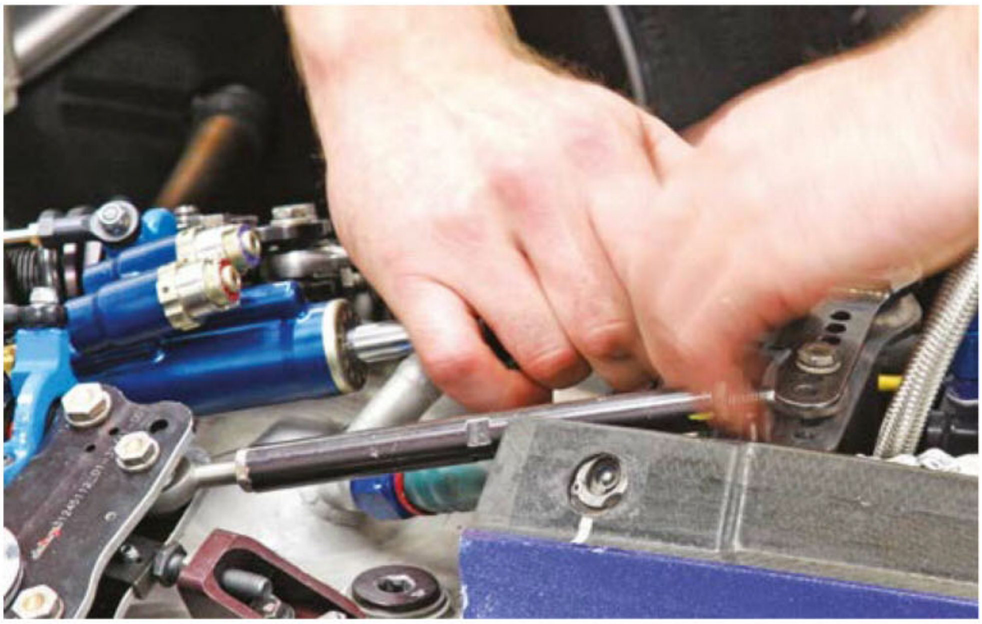


Figure 1: Working on a Multimatics third damper on the rear of the Team West Tec Dallara F312

Figure 2: Third element on Fortec Motorsport's 2007 Dallara F307 – 'about as light as you could make it'

(PHOTO COURTESY: M KOUROS & FORTEC MOTORSPORT)

Formula 3 is not just a stepping stone for racecar drivers it is – or at least it always has been – a valuable training ground for racecar engineers too. Gradually though, the technical regulations have become more restrictive, with less aerodynamic development possible, and in the last couple of seasons with prohibitions on certain types of components in the suspension systems. However, leaving aside the merits or otherwise of such changes, the past four or five years have seen some fascinating developments appear (and disappear) in the suspension department. We take a look at what has been happening and visit the Multimatic servo-hydraulic test rig at its European headquarters in Thetford, Norfolk with FIA European F3 contenders Team West Tec.

Rolling back the years

In our January 2009 (RE V19N1) issue we examined 'third elements' in racecar suspension systems, with a particular focus on developments among British Formula 3 teams. At the time one could find a mix of springs, dampers and/or bump rubbers in various combinations in the third elements at different teams and on different tracks, and there certainly was no one-size-fits-all solution to the conundrum of keeping the drivers happy while simultaneously optimising the tyre contact patches and exploiting aerodynamics to the full. Our featured team then, Fortec Motorsport, had tried combinations of springs, dampers and bump stops in third elements, but by 2007 had adopted third elements that utilised just bump rubbers, but arranged so that they operated in compression and rebound in a compact device that then-chief engineer Mick Kouros described as 'about as small and light as you can make a third element'. **Figure 2.**

But among alternatives that had been tried prior to that, made in-house in cooperation with damper supplier at the time Nitron, was a displacement-sensitive third element that Fortec race engineer (now a driver development engineer at Red Bull Technology) Andi Scott described as 'similar to that found on the rear suspension of a motocross bike involving a tapered needle to restrict the fluid flow that

Figure 3: DTM damper from Multimatic
(PHOTO COURTESY: MULTIMATIC)

The past five years have seen some fascinating developments appear (and disappear) in the suspension department

Figures 4 and 5: 'Two humps or three, sir?' One of Fortec Motorsport's Dallara F308s had grown a third damper blister in 2008…

allowed a larger difference in damping between low-speed and high-speed [damper motion].'

The route that Fortec was following at the time served to illustrate the ingenuity going into finding tiny fractions of lap time, but fractions that could make a huge difference to grid and track position in a competitive category.

Fortec, along with others, had been using the servo-hydraulic test rig at Multimatic since around 2006. Multimatic, of course, had been designing and manufacturing damper products for many years, having introduced its patented four-way adjustable high precision 'DSSV®' or Dynamic Suspension Spool Valve damper, which first raced in ChampCar in 2001 and was taken up by DTM and F1 in 2002. Among other notable successes for DSSV dampers were four consecutive F1 titles with Red Bull. **Figure 3.**

By 2004 a more modular version of this was developed for the GT and Le Mans markets, and a bespoke four-way adjustable variant was also developed for a single team in Formula 3 using what design manager Damian O'Flynn described as 'the same strategy we use in Formula 1, the design being 100 per cent unique and optimised for the application, engineered, analysed and packaged for the specific application rather than off-the-shelf'. With this proving to be very successful, other teams clearly took notice and, with Dallara's F308 being developed and manufactured for late 2007/early 2008 deliveries, Damian O'Flynn commented that 'a number of teams requested DSSV dampers. So Multimatic released a four-way adjustable version for general use as well as a two-way version for those wanting to minimise weight (around 35g per unit was saved).'

Fortec Motorsport had not moved over to Multimatic's offerings just yet, but it was using its own design third elements mentioned above. Then, not long after RE's 2009 article on third elements, Fortec began work on their own design of inerter, with Scott taking charge of the project under Kouros's managing eye. Scott: 'I started work on inerters late in the 2009 season. God knows how many hours I spent going through different journals and university studies that winter! The hardest part of the design was packaging it in the limited space and ensuring the installation stiffness was sufficient; it took quite a few long nights at Fortec on CAD! A small company called Delta Engineering in Daventry (near Fortec's raceshop) did all the manufacture work and became my second home for the duration of the project. Brian Smith, the owner, had a good amount of engineering input and did a fantastic job too, as he has been around for a long time working in various areas of motorsport.' **Figures 4 and 5.**

This first iteration of in-house designed inerter was run as a third element front and rear for 2010, together with Multimatic side dampers for the first time 'which provided better pitch control and large weight savings' commented Kouros. Scott continued: 'The majority of the pre-season was spent with [renowned vehicle dynamics consultant] Dave Williams and Damian O'Flynn at Multimatic, ensuring we were on the correct path. We had a very good year with Oli Webb in F3 (third overall in the British Championship) and in my view made a good step forward with the car.' Kouros added that 'with some rig work and track tuning the car was more stable and brought the tyres in better with inerters.' **Figures 6 and 7.**

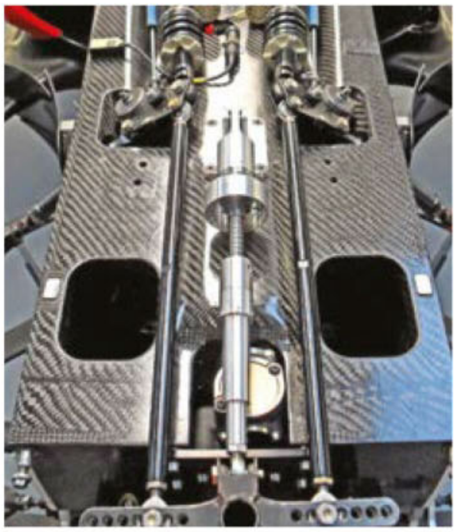
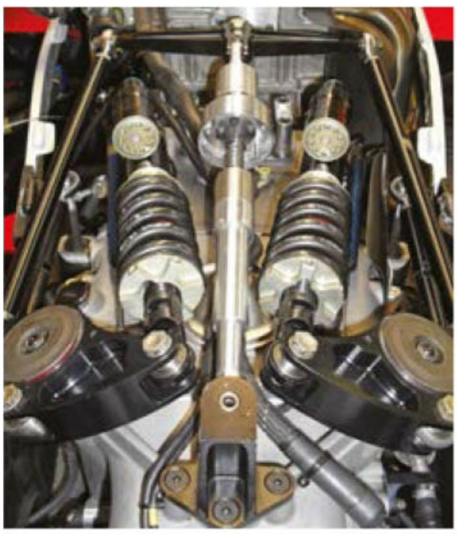


Figure 6: … which concealed the team's own design inerter at the front…



IMAGES COURTESY OF: ANDI SCOTT & FORTEC MOTORSPORT

Figure 7: …and there was also an inerter at the rear

Figure 8: Multimatic's 'G-sensitive' damper automatically changed characteristics depending on sprung mass accelerations

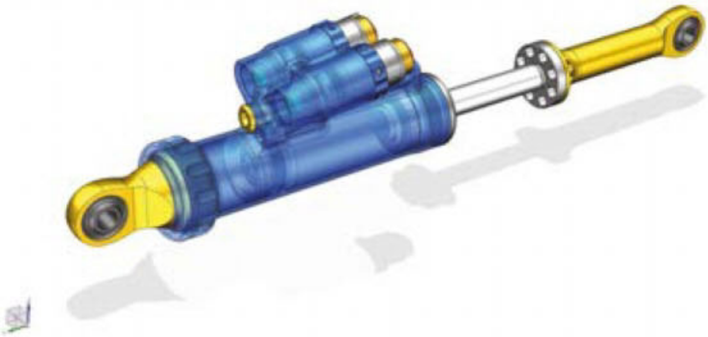


Figure 9: A Multimatic two-way adjustable damper

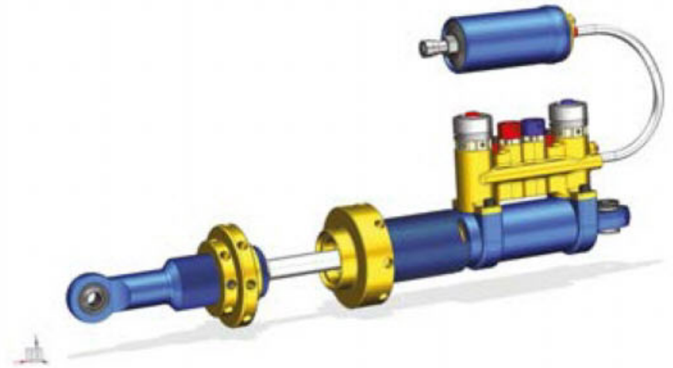


Figure 10: A Multimatic four-way adjustable damper

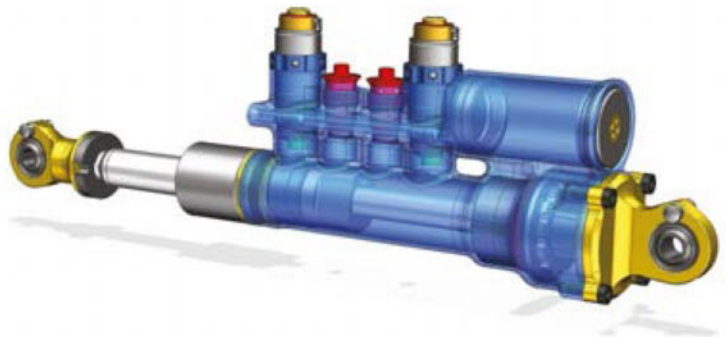


Figure 11: Mutlimatic's integrated F3 damper inerter (IMAGES COURTESY: MULTIMATIC)

For 2011, Scott attempted to take the inerter concept a step further by running them in parallel with the side dampers on each corner of the car, rather than as third elements, and again he takes up the tale: 'The four inerter layout had pros and cons. On smooth circuits we were very strong. However on circuits which required using kerbs, the single wheel displacement was hindered.'

The 2011 season was an interesting year for Multimatic too. 'With more teams now using DSSV dampers, Multimatic integrated a new technology that had been developed with DTM customers, 'G-sensitive' damping" said O'Flynn. 'Utilising a simple mechanical system the characteristics of the dampers could be changed automatically during various transient manoeuvres (e.g. acceleration or braking). Having proved successful in DTM, LMP and GT categories, this was adopted by nearly all F3 DSSV teams.' **Figure 8.**

While being understandably cagey about the specifics, O'Flynn allowed that the mechanism that effectively switched between damping characteristics was 'a secondary hydraulic circuit that could be mechanically opened or closed depending upon acceleration of the sprung mass. What it changed was the damping forces at low damper speeds, but that did depend upon how it was configured (each team and series did different things).' Scott's comments on this development route were that 'braking was improved on the big stops, but it required different brake bias to the rest of the corners which were below the G threshhold, and we struggled to perfect the balance.'

"It required different brake bias to the rest of the corners and we struggled to perfect the balance"

Bespoke inerter

In 2012, the latest F3 chassis from Dallara was introduced, the F312, the ubiquitous choice in Europe and many national series despite Formula 3 not being a one-make category. The F312 was designed from the outset as a six-damper car, that is, four corner dampers plus third elements front and rear, making the application of inerters in the centre positions much easier. The standard damper supplied by Dallara is from Koni but Multimatic continued to offer its two- and four-way adjustable DSSV corner dampers as well as third element dampers. **Figures 9 and 10**.

Having worked on its in-house inerters with Multimatic, which had been developing integrated dampers for a number of years in other series, Fortec asked Multimatic if they would develop a bespoke inerter damper for F3 in 2012. 'The design, understandably, was much better than our previous attempts and now had the inerter mass internally mounted,' said Scott. 'The design and arrangement was much better packaged.' And O'Flynn commented that 'having worked through 2010 and '11 developing the F3 damper inerters from a mechanical design perspective as well as a vehicle dynamics perspective, Multimatic chose to develop the F3 integrated design to realise packaging and weight improvements.' **Figure 11**.

It might seem that incorporating an inerter into a four-way adjustable damper would be a considerable design challenge, and O'Flynn's response is illuminating. 'Our dampers utilise a remote valve configuration, so incorporating the inerter internally was probably easier for us than others. Mechanically, I think the integration was relatively simple; it is the vehicle dynamic application of the technology that is much more difficult. But with our vehicle dynamics engineers and simulation engineers, together with the technical facilities at our disposal, it was relatively straightforward for us to predict the contact patch load and load-control parameters and their potential improvement with the addition of inerters, long before we built any hardware. These predictions allowed us to optimise the designs and inertance levels for maximum improvement. Subsequent testing on our chassis dynamics rigs with hardware allowed us to fine-tune the optimums for each vehicle, chassis, spring, damper and tyre. Like springs and dampers, inerters have an optimum setting and this optimum is affected by the springs and dampers as well as the tyres and the structural integrity of the chassis. The [on-track] benefits are clear in my mind. Inerters can be used to improve the level of grip under the tyre as well as improve how that grip varies with input. These benefits can be realised through the entire frequency range of road/track inputs.'

Forward thinking

The new Zero 360 is a prime example of how a manufacturer, in touch with the objectives of the sport's rulemakers, stays ahead of the game.

NEW zero 360

- Bottle mounts directly to the vehicle
- Mechanical or electrical operating heads
- Plug and play electrical wiring
- Operates in any orientation
- 2.25Kg and 3.0Kg variants.

ALL PRODUCTS DESIGNED & MADE IN THE UK.

Fire suppression

and safety products

An advanced R&D programme for all our products ensures that even our longest selling lines are continually appraised to see if they can be improved upon.

QUICK RELEASE STEERING BOSSES

Formula, Touring, Rally. Available with pre-wired 8-way electrical connector.

RACE MIRRORS

Formula, Touring, Sports and GT. Conform to FIA and MSA requirements.

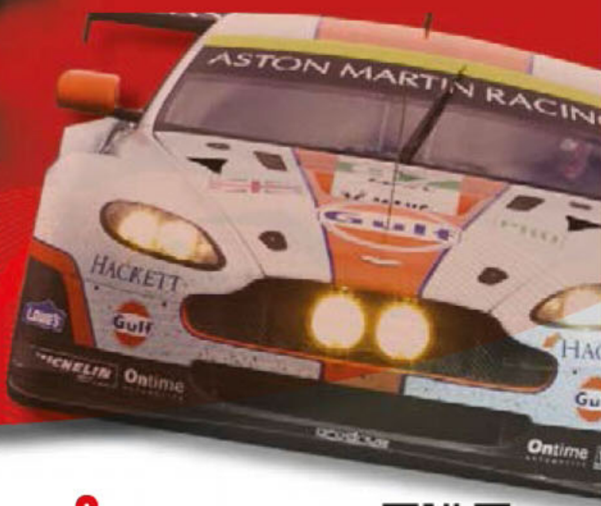
ROLLCAGE PADDING

Available in 5 different tube sizes. Exceeds latest FIA standard.

NEW HIGH INTENSITY RAIN LIGHT

Manufactured from aluminium with sealed-in high intensity, low energy LEDs, our new rain light is suitable for ALL racecars.

- Flashing facility
- Greater viewing angle
- Brighter
- More compact



MOTORSPORT INDUSTRY ASSOCIATION

ASTON MARTIN RACING OFFICIAL PARTNER

Champions of Safety lifeline®

Lifeline Fire and Safety Systems Ltd **UK:** +44 (0)24 7671 2999 **USA:** Sube Sports +1-714-847-1501 **www.lifeline-fire.co.uk**

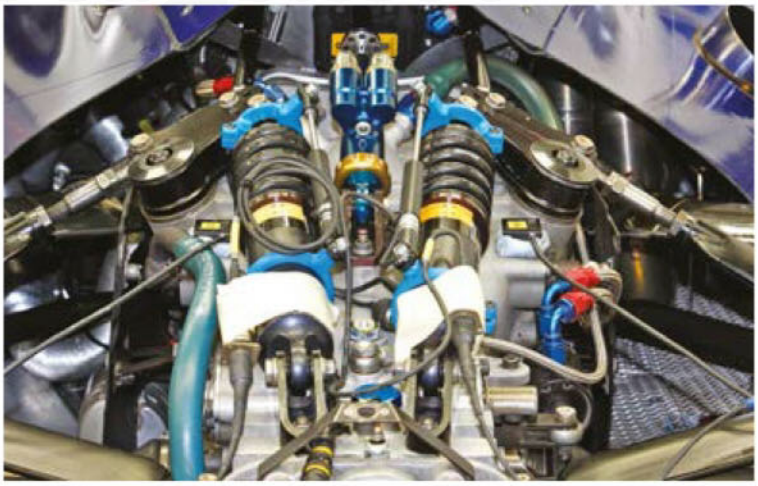


Figure 12: Inerters and four-way adjustables have been banned but teams continue to push suppliers to find performance gains and Team West Tec's Dallaras feature Multimatic third elements front (above) and rear

So, it was unfortunate that the FIA saw fit to ban inerters in F3 at the end of 2012, not least for Multimatic who were unable to fully realise the commercial benefits that would have been forthcoming from their inerter deal with Fortec. But for the teams too, there was no cost saving, just an inventory of leftover parts that were no longer of any use, plus an additional exercise in re-optimising the suspension settings. O'Flynn: 'The inerter ban meant that we had to remove the system from inside the dampers. The dampers then needed to be re-optimised for the car with no inerter fitted. Inerters typically drive a change to the baseline spring and damper settings, so all this work needed to be re-done without the presence of the inerters. Most teams did not want the expense of new inerter-less dampers, so simply removing the inerter parts and running the damper only was the cheapest solution. In our opinion this meant a sub-optimal damper design, as improvements could have been made to the design with the inerter removed.'

From the team's perspective Mick Kouros remarked; 'We had to re-tune the car with rig work and damper development, both of which involved additional cost, and the car was never as good again.'

So 2013 saw the cars run without inerters but another rule change for 2014 then came along which this time saw four-way adjustable dampers banned, two-way adjustables now being mandatory. 'As most [Multimatic supplied] teams were already in possession of the four-way hardware and were not keen to incur the cost of replacement dampers, we engineered a plug to replace two of the valves in the system while still keeping the hydraulic function correct,' said O'Flynn. 'Again, the damper was then sub-optimal because the potential weight saving could not be realised without entirely new hardware.'

Kouros, who from January 2014 was running the FIA European Championship F3 operation at Team West Tec, was phlegmatic about the banning of four-way dampers, remarking that 'this change was no drama because the two-way dampers from Multimatic work so well. But we need to do more track work now and need to compromise at some circuits.'

Ongoing rig work is a routine part of the development and refinement to optimise the car for individual tracks. Indeed, our session with the team in early September 2014 was part in preparation for the final two events in the series at Imola and Hockenheim, both of which require compliance over kerbs, and part for the Macau GP in November, a bumpy track that demands higher than normal ride heights as well as supple suspension. **Figures 12 and 13**.

So it has been a fascinating few years in F3 as new suspension developments have come and gone. But have the regulators gone too far in closing off some avenues? It depends on your viewpoint and involvement. But for those who wrestle with and observe technical challenges in motorsport, it seems a shame.

Why rig test?

The massively experienced Dave Williams ('The Rig Guru' profiled in our June 2009 issue, RE V19N6) is a consultant to Multimatic who, together with his trusty assistant, dynamics engineer Russell Paddon, a graduate of the University of Hertfordshire, runs the company's servo-hydraulic test rigs in Thetford, UK, and Toronto, Canada. Here he explains the ins and outs of rig testing.

'Rig tests provide the opportunity for examining in some detail the way in which a real vehicle and its suspension will respond dynamically to road inputs. They are useful for:

- **providing estimates of some vehicle properties**
- **exposing some types of vehicle deficiency**
- **quantifying their effect on suspension performance**
- **matching dampers to a vehicle, its tyres and springs**
- **exploring the effects upon response of different suspension setups**
- **reviewing previous/existing race setups**

'Rig tests usually result in improved performance on track.' Why not always? 'There are a number of possible reasons:

- **The setup was already optimal**
- **Deficiencies can affect the optimal compromise (usually lack of toe control and unforgiving aerodynamic properties)**
- **Inappropriate spring selection (initial track tests should always precede a rig test).**
- **Dominant drivers can push suspension setup away from optimal.'**

The Thetford rig is a four-post device, so what are the pros and cons of this versus, say, a seven-post rig? Dave Williams explains: 'Four-post rigs use idealised road (sinusoidal) inputs, with passive downforce devices generating constant forces, and "analogues" to describe and compare performance. Seven-post rigs use track data to derive approximations to actual track surface inputs and hence can achieve close to actual track maximum suspension velocities and displacements. They also use active downforce devices to simulate the moment effect of inertia and aerodynamic forces. And again they use "analogues" to describe and compare performance. Four-post tests are good for identifying setting limits, vehicle properties and deficiencies and for optimising linear range suspension settings. Seven-post tests are good for setting packer gaps, spring preloads (because of realistic input amplitudes) and exposing damper deficiencies (cavitation).

They can be poor for setting dampers because the downforce actuators can act as "skyhook" dampers. Neither can optimise the driver/vehicle compromise nor set the mechanical lateral balance of a vehicle.'

The driver/vehicle compromise is a reference to what Dave Williams identifies as the contradictory requirements of vehicle performance versus a driver's ability to use that performance.

'The issue is that the two are not always compatible. Thus it is often necessary to reduce vehicle performance so that a driver can use what remains.'

World wide dealer inquiries invited

PowerStream

GEO

2015 GEO Systems

Motorsports Test Equipment

Electromechanical and Electromagnetic operation

Discovery

Kinematics, Compliance & Dynamics

8 Post 26 Axis

No outdated hydraulic systems utilized

Diagnosis in-excess of 40 Critical chassis and suspension conditions

Clean, Quiet, Safe and Precise

No Data Clipping Required

Fastest DAQ System

Expandable with Full Native Data Integration

Insight

Kinematics & Dynamics

4 Post 12 Axis

- 3 Dimensional Center of Gravity
- Multi-Angle Loading Wheel Pads
- Floating Multi-Axis Towers
- 18″ Aero Loading Range
- 36″ Vert. Wheel Travel Range
- Road and Track Profile Testing
- High Speed DAQ System

ahead in every measurable way

World's Most Advanced Motorsports Kinematics, Compliance and Dynamics Test Systems

www.powerstreamindustries.com
cmeurett@powerstreamindustries.com
Ph. 704-888-9930

On the servo-hydraulic test rig

Racecar Engineering was invited along to a September 2014 rig session with FIA European Formula 3 entrant Team West Tec, whose recently recruited F3 chief engineer Mick Kouros was carrying out a scheduled development test to continue post-inerter, post-four-way damper optimisation and more specifically to obtain some improved set ups for the upcoming last two events at Imola, Italy and Hockenheim, Germany in the Euro F3 series, and the Macau GP.

