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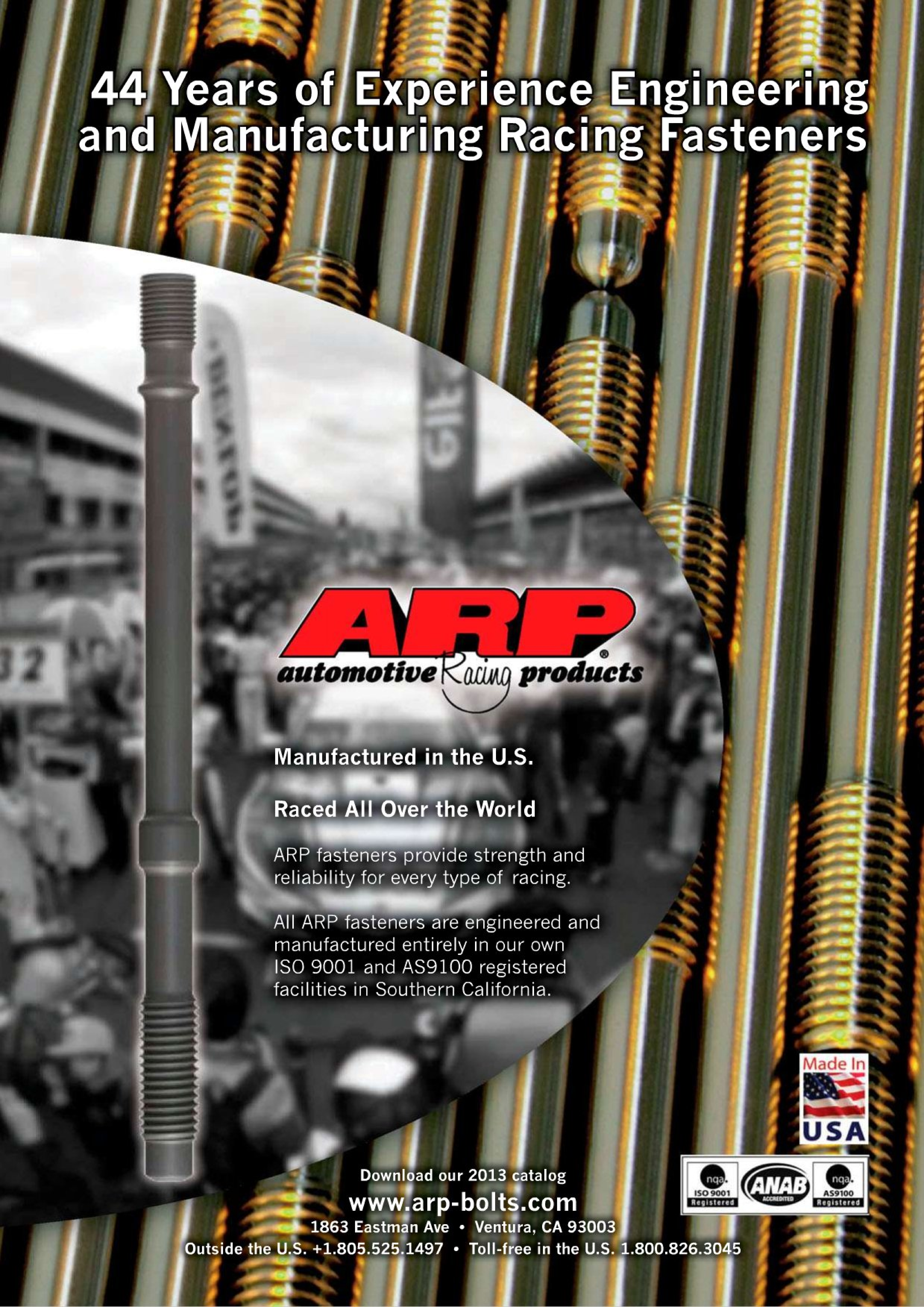
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Racing by remote

There's too much information in the pitlane, and not enough skill on track...

If I look at a racing track, the black stuff between the white lines is pretty similar to what has been there since the first closed circuit racing, eliding the dirt tracks and board tracks. Similarly, what the driver does on it has hardly changed, given the goal of running round in circles until time, or the given distance to do, runs out.

But the pits side has changed considerably. We don't see Alfred Neuberger's beloved signalling flags, and we have gone from the old days of a stopwatch (or clepsydra for the slow cars) and a pit board to the prat perch monitor wall of today, which totally obscures any view of the track in front of the labouring bods. You don't see anything if you also add the mesh fence or plate glass barrier, so what is the point of sitting out there?

At Le Mans I tend to spend time in the back room, looking at the telemetry monitors, doing simulations for the strategy and surveying the opposition's options, while an electronic pit board sliding out on a motorised rail gives the driver additional information you have keyed in to a computer at the control room, much as the bank of computers that is hidden behind the panels in an F1 pit.

So why be at the track at all? Do it from a distance, given the on-board cameras, radio, telemetry and full electronic sector timing that give you more information than just eyeballing it on a wet day at Snetterton.

Your car could be racing at a aesthetically boring track such as today's Hockenheim while you're on a sunny beach in the Bahamas with a couple of blondes applying suntan oil on your back and cosseting your palate with caviar and sour cream on blinis and bringing you some cool orange juice (or other beverages). Data is already being transmitted in F1 to the shaker rig at the factory to be tried out in real time, why not the rest?

Background music would be a soundtrack to the action on track, let's say The Ride of the Valkyries, when your car is gaining ground on the race leader, or Benny Hill's theme for certain drivers, while Mozart's Requièm Mass in D minor (K 626) could mope in when your car retires. The work wouldn't change much, but your level of personal enjoyment would be considerably higher.

Testing a Formula 3000 at Enna in the mid-80s was much like all this, sadly minus the blondes. The hotel was on the hill overlooking the pits, and lying by the pool with headphones and computer gave me a pleasant tan, while I could enjoy occasional dips to assuage the stifling heat and snacks from the bar. A good time was had by, well, principally me. The testing also went very well, despite being seen rather sniffily by the team.

Managing a car from a hotel balcony is possible, though the team may object

Going back a bit, Camus once wrote that everyone's life looks like it's in pieces from the inside for a whole variety of reasons – it's how you deal with your personal freak show that establishes who you are. And that includes how you notice things, what strikes you as strange and what you say about it.

Driving on the Dakar, I became very aware of the moustache tropic. There's a meandering line that stretches through Africa, the Balkans and Asia Minor, particularly visible as you travel south through Libya. Past it, everyone has moustaches, although when I say everyone I mostly (though by no means exclusively) mean the men.

As is often said, western civilisation sprang from Greece, and Greece from Sparta – or saved by Sparta – so maybe we can say we are what we are because of Lycurgus, who established the military-oriented reformation of Spartan society. His precepts, reputedly under the guidance of the Oracle of Apollo at Delphi, were directed towards the three Spartan virtues: equality (among citizens), military fitness, and austerity. But most importantly, he also banned moustaches. Things improved after that. Before, Sparta had oscillated between the extremes of democracy and tyranny: anarchy and dictatorship. More F1 parallels...

The ubiquity of moustaches in that region is clear reflection of cultural bias, which brings me to another bat flapping in my belfry, the proliferation of 'safe' tracks.

"Having the track surrounded by a moat filled with alligators would keep drivers honest"

Tracks are not 'dangerous', because every corner is safe at the right speed. If drivers don't feel safe at a given point on the racetrack, they can take their foot off the loud pedal and make it as safe as they wish.

Given the use of every inch of tarmac by drivers trying to increase the radius of their corner, seeing two wheels on the kerbs makes a mockery of track limits. Every year they would build up the worn grass with a tarmac patch, only to have the drivers use up the additional space. The rumble strips need a label: 'Drive on here'. Stirling Moss has spoken out on this, calling for brick walls to be built around the outside of today's tracks. 'To race a car through a turn at maximum speed is difficult,' he said, 'but to race a car at maximum speed through that same turn when there is a brick wall on one side and a precipice on the other – ah, that's an achievement.' He knows what he is speaking about, having often reflected on results from a hospital bed. 'Formula 1 has become a safe sport. It has no more risk than football – the new level of safety emasculates it. People say I advocate being killed. It's not advocating killing, but the freedom to drive with danger.'

I would agree, with the obvious caveat of not having the track lined with trees, lamp posts or hay bales, though I would stretch to a moat on both sides filled with alligators, shark or piranhas – that'd keep drivers honest. Few tracks are left as a major challenge that reward skill within limits. Not surprising the fulsome praise from drivers for Spa – even though Eau Rouge is a shadow of itself – Suzuka and Monaco with corners where not all will go at the same speed. They inspire awe and a sense of self preservation.

So I will be going to these tracks, but can quite contentedly run my cars remotely while evilly twirling my moustache (cue Scarpia singing Te Deum on the soundtrack).


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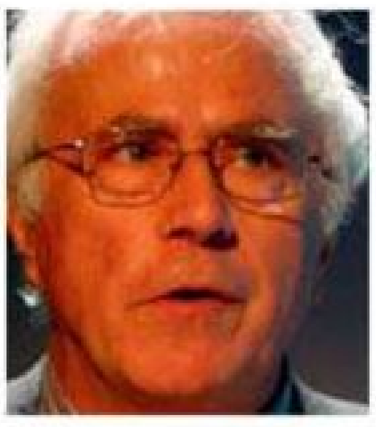


It's all in the timing

New regulations require new thinking – and the devil is in the detail

Never have the technical regulations influenced the sporting regulations as much as they will in both Formula 1 and WEC in 2014. At the heart of this new era is a concept first conceived by Keith Duckworth in the late-'70s, whereby the fuel flow rate to the engine (or energy flow rate if different fuels are used in the same competition) is limited. Duckworth envisaged a mechanical valve that limited the flow rate, and it was then up to the engine manufacturers to manage the consequences. Nearly 35 years later, as his vision comes to fruition, electronics have changed how it will be applied, altering the sporting contest.

Even in Roman times, when promoters realised that sporting contests had the potential to separate punters from their dinars if you could use the contest to entertain them, technology dominated the sport of gladiators, Christians and animals. The animals were armed with teeth and claws; the gladiators with armour, swords, nets and tridents. The Christians had nothing. However, if technology had allowed a Christian to whip out a Colt 45 from under his loincloth, the punters would have felt cheated, there would have been protests, enquiries, and an instant ban.

The fuel flow rate regulation, around which both these 2014 Formula 1 and WEC technology regulations are written, is a bit subtler, but the detail of how it is written is crucial to the contest the drivers and teams will be waging. The rule to control the fuel flow rate is written as:

Quantity of fuel/Unit of time

The number chosen for this parameter is a simple determinant of the maximum power and/or average power and hence engine performance. The unit of time chosen determines the relative roles of driver, team and engineer in the contest. If the unit of time is very short, the engineers simply have to use the permitted maximum fuel flow rate as efficiently as possible to generate as much power as possible – hence the turbo-cycle, low rpm engine configurations with all the waste energy recovery that is practical. The driver has to use maximum power as much of the time as possible to be fast. The team strategists will have little to do.

Measurement is simple, relatively

If the unit of time is long – say, the length of the race – then the engineers still have to do their jobs as before, but the driver now has to be as fast as possible spending as little time at maximum power as possible, and the team data analysis and simulation computers will be running red-hot to inform the driver how to drive and adjust the car/engine for greatest efficiency. And then there is everything in-between, including combinations of these two extremes.

The possible units of time that might come into play include:

Race time: Usually converted into total fuel used or tank size. In Formula 1; around two hours. For WEC; up to 24 hours. If used in isolation, some other limit must be put on maximum power to prevent the most powerful engines possible being developed for the sprint to the line.

Stint time between refuelling stops: Again as a tank size. Formula 1; not applicable. WEC; around 10-12 laps of Le Mans, depending on class. If used in isolation, some other limit must be put on maximum power.

Lap time: Allows drivers to store fuel during part of the lap to provide a boost for overtaking (not dissimilar to KERS), but again, if used in isolation some other limit must be put on maximum power.

Minute: Similar to lap time

Second: Any time less than 1 second effectively imposes a limit on maximum power. 1 sec equates to around 200 engine revolutions.

Revolution: Here we get out of the time domain, and use units based on the cycle of the engine (1 cycle/2 revolutions for a 4-stroke).

Cycle: This unit (2 revolutions) makes sense, as it averages all cylinders over one complete cycle.

Cylinder cycle: Not as simple as a complete cycle of the engine as individual cylinders may vary due to air intake conditions and require different fuelling.

Millisecond (or some other unit of time much smaller than any relevant engine cycle time): Once the unit of time is less than a cylinder cycle, a new problem occurs: DI engines, both gasoline and diesel, used multiple injection events during the intake stroke. These are used to control combustion and shape the combustion pressure rise. A rich mixture may also be used to initiate combustion, followed by a weaker one for economy once the flame is established. Limiting the fuel flow rate down to milliseconds or less may inhibit this area of combustion technology.

It is probably one of the many reasons the 2014 Formula 1 and WEC technical regulations are taking time to finalise. In fact, it is not necessary to state the exact time unit used in the regs, as the actual measurement and units used will be embedded in the engine controller/scrutineering data recorder (SDR) used to determine compliance. The chosen fuel flow rate sensor will pass its data to the SDR at some very high frequency, where it will be signal conditioned in a way that is relevant to the unit of time chosen to limit the fuel flow. The SDR will not control the fuel flow, as that would cause all sorts of disputes if the sanctioning body's device erroneously limited engine power during a race. Instead, the data will be passed to the engine ECU and the engine manufacturer's engineers and software experts will decide how to react to it. The flow rate will be recorded and the regulation maximum figure must never be exceeded. A simple principle that is surrounded by complex detail!

"If the unit of time is short, team strategists will have little to do"

The most satisfactory rule combination is a fuel flow rate limit for around one or two revolutions of the engine, allied to a race (F1) or refuelling-stint limit (WEC), which can be imposed via a maximum tank size.

One challenging issue, particularly if the unit of time is chosen as one or two revolutions equivalent to 5 or 10 msecs at the likely maximum RPM of 12,500 for a typical 2014 Formula 1 engine, is that the fuel flow rate sensor is going to be vibrated hard at some frequency linked to engine RPM, such as at a cycle time similar to or some multiple of the fuel flow rate averaging time. The favoured sensor is an ultrasonic sensor, which have no moving parts so should be relatively immune to vibrations, but this is a whole new area for this technology.

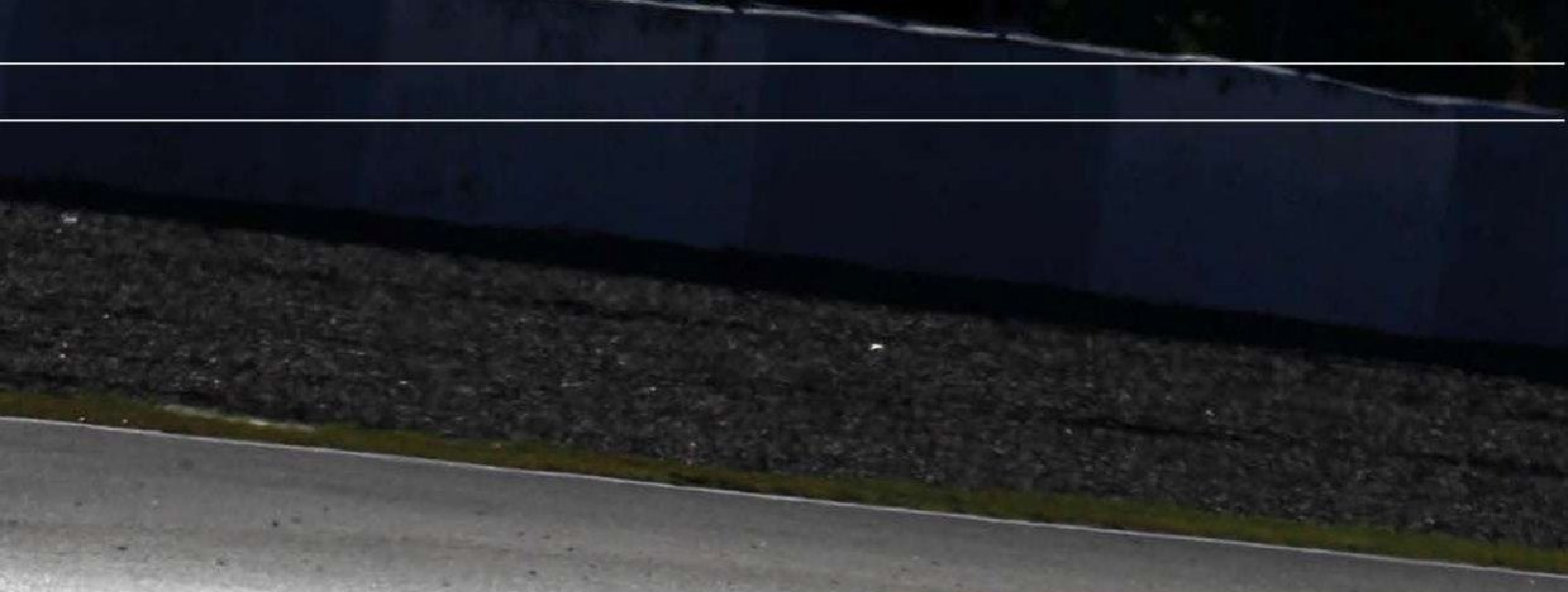
The drivers will resolve all this on the track, and it looks as if the regulations will favour the thinking man's driver rather than the absolute fastest.

The last of the V8s

With new regulations anticipated for 2014, not much has changed for the 2013 F1 season, but that doesn't mean that teams have been standing still

BY SAM COLLINS

On paper Formula 1, has not changed a great deal going into the 2013 season. The engines remain unaltered, with the specification essentially frozen since 2007. Chassis regulations are almost identical. Similarly, the aerodynamic requirements are the same. Indeed, the current aerodynamic and chassis rulebook has remained roughly the same since its introduction in 2009. For the 2013 season, teams could essentially have carried over their 2012 cars, although none have chosen to do so. So, teams are chasing ever smaller gains, and with the grid already tightly bunched on lap time, the smallest gain can be the difference between being on the podium or out of the points completely.



'The incremental gains are getting smaller and smaller so we had to have a new chassis,' said Force India's technical director Andy Green. 'We could not just sit on our laurels and roll out last year's chassis. While the gains are small we will need them. We optimised the layups as we are always looking to get weight out. For the 2013 tub, the weight has gone down and the stiffness has gone up. There are some new devices coming later in the season that will increase the weight though. The reworking of the chassis allowed us to optimise some of the suspension pickups. This was needed to give us the tools to do things with the tyres that we learned about last year.'

One of the things that has changed once again is the Pirelli tyres. The defining characteristic of Pirelli's new tyres is softer compounds all round, and the new hard tyre is roughly equivalent to last year's medium compound. The tyre sidewalls are softer this year, but the shoulders are stronger.

The effect of this is faster thermal degradation while the tyre's peak performance window is extended. The new structures have been designed with new materials that increase the footprint of the tyre, allowing more rubber to be in contact with the track and leading to better performance – particularly when it comes to combined traction and cornering. It also means that temperatures are more evenly distributed across the whole surface of the tyre, meaning that there is no localised heat build-up that can lead to blistering.

The new construction means that the weight of the tyres has increased slightly, but not enough to affect the performance of the cars. On average, each front tyre now weighs around 200g more than they did last year, while each rear tyre is 700g heavier, meaning that approximately two kilograms have been added to the overall weight of a set of tyres. However, the overall minimum weight of the car has been adjusted in the 2013 technical regulations to compensate for this.

"Conditions at Jerez were not ideal this year, as it was an extremely abrasive track. It was hard to draw any proper conclusions"

The performance gap between the different compounds is now meant to be in excess of 0.5 seconds per lap, as opposed to last year when the difference was often smaller, particularly in the latter half of the season. Faster thermal degradation and a bigger performance gap between the compounds should encourage overtaking throughout each race.

Due to restrictions on testing, the teams had not run the new tyres before they got to the first four day pre-season test at Jerez, though they had tried out the basic construction in free practice at the final race of the 2012 season.

'We got quite a lot of data about the tyres from Pirelli and we got to run the casings in Brazil,' said McLaren sporting director Sam Michael. 'We know what they do from a handling point of view. We have not run the compounds, although we know where they are going to shift to. We get all the book data from Pirelli, but running the tyres is the best data of all – you have your own car, your drivers and your own sensors. That's always better than book data, which is always a mixture of academic and theoretical data vs some rig tests that they have done.'

Even after the teams arrived at the Jerez test, they were not able to glean much information. 'Conditions at Jerez were not ideal this year, as it was an extremely abrasive track,' said Pirelli's F1 boss Paul Hembery. 'It's the most abrasive of all the circuits we visit all year and consequently it was hard to draw any proper conclusions. The surface had actually become even more abrasive than last season. We came away with plenty of data for the hard and medium tyres, very little for the soft tyre and none for the supersoft.'

The subsequent tests may well also not yield adequate data for the teams either, sending them into the first race, at Melbourne, Australia somewhat in the dark. 'In testing we had to artificially induce some things into the tyres, as winter testing will not teach us what we need to know,' Green admits.

Suspension design has been one of the areas where the teams have worked hard to be able to increase the car's ability to work with the tyres, with most on the grid reworking both the front and rear units. McLaren has interestingly followed Ferrari down the pull rod front suspension route. 'What convinced us to do this was a lot of research,' explains Tim Goss, director of engineering at McLaren. 'In F1 you cannot just copy someone else's concept – if you do it tends not to work. What you have to do is get a thorough understanding of why they have done it. We looked at it and after some time we found that it would benefit our car and what we wanted to do with our car. We found its benefits in terms of aerodynamics overcome the negatives in terms of kinematics and the structural negatives of doing a slightly more extreme anhedral suspension.'

Not everyone thinks that the switch to a pull rod front end is worthwhile, including Red Bull's Adrian Newey. 'The pushrod vs pull rod debate is a feature that has attracted attention because you can see it,' he says. 'I don't honestly think it is a big change from a vehicle dynamic or aerodynamic perspective.'

Meanwhile, many teams have been revising the rear suspension layouts, not only to improve the car's interaction with the tyres, but also to clean up the airflow around the rear of the car. Some teams are now fully enclosing the drive shaft. 'Enclosing it has a relatively small effect,' says Green, 'but lifting the wishbone up off the floor away from the diffuser area is a larger effect, in essence you are clearing the way for the air around the top of the floor.'

The stepped noses of 2012, which were brought about by regulations that stipulated a low nose to reduce the risk of injury in a side-impact, have been covered over with so-called 'vanity panels'. These carbon fibre panels help to smooth the airflow over the front of the car, but two teams - Sauber and Red Bull - have retained the vents, while some teams didn't bother with the panels at all. British company epm:technology supply carbon fibre panels to four Formula 1 teams, including Force India.

Nico Rosberg takes the 2013 Mercedes through its paces during testing at Jerez in February

Ever since the banning of double diffusers at the start of 2011, teams have been exploiting the exhaust flow to increase downforce on the car. Even after the effective ban of off-throttle blowing at the start of 2012, the exhaust designs still provide a significant amount of downforce.

'It still is a battleground as it is not a simple job,' explains Goss. 'One of the reasons our car performed last year is that we did a good job of understanding it. The understanding of aerodynamics and vehicle dynamics - the what and why - are really what underpins our performance. Understanding why things work is what allows you to get them to work. We have seen teams copy us and not make a dramatic leap in performance. It's not a simple case of putting one of these exhaust bodywork solutions on the car and expecting it to perform.'

Most teams on the grid have followed McLaren's lead on exhaust design, but Lotus and Red Bull have pursued an alternative layout featuring tunnels under the exhaust exit. Goss argues that this approach is not as good as McLaren's. 'We tried it back in 2011,' he said. 'There are some significant negatives to doing it in that it becomes very difficult to feed the central diffuser ramp and the starter hole, and sure enough we looked at the Red Bull solution. But we found greater benefits using the concept we launched last year, where you have quite an extreme undercut running through that area which is used to drive the diffuser and the starter hole. Fundamentally it's two different approaches to the same issue. The thing is you have to make sure that when the exhaust gases are not flowing, the rear end of the car is still behaving itself.'

One change to the regulations has led to a very visual difference between the 2012 and 2013 cars, the partial elimination of the ugly step on the noses of the cars. This appeared last season due to a minor regulation change which would see teams forced to lower the overall height of the car nose for safety reasons. Much was made of the aesthetically unappealing design solution developed by the majority of the grid. As the reaction to the look of the cars was so negative, the 2013 regulations allow fitment of a small piece of laminate known as a "vanity panel' to smooth the appearance of the nose section.

While most teams have opted to use the panel, Sauber and Red Bull use a partial panel and retain vented noses, while Lotus and Caterham have decided against the panel all together.

'We feel that we want to run the nose and chassis has high as possible, so we have done that and used the vanity panel,' says Green. 'Aerodynamically it is close to neutral, but it does tidy up the flow on the top of the chassis. But the improvement is very small. It is not an area of performance at all. It is not what is going on on top of the chassis, it's what's going on underneath that matters. There is a weight gain from using it, but it is offset by the aerodynamic gain. It really does not take much aerodynamic improvement to offset any weight penalty, especially when the car is underweight anyway, though the additional weight is high up and forward of the centre of gravity. It only weighs grams – it's just one ply of carbon fibre either side of a 3mm Nomex core. it has to be like that as it is not allowed to influence the impact test.'

A more significant, though less visual, change to the aerodynamic regulations surrounds the rear wing and the so called 'drag reduction system', or DRS. Last season drivers were able to use it anywhere on the track during practice and qualifying, but were limited to specific overtaking zones during the race. In 2013 however, new rules stipulate that DRS usage will be restricted in qualifying to the designated zones used during the races.

'As usual teams and drivers were pushing to the limit with DRS,' said Laurent Mekies, head of vehicle performance at Toro Rosso. 'There was a strong incentive to switch it on as soon as you came out of a corner, especially in qualifying, and – in some cases – actually going through the corner with the DRS on. Because it is a very on-off phenomenon with a high amplitude – we are not talking about just a few points of downforce, in fact it's a massive step – the mental commitment you need to tell yourself to go through a corner with the DRS on was becoming a bit of a dangerous game. This change will have an impact on the engineering and on the racing itself – there is small impact on the optimum aero level you will want at the track and also a small effect on the gearing you will want to run. In general, it could also affect the balance of power between the teams, because those teams that had the most effective DRS will lose a bit of their qualifying advantage.'

But for some they feel that this change makes the design of a rear wing somewhat easier as the benefit of a good DRS is reduced. 'DRS is easy in terms of setup, but it is tough in another way,' says Lotus technical director James Allison. 'Rear wings used to be about the easiest thing on the car aerodynamically to do.

Lotus technical director James Allison feels that the delicate balance coming from running at the edge of stall is lessened with the new DRS usage rule, which could allow more emphasis to be put on stability

"In F1, you cannot just copy someone else's concept – if you do, it tends not to work"

There has already been some controversy surrounding exhaust design. A flow conditioner in the exhaust channel of the Caterham CT03 is thought to be outside of the regulations with Lotus publicly questioning its legality. See www.racecar-engineering.com for more information

FRONT WINGS

In years gone by, it has become accepted practice to allow front wing systems to run up to 3mm lower than the regulations prescribed. Decades ago, when this trend was established, it was a nod to the difficulties of manufacturing and measuring to a precise tolerance. However, for many years it has been possible to be much more accurate in the production process, and so from 2013 the front wing height dimensions will need to be respected without any implied tolerance. This means that all teams will be forced to lift their front wing assemblies by up to 3mm, giving rise to a certain loss of front wing performance.

Flexible bodywork became a major talking point last season, with a number of teams believed to have excessive movement in their front wing design and subsequently gaining aerodynamic performance. As a result, a further deflection test has been introduced to ensure that the front wing assembly remains as rigid as possible as speed increases, thereby reducing the possibility of such advantages being made.

While continuing to limit the extent to which the tips of the front wing 'droop' under load, the new test will also ensure that the assembly is not capable of rotating the nose up or down around a lap.

Everyone had more or less the same rear wing, and it just wasn't an area of competitive advantage – you just had big ones for Monaco and small ones for Monza and inbetweeny ones for everywhere else. With DRS you have to have a wing that produces reliable downforce, but shifts a huge amount of drag when you switch it on. That means taking the wing much closer to the edge of stalling in normal operation than you would traditionally have done. The obvious dilemma is that skirting the edge of stall with a wing means that things like bugs hitting the leading edge of the wing, or a bit of rain, or just misjudging it a bit in the wind tunnel, means that your wing is not stable enough – that's where all the setup difficulty is with the rear wing. It's just getting the right compromise between stability and switch size. The changes to the DRS rules don't effect that – all it does is de-power the effect of DRS on lap time. So there is slightly less incentive to put a lot of effort into maximising the switch versus the stability, but there is still lap time there. It's a competitive pressure to make this knife-edge wing, which is difficult to do.'

Also banned this year is the so called "double-DRS". In 2012, some teams developed a concept which allowed air to be channelled through an opening in the rear wing endplate when DRS was activated, subsequently travelling through the car to help stall the front wing. Not only is it now forbidden for the rear wing end plates to transport air around the car, but a similar rule also applies to the centre section of the front wing. This will not, however, affect so-called passive DRS systems as trialled by Lotus last season.

DUCT SHOOT

'Passive DRS is not the right term really – it should be called a passive fluidic switch,' explains Michael. 'It is a device or ducting that remains the same all the time and causes a stall on the rear wing. I think fluidic switches have still got a place in F1, and I think we will see them developed in the coming years. But they are extremely sensitive, as the people who have tried to develop them have found out, and they are only second or third order gains. When you are talking about something that small, it's just that your resources are better off put somewhere else. In the theoretical world they work, but they are hugely sensitive in the real world and extremely hard to get right.'

Some teams are definitely evaluating systems for use in 2013, including Lotus, and many suspect also Red Bull. 'What people call passive DRS is the device that Lotus trialled last year, which will use some speed sensing device – whatever that may be – to augment or replace the DRS effect where DRS is not allowed,' said Newey. 'It is an interesting area, but a very tricky one to get a signal that is reliable and withstand things like following another car. It is not straightforward.'

The 2013 season will be all about the details. Every little gain will matter, and when some teams switch their focus to 2014 they will likely fall down the order rapidly.

Full technical analysis of the Formula 1 grid 2013 can be found at www.racecar-engineering.com. The website will be updated throughout the season with the latest news and developments, and interviews.

OTHER RULE CHANGES

Suspension members

A traditional Formula 1 suspension system has six members, namely the top wishbone front leg, top wishbone rear leg, lower wishbone front leg, lower wishbone rear leg, trackrod and push/pullrod. Although not previously exploited, it became clear during the 2012 season that it was possible to make a suspension system which satisfied the written rules, but which consisted of more than six members. The potential benefit of such a system would be that it could afford more aerodynamic surfaces to exploit. To forestall such a system, it has been agreed to amend the rules to limit all suspension systems to just six members.

Chassis testing

In the weeks building up to the first test, all Formula 1 chassis are subjected to a series of squeeze tests, where large forces are applied to the chassis to prove that it is strong enough to be used in anger. In the past, the first chassis under production was subjected to a special series of tests that were at 120 per cent of the level applied to each subsequent chassis. As this difference was agreed to be somewhat spurious, the rule has been changed for 2013 such that all chassis must now demonstrate satisfactory performance at the higher level of load given to the first chassis, thereby providing further assurances in terms of driver safety.

Force majeure

In previous seasons, the 'force majeure' allowance has provided teams with some leeway in terms of fuel levels remaining in a car should it stop on the track during qualifying. This element has been removed from the regulations for 2013, with rules now stating that any car which stops out on track must have enough fuel for the mandatory 1-litre minimum sample, plus an additional amount proportional to the amount of fuel that would have been used in returning to the pits, as determined by the FIA.

Qualifying

With the 2013 grid fielding an entry list of 22 cars – reduced from 24 last season – there will be six drivers eliminated at the end of both the Q1 and Q2 qualifying sessions, as opposed to the seven ruled out at each stage in 2012.

The 2013 runners

Evolution of last year's cars is the trend among manufacturers ahead of 2014's rule changes - but there's still room for some interesting developments

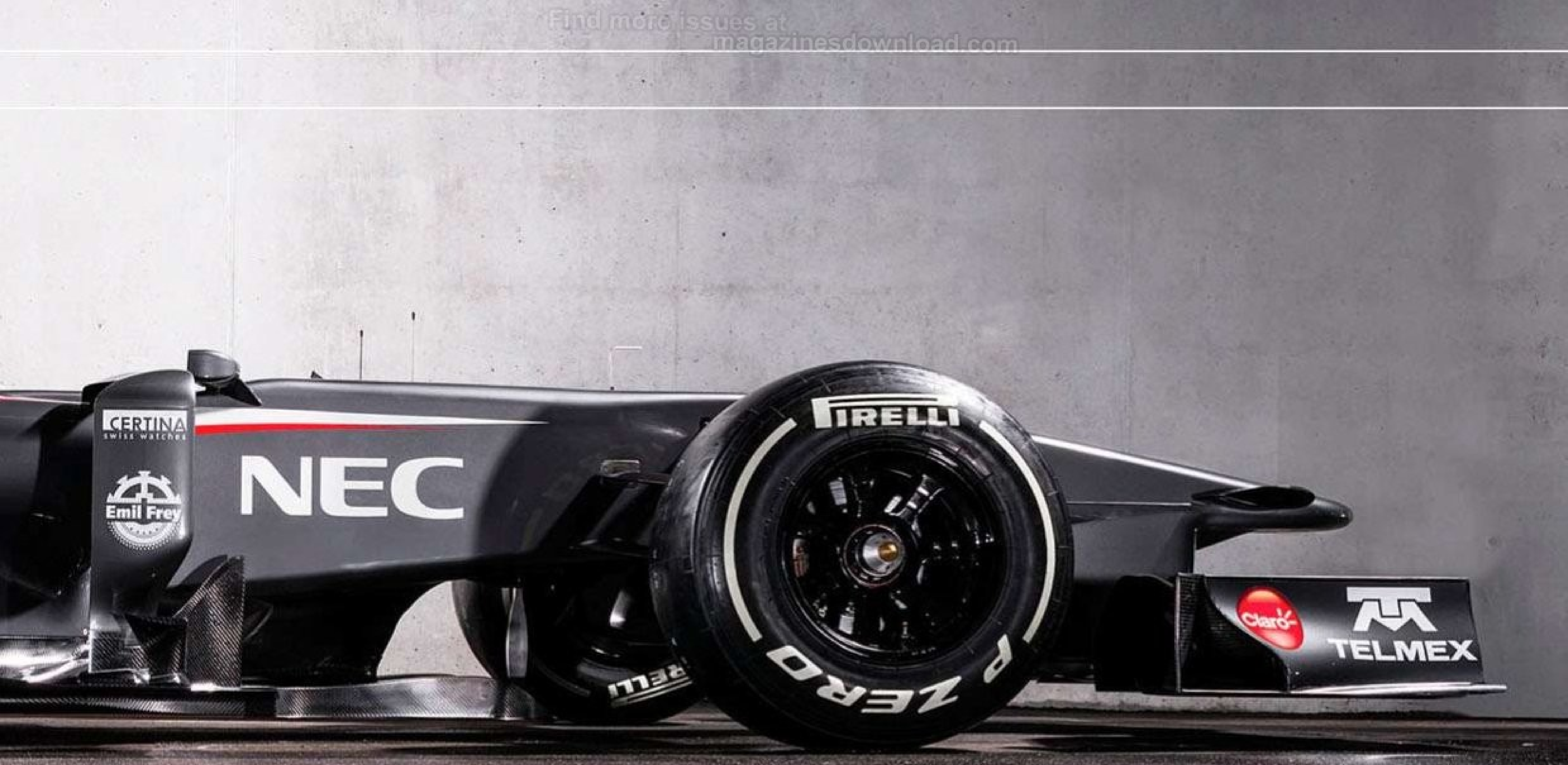
BY SAM COLLINS

RED BULL RB9

The RB9 is an evolutionary car according to Adrian Newey, retaining all the key elements of recent Red Bulls. 'The most work has probably gone into the middle of the car as that is the area that is most fixed for the season,' he says. 'Things like the front wing you can change as you go through the season relatively easily. The middle of the car - in which I include the gearbox and rear suspension - would be a huge effort to change during the season, so that is the area where most of the work goes in. You can change the rest as the year goes on.' The RB9 retains the exhaust concept of the RB8 but has switched to a Sauber-style vented nose.

MARUSSIA MR02

The MR02 represents a comprehensive evolution of the 2012 car, which proved to be the most successful package in Marussia's three formative years of competition, borne out by its progressive development during the latter half of last season. Certain elements of the new chassis have been subject to redesign to accommodate important new developments aimed at achieving a further performance step. In addition, the MR02 is the first complete car conceived using a design philosophy of CFD complementing wind tunnel. Although the 2012 in-season development was conducted in this way, the MR01 from conception to launch was all-CFD. The heart of the car bears the most significant area of redevelopment due to the requirement to accommodate the KERS installation, new to the package this season.
The MR02 retains a number of features from the MR01 such as the front and rear suspension, as much of the teams development work was focused on integrating KERS.



SAUBER C32 (above)

A year ago almost all the cars on the grid had one particular feature in common: a stepped nose. This design element caused an outcry among the fans, but was rendered nigh-on unavoidable by the regulations. For 2013, the FIA has now allowed a cosmetic fairing to be used in this area, while retaining the current chassis and structural nose height regulations. Sauber has used this fairing, but also retains its nose vent.

The sidepods of the C32 are notably slimmer than the Formula 1 norm up to now and are responsible for giving the new car a very distinctive look. 'The airflow in this area has a major influence over everything that happens at the rear of the car,' said chief designer Matt Morris, offering a glimpse into the team's thinking. The significantly reduced volume of the sidepods over conventional variants makes packaging a particular challenge.

An extremely slim rear end was high up the engineers' list of priorities. One of the key aspects here is the arrangement of the radiators, which is very different from that in the C31. A look at the rear end of the new car reveals the engineers' rigorous approach to this area.

The aerodynamicists have also invested a lot of time developing the details around the exhaust exits – an area which has a major impact on performance and in which the Sauber F1 team was one of the leading exponents last season. Interestingly, the car has migrated towards the McLaren-style solution rather than its own route, now followed by Red Bull and Lotus.

The rear axle is a totally new development. Although it still works according to the pullrod principle, its layout has been designed to better interact with the airflow around the rear of the car, while further improving the tyre management.

Another high priority was reducing the car's overall component weight, to allow a better distribution of the ballast, while retaining its structural requirements and mechanical setup flexibility.

'We have set ourselves lofty goals with the Sauber C32-Ferrari, and I'm confident that we'll be able to meet them,' said Morris. 'The C31 gave us a very good basis, to which we've made further improvements. Our aim is to line up for 2013 with a car that is competitive from the first race, but which also offers extensive potential for further development.'

LOTUS E21

Lotus was the first team to show off its 2013 design, albeit in digital form via a launch on YouTube. At the launch, technical director James Allison said 'The E20 proved itself to be an effective racing car – particularly towards the end of last season – so there is an element of expectation from the E21 and plenty to build upon. We have continued with our design themes and tried to create a more efficient and faster racing car based on all the lessons we learned last year. How successful we have been in this task will only be discovered when we take to the track at the winter tests and – more significantly – at grands prix. Depending on where you look, some parts of the new car are a ground up redesign and in other areas we have further optimised the best bits of the design philosophy we've adopted for several seasons. The front and rear suspension layouts are substantially revised to try and give us better aerodynamic opportunities. The front wing is a continuation of the concepts we have worked on since the 2009 rules were published. For the rear wing system, we've continued to try to work on having a satisfactory level of rear downforce stability while having maximum DRS switching potential.'