The session began with baseline runs to establish a range of characteristics from which dynamics engineer Russell Paddon and consultant Dave Williams (see sidebar – Why rig test?) produced a series of interpretations and recommendations for parameters to work on, which were then prioritised. A summary of the session follows:

- **Softened front third damper (because it was felt that making the corner dampers do the work provides better driver feel)**
- **Iterative softening of the front corner dampers in rebound; improvements achieved**
- **Reduced compression damping on front corner dampers; better front to rear balance obtained**
- **Identified a problem with something at the front just bottoming out, presumably because softer damping was allowing greater travel; decided to work around it**
- **Softened spring rate at rear; improved rear damping but damping at front still too stiff**
- **Changed to stiffer front torsion bars; some parameters improved, some did not.**
- **Increased front damping; front to rear balance improved.**
- **Still softer rear springs fitted; required softer damping but yielded a useful overall set up**
- **Tyre pressures adjusted to see if further improvement could be found; results not fully as expected, reverted to standard 'hot' pressures.**
- **Moved on to softening the rear side dampers; beneficial result**
- **Added more bump and then rebound damping to the rear third damper; result not conclusive but thought that drivers would prefer it on track**
- **Moved on to assessment of anti-roll bars front and rear; range of ARB settings tried with Imola in mind (two big kerb strikes per lap); good settings found**
- **Fitted new, lightweight third damper for the front; worked as expected**
- **Moved on to bump stops on the third elements. ('This was the most interesting stage for me,' remarked Kouros, 'to see if the data agreed with driver feedback.')**
  Bump stops did good job with very progressive transition as load came on
- **Reverted to a previous rear spring and ARB setup ready for a track test the following week; produced good balance and good kerbing ability**

In summary Russell Paddon's assessment was that the car was behaving well despite the loss of the inerters. Kouros was pleased to derive improved settings for Imola and Macau (the softest set up).

And Dave Williams commented that the biggest improvement seemed to come from softening the rear springs, which Mick Kouros agreed with but qualified by saying he would probably give the drivers back some feel by stiffening the rear ARB as well.

Figure 14: Team West Tec setting up their Dallara F312 for the session on the servo-hydraulic test rig

Figure 15: Systems checks before the session begins

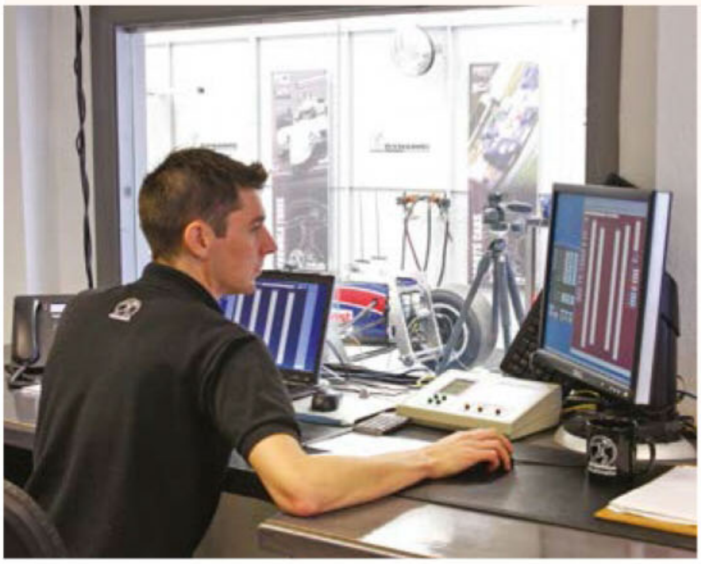


Figure 16: In the control room driving seat

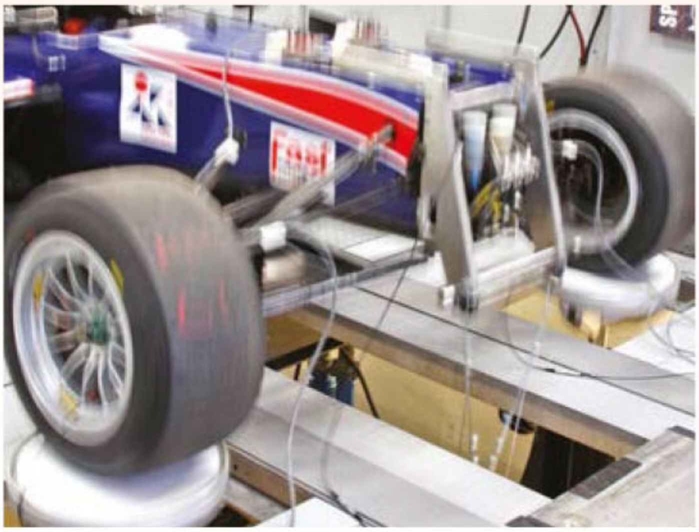


Figure 17: Testing underway. Cable tethers on the front (and rear) simulate a fixed, medium downforce load; the car is subjected to standardised inputs across a range of frequencies and amplitudes


-35mm
Worlds apart
Our technology centre is the most advanced in Europe.
That is how we can achieve a negative radius of up to -35mm. Extreme engineering and precision that other performance cam manufacturers in Europe cannot match. All our camshafts and ancillaries have been developed by the best to be the best.
Nº1 Kent Cams – the best in Europe:
No.1 for product development expertise
The greatest performance increase of any single modification
The widest range of camshaft ancillaries produced on site
The most advanced technology:
Negative radius to -35mm
CBN wheels with constant surface speed
Multi-angle lobes with CNC dressing
Marposs 3D C and Z axis position probe
Microphonic wheel dressing
Lotus Concept Valve Train software
KENT CAMS
HIGH PERFORMANCE ENGINEERING
www.kentcams.com
Cams + Pulleys, Belts & Chains
Valves & Valve Springs
Performance Cam Kits & Valve Spring Kits
Followers & Tappets


Call us first...
Trident
Racing Supplies
MasterCard
VISA
Unit 31 Silverstone Circuit Towcester Northants NN12 8TN
T: 01327 857822 F: 01327 858096 www.tridentracing.co.uk

How to wing it

If the technical regulations allow the requisite freedom, just where do you locate your rear wing? At the rear of course – but exactly where?

By SIMON McBEATH

A topic in which there appears to be no single answer to a simple question is always going to be interesting to study. Rear wing location on sports racing cars is, perhaps, one such area. Looking at sports racing cars around the world, a huge range of wing location solutions is on display, from high up and far back, to low down over the rear deck, to – most intriguingly of all – apparently tucked so low and far back that at first glance the wing appears to be in the wake of the main body. So, with the aid of Ansys CFD software and a sports racer model, we have taken a closer look.

We have also been privileged to speak with a well-known adherent of the low rear wing concept, Rennie Clayton at Dauntless Racing in the USA, who has shared some fascinating insights on his company's aerodynamic package for the Stohr WF1 sports racer.

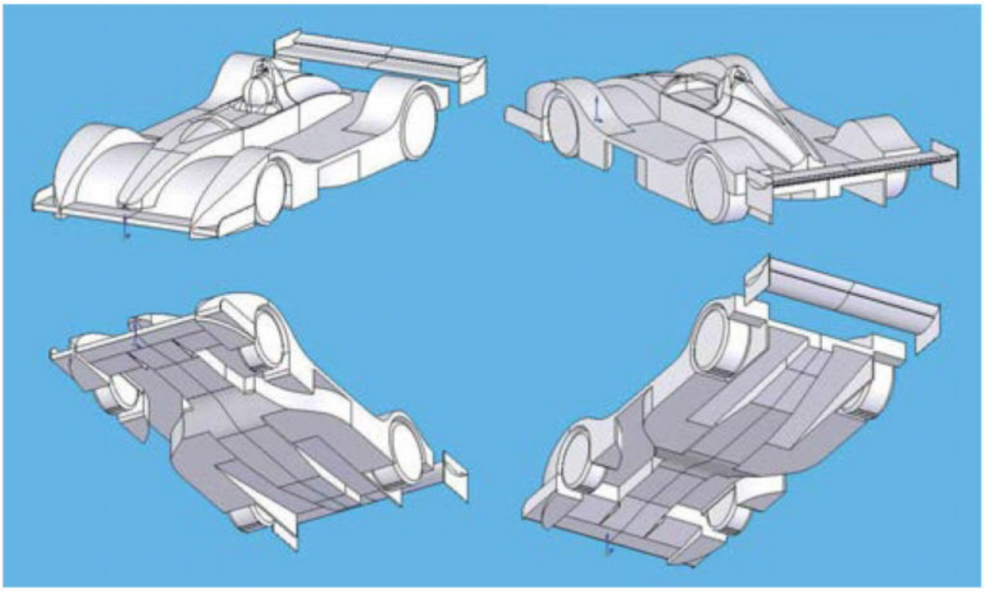
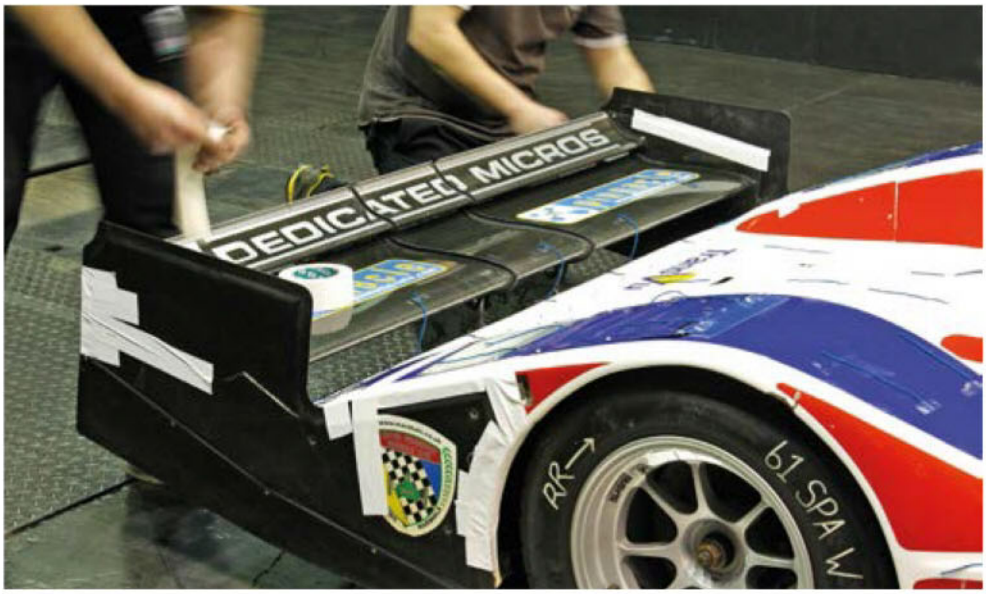


Figure 1: The sports racer model used for our simulations



Tiga A evaluated in September 2014's Aerobytes prompted this exercise

Virtual assessment

The basis for the CFD exercise was one of the simple CAD models the writer originally produced for the article in our October 2012 issue (V22N10) in which a variety of fundamental layout concepts was evaluated for Project Pipedream, the writer's long-running back-burner - 'fast becoming retirement project' – to design and build his own "sports libre" hillclimb car, the Vortex. Examining rear wing location on this model was thus another short step on the long road towards that project eventually becoming a solid object…

The model (see **Figure 1**) was deployed again more recently in Aerobytes in our September 2014 issue when we looked at wing location on one of the Tiga CN cars in the MIRA wind tunnel. The brief CFD exercise featured in that Aerobytes showed that while the wing's downforce reduced as its height was reduced, the downforce produced by the body initially increased as height was reduced. And although total downforce nevertheless declined as wing height was reduced (see **Figure 2**), balance (unfortunately not portrayed in September's Aerobytes thanks to duplication of the downforce plot instead) shifted markedly forwards as the wing was lowered (see **Figure 3**, hopefully depicting balance versus wing height this time).

This only portrayed the situation at one fore/aft, or x-location of the wing, which had been selected using the time-honoured finger-in-the-air process that has to be applied in the absence of any better information. This saw the wing's leading edge overlapping the rear deck trailing edge by about 50mm (2in), with the datum height putting the highest part of the wing assembly at the permitted maximum in UK hillclimbing of 900mm (35.4in) above the ground plane. The reasoning behind this particular x-location was that it would have put the wing's region of maximum suction directly above the diffuser exits, and hopefully this would help to drive the flow through the underbody and diffusers in a manner analogous to the relationship between the flap and the main element of a dual-element wing layout.

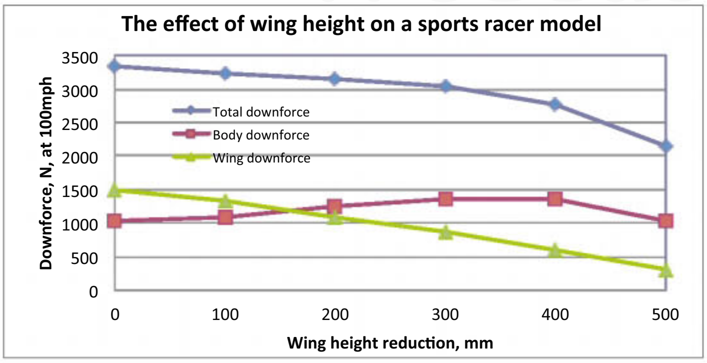


Figure 2: In our initial trial, varying wing height at the datum wing x-location affected body downforce differently from total downforce

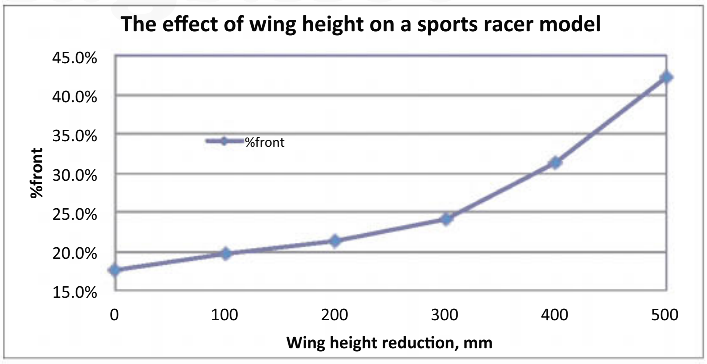


Figure 3: Varying the wing height also had a significant effect on balance

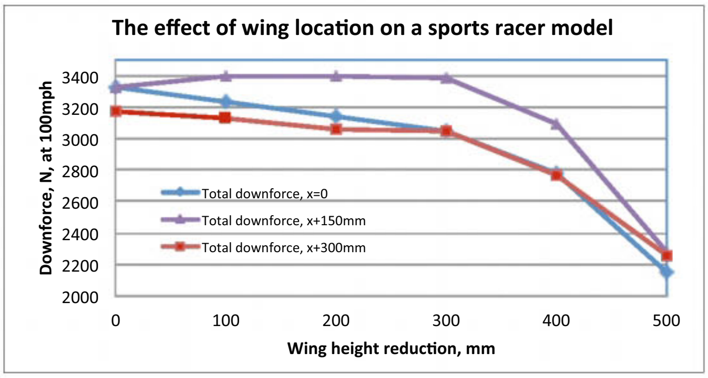


Figure 4: Adding further x-locations revealed a much more interesting picture of how total downforce varied with wing height

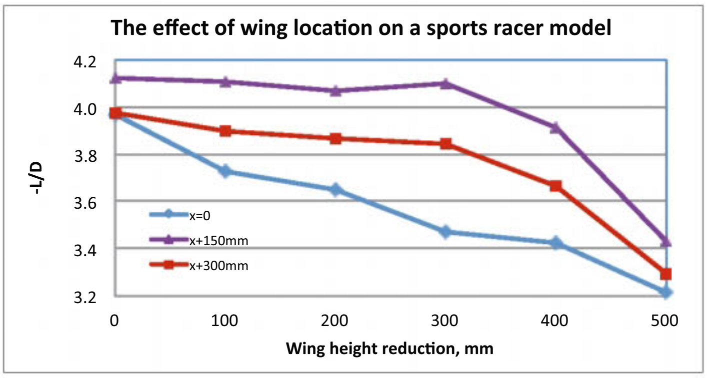


Figure 5: The efficiency plot also highlighted the potential benefit to be found by altering wing height and x-location

Table 1 – The basic aerodynamic parameters at maximum wing height and three different wing x-locations. Forces in Newtons at 100mph (divide by 4.459 to get downforce in lb)

x-location	Total Df, N	Drag, N	-L/D	%front
Datum	3330.6	839.2	3.97	17.5%
x+150mm	3332.0	808.6	4.12	15.4%
x+300mm	3172.3	798.3	3.97	13.1%

Table 2 – Separating wing and body downforce

x-location	Wing Df, N	Body Df, N
Datum	1491.6	1027.0
x+150mm	1448.1	1089.9
x+300mm	1431.0	928.5

But in making this choice it was also borne in mind that the initial vertical separation between the wing and the diffuser exit might better see the wing further aft as well as lower.

So, the next phase of work thus saw the wing moved to two additional x-locations, 150mm (5.9in) and 300mm (11.8in) further aft, and the model was evaluated once again at six different heights, ranging from maximum height to 500mm (19.7in) below maximum, in 100mm (3.9in) increments to create a matrix of data points, all at the datum static ride height of 40mm and with zero rake.

Simulated results

Available time often restricts wind tunnel evaluations to just a few variations of something relatively time-consuming like a wing location change, and in the case of Tiga A just two wing heights were tried, although in fairness this was more about validating prior background work. Nevertheless, by way of illustrating how easy it is to miss a useful development direction with just a few variations let's look initially at the CFD comparisons between the three x-locations at just the datum maximum wing height of 900mm, **Table 1** shows the basic aerodynamic parameters.

Clearly, if this was the extent of a toe-in-the-water glimpse at the effect of changing wing location then the data in **Table 1** wouldn't look too promising. Downforce had barely changed at x+150mm, and although drag decreased and efficiency (-L/D) improved, these benefits were offset by an unsurprising rearwards shift in aerodynamic balance (%front). At x+300mm downforce actually declined and although –L/D remained as at x=datum, balance had shifted still further rearwards. However the data in **Table 2**, showing wing and body downforce separated out, offered more hope.

Although wing downforce declined with each rearward increment, probably because the onset angle of the airflow to the wing reduced with each rearward step, body downforce increased at x+150mm, reinforcing the suggestion from the –L/D improvement in table 1 that there was a positive interaction at this x-location. Moving on, then to the data from the whole test matrix, **Figure 4** shows the plot of total downforce at the three x-locations and six heights evaluated.

A totally different pattern becomes visible from **Figure 4**, and the first thing to stand out is that downforce at x+150mm actually increased slightly compared to the datum location at the first reduction in wing height, h-100mm, and then pretty much levelled out until h-300mm rather than declining with each height reduction as it did at the other x-locations. Common to each x-location, though, was the rapid decline in total downforce as the height reduction exceeded 300mm. So **Figure 4** confirms that there was something important happening at x+150mm. What happened to the other aerodynamic parameters?

Figure 5 shows –L/D versus wing location and the pattern is similar to the total downforce plot, with the x+150mm location standing out as the most efficient across the whole range of wing heights. In fact efficiency at x+150mm remained pretty much at the same level from h=datum to h-300mm before declining, whereas at the other two x-locations –L/D reduced as soon as height was reduced.

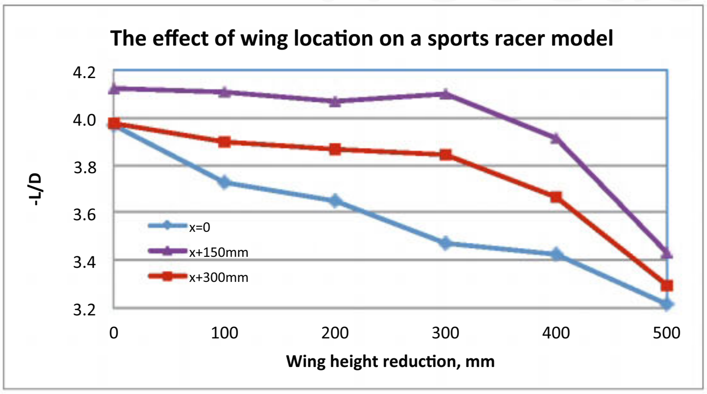


Figure 5: The efficiency plot also highlighted the potential benefit to be found by altering wing height and x-location

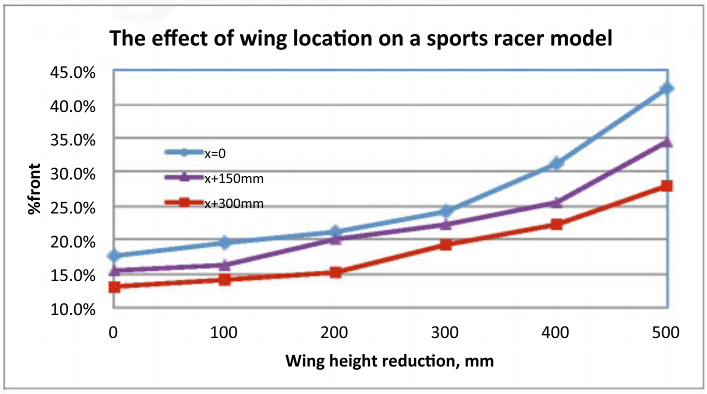


Figure 6: The balance curves of the further aft locations were slightly more rear biased, but not by much

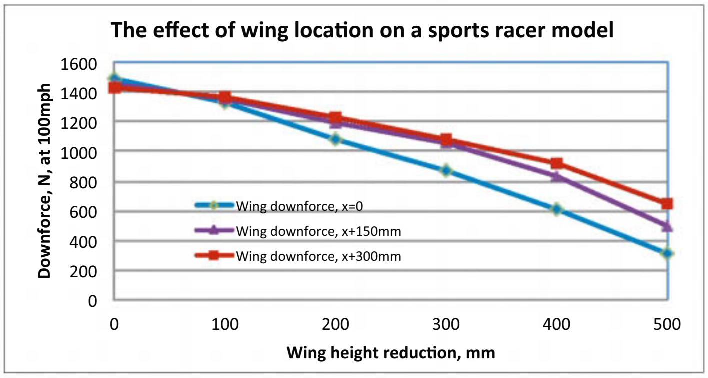


Figure 7: Wing-only downforce declined with wing height in all cases, but x-location was again significant

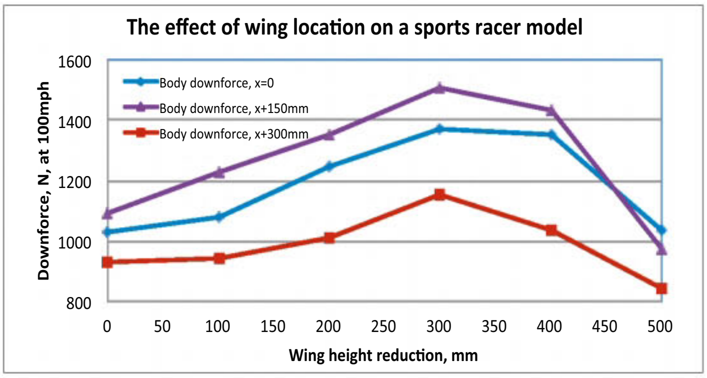


Figure 8: Body-only downforce produced the most interesting patterns

Aerodynamic balance (%front) showed a slightly different pattern, as shown in **Figure 6**. All three x-locations saw a forward shift in balance as wing height was reduced, but repeating the pattern we saw in **Table 1**, where balance unsurprisingly shifted more rearwards with each rearwards shift of the wing at the datum height, we see that the datum x-location produced the highest forward balance across the range evaluated. Nevertheless at x+150mm and h-200mm and h-300mm the %front value was quite close to the %front values at x=datum.

Next, an overall view of wing only downforce is instructive, as **Figure 7** illustrates. Clearly the downforce generated by the wing declined with each height reduction in all three x-locations. But the pattern shown in **Table 2**, where the highest wing downforce was produced at the datum x-location, downforce declining with each rearward increment, was reversed with the first reduction in height. And this reversal persisted across the rest of the range, with x+300mm yielding the highest wing downforce at each height. Perhaps the most likely explanation for this is that there was more room for reasonably energetic flow to reach the wing the further back it was shifted. But importantly, the values at x+150mm were not far behind those at x+300mm…

Finally, body downforce (not including splitter downforce, which showed only minor changes across the range) produced the most interesting plot, as shown in **Figure 8**.

Here we can see that the body produced peak downforce when the wing was at h-300mm in all three x-locations, but that the clear winner was with the wing at a fore/aft location of x+150mm. The second best fore/aft position was the initial datum location, and x+300mm was obviously the least effective across the range for body downforce.