There are a number of areas of the car which show off the current design trends in F1, and it retains a humped nose despite the rule change allowing teams to fit a vanity cover.

FERRARI F138 (above)

The F138 is the 59th car built by Ferrari specifically to take part in the Formula 1 World Championship. The name comes from a combination of the current year and the number of cylinders, to mark the fact that this is the eighth and final year of competition for the V8 engine configuration. It is the first car designed by Simone Resta. 'There were very few changes to the regulations, but nevertheless we chose to work on and modify all aspects of the car, trying to move forward in every area, because we felt there was a significant amount of performance that could be gained with this new car,' he says. 'I would say the biggest changes relate to the front suspension, which has an improved layout, while at the rear, the suspension is completely new. We also have a revised sidepod design, aimed at improving the aerodynamics in this area, as well as a completely new layout for the exhaust system.'

FORCE INDIA VJM06

'It's a brand new car from the ground up – everything is new,' explains Force India technical director Andrew Green of the VJM06. 'We discussed carrying over big chunks of last year's car, including the chassis, but decided not to. There were still some gains to be had with the chassis, so we elected to take the performance benefits. However, the car is evolution rather than revolution compared with last year, simply because of the nature of the regulations. 'There are quite a few large changes under the skin. Because we focused a lot on the tyres last year, we've given ourselves a few more options on setup to help manage them from qualifying to the race. So that's something we will focus on going into winter testing – we'll be looking at those options and trying to understand them. It's going to be a challenge assessing these during the cold winter tests, but those options will give the engineers more weapons in their armoury.'

CATERHAM CT03

The Caterham CT03 is a mild evolution of the CT01, according to technical director Mark Smith. 'The season ahead presented us with an interesting challenge early in the design process as it is the last year of the current regulations before the introduction of the new engine rules in 2014,' he said. 'With that in mind we decided that CT03 would be an evolution of CT01 rather than a complete redesign, allowing us to focus our resources on developing areas of last year's package where opportunities would give us the greatest return, while also beginning work on the 2014 package.' Caterham's preparations, however, have been disrupted after the FIA deemed their exhaust design – along with that on the new Williams – to breach the rules.

WILLIAMS FW35

The Williams FW35 is an evolution of the 2012 FW34, though according to the team more than 80 per cent of the FW35 is new. It has a new gearbox, new rear suspension, new radiators, a new floor, new exhausts, new bodywork, a new nose and a significant amount of weight has been saved as well. With many new parts on the car, the team has carried out a lot of reliability work over the winter. The gearbox alone has already completed 3200kms on the dyno, a lot of which was conducted in the form of five straight simulated grand prix weekends.

The exhaust solution on the Williams, like that of the Caterham, has attracted controversy, with the FIA far from convinced of its legality. 'The Coanda effect is going to be a big thing for us,' says technical director Mike Coughlan. 'There's been no rule clarification concerning this area of the car, so we'll work closely with Renault to maximise the available gains. Use of the DRS is more restricted this year, so we'll take some resource away from that and focus on other areas.'

TORO ROSSO STR8 (below)

'In pre-season testing last year, we were able to get a first look at the strengths and limitations of the STR7,' explains designer Luca Furbatto. 'It was clear from the start that we had some issues with the weight distribution of the car and we were not able to effectively cover the entire weight distribution range, as controlled by the FIA regulations. This therefore became a point we wanted to rectify with the STR8. A further key point was that I wanted to create a platform for aerodynamic development of the car. The rear end of the STR7 was effectively derived from the STR6, and I felt the rear could be made much slimmer and more compact and that was another area we focussed on in designing STR8.'

MERCEDES W04

The Mercedes W04 is an evolution of the 2012 car, and is likely to feature a rear wing stalling device. Preparations were hampered when the car suffered from a fire and a brake failure that disrupted its first test.

'We had a transition of the management of the aero group last year, and the task was to produce a strong, predictable car,' explains Ross Brawn. 'They've been looking at a number of concepts and this car has taken a good step forward in terms of aerodynamic performance and that is all that matters. We are comfortable with the design solutions that we have come up with. Aerodynamic performance is always very significant and if you improve there – if you improve the efficiency – then you have a better chance to do well. I think we have a much better understanding now about the exhaust and the suspension – all these things that have a huge impact on the performance.'

McLAREN MP4-28

The 2013 McLaren MP4-28 is a fairly major departure from the 2012 car, as the team hopes to take a major step forward. The new car features 16,000 components. 'We have pushed all the areas you can with a car that will have no carry over into next year, when everything will go into the bin,' says McLaren's Sam Michael. The new model features pullrod front suspension and a much higher chassis compared to the 2012 car, a major departure for the Woking team.

Let it flow

The future of Formula 1 and World Endurance Championship performance management lies in the accuracy of the fuel flow sensor

BY ANDREW COTTON

The regulations for Formula 1 and the World Endurance Championship are all but finalised, and one major piece of the jigsaw that has yet to be confirmed is the identity of the supplier for the fuel flow sensor that is at the heart of both.

The FIA has refused to rush ahead with a decision as suppliers vie to provide the incredible accuracy that is needed to measure performance in two of the premier world championship events. It is critical to get it right, not only because of the competition today, but because the sensor could become a performance equaliser throughout motorsport, should the sensors become more affordable.

'For high level competition with a small amount of sensors, we can produce the sensors, make a selection, double check them in order to be sure that they are OK, and deliver them,' says Fabrice Lom, head of powertrain at the FIA. 'It is controlled, but this process is expensive. If you go to lower level of competition, Formula 3, for example, you will have 100 cars around the world, managed by the ASNs, not by the FIA. It won't be possible to apply the same selection of sensors and to ensure all the checks are done. Moreover, it is a lower cost formula and they can't afford the price of this selection and checks in addition to the price of the sensor itself, which won't be cost-effective, at least for the first years.

'I therefore don't think we are close to putting them on the lower categories, but it is an aim. With the air restrictor, as air flow is limited, to get the performance you try to burn more fuel into the engine, so it is not pushing you towards more efficient engines. To use a fuel flow meter to limit performance pushes you to improve efficiency, and that is a target of the FIA.'

Although the decision has yet to be taken on the supplier for the sensor in both Formula 1 and sports car racing, British company Gill Sensors has invested heavily in the development of an ultrasonic sensor that fits all the necessary criteria. Bar one. '[With the WEC] there are two fuels involved, the Shell E10, and the LM24 diesel, predominantly for Audi,' says Gill's lead consultant engineer, Neville Meech. 'The other fuel that will be used is essentially the F1 variants which will come from different manufacturers, but are blended to a minimum 5.75 per cent ethanol content. Our technology has been developed to provide error figures not greater than plus or minus 0.25 per cent, and we have used E10 as the reference fuel. In all the gasoline-based fuels that we have used, from straight pump fuel to E10, biobutanol and many

iso-based single molecule fuels that have equivalent density and performance specification as a performance fuel but are safer to use in a laboratory, we have demonstrated to the FIA that we have achieved their accuracy figures, and have exceeded that in many areas, averaging to a maximum error of 0.15 per cent in many cases.

'The performance in diesel, however, is still being finalised. We have not yet made the same performance value and we are currently working on improving that part of the process. The ultrasonic attenuation through diesel is more complex due to the density and viscosity of the medium. It is therefore much more difficult to get a good clean ultrasound signal through the liquid, unlike gasoline fuels. We are currently focused on a software development programme to filter out the "noise" effects that this causes, with very positive results to date.

'One of the biggest challenges is that you are making an accurate measurement over a wide range of temperature. In F1, the fuel temperature could be anything from 10 degrees to 60 degrees centigrade, and you need to be sure for any given flow rate, you can ensure the same flow rate parameter, and the density of the fuel and viscosity of the fuel will change with temperature. Much of our work over the last 12 months has been to develop the algorithms in the sensor to compensate for those changes in temperature. That has been quite a challenge in the petroleum fuels, and a much bigger challenge in diesel because of the components that are in the diesel, and the ultrasound pulse through the medium.

'Pressure drop has been another one that we have worked hard on to achieve the accuracy and minimal pressure drop, which meant some clever mechanical design work and a lot of CFD modelling to model the fluid dynamics in conjunction with the ultrasound properties. Of course it is very difficult to find fluid dynamic information. None of the fuel manufacturers routinely tests its fuel for how it performs ultrasonically, so we have had to pioneer all that work in all these different fuels. Then you have to match that to a set of mechanical parameters with minimal pressure drop, and a good turbulent flow path. You don't want the fuel to go through the sensor in a laminate format – you want turbulence as it is much easier and more reliable if it is in a turbulent state as it passes through the sensor. The last part of the puzzle is that all the materials that you use in the design and manufacture are compatible with all these different fuels.'

Gill's ultrasonic fuel flow sensor has tested at Le Mans with the Starworks team, though didn't race

Gill's sensor measures just 164.4mm x 67.5mm x 36mm and weighs 325g (11.46oz)

Working with Stäubli, a custom dry break system has been developed for the WEC cars, which will run the sensors outside the fuel cell. In Formula 1, the sensors will be submerged in the fuel cell.

However, Audi has complained that the size of the sensor compromises the work already undertaken in the monocoque of its 2014 car. It is not that the sensor is too big, more that three are stipulated by the regulations. With three sensors, and three connectors, the size of the overall package is significant, says Audi.

Taking into account the parameters that packaging up to three sensors creates initially seemed a straightforward application, but has ended with both a new and adapted solution for Stäubli's motorsports series of connectors. The solutions will give the teams a reliable, safe, ergonomic and efficient solution when installing or removing the flow sensors.

'We have achieved all the requirements, that the sensor has to be within the weight restriction for the FIA, all the pressure ratings that are necessary, and we have moved from an analogue and CAN-based system to a purely CAN-based system for FIA,' says Meech. 'It has gone from development sensors to twin connectors, to a single connector. Deutsch have worked to produce a specific connector that can be fully submersible for us for this project – the first time that that has been done in this format – with the understanding that F1 is going to adopt this technology.'

The approved system is requested to be able to achieve a repeatable accuracy of plus or minus 0.25 per cent, the most accurate ever seen in the sport, regardless of whether the engine runs on diesel or gasoline, or the different fuels used by the various manufacturers in Formula 1.

'Regulations are on one hand based on consumption per lap, or for the race in Formula 1,' says Lom. 'This could have been done after the race, by measuring how much goes in at the start and how much is left at the end, and in LMP1 by how much is filled into the tank at each stop, but this is complicated and not very accurate. On the other hand regulations are based on instantaneous flow, constant maximum flow in LMP1, and a maximum flow function of revs in Formula 1. This is why inboard equipment able to measure flow live is needed.

'One of the big issues is that in LMP1 we have one competitor with petrol, and one has diesel – it's complicated to make it repetitive and accurate between them. The second thing is the different fuels in Formula 1. In F1, every engine manufacturer has its own fuel.'

So accurate and sensitive is Gill's system, it's possible to use the recorded fuel flow data to detect injector pulses, which could give an indication of the start of a misfire.

'You have a fuel inlet port, and an outlet port,' says Meech. 'The fuel is then diverted inside the housing, and channelled through a flow tube which sits in the flow body. The flow tube itself has a smaller aperture that runs through the centre of the tube. At either end you have ultrasonic transducers, which send an ultrasound signal down the centre of the flow tube bore. They are positioned in the fuel flow line, so have to be compatible with the fuel and the pressure. The sensor is designed to be located in the low-pressure side of the fuel system at approximately 6 bar.

'As fuel passes through the sensor, one transducer sends an ultrasound signal through to the opposing transducer, and because we know the physical distance between the opposing faces of the transducers, we can determine the time of flight. We record that time, and then we switch off that transducer and send a pulse from the receiving transducer in return. We do this 2000 times per second. Once we have both those readings, we take one from the other, and knowing the distance and the density of the fuel we can carefully calculate the flow rate, and therefore the mass flow rate. That is the basic principal of the system. It is simple, but there is a lot of maths that goes on in there.

'We can use the speed of sound in a number of other ways. As a result of having that number, we can use it technically to do a fuel fingerprint. Because we know what the speed should be, if that number falls outside that boundary, we can then say that maybe the team is not using the fuel it is supposed to be.'

Security is something that the team at Gill has taken seriously, commissioning former Formula 1 engine manufacturers to conduct cheat tests, and trying to identify the problems ahead of introduction into the car.

'Together with our partners Hyspeed, we have commissioned two independent cheating studies, and approached former F1 engine builders who have compiled reports and we have presented them to the FIA,' says Meech. 'The FIA is focused on fairness and ensuring whatever system is finally adopted is considered fair to all the competitors and end users irrespective of fuel type.'

"Fuel flow data can detect injector pulses, which could give an indication of the start of a misfire"

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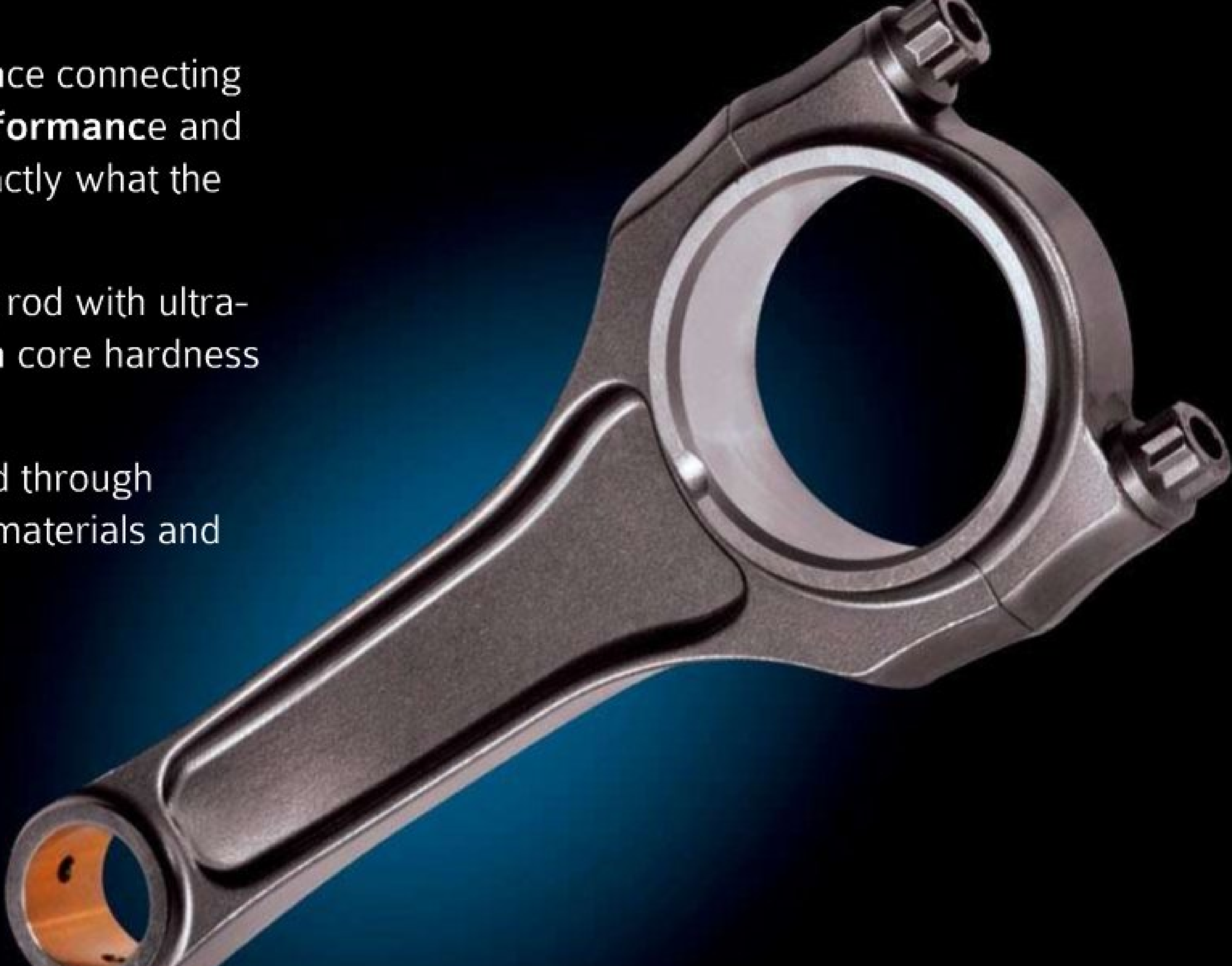

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2014: A seismic change

Torn between the new season and the enormous preparation needed for next year's regulations, F1 teams have had some tough decisions to make

There was one thing that all the Formula 1 technical directors agreed on – the hardest thing about the 2013 season is the 2014 season. 'The biggest challenge with this car was that through most of its gestation, there was a pretty hard fight going on for the championship,' explains Lotus F1 Team's technical director James Allison. 'On top of that, a big chunk of the factory was also looking at the 2014 car, so looking after three cars simultaneously was tough. You run out of people.'

Formula 1 teams comply with the Resource Restriction Agreement (RRA) which limits the annual spend of teams, as well as how they utilise their resources in a given year. This restriction bites especially deep when it comes to developing cars for 2014, when a new powertrain formula is introduced along with revised aerodynamic regulations.

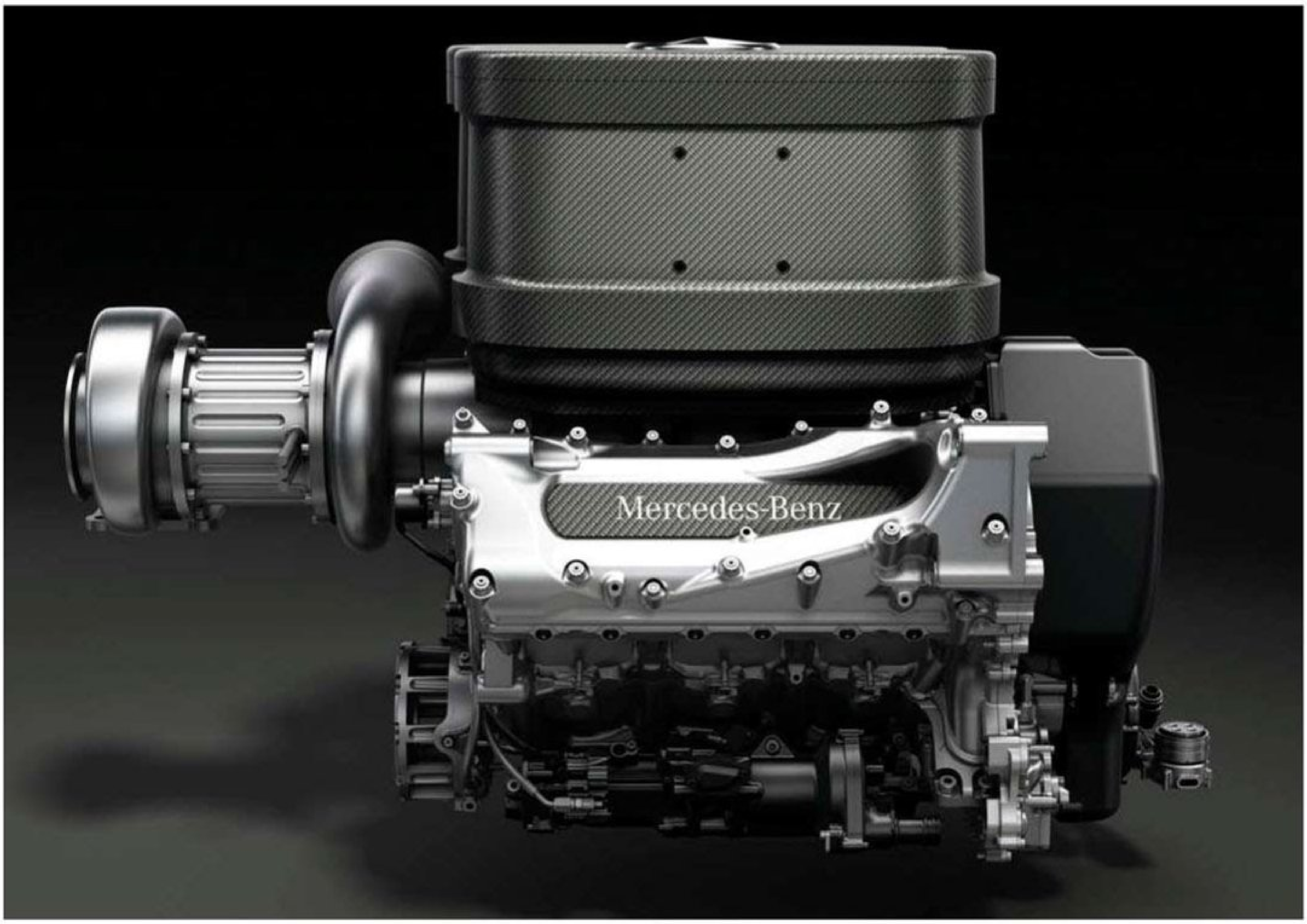
'The main difficulty with 2014 is how much resource you have got,' continued Allison. 'You know you have to take a certain number of people out of this car and devote them to next year's car, otherwise next year's car won't be competitive. Investment into next year's car has a longer shelf life than this year. Once you have taken out the key people, you then have to do the bravest, most aggressive car you can in 2013 with the people you have left.'

The top teams already have significant resources already dedicated to the 2014 cars, Ferrari has brought Rory Byrne out of retirement to develop its design, while Geoff Willis is heading up the efforts at Mercedes. One of the issues that they are already facing is that the goalposts are not quite set.

'The aero package is a slightly watered-down version of what we have now,' says Allison. 'One of the things the sport consciously had to do was not to bite off more than it could chew. With the engine, chassis, gearbox, cooling integration and all that goes with it, that's mammoth enough without having to reinvent the aero package as well.

'There will be opportunity. I suspect things like the front wing and the diffuser will follow similar paths to recent years, and the hunting ground will be how you cope with the low nose chassis and how you integrate what is a very fierce cooling requirement into the chassis without haemorrhaging downforce. There is a very wide field aerodynamically to play on, but the rules are very similar to now, though some things are still under discussion.'

The aerodynamic regulations may be similar, but the changes to the powertrain are likely to have a knock-on effect on how the design trade-offs are handled aerodynamically. With a fuel flow



Formula 1 teams are under pressure to divert resources from their 2013 cars to 2014 models, which will feature 1.6 litre V6 engines

Renault was the first to release information on its 2014 engine. Development continues apace

limit in place there will be a real restriction on how much drag is acceptable. 'There are lots of things that cause you to burn fuel, and lots of things that give you lap time and when you design the cars for any year you are trying to find the optimum combination of all of those things to make the fastest race time coupled with the best qualifying lap,' continues Allison. 'It is certainly the case that you will have a different response next year to this year in terms of how dirty – in terms of drag – a downforce device you can use. But that does not mean that you will see the cars just scissoring downforce off it compared to what you are used to.'

That will not be the toughest trade-off for the teams. Just managing the access to the tools required is a major issue, with the RRA covering CFD and wind tunnel testing, while the FIA's sporting regulations restrict straight line testing and full scale tunnel runs. Indeed, according to some in the paddock, there will be teams who do not do any development on the 2013 car in order to concentrate on 2014.

'We are behind on 2014,' admits Force India technical director Andy Green. 'We have to keep an eye on the gains we are making in the tunnel with this year's car and where we are with next year's. It's a big trade-off, and the question is, when do you turn off development with this year's car and focus purely on 2014? The development curve for next year's car is very steep, and with this year's car the gains are marginal. It's a big compromise. It may be there's a gain to be had this year at the expense of next year, but there will be three teams fighting for a championship who are going to find it very difficult to turn off 2013 development. But as you go further back, the decision gets a lot easier. I'm sure there are some teams behind us who are thinking "why bother with 2013 at all – let's focus on 2014 now and get the advantage."'

Adding to the trade-off for midfield teams is the fight for prize money. The difference between constructors championship positions at the end of the year can be huge in financial terms. With the field being as close as it is, the teams that switch off 2013 development could pay a huge financial penalty at the end of the year, but could make hay when the new season starts.

'The biggest issue is the restriction on aerodynamic testing,' says Green. 'Next year's car is going to be all about aerodynamic development and what you can get out of it in the time you've got. Whatever you have on next year's car you have to take off this year's car – you can't have both. I think some teams at the back will just present the 2013 car and move all of their resources to 2014. At the front it'll be much harder to do that, and we are in the middle so we could lose out doubly.'

"The development curve for next year is very steep, and with this year's car the gains are marginal"

Some of the larger teams, like McLaren, started 2014 wind tunnel testing back in 2012 to be able to spread the burden, but as the designs get closer to reality, the demand on resources increases. 'Tunnel time and design time are pretty difficult to balance with the 2014 car, the tunnel is a first order thing,' explains Sam Michael, McLaren's sporting director. 'We are using both our own tunnel in working and TMG in Cologne. We have three models. But for 2014 you are in such broad brush changes and you are looking for big gains, and that means the correlation between the models does not have to be too tight. But as you get more advanced you need to focus on one. The change in the front wing design and the loss of the rear wing lower element are both first order for principal flow mechanisms around the car. That means you have to start again in defining what you want from flow structures.'

Some in the paddock have suggested that the new powertrains will cause substantial reliability issues with the new cars, but most technical directors are playing that down.

'From a reliability point of view we can be ready for the start of the season,' says Allison. 'Dynos are quite good at telling you if the engine is reliable, and they are quite good at making gearboxes reliable – and that's the majority of the drivetrain. So really the only open point is whether you are going to produce a car that has enough cooling, which is a fair challenge in 2014, but wind tunnels are not bad either. Most of the things that allow us to put the car on the ground and expect it to work are there, so testing will be about unloving some performance.'

But it is certain that the field of play in Formula 1 is about to change substantially and the order of teams could change with it. Allison believes that there may be one team that will become dominant. He hopes that it will be his, but only time will tell. 'When there is that much new stuff on the car and no rule on where you bung it, people will have different ideas about what the right way to put it in,' he says. 'As sure as eggs are eggs, someone will have the best idea and it will be substantially different to everyone else. Its going to be scary and exciting at the first test next year, the 2009 changes were a ripple compared to the tsunami of 2014.'

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The waiting game

Toyota has launched its 2013 TS030, but its sights are set firmly on 2014

Toyota's 2013 Le Mans car is so similar to the 2012 machine that there is no new model designation, despite a new tub, a more central seating position for the driver to improve visibility, and a new aero package that is aimed at reducing the sensitivity of the car to changing conditions.

Despite winning three races in 2012, Toyota has changed its overall philosophy towards the new car, making it more serviceable and built more for endurance than for speed. A regulation change – increasing the minimum limit by 15kg to 915kg this year – has helped as components have been beefed up. Meanwhile, accessibility to the suspension, and to vital organs of the car such as the alternator, have been improved.

BY ANDREW COTTON

'In Bahrain, we had a light fail, and had to change almost the complete side bodywork for that,' said John Litjens, chassis project leader. 'The alternator we couldn't change the position, but we can change the access to it and also the suspension, to make it quicker and easier to change as we try to reduce the damage to the monocoque in case of a barrier impact. At Le Mans, Audi had some accidents, changed the suspension and went back out again. We couldn't do that last year, but I hope we can this year. That was partly the philosophy for last year, and for sure that is the experience that you gather. There were still quite some Formula 1 philosophies in the first tub.'

With the new tub, weight distribution has been a major factor, but the team has not opted to go with a carbon gearbox, similar to that used by Audi in 2012, despite the need to shift the weight as far forward as possible. 'In general, the balance is changed with the aero package,' says Litjens. 'You go as far forward as you can, but you have to be careful where you put the extra weight, and try to limit the damage of the extra 15kg.'

The rear suspension kinematics have also changed, although there is no all-new system. This was to improve driveability following feedback from the drivers, while the hybrid system has also been tuned to provide a smooth delivery of power. At the rear, the roll-out car of 2013 featured the Le Mans bodywork of 2012, complete with the narrow rear wing and without the huge rear wheel arches that debuted at Silverstone last year. However, the 2013 car will race with the wheel arches, and the team believes that it has made enough of an aero gain that it can run these flared arches at Le Mans. 'We were working on the details of the aero to make sure this doesn't affect the drag so much,' said Litjens. 'It looks as though we will bring it.' A high-downforce package will be introduced, but Litjens says that it will not be as significant as in the latter half of 2012.

One of the most noticeable differences between the 2012 racecar and the 2013 version is the nose, which is more similar to that rolled out at the start

of 2012. The tub used last year was designed to evaluate both front and rear hybrid systems, and the team raced with the compromised chassis. Now that it has settled on a rear-only solution, the tub has changed to reflect that, leading to a new, tightly controlled aero package. The new nose is lower, and the change means that the team will have to re-crash test the tub ahead of its first race.

'The major changes are invisible to the spectators,' said project leader Pascal Vasselon. 'The concept of the splitter, and what is facing the ground, is different. Last year was quite interesting. We lost more than we expected in the two scoops in the wishbone fairings. We went from the roll out-car with a conventional splitter to the racecar with an F1-like front end, and now we are more conventional again. We will upgrade the rear, and that will come later. At the moment we are still running last year's Le Mans aero. We are not targeting only efficiency, but we have targeted a more consistent front-end so that it is not so sensitive.'

"The major changes are invisible to spectators – the splitter and what is facing the ground is different"

The team will introduce the new car in race conditions at Spa in May, preferring the 2012 car at Silverstone, but the team still expects to challenge for the World Championship title. 'We can be favourite for six hours because we have done that, but at Le Mans we are still the challengers.'

On speed alone, the TS030 had an advantage over Audi's R18 over the shorter distances, but needed to open out a lead of around 50 seconds over the race distance to accommodate an extra fuel stop, despite carrying a larger fuel tank than the diesel hybrid (73 litres for a petrol hybrid compared to 58 litres for diesel). One of the regulation changes for 2013 is that the fuel stops will take longer, thanks to a reduced size of refuelling restrictor (25mm compared to 33mm for non-hybrid petrol cars, which also receive an extra 5 litres in fuel), again an offer to close the gap for the privateers. However, that could have far-reaching consequences for Toyota. Instead of having to open out a 50 second gap, it could have to open between 10 and 15 seconds more if the TS030 has to accommodate an extra fuel stop.

At Silverstone in 2012, the TS030 had to complete two extra fuel stops, but that was due to poor management of the fuel maps available, says Vasselon. 'It is a question mark for this year,' he said, although he admits that nothing is expected to happen this year. 'It is easier to restrict the size of Audi's fuel tank than to inflate ours, but at some point if we want to be balanced, why would we accept that we have to do one more pit stop?'

While cosmetic changes are minimal, Toyota's new philosophy for the 2013 car has placed more emphasis on endurance than speed

The new nose is lower than last year's model, meaning that Toyota will have to conduct new crash testing on the tub ahead of the first race in May

The TS030 was launched with the 2012 Le Mans bodywork. The team believes it can run its high downforce wheel arches at Le Mans

RULE RUCTIONS

Despite rumours that Toyota could pull out of sportscar racing at the end of 2013, the team has already started to develop the long lead time items for 2014, including the hybrid system, the tub and the gearbox, while the drivers are under contract for a further year.

Audi has hinted that it would like to see a change to the regenerative braking zones, which influence the outcome of the race, but project leader Pascal Vasselon dismissed the idea. 'It is a rule based on physics,' he said. 'It is a rule that is based on braking of more than one second, and more than 1g, and that is it. There is no room for negotiation. If it changes largely, we have developed our system for nothing. I don't see the point. The regulation is in place for two years, we have sized our system for this regulation, and it would not make sense to change it because Audi hasn't the power to generate 500kJ.'

Achieving the 870kg weight limit for the 2014 cars will be a challenge for the manufacturers, which will have to run two hybrid systems to achieve the target. Toyota has not developed a lightweight bodywork kit for simple durability. 'If you make it too light, with the pick up and dirt during the race, you throw away the bodywork at the end of the race,' says Litjens. 'For 2014 it will be far more critical with the 870kg weight limit. It was very early in the discussions to go to 750kg minimum weight, but if you do that, you say goodbye to hybrid systems. We are still at the bottom of the curve with hybrid systems, so it was too early.'

Eyes are firmly set on the 2014 regulations. Internal parts of the hybrid system will already debut in 2013 as the team works to improve cooling and deliver the full 500kJ of power in any temperature, having been forced to reduce power at Bahrain due to the high ambient temperatures.

'Performance stayed constant from the first test to the last race, but more tuning means better driveability or more smoothness, said Hisatake Murata, hybrid project leader. 'The 2014 system is being developed in the technical research centre now, but some small parts give us some idea [for next year's system]. Next year the hybrid system will change, and the power to weight ratio will increase. To produce 8mJ is a tough target, but we are trying now. We will have to have two motors. It is impossible to achieve this target with one motor. 500kJ is around 300bhp, so that is a good balance.'

That extra 300bhp, added to the 530bhp from the internal combustion engine (both quoted figures, so likely to have underestimated the true figure), makes this one of the most powerful racing cars around, when the hybrid system is active under acceleration.

Tyre performance will also improve, although Toyota says that it is not its strategy to come up with unique rubber for its cars. Toyota is working with Michelin to develop tyres that are better suited for low temperature running than in 2012, after both they and Audi struggled during the night. 'If you have to manage your track time, it is better to have an understanding of the existing tyres and engineer your car to use them than to use the track time to develop new tyres,' said Vasselon. 'Last year we started from an existing range and it showed a few voids, such as at night at Le Mans. We are developing the range, but there is no strategy to have different tyres.'

From Russia with downforce

In the 1970s, three Russians began work on a true engineering project. Results weren't important, but to test theories was

BY OLEG STOZHKOV

The Moscow Automotive Plant began building cars in 1929, and at the start of the second world war devoted its entire production to manufacturer of the military equipment. After the war, the company bought the Opel manufacturing line from Brandenburg in Germany, and built the Moskvitch 400, based on the Opel Kadett, in 1947.

Igor Ermilin, a former Soviet racer and engineer – now vice-president of the Russian Automobile Federation – came to MADI early in 1975, when the idea of making a Group 2 Moskvitch was already being considered by Stanislav Borisovitch Gess de Calve.

At that time, Ermilin, a student of MAMI (Moscow Auto-Mechanical Institute) decided to make an 'engineering name' at the Laboratory for Sports Automobiles (MADI-LSA) that was situated at MADI.

The very first month of practice was used for adaptation and work on a Soviet F1 car, a Lotus 72 lookalike that was powered by an experimental Volga V6 engine, but in Ermilin then turned his attention to the Moskvitch project.

And that Group 2 car gave some valuable ideas for the future. Anatoly Dmitriev – who was responsible for the Moskvitch 412 – had discussed with Ermilin a new suspension layout.

It was the last year for Group 2 rules, which allowed for some deep reconstruction of the car, especially if designers had read technical regulations properly. Much depended on the energy and erudition of an engineer and, of course, the technical stewards who had to inspect the design, remembers Igor Ermilin.

'Regulations of Group 2 said: "Material and dimensions of resilient elements in suspension are free. It's allowed to use additional resilient elements if the originals are in their places." And here we get that logical seesaw,' he said. 'What do we mean by "if the original are in their places"? Do we mean that their material or dimensions are already changed? So we made an originally shaped spring from light material and the main working – racing – spring was placed much higher, over the top arm of suspension.' It was the trend of the time – the same idea was used on the rear suspension of Cologne Ford Capri RS3100.

The whole car was unique for that class of racing. As Dmitriev remembers, it weighed only 680kg thanks to a wide usage of aluminium in body panels taken from IZH-rally cars (that factory, IZH, made the same base car as Moskvitch) and modifications of the front frame. Parts of the braking system were taken from Estonian racing cars. Wheels were taken from an IL-18 aircraft.

Those wide wheels solved two problems. For the first time in the class, a car had a negative scrub radius (pivot radius) on the front with the wheel mounting situated outside and wide track at the rear without any spacers – just putting the same wheel mounting inside. So, the car was really good under braking in rain, and had better traction at the rear in the corners.

The engine was almost standard. The main goal of the project was to create a lightweight car with a very sophisticated (for Group 2) suspension. The minor changes were two Weber carburettors, and some camshaft work.

At that time it was rather a strange situation. Usually people have enough money, but couldn't get any cars. The Lada 2101 was the only car that was supplied to the factory teams and all the racing clubs. So, MADI had chosen the Moskvitch 412, a car that was used in rallying but had almost no success in racing.

Therefore, the car had some mileage – about 6000 km – which was good for a standard engine. 'I liked to work in MADI, with Gess, because it wasn't a pure sport,' says Ermilen. 'We didn't pursue any high results. We just liked the engineering process, generating ideas, making some interesting solutions to test them in racing. In 1976 we had almost 6000km of testing. Compare that with 3000km that the legendary sportsman Edgar Lindgren (also from MADI) had completed in all the 13 races that were held that season. He conducted some tests too, but his engineering process was limited by the rules. We had more freedom. The motto was: "We have an idea – let's go testing."

"The goal was to create a car with a sophisticated suspension"

'As for restoring the car, I should better say we are restoring the justice. I left Marussia in May and got some free time to work with my old drawings and archives. And while digitising all those papers I was suddenly stirred by that Moskvitch. Sometimes I read articles about our cars that we made with Gess, ones that were interesting but weren't successful. Today you can reach a conclusion that our cars were not good enough. But in the 1970s, our MADI-LSA team appeared at the track, and always became a showstopper. But our lack of material base and a huge enthusiasm of a very mixed team sometimes looked a bit muddled for the public who even called us a "chapiteau". And we didn't pursue the top positions – we were pleased just with pure speed demonstrated by our cars.

'The whole sense of the project is to remind people that our laboratory produced some really interesting and unique cars and a unique engineering team: Gess, Dmitriev, Lindgren.'

After the Moskvitch program was closed due to the rule change in 1976, Ermilin became the leading engineer of the Experimental Construction Bureau and started a new project. It was apparent that it was the very beginning of a model range of

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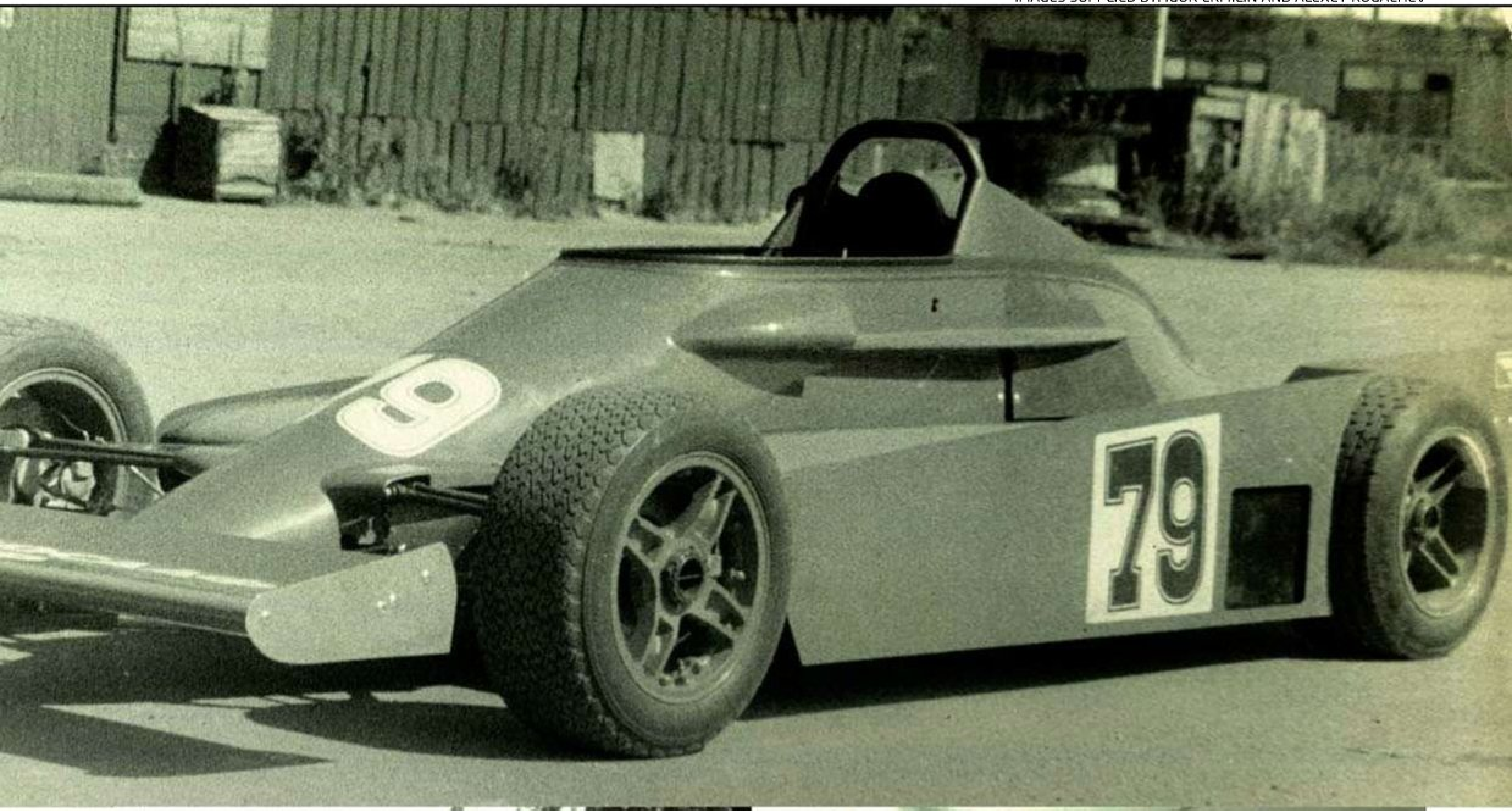
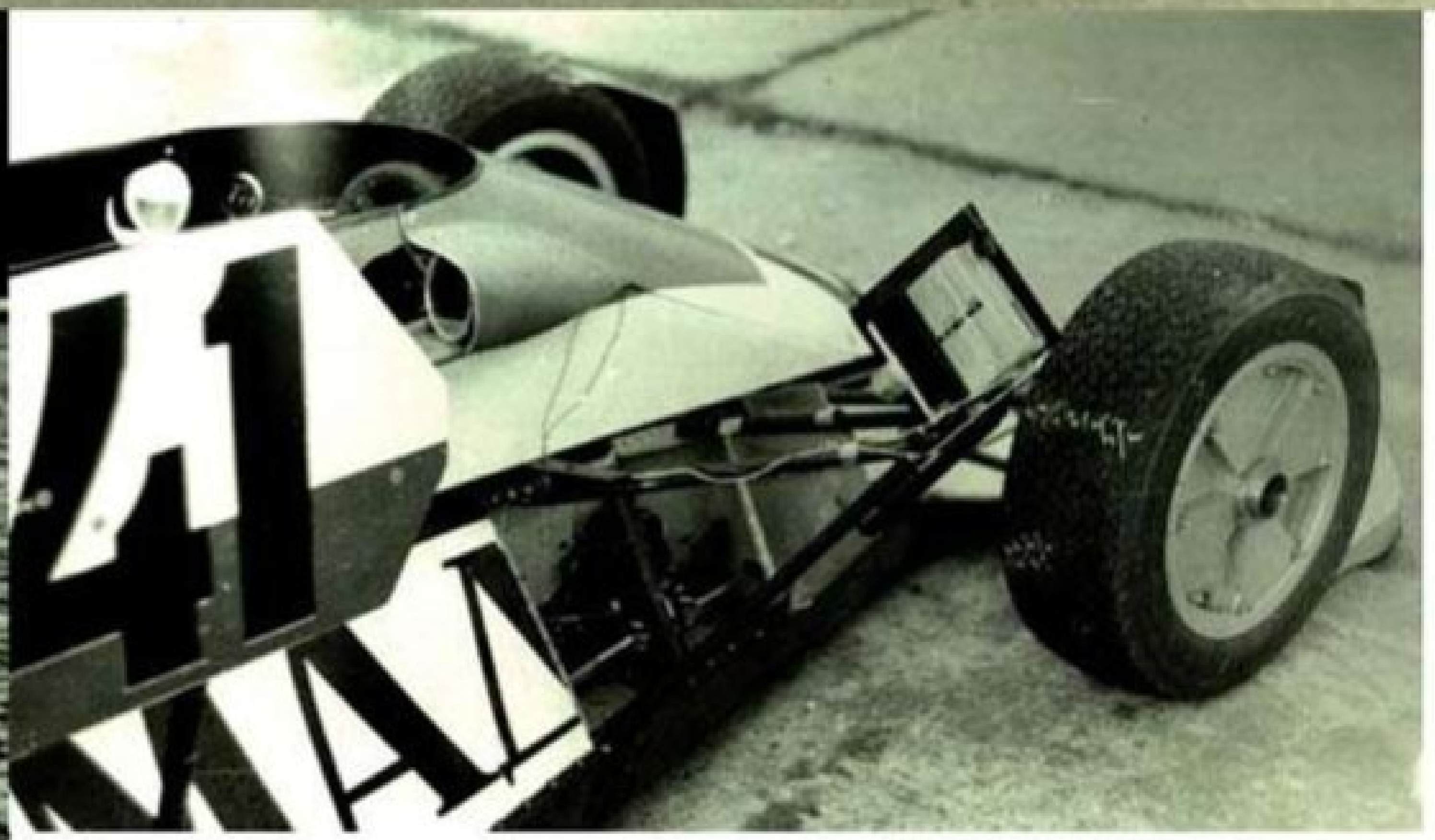




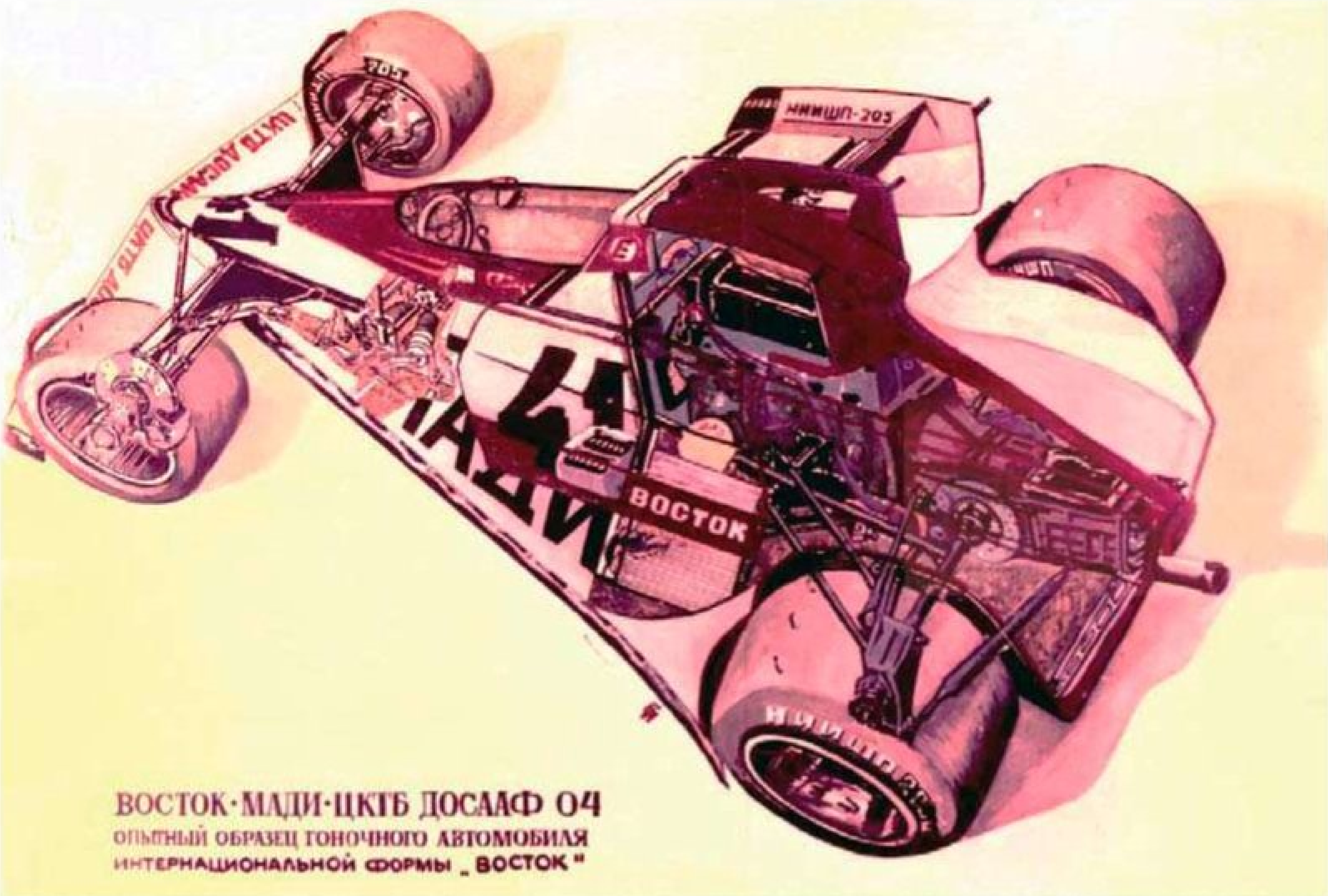
The MADI-0313 (top) was used for testing underfloor aerodynamics. Produced in 1979, it was tested for ground effect, Venturi effect and "box effect". Much of the testing work was completed at Estonia's Talinn airport and involved the car being shaken. The 1976 0113 weighed just 380kg, 40kg less than its rivals, though it put on weight following the testing and subsequent beefing up of the suspension.

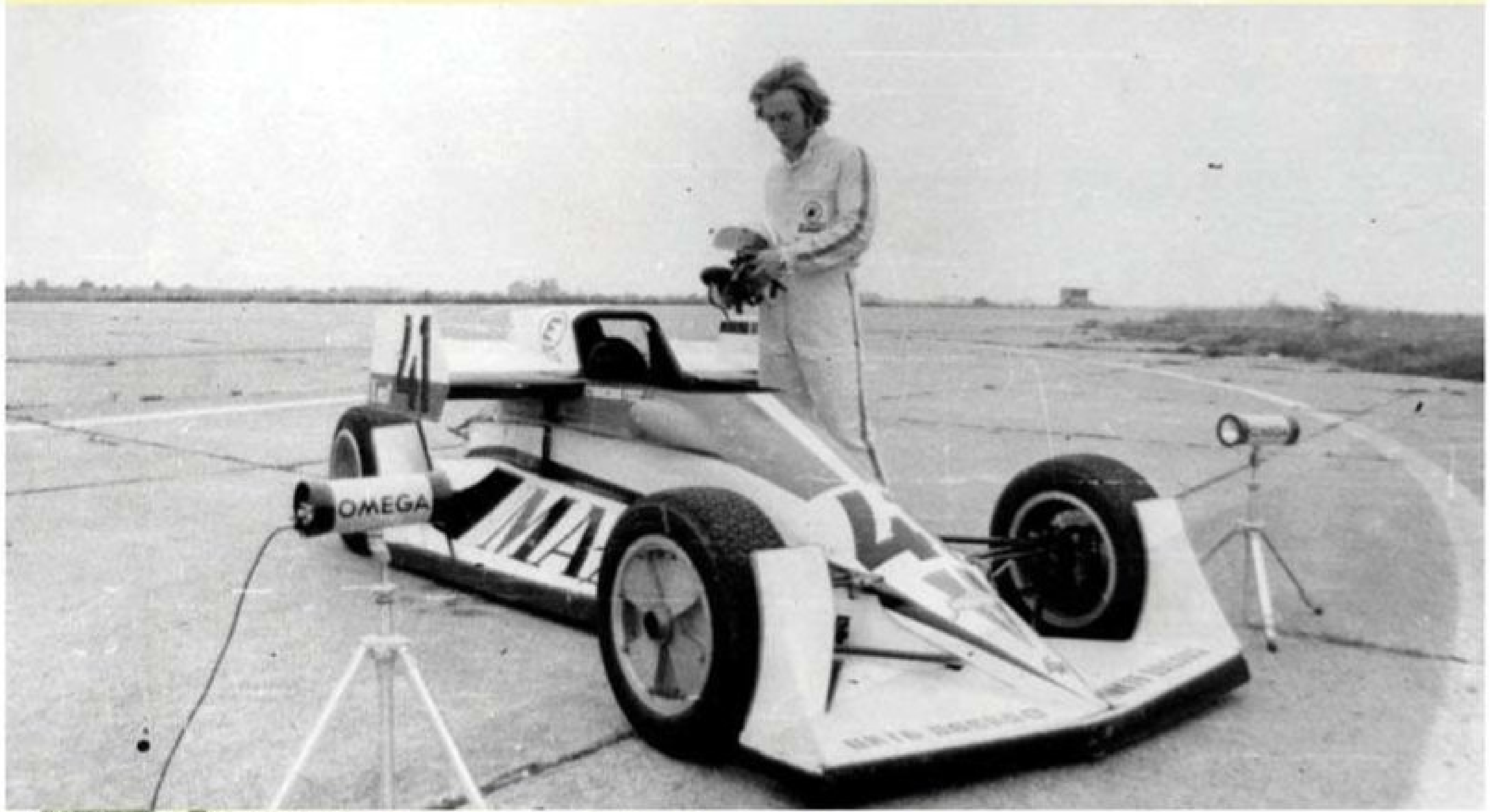
racing cars with a very interesting suspension. At that time it was just MADI-0113 (01 was the first car of the Bureau, 13 for the engine capacity of 1.3-litre).

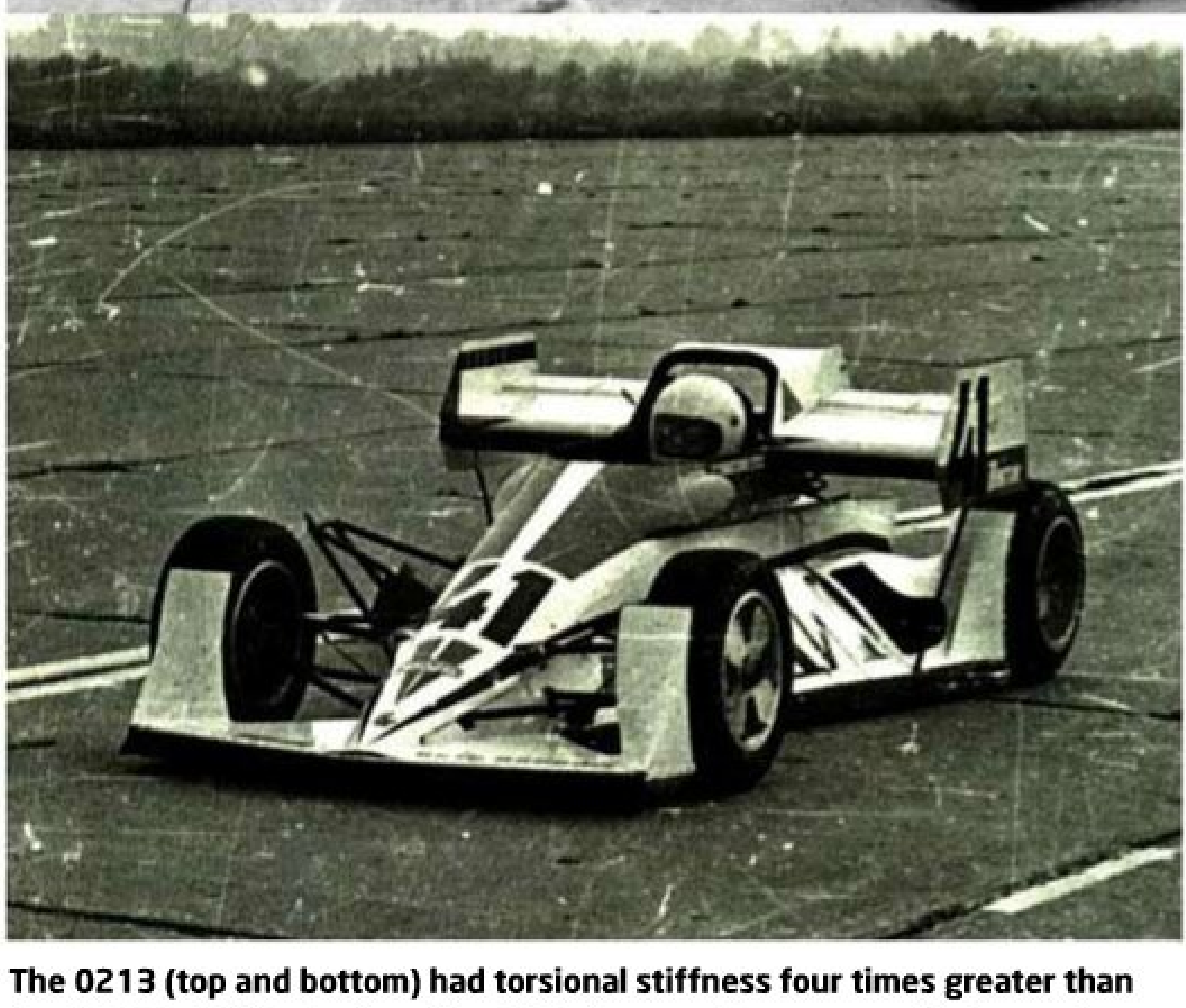
The car was built according to the new Formula East 1.3-litre (Lada engine) rules. The class was used in The Friendship of Socialist Countries Cup (FSCC). As Group 2 and Soviet F1 classes were closed, MADI-LSA had a lot of free time and resources to make a completely new car. There were two groups within the laboratory. Ermilin worked with Gess while Dmitriev worked with the engine specialist, Mark Bolezin.

Usually, all the projects started in November, when the team decided what to do. Gess was busy with financial matters, and some welding, Ermilin was responsible for construction. The MADI-0113 was based on the Estonia-19. The front suspension remained almost the same, but there was a negative scrub radius – the idea successfully used at Moskvitch (not just theoretically but practically good for racing). The angle of spring mounting was changed a little, taking into account the narrower front track.

MADI-0113/01 had motorbike pneumatic elements in the front suspension, which gave some non-linear characteristics. The 0113/01 used a heavily modified Estonia tube frame chassis with an original rear subframe that allowed the team to completely change an engine and suspension quickly, which was useful during testing. There were some experiments with non-linear characteristics in rear suspension by using top arms with rubber engine rings over them. The unit became stiffer under pressure.







The 0213 (top and bottom) had torsional stiffness four times greater than the 0113 (middle). Produced in 1978, it was only two seconds slower than the Formula 3 cars of the time, and had outstanding performance in the long radius corners. The 0213 was initially fitted with inboard brakes, but designer Igor Ermilin moved to outboard brakes in later versions. The 0213 completed more than 12,000km of testing at Talinn airport.

Almost all its life, the car was based at Estonia's Talinn airport, conducting aerodynamic testing. At 380 kg, 40kg lighter than its rivals, the Moskvitch MADI-0113 had to gain a little weight following testing after components were broken due to shaking at the airport.

The MADI-0113/2 (1977) chassis was made of three modules to make it easier to experiment with front suspension. And there was a prototype of cable suspension. Instead of cable, a motorbike chain was used. It was connected to the upper arm, went over a chain wheel and into the box with resilient elements. Under pressure the chain was trying to draw out, tightening the resilient element.

The MADI-0213 (1978) was much faster than other F-East cars. In fact it was almost as quick as F3 cars with 1.6-litre engines. At Nevskoe Ring, the 0213 was only two seconds slower than leading F3 cars. It couldn't stay under the radar with performance like this, and some technical improvements led to a strange disqualification. Originally, the Estonia gearbox was inverted with its cap under the unit. It was too close to the ground, and it was difficult to maintain. So, the team decided to flip it, with the cap moved to the top. But after that, the designers had to incline the engine. And in that position carburettors didn't work properly. So, it was decided to make a small wedge to situate the carburettors horizontally. The stewards called it a modernisation of the engine, which was not allowed in F-East. So Gess and Ermilin had to remove that wedge which led to a very complicated tuning of the carburetors. Besides, the most powerful engine was broken due to an oil leak. The team had to work and test the car at night before the race – it was allowed to run some laps at that time.

TRAINS AND PAUPERS

The car started from the back of the grid, but soon it was up to third. The late Vladislav Barkovsky recounted that the greatest difference was in the famous Long Radius high speed turn. Barkovsky was able to accelerate only for the first quarter of the arc while Gess, having a slower car, was still maintaining speed up to the last quarter of the turn. 'As a fast train passing a pauper,' remembered Barkovsky. The car was much stable that a usual F-East and F3 machinery.

Unfortunately, on lap four, the driveshaft broke, and Gess had to retire. He was lucky enough to go home without an injury as the brake discs on 0213 were still mounted to the gearbox. When the car used usual tyres it was reasonable, because it helped to reduce unsprung masses. But when 0213 was equipped with slicks, the braking moment appeared to be much greater than engine moment, and the driveshafts were not designed for such loads. Later Ermilin put


PFC

Suspension technology was at the heart of the MADI programme

The 0113 was fitted with a 1.3-litre engine. Its wheels were from an aircraft

brake disks into the rims because strengthening the driveshafts eliminated all the advantages of the inboard scheme.

The car was destroyed in Riga. At that time, it had completed more than 12,000km, most of which were at the airport where the surface was not ideal. There were some problems with changing gears – once it led to a crash. Gess walked away without injuries thanks to strengthened tubular frame and special anatomic seat made in MADI.

Information and data gathered during testing and racing this car was enough to make a next generation. A new car, 0213/2, had a mixed frame of steel tubes and aluminium sheets joined by aviation rivets. It gave torsional stiffness of about 2500 Nm/degree. Wheels, hubs, braking discs – all were self-made and very light with a wide use of titanium and magnesium. The main idea was to make aerodynamic pressure centre and centre of gravity as close as possible. Its rear wing was mounted on to the central air intake where the stream is clean. The CoG was almost under the wing. There was no need for a big wing at the front – it needed only small winglets to balance the car. For the first time, Ermilin used a narrow aluminium plate, but after a few laps it became damaged and was replaced with an element made of stiff rubber.

The main goal led to a very interesting solution in suspension. It had cables on all four corners. All resilient elements were grouped in a small block near the CoG. The size of that unit allowed the engineers to use very short anti-roll bars,

The Group 2 Moskvitch pushed the boundaries of the regulations

and even two anti-pitch bars, located on top of the block. A cable, made at an aerospace factory, went from the upper arms, over a roller to the rocker arm near the block. Those rocker arms had three positions for quick setup. Then the cable went to the block where it interacted with resilient elements.

Anti-pitch bars were necessary as the whole concept of the car was built around aerodynamics. During acceleration or braking, body incline was a problem as the suspension was soft.

It took only five months to build MADI-0213/2. At that time there was no technology to make

"The car generated 350kg of downforce. It only weighed 400kg"

characteristics of front winglets stable enough. So, Ermilin had to instal the rear and front wings instead of one central wing.

'We reached all the goals with 0213/2, but an effect was, I should say, academic,' says Ermilin. 'It was not practical. It was good for theory but too complicated for racing.'

For the next car, the main interest was ground effect. A skirt was added to the sides and to the front, creating a vacuum at the rear end. The car was called 'Smoothing Iron'. It was tested in a wind tunnel, but some problems appeared at the very first road test in Kiev. The car was too nervous, the suspension too stiff.

'You should understand that it was 1978,' says Ermilin. '"500hp karting" [ironic name for ground effect cars with almost no suspension] appeared a bit later. And at that moment we could not understand what was happening. We thought that suspension was initially too stiff and so softened it, but that had no effect at all. The suspension was designed with a hypothetical influence of aerodynamics. So, we got back to our garage, and got some self-recorders from jet planes. After the first test at the Dmitrov track, we understood that at 170 km/h, the car generated 350kg of downforce. The whole car weighed 400kg. We just changed resilient elements and the car handled superbly, but it had a weak area. As the tracks were not clean, sand lifted to the rollers. As those units were made from duraluminium, some pieces pressed into it and began rubbing the cables. The team changed cables once a race weekend, and that material was very expensive.

'The result of using cables was amazing but short-lived,' remembers Emilin. 'We just couldn't solve the problem with the cable working resource. We had patents in which there was a next step of development – to use electric-hydraulic units instead of anti-roll and anti-pitch bars. It's all written in the patent. It would stabilise the road height at every speed to help the aerodynamics.'

Lateral acceleration at that time was about 70 per cent of what it should have been in theory because of the unstable behaviour of the tyre contact spot. LSA-MADI tested Estonia and 0213/2 at a special ring where lateral acceleration was checked. The usual car had 70 per cent and the MADI car on the same tyres gave about 95 per cent of theoretical numbers. It's all down to better road bump tracking by softer progressive suspension.

MADI 0313 (autumn of 1979) had the usual ground effect. For the first time it had no wings and at the very first tests it just flew as there was a big pressure under the nose. After some tests in the wind tunnel at Moscow State University the problem was solved. It was planned that this car would be produced in Leningrad and used by the national team in The Friendship of Socialist Countries Cup (FSCC).

Unfortunately, by the end of testing, Gess had left MADI, and the whole structure of LSA-MADI changed. The next models, 04 and 05, were just modified road cars, and the last racing car made by Ermilin in MADI was the 0620, with a 2-litre engine. It was an F3 car with cable suspension but wasn't even used in testing.

'We were not copying foreign ideas,' says Ermilin. 'We knew what the goal was, and we saw the way to reach it. That testing work was more interesting than the races. It was a very interesting time when we had to weld, to mill, to turn details and use that period to keep away, rethink and produce some results.'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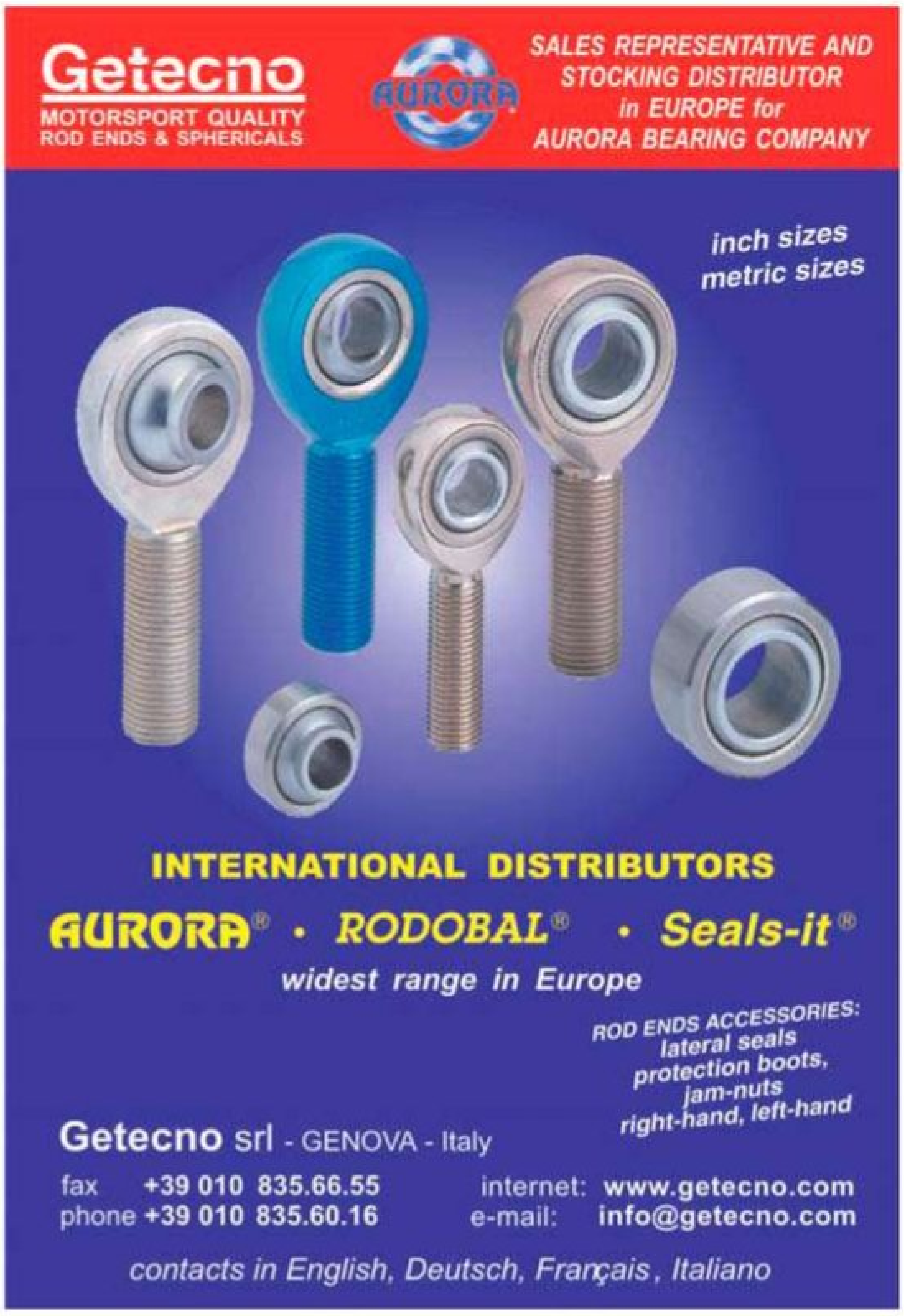
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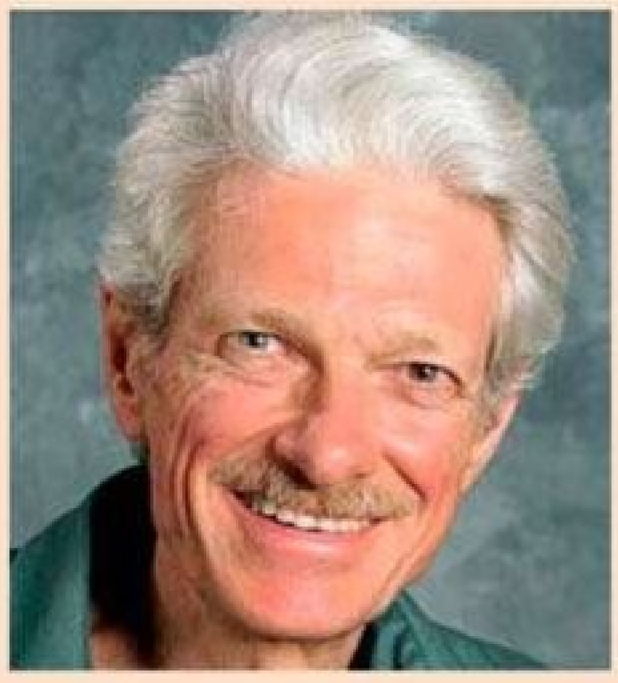

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Loose in sweepers, tight in tight turns

Some problems can't be solved entirely, but there are still measures that can be taken to help alleviate effects...

Q What can one do to solve the oversteer (fast) understeer (slow) problem mentioned last month?

I'm racing a Lotus 7, with open diff, about 150hp, on semi-slicks with no aero assistance.

A The causes of this effect are things we can't do much about. Aero balance is the only really powerful tool we have to attack it with. If our hands are tied regarding that, we are limited to minor tweaks that have small effects and carry some penalties. Reducing yaw inertia helps, so centralising whatever masses we can is good. With a production car, there often isn't much we can relocate. In some cases we have a choice with ballast location, but this often plays off against getting the static weight distribution we want.

Lengthening the wheelbase is good, except maybe for very tight turns, but carries penalties in packaging and weight. Generally we can't do much to change wheelbase on an existing car.

We can add low-speed damping at the rear, and/or reduce it at the front. This will, to some degree, free up entry and tighten exit, particularly when steering inputs have to be abrupt. However, using this trick conflicts with the objective of calibrating the damping to make the car ride bumps as well as possible.

Finally, we can simply accept the characteristic and drive around it. That's what we generally do, with varying levels of awareness that we're doing it. This involves setting up the car so the driver can live with it in sweepers, and then managing its behaviour with throttle and brakes in the slower turns.

Q I still haven't been able to get the fog to lift while trying to develop a spreadsheet to calculate lateral load transfer to get a better 'feel' for the contribution of geometric and elastic load transfer contributions to dynamic wedge in just a steady state, flat, constant radius corner (ie: relative wheel load changes to roll centre and asymmetric spring changes). Can't wait until I lay geometric anti-forces and shock forces in transients on top of this! I'm trying to compile some rough data for all of the setups we tried last season to see if there is a common thread and recalibrate our baseline for the coming season.

All of this relates to racecars with beam axles front and rear for oval tracks, ie: left-hand turns.

"Aero balance is the only really powerful tool we have to attack it with"

Here's an excerpt from one of your past newsletters (July 2008):

'I probably should spell out exactly what I mean by the wheel rate in roll, as I have encountered some confusion on this from various quarters. Wheel rate in roll, as I use the expression, is the rate of elastic change in wheel load with respect to linear suspension displacement, when the two wheels of a front or rear pair each move the same amount in opposite directions – in English units, the pounds of load change per wheel when one side compresses one inch and the other side extends one inch. This relates to the angular roll resistance as follows:

$$K_\phi = ½ * K_{roll} * t^2 * \pi/180$$
$$K_{roll} = (2 * K_\phi) / (t^2 * \pi/180) = 360K_\phi / \pi t^2$$

Or, approximating $180/\pi$ to three significant figures:

$$K_\phi = ½ * Kroll * t^2 / 57.3$$
$$K_{roll} = 2 * 57.3 * K_\phi / t^2$$

Where:

K_ϕ = angular roll resistance, lb-in/deg
K_{roll} = linear wheel rate in the roll mode, lb/in
t = track width, inches

All of this is clear for a racecar that is symmetric about the chassis centreline – ie cg and roll axis are considered to be on the chassis centreline, and the spring rates left and right are identical.

My question, though, is how you go about modifying the above as the total vehicle and sprung mass centre of gravity moves to the left and you add asymmetrical springing to the front and rear wheel pair?

Every reference work I have seems to fall back to the 'well, let's take a symmetric car as an example' and I agree half rear track width which, for me at least, confuses the issue. Even when I take the RCVD equations and use a banking angle of zero I do not get the result I think I should get.

I have a very good understanding of how the four primary torques that produce TLLT – unsprung weight, geometric sprung and elastic sprung and movement of the cg due to roll – are derived. The conundrum for me is how these torques are distributed out to front/rear tire contact patch load as asymmetries increase.

"It may be useful to use the spring centre as a centre of rotation"

with this approach when first introducing the basics of LLT and the concept of a three mass system. But no one seems to take the next step completely.

RCVD takes what I believe is a slightly different approach to yours and attempts to introduce a LLT correction, so to speak, for an offset cg. But the example used is combined with banking angle effects, uses their 'simplified' one mass model, all the while maintaining a vehicle centreline defined by half rear track width which, for me at least, confuses the issue.

The continued use of a chassis centreline by RCVD, as opposed to the use of the sprung mass centreline as you do in your articles pertaining to asymmetric racecar setups, also seems to add to my confusion. I like your use of the cg location and definition of the vehicles X-axis along the cg plane as it clearly shows the difference in the moment arms left to right and how these asymmetries effect car behaviour.

If possible, could you expand on this to your method of treating asymmetrical load transfer when the cg is offset and you have asymmetrical springing?

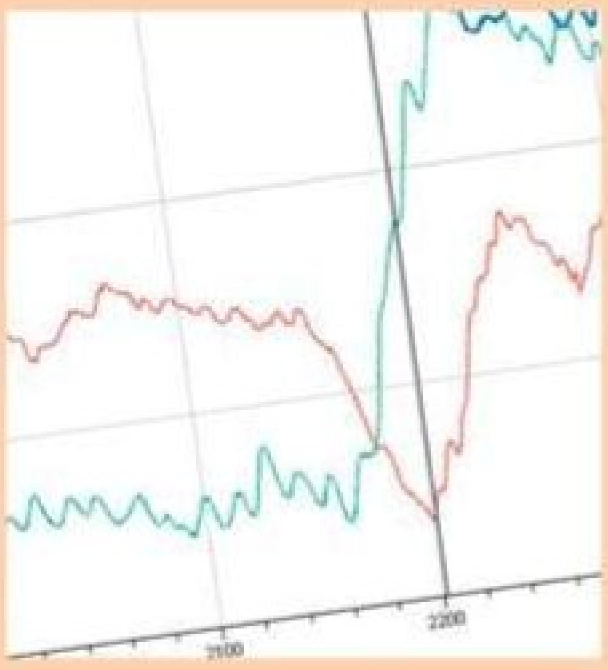
A Actually, when defining wheel rates for the four modes of suspension movement, it is necessary to think in terms of equal absolute amounts of linear displacement at the four wheels. This is normally equivalent to using an origin at the track/wheelbase midpoint, and not at the cg when the cg is offset, either laterally or longitudinally.

If pure roll – or pitch, or warp – is defined as some combination of equal and opposite displacements at the wheels, then when the cg is not central to the wheels and we have spring splits and other asymmetries, pure roll or pitch in terms of displacements at the wheels necessarily implies some vertical translation at the cg, and/or some change in total wheel load.

In an asymmetrical car, we do get somewhat different K_ϕ depending on whether we assume rotation about the track midpoint, the spring centre or the cg plane. However, in most cases the differences are small. The objective is to come up with a reasonable K_ϕ, by some method that makes sense to us. With an asymmetrical beam axle setup, it may be useful to use the spring centre as a centre of rotation, as that will model a condition where the total load on the axle is constant.

Remember that when we assign a K_ϕ – or a roll centre for that matter – we are engaging in simplifications, for the purpose of avoiding the need to solve large numbers of simultaneous equations using elaborate computer programs. We are not going to get exact modelling of loads and displacements.

In most cases, the errors introduced will be small compared to those we're getting by ignoring tyre compliance and the aerodynamic forces.



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

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

Refining fly-by-wire control strategy

Now your system's calibrated, it's time for some fine-tuning...

Continuing on from last issue where a fly-by-wire (FBW) throttle system was calibrated for steady state conditions, it is time to look at further steps needed to perfect the control strategy. As a quick reminder, this method applies to an engine with one FBW motor and uses a PID controller. Currently the I and D terms are set to zero, and work continues on the P term.

Once the steady state values have been tuned and thoroughly checked, it is time to look at the next step. This is looking at step changes and to observe how the system responds to step inputs. This means that an instant change to the FBW Requested TPS is introduced to create a square wave, forcing the controller to react immediately.

In order to get the best response out of the system, it is necessary to tune the system to be overdamped. This means we get the fast reaction needed, but equally care must be taken to stop the oscillation of the response, and reach a stable target as soon as possible.

To introduce a step change, the ECU configuration software must have a live update 'patching' mode so the step input can be simulated. Start by going through the throttle position value range from 10 to 90 and back down to 10 while logging the relevant data. In this case the following channels should be logged to gauge the response of the system: FBW Control Duty (Green), FBW P term, FBW Error Angle (Blue), FBW Target TPS (Pink) and Throttle Position (Red). These can be seen in the image below.