So, given that there is clearly plenty room for optimisation to the simple shape of this model's body, and its underbody in particular, potentially also the span-wise and chord-wise profiles of the wing too, there was every reason to think that in this instance the x+150mm, h-300mm location for this wing was the best of the three evaluated here, with its combination of peak downforce, efficiency and aerodynamic balance.

Equally clear is that there must be a continuation of this exercise to better refine the wing's position, concentrating on locations close to x+150mm and h-300mm.

Having said that, there may well be applications where minimum drag is of more interest than maximum downforce or maximum efficiency, so **Figure 9** shows how drag varied across the range of wing positions. Clearly the x+300mm location achieved the lowest drag across most of the wing height range.

Assuming minimum drag with useful downforce and aerodynamic balance was the aim then the preferred location might be x+300mm and h-300mm, this generating about 4 per cent less drag than the x+150mm, h-300mm location. And addressing the slightly lower %front value this lower drag position achieved might involve a reduction in rear wing flap angle, which in turn would produce a further reduction in drag.

Interested readers may now be expecting a more specific definition of the optimum wing's location with respect to the rear bodywork of the racecar in this exercise! Well, apart from the model being far from optimised at this juncture, the optimum location on any other car is sure to be dependent on the exact shaping of the rear deck upper surfaces, the underbody and diffuser exit locations and shapes, and the rear wing's potency, profile(s) and plan-form shape. However, the x+150mm, h-300mm location puts the tip of the wing's leading edge, relative to the upper deck's trailing edge, at x+185mm, y+145mm. This may or may not put you in the right ballpark with your sports racer!

This lower drag position achieved might involve a reduction in rear wing flap angle, which in turn would produce a further reduction in drag

Base Performance
SIMULATORS
Driver development simulators for single seater and GT racing
HIRE | CORPORATE EVENTS | SALES
Base Performance Simulators provides state of the art simulator packages tailored to the needs of each driver from its base near Banbury, just twenty minutes from Silverstone.
Visit us at Professional Motorsport World Expo, Cologne
13-15 November, Stand 4034
www.baseperformance.net | info@baseperformance.net | +44 (0) 1295 276611 | @BaseSimulators

man machine
AUTODESK.
Platinum Partner
AUTODESK.
Authorised Training Centre
Did you know?
Not only is the UK home to eight Formula One teams but there are around 2,350 component manufacturers actively involved in the UK Automotive supply chain.
Man and Machine offer CAD solutions including training, consultancy, support and software for design engineers across the whole Automotive manufacturing industry.
VR ED 2015
Software includes:
Alias
VRED
3dsMax
Showcase
Inventor
Product Design Suite
Get in touch today for more information.
E: training@manandmachine.co.uk
W: www.manandmachine.co.uk/training
T: 01844 263 700
Connect with us

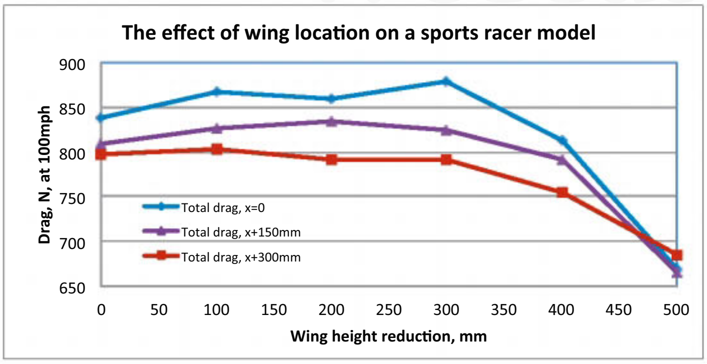


Figure 9: The drag plot showed that if minimum drag was a primary aim then a slightly different approach might be taken

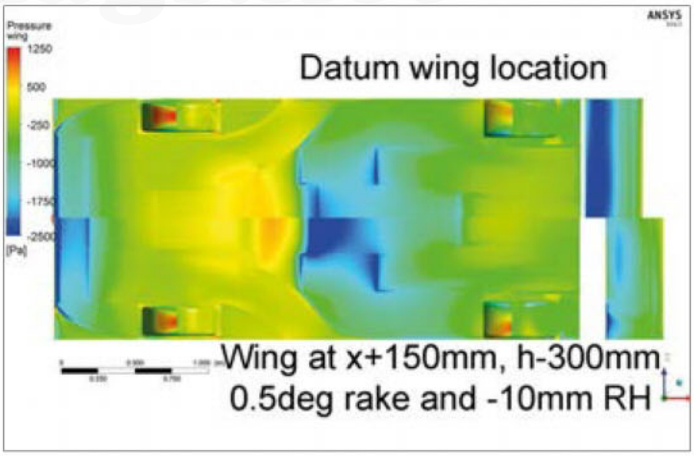


Figure 10: Surface pressure plot of the underside of our model – the upper half is with the datum wing location, lower half is with the final configuration of this exercise. The changes in pressure distribution and magnitudes are very evident

Table 3 – The effects of 0.5 degrees of rake and 10mm reduction in ground clearance

Condition	Total Df, N	Drag, N	-L/D	%front
Zero rake, static ride height	3380.7	825.0	4.10	22.2%
0.5deg rake, -10mm ride height	3805.8	858.9	4.43	36.3%

The Stohr WF1 with Dauntless Racing-developed aerodynamic package (courtesy: Pepper Bowe)

This UK-based Speads runs a Dauntless wing and a splitter devised with Dauntless assistance (Courtesy: BookaTrack.com Ltd)

As shown in **Figure 6**, found on page 60, at the favoured location the one parameter that was not what it would need to be was the aerodynamic balance. However, the trials were all conducted at zero rake and static ride height, and as both these parameters are means of addressing balance (and total downforce) a few changes to both were made, culminating in the results in **table 3**, which shows the comparison at zero rake and static ride height.

Not only did balance shift markedly forwards and well towards an ideal value but total downforce increased by 12.5 per cent and –L/D by 8 per cent. Separating out the sources of the forces, splitter downforce rose by 21.9 per cent, body downforce by 15.9 per cent and rear wing downforce increased by 0.9 per cent. Of course the whole wing location exercise ought now to be repeated across a range of rakes and ride heights.

Above all, this exercise showed that it is most definitely worthwhile trying a matrix of wing locations on this type of racecar, because making the basic aerodynamic elements work together as effectively as possible in an integrated package can bear fruit: see **Figure 10.**

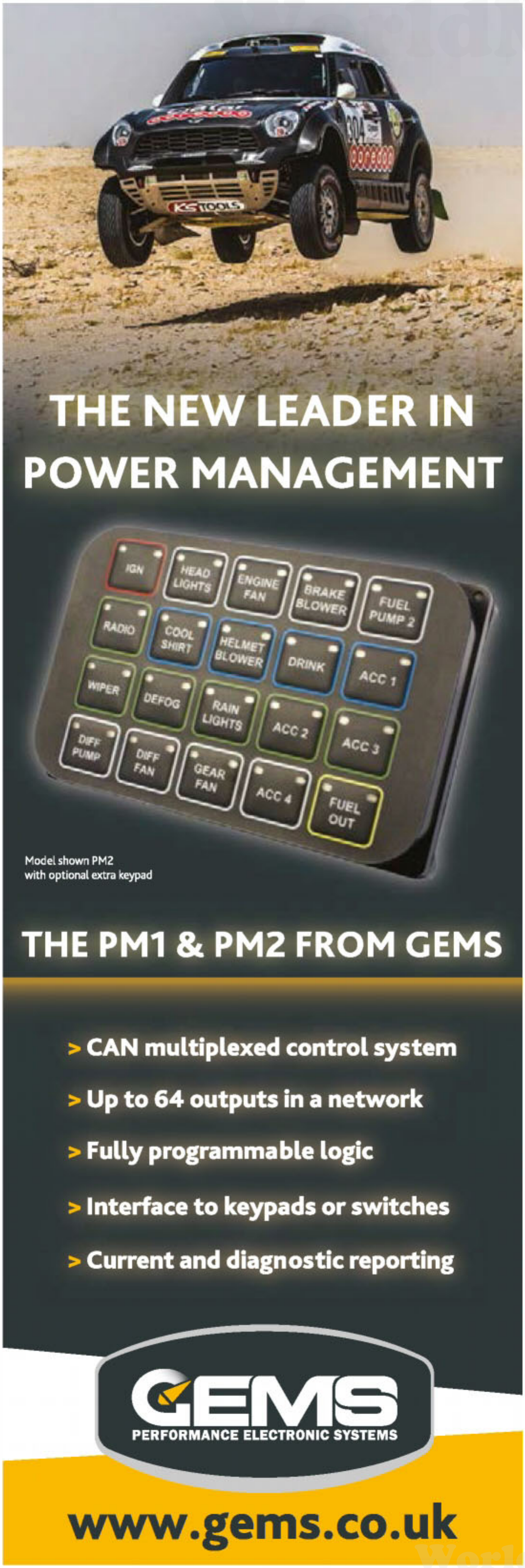
Back in the real world…

A man who would definitely agree with this philosophy, and who has already implemented it in the development of what has become a real world aerodynamic package, is Rennie Clayton at Dauntless Racing. Dauntless purchased the Stohr Cars business in summer 2014, and now owns all of the design and production rights to the WF1 sports racer and F1000 single seater racecar lines. New cars are produced in its Bay Area, California facilities, and support for the existing "ecosystem" of 120+ cars comes from there. Prior to that, although separate from and independent of Stohr Cars, Dauntless designed and produced their WF1 update kits.

'The design work for the WF1 aero kit started in late 2007, and we always took a holistic approach to the design challenge,' says Rennie Clayton. 'Eventually this culminated in three distinct updates to the WF1 which could be applied separately, but were designed from the start to work together for best effect: splitter, undertray, and rear wing. Of note, our basic constraint was that the core mechanical elements and body surfaces of the car were to be left largely intact, so we had to work around such things as radiator placement and orientation with the undertray, and assume that the top – fenders, cockpit surround, engine cover and so on – were as delivered from the factory. Our pieces needed to be bolt-on, inasmuch as that could be achieved in a car like this.

'We decided very quickly to design holistically for best overall effect rather than trying to focus on areas in succession. We didn't want to be stuck in a position where we'd designed a mega rear wing, only to have our new front splitter not be capable of maintaining balance or worse, mucking up the flow to the rear of the car! So we designed it all at once and of course needed to isolate interaction effects as quickly as possible. Our solution to that was a DOE / factorial process with a rather large number of factors in the mix to achieve the best combination of overall downforce, overall drag, pitch sensitivity, and dynamic range of operation. No small challenge, that… it took the better part of a year to arrive at the proper combination of configurations and features.

'Our working hypothesis at the time was to try to treat the rear wing as the secondary element to the "wing" of the main body of the car; use the rear wing to activate the tunnels and front diffuser, rather than using the rear


THE NEW LEADER IN POWER MANAGEMENT
IGN
HEAD LIGHTS
ENGINE FAN
BRAKE BLOWER
FUEL PUMP 2
RADIO
COOL SHIRT
HELMET BLOWER
DRINK
ACC 1
WIPER
DEFOG
RAIN LIGHTS
ACC 2
ACC 3
DIFF PUMP
DIFF FAN
GEAR FAN
ACC 4
FUEL OUT
Model shown PM2 with optional extra keypad
THE PM1 & PM2 FROM GEMS
> CAN multiplexed control system
> Up to 64 outputs in a network
> Fully programmable logic
> Interface to keypads or switches
> Current and diagnostic reporting
GEMS PERFORMANCE ELECTRONIC SYSTEMS
www.gems.co.uk


ATL
AERO TEC LABORATORIES LTD
CUSTOM FUEL SYSTEMS
FIA APPROVED
INTERNAL COLLECTORS AND SURGE TANKS, FUEL PUMPS, FILTERS, FOAM BAFFLING & MUCH MORE!
SOLE SUPPLIER
BTCC
DTM
REFUELLING EQUIPMENT
NEW FOR 2014
FIA APPROVED
STANDARD SAVER CELLS
ATLLTD.COM
+44 (0)1908 351700
sales@atlltd.com

Table 4 – Aerodynamic data on the Stohr WF1, scaled from data supplied in lbf at 150mph

Specification	Total downforce, N, 100mph	-L/D	%front
2007 spec factory WF1	~2280 – 2380	~3.2	41%
Low Df Dauntless WF1	~3170 – 3270	~5.1	45%
High Df Dauntless WF1	~3765	~4.9	44%

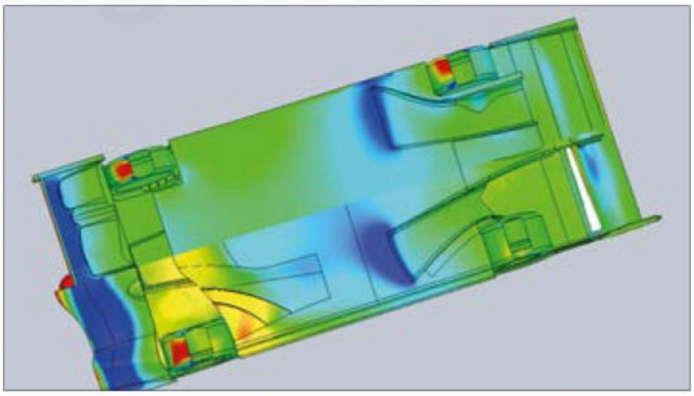
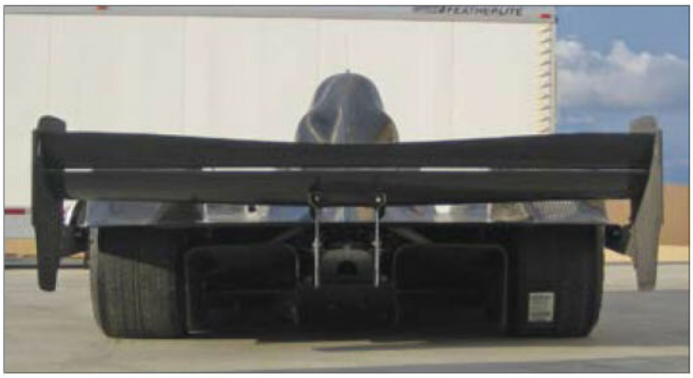


Figure 11: Surface pressure distributions of the underside of the Stohr WF1. Upper half is the 2007 factory spec, lower half is with the low wing, integrated Dauntless package. Once more, the changes in pressure distribution and magnitudes are evident. (Courtesy: Dauntless Racing)

The Dauntless rear wing has been shaped to work with the flows coming off the car (Courtesy: Dauntless Racing)



Rear shot gives a clearer idea of the wing's low position on the Dauntless Racing Stohr WF1 (Courtesy: Dauntless Racing)

"We have to run some pretty wild wheel rates in order to keep the thing off the ground"

wing as a "trim" device for aero balance. In particular, we started from the classic NACA studies on optimum flap gap positioning and distances – this turned out to not be quite correct in our application, but very illuminating none the less. The airfoils (four sections, all told) and basic layout of the rear wing were guided by CFD and track testing of the car without a rear wing to gain a better understanding of airflow patterns over and around the car. That got us into the ballpark for orientation and local wind speed and turbulence factors for choosing airfoils. The exact placement was driven by more factorial experiments for height and setback from the trailing edge of the bodywork – one to establish interaction with the undertray/splitter, and another one to narrow down the precise placement. We could quite readily get better results for the rear wing in isolation by placing it up in clear airflow 300-400mm above the tail of the car, but this always had a negative effect on overall performance numbers for the car. Since our guiding principal was a holistic approach, optimising the car as a package won out.

'CFD was followed by instrumented track testing, and we eventually managed to get a day in the Ford wind tunnel with a WF1 to test our rear wing assembly. As one might expect, the numbers did not match exactly with CFD, but the behavioural patterns were quite predictable and correlated nicely with the virtual work that we'd done on the car. Very gratifying!'

An interesting interjection here comes from UK-based owner/driver Iain Cummings, whose CTR Developments-run Speads features a Dauntless rear wing and a splitter designed with help from Clayton. Cummings said 'Rennie was very specific about the orientation of the leading edge of the wing's main plane in relation to the trailing edge of rear diffuser (90mm up and 105mm rearward).

'He also told me that the secondary plane "does most of the heavy lifting..." and this would appear to be true because when I tore it off on the Silverstone International circuit the car was completely unstuck at both ends (which I'm guessing at least demonstrates that we have good interaction between the wing and the front splitter/diffuser).

'We have to run some pretty wild wheel rates in order to keep the thing off the ground. Variation of the front ride height also has marked effects, so we have arranged for the car to, as far as possible, run at an optimum 26mm dynamic ride height. Variation of the secondary flap angle also produces quite large downforce changes at the front as well as at the rear.'

Clayton also commented on topic of the stiff platform: 'The Stohr WF1 has some interesting characteristics that influence the need for higher rates. Primary among these is that the car does not have anti-roll bars of any sort, nor are the roll centres arranged to do much in the way of inhibiting roll. The chassis is also more flexible than we would like to see at the rear of the car (this is one of the areas that we will be addressing with future updates), and taken together it demands significant spring rates to keep a stable aero platform.'

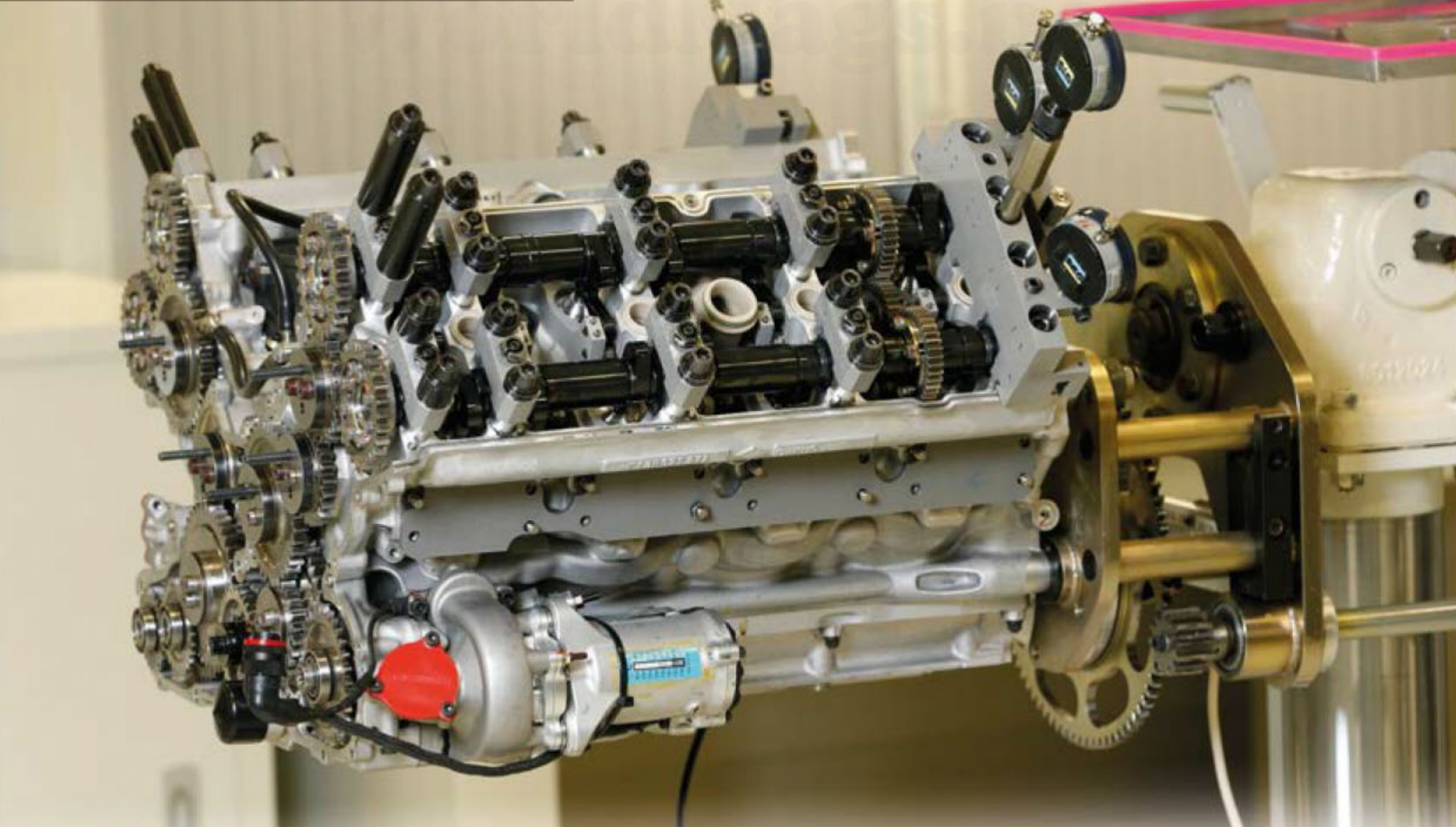
And so to the nub of the matter: how did the aerodynamic data alter between the earlier conventional wing location package and the new, low wing integrated package? Clayton is refreshingly open with some comparisons and hard data, commenting that 'the comparisons vary depending on downforce configuration.' See **Table 4** for the key data.

It's clear from these numbers that the Dauntless aero package represented a considerable advance over the 'pre-low wing' integrated package. And although it plainly isn't sensible to ascribe that entire advance to the low wing per se, it obviously played a large part in the integrated whole. **Figure 11**.

The last word then to Clayton: 'It should be noted our raised splitter (to avoid pitch sensitivity) also creates knock-on effects for the undertray and rear wing – and the philosophy behind the undertray design plays into the airflow patterns around the car, in turn influencing how the rear wing behaves. We've found there is no 'one-size fits all' approach as all can be made to work to a reasonable degree. The question is: can you put them together in a beneficial way where all of the interactions reinforce each other positively?'


The Lightest, Most
Flexible Hose and Fitting
Combination Available!
USA North Carolina
704.793.4319
sales@bmrsusa.com
California NEW!
714.415.0080
socalsales@bmrsusa.com
UK Slough
01753.545554
sales@bmrsuk.com
www.bmrs.net
Brown & Miller Racing Solutions
BMRS
Professional Race Hose & Fittings


ARE DRY SUMP SYSTEMS
"Products Engineered With a Passion"
Everything Dry Sump!
Visit Us at:
PRI #1351
AutoSport E492
Nissan SR20 Kits
LS7 Stage II
Over 60 Varieties of Cast Alloy CNC Machined Dry Sumps
LS7 Stage III
9 Varieties of LS 1-7 Dry Sumps Over 2400 Sold!!
Spintric Air Oil Separator
Spintric I, II & III
3 Versions for Different Flow Rates
Hennessey Venoms ARE Drysump Equipped!
Worlds Record-270.49 MPH
NEW!
ARE's All New Corvette Stingray LT1 Retro Fit Drysump Available from KATECH- November 2014
1005M
1009
GTM
I
II
III
WWW.DRYSUMP.COM
916.652.5282
WWW.SPINTRIC.COM



Friction is the enemy

There are a multitude of 'regimes' which can be engaged by motor engineers to win the war

By GEMMA HATTON

Motorsport's continual drive for efficiency has re-invented the racecars of today. With Formula 1 downsizing to V6s and LMP1's fuel usage now capped, maximising the output power at the wheels per drop of fuel has become the most important tactic to winning races. This has resulted in this year's F1 cars being 30 per cent more fuel efficient than the 2013 machines, showcasing some of the most advanced technologies ever seen in the category, which will no doubt filter down to the automotive industry in coming years.

Of course, the arch enemy of efficiency is friction. As much as 20 per cent of the energy in fuel lost through internal friction in the engine, leading to wear, potential failure and a DNF, and so ensuring sufficient lubrication to minimise this risk is essential. However, it is not only the engine that suffers from wear; gearboxes, differentials, wheel bearings and suspension joints, all require oil or grease to work efficiently. Technical director of Miller Oils, Martyn Mann highlights the importance of effective lubrication: 'Throughout motorsport, lower friction means quicker lap times, and reduced wear means fewer costly engine rebuilds.'

Lubrication regime

To minimise the effects of friction, lubricants such as engine and transmission oils are used, and various types of greases for bearings and suspension joints. A film of pressurised lubricant between two contacting surfaces results in the lubricant-to-surface friction being much lower when compared to surface-to-surface friction.

The film's thickness and surface roughness determines the type of 'lubrication regime' which is illustrated in the Stribeck curve, **Figure A**. This demonstrates the behaviour of the coefficient of friction in relation to the viscosity of the lubricant, the load and speed.

Boundary regime

Looking at the illustration overleaf, the left of the illustration demonstrates low speed, low viscosity and high load results in boundary lubrication, where there is large surface contact and minimal film thickness, resulting in high friction. This is not a result of fluid under pressure, but rather the surface-active materials that form boundary films between substrate surfaces. This is where anti-wear and extreme-pressure additives come in to either cohere or adhere to the boundary layers.

As the speed and viscosity increases and the load decreases, a film of fluid begins to form and the surfaces start to separate; drastically decreasing the coefficient of friction (as shown

"Throughout motorsport, lower friction means quicker lap times, and reduced wear means fewer costly engine rebuilds"

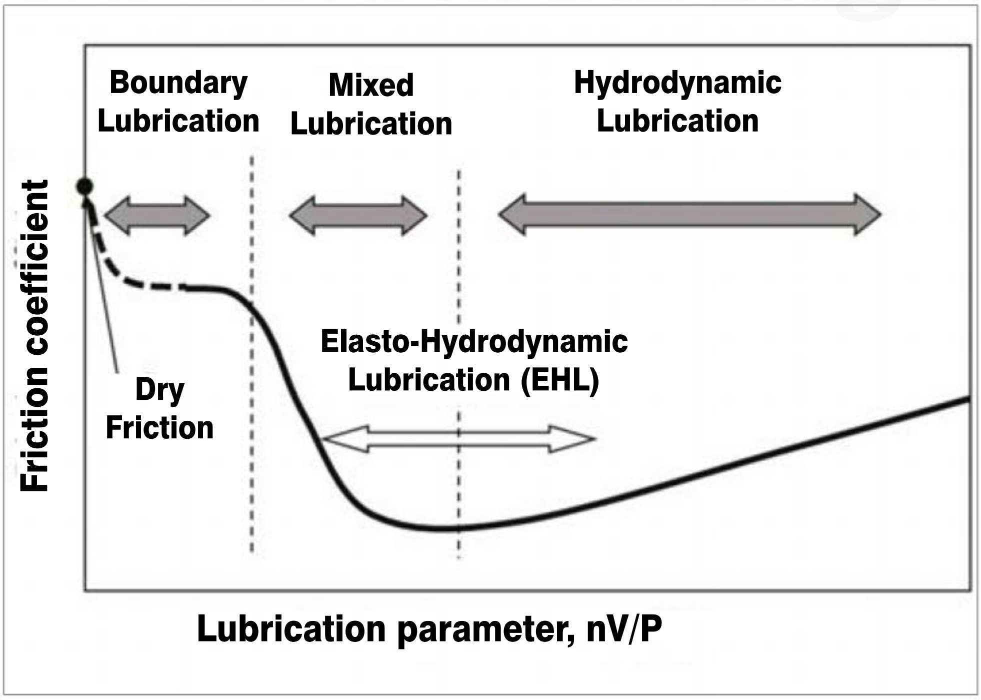


Figure A: The Stribeck curve illustrates how the coefficient of friction between two surfaces varies with load, velocity and viscosity

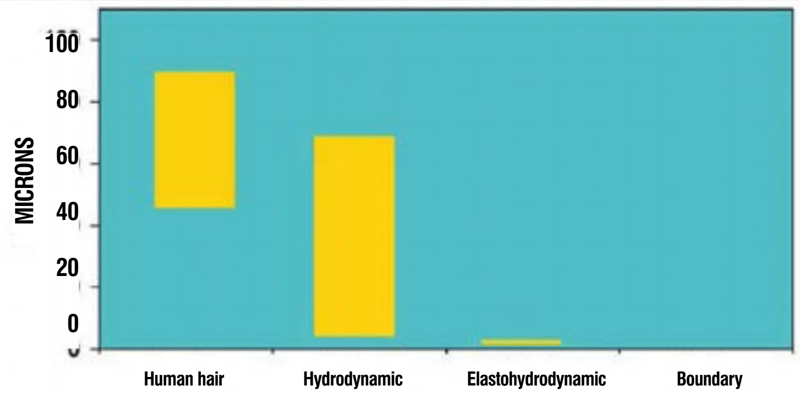


Figure B: The thickness of these regimes differ by microns – with some being half the thickness of a human hair. Yet different regimes can drastically alter the friction coefficients

by the sudden drop in the Stribeck curve) and is called mixed lubrication. In essence this is where both hydrodynamic and boundary regimes are present.

As the dynamic pressure increases due to the continually higher loads and speeds, the fluid is compressed so much that is starts behaving like a solid, leading to elastic deformation of the component surfaces. As there is no contact between the two surfaces, this regime sees the minimum value of friction coefficient.

Finally, there is the transition into the hydrodynamic regime where the load on the interface is entirely supported by the film of fluid as it becomes thicker. Interestingly however, this actually increases the friction coefficient due to the higher speeds creating a higher viscosity film which inhibits fluid drag on the moving surfaces.

This higher viscosity results in shearing between the adjacent layers of the lubricant, generating viscous friction; one of the primary sources of friction within an engine. Imagine running in water in comparison to running in air, it takes more energy to run in water because there is high drag due to the higher viscosity, and the same is happening here.

Despite the drastic variations in friction coefficient between the different regimes, the thickness of each differs by microns. For example, the Mobil 1 SHC Gear Oil in the McLaren Mercedes MP4-29 F1 car is approximately 20µm (micrometers) thick between the gear teeth – equivalent to half the thickness of a human hair. Figure B further illustrates just how thin these regimes are, yet a few microns in thickness can determine whether you have a boundary regime, resulting in high friction or an elastohydrodynamic regime, resulting in low friction.

Engine friction

With approximately 3,000 moving parts and engine forces up to 8,500 times the force of gravity, the engine is the home of friction in a racecar. Some 40 per cent of frictional losses occur within the cylinder liners and the piston ring pack, 25-35 per cent occur in the valve train and other losses come in the main bearings, driver alternators and power steering pumps. As well as viscous friction within the fluid due to shearing forces as previously mentioned, boundary friction between the surfaces due to an insufficiently thick film of oil are the two primary sources of friction within an engine.

To reduce these viscous losses, the trend has been to use lower viscosity lubricating oils with thinner layers which generate less friction. This method is effective and it has been estimated that replacing a 5w30 multigrade oil with a 0w20 grade gives a direct improvement in fuel consumption by 2 per cent. However, as the Stribeck curve demonstrates, the thinner the lubricant, the higher the risk of boundary friction and consequent wear and reduced engine life. Therefore, as ever with engineering, a compromise needs to be found.

Boundary friction can also cause major problems during engine start up because initially there is little lubrication between moving parts. This will become more of a problem in the automotive sector as manufacturers continue to introduce start/stop technology which results in engines now undergoing start-up conditions approximately 1 million times in a lifetime, rather than 40,000 previously.

Synthetic

'The term synthetic implies that the base oils used are chemically further refined from mineral oils [by the addition of special purpose additives] i.e. more impurities are removed and properties such as better low temperature performance and thermal stability, are further enhanced,' explains Mann.

Synthetic oils have been around in a crude form (no pun intended) since the late 1930s. But it was only in the mid 1970s that companies such as Mobil 1 began to introduce synthetic oils into the market. Firstly, this was in the form of PAO which is a synthetic product using olefin polymerization, but by the mid-nineties nearly every oil company was selling and developing a high end synthetic oil for automotive and

Half the thickness of a human hair determines whether you have a high friction boundary regime or a low friction elastohydrodynamic regime

Lane MOTORSPORT
HIGH PERFORMANCE CONNECTORS AND ACCESSORIES FROM STOCK
• Connectors
• Heat Shrink Boots
• Assembly Tooling
• Protective Caps
• Panel Gaskets
• Nut Plates
• 3D Cad Models
Manufactured by
SOURIAU
HellermannTyton
Weald
FC LANE ELECTRONICS LTD
WWW.LANEMOTORSPORT.COM MOTORSPORT@FCLANE.COM
TEL. +44 (0) 1403 790 661

Ferrea RACING COMPONENTS
Competition Plus Hollow Stem Valves
Ferrea Racing Competition Plus Hollow Stem Valves are 22% lighter than conventional stainless steel alloy valves. Their proprietary manufacturing process gun drills and micro polishes the bore of the valve stem. These valves are also made from Super Alloy materials which resist heat much better than conventional Inconel materials.
• Friction Welded Hard Tips
• Radial Groove (Shot Peened & Rolled)
• Micro Polishes & Gun Drilled Stems
(22% lighter than conventional stainless alloy valves)
• "Avionics" Chrome Plated Stems (10 microns thick)
• Superflow (undercut) Stems (Improved flow design)
• 42 Rc Seat Hardness (Long life - resists fatigue fractures)
FERREA RACING COMPONENTS
Tech Line: 954-733-2505 • Toll Free: 888-733-2505
www.ferrea.com
FOLLOW US ON:
Ferrea Now Offers Discounts for Active Duty Military Members and Veterans. *Online purchases only.
MILITARY DISCOUNTS
ACTIVE & RETIRED

As the top layer degrades under pressure, it exposes an identical shell underneath, 'self-healing' to result in continued lubricity between parts

motorsport applications, resulting in synthetic lubricants becoming the fastest-growing segment of the oil industry.

The oil base stocks used for synthetic oils are made from organic compounds or synthetic hydrocarbons with their structure re-arranged so that all the molecules are uniform in size, shape and weight. Not only does this mean that they can be specifically designed for particular applications, but the uniformity also means there is less friction.

A further benefit to synthetics is that they can start circulating the engine straight away as opposed to mineral oils which take some time and therefore allow boundary friction between un-lubricated parts. This attribute also results in improving the fuel economy as the engine can reach peak operating conditions quicker, rather than the thicker and slower mineral oils reducing efficiency due to increased wear during engine warm up.

There are also semi-synthetic oils available which are essentially a mixture between standard base and synthetic oils. These have been designed to exhibit some of the benefits of pure synthetic oils without the high cost implications.

Miller Oils' innovative Nanodrive product range utilises nanotechnology, which essentially acts like billions of 'self-healing' microscopic ball bearings, filling in the gaps and creating a more uniform surface and thus reducing friction

Micro technology

'Nanotechnology is a reference to engineered particles of the order of 10^{-9} metre in size, this puts them around 1000 times smaller than the width of human hair,' explains Mann. 'If they are carefully selected, the advantage is that they supplement the conventional chemical additives used to further reduce friction.'

Miller Oils launched its Nanodrive technology at the 2012 Autosport International Show which in essence is a synthetic oil, using nanoparticles that act like billions of ball bearings that fills the gaps, generating a more uniform surface on the atomic scale.

The nanoparticles in the Nanodrive oil are inorganic fullerenes (molecules composed entirely of carbon) which has a structure composed of multiple progressively smaller concentric spheres, usually 20 or more, similar to the layers found in an onion. This structure is the basis of the many advantages offered by nanoparticles. As the top layer degrades under extreme pressure, it exposes an identical shell underneath, automatically 'self-healing' which results in continued lubricity between parts. As the layers degrade, a protective tribofilm is formed on the surfaces and due to the surface area, the nanospheres will migrate and stick to the walls of the lubricated components. These nanospheres are smaller than one tenth of a micron. To put this into perspective, the size of a nanoparticle compared to a football, is the same as a football compared to the Earth.

'The particles we use have some very special properties that make them uniquely useful as lubricants for extreme conditions. As the contact load between opposing engine parts increases, reactions between the particles and the metallic surfaces actually lead to a reduction in friction. Another useful property is the way nanoparticles nest around each other, like an onion able to peel off under pressure, shedding a slippery, protective film over the metal surfaces to reduce friction and wear,' says Mann.

Positive results

Miller Oils has conducted testing to prove the benefit of such technology, with nothing but positive results as Nanodrive not only reduces viscous friction, but boundary friction as well. It was found that there was a 5 per cent power boost in a Porsche 911 race engine by replacing a top conventional synthetic lubricant with Nanodrive oil of the same viscosity.

Furthermore comparable tests with conventional boundary lubricants such as molybdenum disulphide, concluded that Nanodrive offered up to 25 per cent reduced friction, while increasing load capacity by up to 80 per cent.

Further consequent benefits to this nanoscience is reduced CO_2 emissions which opens the doorway into the automotive sector, particularly for those vehicles with downsized bearings that are fitted with stop-start systems, where an immediate drop in CO_2 is required.

In 2009 Miller Oils claimed awards for their nano-technology gear oils and in 2013 won the MIA award for innovation for their nano-technology engine oils.

The utilisation of nanoscience has revolutionised the oils used in motorsport today, and by the looks of it, will continue to do the same for the automotive sector.

Electric lubrication

It may be thought that with no internal combustion engine, and usually a single-speed reduction gearbox, the effects of friction are less of an issue in electric racecars. However, lubricants are just as essential to winning races, on both combustion, hybrids and electric grids but for different reasons.

Miller Oils also worked closely with Drayson Racing Technologies on the land speed-record-setting Lola B12 69/EV. 'Electric motors generate maximum torque from one rpm, which means that the contact pressures between each pair of teeth in a gear train can reach a maximum before any meaningful rotation has occurred and while the system is still cold,' explains Martyn Mann, technical director of Miller Oils.

'This lack of rotation can cause major problems as the lubricant drains off the surfaces while they remain stationary and the lower temperatures will not suffice the high temperature requirement for anti-wear additives within the lubricant to become chemically reactive.

This is another area where Miller Oil's Nanodrive can be utilised and helped the Drayson's Lola establish the lightweight EV world land speed record of 205.103mph in one mile.

That said, it was a challenge as Mann explains: 'Lubricating the transmission in the Lola required good film strength at both extremes of temperature. With more than 520 kW from the four electric motors, the torque from a standstill creates enormous loads, while at maximum speed, high temperatures were generated, requiring sophisticated thermal management in the oil's properties.'

This project not only helped fuel the technical innovation required for the new Formula E championship, where saving driveline weight and packaging space through the use of fluids is a major advantage, but also has applications in hybrid and electric road car where maximum efficiency, reduced size and weight of the transmission can be achieved through the use of an optimum lubricant.


VAC
MOTORSPORTS
World Leading BMW Performance
Clutch & Flywheel Kits
Tilton Metallic & Carbon Clutches
Twin & Triple Disc Options
5.5" & 7.25" Clutches
Includes Lightweight Flywheel
ATI Harmonic Dampers
Reduces crankshaft vibrations
Reduces internal engine wear
Releases horsepower & torque
VAC Exclusive (BMW M50, S54, & more)
BMW Valve Train
VAC High Performance Valves
High Performance Valve Springs
A must for High HP cars
For BMW N54, S65, S54 and more
www.vacmotorsports.com
+1.215.462.4666
sales@vacmotorsports.com


Rottler CNC True Vertical Honing
Linear slideway stroking and precision ball screw mechanisms create precise cross hatch angle & repeatable accuracy
NHRA Nitro Methane Funny Car
Rottler Makes Power Fast
"Tim Wilkerson"
• Two Stage Honing System Roughs & Finishes in 1 Automatic Cycle
• Intuitive Rottler Software
• Automatic Load & Force Control
Rottler Software senses interference for Automatic Crash Prevention
- Fast Cycle Time
- Dual Stage Honing Capability
- Quick Turn Tool Change
So Advanced, It's Simple
www.rottlermfg.com
www.youtube.com/rottlermfg
www.facebook.com/rottlermfg
contact@rottlermfg.com
ROTTLER
THE CUTTING EDGE
8029 South 200th Street
Kent, WA 98032 USA
+1 253 872 7050
1-800-452-0534


MOCAL
OIL COOLERS
• THE MOST POPULAR COMPONENT IN MOTORSPORT
• COMPREHENSIVE RANGE OF COOLING ACCESSORIES
• BRITISH DESIGN & MANUFACTURE
FOR THE BEST IN OIL COOLING SYSTEMS...
...MAKE IT MOCAL!
WINNING RACES SINCE 1967
Worldwide enquiries go to:
www.mocal.co.uk
USA enquiries go to:
www.mocal.us
0208 232 3525
Like Us


At the heart of motorsports.
fast forward automotive is the specialist in the manufacturing of engine and car components, of high racing-sport quality, for prototype and small batch production.
fast forward automotive provides a programme comprising of engine components and technical solutions to increase the vehicle performance for all Porsche models from 1955 to today.
Professional MotorSport WORLD EXPO 2013
Stand 4148
Nov. 13-15th, 2014
Cologne, Germany
FAST FORWARD AUTOMOTIVE
www.fastforward-automotive.de


XP9
SYNTHETIC 10W-40
RACING MOTOR OIL
XP9 utilises next generation synthetic oil technology to provide unmatched performance and protection in high temperature high shear environments. This competition proven formulation utilises proprietary anti-wear and friction reducing additive package to fight valve train wear and internal component scuffing. XP9 is a "no compromises" race engineered motor oil that provides extended time between oil changes in racing conditions while continuing to provide consistent engine protection.
High temp high shear protection
Friction reducing additives
ZDDP anti-wear package
Extended oil change intervals
European Dealer:
Anglo American Oil Company Ltd
WWW.AAOIL.CO.UK
+44 (0)1929 551557
BORN FROM JOE GIBBS RACING
DRIVEN
DRIVEN TO WIN
RACING OIL
DRIVENRACINGOIL.COM
9340j-3

The writer's colleagues in military engineering are seeing the same trend as in motorsport: over-reliance on computer-aided engineering tools

Numbers game

If the simulation doesn't add up it means something in the model is wrong and needs chasing down with traditional hand calcs

By DANNY NOWLAN

One of the greatest things I struggle with as the principal of ChassisSim is the attitude of some engineers when the correlation doesn't add up. It reveals an underbelly in this business when the millisecond something doesn't add up there are some race engineers and team managers who automatically assume the simulation is wrong and they should never touch it again. The reality, though, is not as clear cut.

When something doesn't add up in the simulation, it doesn't mean the simulation is wrong, it just means there is something you need to chase down. The good news is that when something doesn't add up in your simulation package, ChassisSim in particular will be your best friend in resolving this. The focus of this article will be to show you how can use the advanced channels in ChassisSim, some hand calcs and the track replay simulation feature to identify what the problem is. When you get your head around this you'll have a powerful tool to fill in the blanks about what your racecar is doing, and this information is invaluable.

Before we start this discussion let me add why I've been writing a lot of articles recently about doing hand calculations. Over the last couple of years I have been shell shocked at the falling standard of engineers I have been dealing with. This also just doesn't apply for the motorsport industry. I keep in close contact with colleagues in military aviation and electrical engineering. We are all seeing the same thing. That is the over reliance on computer-aided engineering tools and not having a clue where the numbers come from or how to derive them. The thing that hand calculations bring to the party is it gives you a feel for what the answer will be and that is the art of being an engineer. We are losing this important skill at our peril.

To kick things off most simulation packages, ChassisSim in particular, will return a wealth of information about the forces applied to the car and the manner in which they are applied. The really useful channels are summarised in **Table 1**.

The great thing about **Table 1** is that it tells you all the forces that are acting on the car and the force-based roll and pitch centres tell you where these forces are applied to the sprung and unsprung mass. What this means is that

Hand calculations bring to the party a feel for what the answer will be, and that is the art of being an engineer

Table 1 – Returned ChassisSim channels that can be used for model validation

Channel Name	Unit	Description
Front rc	mm	Force based roll centre at front (combined left and right)
Rear rc	mm	Force based roll centre at front (combined left and right)
Fy FL	kgf	Current Lateral force of the front left tyre
Fy FR	kgf	Current Lateral force of the front right tyre
Fy RL	kgf	Current Lateral force of the rear left tyre
Fy RR	kgf	Current Lateral force of the rear right tyre
Fx FL	kgf	Current Longitudinal force of the front left tyre
Fx FR	kgf	Current Longitudinal force of the front right tyre
Fx RL	kgf	Current Longitudinal force of the rear left tyre
Fx RR	kgf	Current Longitudinal force of the rear right tyre
Faero FL	kgf	Aero force applied to Front left tyre
Faero FR	kgf	Aero force applied to Front right tyre
Faero RL	kgf	Aero force applied to Rear left tyre
Faero RR	kgf	Aero force applied to Rear right tyre
Front PC	mm	Front pitch centre (longitudinal force application point)
Rear PC	mm	Rear pitch centre (longitudinal force application point)

EQUATIONS

EQUATION 1

$$LT_{SM} = \frac{F_{BF}\cdot(h - pc_f) + F_{BR}\cdot(h - pc_r)}{wb}$$

$$= \frac{9.8*1224.5\cdot(0.43 - 50e-3) + 9.8*885\cdot(0.44 - 180e-3)}{2.794}$$

$$= 2408N$$

EQUATION 2

$$\partial Damp\_ft = \frac{0.5 * LT_{SM}}{k_f \cdot MR_f}$$

$$= \frac{0.5\cdot 2408}{122.6\cdot 0.63}$$

$$= 15.6mm$$

EQUATION 3

$$F_S = (k(x_s) + c(\dot{x}_s))\cdot MR$$

$$w_m = \frac{F_S}{k_t}$$

$$d_i = \frac{x_{s_i}}{MR} + w_{m_i}$$

$$rh_f = rh_{f0} - \frac{d_1 + d_2}{2}$$

$$rh_r = rh_{r0} - \frac{d_3 + d_4}{2}$$

Table 2 – Relevant parameters for the pitch calculation

Variable	Value
Front motion ratio (damper/wheel)	0.63
Front spring rate	123 N/mm
Front braking force	1224.5kgf
Rear braking force	885kgf
Front pitch centre	50mm
Rear pitch centre	180mm
c.g height	0.43m
Wheelbase	2.794m

you now have the means to validate this via a hand calculation. We are going to illustrate this via predicting the pitch movement for a given braking force applied to the chassis. For the purposes of this illustration, these where taken from the V8 Supercar template in ChassisSim. These are shown in **Table 2**.

The front and rear braking force and the pitch centres were generated from the data returned from the ChassisSim simulated lap. Just remember, our goal here is to cross reference that the simulated lap is performing as advertised. So calculating the pitch we should see in the data will be given by **Equation 1.**

What this means is that at the wheel there will be a total of 2408N applied at the front springs under load. So the expected change in damper movement will be given by **Equation 2.** So, we should see a change in pitch of the front dampers of 15.6mm. **Figure 1** shows the simulated data we find**.** Looking at the pitch change the front pitch before the braking manoeuvre was 9.8mm and after the braking manoeuvre it was 25.03mm so we were that far off. The difference is due to a combination of round-off error and damping effects. Just remember that at this stage of the game we are not looking for an exact match — we are after an approximation to show us we are in the ball park. In this case there is no problem.

You'll also notice that a place that I validated was braking in a straight line. This was done for two reasons. First to give the car a clear and constant input so it could settle and we could get a clear read on what the car was doing. Also we didn't want the effects of any cross-lateral forces. What this example shows is that for the prescribed inputs the simulation is working as advertised and isn't doing anything silly. This is your first port of call if you get a situation that looks like the one shown in **Figure 2.**

Actual is coloured and simulated is black. Due to the fact this is actual data I have blanked out all numbers and scalings. As we can see, the speeds and accelerations are all the same. The rear damper correlation is also good. However the front damper correlation, particularly under brakes is not good. This becomes very evident looking at the front pitch trace. Most people looking at this would immediately assume the simulation is rubbish.

Investigation

If you ever get a situation like **Figure 2**, then your simulation is telling you something weird is going on with the car and you need to investigate it. Work through this procedure:

- **Go through the procedure we discussed in equations 1 – 2 to validate the simulation is working correctly**
- **Once the simulation has been validated start working through the data and setup to determine what is wrong**

There could be a number of reasons that are giving rise to what is happening in **Figure 2**.

The great news about using a tool like ChassisSim is that you have a tool that can quantify what is wrong. The next great example of correlation going wrong is when you have to fix an aeromap. This situation is presented in **Figure 3.**

Figure 3 has been taken from actual data, so again I have had to blank out scalings and data numbers. However let me walk you through the channels. The top trace is speed, the second trace is steering, the third trace is front pitch, the fourth trace is rear pitch and the final trace is acceleration. In rough terms what we are seeing here is down the straights the correlation is OK but in the corners, the simulated pitches indicated by the black traces diverge significantly. When most people see this, they would throw their hands in the air and would think the simulation is rubbish. But when you are seeing this you have an aeromap that isn't performing as advertised. When you see this, it is your signal to fix the aeromap.

To the young data engineers reading this, this should scream out at you like an alarm bell

Before we discuss how to fix **Figure 3** it would be wise for us to reflect on what **Figure 3** is telling us, which is that, when the rear ride height drops below a certain value it actually stops producing downforce. This screams out at you when the simulated rear pitch keeps on going when the actual pitches level off. To the young data engineers reading this, this should scream out at you like an alarm bell. Typically what is happening here is that the rear diffuser is becoming choked, and its effectiveness at producing downforce has diminished. It is with great regret I say this but I have seen this happen far too often with many of the current generation spec racecars.