In this case, the response is underdamped and the throttle position has overshot the target by a bit too much. The point to consider is the amount of duty when the throttle position is close to its target value. In this case we know that when the FBW error is close to 10, we need to reduce the duty driving the motor to prevent the overshoot. The motor duty is set at 55 per cent at that point, so a logical test would be to reduce this by 5 per cent and check the response again. This process needs to be repeated for all the incremental steps both up and down the throttle position range. Once the small steps show a satisfactory response, it's time to move to larger step inputs that more resemble what might be seen on track. Examples would be a throttle blip (idle to 30) or a hard braking effort (wide open throttle to idle). The procedure is the same as for the smaller step response.

The next step is to simulate normal use of the throttle. This can be done either using the vehicle pedal or – if available – a hand throttle control, such as used in dynamometer cells. It is important that the PPS to TPS map remains linear at this stage so that it does not influence the system in any way. The PPS to TPS mapping should only be calibrated once the control strategy has been implemented satisfactorily. Once the ECU has been started and logging data has commenced, the operator should try to simulate the following conditions:

- **Driver coming on throttle, out of corner. This requires low throttle initially and smooth application to wide open throttle**
- **Driver coming off throttle at the end of a straight, fast movement from wide open throttle to idle**
- **Driver feathering the throttle mid-corner, mid-range throttle opening with fluctuations in both directions**

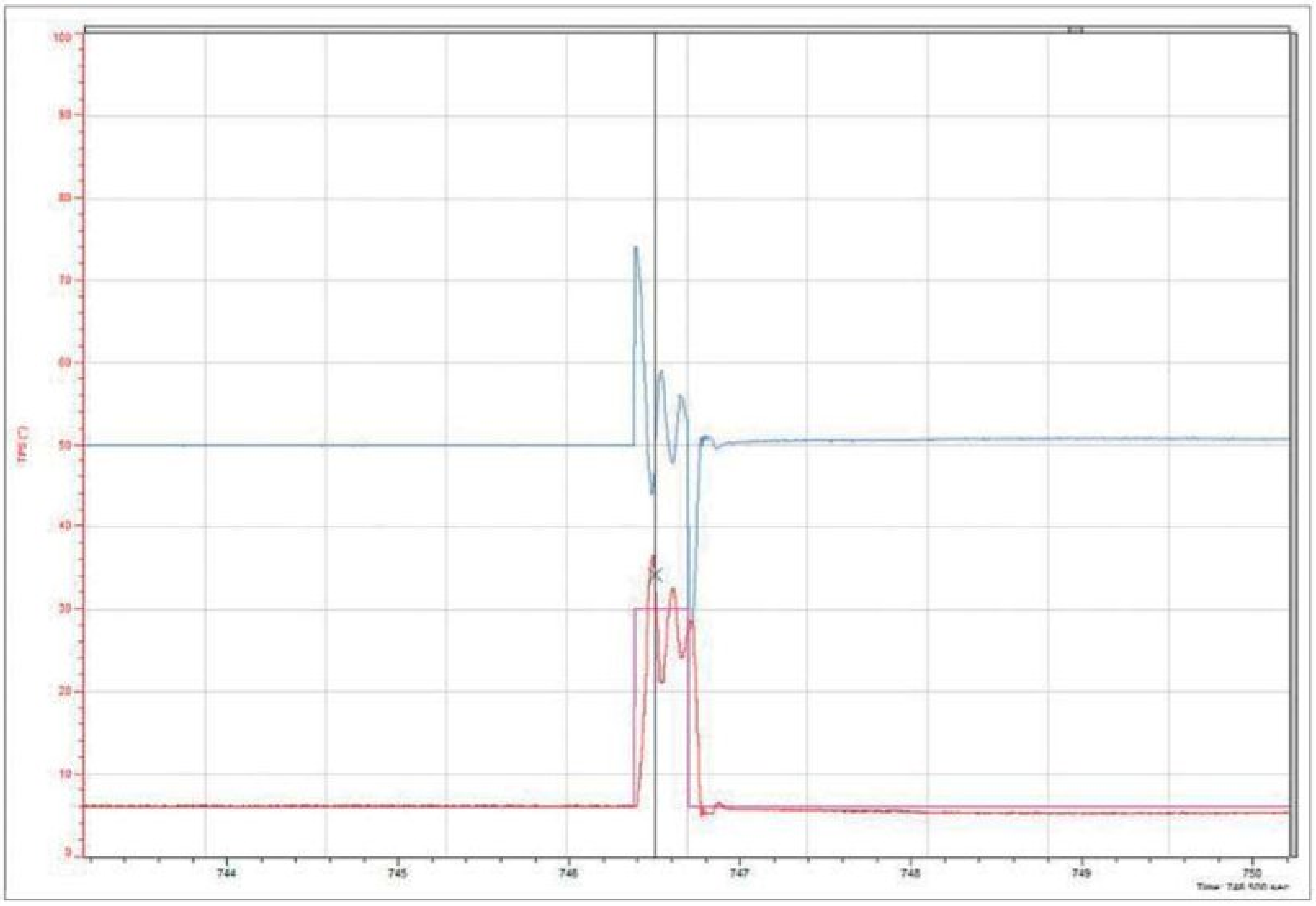


Figure 1: step change input to the FBW Requested TPS (Pink) is introduced and the subsequent behaviour is then observed. FBW Error Angle is blue and throttle position is red

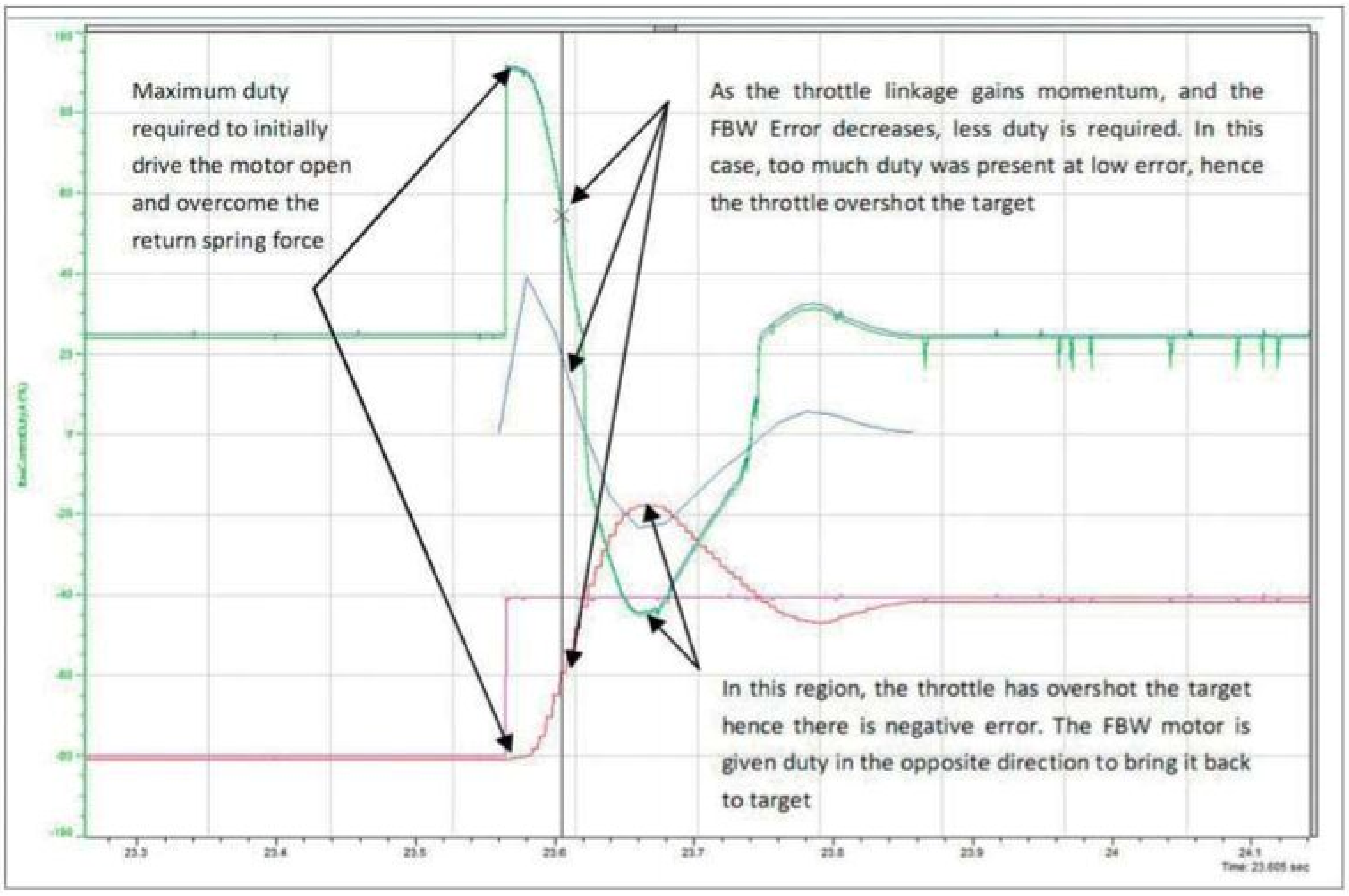


Figure 2: underdamped fly-by-wire system, which has overshot the FBW Target TPS, but then settles. Note that the P-term and the FBW Control Duty are one and the same, as the I and D terms are not influencing the system

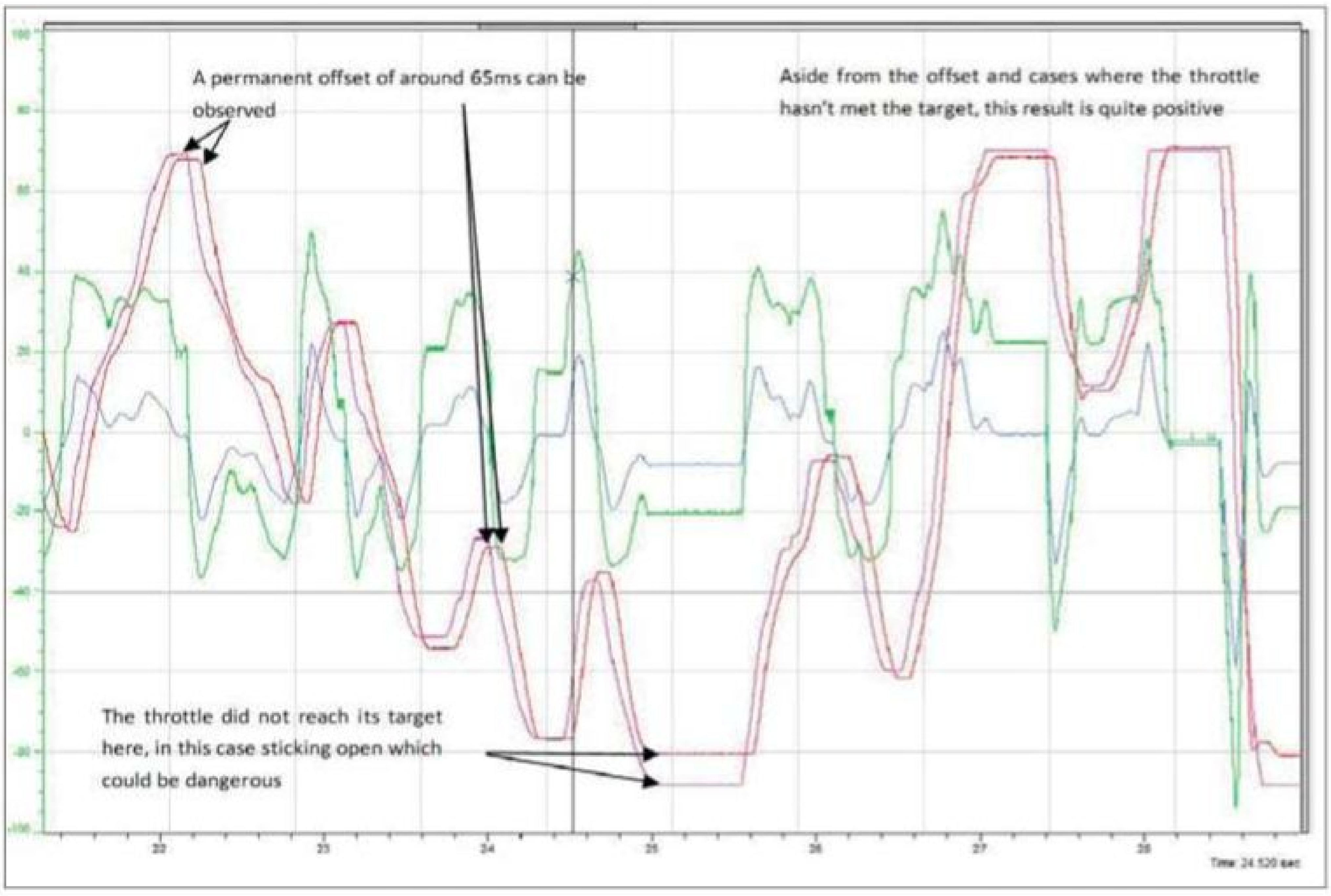


Figure 3: results of first throttle tracking test. Positive, but improvements can be made

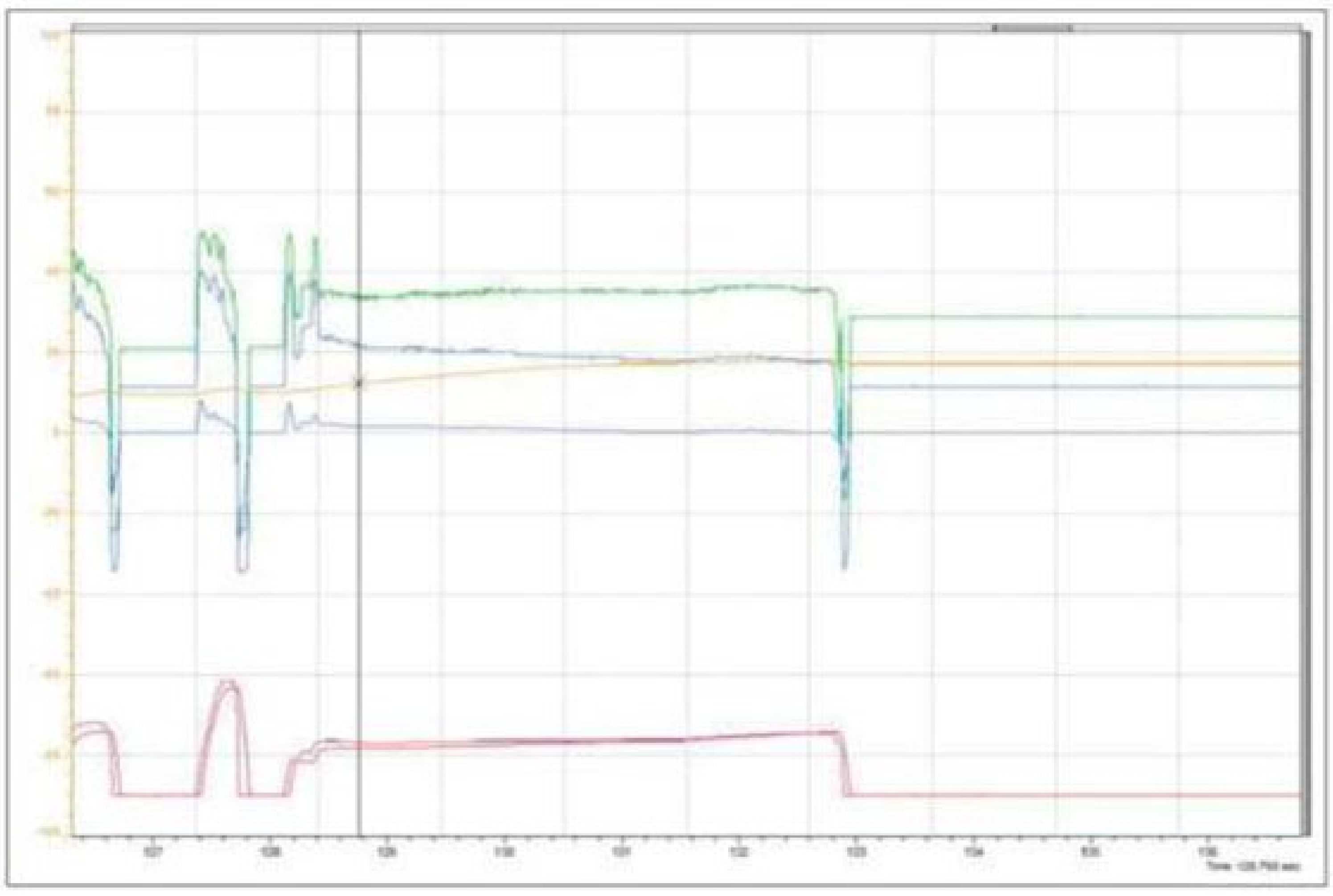


Figure 4: the I-term (yellow) at work reducing the effect of increased friction due to temperature

The results above are positive and in the right direction. However there are points for consideration. The throttle cannot close all the way, so more negative duty is required at around -4 error, and more duty is also required at early opening stages for a faster response. The P-term can be adjusted to improve the systems response. The offset, however, requires adjustment beyond the P-term's ability.

Once the response of the system is satisfactory and it is not possible to get any further with the P-term alone, it is time to look at how the Integral and Differential terms can help.

The contribution of the I-term is proportional to both the magnitude and duration of the error. It is the sum of the instantaneous errors over time and gives the accumulated offset that should have been corrected previously. This accumulated error is multiplied by the I-term gain and then added to the controller output. The I-term can accelerate the movement of the process towards set point and eliminate the residual steady-state error that occurs with a pure proportional controller. The I-term can also help deal with changes in conditions, such as heat or a sticky throttle. However, as the I-term responds to the accumulated errors from the past, it can cause the present value to overshoot the set point value. It is not recommended that the I-term is used to give faster response times – this should be handled by the P-term.

The D-term is calculated by determining the slope of the error over time and multiplying this by a constant, the D-term gain. The D-term slows the rate of change of the controller output in order to reduce the magnitude of the overshoot produced by the I-term and improve the combined controller-process stability. As a result the D-term also slows down the transient response of the controller. Additionally, as the D-term is a differentiation of a signal, it is sensitive to noise and can cause the process to become unstable if the noise and gain are sufficiently large.

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

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Wings and spoilers

Continuing our look at a Subaru Impreza from the UK's Euro Saloon and Classic Thunder championships. This month we investigate interactions between rear spoilers and wings

The Subaru Impreza is a favourite among saloon racers. We took this UK specification 2006 WRX STi of clubman racer Danny Precious for an interesting back-to-basics session in the MIRA full-scale wind tunnel. Preparation experts, Scoobyclinic, had come armed with a raft of components to try, and this month we look at the effect of rear spoilers.

One of the oldest aerodynamic lift-cancelling devices to have found use on racecars, the rear spoiler still has its uses, and where wings are not permitted, it is the only method of obtaining rear downforce from the upper surfaces. The general relationship between length and angle of spoiler and downforce generated are well understood, but perhaps one aspect that has not been well documented is the interactions between wings and spoilers. This session provided the opportunity for some trials on just this topic.

A set of spoilers at two different angles and two different lengths was constructed to attach to the rear deck. The wing configuration used in this instance was the highest position tested in this session, with the wing's leading edge 330mm above the rear deck, and the wing's trailing edge just protruding beyond the rear deck. We examined the effect of rear wing location in last month's *Racecar*, and this high location provided the best rear downforce of the three locations evaluated. The wing was set at an angle of 10 degrees, measured across the top of the wing near the tips.

Let's first look at the data provided by the four different spoiler options compared to the no spoiler configuration. Note that at this point, although the car was fitted with the front splitter raced in 2012, front lift was still in evidence. (This was subsequently eradicated, and we shall look at how next month.)

Table 1 shows the coefficients from the spoiler trials. These fit the expected pattern for rear spoilers, with increased angle and increased length adding rear downforce and drag. However, while downforce gains with increased length tailed off, increases in drag were fairly linear, leading to a tailing off in efficiency with the longer length. **Figures 1-3** make this more evident. Far and away the most efficient change came with fitting the 30-degree, 60mm spoiler, which yielded 91 counts of additional rear downforce for 17 counts of drag (1 count being equal to a coefficient change of 0.001).

One surprising aspect of these results is that the front lift coefficient barely altered despite these quite significant changes at the rear and, if anything, the front lift reduced very slightly with the increased downforce generated by the steeper spoilers. This is in direct contrast to what happened when rear wing angle was increased. The increase in rear downforce was accompanied by an increase in front lift. Given the spoiler's drag contributions, could it be that they were responsible for small increases in mass flow under the front of the car, and that this gave rise to the slight reductions in front lift that were observed? Such upstream effects are possible.

It's interesting to ponder the spoiler mechanisms here, with the wing in this relatively high location. Were the spoilers acting independently of the wing, or were they interacting with it synergistically? Well, following the last run in **Table 1**, with the 60-degree, 100mm spoiler and the wing, the wing was then removed for a run, and then the spoiler was removed as well, giving us an idea of the contributions of each individual component. The results are given in **Table 2**.

Table 1: the effects of varying spoiler angle and length

Configuration	CD	CL	CLfront	CLrear
Wing, no spoiler	0.413	-0.121	0.040	-0.162
Wing + 30deg, 60mm spoiler	0.430	-0.212	0.040	-0.253
Wing + 30deg, 100mm spoiler	0.444	-0.231	0.040	-0.272
Wing + 60deg, 60mm spoiler	0.450	-0.240	0.038	-0.278
Wing + 60deg, 100mm spoiler	0.469	-0.258	0.037	-0.295

Table 2: the effects of the spoiler and the wing

Configuration	CD	CLr
No spoiler or wing	0.377	0.178
60deg, 100mm spoiler only	0.397	0.045
Wing only	0.413	-0.162
Wing and spoiler	0.469	-0.295

Wing in high location at 10 degrees plus 30-degree, 60mm spoiler

From this we can work out the individual contributions from each component relative to the no wing, no spoiler case – check out the results in **Table 3**.

The comparisons between the values obtained via actual testing with the arithmetic sum of the individual spoiler and wing contributions are interesting. The incremental drag of the combined devices was considerably more than the sum of their individual contributions, yet the incremental downforce of the combined devices was identical to the sum of their individual contributions. Perhaps we should not be surprised at this lesser efficiency, as we have seen before that as gains increase from a particular device – especially on the rear of a racecar – the less efficient those gains become.

As to whether the devices were working synergistically, the fact that the test value of the downforce with the wing and spoiler combined was no better than the sum of the two individual contributions, suggests not. And yet wool tufts attached to the trailing edge of the centre of the wing were demonstrating better flow attachment with the spoiler in place, even with this high wing location. It's reasonable to expect that the spoilers were turning the air in a way that could benefit the wing. This particular case may then just have been another example of win some, lose some.

Another thing that is abundantly clear from this trial is how much more effective the rear wing was than a rear spoiler. We can also compare the 60-degree, 100mm spoiler-only configuration with the original baseline wing-only configuration, with the rear wing 155mm lower than in the above trials, and at just 4 degrees angle of attack. This data is collated in **Table 4**. We can see from this that where the spoiler on its own contributed 133 counts of rear lift reduction for 20 counts of drag, the rear wing in its low location and at its minimum angle of 4 degrees contributed 268 counts of lift reduction (and reversal to actual rear downforce) for the same drag as the spoiler.

Next month we'll look at the front of the Impreza and discover that adding airdams and splitters is not always enough.

Racecar's thanks to Jonathan Fletcher, Danny Precious and the crew at Scoobyclinic

Table 3: the contributions of the spoiler and the wing

Configuration	ΔCD, counts	Δ-CLr, counts
60deg, 100mm spoiler only	+20	+133
Wing only	+36	+340
Sum of wing and spoiler	+56	+473
Wing and spoiler, as tested	+92	+473

Table 4: spoiler and wing comparisons relative to the no wing, no spoiler case

Configuration	CD (ΔCD, counts)	CLr (Δ-CLr, counts)
No spoiler or wing	0.377	0.178
60deg, 100mm spoiler only	0.397 (+20)	0.045 (+133)
Low wing at 4deg only	0.397 (+20)	-0.090 (+268)
High wing at 10deg only	0.413 (+36)	-0.162 (+340)

Wing plus 60-degree, 100mm spoiler


Prepping for a wingless run, with 60-degree, 100mm spoiler

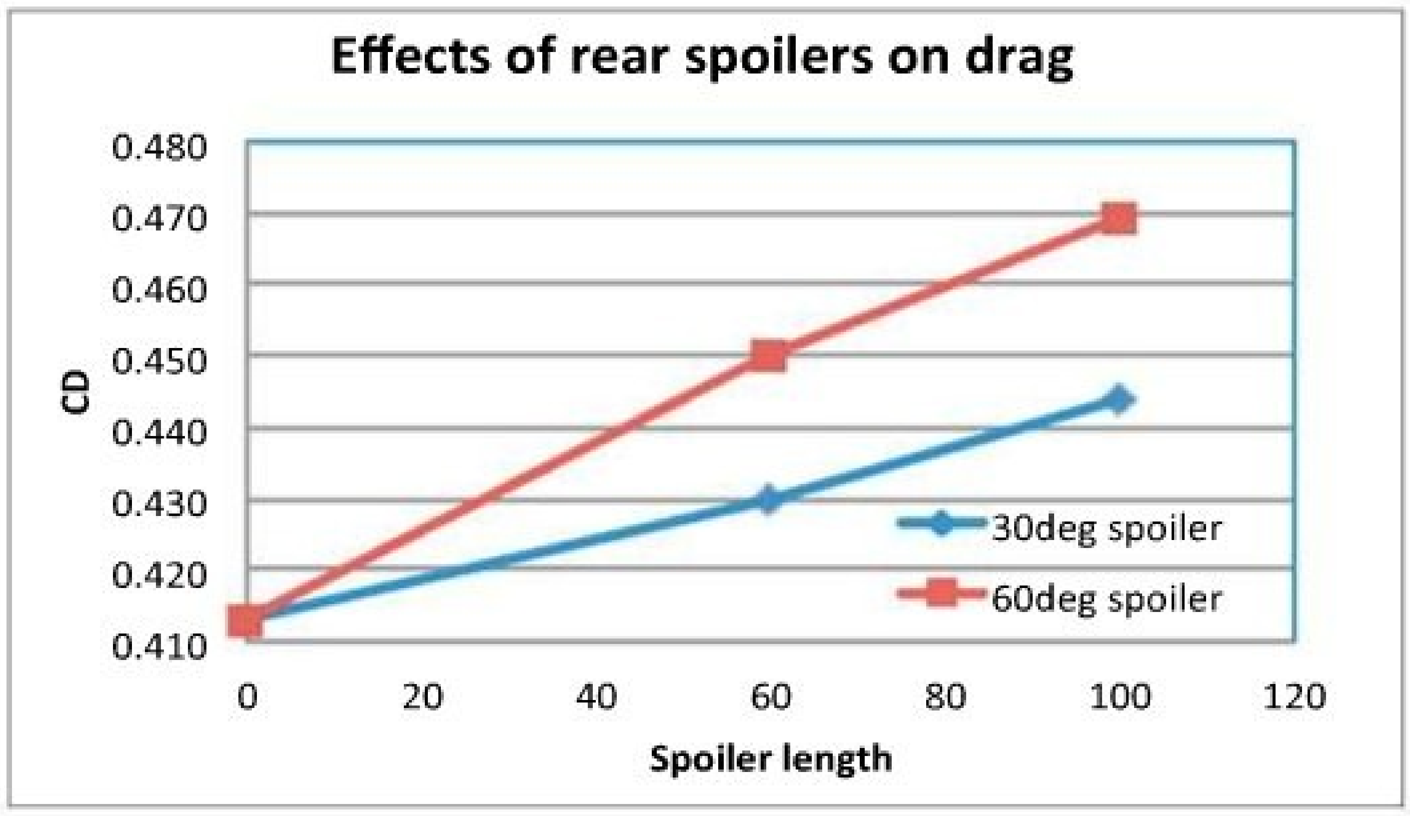


Figure 2: spoiler length and angle versus drag

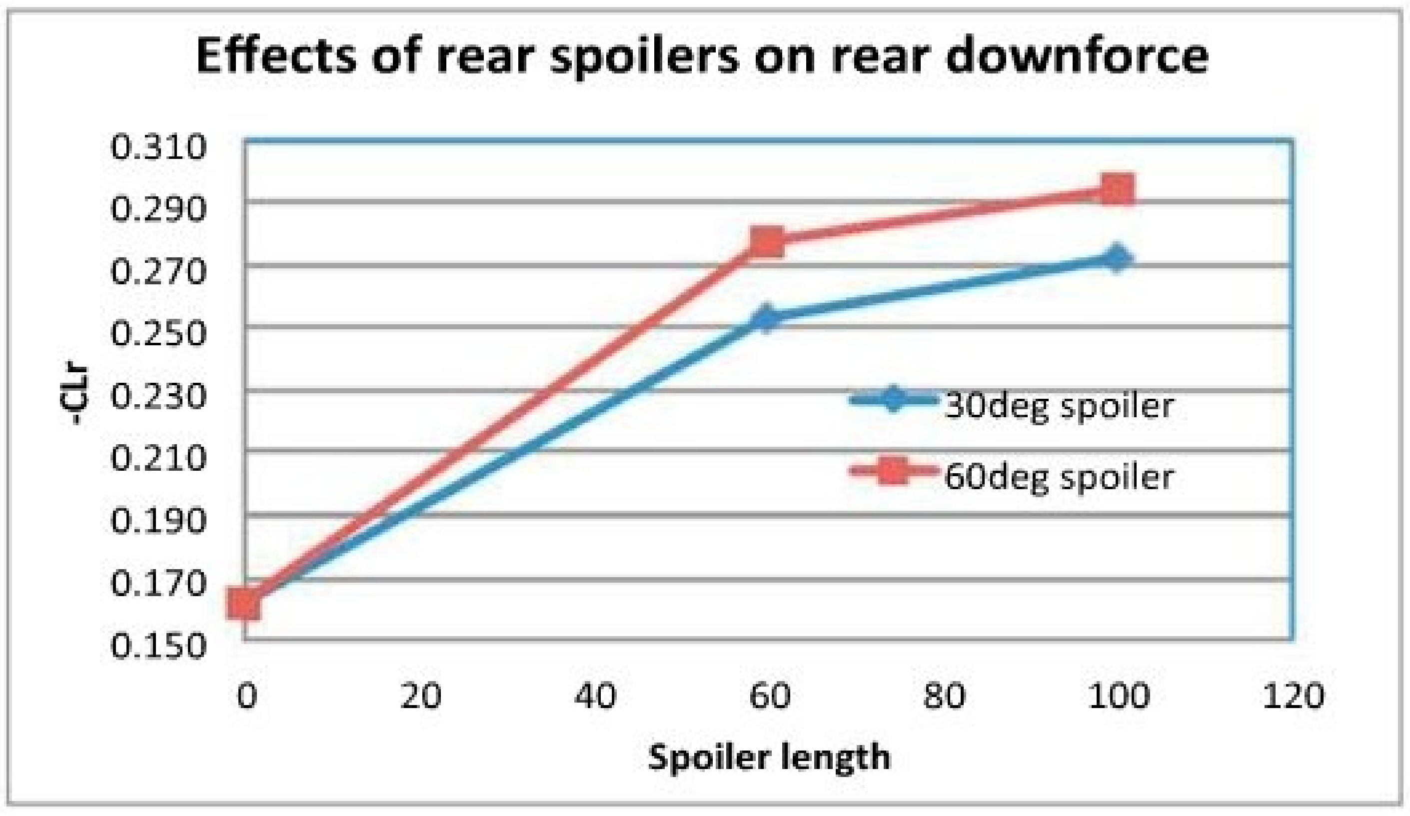


Figure 1: spoiler length and angle versus rear downforce

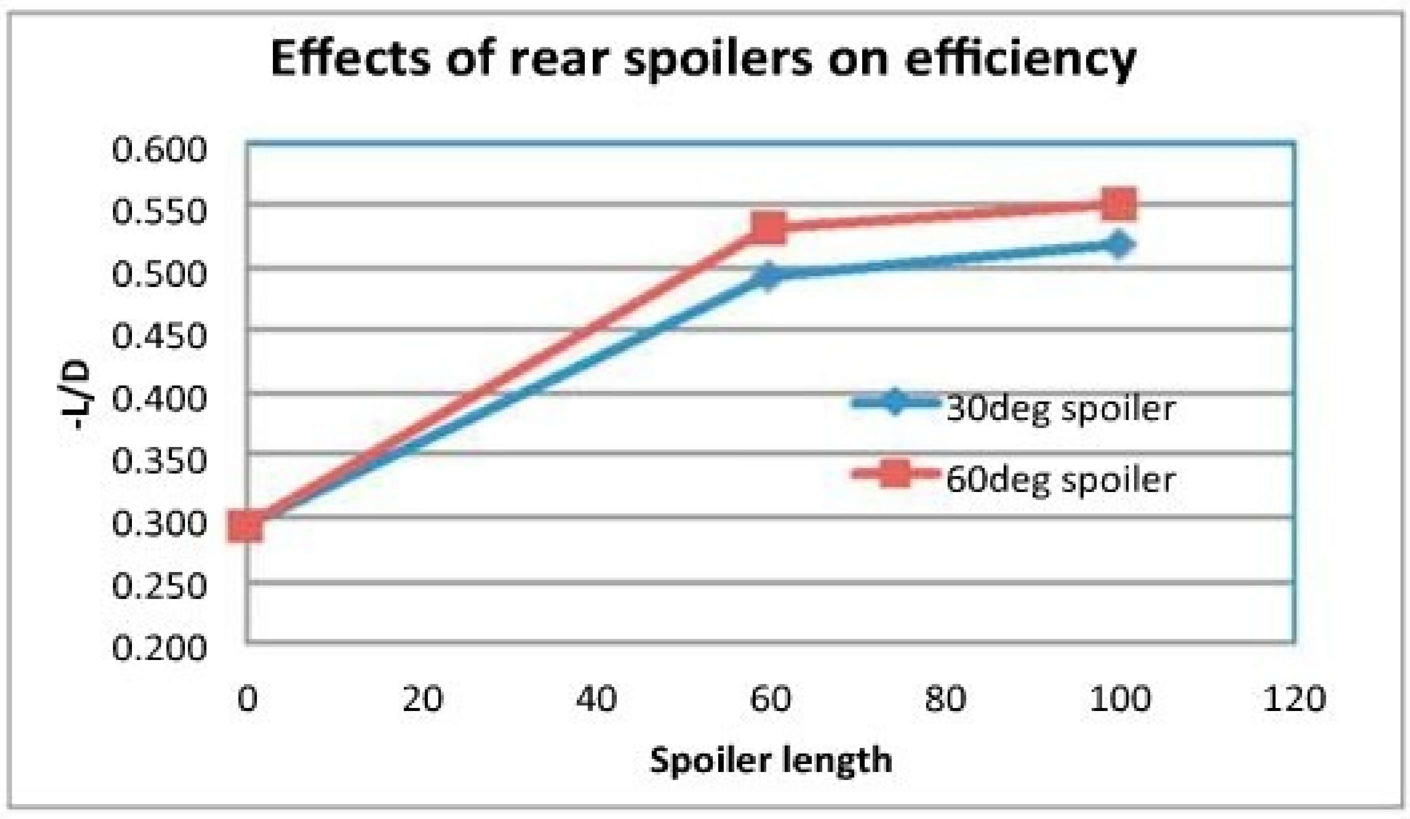


Figure 3: spoiler length and angle versus efficiency

Avon's calling in GTs

From its initial involvement in the British GT championship, Avon Tyres Motorsport has been gaining customers further afield

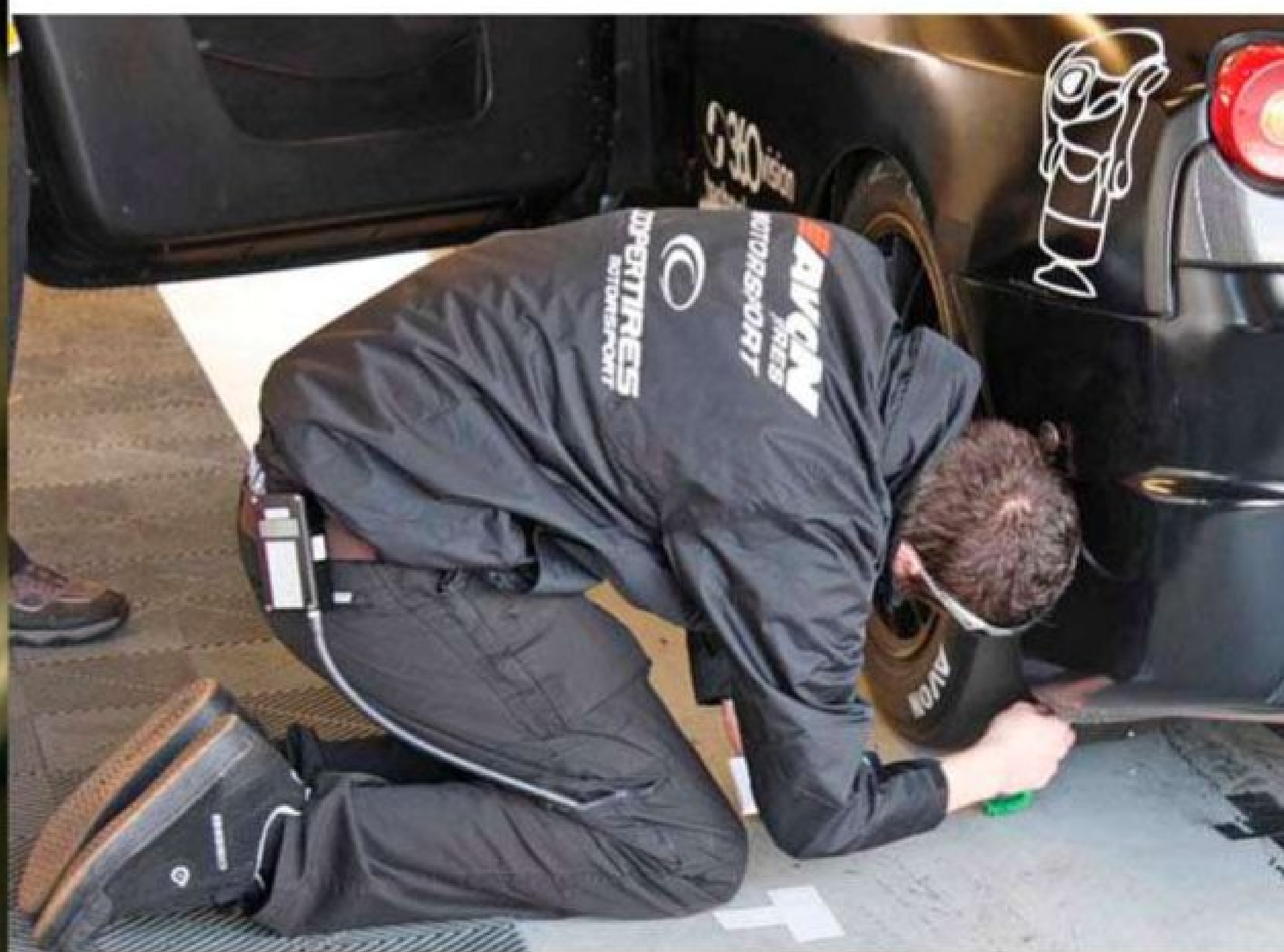
BY SIMON MCBEATH

In 2006 Avon Tyres Motorsport became sole supplier and series sponsor to the British GT Championship. Meanwhile in Europe the tyres in predominant use in GT racing were supplied by Michelin, Pirelli and Dunlop, whether in open series or single supply championships. However, Avon has been making inroads in open series in Europe. It was appointed as sole supplier to the European and Dutch GT4 championships until the end of 2014, and also the Italian GT and sportscar championships, with the Swedish GT Championship also switching to Avons in 2013.