Fortunately the fix is easy. All you need to do is to plot the simulated ride heights and go into that section of the aeromap and fix the numbers. It's actually that simple but nonetheless shows you the power you have at your fingertips with a simulation package. In terms of quantifying a good place to start, use the damper data to approximate the loads. Then you can start calculating the CLA and ride heights to expect by using the following **(see Equation 3)**.

All we have done in **Equation 3** is to calculate the spring force, and use this to infer the ride heights. Once you have that information, fixing up the aeromap is easy.

Validation

The last aspect we need to discuss is the track replay option in ChassisSim. This feature allows you to replay a lap and then use to validate against actual data.

Originally it was designed to approximate what you couldn't see on actual data. However one of the members of the ChassisSim community recognised that this is a really good feature to validate the model on. An example of its output is shown in **Figure 4.**

Actual data is coloured, simulated data is black. Again because this is live race data all scalings are blanked out. The great thing about the overlays in **Figure 4** is it shows you in an instant the areas in the model that you need to work on since all the inputs are the same. It's also logging back all the same data as the lap time simulation so you can use the tools you used for the lap time simulation to work on the open loop simulation.

In closing you can see that if the simulation does not correlate immediately it is a surefire indicator that something in the model needs to be corrected.

Remember to use the hand calculation to validate the simulator is performing correctly. Once that is confirmed use the lap time and track replay tools in ChassisSim to trouble shoot what is wrong.

If you approach it this way not only will you get great correlation you will learn a great deal about your car in the process. That knowledge is power on the race track.

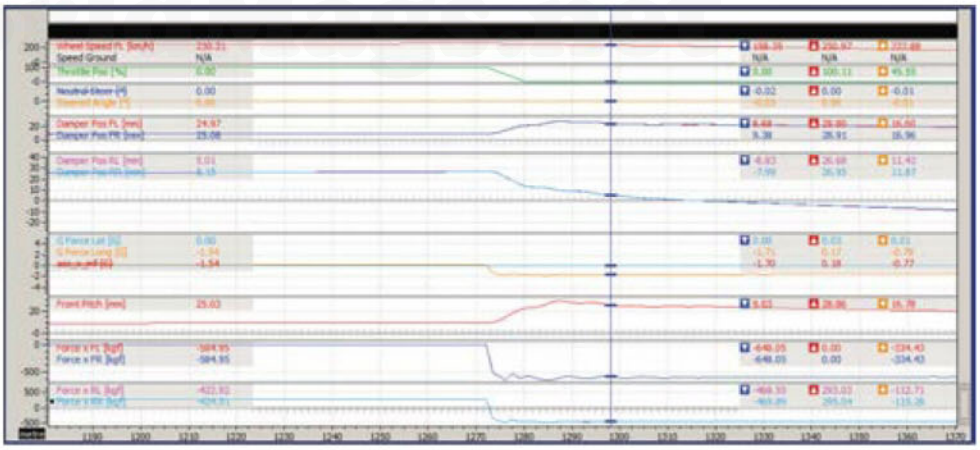


Figure 1: Simulation pitch change of a V8 supercar

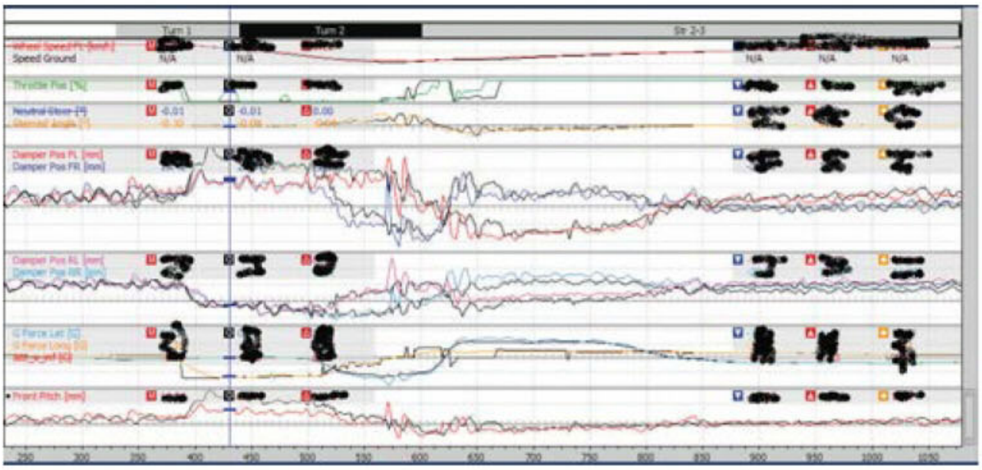


Figure 2: Actual vs simulated pitch data

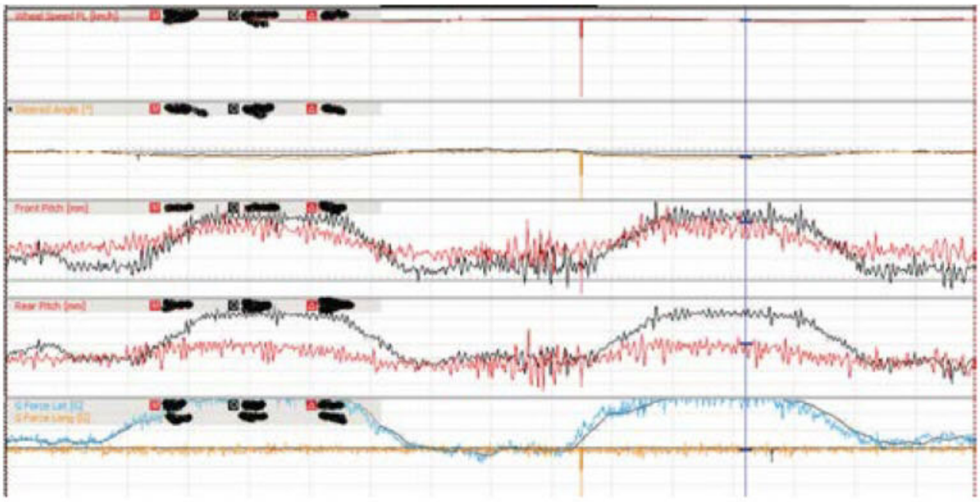


Figure 3: An aeromap that needs to be fixed

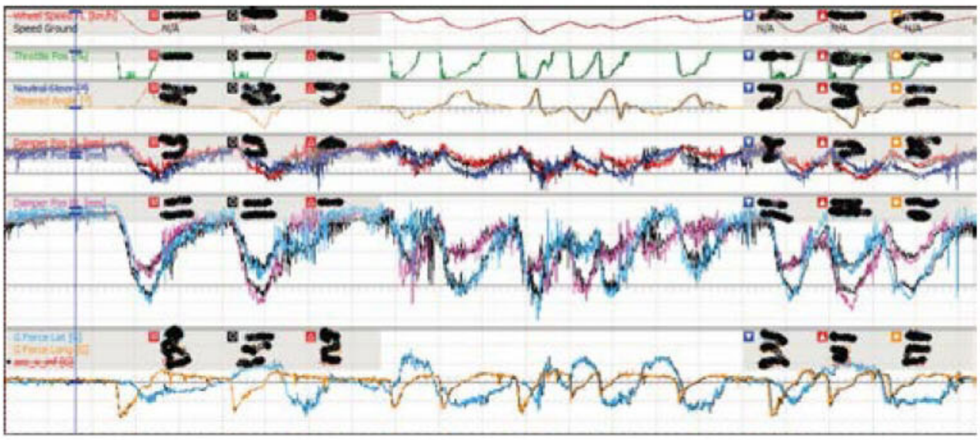


Figure 4: Track replay


3Force Combined Sensor
G-Force, Gyroscopic, Magnetic
Simultaneous full triple-axis measurement
Anodised CNC machined 6016 grade Aluminium enclosure
Lightweight (<55g) but sturdy
CAN bus interface with a high level of configurability
Upgradeable allowing for enhanced functionality
Spare processing capability for custom firmware
Jacobs Design has been invovled in the Australian motor racing industry for the past 18 years and is a highly trusted supplier of sensors to V8 Supercars and Formula Ford.
3Force
cost effective
versatile
resilient
www.jacobsdesign.com.au
M +61 0413 442 734 E support@JacobsDesign.com.au


kmp motorsport products
PADDLESHIFT
SERVICE & REBUILD
GEARS
DIFFERENTIALS
LIGHTWEIGHT PADDLESHIFT
SYSTEMS & COMPONENTS
www.k-m-p.nl


Your
STRUCTURAL
partner
Thanks to our great experience and our ability to handle every kind of process related to the composites, HP Composites is the ideal partner for advanced composite materials productions. Our goal is to improve our position of world-class expert in implementation of composite materials and technologies and to be a forerunner of human changes by producing increasingly lighter and even more efficient components.
Engineering
Tooling
Training
R&D
Total Quality
Prototype development
Racing & Industrial manufacturing
Composite mass production
HP COMPOSITES TECHNOLOGIES
www.hpcomposites.it


The Master's Degree
What an amazing accomplishment and achievement, a vital tool to equip you for life. Or so you would believe!!
That Degree you have strived for, worked your backside off for, dedicated 3/4years of your life to a subject you love and are so passionate about is absolutely worthless when you cannot find a career you have dreamt and worked so hard to be qualified to work in.
After all, your degree is a piece of paper, made out of the same stuff you clean your butt with!!
Motorsport is a vast industry, so many roles but all with the same goal, TO WIN!! Now, we know you could probably design a car, an engine or vital components with your eyes closed and in your sleep, so why are you still dreaming and not in the role that was made for you?
You, my friend, are an educated, talented and very gifted individual who can make a huge impact in the Motorsport industry and we are here to introduce you to the world, show the world what you can do and show the industry that they need YOU!!
Talk to us today and lets work on a branding strategy that will propel you up the ladder in the Motorsport Industry and help get you in the role you have worked for, and you were born to do.
www.brandkreaktiv.com
0141 2802386
hithere@brandkreaktiv.com
kreaktiv

Indentity crisis

When is a Lotus not a Lotus? When the branding has been removed, even though it appears on the garage and chassis?

By SAM COLLINS

When the car detailed on this page was first announced, it was called the Lotus T129. It was said to be an all-new design from the Kolles-Kodewa team which campaigned a pair of Lotus T128-branded Adess-designed LMP2s in the World Endurance Championship last year.

By the time the car was launched at Le Mans, an event it was originally meant to contest, it had become known as the Lotus CLM P1/01. When it ran in its first race at Lone Star Le Mans in Austin, Texas it was shown on entry lists simply as the CLM P1/01 and all Lotus branding had disappeared from the bodywork, although it still appeared in the garage and on the car's chassis plate.

The appearance of the new car was delayed early in the season due to a switch of engine supplier. Originally the car was to have been fitted with Audi Sport DTM specification 4.0-litre V8 unit but eventually AER's new P60 V6 was fitted. The direct injection twin turbo has been designed specifically for the 2014 LMP1 technical regulations which limit fuel flow and reward efficiency.

AER set out to design the best possible engine for the LMP1-L rules, which led it to develop an all-aluminium design which can be used as a fully stressed member of the chassis. Some elements of the new engine come from previous AER designs but the P60 still features a new block, sump, and cylinder heads.

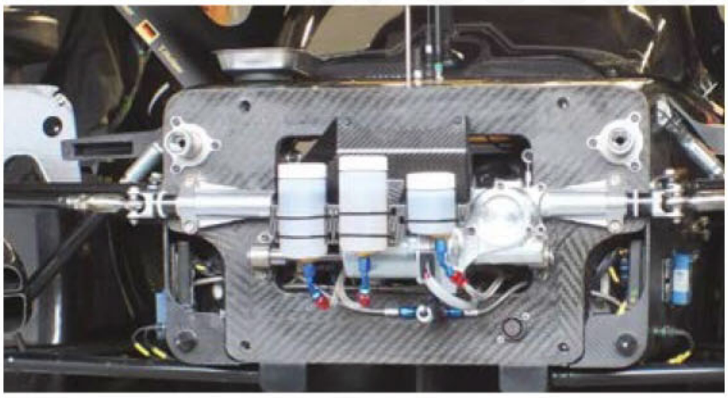
At the rear the bodywork is a mix of old and new: the support for the rear wing is very similar in concept to that of the T128, but the rear wing and endplates are all new

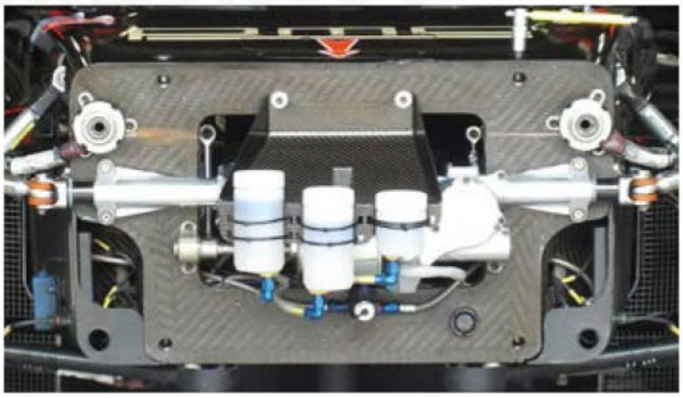
Particular attention was paid during the design and development phases to combustion efficiency. The designs of the cylinder head and combustion chambers were a strong focus for the Essex-based firm. The direct injection system used on the engine carries over from the firm's four cylinder turbo P90 engine. The design of the gear train, and the oil scavenge system along with the GDI cylinder heads and the GDI system itself all carry over to the V6.

The engine has no external belt drives or ancillaries. The camshafts, twin water pumps and oil pumps are driven by fully enclosed gears. The oil system is self-contained within the engine, eliminating the need for external plumbing of chassis-mounted oil radiators. The oil is cooled by an integrated oil/water heat exchanger, located in the vee of the block, directly fed by the oil pressure pump.

The engine has twin barrel throttle bodies, controlled by fly-by-wire stepper motors to optimise throttle pedal sensitivity and engine torque response. The twin turbochargers are specifically designed by Garrett for the LMP1 sports car installation and the boost is controlled by AER's bespoke electronically controlled wastegates.

The P1/01 chassis itself is something of a mystery. The team has claimed that it is an all new design but a quick inspection of the front bulkhead reveals that it is almost identical to the LMP2 specification T128 which was developed by Adess AG. The steering rack, electronics, uprights and suspension mountings are all either identical or very similar indeed. An ongoing legal dispute arose over that chassis and its development, both T128s were passed on to the Charouz team which plans to use them in future under the Praga brand. The roof line (and thus the crash structure) of the P1/01 is identical to that of the T128 as is the windscreen and forward cockpit area.





Spot the difference: the front bulkhead of the Lotus T128, left, and the CLM P1/01, right, show almost no difference whatsoever, yet the P1/01 team insists that its project uses an 'all new' chassis (perhaps with the T128 chassis used as a base although in the absense of detail it is hard to establish this point)

However the team insists that the P1/01 is an all new chassis, and perhaps while the T128 chassis was used as a base, the rear of the car would likely be notably different to accommodate the fully stressed V6 engine. Details of the rear of the car are somewhat limited and both AER and the team are reluctant to divulge much about the car's internals though it is known that the transmission shares a number of components with the Xtrac unit used on the ORECA 03.

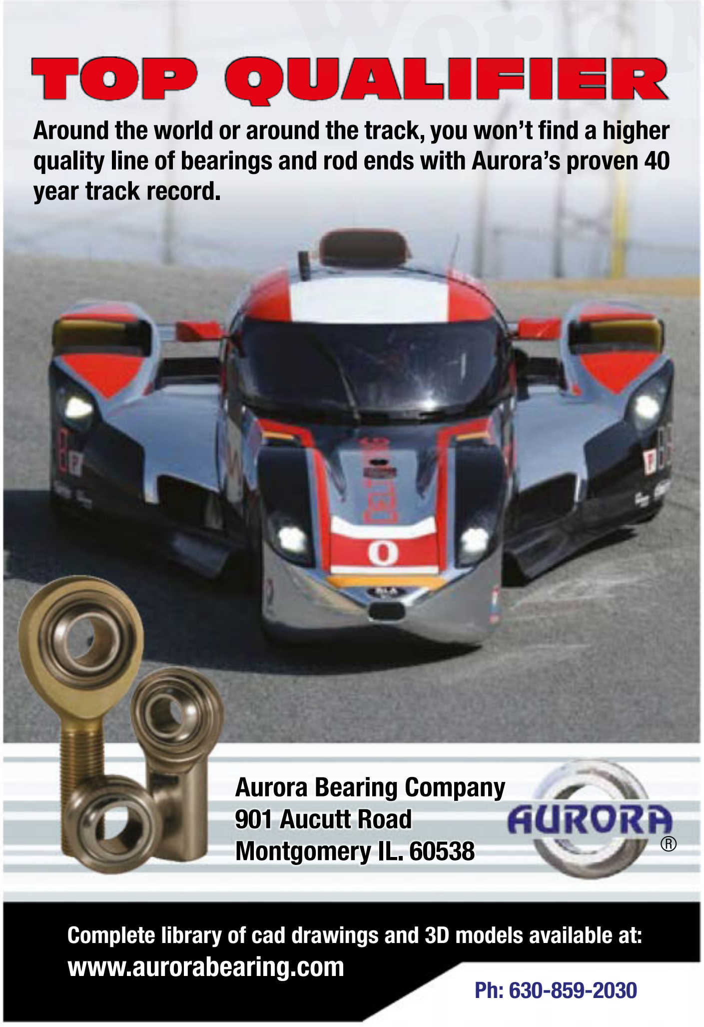
The front suspension is almost completely carried over from the T128 with the same inboard pick-up points, and torsion bars used though the uprights are modified at the top to give a slightly different geometry. The upper wishbone is a very different design on the new car being constructed with a solid component roughly rectangular in section compared with the T128 which featured more conventional tubular upper wishbones.

The bodywork of the car is similar in concept to the T128 but is quite different in detail, the nose shape has been totally revised at the front but picks up on the same mountings on the tub. Cooling is of course totally different with the AER P60 having different demands to the Judd engine used in the LMP2 design.

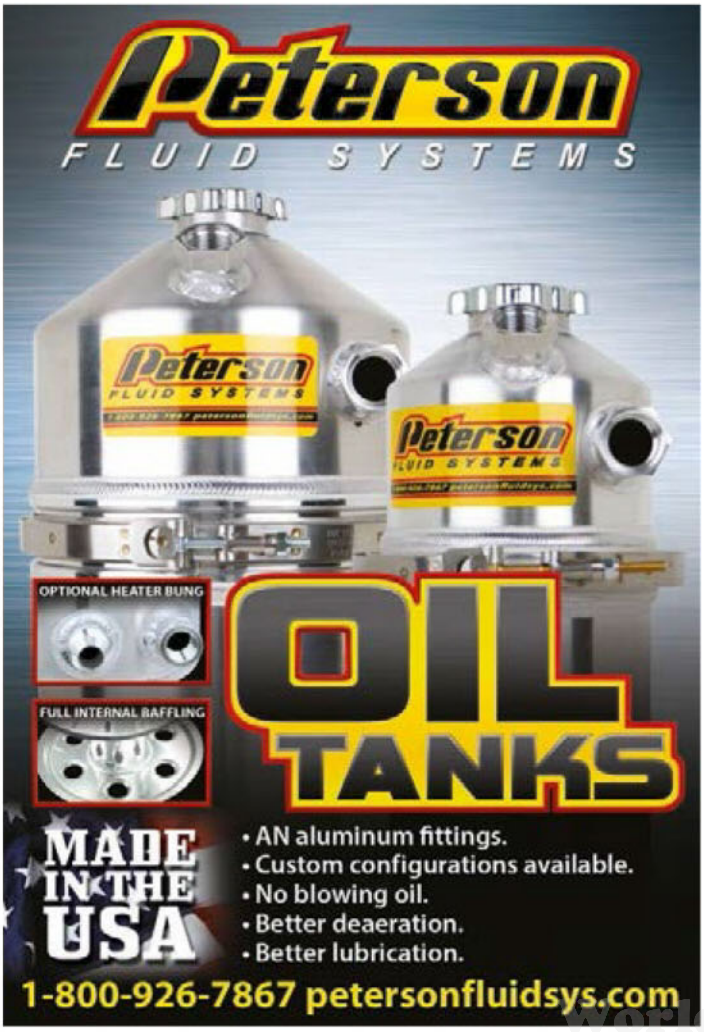
At the rear, the bodywork is a mix of old and new. The rectangular swan next support for the rear wing is very similar in concept to that of the T128, but the rear wing and endplates are all new. The rear wheel pod is much shorter than those seen on the LMP2 design.

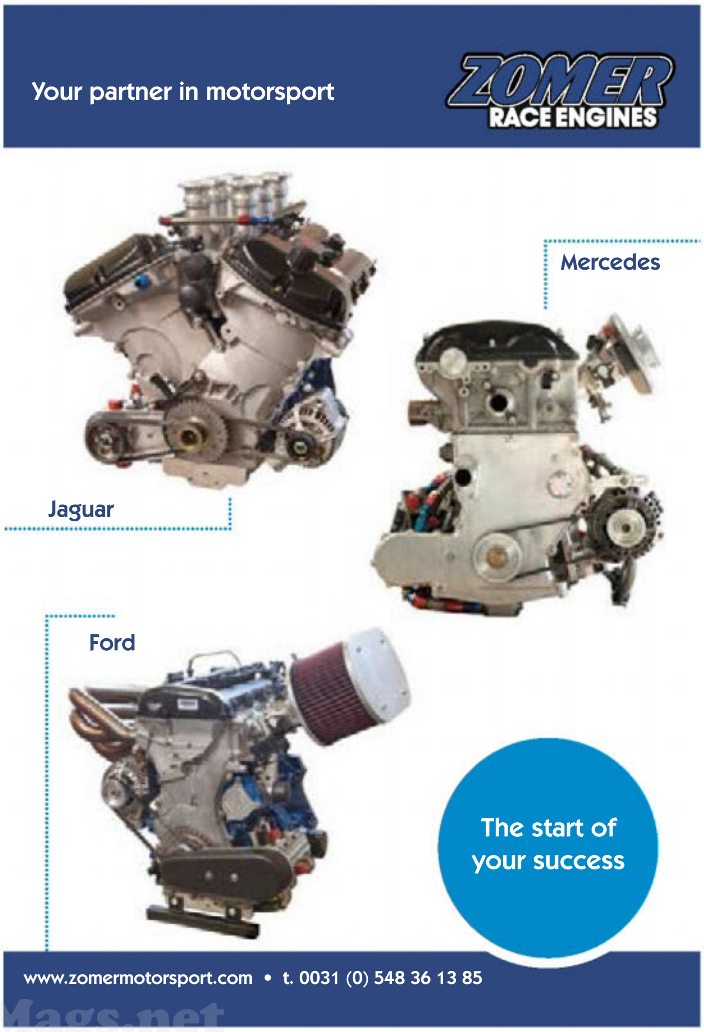
In competition the new car has proven to be somewhat off the pace of the only other LMP1-L design in the WEC field, the Rebellion R1 – although that car has three more races under its belt. At Fuji, the car's second outing, the CLM proved to be slower than the best LMP2 entries but showed good top speed (matching some LMP1-H entries). It suggests the car is somewhat behind in terms of downforce, possibly due to its stunted development and engine change.

The race at Fuji ended badly for the CLM. A failure in the car's low-pressure fuel system started a small fire which very quickly found its way into the cockpit of the car raising questions about the firewall at the rear, and the team was forced to try to get its spare chassis built up ahead of the next race at Shanghai.


TOP QUALIFIER
Around the world or around the track, you won't find a higher quality line of bearings and rod ends with Aurora's proven 40 year track record.
Aurora Bearing Company
901 Aucutt Road
Montgomery IL. 60538
AURORA®
Complete library of cad drawings and 3D models available at:
www.aurorabearing.com
Ph: 630-859-2030


LifeRacing
Professional Electronics for Automotive and Motorsport
• GDI Engine Controllers
• High Performance ECUs
• EURO6 Emission Capable
• MIL Specification Electronics
• Bespoke System 25 Wiring
• Modular Power Distribution
• Transmission Controllers
Tel: +44 (0) 1268 274 421
E-mail: info@liferacing.com
6 Repton Close, Basildon, Essex SS13 1LE

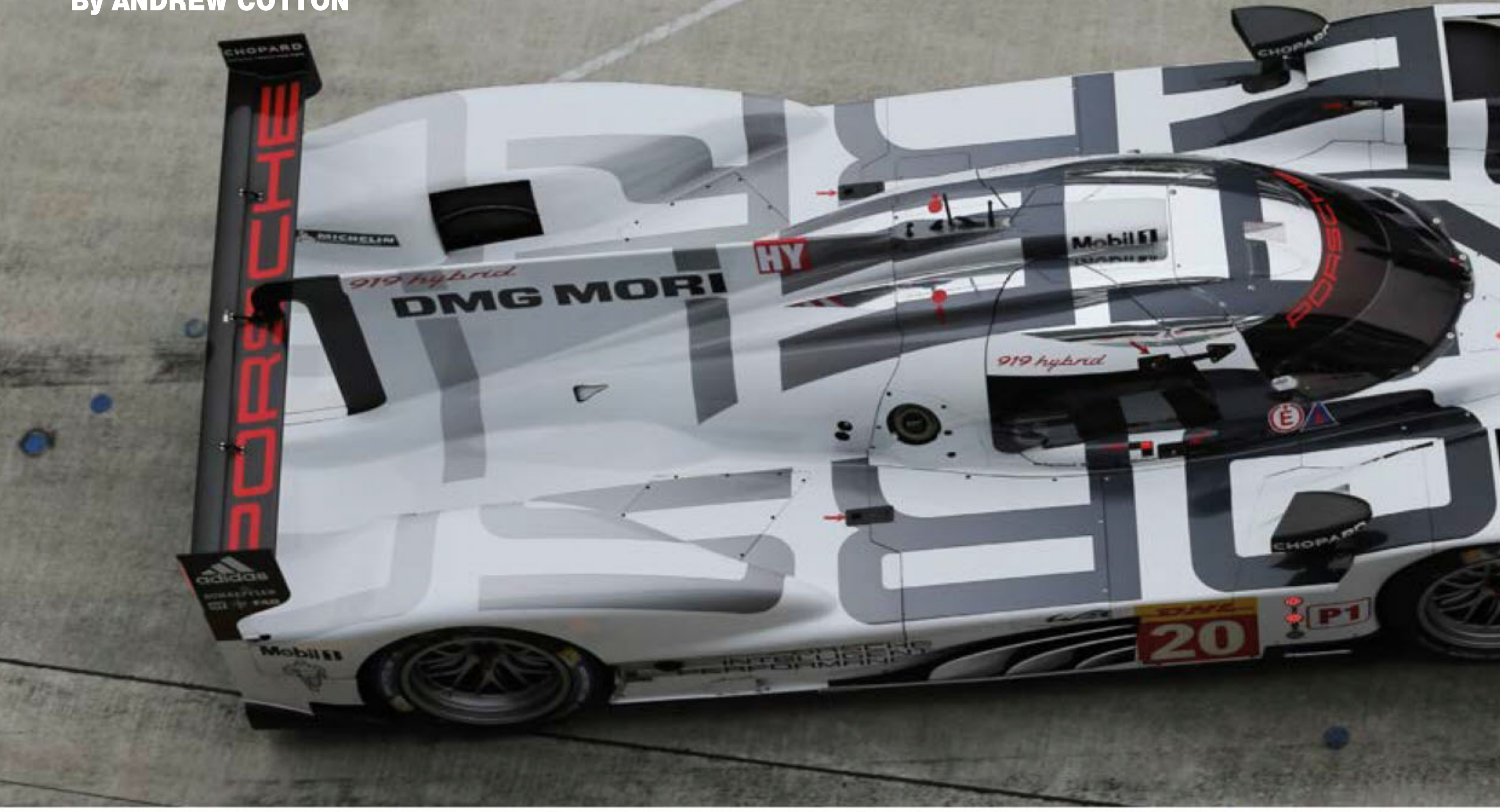

Peterson
FLUID SYSTEMS
OPTIONAL HEATER BUNG
FULL INTERNAL BAFFLING
OIL
TANKS
MADE IN THE USA
• AN aluminum fittings.
• Custom configurations available.
• No blowing oil.
• Better deaeration.
• Better lubrication.
1-800-926-7867 petersonfluidsys.com


Your partner in motorsport
ZOMER RACE ENGINES
Mercedes
Jaguar
Ford
The start of your success
www.zomermotorsport.com • t. 0031 (0) 548 36 13 85

Porsche's second step

Porsche's hybrid LMP1 has undergone a huge update post Le Mans

By ANDREW COTTON



Porsche introduced the 919 Hybrid at the Geneva Show in March and, since then, refinined and developed the car with a primary focus on Le Mans in June. There, against all odds, the car led on Sunday morning before a failure in the 2-litre V4 engine stopped the lead car prematurely.

After Le Mans, there was a three-month gap in the schedule before the cars lined up on the grid in Austin, Texas for the next round of the World Endurance Championship, and Porsche had used this time to extensively develop the car. Three tests, each of three days, saw the cars complete more than 6,000km. A new specification engine, improving the oil delivery to the unit, a new specification gearbox to help reliability (after sixth gear broke at Le Mans which led to the second 919 Hybrid dropping out of contention), a new aero package and a new engine cover were all tested.

> **"Every track is a new track – reliability, hybrid strategies, energy, we have done a lot there"**

The result was a more competitive car, which finished on the podium in Fuji, Japan, a remarkable achievement given that the race was dry and that there were no safety cars. Audi struggled to generate heat into its tyres throughout the six-hour race, and was well beaten, while Toyota marched to a comfortable 1-2 finish on home soil.

'One focus was to improve the reliability of the car, the robustness and this is a process that is ongoing,' says Alex Hitzinger, Technical Director of the LMP1 project. 'From the performance point of view, the characteristics of these tracks require different downforce levels [compared to Le Mans] and we have focused on the lower downforce side, and increased it quite a bit since Le Mans. As you increase downforce, it has an effect on how you use the tyres, the setup of the car, the mechanical balance and aero balance, and as you go to an almost new track every track, reliability, hybrid strategies, the way that you manage the energy, we have done quite a lot there.

'We have made gains everywhere. We can see it when we compare lap times at test tracks where we have been six or nine months ago, and when we go now we are a lot faster, but clearly others have made steps forward. In Austin, we made a good step and others progressed as well. The cars are quite close, and in terms of pecking order we are a little behind, but we know exactly why, and I am quite confident that we can sort this out for next year.'

One bone of contention between the manufacturers is still the Equivalence of Technology formula. After winning at Le Mans, Audi was given an advantage in the Equivalency of Technology table, which Porsche thinks is worth up to four tenths of a second at Le Mans (adjusted for the shorter circuits), although this figure is challenged by Toyota. Regardless, the issue of balancing gasoline and diesel is not yet resolved.

'There is some game-playing going on, and there is some sand-bagging,' says Hitzinger. 'People will also think about next year already. Maybe they are not playing in an obvious way, but there are certain trade-offs, which opens the potential for next year in terms of EoT. I didn't understand why the diesel got an improvement after Le Mans. I asked and nobody explained it. They said it was confidential. [The Audi] was the fastest car, it won, and the Appendix B gets changed in their favour. Where is the logic? I don't know why they got this benefit. I was disappointed in that as we were in a good way.'

Porsche has clearly targeted a win in its first year but, following the performance of Toyota

Porsche ran with a revised tail in Japan. The trailing edge of the bodywork still has scop to flex at high speed

A new front splitter was used in Japan, with a subtle change in shape to that used at Le Mans

A small turning vane has been added to the leading edge of the floor behind the front wheel

in Fuji, that looks to be a tall order and the team itself admits that, all things being equal they shouldn't win a race this season.

'If everything runs perfectly for everyone, in theory we shouldn't win,' says Hitzinger. 'Even if we don't have a gap, we are behind the other two. A lot can happen, the tracks are different. Our car gets better as the track builds up grip, so we are behind in the beginning of the weekend.

'Audi and Toyota come to the tracks with a sorted out setup from the previous year, and this is all lap time and performance, which is missing for us. Our car is not a lot behind if anything. Overall, as a car and a team and level of team we are slower, but where we are is difficult to pinpoint. We are half a second off as a newcomer on a new track - actually quite good.'

Much was made of the fact that Porsche will build a new car for the 2015 season, but this was obvious from the start. The 2014 car was the first attempt and there would always be improvements, but clarifications around particularly the braking systems at Le Mans mean that the car will need a heavy redesign.

'[The 2015 car] is an evolution, the concept stays pretty much the same, but it is a new car because every component is new,' says Hitzinger. 'It is all about optimising weight, stiffness, robustness, setup options, and of course further improvements in efficiency in aerodynamics, engine, it is optimising every component without changing the concept. There have been some clarifications over the course of the year in terms of the regulations that we have to react to, bodywork, aero, brakes, the skid blocks under the car.

Brake compensation

'We already have some form of brake compensation for ERS, but the regulations have changed quite a lot and opened up. It can't be policed, so you open it up and then, of course, there is a lot more potential which we did not use before because we thought that it was illegal – and now that it is legal we are working in that area.'

This is a clear reference to Toyota's fly-by-wire braking system that was declared legal at Le Mans. The regulations state that the system should 'endure balanced and stable braking, whatever the amount of energy recovered.

'It must ensure a constant front/rear braking load distribution (sum of the electrical and hydraulic efforts) which can be adjusted only manually by the driver.' Toyota's system was adjusted by the driver, according to the amount of brake pressure, but to most other manufacturers, it was an automatic system.

'You want to compensate the amount of torque that you have from the KERS in the hydraulic brakes, and that changes all the time. It is not a constant torque, and it should be invisible for the driver what the KERS does. It should have the same braking feeling, and the two systems have to compensate. Then, if you have such an active input into the hydraulic brakes, you can use that for brake balance migration and that sort of thing. That was clear in the regulation that this was illegal, but we can now do that.'

One issue that has yet to be addressed is whether or not the Hybrid system could be adapted to run at 8MJ next year. Hitzinger is considering the possibility although the performance advantage is apparently not clear. 'Exactly in the same way as we did last year, we also re-work our hybrid system and then we will test it, and we will see what is the best class for our system, looking at the whole season. It will be either 6 or 8, but we don't know yet which one of the two we will need. There is quite a big difference between Le Mans and the other tracks because of this Appendix B factor, 1.55. So if you run at Le Mans with 8MJ, you cannot achieve the full potential at the other WEC races. Depending on where you stand, 6MJ is the ideal compromise.'

Mercedes spend hits record high

Big spending in 2013 helped Mercedes to wrap up the F1 constructors' title in Russia recently

XPB

Recently-crowned Formula 1 Constructors' champion Mercedes has revealed it spent a whopping £325m last year as it developed its dominant 2014 engine and racecar in tandem with its 2013 campaign.

The figure, a record F1 spend for Mercedes, comes from accounts recently filed by its F1 race team – Mercedes-Benz Grand Prix, based in Brackley, Northamptonshire – and its engine division – Mercedes AMG High Performance Powertrains, based in Brixworth, also in Northamptonshire.

The race team spent £190.7m in 2013, a 26.2 per cent increase on 2012 and the biggest spend since Mercedes took control of the outfit from Brawn GP at the end of 2009. Toto Wolff, executive director at Mercedes GP, said of the increased expenditure: 'Operating costs rose by £39.6 million due to increased expenditure on in-season upgrades to the 2013 racecar; increased costs arising from the parallel car programmes for 2013 and 2014; and increased personnel costs.'

Meanwhile, engine spend for 2013 was £133.9m, which is a modest £7.6m up on the previous year, but more tellingly is almost three-times the budget expended three years earlier. This escalation over the past two years has been largely fuelled by the switch from 2.4-litre V8s to 1.6-litre turbocharged V6 engines for the 2014 season.

The 'increased personnel costs' are the 51 additional staff the firm took on during 2013, taking the total to 663 – the engine division increased its staff by 21 to 523 in the same period.

Mercedes says that some of its costs are offset by extra sponsorship revenues coupled with increases in payments from the Commercial Rights Holder, under the terms of the F1 teams agreement in 2012.

But the team still made a loss of £51.1m in 2013, an increase of £19.5m over 2012 (£31.6m). On the other hand the engine business made a profit of £6.6m, close to a million up on the previous year (£5.7m).

Meanwhile it's been reported that Mercedes will pay out at least £10,000 to each member of its race team to celebrate it clinching the Formula 1 Constructors' World Championship at the Russian Grand Prix in October. This generous move would mean that the Brackley-based team could cough up a total of at least £6.6m in bonus payments, shared among its 663 staff members.

F1 draws in $69m in extra advertising revenue

The amount Formula 1 made through its trackside advertising last year rose by nearly $69m (£43m) over the previous year thanks to lucrative partnership deals, with a $241.4m (£150m) total of advertising money pouring in to F1 coffers in 2013.

Figures for trackside advertising have recently been released in the accounts for Formula One Marketing – the first time these accounts have been made available following a restructuring of the F1 business by parent company Delta Topco.

The accounts for Formula One Hospitality and Event Services, which deals with the corporate hospitality in the sport, have also been released. These show revenues of $89.3m (£56m) in 2013.

Both companies previously operated under the Allsport banner, and they were formed in 1983 by former journalist and Marlboro PR man Paddy McNally, alongside Bernie Ecclestone. Until the recent restructure the companies were based offshore, meaning that public accounts have not needed to be filed in the UK until this year.

Rolex trackside sponsorship deal has helped fuel rising F1 advertising income

The main drivers in the trackside advertising profits were said to be the deals with Rolex and UAE-based airline Emirates, both of which became official partners to Formula 1 at the start of the 2013 season.

The deals resulted in a $68.9m (£43m) increase in advertising and sponsorship revenue over 2012, with total revenues of $241m (£150m).

When the deal was signed with Rolex at end of 2012 Bernie Ecclestone said: 'Without question Rolex is the partner of choice for a world class sporting series like Formula 1.

'The brand's prestige, the excellence of its watches as well as Rolex's passionate and long-standing commitment to motorsports gives it true credibility.'

He added: 'This partnership is something that many people interested in Formula 1 will have been waiting for and should rightly be excited about. Rolex has incredible sporting heritage and therefore Formula 1 is the right place for Rolex to be.'

Formula E looking for manufacturer involvement

Formula E boss Alejandro Agag has said he hopes to attract 'two or three' manufacturers for the second season of the new FIA-backed electric racecar series.

Agag has also said he intends to move FE away from the current one-make regulations for year two, something that has always been part of the long-term plan for the series. This means teams should be able to develop their own powertrains for the 2015/16 season, and their own batteries from season three, and Agag believes this could help attract manufacturers into the series.

'In year two the teams will be able to build their own batteries and their own motors,' he said. 'They could build their own whole car if they wanted. But the regulations are quite strict and they don't allow a lot of development in aerodynamics, but they do allow development in motor and battery. I hope we have three or four different makers of motors and batteries in the championship for year two.'

If the series was successful in attracting more than three manufacturers it could also mean an upgrade to world championship status – one of the FIA's criteria for which is the involvement of four manufacturers.

Speaking at the first ever 'ePrix' in Beijing in September Agag said: 'There is a condition of a world championship to have a certain number of manufacturers; you cannot be a world championship as a one-make series. We hope to attract manufacturers, meet the conditions and hopefully the FIA will grant us world championship status.'

Agag has also said that he wants the Formula E Championship to expand from the nine dates of its inaugural 2014/15 schedule to an 11 or 12-event calendar in season two and as many as 18 beyond that. 'For year two we are already planning at least two additions, and we want to grow slowly to get to a figure of around 18 races per year,' he said.

XPB

Agag wants manufacturers in Formula E by season two

Interest in hosting FE races is high after the inaugural Beijing event, Agag insists. 'We are talking to many cities; after Beijing we probably received requests from 40 or 50 cities from all over the world to host a race, so that's been really positive.'

SEEN: Next generation Hyundai i20 WRC

Hyundai Motorsport has started to test its next WRC car, which is based on the recently launched new generation i20. The first shakedown was carried out at a private testing ground in Germany, with French driver Bryan Bouffier at the wheel. Hyundai tells us the car is totally different from its current WRC model, which chalked up the marque's first win in Germany this year. The new car is said to be longer, lower and wider than the i20 now competing in the WRC, while it also features a new engine and transmission.

Commenting on the test Hyundai Motorsport team principal Michel Nandan said: 'It's always an important moment when you take a car to the road for the first time and this one was no exception. We have been working on the development of our future WRC car for some time now and we were finally able to put the first prototype on its wheels last month. The data and experience that we have accumulated during our debut WRC season [this year] has contributed to our approach with this new car.'

Nandon added that the company will not rush the development of the new i20: 'We will introduce it in competition when we are absolutely sure that it is ready to replace the current Hyundai i20 WRC – we're not in a rush,' he said. 'We are just at the beginning of a long process and we will continue to work hard on development and continue testing in the next months and throughout 2015.'

IN BRIEF

Chrysler axes Viper United SportsCar programme

US car maker Chrysler has called a halt to its United SportsCar Championship campaign in the face of slow sales of its Dodge Viper model. The news came two days after the Dodge Viper fielded by the Riley Technologies-run SRT Motosports team won the GT Le Mans class title in USC. SRT also scooped the teams' title this year, while it finished second to Porsche in the GTLM manufacturers' championship.

Chrysler says the decision has been made for business reasons, and that it now intends to refocus the marketing strategy for the Dodge brand. It's been reported that there have been a pauses in production this year as the company has tried to clear stocks of unsold Vipers.

Ralph Gilles, senior vice-president of product design at Chrysler, said: 'Our company has made a business decision to discontinue the SRT Motorsports Dodge Viper GTS-R racing programme. We are proud of the achievements our fantastic teams, drivers and partners have achieved on track the last few seasons.'

Earlier this year Chrysler also withdrew from the Le Mans 24 Hours, again a decision said to have been made for business reasons.

Ironically, sales of Vipers have picked up in recent months, following dramatic cuts in prices. Dodge sold 108 Vipers in September, the best monthly sales for the current version of the car. This compared with only 38 sold in August, 48 in July and 36 in June. Chrysler returned to racing with the current-generation Viper under the SRT banner in the American Le Mans Series in 2012. The cars were rebranded as Dodges this year.

Circuit arm of NASCAR posts upswing

International Speedway Corporation (ISC), the race circuit operating arm of NASCAR, has reported an upswing in its revenues over the past year.

ISC, which as a public company is often seen as a bellwether for the private family-owned NASCAR, has reported $130.1m in revenues for the third quarter of 2014 – that is over $13m up on the same period last year ($117m).

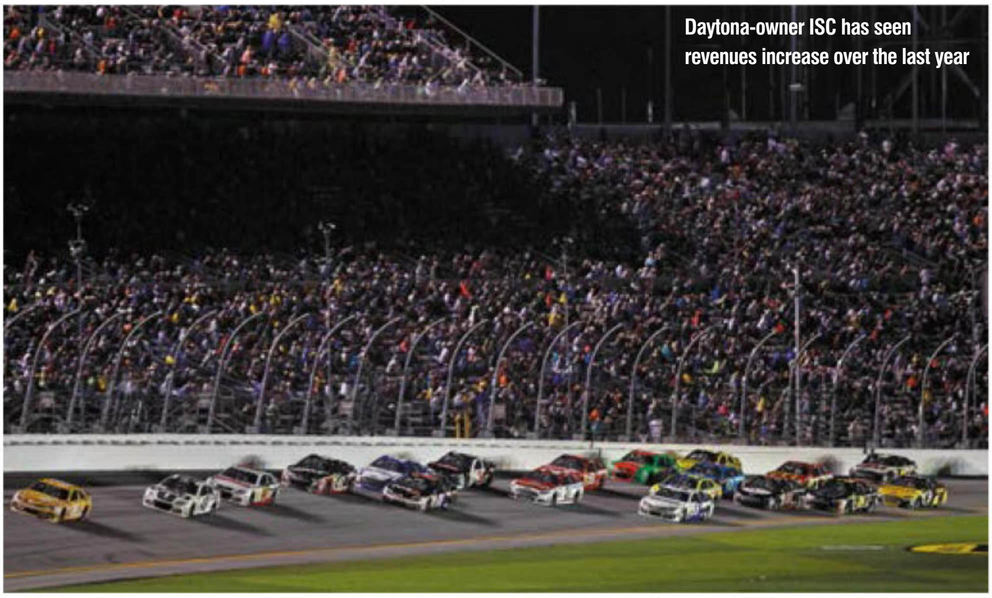
However, the company still reported an operating loss of $3.5m, although this is well down on the £13.1m loss reported for the same period in 2013.

ISC chief executive officer Lesa France Kennedy said: 'We are pleased to report higher revenues on a comparable basis for our third quarter, driven by contractual increases in television broadcast rights and stabilising admissions.'

Revenues from admissions over the period are up by close to $1m ($25.5m in 2013, $26.3m in 2014) while revenues from motorsport related business is up $2m ($79.8 in 2013, $81.9m in 2014).

Yet while ISC seems to have improved its performance in terms of money taken at the gate so far this year, France Kennedy says it is NASCAR's TV contracts that have given the company the bulk of its revenue, while its big-money new deal for 2015 has provided it with financial security: 'Broadcast rights represent ISC's largest revenue segment and these recent agreements provide us the long-term visibility to continue investing in our business to the benefit of our fans, partners and local communities while continuing to build shareholder value. We are poised to elevate ISC and the sport by having two of the world's largest media companies, NBC and FOX, promote NASCAR racing,' she said.

NASCAR's TV deal with both Fox Sports and NBC Sports for its US rights, which has been valued at $8.2bn in total, will run from the start of next season until 2024.



Daytona-owner ISC has seen revenues increase over the last year

XPB

SEEN: Toyota Camry Sprint Cup car

Toyota has unveiled its 2015 NASCAR Sprint Cup challenger, the first updated version of the Gen-6 cars to break cover. In keeping with the philosophy of the Gen-6 formula, which goes into its second year in 2015, the new Camry bears a strong resemblance to its street car cousin. Toyota will also launch a new Xfinity Series car – the new name for the second tier Nationwide Series – in due course. Both cars will make their debuts at the Daytona Speedweek at the beginning of next year.

IN BRIEF

Future class winners

Nissan is to sponsor the F1 in Schools initiative as part of a drive to encourage youngsters to take up careers in engineering. The competition gives children a chance to gain skills by running their own motorsport team, racing model cars while also learning about the engineering, design, logistics and management skills required to compete in motorsport. Nissan is also set to run workshops, competitions, practical activities and facility tours which will see more than 15,000 students experience the 'innovation and excitement of 21st century automotive design, engineering and manufacturing' over two years.

Fox scoops F1 TV rights in Asia

Fox Sports and Star Sports have secured a seven year agreement for the rights to broadcast Formula 1 in Asia. The deal also includes Japan.

Penske eyes Australia debut

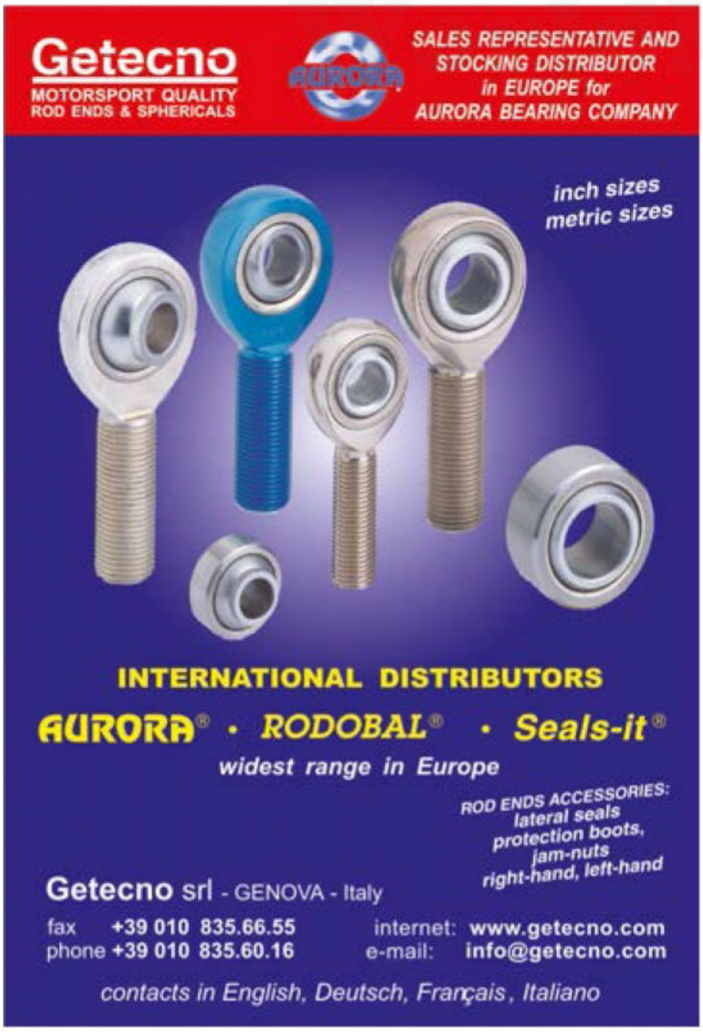
Penske has confirmed it is to enter the Australian V8 Supercars Championship in 2015, in partnership with V8S outfit Dick Johnson Racing. NASCAR driver Marcos Ambrose, an Australian who won two V8S titles with Stone Brothers Racing before moving to the US, will return to drive for the team, to be called DJR Team Penske. DJR boss Dick Johnson said: 'I admire what Roger Penske has accomplished in business and with his racing teams, and it will be a thrill to work with Team Penske and Marcos in 2015.'