How has the company achieved this progress? We talked to Avon's technical top brass at the Cooper Avon Tire & Rubber Company Europe's base, located on the banks of the River Avon (from which the original company name was taken) at Melksham in Wiltshire, England.

'It has been a steep learning curve,' said motorsport general manager Paul Coates. 'We came into GTs with an amount to catch up relative to the rest, and we had limited experience except in Sports Cars and single-seaters, although we knew the tracks from International F3000 and so on. We effectively had one year

Different cars, different sizes. But all the British GT competitors have been running on Avons since the firm became sole supplier in 2006



Monitoring performance at the track is a key part of the raceday support provided by the company's skilled team

to produce new moulds and new tyre sizes, and as we become more familiar we improve with development. But we've had good results already. At the Spa 24 hours in 2011, the CRS Racing McLarens chose Avons [as did the Team Preci-Spark Mercedes and Ecurie Ecosse Aston Martins, seventh and 20th in the race respectively] and we are now a tyre of choice in open competition for specific models. We won't suit every model, but we will be good on most cars.'

So, technically speaking, how did Avon go about developing tyres for the open GT market? Technical manager Mike Lynch explains: 'To an extent, it involves matching "shelf technology" to the needs of the teams. It's about the requirements of the car and tailoring the product to that using compounds and [tyre] spring rates.' Avon's time in British GT since 2006 would, no doubt, have stood it in good stead to tackle other GT markets, but how do you go about matching or exceeding competitors' products in an open series? 'There is obviously no discussion between tyre manufacturers, so we have no idea how others do the job,' said Lynch. 'You can evaluate other tyres, but you can't really reverse engineer them, so you do what you know best, and at Avon Motorsport we have key people who understand what's needed. Although you start off with shelf technology as a basis, we have had to do specific development. But we have found, for example, that cars that have been running on Michelins have been quite easy to make work on Avons too. And as some teams compete in different championships that use different tyre makes, this helps because they don't have to make big setup changes.

'Not only is it technically beneficial for us to be invited into open categories, it is commercially beneficial too. For example, we were asked to be sole supplier for the inaugural Gulf 12 Hours in Abu Dhabi in January 2012. That provided good feedback and the teams have been positive about our capabilities. Hopefully this will be influential in the choice for other one make tyre series – we have picked up the Italian GT Championship for example, and they will run on the same specification and 18in and 19in sizes of tyres as were used in Abu Dhabi.'

"Cars that have been running on Michelins have been quite easy to make work on Avons too"

Logistically, supplying teams in both open and one-tyre make series is a serious challenge for any tyre supplier, but it's interesting that tyre development can actually simplify the challenge. 'When we started doing British GT we went with 95 different specifications of tyre,' said Coates. 'The logistical problems were colossal and the first year was a struggle. We were taking 1200 tyres per round – we had hard, medium and soft compounds, plus intermediates and wets. But with development you can get both durability and performance from a single compound, and that means fewer tyres are needed. So it became easier for everybody.'

Even so, with a wide range of cars in any given GT championship with different weights, different weight distributions, different rim sizes – not to mention varying driver techniques between the professionals and the gentleman racers – making tyres that everyone is happy with is still no cakewalk. 'The constructions in a given series are conceptually similar, although there are some variations with respect to different car characteristics,' said Lynch. 'Compounds are consistent across the range, but there is a wide range of sizes from 12in to 18in wide in different diameters. Balance of performance measures can help, but the aim is to provide tyres on which the teams can

Having been sole tyre supplier to the British GT for the past seven years, Avon are now branching out into Europe, including supplying Dutch GT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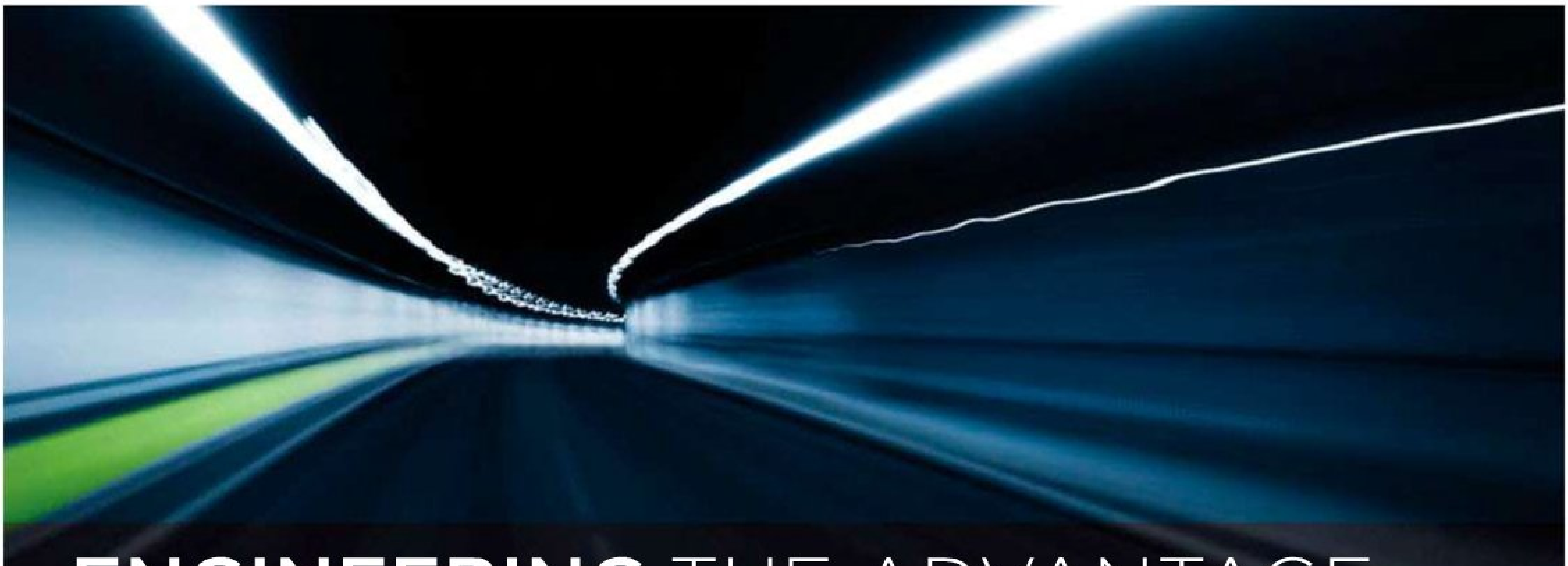
GREAVES MOTORSPORT



compete happily. So you come up with a product for a range of cars initially, but then you aim to improve longevity and consistency without losing ultimate performance and that part is mainly down to the compounds.'

Asking a tyre engineer to explain exactly what goes into a tyre compound is akin to asking an engine builder to explain what matters most in the design of a cylinder head – neither is going to give away hard won knowledge and experience, especially through the pages of a widely-read industry journal. Suffice to say here that there are natural and synthetic constituents, some petrochemical-based, some crop-based, and essentially the 'rubber' compound is a mix of polymers, some oil and/or resins, and carbon black in compositions and proportions that can be almost infinitely adjusted. Natural rubber is unlikely to be found in a race tyre these days. 'The components are perhaps not what you might expect,' said Lynch. 'But in the overall performance of a tyre there are also structural aspects too in terms of stability and consistency, so there is probably more physics than chemistry involved.' Lynch himself is a polymer engineer, while Avon Motorsport's compounder is a polymer chemist. So, together with the mechanical engineering side, a range of disciplines is involved.

'But don't think about it as a compound being either hard or soft,' says Coates. 'It's about the heat that is generated as well.' The new tyre for the 2012 British GT championship, the fourth iteration since Avon became sole supplier and sponsor in 2006, took two years to develop and was the tyre that Avon took to the Gulf 12 Hours in Abu Dhabi in January 2012. It is said to be around a second a lap quicker around most of the tracks used in the British GT championship, more consistent and have a wider operating range too. 'It is more consistent and faster, and will provide a more stable drive, so our drivers should feel more comfortable when pushing their cars to the limit,' said Lynch. 'We found in testing that the drop-off in terms of grip was almost insignificant, so drivers wishing to use a longer-stint strategy will be able to do so.' A new wet weather tyre has also been produced which is also expected to be quicker and easier to drive than its predecessor.

"With the new tyre, our drivers should feel more comfortable pushing their cars to the limit"

The Avon brand is used in GT racing, whereas parent company Cooper Tires is branded on the British F3 series


Things have changed somewhat from Avon's early British GT adventures, where they took 1200 tyres to each round

Avon's developing expertise in the GT tyre market is now bringing its rewards through a raft of new contracts, and Paul Coates confirmed the company's intentions to move forwards in similar vein: 'There has been a steady and relentless development of our GT products since their introduction in the British GT Championship in 2006, and our reputation in GT racing has been growing ever since. Our GT tyres are now the product of choice of many top teams in open competition situations, and we are justifiably proud of the level of performance that we have achieved.

'The new partnerships, as well as being sole supplier to the Gulf 12 hour race in January, show that Avon is now seen as a world-class supplier of Grand Touring tyres. We intend to continue development of our products and increase further our involvement in international Grand Touring and sportscar racing.'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Mussett Racing MR-1500T
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Produced in partnership with Geoff Page Racing, the new Mussett racing MR-1500T utilises a CNC machined, aerospace specification, aluminium alloy crankcase mated to a highly modified Suzuki Hayabusa head. This design allows the engine to be bolted directly to the vehicle bulkhead and removes the packaging problems normally encountered when using motorcycle engines in automotive applications.
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Height 466mm
Dry weight 76kg
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Capacity 1489cc
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Championship challenger

After a remarkable British Hillclimb Championship winning streak was broken last year, Gould Engineering's GR59 was a long time in the making, and attracted the attention of Formulec in build

PHOTOGRAPHY BY SIMON McBEATH and STEVE WILKINSON

BY SIMON MCBEATH

Gould GR59 chassis number one made its long-awaited first track appearance back in April 2012

When OMS won its first British Hillclimb Championship in 2012 with driver Trevor Willis's 3.2 OMS 25 Powertec, holding off Gould-mounted three-time champion Scott Moran, it marked the end of an unprecedented 14-year run of British titles for Gould Engineering. Indeed, 2012 was perhaps one of the most open seasons in recent years, with no fewer than five different marques taking 'Run Off' victories, GWR, DJ and Force winning those that Gould and OMS did not. This was in marked contrast with the situation of a few years ago when Gould dominated both in terms of the number of its chassis being used and in terms of wins. But a hiatus in new cars appearing from Newbury, UK-based constructor Gould had masked the fact that they have been quietly working on the design and build of their latest challenger, which made its long-awaited track debut at the annual pre-season test session at Gurston Down hillclimb last April. We caught up with David Gould, co-founder and partner of Gould Engineering, the company he runs with son Sean, to learn about the thinking behind his svelte new turbo challenger.

BASIC CONCEPTS

Hillclimbing's past has seen the pendulum swing to and fro between 'small and nimble' and 'large and powerful' racecars. With a wide range of track types, the preferred choice can alter from weekend to weekend, but the best concept for overall championship victory has also fluctuated on a longer timeframe. After a run of championship wins for Hart four-cylinder based engines through the 1980s, since 1990 F1 or Indycar V8-based engines have dominated, with the exception of 2001/02 when the talented Graeme Wight Jr took his 2.8-litre V6 DTM Opel-powered Gould GR51 to consecutive championship titles. From 2003 to 2011 the championship has been won by 3.3 then 3.5-litre versions of the Nicholson McLaren Engines Cosworth XB-based NME V8, 2012 of course going to the Powertec V8 in 3.2-litre guise.

However, recent seasons have shown that the 'small and nimble' approach using one or other variant of the motorbike engines now available can do more than just cause the occasional surprise. For example in 2012 the lightweight 1600cc GWR Raptor enjoyed several wins and snapped up two hill records. And supercharged and turbocharged versions of the ubiquitous Suzuki Hayabusa engine have been getting more potent and more reliable in recent years. Which leads us nicely to the new Gould.

David Gould gave his first championship winning car, the 84/2, a run out in 2012 at the Harewood Hill 50th Anniversary event

The first GR59 to hit the track (two more were in build in December 2012, one of which will be ready for the 2013 season)

The GR37 was Gould's first customer car, and an immediate success, winning the BHCC titles between 1998 to 2000

The GR51 took the 2001/02 BHCC titles with 2.5 V6 DTM power. It now features an ethanol-fuelled 4.0 Judd EV

The GR61X was a GR55 with different upper chassis; powered by NME V8s, the GR55/61X took nine consecutive BHCC titles from 2003-2011

was propelled by a supercharged 1300cc Hayabusa engine. Hillclimb technical regulations mandate a 1.4 equivalency factor for pressure-charged engines, and with one of the class capacity splits for single-seater racing cars being at 2000cc, the maximum swept volume in this class for a 'blown' engine is 1428cc. One of the popular conversions for the Hayabusa is a large bore kit that takes the capacity out to 1400cc, and this would initially seem like an ideal basis to pressure charge and stay under the 2000cc limit with equivalency factor applied. But some engine builders have found that the small bore spacing, and subsequently limited amount of head gasket material between cylinders, was less than ideal when pressure charging. So, for reliability reasons the standard 1300cc capacity of pre-2008 engines is generally preferred.

The second GR59 will be turbocharged, however, which will make for an interesting comparison alongside its sister car. But why was the pressure-charged bike engine route chosen for the GR59? David Gould recounted the underlying philosophy: 'We started with an understanding of just how expensive racing engines have become,' he says. 'With the GR55B the engine and transmission cost roughly double what the rest of the entire car did, so we felt we had to find another solution. And the motorcycle engine with integral gearbox was a logical route. Even highly developed we reckon it will be 10 times cheaper. And most importantly we also felt that with 350 to 400bhp the car could probably match the times of the earlier cars, but it would have to be a light car with a very good aero package. This fundamentally dictated the rest of our thinking.

'Other than that there are not many constraints in UK hillclimbing, so we thought – why don't we have a go at something really advanced? We decided we wanted to produce a good quality, advanced car using similar materials to Formula 1. And from the company's viewpoint, the car had to be a shop window for our capabilities.' This last comment relates to Gould Engineering's position as a long-time tier 1 supplier of complex composite products to Formula 1, and this level of expertise quite clearly shines through in all respects in the workmanship on the GR59, not just on the composite side but also in the metallic components.

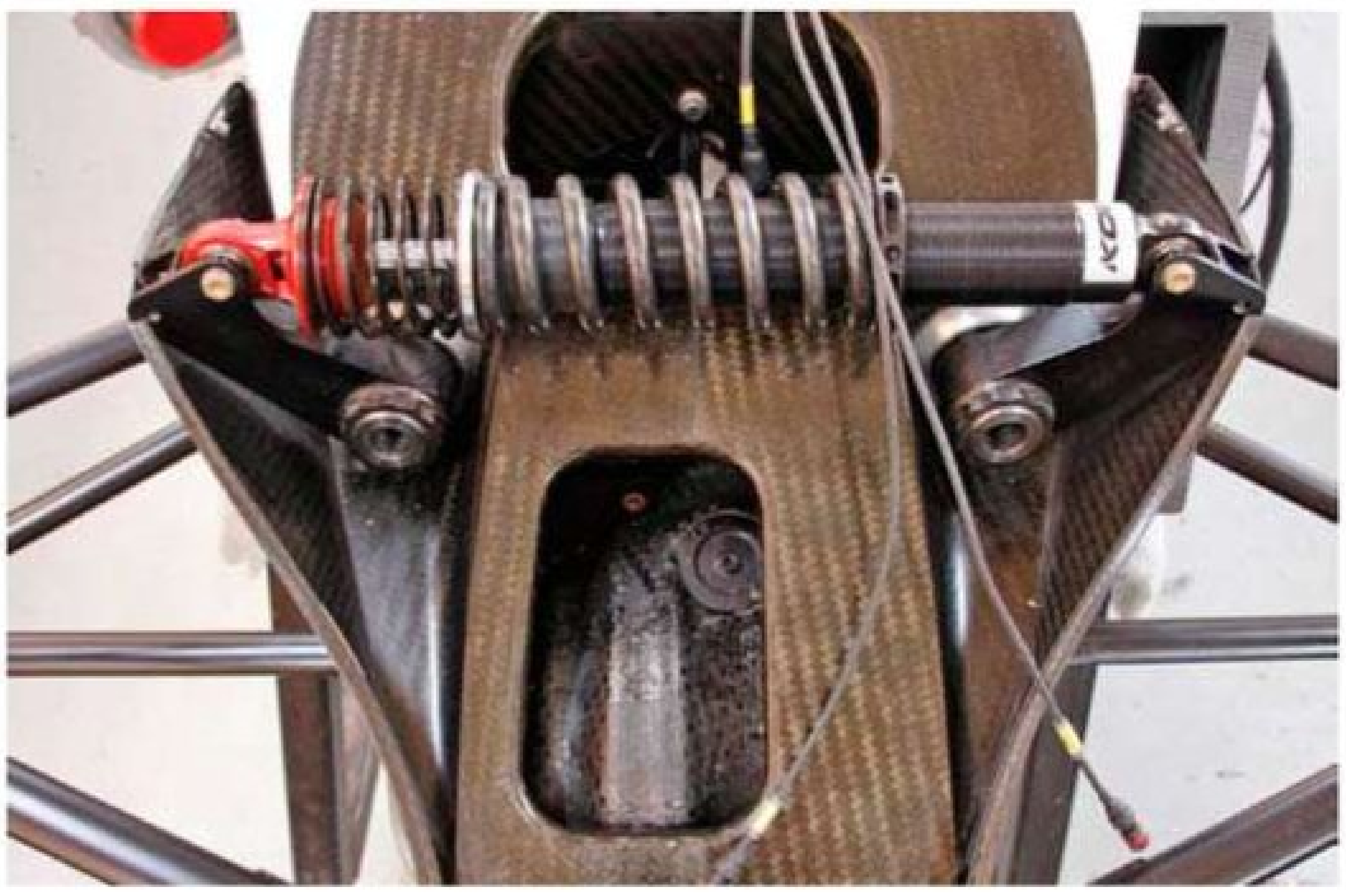
CHASSIS GESTATION

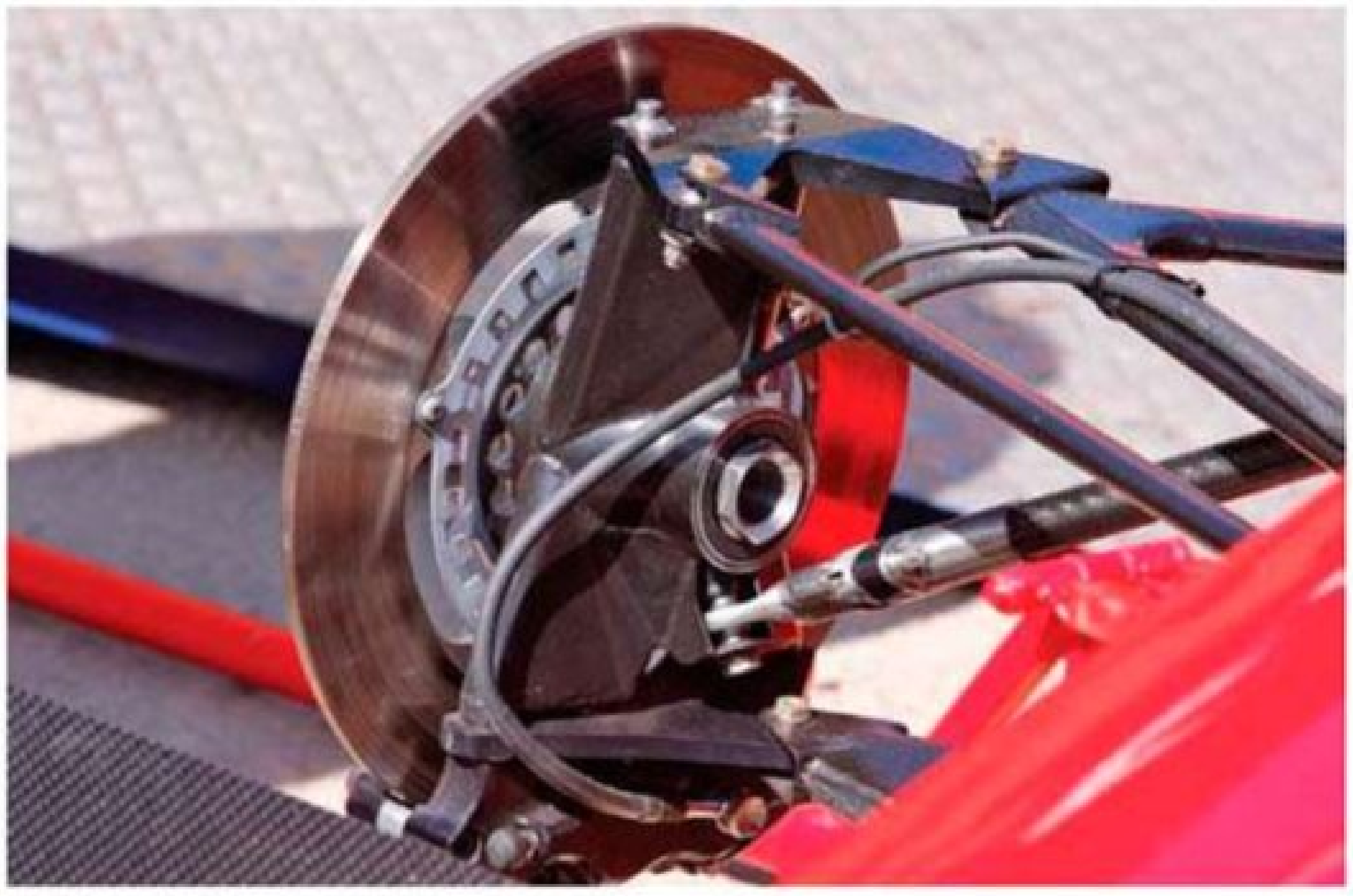
With so few regulatory constraints, some decisions are necessarily slightly arbitrary in nature, boiling down simply to preference. One such decision was to make the cockpit opening of the car adhere to the then current Formula 3 rules as laid down in FIA Appendix J Article 275. Not only was this a safety enhancement for the car, it also led to another business opportunity, as Gould explained. 'We were quite well on with the design, which was laid out to facilitate a no-compromise aerodynamic and weight distribution package for hillclimbing,' he said. 'We had almost completed a monocoque when we were approached by someone from what was then Brawn GP, who were working on a project with Segula Matra for an electric car, the Formulec EF01. They were very interested in our car because it met the relevant safety rules for the cockpit dimensions and roll hoop. And Brawn/Mercedes then did an aerodynamics programme with that design for Segula Matra. This included making a 40 per cent scale wind tunnel model for testing in the Brackley wind tunnel. They developed their own under-body shape to suit the EF01, but out of necessity this shape had to incorporate all the basic chassis shapes, principles and parameters already designed by us. The hillclimb underbody and sidepods were designed by us, with some unofficial help and guidance from Brawn during the later development stage. The underbody, sidepods and rear wing are completely different from the EF01, although the EF01 uses a GR55 front wing with shortened flaps, as does the GR59.'

It's worth pausing briefly to reflect on the changes that have occurred since Gould became a hillclimb constructor. The first British Hillclimb Championship won by a Gould was back in 1985, with the Hart-powered Gould 84/2, an aluminium honeycomb tubbed ground effect car created by the family in a rather cramped residential garage. This car was in fact sitting in the spacious, modern factory that the company now operates from at the time of *Racecar*'s recent visit, receiving a check-over – the tub is still fully usable. For its first foray into commercial construction, the GR37 was based on the ex-Formula 3 Ralt RT37, and this brought three successive BHCC titles from 1998 to 2000.

"There are not many constraints in UK hillclimbing, so we thought – why don't we have a go at something really advanced?"


The roll hoop unofficially passed the F1-specification static load test


The composite differential carrier may be seen through the opening in the rear chassis section, below centre


The front upright and hub. Note the carbon pushrod

The next generation began with the GR51, followed by the GR55, cars which were created around tubs that utilised chassis tooling from the Ralt 93C, as Gould related: 'The GR51/55 used the lower half monocoque tooling of the Ralt 1993 F3 car, although it was completely designed by us, including the chassis layup and every single component in the car as well as the complete aero package,' he said. 'The only thing retained was the external shape of the monocoque forward section and nose, which was as drawn originally by Ralt. This was a compromise necessary to save the prohibitive costs of manufacturing all new monocoque and nose tooling (as well as everything else). The original shape was a handicap we decided we had to live with to make the project viable – the car would have been even more effective if funds had permitted new monocoque tooling as well.' The slightly different GR61X used by Scott Moran to win the 2008/09/11 BHCC titles also utilised the upper chassis tooling of the Ralt F399, purchased by the Morans from Ralt. This featured the later cockpit surround with raised sides, incorporating lateral protective padding.

The GR59 therefore is Gould's first entirely in-house designed car, wherein the monocoque shape and all the tooling has been created from the ground up by them, which fits in with the stated no-compromise approach. The chassis is made in an ingenious modular fashion comprising three main sections, which Gould described as 'the leg bit, the central bit and the rear bit'. 'The electric car was a bit longer overall, to accommodate batteries and so forth, and the rear section was modified accordingly,' he said. The main sections have been made so that the overlaps engage and register at the main bulkhead locations, offering substantial bonding area and consequent high strength and stiffness. The modular approach also theoretically permits partial disbonding in case of needing repair or shape changes.

The roll hoop is the same as that used on the Formulec car, and was actually tested by Mercedes F1 at their Brackley test facility, exceeding the values required to pass the FIA F3 ROPS regulations. The requisite calculations were still needed, however, for the UK's governing body, the MSA, in order to obtain homologation.

Gould has always gone to considerable lengths to ensure their suspension systems offer maximum rigidity, and a look at the fabricated steel uprights at the outboard end of the GR59's suspension shows the same philosophy adopted here, with wide-based attachments. Carbon pushrods are used front and rear, and flexure joints are used at the inboard end of the steel lower front wishbones.

In common with its GR55 predecessor, the GR59 uses a front monoshock, and Gould confirmed that this was a development of the GR55's successful setup. 'There are a number of similarities at the front, with a few more adjustable things,' he conceded. 'We can add or take off tyre loading – the GR55 needed to quite heavily load its tyres before they worked. The GR59 is very light, just 305kg with the supercharger ['wet' but excluding driver], so we thought the ability to load the tyres up, especially on turn-in, was important.'

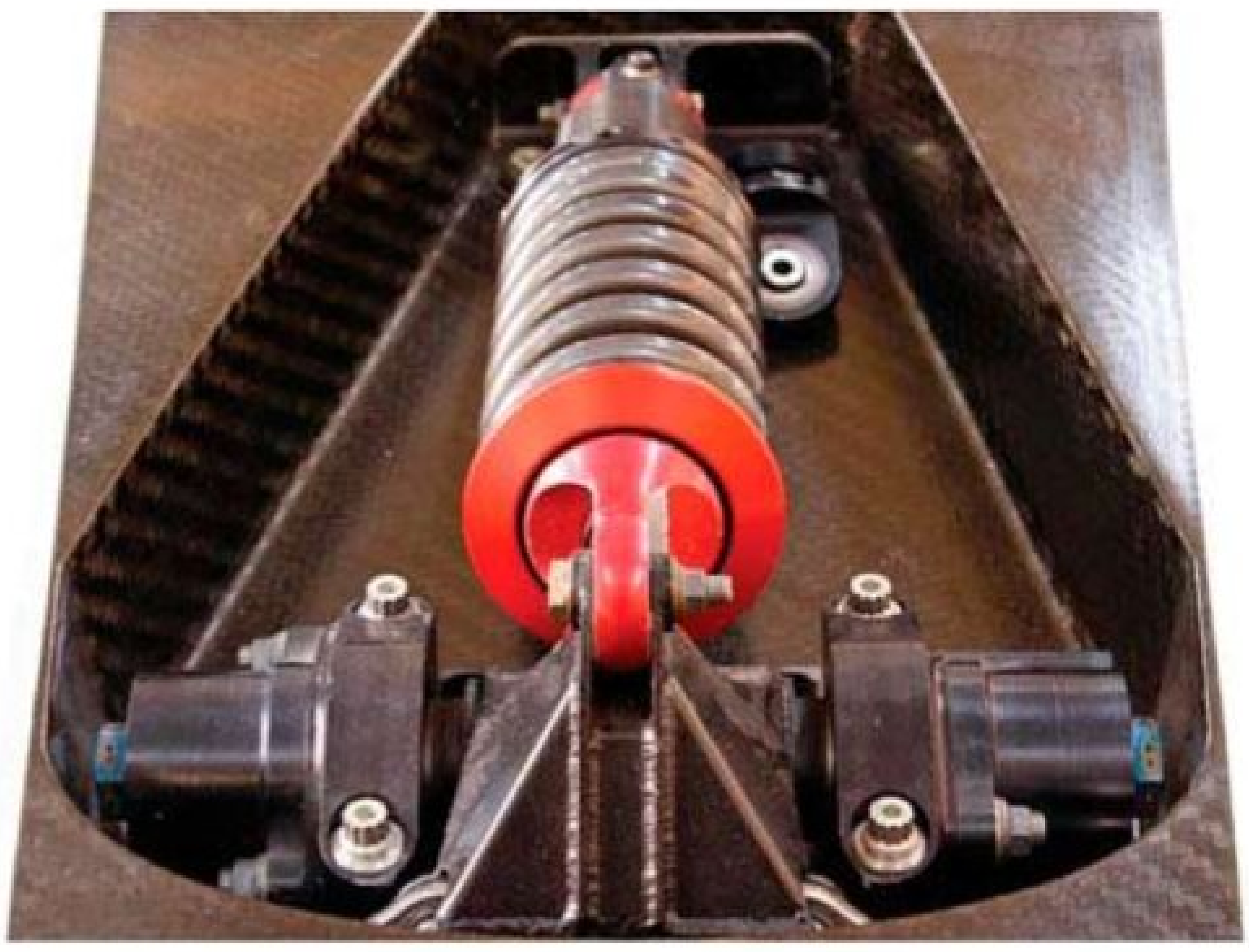
"We think that the new aerodynamic package is worth the extra weight on most hills"

At the rear, the car currently features a three-spring system using a pair of roll spring/damper units (tucked inside the carbon rear end) as well as the pitch control spring/damper sitting across the top of the chassis. There is provision for an anti-roll bar, and intriguingly Gould remarked that they hope to drop the roll damping in 2013 and rely on just the springs.

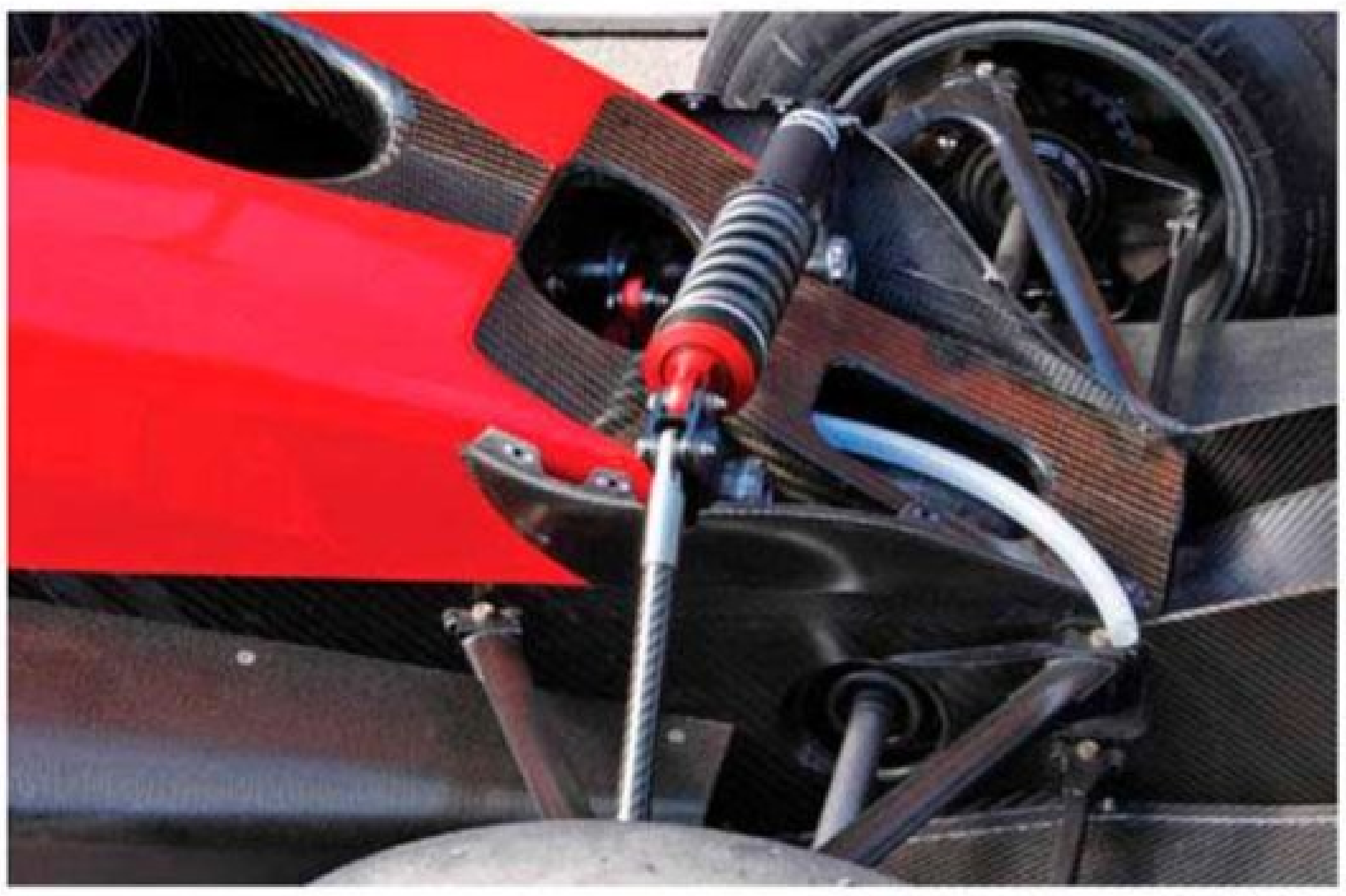
Gould Engineering shunned the more usual chain drive deployed on most bike-engined single-seaters and opted instead for an 'essentially longitudinal' engine/gearbox alignment with a Gould-manufactured steel propshaft driving a bespoke final drive arrangement. However, to get the centre of gravity on the car's centreline, the engine/gearbox had to be offset to the right-hand side of the chassis, and to achieve equal length drive shafts this also required that the engine was angled at some 15 degrees to the longitudinal axis. Furthermore, a large diffuser volume was a key aerodynamic requirement, and this required that the engine/gearbox was angled up at the rear by 10 degrees to its usual installation angle!

The final drive currently consists of a Hewland FTR differential mounted in a bespoke moulded carbon carrier, although Gould aims to make a lighter differential unit at some stage. Why add the apparent extra complication of the non-alignment with the car's longitudinal axis?

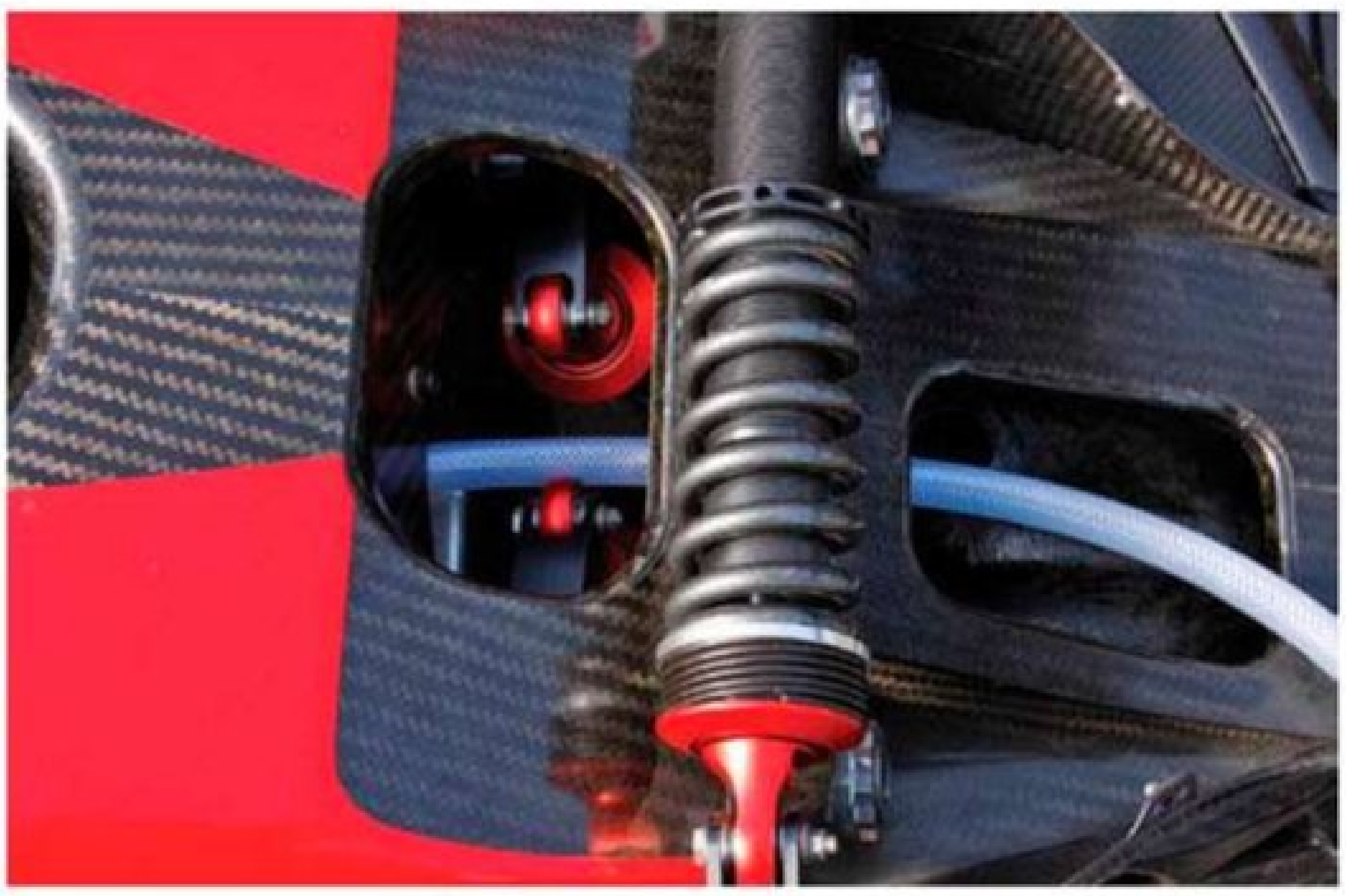
The rear upright and hub carrier



Monoshock front end



The triple spring/damper rear suspension sees the heave spring transversely mounted over the top of the rear chassis...



... while the twin roll springs can be seen tucked inside the rear chassis

Because getting a chain on the centreline would have needed a still larger engine offset, which in turn would have made a symmetric weight distribution harder to achieve.

The engine sits on a stressed carbon composite floor section and is bolted to it via a bespoke dry sump. The underside of this floor section is an aerodynamic surface, connects the rear end to the differential casing via the bottom of the engine and is indexed into the bottom of the chassis. The carbon composite sections above and around the engine are also structural and integral with the tub.