Good measure

MEPC, the firm that is developing the Silverstone Park industrial area on the fringes of the circuit, has secured Government funding for a metrology centre. MEPC says the centre will give a valuable facility for technology and motorsport companies at the park. Silverstone Park commercial director Roz Bird said: 'MEPC knows from experience managing Granta Park in the Cambridge biotech cluster that access to specialist facilities benefits high-growth firms enormously.'

Winter on hold

Plans to run the World Endurance Championship over the winter with its climax at the Le Mans 24 Hours have now been put on hold until at least the end of 2016. The original idea was for the championship to kick off in September, taking in the flyaway races during the winter months in the northern hemisphere, then returning to Europe in the spring and early summer in the lead up to Le Mans in June. The reason for the backtrack is said to be to do with time-related rules changes that are coming in over the next couple of years (for GT in 2016 and LMP in 2017).


Getecno
MOTORSPORT QUALITY
ROD ENDS & SPHERICALS
SALES REPRESENTATIVE AND STOCKING DISTRIBUTOR in EUROPE for AURORA BEARING COMPANY
inch sizes
metric sizes
INTERNATIONAL DISTRIBUTORS
AURORA® • RODOBAL® • Seals-it®
widest range in Europe
ROD ENDS ACCESSORIES:
lateral seals
protection boots,
jam-nuts
right-hand, left-hand
Getecno srl - GENOVA - Italy
fax +39 010 835.66.55
phone +39 010 835.60.16
internet: www.getecno.com
e-mail: info@getecno.com
contacts in English, Deutsch, Français, Italiano


JLS MOTORSPORT
Air Jacks
• Designed & manufactured by JLS Motorsport, bespoke strokes are available.
• Manufactured with forged alloys & high tensile steels
• Lightweight & compact in design
• Delivering maximum performance & optimum safety
• All Air Jacks are supplied with 3 location rings for positioning & alignment
Air Jack Lance
Air Jack Probe
Made in the UK
European Sales
JLS Motorsport
email : motorsport@lister.co.uk
tel : +44 (0)121 525 5800
fax : +44 (0)121 525 4833
USA Sales
XRP THE XTREME IN RACECAR PLUMBING
XRP Inc. email : sales@xrp.com
tel : 562 861 4765 fax : 562 861 5503
lister


PRO-SHIFT
electronic gearshift
Championship Winning
Semi-Automatic
Electronic Gearshifters
for Racecars & Superbikes
Now available
This superfast and highly sophisticated
Gearshifting PS3 Paddleshift System suitable
for Racecars and Superbikes with over 170
adjustable parameters
PS3 System
Offering Fully Closed Loop Gearshifting for both Racecars and Superbikes
Auto-Blip & Downshift Lockout
For clutchless downshifts plus engine over-rev protection
Graduated Ignition Cuts
Individually programmable for all gears
Auto Upshift Facility
Max power upshifting at full throttle..!
For more information:
email: info@proshift.com
telephone: +44 (0)1332 668100
www.proshift.com


RINGSPANN®
RCS® Remote Control Systems
Market Leading Manufacturers of Control cables for:
• Gearshift
• Throttle
• Handbrake
• Clutch
• Support
• Anti-roll Bar
• Fire Pull
Contact details
RINGSPANN (U.K.) LTD.
3 napier Road
Bedford MK41 0QS
GORDON RISELEY
Office: 01234 342511
Mobile: 07831 863008
Email: griseley@ringspann.co.uk
www.ringspann.co.uk

SEEN: BMW M6 GT

BMW is to replace its Z4 GT3 racer with a car based on its M6 coupe from 2016. The German car giant has said that development of the new car is already under way and that testing will begin at the start of next year.

BMW's M6 racecar will make use of the twin-turbo 4.4-litre V8 that's found in the road going version of the M6, rather than carry on with the normally aspirated V8 the Z4 uses. A price for the GT M6 has not yet been set. BMW motorsport director Jens Marquardt said: 'For me there are few things more exciting than the development of a completely new car like the BMW M6 GT3.

'This car's properties make it destined to succeed the BMW Z4 GT3.'

Marquardt added that part of the reason for the switch was to showcase BMW's 'M' branding and an M version of the current Z4 is not available. 'We also want to demonstrate the high product substance of BMW M cars in motorsport with the BMW M6 GT3,' he said.

'We are all very excited to see it in action [when it gets to] the initial tests,' Marquardt added. 'One thing is certain from the first design sketches: this car is going to have the wow factor.' Marquardt also confirmed that current Z4 customers will still receive factory support as they compete with the brand. 'It goes without saying that we will continue to offer BMW Z4 GT3 customers our full support.'

Infiniti and 'Support our Paras Racing' enter BTCC

The BTCC welcomed a new team, Support Our Paras Racing, for the 2015 season. The aim of the team is to help raise awareness and funds for Support Our Paras, the official charity of The Parachute Regiment, one of the most iconic Regiments in the British Army.

The team, overseen by Team Principal Derek Palmer, will consist of a number of injured Paratroopers. The team has also set itself the ultimate long-term goal of developing, training and ensuring an injured Paratrooper graduates through the racing ranks to race in the future. The introduction of the new team coincides with the amalgamation of the two main Parachute Regiment charities. At the beginning of next year, the former Parachute Regiment Afghanistan Trust will merge with the Parachute Regiment Charity.

Fundraising for the Armed Forces in the United Kingdom has dropped 30-40 per cent in the last two years due to the drawdown in Afghanistan. The Parachute Regiment lost 26 soldiers during the campaign in Afghanistan, with more than 130 others wounded. The charity looks after the bereaved families and those who have lost loved ones. All profits generated by the Infiniti Support Our Paras Racing Team will be donated to the 'Support Our Paras' charity.

Formula 1 in crisis?

Alarm bells have been ringing since 2008, but no one has been listening

The financial troubles that have seen two Formula 1 teams fall into administration and forced to miss races perhaps should not come as a great surprise to those in the paddock. After all there have been many warnings about the financial health of the smaller teams, but little action has been taken to do anything about it.

'There is something terribly flawed in the system,' Sauber team boss Monisha Kaltenborn said of the sport's financial model. 'For me it starts with what the system and the sport is about. It is about different teams, not the big teams and the big budgets. This is a competition and the best win. But if the best are simply defined by the financial resources then something is not right because it not about finance, it is about sport.'

It is worth noting that Caterham, Marussia and the defunct HRT teams all signed up to Formula 1 on the understanding that a cost cap would be in force when they started. However, seemingly endless politics stopped that from happening. They had expected to be racing in a class where engineering and innovation would be the key performance differentiators, but they ended up in an unlimited spending war with only small change in their wallets.

Three musketeers

The three (four if you count the non-starting USF1) new teams were the leading entries of a group of 15 who all wanted to be on the grid, and the level of interest took many, including the FIA, by surprise. It led its then president Max Mosley to claim that 'this exercise has demonstrated that the only reason there have been vacancies on the F1 grid for many years was the excessive cost of participation.'

Even though the problem was recognised in 2008 when the new team entry process started, efforts to cut the costs have foundered, resource restriction agreements have proved ineffectual and every suggestion of a cost cap has got nowhere. At the US Grand Prix, only 18 cars were on the grid, prompting calls for big teams to run third cars or for those teams to make customer cars available for the smaller teams.

In my opinion these are only cures for the symptom of dwindling grid numbers, not cures for the disease (which these 'cures' would actually worsen). Three car teams and customer cars, could do irreparable damage to grand prix racing and the wider motosport industry. The problem, I think, is that F1 sometimes struggles to look outside the security fences of its paddock and has a tendency to follow overly complex routes. The technical and sporting regulations are far too restrictive and as Kaltenborn suggests, the contractual arrangements do not allow small teams to flourish.

Using customer cars would spoil the DNA of Formula 1 which has long been all about designing and developing a car, being a constructor. Formula 1 needs the small constructors. They not only bring on driving talent, but more importantly they develop the skills of young engineers.

The small budgets of teams like Minardi or Marussia forced engineers to be efficient and innovative, and drivers to give good technical feedback because testing was at a premium. F1 needs to find a way to bring back such teams. One idea is to loosen the sporting and contractual requirements. Ways for new teams, engineers and drivers to get into F1 organically need to be found.

Single car teams should be permitted, while the cost of designing and developing a single car should be the same regardless of how many are built. The costs of staffing, shipping, running and maintaining a single car are much lower. Of course, the opportunity to sell the second seat is also gone with a single car, but if the opportunity arises then the single car team should be given the opportunity to expand to two cars.

Formula 1 has always been about designing and developing a car

Marussia and Caterham are both in administration, and the solution to F1's growing problem is not customer cars

Two-car teams should not be required to run the same paint job on both cars. I actually struggle to understand why this rule is so strictly enforced in F1. After all, even if it was not in place you would still see two silver Mercedes and two red Ferraris. But further down the grid you would start to see split paint jobs. To my mind this can only be a good thing. There will be more variety on the grid, more colour, and at the same time more opportunity for teams to attract sponsors. Imagine the Lotus team with Maldonado's car painted in a patriotic yellow blue and red livery in deference to his main backers, while Grosjean's car could be heavily backed by Total and Renault.

This is not a new idea - it's universal in NASCAR and common in Indycar. In F1, BAR wanted to do it way back in 1999, indeed it even launched its cars with two different paint jobs in order to promote two different tobacco brands but it was not allowed to race the cars like that, and ended up running the famous zipper livery.

Customer is not always right

There is a strong financial case for the introduction of customer cars, which is why they are still on the agenda. Customer cars featured in F1 in recent years with Super Aguri and Toro Rosso using other people's designs, despite it not really being allowed. The practice ended in 2010. But strong financial case or not, customer cars are bad for the sport. Formula 1 is about teams engineering and developing cars themselves, and that should be protected.

However a compromise could be found. At the end of the season teams could sell off their old chassis to smaller teams. This would save some costs, but when I say chassis I mean the bare monocoque. If a team were to buy a year old chassis then it could not acquire any data from the vendor, bodywork or any other parts. The team would still have to develop its own front crash structure, rear crash structure, uprights, suspension geometry and control systems. They would have to do their own aero and power unit installation. This has happened before, the Super Aguri SA05 and SA06 designs were built around the Arrows A23 tub. It is an approach that saves time and money for small teams without removing the engineering aspect from the sport.

But the biggest thing that could make F1 sustainable for junior teams would be a cost cap, as Mosley suggested years ago. To ensure that the cost capped teams are not left behind resulting in a two-class F1, they should be given much more technical freedom.

The cars could have larger wings, a higher peak fuel flow rate, free weight distribution, adjustable gear ratios, active suspension, maybe fully active aerodynamics. Teams could not afford to develop it all so efficient engineering and innovation would be rewarded. The additional technical freedoms would ensure that the cars have strong pace.

F1 has to take a look at where it is, and where it is heading. It needs to decide where it wants to be, but introducing third cars, or pure customer cars, is not the right way forward. It needs to decide what to do soon however as history is repeating itself. Moves to introduce a cost cap have once again been blocked and the grid is being opened up for new teams to join.


CARTEK
MOTORSPORT ELECTRONICS
NEW
Power Control Panels
FiA Rain Lights
Battery Isolators
Shift Lights
Power Distribution Modules
Coolant Level Alarms
Wireless Steering Wheel Controls
Suppliers to:
HWA AMG
PORSCHE
Ford
Rage
KTM X-BOW
V8 SUPERCARS
www.CARTEKMOTORSPORT.com
CARTEK AUTOMOTIVE ELECTRONICS Ltd
02380 637600
info@cartekmotorsport.com


PEGASUS
Beta
Exclusive North American
Motorsports Distributor for Beta Tools
US importer of Jabroc® skid plate sheets
Stocking distributor of MS21071 Apex Joints
(all sizes, ¼" to 1 ¼")
Pegasus Auto Racing Supplies • New Berlin, WI USA
800-688-6946 • 262-317-1234
PegasusAutoRacing.com
Racers serving racers around the world since 1980


D.A.T.A.S. LTD.
Data Analysis Tools And Simulation
RaceSim version 2.7.x
• Expert: Steady state, transient, 4 post, optimisation, strategy, etc
• Standard: Low cost lap simulation
• NasCar: Stock cars with live axle
• RaceSimE: For Formula E electric vehicles New
• RaceAlyzer: Race strategy tool
• ManagePart: Parts management tool
Consultancy
• Vehicle Dynamics
• Racetrack support
• Software Development
Multi Media
• Photo realistic virtual animations
• Technical Features for TV
• Animated virtual walk thro' grid
D.A.T.A.S. LTD. THE OLD CHAPEL NORFOLK IP21 4XP
TEL: +44 (0)1603 506526 +44 (0)7802 770345
http:// www. datas-ltd.com e-mail: info@datas-ltd.com


EARL'S
PERFORMANCE PRODUCTS
CUSTOM BRAKE LINES | OIL COOLERS | HOSE | FITTINGS
ADAPTERS | FILTERS | NOS | FUEL PUMPS & REGULATORS
FUELAB
NOS
Holley
EARL'S
STÄUBLI
Visit www.earls.co.uk for the full range
Online Shop now Available
QUOTE "RCE10" WHEN ORDERING TO RECEIVE 5% DISCOUNT
Earl's Performance Products UK Ltd
Units 15-16 Silverstone Circuit, Northants, United Kingdom NN12 8TL
+44(0)1803 869850 | sales@earls.co.uk

INTERVIEW – Dan Andersen

Holding the ladder

We talk to the man behind IndyCar's feeder formulae about the US single-seater scene's clear pathway to the top of the sport and the all-new Indy Lights car

By MIKE BRESLIN

"Drivers aspire to race in IndyCar again; sure, most young guys want to race Formula 1 but getting an F1 seat is nigh-on impossible"

The Americans don't get everything right. But when it comes to the stuff of aspiration, the American dream if you will, they tend to be spot on. Take the professional single-seater scene in the States. Right now it has a clear structure of progressing formulae, sensible budgets, and a scholarship that helps drivers progress to the very pinnacle of the sport. It's just what a ladder should be, if you think about it: simple, none too expensive, and easy to climb.

This US single-seater ladder is now under the watchful eye of Andersen Promotions, a company headed by Dan Andersen, a businessman who has been involved in racing – running teams and series – since 1990. Andersen Promotions has been looking after the first two rungs on the Mazda Road to Indy ladder for the past few years (USF2000 since 2010, Pro Mazda since 2012). This year he's also taken over Indy Lights, and it seems as if his timing has been pretty good, for things are on the up in single-seaters in the US, from Indycar down.

'IndyCar has gained in a downward racing economy here in the US,' says Andersen. 'NASCAR TV audiences and fans in the stands have been falling off the last couple of years, while IndyCar's have been rising. Okay, IndyCar is starting from a pretty small number, in both TV and attendance, but the fact is they're increasing about 20 per cent year over year. IndyCar's bottomed out and turned the corner, and so I have some optimism for open wheel racing in North America.'

Andersen explains that when IndyCar's doing well that can only be good news for its feeder championships. 'Drivers aspire to race in Indycar again, and that's an improvement,' Andersen says. 'Most young guys want to race Formula 1, but there's a growing understanding that getting a Formula 1 seat is nigh on impossible. Getting an IndyCar seat is a bit less difficult.'

Tremendous initiative

The Mazda Road to Indy scholarship certainly helps here. This is a tremendous initiative which provides budgets for each winning driver in the feeder series to progress, and theoretically a driver could go from Skip Barber's school competition to the Indy 500 without paying a penny.

While such an opportunity is obviously attractive to career drivers, if there is one problem for the formulae that paves the way it's probably the age of the cars used – though as we'll see, that's been addressed with Indy Lights.

The first rung of the US ladder is USF2000, a spec series using 2001-vintage spaceframe Van Diemens packing 170bhp Mazda 2.0-litre powerplants. For 2014, an H-pattern Hewland box was replaced with a sequential unit from the same company. Rung two is Pro Mazda, another spec series using the Van Diemen-built carbon chassis once marketed as Formula X in the UK, mated to a 260bhp Mazda rotary engine – interestingly, Andersen actually says the compact engine makes the Pro Mazda's wheelbase a little short for his liking.

Andersen admits that both of these chassis are certainly very long in the tooth in single-seater terms, especially compared with what's on offer in Europe. But then the budgets reflect this, and right now Andersen believes that's more important.

So just how much does single-seater racing in the US cost? 'Some of it depends on how extensive a testing programme one selects,' says Andersen. 'But I would say there are drivers in USF2000 spending less than $150,000, and other drivers spending $250,000. You can be competitive with 150, but money always helps if you want to do a lot of testing. I think a lot of the drivers are in the 200 to 225 range. ProMazda runs between 350 and 450 per season, and Indy Lights this past year was probably around $750,000.'

A year of second tier racing for $750,000 is pretty good by any measure – GP2 is around $2m with little chance of progression into F1 without more investment – and yet Indy Lights has struggled badly in recent times, reaching a point where it could muster just six regular teams. But Andersen maintains this was never about costs anyway: 'In Indy Lights the cost was not the reason the series was struggling. The series was struggling because of two things. The car was very dated and was not attractive to drivers at all, and frankly IndyCar took its eye off the ball and didn't do much in the way of marketing. They had a better story to tell than they were telling.

'So, we didn't go into Indy Lights thinking we were going to increase the field by cutting costs, we went in thinking we were going to increase the field by treating the team owners better, getting the message out about all the benefits of Indy Lights racing, and introducing a pretty sharp new car.'

Mazda 2.0-litre powerplants drive those on the first rung of the US ladder learning curve: USF2000

That pretty sharp new car is the Dallara IL-15, which replaces the Italian company's 2002-vintage offering as the spec chassis. Both Mygale and Multimatic were also in with a shout for the contract, says Andersen, and 'they would have done fine – it's not that they're bad companies at all. I just think that given the transfer of technology from the old car, and the history that IndyCar has with Dallara, this suited us better.'

That said, he adds: 'Bottom line, Dallara also had the best price and the other cars would have been a bit more than the $270,000 [car cost] number for the teams.'

Early tests of the IL-15 suggest Andersen made the right decision, with the car performing very well and suffering nothing more than teething problems. 'It's nearly an IndyCar in performance,' says Andersen. 'We're doing 200mph at the [Indianapolis] Speedway, on the oval, and we're within 10mph of IndyCars on the road course, so it's got a lot going for it. It's been fun to watch and the car sounds great, everybody loves it. Some of the IndyCar drivers are even wishing it was the IndyCar!'

Series revival

The new car certainly seems to have revived the series, too, with nine teams now signed on for 2015 and another three looking likely to join at the time of writing. 'I am confident that we will go into next year with double the number of teams, which is always helpful for a promoter because frankly the teams are out there prospecting for drivers and they become my salesmen,' Andersen says.

Of course, the most important thing for Lights, and the two Andersen-run series below it, is that IndyCar remains in good fettle. If it's a desirable goal for career drivers then its feeder series can only flourish. 'It's working right now,' says Andersen. 'If you're racing in North America there are no other serious options. There are a couple of regional semi-pro series, but in terms of visibility and choice there's really only one way to go, and hopefully it will stay that way because it's not helpful to anybody to dilute the fields and have a lot of different options. In Europe everyone wants to have their own ladder, and it's not clear, and that's not helpful to open wheel racing in my view.'

To put it another way, the US has a simple ladder that's cheap to use and easy to understand. In Europe there is a distorted and over-complicated climbing frame which, while it might be built from titanium and carbon, is not quite as useful when it comes to getting to the top.

RACE MOVES

XPB

Kenny Handkammer has left the Red Bull Racing Formula 1 team, where he was **Sebastian Vettel**'s chief mechanic. At the time of writing there was no word on where Handkammer was moving to, although he is expected to follow Vettel to Ferrari if the German driver moves to the Scuderia in 2015, as is widely expected.

Alan Kinch is to fill the position of chief financial officer at Williams, replacing outgoing finance director **Louise Evans**. Kinch joins the group from Vodafone, where he was finance director. He has also worked at Cable & Wireless, spending three years as its group financial controller. Evans joined Williams in 2004 and was appointed head of finance in 2005, and finance director in 2011.

Jonathan Dean has joined famed motorsport transmission company Hewland Engineering as its new technical director. Dean previously headed the Caterham F1 design office, but he also has decades of experience in transmission design for sports and touring cars.

As well as appointing a new technical director Hewland has signed **Mark Baker** as operations manager, former Caterham F1 man **Peter Metcalf** as head of assembly, **Daniel Broomfield** as marketing assistant, and former McLaren employee **Duncan Medlock** as procurement manager.

Nick Hughes is to be technical director at the new DJR Team Penske V8 Supercar team. Hughes, who is originally from Adelaide, returns to Australia after some years in NASCAR in the US. He has previous experience in V8S, having worked in the championship with Penske Racing Shocks early in his career.

Allison Melangton has joined Hulman Motorsports, the company behind the Indianapolis Motor Speedway, as its senior vice-president of events. Melangton was formerly president of the Indiana Sports Corporation and was also president of the 2012 Indianapolis Super Bowl Host Committee.

Richard Childress Racing NASCAR Sprint Cup crew chief **Slugger Labbe** has taken on a new research and development role within the organisation. **Justin Alexander**, formerly a race engineer with RCR, will now fill Labbe's position as crew chief on the No.27 **Paul Menard**-driven Chevrolet.

Former NASCAR and sportscar racing crew chief **Dan Ford** has died at the age of 78. Ford made his name building Le Mans-winning Ford GT40s at Holman & Moody in the 1960s before switching to a hugely successful career in NASCAR in 1968. He retired in 2007.

Hans-Dieter Dechent, the man who brought Porsche and Martini together in the late '60s, has died at the age of 74. Dechent was a capable driver before he turned to team management in 1970 with the Porsche 917-equipped Martini International Racing Team, an organisation which won Le Mans in 1971.

Peter Prodromou has now started work at McLaren as chief engineer. He comes to the Woking organisation from Red Bull Racing, although he is familiar with McLaren, having previously worked for the team from 1991 until 2006.

The MSA, motorsport's governing body in the UK, has confirmed the reappointments of **Rod Parkin, Dennis Carter** and **Mike Sones** to its board of directors, while **Alan Gow** has been re-elected to the post of chairman. All four have now started new three-year terms with the organisation.

Marion Barnaby is to leave her post as motorsport manager at Porsche Great Britain at the end of this season. Barnaby has held the position for the past 14 years, and has been in charge of the UK's Carrera Cup series since its inception back in 2003.


PRI2014
Indianapolis
December 11–13, 2014
• The World's Largest Racing Trade Show
• 1,100 Exhibiting Companies
• 72 Countries Represented
RACE ONLY
Credentials Required
14
www.pri2014.com
UK funding available through the Motorsport Industry Association (MIA)
Contact Clare at clare.kelly@the-mia.com

IndyCar appoints former HPD man as engine boss

Former Honda Performance Development (HPD) employee Marvin Riley has been signed up as director of engine development at IndyCar.

In the new role Riley will help with the performance standards and the formulating of engine rules for the series' two powerplant manufacturers, Chevrolet and Honda.

IndyCar's vice-president of technology, Will Phillips, said of the appointment: 'I'm happy to have someone of Marvin's experience join the team. As well as helping to define the future IndyCar powertrain regulations, Marvin will oversee the engine manufacturers' performance and competition to ensure they are competing within the current rules.'

Riley worked at HPD for a decade, and he was most recently assistant manager of the engine development department at Honda's US motorsport and performance subsidiary.

Meanwhile, IndyCar team Rahal Letterman Lanigan (RLL) has restructured its engineering department, with Bill Pappas, John Dick and Mitch Davis all leaving the team. RLL has struggled this season with its single full-time entry Graham Rahal finishing a lowly 19th in the championship.

All three of the departing engineers were relatively recent arrivals at RLL, joining within the past two seasons. Rahal's engineer Pappas and head of R&D Dick came from Dale Coyne Racing, while crew chief Davis joined from Ganassi.