Paddock commentators inevitably point at compromised maintainability with an installation such as this. Gould conceded that there is a degree of compromise here. 'You can get to the fuel and electrical systems easily enough, and the clutch is accessible with some difficulty,' he said, 'Also, the stressed floor and sump are removable with the engine in place, so it is possible to gain access to gearbox internals quite easily – although something seriously amiss would require a two-to-three hour engine removal. But you're unlikely to want to try to fix a major engine or gearbox blow-up at an event.'

AERO PACKAGE

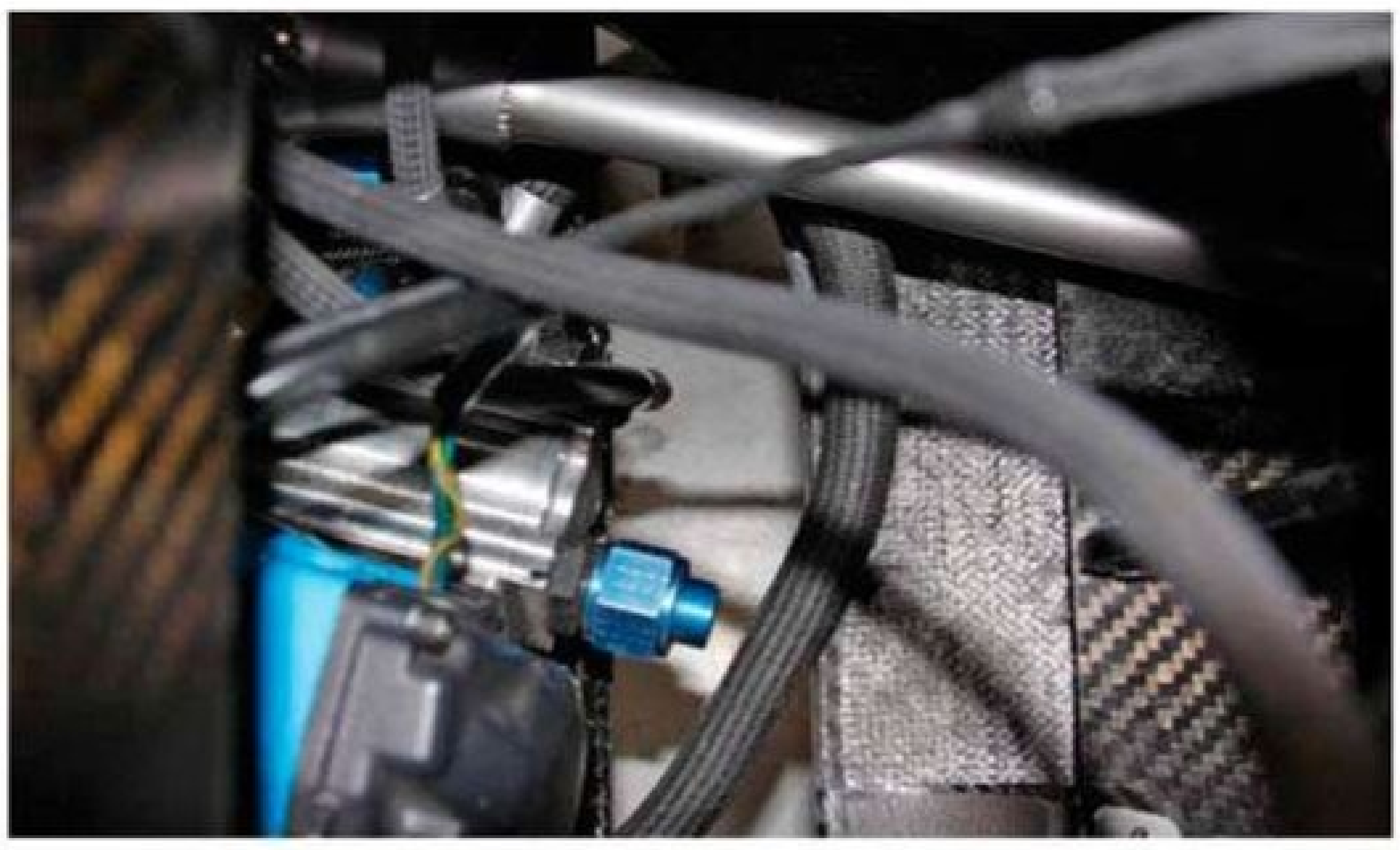
The first impression of the GR59's body and aerodynamic package is of a very tidy and uncluttered setup, the dominant feature of which is the beautifully crafted underbody. UK hillclimbing technical regulations are remarkably free, providing ample design freedoms. However, as applied to earlier Gould designs, with dynamic suspension movement that is – in some aspects at least – greater than circuit racing counterparts would ever see, having a benign aerodynamic package with low ride height and pitch sensitivity is paramount. 'On the GR55 we achieved that, among other things, by progressively raising the front wing height,' said Gould. 'A similar approach has been applied to the current car. The shape of the underbody is well cambered for low sensitivity, but with the large diffuser exit it needed a large inlet too.' This last comment was of course referring to the high sculpted ramps beneath the radiator inlets, which taper sideways neatly to near to the minimum ground clearance level (40mm).

It seems that the Goulds questioned the weight of the aerodynamics package in relation to the target overall weight during the design, despite the projected engine power approaching 400bhp. 'We think the aerodynamic package is worth its weight on most hills, even though there is quite a bit of weight involved,' Gould remarked. In reality the weight of the composite panels available for 'hand checking' in the race shop during *Racecar*'s visit seemed very minor, but then it is with attention to this sort of detail that the overall weight was kept close to 300kg.

Cooling on a pressure-charged racecar is a different prospect to that on a normally aspirated setup, with an intercooler necessary for both the supercharged and turbocharged cars as well as a water radiator. And this is an area still under development after the first somewhat disjointed season with the supercharged car. The cooling layout sees an intercooler and a radiator sharing the right-hand sidepod, fed by diffusing inlet ducts and a split plenum with a variable vane, allowing air to be

"The shape of the underbody is well cambered for low sensitivity, but with the large diffuser exit it needed a large inlet too"

The voluminous diffuser may feature strakes in future



The 15 degree angle between the longitudinal axis, which runs across this image, is reflected in the angle of the propshaft (upper centre) and the end housings on the engine (lower left centre)

The rear wing features the same section profiles as the GR55 but at reduced span and with a single element lower tier

Close attention to internal aerodynamic detail reveals a split plenum featuring twin diffusers feeding the water radiator (centre) and intercooler (left) from a single inlet aperture

TECH SPEC

Category: UK Hillclimb

Class: Racing cars up to 2000cc

Chassis: Carbon composite with aluminium honeycomb throughout

Engine: Suzuki Hayabusa derivatives, supercharged, turbocharged or normally aspirated

Transmission: Suzuki Hayabusa-based gearbox; shaft drive to composite housed final drive; Hewland FTR differential internals mated to bespoke CW&P

Data system: Life as standard, others may be specified

Suspension: Double wishbones, front mono-shock, rear triple spring and damper system

Dampers: Koni 2612

Brakes: HiSpec four piston calipers, solid Brembo discs

Wheels: OZ magnesium, 10in front, 12.5in rear

Tyres: Avon, front 210/550 R13, rear 245/600 R13

Fuel tank: Fabricated aluminium, 4 litres

Dimensions:
Length: 4103mm
Width: 1720mm
Height: 985mm plus roll hoop
Wheelbase: 2450mm
Track: front 1430mm, rear 1370mm

Weight: 280-305kg wet, depending on engine configuration

directed one way or the other. Gould remarked that more work was needed on this to get it absolutely right.

The GR59 uses essentially the same front wing as the GR55, but with shortened flaps, while the rear wing uses the same dual-element profiles as the GR55, but the span has been reduced from the maximum permitted 1400mm used on the GR55 to just 1020mm on the GR59. The belief is that, with its potent underbody, the car will be able to provide sufficient downforce while using less rear wing, which ought to provide good efficiency, as measured by the downforce-to-drag ratio. The currently completely uncluttered underbody leads into the large diffuser with no intermediate strakes present, but Gould did concede that such devices might well appear in future.

It is to be expected that any new car will experience some teething problems in its first season, but it's fair to say that some of the niggles that hampered progress in 2012, about which the Goulds are refreshingly honest, were most definitely unexpected. In some of its early outings, although initial pace seemed to be competitive, a total loss of drive was experienced on occasions as the propshaft managed to disengage itself from the final drive pinion. It transpired that a particular vibration frequency was exciting the snap ring – which would ordinarily have held the shaft securely in place – to hop out of its groove, allowing the propshaft to slide forward and disengage. Once it was realised what was happening, a fix was soon engineered.

'There were also a few issues with the engine lubrication system,' said Gould. 'We were used to dealing with race engines in the previous cars that scavenge very effectively, but the scavenge pumps in these bike-based engines didn't have seals between rotors, so when one scavenge pick-up began sucking air, the other two stages failed to pump as well. We now have a three-stage Pace pump that has fully sealed rotors, so oil will continue to be pumped at all times. It has proven to be a different world dealing with bike engines!'

And perhaps the toughest gremlin to track down involved the quick shift system that developed a habit of changing gear on its own. This was eventually traced to a broken wire sending incorrect signals to the control unit, but not before a good few events had been spoiled.

Teething troubles aside, the Gould GR59 was able to show respectable early season pace, qualifying for its third BHCC 'Run Off' and finishing in seventh place. All involved will be hoping for reliable running in 2013 so the car can demonstrate its true potential.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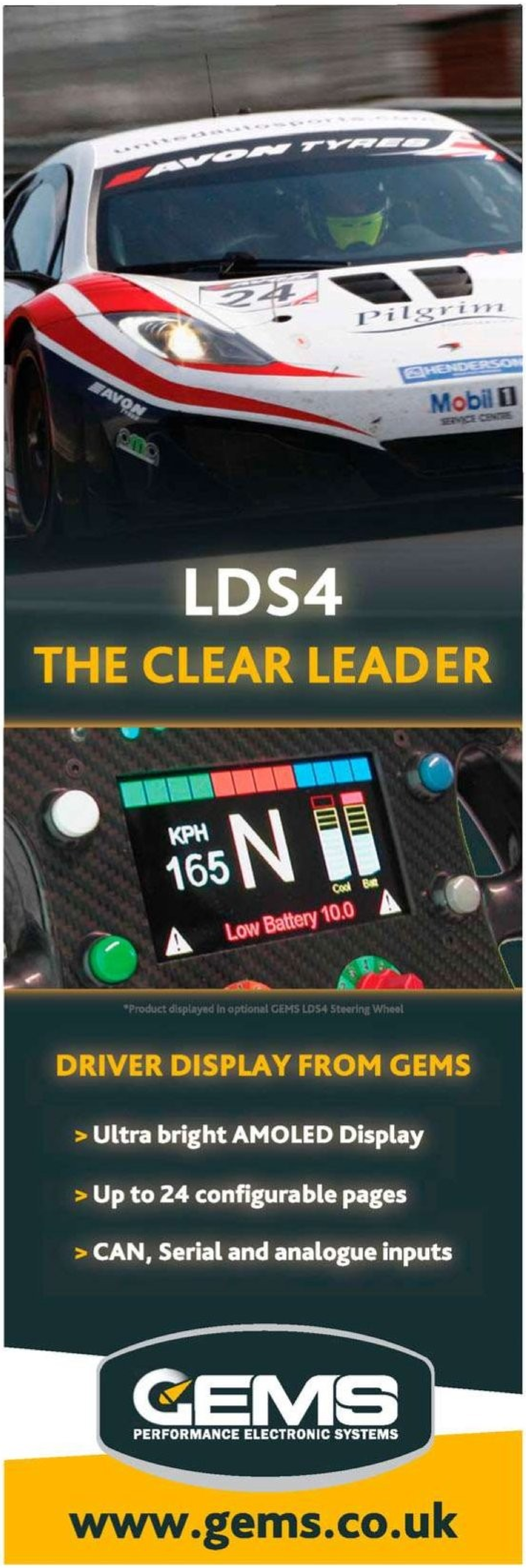
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An extra layer of innovation

Zircotec's award-winning range of coatings are helping to extend the life of components and improve reliability across the board

BY GEMMA HATTON

Rapidly becoming the motorsport equivalent of a household name, Zircotec are taking the benefits of their highly advanced coatings to a host of motorsport sectors including F1, Le Mans, NASCAR and World Rally. 'In F1 last year we supplied 11 of the 12 teams with our ThermoHold for composites coating,' explains Terry Graham, managing director of Zircotec. 'Our coating reduces surface temperature by over 125degC, extending the life of parts as well as preventing structural failure. It is used on brake covers and ducts, floors, airboxes, bodywork, suspension parts and bodywork. F1 teams also use ZircoFlex, our flexible heat shield. They like to carry this to races as it is the perfect solution to solve heat issues in the field. At professional motorsport level, ZircoFlex is also very popular and at national level you'll find more exhaust and turbo coatings. Around two-thirds of the BTCC grid use our exhaust or air filter housing coatings.'

"Around two thirds of the BTCC grid use our exhaust or air filter housing coatings"

Their key range of products include thermal barrier exhaust coatings, to manage engine compartment temperatures and protect sensitive parts from heat damage; carbon composite coatings, providing extra protection against heat and wear, allowing these lightweight materials to be used in new applications which were previously unsuitable; ceramic heatshield products, and turbocharger coatings, to reduce heat loss and increase responsiveness.

In terms of composite coatings, there are several types: thermal barrier coatings, RF (Radio Frequency) and EMC (Electro Magnetic Compatibility) shielding, electrical insulation and anti-wear coatings. Their thermal barrier for carbon composites are plasma sprayed by a 12,000degC flame on to the part to protect against radiant heat, hot gas, delamination and resin-melt. The RF and EMC shielding is a thin layer (usually 0.1mm thick) of highly electrical conductive aluminium with a less conductive sub-layer to prevent electrical contact with the carbon composite. Again, the plasma spraying technique ensures that the coating is well adhered

"We firmly believe that thermal energy recovery in all forms of motorsport will lead to more growth. We are experts at managing heat"

and effectively welded in place, resulting in the coating being highly robust, and resistant to vibration and mechanical damage. The coatings used for electrical insulation are ceramic-based and by providing a connection to earth, they increase electrical safety from high voltage devices.

The advantages of these coatings are astounding. Taking Zircotec's exhaust coatings as an example, it is a fit-and-forget scenario as it is in effect 'welded' to the substrate using a proprietary metal bond system, eliminating the need for exhaust wrap. Not only does it protect components against corrosion, but it utilises an extremely high level of thermal performance which make it suitable for applications of up to 1,400degC. It significantly lowers exhaust temperatures, for example. Surface temperatures reduce by approximately 33 per cent, and this reduction in heat loss results in a lower engine bay temperature by roughly 50degC. At only 0.3mm thick, the coating is very lightweight, yet efficient, and it also offers protection for vulnerable components located close to the exhaust. It avoids heat damage, increasing component life, and allows for closer packaging of equipment inside the engine bay.

Another knock-on benefit is the improved engine performance and reliability. Lower air intake temperatures lead to increased engine power, while keeping the heat inside the exhaust gas allows the gases to flow more easily, increasing cylinder scavenging, and allowing turbochargers to spool up more quickly. Furthermore, it reduces heat soak through foot-wells, bulkheads and other areas so drivers are potentially cooler, more comfortable, and more able to concentrate. The surface temperature of the coating cools rapidly when the engine is turned off, making pit stops faster, easier and safer.

Teams throughout the motorsport world are utilising every gain that these types of coatings can offer. For example, JMW uses Zircotec's Zircoflex which is a flexible heat shield to reduce the heat in the cockpit of their GTE 458, with the secondary advantage of minimising the usage of Air Conditioning which in turn, reduces the required power.

Zircotec have shown themselves to be a highly innovative brand, as January demonstrated when they launched their ThermoHold coatings which also got them shortlisted for *Racecar*'s Graham Jones Innovation Award. 'Engineers who previously had to rely on multiple products to protect composites and heat-sensitive parts from different forms of heat damage can now specify a single coating or heatshield from Zircotec,' says Graham. 'Thanks to its unique combination of ceramic and gold, ThermoHold GOLD (for composites) and its sister product ZircoFlex GOLD provide protection from both conductive and radiant heat sources due to the blend of ceramic insulation and real 24 carat gold providing 98 per cent reflectivity.'

Zircotec discovered that on existing 'gold' heatshields available, not many actually contained gold. These were simply aesthetic finishes with no real improvement in heat reflectivity. Other more expensive products were in fact copper-based and while these are effective when new, copper quickly oxidises when temperatures exceeds 500degC, therefore reducing its ability to reflect heat away. Furthermore, neither of the products tested offered any real protection from conductive heat.

'The reflective properties of gold have long been trusted to protect sensitive components against heat. However, real gold foil is rarely used,' adds Graham. 'It is highly expensive and offers little or no protection against conducted heat. Our new products enable engineers to manage both forms of heat with a single gold finished coating or ZircoFlex GOLD heatshield product, thereby helping to solve packaging and installation issues.

'We firmly believe that thermal energy recovery in all forms of motorsport will lead to more growth. We are experts at managing heat. We can retain higher gas temperatures, for example, that will be ideal for TERS. We are also involved

An example of a ceramic thermal coating on an exhaust system

in electrical applications; we can spray metal on to composites, helping to improve EMC performance. With more composites being used we can enable its use in high temperature applications. This is now happening in road cars.' Zircotec's ThermoHOLD or composites material is used on the Aston Martin One-77 Supercar's diffuser, engine air intakes, and engine compartment chimneys, enabling the engineers to use lightweight materials for these high temperature environments which were previously unsuitable. For instance, the ceramic coatings allow exhaust gas to pass over the carbon composite without damage.

Zircotec's future continues to shine as they expand their products into the world of drifting. A technical partnership with the reigning British Drift Champion, and the Falken drift team, will enable their coatings to be tried and tested. Of course, while drifting, the cars spend the majority of their time travelling sideways which leads to restricted airflow through the front of the car – just one of the reasons behind the extreme underbonnet temperatures. 'The turbos are also close to the master brake cylinder, leading to reliability issues,' explains Paul Cheshire, who drives and prepares the drift cars. 'By coating both the turbo and the manifolds we aim to improve performance, increase reliability as well as becoming a rolling-real-world test bed for Zircotec. Already, initial results have suggested major potential for performance gains by introducing Zircotec's coatings to this discipline. 'The coating immediately provides a 200rpm improvement in spool-up time,' adds Cheshire. 'This creates a worthy advantage during competition as we need the power to set up the drift.' Early tests on the rolling road suggest that – with the addition of the coatings and the other engine upgrades – a 60bhp increase has been achieved compared to last year.

This partnership with Falken is similar to previous arrangements with Team DynoJet's BTCC Toyota Avensis and Team JMW's Ferarri 458 GTE and is Zircotec's effective way of advancing their range of ceramic thermal resistance coatings by using cars in competition to gather test data under the harshest environments. This partnership with Falken will raise awareness of the performance gains these coatings can offer to the drifting sector of motorsport.

ADVANCED ADHESIVES

Continuing the theme of extreme thermal resistance, Intertronics have developed the Polytec PT range of Polymide adhesives, which can withstand higher temperatures (approximately from 240-500degC) than other typical organic adhesives. These polymides are available as electrically conductive, thermally conductive and electrically highly insulating adhesives and coatings which can be utilised through dispensing, jet-dispensing and stamping techniques. These advanced adhesives can be used in many applications such as semiconductors, photovoltaics, sensors, fibre optics and general electronics. The Polytec EC P-690 has been qualified for a high temperature die attach (1.4mm chips) for operating temperatures up to 300degC in an application where it has the highest die shear strength of all the polymide adhesives tested.


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Setting the standard

Based in the heart of NASCAR, the AeroDyn wind tunnel has been chosen to validate the figures for the Generation 6 cars

The 2013 Lowe's Chevrolet SS during wind tunnel testing

The introduction of the Generation 6 cars to NASCAR has meant a reliance on the expertise of the wind tunnel specialists, and in particular the AeroDyn facility in North Carolina that was chosen by NASCAR to make the final verification for the bodies ahead of their introduction at Daytona.

AeroDyn will this year celebrate its 10th anniversary, having accepted its first paying client in April 2003. Since then, it has seen business expand rapidly in the first five years, before the financial crash in 2008 that led to a gradual decline in trade over the next two.

However, since 2010, business has picked up once again, and its reputation has strengthened considerably. In the company's early years, their main tunnel - which offers a boundary layer control, spinning wheels and an automatic ride height adjustment that is accurate to the third decimal percentile - was in use 24 hours a day, five days a week, plus extra time on Saturday. They're now running 18 hours a day, five days a week, which is - says general manager Steve Dickert - a more comfortable position to be in, allowing engineers time to maintain the facility between sessions.

'AeroDyn was the first wind tunnel in the United States designed specifically for NASCAR race series,' says Dickert. 'Of late, we have been able to offer some testing capability to OEM manufacturers that they don't get in their own wind tunnel - very controlled and accurate boundary layer system, and automated ride height control system that is accurate to the third decimal place. Those are functionalities that wind tunnels at GM, Ford and Chrysler don't have, all at the same time.'

The move to the new cars, coupled with the official sanction from NASCAR, has meant that the tunnel is busy enough, and the work is becoming more complicated. Teams have to start from scratch with their aero figures as there is no baseline from which to work with the Gen-6 cars. It has been six years since the last big rule change to stockcar racing, and the engineers are, from an aerodynamic point of view, pretty much starting afresh.

"The level of teamwork between NASCAR and manufacturers is unprecented with the new cars"

'The cup teams are extremely sensitive to security,' adds Dickert, 'so we can't have us be a conduit for one cup team's advantage to another cup team's advantage. We provide and operate a precision laboratory that meets or exceeds the needs of our customers.'

The Gen-6 cars have required much the same aerodynamic development as previous generations, but have to immediately be on the pace in a closely contested environment. Much as Formula 1 is looking ahead to the rule changes in 2014 with apprehension after one of its closest seasons ever in 2012, the pressure is on for the NASCAR teams to get it right first time out in 2013.

Wheels are not rotated in A2, the smaller alternative to the main tunnel

A last generation car on the move in the main AeroDyn tunnel

'It is interesting that the level of teamwork between NASCAR and manufacturers is unprecedented with the development of the new cars,' says Dickert. 'The development has always been driven by NASCAR, but this time it really is a team effort.'

The AeroDyn tunnel is built to accommodate full-scale cars only, with speeds up to 130mph. The loads from 130-200mph are linear with dynamic pressure. 'With scale model testing, there is a significant Reynolds number mismatch - for example a half-scale model must be tested at twice the full-scale speed. By using the full-scale car you can appreciate the deflections,' says aerodynamic consultant Gary Romberg. 'We think that gives a better simulation to what you get on the track. Our normal testing is 130mph, but we can run other speeds below that, and even a few speeds above it. The general speed is 130mph, which is almost 40lbs/sqft in kinetic energy.'

Also on site is the second wind tunnel - A2. This tunnel is a smaller, economical solution for customer teams that are involved in everything, from land speed record attempts to road racing, and karting. Available at $490/hour, the company also offers aerodynamic expertise through its own dedicated staff says David Salazar, general manager of A2.

'It is a smaller tunnel, of the same design as AeroDyn with an 85mph maximum wind speed. It does not have spinning wheels, active boundary layer control or ride height control,' says Salazar. 'What is does have is a greatly reduced rate, so that smaller teams and privateers - and by privateers I mean people who are attempting land speed records on salt flats, they come there quite regularly. They can get large gross aero advantages for very little money in a very controlled laboratory.' This can be essential to them, and, for a series were the winner gets a hat colour coded for various speed categories. This proves to be a great tool when on that kind of out of pocket budget.

Most of A2's customers come in as first time users and have never set foot inside a wind tunnel. As such, A2 offers assistance for these teams to help point them in the right direction and teach them how to understand the wind tunnel data. This assistance is valuable because most people are intimidated by testing in a wind tunnel for the first time and don't normally know where to begin. Along with this help is the understanding that A2 does not develop the cars or tell them what other customers are doing with their aero programmes. As many low budget teams don't have an engineer, the firm can offer some assistance in guiding them along until they better understand the process.

"With NASCAR's new cars, the rules are so tight that teams look for microscopic changes"

DEVELOPMENT PROGRAMME

Since opening for business in April 2003, AeroDyn believes that it has tested more racecars than any other independent wind tunnel in the world. It has tripled the amount of data customers collect in a single test session, improved repeatability from 1 per cent to 0.8 per cent, and decreased fault-related down time by a factor of six.

In the period since 2006, AeroDyn has added the following upgrades to the facility:

Ride Height System

Installed in November 2006, the new system is completely computer operated. To increase testing efficiency, teams provide a complete map of heights they

CFD CAPABILITIES

The management team at the AeroDyn facilty do not consider the rise of Computational Flow Dynamics (CFD) to be a threat to its wind tunnel business, having investigated with teams and manufacturers the viability of providing in-house expertise. Most of the teams and manufacturers have their own capabilities, and even the smaller NASCAR teams on the grid have access to such data.

'Nasa has said that CFD and wind tunnels are not at odds,' says AeroDyn aerodynamic consultant Gary Romberg. 'They are complementary.'

EXPANSION PROGRAMME

Having developed a strong reputation within NASCAR, AeroDyn is now looking to expand beyond the confines of stockcar racing, and has started working with teams in Indycar, Grand-Am, and the American Le Mans Series, already with promising results.

'We've had some data with an Indycar team which correlates very closely with what was achieved on the track,' says general manager Steve Dickert. Although European tunnels are looking more to alternatives to motorsport, AeroDyn is looking more at OEMs. 'Manufacturers do have their own tunnels, but most of them don't have the capabilities of the rotating wheels, extensive boundary layers, and precise ride height settings, so we think this is the area we can expand into,' says Dickert.

There are no plans to build a third tunnel, however.

would like to run for a given test. The height tables are imported into AeroDyn's system. This has dramatically increased the efficiency of ride height studies, as well as controlling heights within 0.001-inch.

Automated Yaw System

This system, added in January 2008, is completely computer operated and uses the latest in measurement technology to assure accuracy and repeatability. Standard yaw increments are pre-programmed, based on the customer test schedule. Additional yaw increments can be input with resolution to 0.1 degrees. The accuracy and speed of establishing each yaw setting has increased testing productivity significantly.

New Test Section Floor

Based on the introduction of the Car of Tomorrow, the test section floor was redesigned in June 2008 to increase the performance of the floor boundary layer control. The splitter and front end under-body is an extremely sensitive area on the car. As such, the boundary layer system was significantly improved and offers a very good simulation. The total power in the boundary system is now four times what it used to be.

Active Boundary Layer control

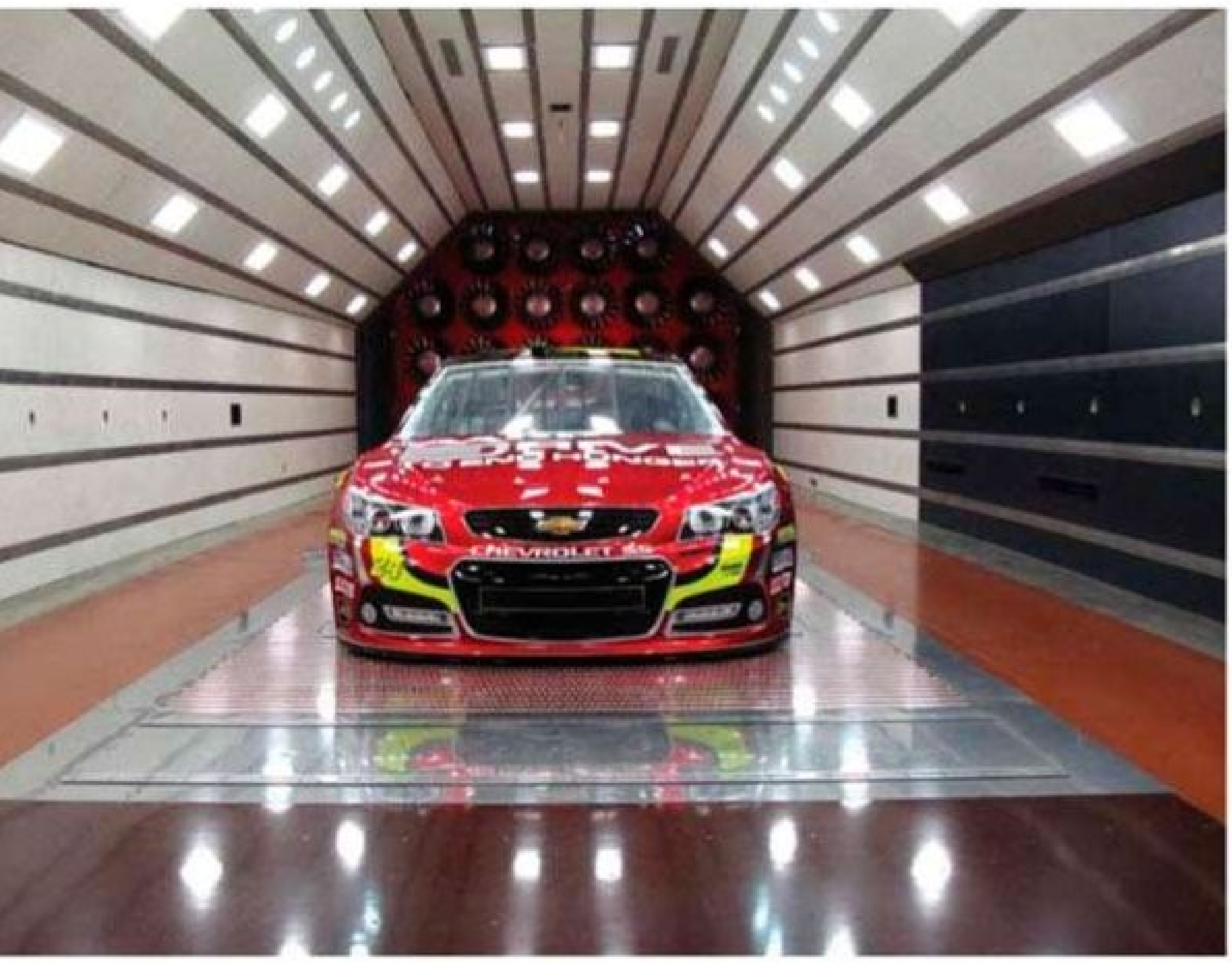
This system, added to the facility in January 2010, is completely computer controlled. By changing the boundary layer control from a 'passive' speed setting to an 'active' pressure setting, the system very accurately matches the boundary layer conditions to actual free-stream dynamic pressure in order to maintain a constant Cp ratio. As a result, the overall tunnel sensitivity is extremely high and the smallest, most subtle changes to a test model can be measured.

HD Camera System

Incorporated in February 2010, this is a completely new system and again is 100 per cent computer controlled. Most tunnels simply provide viewing of the test model through a window, and often only one side view of the model is available. AeroDyn's customers have the ability now to view the model in real-time, in HD (1080p) resolution, and eight different camera angles. The system is valuable in studying panel deflections, flow vis, and model integrity during a test. The data collection system is programmed to automatically capture a snap shot of all eight camera angles at the beginning and of each data point. Additionally, the customer has the ability to record video in 1080p of any camera angle. The video is then downloaded to a customer external hard drive at the end of the test.

Increase Yaw Sweep

The original yaw system was +3 to -3 degrees. With the advent of the new car design, it became necessary to gather data to -5 degrees. This upgrade, added in November 2010, required significant modifications to the tunnel floor, balance, actuation system and data collection.



The test section floor was redesigned in 2008 to increase the performance of the floor boundary layer control

THE OPPOSITION

Windshear was formed in 2006 to provide full-scale rolling road wind tunnel access to North American and international teams. Their facility opened in September, 2008, the first facility of its kind in North America, and the third rolling road wind tunnel that operates on this scale. It was also the first full-width rolling road that supports full scale vehicle testing.

The project was funded by Haas Automation, the company that owns Windshear. Facility design and construction were overseen by Jacobs Technology, whose engineers manage the day-to-day operation of the tunnel.

The air in this closed-circuit wind tunnel covers and area of 160,000 square feet, its main fan is 22 feet in diameter and rated at 5,100 horsepower, capable of producing air speeds of up to 180mph. Air temperature is tightly controlled to within 1degF.

The MTS Flat-Trac Rolling Road measures 10.5 feet wide by 29.5 feet long. It easily keeps pace with the wind, accelerating from zero to 180mph in less than a minute. This 'road' is actually a continuous stainless-steel belt just one millimetre thick. During testing, the through-the-belt sensors precisely measure the aerodynamic downforce under each tyre.

The facility's 40-hour weekly operating schedule is filled with NASCAR and Indycar racing teams from all over North America. Teams from Europe and Asia are also bringing their wind tunnel testing to Windshear.

NASCAR WIND TUNNELS

AERODYN

Also known as 'Eaker's place', AeroDyn was built expressly for the purpose of testing stockcars, and its Mooresville, North Carolina location means that many teams frequent it primarily for the cataloguing of cars. 'We built the walls for stockcars, not for everything from Formula 1 to karts and everything in-between,' explains the tunnel's creator Gary Eaker. 'We have defined that we deal with stockcars and trucks only – we lock these walls and leave them where they are at.'

Opened: 2003
Scale: 100 per cent
Type: Closed Jet with slotted walls
Rolling Road: None, wheels spun on rollers
Max airspeed: 130mph (147mph possible with recalibration)

A2 Tunnel

Opened: 2006
Scale: 100 per cent
Type: Closed Jet with adaptable ceiling
Rolling Road: None
Max Airspeed: 85mph

ARC

The most popular scale tunnel for NASCAR teams is surprisingly not in North Carolina. In fact it is some distance away in Indianapolis. Auto Research Centre (ARC) not only provides its 50 per cent scale tunnel for use, but also makes many of the models used by teams, often in collaboration with C&R Racing.

Scale: 50 per cent
Type: Open Jet
Rolling Road: Belt

WINDSHEAR

Windshear (see sidebar left) is a very large three-quarter open jet rolling roadtunnel situated on the edge of Concord Airport in North Carolina.

This facility, opened in 2008, is capable of running at speeds of up to 180mph, and is climatically controlled. Emphasis has been placed on the full-scale tunnel being used by NASCAR teams though IRL and Formula 1 teams, including Lotus, have also used this facility extensively. Reliability and repeatability are the focus of the technical team behind the tunnel.

Opened: 2008
Scale: 100 per cent
Type: ¾ Open Jet
Rolling Road: Steel belt
Max airspeed: 180mph

Initial testing
A vehicle dynamics perspective

You're presented with a new car for analysis – where do you start?

BY DANNY NOWLAN

I've been involved in the business of making racecars go fast now for over 18 years. This has spanned a career as a data and race engineer, vehicle dynamicist, instructor and business owner. I've had the privilege of working on a wide variety of racecars, spanning open wheelers, sports prototypes, touring cars and GT cars. Yet despite all this I have never seen a comprehensive guide on what to do when you have a brand new car and you don't where to start.

In a world increasingly dominated by spec formula and tightly controlled testing, your initial testing programme becomes very important. A lot of the testing I've seen typically boils around taking a given start setup and making small adjustments to it. There's nothing wrong with this, particularly if the spec formula maker has done a good job. The problem is that they rarely do so. Consequently if you find something with the car, it's generally more by luck than design. So how can we make this process deliberate and draw on our knowledge of vehicle dynamics?

Our first port of call, not surprisingly, is to figure out how much downforce we are running. This has a lot of impact on our testing because as the downforce increases this will increasingly dominate the setup of the car. As a rough rule of thumb, if you are dealing with a C_LA of 2.0 or greater and the mass of the car is less than, say, 1250kg, then aero testing becomes a priority. As another rule of thumb, if C_LA/total car mass is greater than 2, you need to have an aero testing programme. To assist you in getting a feel for the downforce to expect I've quoted some typical C_LA numbers below.

Table 1: typical C_LA and C_DA numbers for various racing cars

Car	C_LA	C_DA
Touring car	0.5 - 1.4	0.9 - 1.3
FIA GT3 - GT2	1.7 - 2 (configuration dependant)	0.9 - 1.3
F3 or equivalent	1.5 - 2.7 (configuration dependant)	0.7 - 1.1
F3000	2.4 - 2.7 (configuration dependant)	1.2 - 1.3
Champ Car	4.5 - 5 (configuration dependant)	1.6 - 1.8
LMP2	3.5 - 5 (configuration dependant)	1.3 - 1.6

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Table 2: suggested aero test procedure	
Run No	**Setup**
1	frh_0 and rrh_0 + baseline rear wing
2	frh_0 and rrh_0 + d_rrh + baseline rear wing
3	frh_0 and rrh_0 + 2*d_rrh + baseline rear wing
4	frh_0 and rrh_0 + 3*d_rrh + baseline rear wing
5	frh_0 - d_rrh and rrh_0 + baseline rear wing
6	frh_0 + d_rrh and rrh_0 + baseline rear wing
7	frh_0 and rrh_0 + baseline rear wing
8	frh_0 and rrh_0 + baseline rear wing + 2 holes
9	frh_0 and rrh_0 + baseline rear wing + 3 holes

Table 3: tests to pin down hot running tyre pressures		
Test No	**Setup**	**What to record**
1	Base Setup	Tyre Pressures + data
2	Base Setup + Fnt TP -2psi	Tyre Pressures + data
3	Base Setup + Fnt TP -1psi	Tyre Pressures + data
4	Base Setup + Fnt TP +1psi	Tyre Pressures + data
5	Base Setup + Fnt TP +2psi	Tyre Pressures + data
6	Base Setup + Rear TP -2psi	Tyre Pressures + data
7	Base Setup + Rear TP -1psi	Tyre Pressures + data
8	Base Setup + Rear TP +1psi	Tyre Pressures + data
9	Base Setup + Rear TP +2psi	Tyre Pressures + data

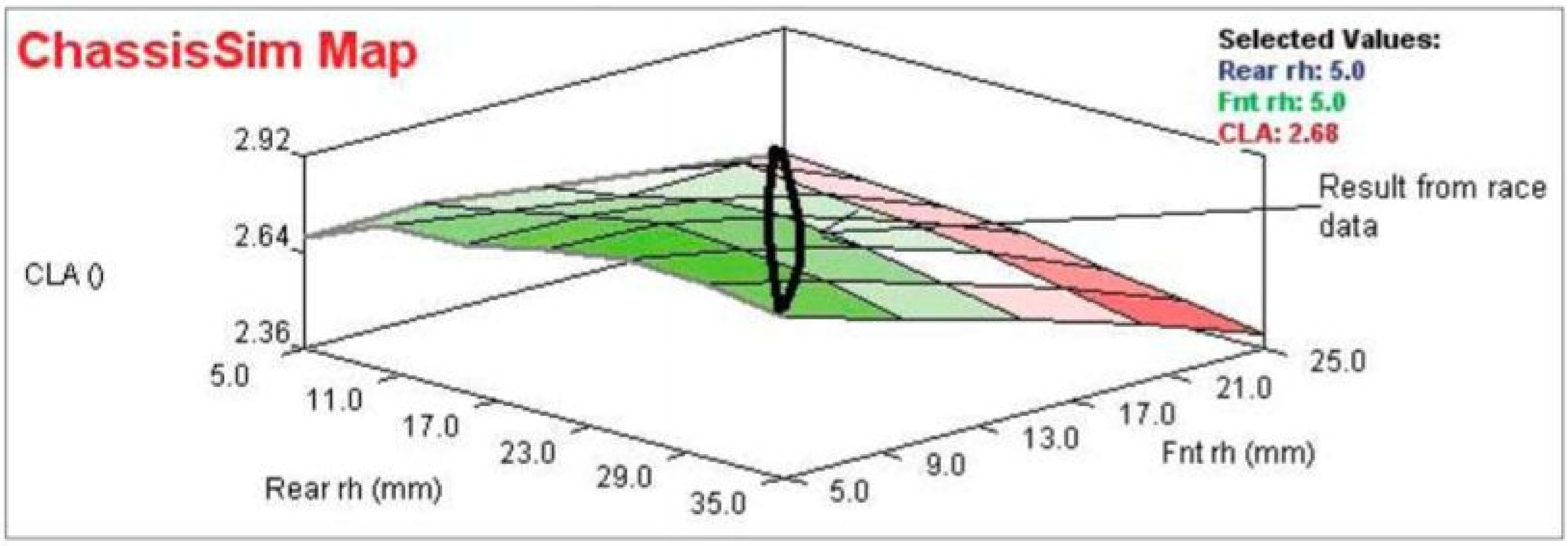

Figure 1: thin sliver of the aeromap

Believe it or not, validating or running an aero test is not as difficult as you might think. The first port of call is to run the car with the base standard setup and then validate it using simulation. If you're extremely lucky, it will work first time. In the vast majority of cases, however, the aero is not going to add up. If this is the case, there's no need to panic. This is the procedure you need to follow:

1. Hand Calc the aero at the end of the main straight.
2. Adjust your global downforce and drag multipliers until these match up. I can't speak for other simulation packages but in ChassisSim you do this by clicking on the rear wing and adjusting the maximum C_LA and C_DA values and aero balance offsets.

Once you have done this, rerun the simulation. What you want to be looking at is the pitch correlation. If you find it's pretty good everywhere, all you need to do is just scale the C_LA and C_DA parameters and you are pretty much done. It gives me great regret, however, to say this is the exception to the rule. Some of the aeromaps I've seen looked as though they came from Hogwarts School of magic as opposed to a wind tunnel.

If the pitch sensitivity maps don't add up, or you simply don't have them, constructing them from race data is not as hard as you might think. Start from the baseline setup provided with the car and implement a test programme that looks like **Table 2**. Just to clarify the nomenclature we have:

frh_0 = baseline front ride height as specified in the starting setup
rrh_0 = baseline front ride height as specified in the starting setup
d_rrh = delta rear ride height
d_frh = delta front ride height

The deltas you choose will depend on what the racecar is, and it is sensitive too. As an example, with an open wheeler/ Sportscar these might only be in the order of 2mm. For a touring car these deltas might be in the order of 5mm. As a rough rule of thumb, choose the delta where you know it will have an effect on the car. The goal of tests 1-6 is to establish the pitch sensitivity map. The goal of tests 7-9 is to assess the variation in downforce levels. You can do these tests very quickly – they just need to be in/out laps or one flying lap on a circuit with a long straight. The goal is to log each test individually.

What you get from each test is a thin sliver of the aeromap. This represents what you'll see illustrated in **Figure 1** above.

The whole idea is that if you get enough of these thin slivers, constructing an aeromap is child's play. Tests 7-9 (above) allow you to scale the downforce, drag and aero balance for various wing changes.

Once we have a picture, we need to nail down the hot tyre pressures we need to be running at. A lot of you might be wondering – why tyre pressures?

"Some aeromaps I've seen look as though they came from Hogwarts as opposed to a wind tunnel"

This is actually very important, because unless our tyres are up to temperature and we can maintain temperature you might as well pack up and go home – it's always wise to review some basic tyre mechanics. From the research that Michelin did in constructing the TameTire model, the overall friction of the tyre is given by **Equation 1**:

$$\mu = fn(P_L, V_s, T_{INT})$$

Where:

u = co-efficient of friction of the tyre
P_L = local tyre pressure applied at the tyre
V_s = sliding velocity of the tyre
T_{INT} = core temperature of the tyre

This, combined with the contact pressure, will have a significant effect on the tyre forces and you ignore it at your peril.

The test procedure for this is very straightforward. You start with manufacturer setup, and you sweep tyre pressures. The test procedure is illustrated above in **Table 3.**

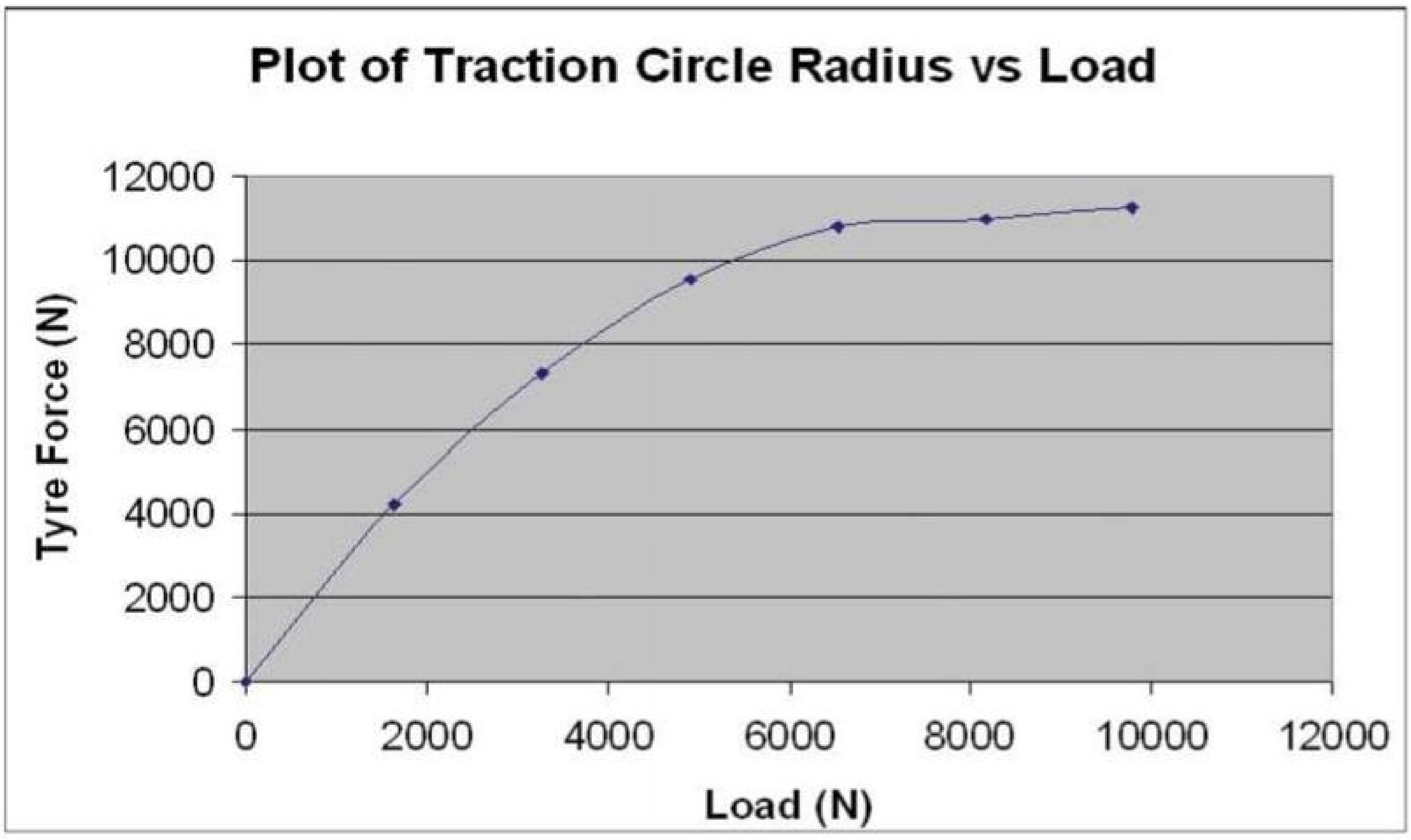

Figure 2: traction circle radius vs load characteristics

It hopefully goes without saying that it is critical for every run where you are recording the hot tyre pressures. You'll also note I've indicated a sweep of +/- 1 psi. In reality this is going to be dictated by your running experience and what the car wants.

The critical thing to be paying attention to here is the lateral acceleration data, lap times and what the driver tells you. Due to the nature of this test, if there is a change it's very easy to isolate what caused it – the change can be readily quantified. For example, if we are dealing with a front tyre pressure change, the delta FFact will look like **Equation 2** below:

$$\Delta FF_{FACT} = \frac{a_{y\_cur} - a_{y\_ref}}{wdf \cdot a_{y\_ref}}$$

Here we have:

ΔFF_{FACT} = change in Force factor
a_{y_cur} = measured lateral acceleration for the change
a_{y_ref} = measured lateral acceleration for the base setup
wdf = weight distribution at the front

So, if you're measuring a change at the rear, you simply substitute the wdf with weight distribution at the rear. The great thing about the test matrix and **Equation 2** is that it allows us to readily nail down the hot tyre pressures we need to be at.

The next step is to nail down springs and bars and roll and pitch centres. The key thing is once again to take the base setup, and sweep springs, bars and roll centres sequentially and sensibly. Our goal is to run a series of, say, two to three flying laps, record our tyre pressures and get data. As you tabulate this data you'll build a database where you can populate the traction circle radius vs load curve. This is illustrated in **Figure 2.**

This, combined with the knowledge we gained from the tyre pressure testing, puts us in the box seat to truly understand what the car is doing.

At this point it would be wise to add an observation about roll and pitch centres. They are actually one of your most powerful go-to tools for generating temperature in the tyre. This is due to the fact that due to the nature of force application points, the lateral and horizontal loads are being driven straight into the tyre. Mathematically we can quantify this by **Equation 3**:

$$F_t = \frac{F_y \cdot rc_f}{t}$$

where:

Ft = force being applied straight to the tyre (N)
Fy = The applied lateral force (N)
t = the horizontal distance from the tyre to the centre of gravity (m)
rcf = force based roll centre/ force application point height from the ground (m)

This applies for both roll centres and pitch centres. This is a very powerful tool, so you would be mad not to consider it. But don't overdo it!

The final step in the process is to nail down what you want to do with the damping. Once you have nailed down where you need to be on springs and bars, this is where tools such as ChassisSim transient simulation, and shaker rig testing, really makes its presence felt. It's that cherry on top, but it can make such a difference. Damper testing and refinement is a book on its own, but let me give you some rough rules of thumb:

"If you have the ability to play with the diff, you would be mad not to look at it seriously"

- When shaker rig testing, it truly is horses for courses. If mechanical grip dominates, tune for CPL. However, if you are running high downforce your results will be biased to body control.
- Pay attention to what the guys on the rig tell you, but ultimately make your own judgments.
- Learn everything you can about damping ratios.

Also just remember that this process can be circular. Remember tyre pressures, springs and dampers are ultimately inter-related. Consequently our procedures of working through tyre pressures, springs and bars and dampers might become a bit samey. That's perfectly OK, because you'll learn a lot about the car in the process and it will allow you to make the best use of your simulation software.

One of the things that I haven't touched upon is differential setup. If you have the ability to play with a diff, you would be mad not to look at it seriously. Most diffs should be set to open under brakes and locking under power. The locking ratio and ramps will be a function of tyres and engine power. As per dampers, this is the cherry on top, but again, is a book in its own right. It's also the thing you do at the end. That being said, I've seen an F3 race weekend ruined because the braking and power ramps were installed back to front and I was at an F3000 event when one of the teams discovered a tweak with the diff that made us all look silly. If you can play with it, take the differential seriously.

In closing, figuring out a test program is a very simple affair. The first step is to classify the aero. Once the aero is done, nail down your hot tyre pressures. Once we have this, we sweep springs, bars, roll centres and pitch centres to get to these hot tyre pressures. Then there's the damping. Yes, you might need to loop through pressures/ springs and damping a few times. However you are doing this in a sequential manner and you will learn so much about your car.


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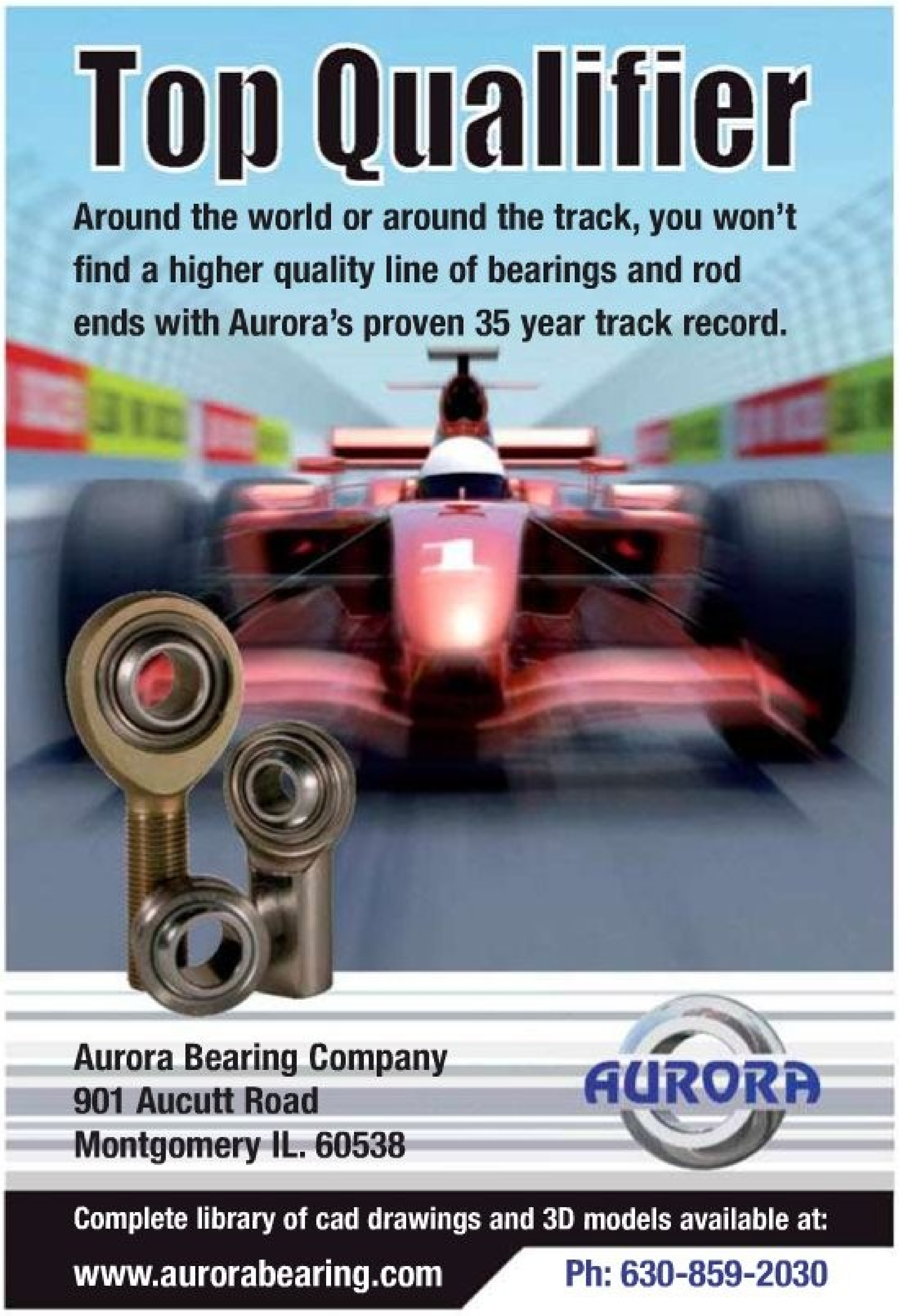
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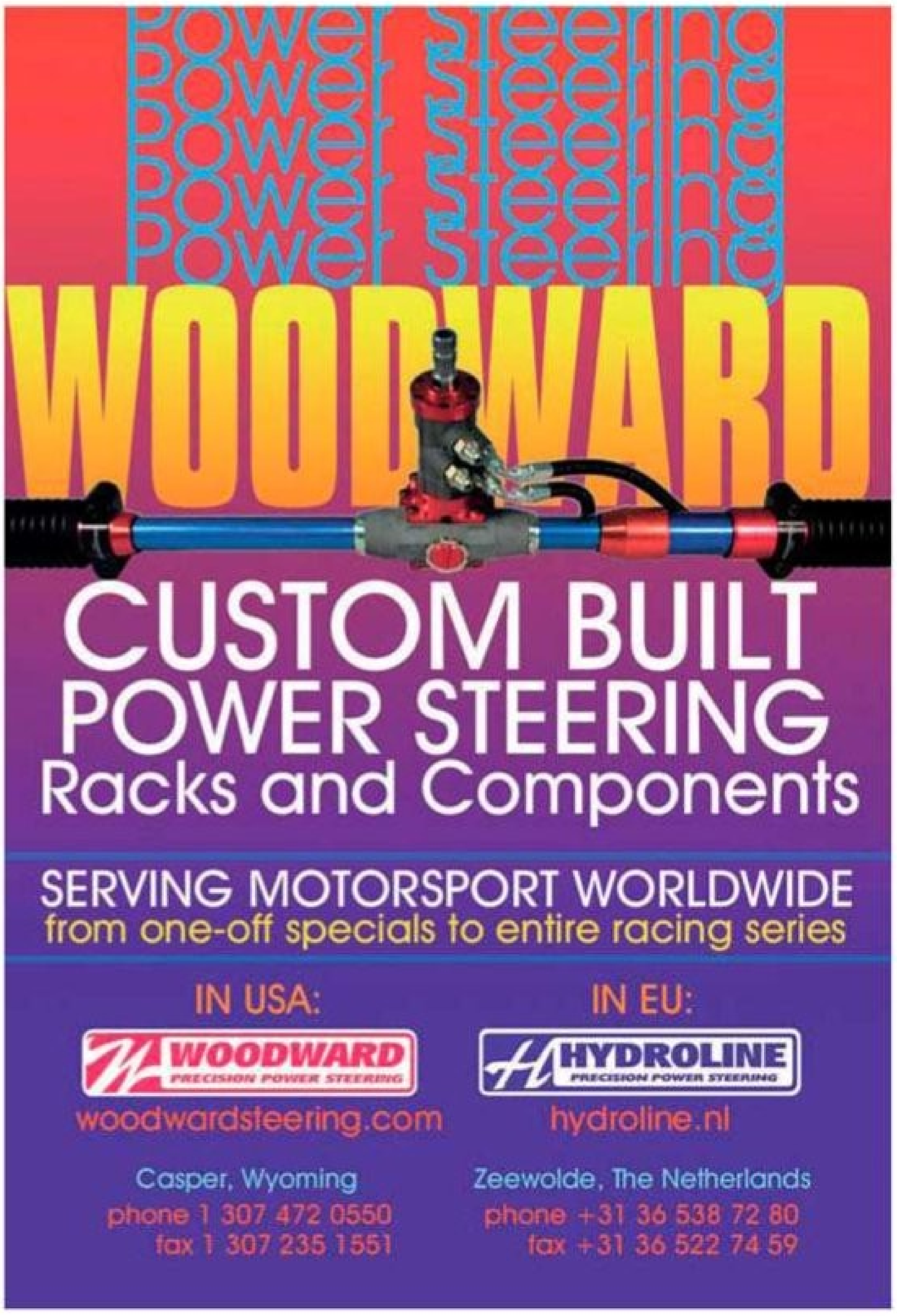
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BoP buster

After a season of adjustments in the boardrooms of the rule-makers, Ferrari has taken steps to make its GTE car even better for 2013

BY ANDREW COTTON

The main update for the 458 is aerodynamic. The Ferrari has a wider front cross section compared to the Porsche, and has a lower top speed, which had to be increased without compromising fuel consumption

The GTE category is something of an enigma. It often provides the best racing in an endurance racing field, has the support of Ferrari, Porsche, Aston Martin, General Motors and BMW, with others waiting to join in, yet the ACO has long insisted that costs are rising out of control, and need to be curbed.

As the category goes through a process of adjustment, manufacturers are piling on the pressure to maintain the status quo. Porsche will this year develop the 991 in competition in the World Endurance Championship. In October 2012, General Motors unveiled the C7, which will eventually replace the C6, while in February, BMW unveiled the Z4 that replaces the old M3. McLaren will not race a GTE version of the MP4-12C this year, but there is little doubt that one is coming.

Ferrari, meanwhile, having produced a winning car in 2012 with its 458, victorious at Le Mans and in the WEC, has updated the 458 in 2013, with an emphasis on aerodynamic development to reduce the effect of having a wider nose than its rivals, and to negate a reduction in fuel tank size mid-way through 2012, placing the emphasis on fuel economy.

Timing is important – the FIA regulations permit one evolution per period of two years, rather than one per year, so Ferrari has to get this right in the face of increasing competition.

Ferrari's drivers have long felt that the balance of performance measures were working against them. Aston Martin, for example, did not have to run a Gurney flap at Le Mans, and ran with five litres more fuel, while the Ferrari's capacity was reduced by five litres, which took away its ability to do a six-hour race on fewer stops than the rest of the GTE pack, though the 458 was given a 15kg weight reduction. The 458, which features a direct injection engine, has worked on the electronics to improve fuel economy and try to get back some of the lost performance.

"The Ferrari's fuel tank was reduced by five litres, effectively taking away their ability to do a six-hour race on fewer stops"

Ferrari's drivers reported that the Porsche, with its faster speed on the straights, was able to reach the braking zone ahead of the LMP2s more easily than the Italian factory's cars

At the rear, the bumper has been redesigned to improve the extraction of the air and to make the diffuser more efficient. The wing now has a different profile and features the mandatory 25mm Gurney flap

During 2012, Ferrari drivers complained that their cornering speed, a strength over their rivals with a mid-engine layout compared to the front-engine for the BMW, Corvette and Aston Martin, was being compromised by the LMP2 cars, which could more easily pass just ahead of the braking areas, but badly driven ones were slower in the corners and tripped up the 458s.

The FIA changed the bodywork regulations for 2012, and increased the permitted width of the GTE cars by 15cm across the front wheel arch to accommodate a larger front tyre, and also increased the size of the rear wheel arches. The overall width, not including the rear-view mirrors, is 205cm, which was not necessarily a bonus for the Ferrari, which already had a larger snout than the Porsche or Aston Martin, and consequently had an aero disadvantage. The aero work was aimed at making the car more stable, less sensitive to the variation of the ground clearance to take maximum advantage of its already very good downforce.

In order to reduce the drag, Ferrari has redesigned the bumper, which is now closed immediately over the splitter. The splitter has also been redesigned, a second dive plane has been added to each side, the openings of the bonnet have been reduced, while the wheel arches are more rounded.

In order to make the car less sensitive to the variation of the ground clearance, a small channel has been opened up on the central lower part of the front bumper (in the middle of the splitter), which reduces the pitch sensitivity. For the same reason, the suspension has been slightly modified, but the geometry is unchanged.

At the rear, the bumper has been also redesigned to improve the extraction of the air and to make the diffuser more efficient. The wing has a different profile and features the mandatory 25mm Gurney flap.

Emirates signs multi-million dollar deal to sponsor F1

Emirates branding will be highly visible in F1 starting from race 2 in Malaysia

Emirates Airline has been signed up as a global partner to Formula 1 in a five-year deal worth in excess of $50m, as the Gulf countries continue to vie for prominence in the motorsport market place.

The branding of the airline, which is ultimately owned by the Dubai state, will now be displayed on Formula 1 circuit bridges, around the tracks and in the paddocks, the deal beginning at the Malaysian Grand Prix in March.

Emirates chairman Sheikh Ahmed bin Saeed al-Maktoum announced the deal alongside Formula 1 commercial boss Bernie Ecclestone in Dubai. According to sources in Dubai, Sheikh Ahmed said the five-year agreement had an annual value of more than $10m a year, although some UK news outlets have valued it as much as $200m in total.

The deal comes in the wake of a flurry of motorsport tie-ups involving Gulf governments, with Qatar and Abu Dhabi now involved as title sponsors in the WRC (with Citroën and M-Sport Ford respectively) while Bahrain and Abu Dhabi host well-established grands prix.

Dubai is also extremely keen to increase its profile globally and Sheikh Ahmed, an uncle of the ruler of Dubai, told reporters that the airline's total sports sponsorship now stood at 1bn dirhams (around $272m) this year. In November, Emirates agreed a new $239m sponsorship deal with Arsenal that extends its shirt partnership with the north London football club to the end of the 2018/19 season.

'For many years, Emirates has been at the forefront of sports partnerships across the world, said Sheik Ahmed. 'With the addition of this global partnership with the Formula 1 group, we are continuing to expand our sponsorship portfolio, which I'm sure will be appreciated by sports fans. Today's Formula 1 partnership follows on from our recent sporting announcements such as re-signing a multi-year sponsorship agreement with Arsenal Football Club, being a sponsorship partner of the 2014 Commonwealth Games and becoming the Official Airline of the ATP World Tour.'

Emirates Airline is an enormously successful operation, running a fleet of 191 jets, and raking in revenues of around AED 62bn ($17bn) in the financial year 2011-12, which represented an increase of approximately 15 per cent over the previous year's revenues of AED 54bn ($14.5bn).

IndyCar dishes out million dollar-plus grants to all entries

IndyCar has announced that it's to award all 22 of its expected entries for the 2013 championship with its Leaders Circle contracts this year.

The Leaders Circle programme was established in 2002 to provide incentives to teams that participate full-time in the IndyCar Series. Each Leaders Circle member is assured a minimum of $1m for the 19-race season, providing the entrant successfully qualifies for the Indianapolis 500.

The 19 confirmed returning entries that finished within the top 22 places in the 2012 championship have all been awarded contracts, but on top of this IndyCar has opted to fill the three open positions based on the remaining order of 2012 entrant point standings – this means that single entries from Sarah Fisher Hartman Racing, HVM Racing and Dragon Racing were each awarded Leaders Circle positions.


The IndyCar Series champion and championship entrant will share a $1m bonus

IndyCar CEO Jeff Belskus said: 'While the Leaders Circle programme was designed to ensure the quality of on-track competition was balanced throughout the field, we felt it was important to extend Leaders Circle benefits to all returning full-time entrants from last season.

'Including all 22 entrants for 2013 allows the IZOD IndyCar Series to continue to build upon the foundation the programme has laid over the last several years,' Belskus added.

The series has also revealed details of its prize structure, confirming that non-Leaders Circle entrants will compete for payouts awarded to the top three finishers. In each race aside from the Indianapolis 500, the highest-finishing non-Leaders Circle entrant will receive $40,000, followed by $35,000 and $30,000.

Meanwhile, all entrants will continue to compete for bonuses of $35,000 for first place, $25,000 for second, $20,000 for third, $15,000 for fourth and $10,000 for fifth place at each IndyCar Series race except for the Indianapolis 500.

The IndyCar Series champion and championship entrant will share a $1m bonus, with second through fifth in the standings sharing bonuses of $250,000, $175,000, $125,000 and $75,000.

Drastic 'Three' surgery saves premier UK single-seater championship

A move to slash the British Formula 3 Championship calendar looks to have gone some way to saving the series, while its promoter has not ruled out regulation changes next year as it strives to cut costs in order to secure the championship's future.

British F3 struggled to attract entries early this year – largely as a result of huge interest in the burgeoning European Championship – so promoter SRO took the bold decision to cut it down to just four three-race events: Silverstone, Spa, Brands Hatch (GP) and Nürburgring.

Series manager Benjamin Franassovici told *Racecar*: 'We had some interest, but we knew it was not going to be enough for it to be stable, so we went down to a slimline version and it's been very well received. For Silverstone and Spa I think we're looking at decent entries. For Spa we'll definitely attract over 20. For Silverstone I think we will get 12 to 15 cars, and that's only [as things stand] today.'

Three of the big four British regular teams – Fortec, RR and Carlin – have said they will race in the championship, while also pursuing European campaigns, with only T-Sport doubtful about competing. 'For us the drivers wanted to compete in the FIA championship,' said T-Sport boss Russell Eacott, 'and obviously you have to go where your drivers want to be.'

Among other teams to be attracted to the new look series is West-Tec, which will be making a return to the championship in the National Class this year with its European F3 Open Championship cars, which are now eligible. West-Tec boss Gavin Wills believes that if the championship is to have a future, it may have to take a leaf out of the Open Series' book.


The British F3 International Series at Donington Park last September

'I just think that it needs to be more appropriately constructed, so that it represents much better value for money,' said Wills. 'The problems with the championship were that its cost controls had totally gone out of proportion, and now that the FIA were trying to force it to become a domestic series, the product was inappropriate for its marketplace.

'I understand that in past years, to do British F3 in a way that some of the teams have wanted to, cost €1m. And we do the European Open Championship with the same cars [running spec Toyota engines] for €350,000.'

Franassovici says that looking at a spec engine model was not beyond the bounds of possibility and that many other cost cutting avenues are also currently being explored: 'It's on my shortlist of things which need to be investigated. You need to look at what's surrounding you, what's attractive and what's economically viable. But what we don't want to do is set the bar too low.'

Williams scoops top green award for Hybrid tech

Williams Hybrid Power has been lauded at the UK's Low Carbon Champion Awards, where it was honoured in the category of 'Innovation by an SME' for its partnership with Go-Ahead Group, one of the country's top public transport operators.

The awards are an initiative of the Low Carbon Vehicle Partnership (LowCVP) and they celebrate outstanding and innovative practice in reducing road transport emissions. Williams Hybrid Power established a partnership with Go-Ahead Group in March 2012 and it was this tie-up that it submitted as a case study for the category of Low Carbon Innovation by an SME.

The collaboration has seen the companies develop a number of hybrid buses that utilise Williams Hybrid Power's electromechanical flywheel energy storage technology. Initially developed for the 2009 Williams Formula 1 car, this technology has since been adapted for public transport applications and for use in other areas of motorsport, such as with Audi in the World Endurance Championship and at Le Mans.

Frank Thorpe, head of Bus Systems for Williams Hybrid Power, said: 'Our partnership is truly unique and is seeing two leading British companies come together and share their resources in a bid to reduce carbon emissions on Britain's roads. This award is a great honour and validates the hard work of both companies to produce a number of hybrid buses. Energy efficiency is an important issue for Williams, and initiatives such as this demonstrates how Formula 1-based technology can play a key role in helping to tackle an important global issue.'

The technology appealed to the judging panel because of the 20 per cent fuel efficiency savings on offer and attractive installation costs, a combination which has the potential to see mass market.

SEEN: BMW Z4 GTE

BMW has unveiled its new American Le Mans Series challenger. The Z4 GTE, which was developed at BMW Motorsport in Munich, replaces the M3 GT, which won the GT class two years ago. Another notable change is a switch from Dunlop to Michelin rubber, but the car will still be run by the same Rahal Letterman Lanigan Racing squad that was responsible for the M3.

BMW Motorsport boss Jens Marquardt said: 'We are setting out on a development year, but are very confident we have once again developed a car that has the potential to win races and titles.'

NASCAR sponsorship market to get tougher as NBA shirt deals introduced

A top NASCAR sponsorship expert has told *Racecar* that $100m of possible backing could be sucked from the sport if plans to allow shirt sponsorship in the NBA come to fruition.

The NBA (National Basketball Association) looks set to introduce shirt sponsorship – still relatively rare in mainstream US sports – this year, although on a small scale to begin with, allowing just small patches on the shoulder area.

But David Jessey, executive vice president at Fuel SMG and a former vice-president of sales and marketing for Evernham Motorsports, and also a well-known sponsor hunter in NASCAR circles, told us that this is likely to make finding sponsorship for motorsport far more difficult.

'You are competing with other sports,' Jessey said. 'American motorsports was the only major sport that you could put a logo on the field; you could be on the car, you could be on the driver. Just a few years ago that was it.

'But now the NBA looks like they're about to approve sponsor logos on their uniforms. That will take over $100m out of the market. That will be big money, and we will be competing against them. It will definitely make things tougher when it comes to finding sponsorship.'

Experts say NASCAR deals could be hit hard

Jessey added that the sport is already seeing brisk competition for backing from Major League Soccer in the US, which already allows shirt sponsorship: 'MLS is on a nice roll, it's doing very well, they're building these soccer-specific stadiums that are doing really well, and they have sponsors on their chests, so now there are sponsorships going for millions of dollars, and we're competing against them.'

The experience of sponsor hunters in the UK when soccer shirt sponsorship was seen on a wide scale in the 80s, following Liverpool's link-up with Hitachi in 1979, seems to bear this out. Former driver and F3 team owner, and boss of Speedsports Promotions, Mike O'Brien, a man well-known for his ability to put a deal together, told us: 'I think that the advent of soccer shirt sponsorship did have an effect, and when I was based in Luton I remember feeling that the better Luton Town did, the harder it would be for me to compete and get sponsorship in that area.

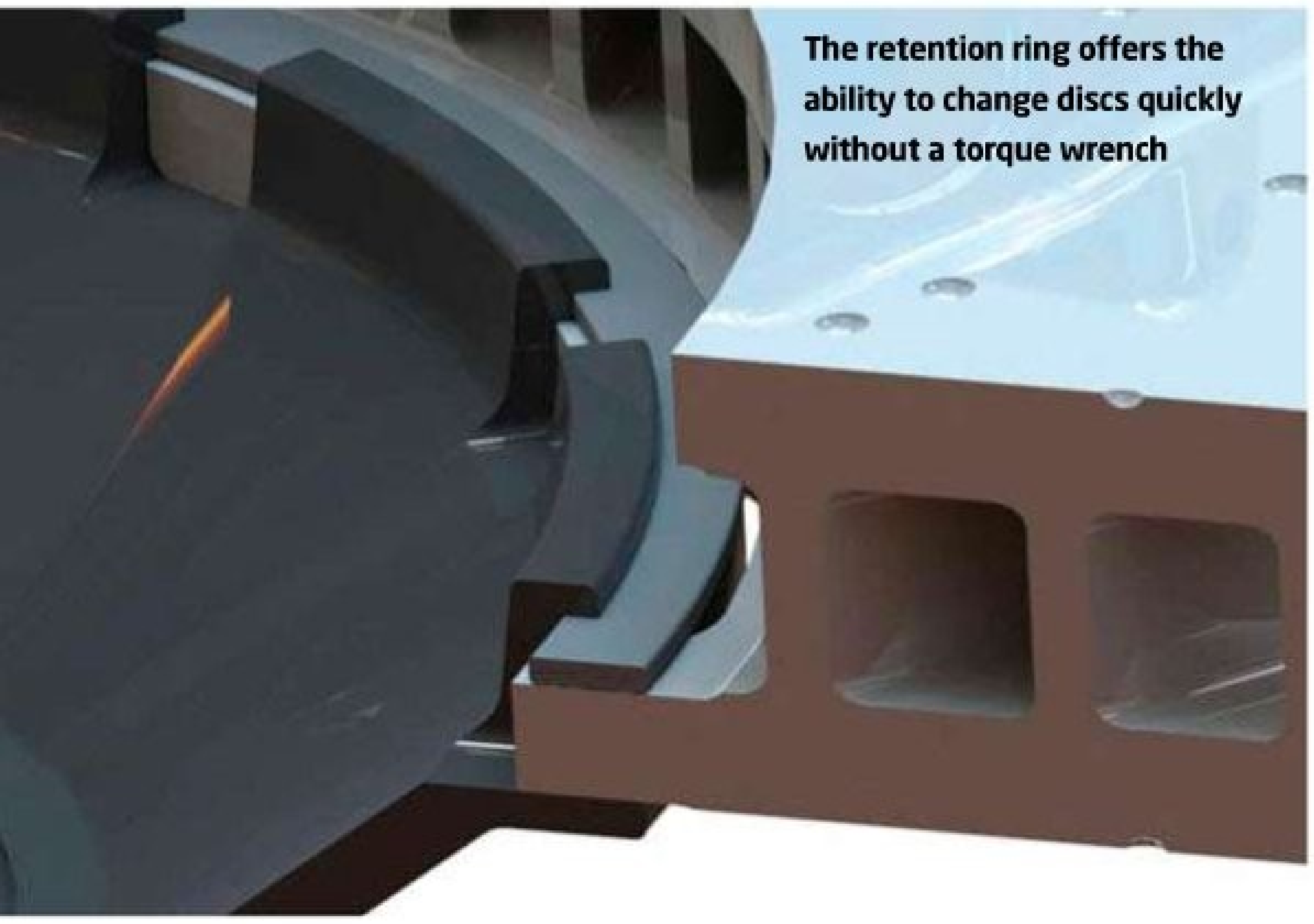
'I think any really mainstream sport which offers sponsorship possibilities that weren't previously available will damage motorsport sponsorship to some extent.'

PFC releases new V3 disc retention ring technology

PFC has released new V3 disc and hat technology. The advanced design boasts a retention ring that holds the hat and disc together.

The ring means no need for torque wrenches, and the ability to change a disc quickly and efficiently saves time and effort. As well as offering convenience, the new V3 technology is much lighter than previous designs, making it easier to put on and pull off, and making the vehicle lighter.

The V3 rotor retention method is based on the use of a two-turn retaining ring, which is held in a groove in the hag that overlaps the disc flanges, effectively locking the disc to the hat.


The retention ring offers the ability to change discs quickly without a torque wrench

Sportscar scene healthy – but numbers down in LMP1

Entry lists for the WEC, ELMS and the Le Mans 24 Hours show that the endurance racing sector is in robust condition, although the flagship LMP1 class is worryingly short of non-works entries at Le Mans and in the World Championship.

The WEC boasts 32 entries this year, with six LMP1, 12 LMP2 and 14 GT cars (across two classes),

while at Le Mans there are just eight LMP1s listed, 21 LMP2 and 25 GTs. A late withdrawal of entries from JRM and OAK has affected the LMP1 entry – which now consists of three Audis and two Toyotas – and has left the race with just three privateers in the top division this year. In the WEC there will be just two non-works P1s, one each from Rebellion and Strakka.

Within the GT Le Mans entries, the presence of a brace of Dodge Vipers, confirming the manufacturer's return to the race, is worth noting. Two GTE Pro class Viper GTS-Rs have been entered under by the Riley Technologies-run SRT Motorsports team.

Meanwhile, the European Le Mans Series has seemingly come back from the dead. ELMS, which does not include a class for LMP1, has received 29 entries, including 11 LMP2s in its top class.

World Endurance Championship boss Gérard Neveu says he is optimistic for this year, but admits there are still challenges ahead: 'We will start the new season with a fantastic grid of 29 cars. This year is going to be a hard year and we know we will face some very exciting challenges, but this is a good start.'

SEEN: MASERATI GRANTURISMO MC GT3

Maserati is to re-enter GT3 later this year, thanks to this development by Swiss Racing, an outfit which has already had success with the marque's Quattroporte in the Superstars series. Subject to homologation, the car will be made available for teams competing in a number of GT championships, including the FIA GT Series and the Blancpain Endurance Series. 'We wanted to develop the Maserati GranTurismo MC GT3 version because we believe it is a winning project, stimulating for all involved,' said Swiss Racing head Guido Bonfiglio. 'We are perfectly aware of the difficulties we'll face in tackling such an ambitious project, but challenges are the heart of a team's dynamics, whether on the track or the design table. Our direct competitors are manufacturers who, disguised to a greater or lesser degree, participate directly in the development of the vehicles and actual racing. We are a small outfit, but we have great hopes of being a thorn in the side of these giants of motorsport.'

New cars and enhanced track drying 'could boost raceday attendance' for NASCAR

The CEO of the International Speedway Corporation is hoping the introduction of the new Gen-6 NASCAR racers and better track drying equipment, plus improvements to the fan experience, will help arrest a decline in raceday attendances.

NASCAR's track operating arm recently posted total revenues of $612.4m for 2012, that's down $17.3m on 2011 ($629.7m), while the operating income for 2012 was $105m, a drop from $133.3m in 2011. Net income for 2012 was $54.6m, down $14.8m from 2011's $60.4m.