Eddie Jones, who engineered a second RLL car when it was fielded this year, will now replace Pappas as engineer on the Graham Rahal entry, while Mike Talbot, who joins the team from HPD, will work in R&D.

The team is also searching for a new sponsor for 2015 following the decision of the US National Guard to pull out of motorsport at the end of this season (see October's *RE*).

SPONSORSHIP

The **Red Bull Formula 1** squad has a new sponsor for 2015 in the shape of **Exness**, which is one of the world's largest retail foreign exchange brokers. The name of the company, which in August of this year exceeded $170bn in terms of trading volumes, will feature prominently on the cockpit surrounds of next year's RB11.

One of the **British Touring Car Championship**'s standout sponsorship partnerships has come to an end. **Wrigley's Airwaves** chewing gum brand has been supporting the **Motorbase Performance** team since 2009, but Airwaves has now said it feels it has achieved the goals it set for itself in motor racing and will be leaving the sport. **Motorbase** has now started the process of searching for a replacement title sponsor.

Lukoil has pulled out of its sponsorship deal with the **Lada World Touring Car Championship** team. The Russian oil company says it's now planning on shifting its focus on to other motorsport programmes for 2015.

Hayashi hands over Dome reins

Japanese racing car constructor Dome has changed ownership as its founder, Minoru Hayashi, turned 70 and wanted to protect the future of the company. Shares in the company, which was set up primarily to demonstrate Japanese engineering at Le Mans, have been transferred to Hayashi's long-time friend Igawa KoHiroshi who takes over the company in July 2015.

Parts of the Dome empire have been sold off, including Dome Carbon Magic to Toray Industries and what is considered to be the country's most advanced 50 per cent wind tunnel to Toyota.

'Currently, in order to develop a modern racing car, large scale human resources, facilities and equipment are required,' said Hayashi. 'But, in our country, because there is no environment to keep it, it is a business as difficult as selling refrigerators in Antarctica and stoves in Africa.'

The company has come up with an all-new F4 car and produced the first mother chassis for the GT300 category, and expects a bright future in racing car construction. The Dome S103, built by Strakka Racing in the UK, was expected to make a race debut at the end of November.

RACE MOVES – continued

XPB

Audi DTM driver **Timo Scheider** has set up a team to run young drivers in the new ADAC Formula 4 series in Germany from 2015 onwards. The two-time DTM champion will also continue to run his successful karting operation.

Racecar Engineering news editor **Mike Breslin** has published his second novel, Pieces of Silver, which is available as a large format paperback on Amazon and at selected bookshops. The book is set in the 1930s and during WWII and follows the adventures of a British driver who races for the German Auto Union team, and then goes on to fly Hurricane fighters in the war.

William Coralline, a crew member in the NASCAR Nationwide Series, has been indefinitely suspended from all NASCAR competition after violating the US stock car sanctioning body's strict substance abuse policy.

Well-known rally broadcaster **Greg Strange** has died at the age of 61. For many years Strange was the BBC radio correspondent for the WRC, where he also covered other sports such as rugby, but more recently he has been known for his work on his own radio station, iRally.

Toyota LMP1 and former F1 driver **Alex Wurz** is the new chairman of the Grand Prix Drivers' Association (GPDA), taking over the post previously held by Ferrari test driver **Pedro de la Rosa**. Current F1 drivers **Sebastian Vettel** and **Jenson Button** will continue as GPDA directors.

Will Fewkes is the new championship manager of the Renault UK Clio Cup. Fewkes, who has a background in motorsport PR and marketing, has a long relationship with Renault through his father Roy, who acted as an MSA technical commissioner for Renault-run championships for over a decade.

Specialist and motorsport insurance broker **Ellis Clowes** has appointed former TV sports broadcaster **Jill Douglas** as its group head of marketing and communications. Douglas is best known for her TV work in rugby and cycling, while she has also covered four Olympic Games for the BBC.

FISITA, the International Federation of Automotive Engineers, is now accepting applications for the second round of its 2014 Student Travel Bursary, which offers up to €2000 to any engineering student wishing to work or study abroad. Go to www.YourFutureInAutomotive.com for more information.

Racecar Engineering has a new and exciting opportunity to join its rapidly expanding advertising team, starting in March. If you want to join this heavyweight of the motorsport industry contact our advertising manager Lauren Mills on +44 207349 3740, or email your cv and a covering letter detailing your sales skills to jobs@chelseamagazines.com.

◆ 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**

International showtime

PMW, PRI and Autosport International offer a vital eight-week window for motorsport

We are heading in to the vital eight-week period of our business calendar where those who want to grow their business will be visiting PMW to reach Europe, PRI to access the US and Autosport International for the UK and rest of the world. I wish you well, not only at the shows, but in your forward planning, to ensure you capture as much business as possible.

The MIA has a Business Lounge at all three shows where you are welcome to meet overseas customers. Contact us before, or at the shows, and my team will be there to help you boost exports.

The most important tip I give everyone is to work hard before the show – write to every contact you have, invite them to your stand, tell them you have something new to show them, invite them to an MIA party or reception to get to know them better. Even if you are just walking the shows, invite them to use the MIA business lounge to do business. The hard work before the show is the most valuable – it is too late if you start looking for customers while you are there.

Only 170 days or so from now, the UK will have a general election and a new administration. I am determined that the UK motorsport industry will make its voice heard loudly before the election, and press MPs on how they are going to support our industry if they are wanting our votes, and those of our employees.

Our industry, which employs over 40,000 people, is a strong exporter and has had five years of significant growth during really tough times, primarily in the engineering industry. We deserve support from the new government, but many other industries will be campaigning in a similar manner, so I want to help, through the MIA, to get your message in front of the new administration.

I would like to ask for your help in ensuring we get the strongest performance figures we can – please follow the following link – https://www.surveymonkey.com/s/BusinessSurvey2013-14 - and spend just 10 minutes to complete this survey. The MIA is going to pull all these responses together and put forward a Manifesto for Motorsport to be launched at the Autosport Show in January and will work for the following few months at getting support from parliamentarians. We need their help to increase R&D tax credits, increase support for exporting, help with recruitment of apprenticeships and the funding of training programmes, support for the closed roads proposed change in law and other activities which your response will direct us to secure.

Recently I talked to business leaders from motorsport throughout Europe and the US – the focus being on the next two or three years of development where business may occur and I want share some of the comments they made.

Hybrid power will follow the development of OEMs here and in the US and will only become a significant player, directly influencing lower end motorsport, once the volumes of OEMs using hybrid solutions grows. The systems currently used in the upper tiers of motorsport are too expensive to reach down to the middle and lower levels of motorsport, but they will in time.

Germany are major exporters of motorsport products and those attending PMW should realise that not only are they selling to German exhibitors and visitors for that market, but in almost every case will be selling on to another area, and it is worth finding out where these will be. The worries of the German economy have not yet attacked the German motorsport business, partly because of their export sales, but also the strength of

Our industry employs over 40,000 people and has had five years of significant growth

Hospitality and conversation will cement industry links and promote new business in the sector

their automotive industry. The most successful of European motorsport companies have, for the past few years, strengthened their work with the automotive industry, particularly in hybrid, electric propulsion and light weighting. There is good business to be had from the MIA's Motorsport to Automotive programme, in the UK and Europe. This is less so in the US, where the hybrid/electric programmes are having little effect on the current OEM motorsport programmes, but this is undoubtedly going to change.

It is thought that IndyCar and United SportsCar will, by 2017, have some form of hybrid/electric power units within their series. The latter is getting closer to the ACO European model and it is expected that a single prototype chassis with variable power units will be in place in sports car racing both in Europe and the US by 2017, so beginning to make a truly global sports car business opportunity for drivers and companies.

In IndyCar, a battle between Chevrolet and Honda looks set to widen the number of engine suppliers and, in 2015 and beyond, is allowing changes in aero kits to create even better competition, with luck bringing new business and OEMs into the series. Most endorsed the fact that the UK and the US are the most active motorsport markets and warrant significant attention, as both have a wide diversity of motorsport to supply and growing connections with the OEMs. A long shot would be to work in Asia, particularly China, where there is growth potential.

New testing regulations for NASCAR in 2015 will boost their requirements for services linked to simulation. It seems the number of tracks to be used will be dropped considerably and the parts usage and costs will fall – a great opening for those who have knowledge of advanced simulation in Europe to make contact with those NASCAR teams where the front-ranking have good knowledge but the rest of the grid need to catch up.

While hybrid and electric may not be catching on in NASCAR, the suggestion was that within three to five years, direct injection would be used, which again opens up new opportunities. The class structure of United SportsCar has been confirmed as maintaining a similar structure to 2014, with a prototype class, an Oreca spec chassis class, and then GTLM (similar to GTE Pro) and GT Daytona which is modified GT3 FIA class. All of these rely not only on US, but also European knowledge, and the series has attracted an average of over 50 cars per race – superb grids for a young championship.

Testing is again going to be limited in 2015, so simulation is vital. PRI this year will be the place to discuss future sports car developments with United SportCar and IndyCar, and both Will Phillips and Scot Elkin, will be on the MIA booth.

GTC has had another successful year and it must be hoped that they will link with the FIA in the next year or two, to boost Rallycross. The general view on Formula E was that it was good for the sport, and it is catching the attention of new sponsors, new audiences and new venues.

I hope the above will give you tips to help prepare for conversations at PMW, PRI and Autosport, but if want further information, please contact the MIA who are determined to help you boost exports and all the rest of our friends around the world, build new motorsport business – www.the-mia.com. See you at one of the shows – do please call by and say hi.

Technology appeal

Working an international trade show is hard enough – but there is technology out there to help you

Working a trade show is complicated enough. We have written in the past about the need to prepare properly – business cards, appointments and a study of the floor plan before you even arrive is the basic requirement for covering shows. Yet, that is only the start of the process. After the shows, you then have to follow them up, and there is a high percentage chance that the business cards that you have collected will be wrapped up with the receipts for coffee and lunch.

With the development of the Smartphones from all companies, and the rise in the number of apps that are available, there have been some interesting launches over the last few years that will help you to make the most of your time at the shows. Clearly, they are intended to help you with your networking and with building databases, aids to help you turn that crucial first meeting into money. However, there are others that are always useful, including those that cover transport links to and from the shows, and link to town centres, restaurants and events outside the show that can be used for meetings.

One of the key networking apps that we have found to be useful is the World Card Reader which, for a modest fee, will allow you to photograph and log the contact details of the business cards in your contents folder. Not only do you then store the phone number and name of the person you have met, but it also records the postal and email addresses that you would normally not have the time to include for everyone. Other options that complete a similar task is Quick lead, for the iPad, which records all the relevant data into a central system and allows you to easily use the information for building a database. The Excel export function means that you can process your leads digitally, and efficiently.

Another increasingly common tool is the scanning of a QR code on the exhibitors ticket. Companies, such as Zuant, offer to collate the data and present it as a spreadsheet for you to work from back in the office. Taking this information and digesting it in the office can sometimes be a laborious task, and one that, particularly around Christmas time, doesn't often lead to new contacts.

Zoho CRM allows you to scan the QR code on your iPhone and Android smartphone, or take a picture of their business card, follow-up with the attendees instantly by assigning a lead owner to quickly follow up tasks, or send follow-up emails right from the app, all while still attending the show. There are others, including Quicktag, QRAugmented and Easy QR. Others will allow you to take note of where you have walked, how long you spent at each stand, and will even help you to make appointments. Take some time to take a look through the various online stores to establish the best places to find apps that will help you.

Q&A WITH WIRTH RESEARCH LTD

Q. Wirth Research has been in the industry for a number of years, what expertise do you offer customers?

A. Wirth Research offers flow simulation and Computational Fluid Dynamics (CFD) services. The business pioneers the use of advanced virtual engineering technologies, developed in-house, which enable the use of a complete simulated vehicle design, development and testing process. This reduces the need for wasteful manufacture of development models and prototypes. Additionally Wirth Research has developed valuable, in-house resources such as Composite Manufacturing and a leading edge Vehicle Simulator.

In motorsports, Wirth Research is proud to continue its decade-long partnership with Honda Performance Development Inc (HPD) on the design, development and manufacture of the championship-winning ARX sports car programme, and providing Honda-powered IndyCar teams with advanced chassis technical support. The IndyCar project continues with the development of new aerodynamic bodywork kits that Honda is set to offer its teams from the start of 2015.

In September 2014, Wirth Research was involved in the world's first FIA Formula E Championship in Beijing, providing Andretti Autosport Formula-E with engineering support services for the series. Andretti's Franck Montagny won second place and his team mate Charles Pic came fourth in the first race, giving Andretti the lead in the teams' championship. The company carries out project work both within and outside of motorsport.

Q. How has your business changed over the past 25 years? What have been the most important changes/highlights in your business?

A. The business was founded in 2003.

Wirth Research has applied its motorsport-derived Computational Fluid Dynamics (CFD) development processes to large vehicles and architecture. The company is also providing engineering support to Andretti Formula E for the FIA Formula E Championship.

Q. What do you see as the main challenges of working in the motorsport industry?

A. Homologation. The approval process through which a vehicle or a standardised part is required to go for certification to race in a given league or series. However, Wirth Research's president, Nick Wirth, has a huge amount of

Q&A WITH CLAYTEX SERVICES LIMITED

Q. Claytex has been in the industry for a number of years. What has been the most significant change that you have noticed over that time?
A. As restrictions on testing have been introduced across many series we find the engineers are driven to use simulation. Within the simulation field one of the biggest changes has been the desire to use one common model across the team within the design office, trackside tools and driver-in-the-loop systems.

Q. Autosport International is celebrating its 25th anniversary in January 2015, what has been the most significant anniversary for your business so far?
A. Claytex was founded in 1998, so 2013 was our 15 year anniversary. This milestone coincided with the expansion of the company and significant success in real-time modelling applications for motorsport.

Q. What are the main challenges that you currently face working in the motorsport industry?
A. Providing models, or at least the model elements, to enable our customers to model the increasingly complex systems on the cars with a constant demand to be able to add more detail to the models and still run them in real-time. .

Q. What is next from Claytex in 2015?
A. A continued evolution of our solutions for driver-in-the-loop simulators and the simulation of the powertrain. We will introduce a solution for modelling batteries to enhance solutions for simulating hybrid and electric vehicles.

Q. What is the most significant industry issue for your business at the moment?
A. Recruitment! Finding engineers, whether experienced or graduates, that understand modelling and simulation at a suitable level. We have open vacancies that we are trying to fill.

Q. What are your hopes for Autosport International 2015?
A. Further showcasing advances in the class leading solutions Claytex offer for simulation.

Q. What will change over the next 25 years?
A. Increase in powertrain complexity via hybridisation. Simulating systems' interaction with the mechanical side will increase understanding of phenomenons which affect system efficiency, performance and reliability.

Tickets are on sale for the Autosport International Engineering 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 passes cost from £120.

Paddock passes include general admission plus access to the 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, free 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**

Trade stands are available for the Autosport Engineering Show, held in association with *Racecar Engineering*. Don't miss out on your opportunity to exhibit in a trade-dedicated area for two days ahead of the main show. To exhibit, please log on to **www.autosportinternational.com/trade**, or contact Tony Tobias; **tony.tobias@haymarket.com**

experience designing cars to specifically meet the governing bodies' requirements, such as the FIA's budget capped regulations in F1 and the evolving of the HPD ARX sports car into a coupe.

Q. What can we look forward to seeing from Wirth Research in the coming years?
A. The next developments for Wirth Research really are continuing diversification to include areas of engineering outside of motorsport.

We have had amazing success in motorsport in the last decade plus, and our technology is uniquely able to solve problems in other industries other than motorsport and is really helping to move things forward in those industries.

Q. What is the most significant industry issue for your business and others in the sector at present?
A. A significant industry issue for companies both within and outside of motorsports is CSR (corporate social responsibility). Wirth Research specialises in using advances in virtual engineering technology, developed within the company, enabling simulated testing and vehicle development so reducing the need for costly and wasteful prototype manufacture.

Q. Many people in the industry talk about a lack of skilled talent and graduates in the industry, what are your thoughts?
A. Wirth Research chooses people who are obsessive, compulsive engineers, people who were born engineers who are fascinated by problem solving. It doesn't matter what the problem is, if it's motorsport or in the other diverse work that we're doing at the moment. Our staff are creative people who like working in a team. We have a very strong company philosophy here in terms of team work. It's a very non-political working environment. We don't encourage internal competition. We encourage everybody to support everyone else and focus their competitive instincts outside so we try as hard as we can to make a great working environment, give them the best tools that we possibly can and they're motivated by the success we have in all of our diverse projects. It's a great place to work.

Q. Tell us more about your time at Autosport International 2014
A. At Autosport International 2014, Nick Wirth was interviewed on the stage by Henry Hope-Frost and Pistonheads, and also for articles to appear in racing and technical publications such as Autosport, Tire Technology International, and Automotive Testing Technology International.

Our unique-looking stand generated attracted a good number of visitors and we were able to meet up with our existing and prospective clients and suppliers.

Q. Since you have been exhibiting at Autosport International, what has been your most significant achievement/outcome?
A. Wirth Research has been working on the new Honda Performance Development ARX-04b LMP2 Coupe, unveiled in Autosport earlier this year. Nick Wirth developed the Wirth Rule of Maximum Engineering Performance from his years of observing the developments and the success the company has had in all sorts of different programmes. Very simply stated, we've learnt that to develop the performance of a product substantially beyond that of which the manufacturer has provided requires the application of technology substantially more advanced than those used to design it. So essentially, we have got creative, clever, motivated engineers throughout the company but we have found that the really big steps in development come when you provide them with tools which are so advanced that allow them to see really detailed issues and what's going on in terms of why a product is performing in the way it is. When you give them tools which are more advanced than people have used to design it that really allows them to understand exactly what's happening in terms of the physics of a problem and then come to a solution far quicker.

The International Journal of Motorsport Technology
Racecar engineering

PIT CREW

Editor
Andrew Cotton
@RacecarEd

Deputy editor
Sam Collins
@RacecarEngineer

News editor
Mike Breslin

Design
Dave Oswald

Chief sub editor
Henry Giles

Technical consultant
Peter Wright

Contributors
George Bolt jr, Ricardo Divila, Gemma Hatton, Simon McBeath, Danny Nowlan, Mark Ortiz, Peter Wright

Photography
James Moy

Deputy managing director
Steve Ross
Tel +44 (0) 20 7349 3730
Email steve.ross@chelseamagazines.com

Head of business development
Tony Tobias **Tel** +44 (0) 20 7349 3743
Email tony.tobias@chelseamagazines.com

Advertisement manager Lauren Mills
Tel +44 (0) 20 7349 3740
Email lauren.mills@chelseamagazines.com

Advertisement sales executive
Stewart Mitchell **Tel** +44 (0) 20 7349 3745
Email stewart.mitchell@chelseamagazines.com

Marketing manager Will Delmont
Tel +44 (0) 20 7349 3710
Email will.delmont@chelseamagazines.com

Publisher Simon Temlett

Managing director Paul Dobson

Editorial
Racecar Engineering, Chelsea Magazine Company, Jubilee House, 2 Jubilee Place, London, SW3 3TQ
Tel +44 (0) 20 7349 3700

Advertising
Racecar Engineering, Chelsea Magazine Company, Jubilee House, 2 Jubilee Place, London, SW3 3TQ
Tel +44 (0) 20 7349 3700
Fax +44 (0) 20 7349 3701

Subscriptions
Subscriptions Department
800 Guillat Avenue, Kent Science Park
Sittingbourne, Kent ME9 8GU
Tel +44 (0) 1795 419837
Email racecar@servicehelpline.co.uk
http://racecar.subscribeonline.co.uk

Subscription rates
UK £66 (12 issues)
USA $162 (12 issues)
ROW £84 (12 issues)

News distribution
Seymour International Ltd, 2 East Poultry Avenue, London EC1A 9PT
Tel +44 (0) 20 7429 4000
Fax +44 (0) 20 7429 4001
Email info@seymour.co.uk

Printed by Wyndeham Heron
Printed in England

ISSN No 0961-1096
USPS No 007-969

recycle

www.racecar-engineering.com

An eye on the future

It has been three years since the ILMC morphed into the rather more valuable and recognisable World Endurance Championship, with races on three continents, and with manufacturer support from Audi, Toyota and Porsche. In 2015, Nissan will also join the fray in the LMP1-H category as the regulations continue to appeal, but although the news is thus far positive, the question remains; what will happen next?

This is the first year of new, more powerful hybrid regulations but now teams are getting the hang of them, the debate for the future is already underway. Should the cars carry less fuel, and place a heavy reliance on the hybrid system, which can therefore have increased performance? Currently they are limited to eight megajoules, and teams haven't yet reached that level of performance. Should they do so, they would pay a penalty around the rest of the season, so should that theory be examined also?

'There is quite a big difference between Le Mans and the other tracks because of this factor of 1.55,' says Porsche's technical director Alex Hitzinger of the Appendix B, a table that lays out the specifications of gasoline and diesel cars, in the various MJ categories, ranging from 0MJ for the privateers, to 2MJ, 4MJ, 6MJ and 8MJ for the manufacturer entries.

These classifications apply only to Le Mans, but at other race tracks, invariably shorter and with different characteristics, a factor has been applied to reduce the power available from the hybrid system to avoid spectacular speeds.

'You can do 8MJ in Le Mans, and with that system you would not be able to achieve the maximum energy allowed on the other tracks, so you would take a disadvantage,' continues Hitzinger. 'If you took the same system with 6MJ in Le Mans, this has more scope to achieve the full potential on the other WEC races. Depending on where you stand, this is the ideal compromise.' So, perhaps this 1.55 factor needs to be changed to reduce the penalty for a more powerful hybrid system. But what about other technologies, such as fuel cells, or five stroke engines?

'At the moment, we have the most advanced car, and I would push for more technology because that is our strength,' says Porsche's Wolfgang Hatz, Board member in charge of research and development. 'Generally I like the regulations, which give you an amount of energy and you have to pull out the maximum energy you can. Sometimes you could do with a bit more, and I would prefer that.

'Fuel cell technology is for me not at the moment the thing for a racecar. Regarding cars with hydrogen, for security and in an endurance race, to play with high pressure hydrogen would be too risky from a security point of view. We have two different regeneration systems on board, and we believe very much in these technologies and so to further encourage those technologies by regulation is the way that I would prefer.'

But for Audi the push should not be for new technologies. Rather, a close eye on the cost of development is a key factor.

'We have to find a good compromise between being more efficient again, and we have to be careful that we do not push the cost into areas where some do not agree are the right way to go,' says Audi's head of motorsport, Dr Wolfgang Ullrich. 'This is a very delicate thing to be combined, and that is what we work on. We have technical working groups working on that, a group that looks after costs, and what we can do to keep it at an acceptable level. To bring these together in the rule book is a tough task, but we all push for it.

'Reduction in minimum weight is something about which from the first moment you think 'yes', but weight is always efficiency. Now we are at the level where the cars, with the technology from the propulsion and the hybrid side, push you into very interesting work on lightweight which costs a lot of money. Maybe you cannot fully bring it into the road cars. Lightweight is very interesting for road cars, but at this level you take it to extremes. This is something that we really have to bear in mind. Is it worth having cars a little bit lighter and the costs going up, or should we find a different compromise?'

The limitation is the minimum weight, and that's not clever

For Toyota, the floor should be opened up completely. 'We are in a very good way so I think that we do not need big changes, just limitation of the weight and the hybrid systems,' says Toyota's team president, Yoshiaki Kinoshita. 'New technologies should be allowed. This is the reason for sports car racing. Manufacturers have to bring new technologies. If a manufacturer wants to bring 5-stroke engines, for example, I welcome them, although as an engineer, I don't think that it will work for racing.

'Regarding the weight, we have two opinions. My opinion is that we should increase the weight because we should have stronger hybrid directions and we need the weight. If the weight limitation is as now, we will use very expensive materials, very high costs, and that doesn't mean anything.

'We should raise the minimum weight to 900kg. Then we can use bigger hybrid systems without penalty cost or weight. If the minimum weight of the car is more, currently the limitation is the minimum weight and that is not a clever way.'

So, open up regulations to allow more technology, increase the weight to reduce costs, and increase efficiency. Perhaps the manufacturers are not so far apart after all.

ANDREW COTTON Editor


What's the
secret
about the new 911 GT3 Cup's
new brakes?
GT3
Cup
MICHELIN
Mobil 1
It's Quicker.™
PFC
PORSCHE
OFFICIAL PARTNER
PORSCHE
MOTORSPORT
PFC
BREMSE
www.pfcbrakes.com
*44(0) 1295 221 020