These results are all the more interesting as ISC can be seen as a bellweather for the state of NASCAR as a whole – as the sport is privately-owned it is not obliged to publish financial results. With that in mind NASCAR might be worried about the decline in revenues from race attendances with $136m taken at the gate in 2012, against $144m in 2011.

However, ISC chief executive officer Lesa France Kennedy said she was sure that improvements planned by both NASCAR and ISC to improve the fans' experience are likely to help matters throughout 2013: 'Based on our experience and view of the evolution of modern sports facilities, demand for our events depends, in part, on the fans' experience.' she said. 'We are committed to meeting and exceeding our fans' expectations through ongoing capital improvements at our facilities.'

France Kennedy also believes the new generation car will go some way to attracting more fans to the races: 'Another area of focus within NASCAR's Industry Action Plan is building product relevance. Beginning with this season, NASCAR introduced the next generation Sprint Cup car for 2013, what we are calling "Gen-6". This programme is the most comprehensive overhaul in the sport since 2007. Its goal is to re-establish brand identity among the automotive manufacturers and provide competitive upgrades in an effort to improve competition in NASCAR's Sprint Cup Series.'

NASCAR has also invested in track drying equipment which, France Kennedy says, will help avoid wash-out events and the knock-on effect these have on future meetings: 'Weather is one of our biggest impediments to stronger ticket renewals. After a rain delayed or postponed event due to weather, the following year's ticket renewals for that event are negatively impacted. NASCAR's ultimate goal is to see a superspeedway like Daytona International Speedway race-ready in 30 minutes, rather than two hours, and a short track like Martinsville Speedway completed in 15 minutes.'

Log on to our website to read our special supplement, Stockcar Engineering, which features the latest information on the Generation 6 cars, as well as the technical background to the 2013 NASCAR season. Please visit www.racecar-engineering.com/stockcar-engineering

BRIEFLY

Parking fines

NASCAR has made a move to discourage teams from running cars just to collect a share of the purse by rejigging its Sprint Cup prize fund. The change has been made because some lower order teams have been known to retire cars after just a few laps, so-called 'start and park', yet still be in a position to claim prize money. The prize cash for places 39 to 43 will be cut by $4000 a position, and the money saved will be redistributed to those finishing higher up the order.

Boeing, Boeing, gong!

Well-known engine company Ilmor has won a 2012 Boeing Performance Excellence Award. The company, which is responsible for the Chevrolet IndyCar engines, was one of only 594 suppliers to receive recognition (either Gold or Silver) from the famed aircraft manufacturer. The company issues the award annually to recognise suppliers who have achieved superior performance.

Thai track

Newin Chidchob, president of Thai Premier League soccer club Buriram United, is said to be planning a $67m F1-spec track development in his hometown of Buriram, Thailand. According to reports from Bangkok, Chidchob has contacted famed F1 circuit designer Hermann Tilke in relation to the project, which is expected to be completed by the end of next year. The motorsport development will also include a racing school and motocross track.

Ace of Club

The British Racing Mechanics Club has awarded JRM for its 2012 sportscar exploits. The club, whose awards recognise excellence in mechanical engineering and race preparation, presented JRM with a trophy for its effort at Le Mans, where its Honda HPD ARX-03a – driven by Karun Chandhok, Peter Dumbreck and David Brabham – came in sixth place overall, the highest placed British entry.

INTERVIEW: RAPHAËL CAILLÉ

Q. How are you getting on at Swindon?
Very good. Swindon was a company with a very good manufacturing tradition. But perhaps it was lacking a modern vision on the technology side. I think that – not only myself but the team I have brought in with me – have brought that, and we've really changed the company: grown it, brought it back to profitability. It's been three incredible years, really.

Q. What are you involved in on the motorsport side of the business?
Quite a few things, but the biggest project that we can talk about is what we do for the British Touring Car Championship, where we have a contract with TOCA to supply an unbranded engine [the NGTC unit]. It's an engine that we've developed, a four-cylinder, direct injection, turbocharged engine, which we're supplying to about 12 cars this year. This is actually the reason why I ended up buying the company. This contract was in my mind, we won the bid and it's sort of snowballed.

We've also done a lot of work for Lotus GT cars, such as the GT4 engine in the Evora, which has been designed, developed and manufactured by us.

Raphaël Caillé (40) is managing director of Swindon Engines, having bought the company three years ago. Prior to this he worked at Triple Eight Race Engineering and motorsport engine departments in France, including Citroën Sport. Swindon was set up by John Dunn in 1971 and it remained in the Dunn family, working on engines for everything from F1 to rallying, until January 2010.

Q. What sort of design and manufacturing facilities have you in place?
On the design side we have Catia V5 (CAD) Ansys (FEA), valvetrain, cranktrain, and bearings calculation software; power modelling and vehicle straight-line simulation, plus access to CFD. On the manufacturing side there's a Siemens NX (CAM); Millturn crankshaft and camshaft machine, 5-axis DMGs and a range of more conventional machines.

Q. What percentage of your work is motorsport related?
It's 50-50. That was really my vision when coming into the company. In this day and age it's actually quite difficult to develop a company using motorsport only, because over the years the margins have become smaller and smaller. If you look purely at the engine, the engines have to last longer and longer, even in Formula 1. But if you want to be competitive you have to invest in the right hardware and software for your company, so you have to find some extra work, you have to diversify.

Q. What would you say sets the company apart?
We are still a small team, barely 20 people, and so we are good at reacting quickly. We are flexible and cost-effective. In the future, I see us as keeping a reasonable size, because these advantages are things we can keep only by managing our size as a company.

Q. How pleased were you to win the MIA Business of the Year award for 2012?
That was fantastic, because it was recognition in front of the whole industry. We are not a big company and there we were getting an award for business excellence in front of Red Bull and Mercedes HPE, the best in this world of motor racing. It's also good for our employees, because they have been really pushing hard in the last year and it's great for everybody to look at this trophy and think: 'yes, that's what happens when you work hard'.

Q. Coming from a team background, are you more aware of the competitive aspects of business?
It could be that I have this trait more than someone who has not been in a team. I certainly see it that way. At the end of the day the world is full of competitions – and we are certainly winning one or two.

Half a billion switched on by WTCC

The World Touring Car Championship (WTCC) claims that over 500 million viewers tuned in to its coverage in 2012.

The figures, taken from a report issued by German-based research firm IFM, amount to a 12 per cent increase on the viewing figures for 2011. IFM says that a total of 512 million viewers watched the WTCC on TV last year, while 144 TV channels are said to have aired at least one of the championship's events, adding up to 1081 hours of broadcasting in total.

These figures are all the more impressive because they are actually better than those claimed for viewers of F1 in 2012, said to be around the 500m mark.

However, this is not a like-for-like comparison, as an IFM spokesperson told *Racecar*: 'We can confirm this figure, however it should be noted that it includes also viewing figures for secondary coverage in news programmes and general sports magazine formats – which usually pull a much higher audience than live race coverage – whereas the F1 figure probably included only live race audiences. So the base might not be the same and results not directly comparable.'

Yet whichever way the figures were compiled, the WTCC has done well to entice extra viewers in a year when then there was so much competition from major sporting events, as Ulrich Lacher, managing director of IFM, explained: 'Despite the Olympics and Euro 2012, WTCC – unlike many other series – increased in audiences and overall impact again. It showed a healthy increase, continuing the trend from previous years. We reckon that the growing popularity is a result of the good TV distribution of the series.'

Antonios Argyropoulos, head of Media Rights Distribution at Eurosport Events, said: 'This proved that WTCC it is not only an entertaining sporting show, but also a powerful communication platform, thanks to quality programmes and extensive television coverage.'

CAUGHT

The Michael Shank Racing-run car that finished third in the Daytona 24 Hours has been stripped if its $35,000 prize money and fined an additional $15,000 (which will go to charity) after the Ford/Riley Daytona prototype was found to be running with what Grand-Am describes as 'mechanical adjustments [to the engine] resulting in performance levels outside documented maximums'. The team has also been penalised 30 points in the Grand-Am teams' championship.

FINE: $15,000
PENALTY: 30 points

OBITUARY

Jack Cunningham

Despite a relatively short involvement in motor racing Jack Cunningham, who died recently at the age of 60, managed to cram in plenty of achievement in the sport, including setting up a race-winning high-level single-seater team, and helping to bring a respected marque back to Le Mans.

Cunningham came to racing after investing in Hugh Chamberlain's sportscar team at the end of the 1990s – before this he had been very successful in the aviation business and had once been an airline pilot. The partnership with Chamberlain subsequently landed the deal to run MG's Lola-developed EX257 LMP675 sport prototype at Le Mans in 2001. Chamberlain Motorsport then became CMS Motorsport in 2002 and continued to run the MGs, and then went on to run GTs in 2003.

In 2005 Cunningham set up the Malaysian team for the then new, now defunct, A1 GP. The team scored five race wins during the four-season life of the championship, and he went on to also run the Indonesian A1 GP outfit through 2006/07.

Jack Cunningham 1952-2013

SPONSORSHIP

Ferrari has picked up sponsorship from Weichai Power, a Chinese manufacturer of heavy machinery vehicles and powertrain systems. Weichai is the Italian F1 team's first Chinese backer, but the road car arm of the company has had a presence in the country, which Ferrari considers to be one of its most important markets, for over 20 years.

The Mercedes F1 team has signed a sponsorship deal with BlackBerry. The new partnership sees the BlackBerry branding featured prominently on the chassis and headrest of the F1 W04 racecar, the race suits of the drivers, and on team kit. As the 'official mobile computing partner', BlackBerry will also be working closely with Mercedes to develop the team's use of the BlackBerry 10 platform at its headquarters and at the races.

Force India has signed a multi-year deal with equipment and support services supplier Speedy Services. The company, which is involved in the infrastructure, industrial, construction and the events industries, is now an official supplier to the team and its branding will be visible on the racecar at this year's British Grand Prix.

NASCAR has signed a multi-year partnership extension with ExxonMobil. The deal means Mobil 1 synthetic motor oil will continue to be the 'Official Motor Oil of NASCAR' until the end of 2017. This season marks the 11th consecutive year of the partnership.

Dutch fashion company McGregor has signed up as a sponsor of the Caterham F1 team, its logo now in a prominent position on the new CT03 racecar. As part of the tie-up, the company plans to launch a 'Caterham by McGregor' range during this year's Monaco Grand Prix.

RACE MOVES

It has emerged that one-time Ferrari chief designer **Rory Byrne** is taking an active part in the design of the Scuderia's 2014 F1 car. Byrne (69), who is employed by Ferrari as a consultant on the road car side of the business, left the F1 team in 2006, since when he's had a limited input into the racing programme. However, it's been confirmed that Byrne is now playing a large part in the design of the 2014 car, which will be built to the new turbocharged engine formula.

Toto Wolff is now a shareholder and executive director of the Mercedes F1 team, where he has taken on the responsibility of managing the outfit. He has also taken over the management of all the Mercedes-Benz motorsport activities, thereby stepping into the void created by the departure of **Norbert Haug**. Mercedes GP non-executive chairman **Niki Lauda** has also bought shares in the F1 team.

Simon Rennie is now **Mark Webber**'s race engineer for the 2013 season. He takes the place of Ciaron Pilbeam, who has left Red Bull Racing to take up the position of chief race engineer at Lotus. Rennie worked as **Kimi Räikkönen's** engineer at Lotus last season.


LAT
Christian Horner

Christian Horner will remain in his post as team principal at Red Bull Racing after extending his contract with the F1 championship-winning team, with Red Bull saying it's a multi-year deal. Horner (39) joined Red Bull in 2005.

Dr Ian Roberts is the new Formula 1 medical rescue coordinator, replacing Gary Hartstein in the position. Roberts, who has previously worked as chief medical officer for Silverstone and the British GP, will report to the FIA's permanent medical delegate, **Professor Jean-Charles Piette**.

Former Toro Rosso technical director, **Giorgio Ascanelli,** is now the chief technical officer at F1 brake supplier Brembo. Ascanelli was in charge of the tech team at Toro Rosso from 2007 until the summer of last year.

NASCAR camping World Truck Series team NTS Motorsports has hired veteran crew chief **Eddie Pardue** for this year's assault on the US pickup truck championship. Pardue has worked in NASCAR since 1993 but will now serve as a crew chief in the Truck Series for the first time in his career. He has chalked up 276 NASCAR races as a crew chief, the vast majority of those in the Nationwide Series. This is Pardue's first job as a Truck crew chief having been crew chief in the Nationwide Series since 1998, winning races with such notables at **Matt Kenseth** and **Greg Biffle**.

Former American football star **Bill Romanowski**, who played for 16 years in the NFL, during which time he started an amazing 243 consecutive games, has signed on as a minority owner of the new for 2013 Swan Racing NASCAR Sprint Cup team. His health supplement company, Nutrition53, also joins the team as a primary sponsor for 10 races this year.

Pete Rondeau has been promoted to director of competition at NASCAR Sprint Cup team Furniture Row Racing. Rondeau was previously crew chief on the team, a position he handed over to **Todd Berrier** midway through 2012. Before he joined Furniture Row, Rondeau worked at Evernham Motorsports, Dale Earnhardt Inc and Jasper Motorsports, in positions that included director of research and development and crew chief.

Xevi Pujolar, the former race engineer for Pastor Maldonado at Williams, has moved into a newly created position of chief race engineer within the team. Andrew Murdoch has moved up from within Maldonado's car crew to take Pujolar's place as the Venezuelan driver's race engineer.

Former team owner **Richard Redgrave** has died of cancer at the age of 74. Redgrave competed in sportscar racing in the 60s before setting up his own team, Redgrave Racing, to run drivers including his own son and daughter in the 90s. While the team was best known for its successes in Formula First and Formula Renault, it also competed, and won, in Italian Formula 3000.

British rallycross race engineer and driver **Ryan Lawford** was found dead at his home in January. Lawford (26) started his career working for **Will Gollop's** G-Tech outfit and later worked for Team Eurotech in the BTCC.

Belgian race and rally legend **Marc Duez** has been signed up as race director for the Euro Racecar NASCAR Touring Series, for which he will be responsible for driving standards. Duez has victories in both the Nürburgring and Spa 24 Hour races on his CV.

OBITUARY

Phil Remington

The man popularly known as 'Mr Fix it' in US motorsport circles, Phil Remington, has died at the age of 92. Remington's involvement in motorsport started before WWII, when he raced a modified roadster on the dry lakes of Southern California. After the war, in which he served as a flight engineer in the South Pacific, he returned to racing, but cut short a career as a driver to concentrate on engineering after he nearly lost a leg in a motorbike accident.

The decision proved a happy one for the world of US race engineering, and ace fabricator Remington went on to play a part in some of the most memorable American motorsport adventures, including Lance Reventlow's Scarab F1 project and Carroll Shelby's legendary Cobra and GT40 Le Mans assaults.

Yet he will always be most closely associated with Dan Gurney's All American Racers (AAR) organisation, where he spent 45 years – the second half of his life. AAR released this tribute to Remington: 'All American Racers is sad to announce that Phil Remington passed away in his sleep Saturday morning, February 9th, just two weeks after his 92nd birthday. "Rem" joined AAR in the fall of 1968 after an already stellar career in the motor racing world. He was universally admired and recognised as the greatest fabricator of his time. Until his health started failing last summer, Phil never missed a day of work, he was an example both professionally and personally to legions of young people who studied under him and who worked by his side.

'It will be difficult for us to walk by his old wooden workbench on the shop floor and not hear the sound of his hammer or see a smile break out on his face having just finished his latest masterpiece.'

Phil Remington 1921-2013

DC Electronics hosts Formula Student workshops

Well-known motorsport wiring wizard DC Electronics has hosted a pair of Formula Student workshops, where students were given the opportunity to get hands on experience while learning about the industry.

Nearly 30 students attended the events, where they were taught how to design and build a bespoke wiring harness, and even got to take home the practice looms they built.

The students – from a number of top universities in the UK and Europe, including Birmingham, Newcastle, Brunel and Glasgow – were also taught how to plan and layout wiring looms, how to choose the correct materials, as well as being given instruction on splicing, crimping, soldering and contra-winding cable looms. DC hosted the two separate half-day wiring loom workshops in partnership with Deutsch Autosport and IS Motorsport – both of whom generously supplied practice materials for the students.

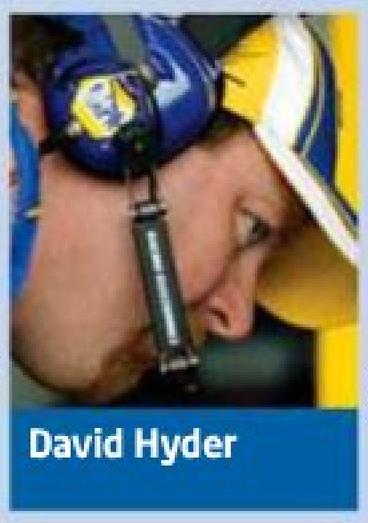
David Cunliffe, director of DC Electronics, said: 'Formula Student provides an excellent opportunity for budding motorsport professionals to gain valuable experience, while benefitting from an insight into our experience in the industry. The workshop has helped attendees develop important skills which will aid their future career development.'

DC Electronics is based in Maldon, UK and is one of the motorsport industry's leading manufacturers of custom electrical systems, with over 15 years' experience in the industry. It also has a production facility in Mooresville, North Carolina. Products designed and built by the company have been used in championships across the globe, including NASCAR, Formula 1, World Rally, Superbike and even F1 Powerboats.

RACE MOVES

Richard Peacock, the boss of the Anglesey circuit in north Wales, has been given an Outstanding Contribution award at the Anglesey Tourism Awards.

Carl Sanderson has re-joined the Doncasters Turbocharger Components Division, where he will act as general manager of Doncasters Trucast Ltd. Sanderson was formerly operations manager at Doncasters Aerospace Components, but has more recently worked at Belgian company Fremach, where he held the post of general manager.


David Hyder
LAT

Long-serving BTCC media officer **Carl McKellar** has stepped down from the position to take on other work within motorsport, including a role with new WRC promoter Red Bull Media House. McKellar's place in the BTCC press office has been taken by former MotorSport Vision man **Simon Melluish**.

Two V8 Supercars event organisers, Northern Territory major events general manager **Paul Cattermole** and Adelaide's Clipsal 500 event manager **Brian Gleeson**, have picked up awards in the annual Australia Day Honours.

Larry Perkins has retired from motorsport, shutting down his Australian V8 Supercar team. The former F1 and Le Mans driver, who scored three of his six Bathurst 1000 victories at the wheel of his own car, has now sold his two 'Racing Entitlement Contracts' to Kelly Racing.


Larry Perkins
LAT

David Coe, the founding chairman of Australian company Sports & Entertainment Ltd (SEL) has passed away. Coe, whose company played an important part in the success of the V8 Supercars series in Australia after securing the rights to the sport in 1996, died suddenly while on holiday in the USA.

The Audi Sport Team Abt Sportsline DTM pit crew has been recognised as the best wheel changers of 2012 by Hankook, the tyre supplier to the championship, for consistently banging in the quickest pit stops during last year's races.

Michelin has appointed Influence Associates to handle PR and promotional activities across its motorsport and high performance road car operations in the UK and Ireland. Led by Influence Associates' CEO **Stuart Dyble**, a team of five will manage the Michelin account, supporting marketing, promotional and PR activities at the tyre maker's Stoke-on-Trent UK headquarters and at motorsport events around the country.

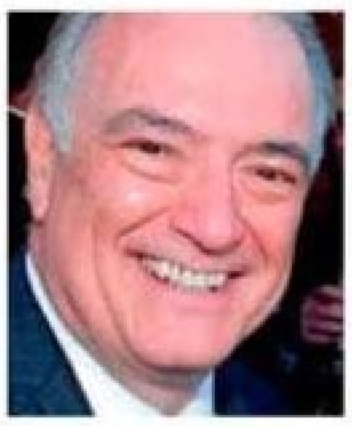
Veteran crew chief **David Hyder** has been hired by Stewart-Haas Racing to form a test team to aid the now three car NASCAR Sprint Cup operation with development of the new Generation 6 car. Hyder worked previously JTG Daugherty Racing, Wood Bros, Kevin Harvick Inc and Michael Waltrip Racing.

Former Furniture Row Racing crew chief **Pete Rondeau**, has been promoted to the competition director position for the Denver Colorado NASCAR Sprint Cup operation. Rondeau will report to **Mark McArdle**, the team's executive director of competition. McArdle also serves as director of racing operations at Richard Childress Racing, the two operations sharing an engineering and technical alliance. RCR's recently hired competition director Dr Eric Warren and McArdle worked together for nine years at the now shuttered Evernham Motorsports.

International Speedway Corp, that owns and operates Daytona International Speedway and 12 other US tracks, generated a net profit of $54.6m for its fiscal year, which ended 30 November, down from $69.4m in the fiscal year of 2011. A fourth-quarter net profit of $24.7m was down from $26.5m the same period the previous year. Its revenues totalled $612.3m in 2012, down from $629.7m in 2011, and in the fourth quarter it generated $189.4m in sales, down from $191.9m the same period the previous year.

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

BUSINESS TALK: CHRIS AYLETT



The great leap forward

A look back to 2003 shows the changing business face of Formula 1

As the 2013 season arrives, the powerful and vital importance of Formula 1 to the global motorsport industry takes centre stage. Its reach, political influence, financial impact on investment and jobs, as well as its dominance of relevant sports media, is unsurpassed. F1 shapes world opinion of motorsport more powerfully than any other race series. In Motorsport Valley UK, it is the top of the 'spending pyramid' and critical to many hundreds of suppliers, particularly in tough economic times.

I wonder where F1 will be in 10 years, and have looked back on their journey since 2003 for some perspective. The way in which F1 management behave commercially, and the response of the F1 teams to that, are central to their commercial future – plus the vital ingredient, the paying audience, and its effect on sponsorship.

In 2003, there were 10 teams and 16 races, and in 2013, 11 teams and 19 races – not much change and perhaps surprisingly, quite a stable platform of businesses. Jaguar, Jordan, BAR, Minardi, and Renault have been re-branded Red Bull, Force India, Mercedes, Toro Rosso, and Lotus, respectively. Two new teams, Caterham and Marussia, replace the only one which has disappeared, Toyota. This recent profile demonstrates that new investors, brands and sponsors have been attracted to the business of F1, bringing fresh ideas and ambition – but will this continue over the next decade?

One major change has been in the countries which host the F1 circus. Gone are San Marino, Austria, Canada and France. Ten years ago, the only Gulf states or Asian hosts were Japan and Malaysia. 2013 will see eight of the 19 races in those areas, but to what business advantage to the wider F1 world? New hosts bring substantial new fees to CVC/FOM and income from new broadcasting rights too, but it is yet to be proven whether they add significantly to the already enormous TV audience of F1. However, these regions do bring increased exposure and so more value to sponsors, adding income to F1 teams.

Since 2003, F1 has lost BMW, Ford, Honda and Petronas as engine suppliers, now relying solely on just four: Renault, Ferrari, Mercedes and Cosworth. Will the 2014 regulations entice others to join this supply chain, for the next decade?

Testing in Jerez in February

We can forecast substantial changes, over the next decade, in the overall management of Formula 1, and the constitution of those who operate, commercially, within it.

Recently, the shareholding and ownership of FOM has moved from being a 'personal investment vehicle' to one owned by the private equity firm, CVC Capital, free to attract investors to share in its success. They will maximise the ROI for their stakeholders from this sports entertainment investment, and will do so dispassionately. Will the long talked about flotation of F1 have taken place by 2023, or will it return to private ownership, with the FIA playing a pivotal role in this decision?

Each 'franchise holder', or F1 team, must maximise their profits. Traditionally they've done so through effective, efficient team operation and race performance, securing the best reward from the FOM prize fund, and attracting the most sponsorship at the highest rates. However, some 2013 teams have changed this operational model, a trend set to continue.

F1 teams are moving towards a 'sporting team franchise', similar to American football and Premier League soccer, with investors replacing the old style of personal ownership. No longer will we have teams of Messrs Ferrari, Chapman, Dennis, Williams, Cooper and the like – replaced by Force India, Red Bull, Caterham. These new franchise holders bring a multiplicity of brands and new blood, with renewed determination to succeed on the track, and earn good profits from doing so.

These investors will make their assets work hard for them. McLaren are building a substantial automotive division, and another which commercialises applied technologies, from its F1 activity. Williams, based on their investment in KERS, through their Advanced Engineering division supply innovative transport solutions, and have created a visionary research partnership in Qatar. Tony Fernandes has relocated much of his Caterham investment to Leafield, retaining their composite business in Norfolk, and is planning to exploit all their technology assets across other sectors. We will see most F1 franchise holders following, as a wider and fast-growing world engages with these R&D-based suppliers.

The world is now obsessed with the cost of energy and in saving it – as well as money – where possible. Motorsport has become expert in the 'efficient use of energy for transportation' – securing maximum efficiency from a given amount of energy (usually gasoline). This race-proven expertise and capability is now highly valued by wider industry, from defence to automotive and commercial transport and is becoming a welcome, new business market for F1 teams.

Investors will see financial returns earned by others, improving investor appeal to these 'F1 franchises', from a more secure, investable commercial base, moving away from sole reliance on track performance attracting sponsorship.

As long as the F1 spectacle remains entertaining to its media audience, this F1 team trend can only be positive – good for jobs, ongoing investments, and capturing new sponsors and investors.

I end by asking why not join me and visit the real home of audience engagement in motorsport – the USA – between 17 and 22 May. Each year, we enjoy one of the best NASCAR races at Charlotte Speedway, where 140,000 fans watch a 'Million dollar – winner takes all' race. We then go to the Indy 500, still a stunning experience in world motorsport. In between these two great races, we visit race teams in all types of motorsport – NHRA, NASCAR, Off-Road and Indycar – to build new business. There's so much to learn from our American friends in motorsport entertainment, see www.the-mia.com for more details.

Make this the year you enjoy one of the great tours in the business of world motorsport.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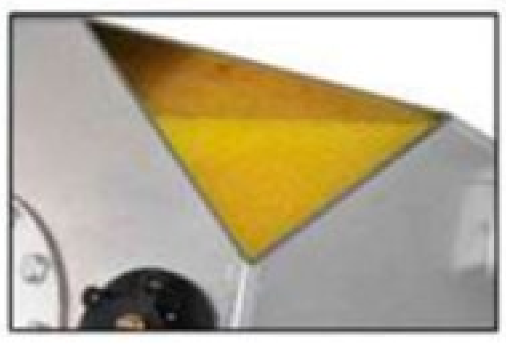
SENSORS

Jenvey TPS

Throttle body manufacturer Jenvey has released the TP11 throttle position sensor, based on the successful range motorsport specific sensors produced by Variohm. The design features a potentiometer with multiple fingered wipers to ensure good electrical contact, even under severe vibration. A conductive plastic track provides durability and extended life expectancy, while the sensor has excellent temperature co-efficiency making for more stable readings at all positions. The sensor is sealed to a minimum of IP65 specifications.
For more details, check out www.jenvey.co.uk

FLUID TRANSFER

New Viper releases



Fluid transfer specialists Viper Performance has released two new products to market. First is a new fuel rail extrusion for custom EFI applications. The 6061 aluminium extruded rail has a 16.1mm bore, and is one metre long, ready for the user to cut, drill and modify to suit the required application. The fuel rail extrusion is available in gloss black or mirror polished surface finishes. Also out is a range of fuel cells in 5, 10 and 15 gallon capacities. These aluminium tanks are filled with anti-explosion foam in case of accident, and the fuel pickups are positioned in a cavity at the base of the tank in a small sump area, which prevents fuel starvation under high G-force cornering or braking. The tanks are available in natural metal or anodised black and come with a fuel sender unit, anodised aircraft-style pull-and-twist fuel filler cap, and mounting brackets. All parts are available as spares.
More information can be found at www.viperperformance.co.uk

MEASUREMENTS

Kistler measures up

Kistler Instruments has added three new measuring ranges to its KiTorq torque measuring system. The new ranges of 100, 200, and 5000Nm have been added to the existing ranges of 500, 1000, 2000 or 3000Nm measuring ranges. Rotors of different sizes can be combined with same ringless stator, which is particularly easy to install and allows different items to be tested without the complete reconstruction of the test stand. The ringless stator design speeds up the installation, protects against damage during assembly operations and facilitates visual observation during the test process. The KiTorq measuring flange is ideal for use in test rigs for electric motors, internal combustion engines, transmissions, pumps and compressors.
See www.kistler.com for a full specification sheet

INSTRUMENTS

More from Roar

UK-based electronics specialist Roar Performance has recently released a new gear position and shift indicator, the GDSLM. The unit consists of an integrated dot matrix display and a series of eight RBG shift LEDs. The display can be programmed with a PC, and is fully configured to accept CAN bus channels for RPM, gear position and display brightness. Analogue inputs are also available. The activation of the shift lights can be configured relative to RPM and gear position and by individual colour selection. The brightness settings of both the gear display and the shift lights are fully configurable to suit differing ambient light levels.
Full details of the unit can be found at www.roarperformance.co.uk

cruden

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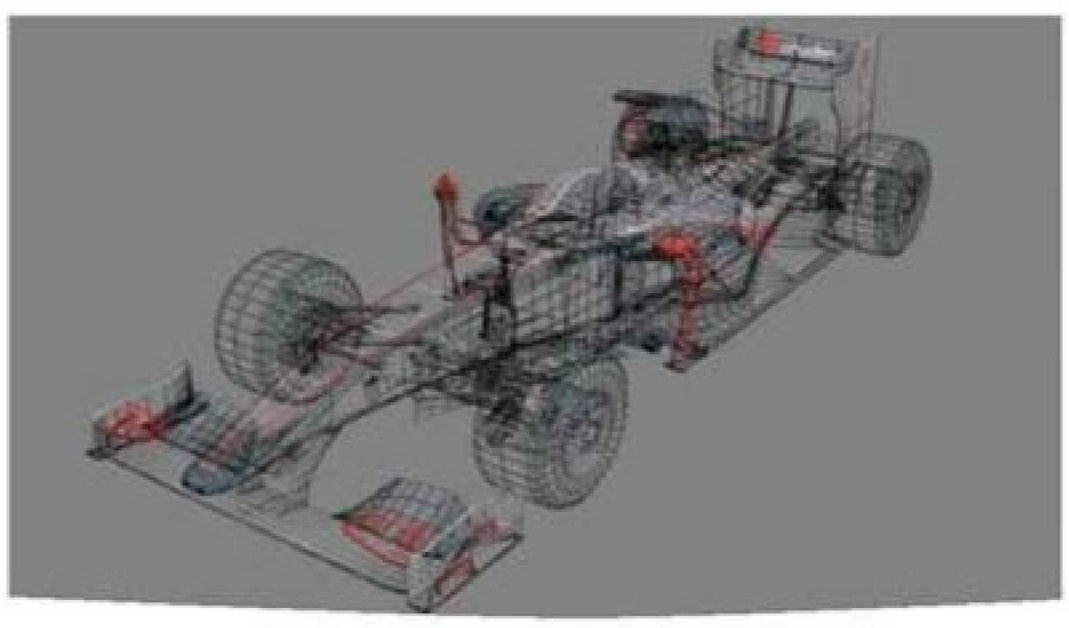

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SOFTWARE

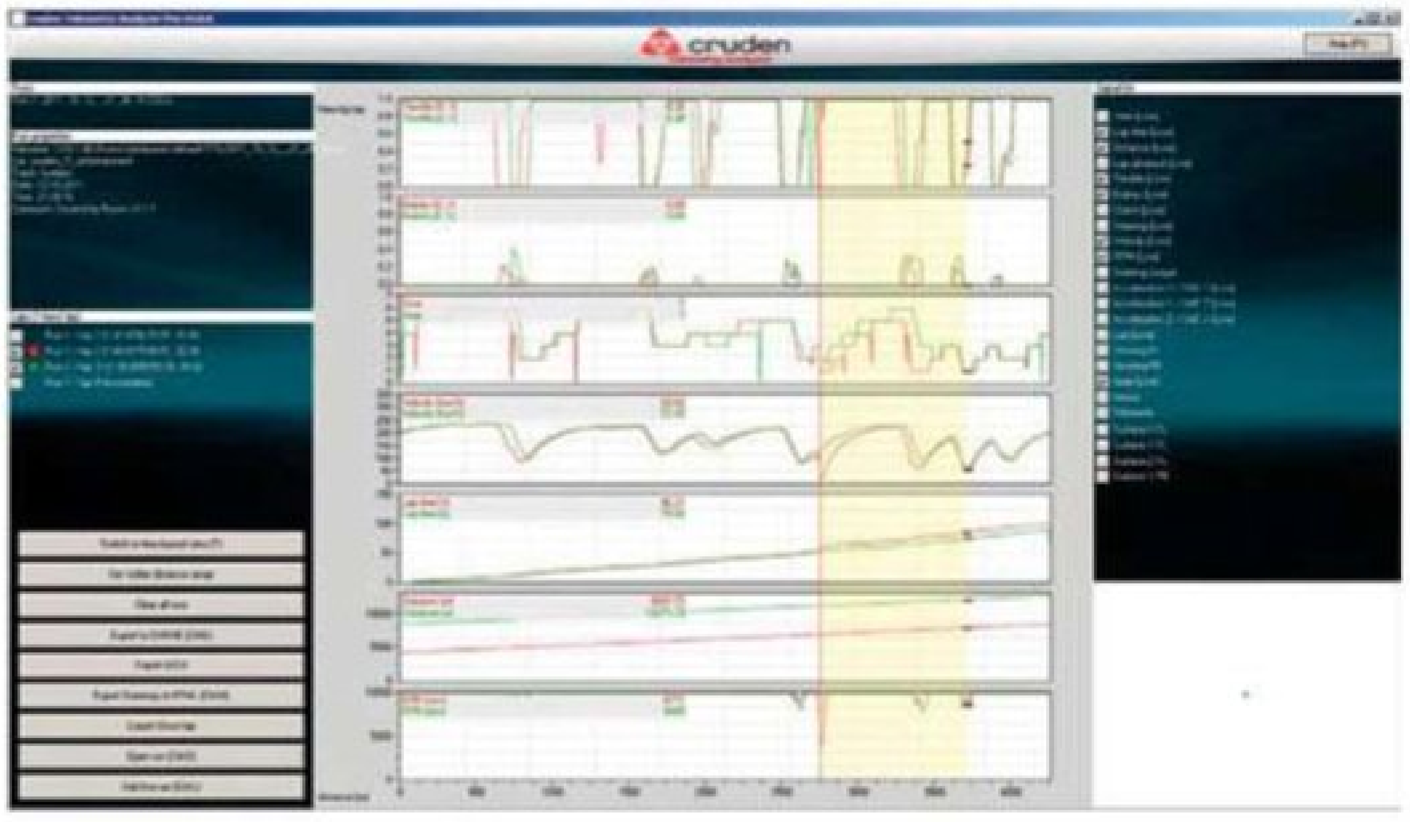
Simulation modules unveiled by Cruden

Simulation specialist Cruden has recently released two new software modules to compliment their range of simulators; a setup tool and a telemetry analyser package. The setup tool allows engineers to change vehicle settings such as shock absorbers, dampers, wing settings and throttle mapping while the simulator is being driven, avoiding the need to stop the test and reset it each time.

The just released Telemetry Analyzer allows race engineers, racing drivers and driver coaches to evaluate vehicle model performance and driving style as the simulated run takes place, or after the session as a download. Instant feedback from data such as lap and sector times, speed, throttle, brakes, steering angles and gears – in addition to many other vehicle parameters – can be used to maximise valuable simulator time. Additionally, with interfaces to PiToolBox, MoTeC, Bosch Windarab or Magnetti Marelli Wintax software available, engineers can analyse simulated telemetry channels as if recorded from the real car and overlay them with actual data logged on the track.

All the new upgrades are available as an optional extension to Cruden's Racer Pro simulator operating software, which is also made available for use with other simulators. They complement ePhyse, a popular extension that allows integration of external physics packages, and means that Cruden simulators are able to seamlessly integrate with Cruden's own Simulink Vehicle Model or with Vi-Grade, IPG CarMaker, veDYNA, CarSim or SIMPACK models.

For further information visit www.cruden.com



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The post-Ecclestone problem

The sport of soccer is a major topic of conversation every morning in the Chelsea Magazine Company. As the fortunes of various supported teams ebb and flow, few need to question the loyalties of our own managing director, whose coffee mug bears the logo of his favourite team. Let's just say, it is unlikely that we will ever leave the Chelsea area of London.

The team has an impressive history of sacking its managers, and few stay in the job for long. Failure to win is not an option. And in the case of Roberto di Matteo, winning is also not an option. Jose Mourinho was a tough act to follow, and no one has managed to fill his shoes. The current victim is Rafa Benitez, a Spaniard who is uniformly despised by the fans as he used to manage Liverpool against the Blues.

Chelsea's penchant for changing managers has led to a lot of head scratching, but at least it has saved the team from the problems that are looming for Manchester United, Arsenal, and, incidentally, Formula 1.

Manchester United has a record that is unparalleled in British football, and at its helm is Sir Alex Ferguson, a 71-year-old who has managed the team since 1986. Ferguson is currently in a position at the club where he can dictate when he leaves. Leading the Premier League, he says that he would never be in the position of Arsenal, who at time of writing are looking at an eighth season without a trophy under Arsene Wenger, who has been at the helm since 1996.

Under Wenger, the team has concentrated on financial stability, and while it is a solid team, consistently finishing fourth will not suffice. That puts them in a similar light to Williams, who have not won a World Championship title since 1997. Williams is different – it's Frank's team. Arsenal's owners publicly back the manager, that's an almost certain death knell for the man.

Which brings me, finally, to Formula 1. Bernie Ecclestone has been in charge of the sport for so long that there is no natural successor for the role. He is now as much part of the fabric of the category as Ferguson is at Manchester United. Except that Bernie is not in a position to say when he will go. F1 needs to have a solution for a post-Bernie era. Who will succeed him? Bernie has spoken of his admiration for the individual who is able to get things done, and in my opinion, despite being castigated for his examples, he's right.

What does the sport actually need, and then, who is best to deliver that? In my opinion, the sport needs to reach a young audience, which, if left unchecked, will rapidly switch off to Formula 1 (and indeed any non-participation activity – witness the rise in audience figures over the last 10 years for major sporting events, and music festivals). These are tech-savvy people who watch events on multiple screens simultaneously, and hunger for more information. Few students actually watch Formula 1 events on the television – they watch on the computer.

The sport needs to remain exclusive, but be accessible to all. It is a fine line to tread. There are two ways of negotiating this path – one is to try to please everyone, the other is to trample all over it in jackboots.

A committee-led approach would end up as a collection of individuals who check every single detail to ensure nothing offends. This would lead to a bland sport that turns everyone off. A committee running the sport would have precisely this, and people with nonsensical titles running 'the company'.

> **"Bernie is as much part of the fabric of F1 as Alex Ferguson is to Manchester United"**

The other approach requires an individual, in this celebrity-obsessed culture, with the charisma to engage a global audience. They need the support of manufacturers, team owners, promoters and the FIA. These credentials are tough to find, but that makes the job easier. There aren't many to choose from.

The obvious ones are Luca di Montezemolo and Flavio Briatore. Both would bring a new atmosphere to the paddock of Formula 1. For that reason, it would be fun to also consider Silvio Berlusconi, although he may well become busy running Italy once again following the summer elections. His knowledge of the media, and global sport, could be good for Formula 1 and its embrace of the new digital age.

The complication with this is that – with an asset so valuable as Formula 1 – would 'the company' accept the nomination of an individual, or would it prefer rule by committee?

EDITOR
Andrew Cotton


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