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The future of NASCAR?

Generation 7 and new technology it will bring



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When I first came to North Carolina about five years ago, I expected to find that the teams were staffed almost entirely by highly skilled crafts men mainly hailing from the southern states. But the reality of what I found really surprised me.

NASCAR had just introduced the car of tomorrow, and with it came a substantial influx of cutting edge technology from Europe. Walking around the Red Bull team you would hardly hear an accent that wasn't from the south ... the south of England, that is! But what really fascinated me was the constant study of the tyres on the cars. With testing then tightly restricted, understanding the behaviour of the control Goodyear's was a major undertaking for the teams, who had little data either from official tests or from the tyre manufacturer.

It was apparent to me that setting up a stock car is largely about getting the most out of the tyres, more so than in a road course car. An engineer at Hendrick confirmed it, telling me 'if a sim guy has a skill in NASCAR, the number one would be being able to pick the right tyre model for what those four sneakers will be like on race day. If you get the model wrong you might predict the car will be loose when it's tight. Ride quality, tyre pressures, lateral plunge rates and sidewall deformation all fall in.' Back then, top European engineers were flocking to North Carolina as the bottom had fallen out of the open wheel market and they needed jobs. Today one suspects that they could find a lot of work back home as Formula 1 teams struggle to overcome the exact same problems that NASCAR teams faced back then, and to an extent still do.

Kurt Romberg told me why he thought that the Cup teams may be better at understanding the rubber: 'Formula 1 set-up is fast, with short and long straights, left and right turns - it's a ballet of compromise,' he said. 'The cars are never optimised. We are way closer to a knife-edge, and that is where tyres really show up as a big tuning device. The range is so much bigger in F1 - you might have a 60mph turn followed by a 200mph straight. We are hyper-focused into a little zone, whereas they are looking at things globally.'

Of course NASCAR and F1 are very different, and the Cup teams are looking for different ways of making their tyres work.

With the Pirelli tyres apparently completely flummoxing top F1 engineers at the moment one wonders if some of them could learn a few lessons from NASCAR engineers. After all, the tools used by the Cup teams are almost identical to those used in Europe; it is just the mindset that is different. While copying the NASCAR teams exactly would not work due to the huge differences in the tyre construction and cars themselves, using the same broad approach and methodology could reap huge rewards.

Interestingly, the team that seems to have coped the best with the F1 tyres - Lotus - also conducts full scale aerodynamic testing at Windshear. Perhaps the engineers it sends out to Mooresville have been picking up a few tips in the bar after work! Interestingly the team that seems to have coped the best with the F1 tyres, Lotus, also conducts full scale aerodynamic testing at Windshear. Perhaps the engineers it sends out to Mooresville have been picking up a few tips in the bar after work!

The tyres are causing upset in F1, could the teams learn lessons from those in NASCAR?

Sam Collins
Editor

NEWS

Penske Racing and Joe Gibbs lose appeals after biggest ever fine



Two of NASCAR's biggest teams took on the rule makers over the legality of their cars and lost. During the ethical inspection before the Cup race at Texas in April both Penske Racing Fords were found to have illegal suspension.

Both cars were found to be in violation of Sections 12-1; 12-4j and 20-12 which state that all suspension systems and components must be approved by NASCAR. Prior to being used in competition, all suspension systems and components must be submitted, in a completed form/assembly, to the office of the NASCAR Competition Administrator for consideration of approval and approved by NASCAR. Each such part may thereafter be used until NASCAR determines that such part is no longer eligible. All suspension fasteners

and mounting hardware must be made of solid magnetic steel. All front end and rear end suspension mounts with mounting hardware assembled must have single round mounting holes that are the correct size for the fastener being used. All front end and rear end suspension mounts and mounting hardware must not allow movement or realignment of any suspension component beyond normal rotation or suspension travel.

As a result, the team was hit with \$200,000 (£131,533) of fines, and suspensions for a number of critical crew members as well as points deductions.

Meanwhile, following the race at Kansas Speedway the engine of the winning car was impounded and later found to be running

illegal lightweight con-rods in its Toyota engine. The rods in the Joe Gibbs-run car were found to be in violation of 20-5.5.3 of the 2013 rule book, which states that only magnetic steel connecting rods with a minimum weight of 525.0g will be permitted.

As a result, the crew chief was suspended and hit with a \$200,000 fine, and points were docked from the owner, driver and manufacturer. This matches the biggest fine issued by NASCAR, which was applied to Carl Long back in 2009 when he was found to be running an oversize engine.

Despite an appeal NASCAR decided to uphold all of the penalties with the exception of a reduction of the points deduction applied to the Joe Gibbs cars.

Dodge return unlikely in 2014

When Dodge quit NASCAR at the end of 2012, it made clear that it was leaving open the door for a future return. The company was the first to reveal a Generation 6 car, but was essentially forced out of the sport when its leading team, Penske, switched to Ford. Recent rumours have pointed to a 2014 return for the manufacturer, possibly in conjunction with Richard Childress Racing, but they are thought to be wide of the mark. NASCAR's Robin Pemberton told the media ahead of Daytona that he did not expect another nameplate to join Ford, Toyota and Chevy 'for the foreseeable future ... the next year or two.' Volkswagen, Hyundai, Nissan and Honda have all been linked to a NASCAR campaign in future



The no.56 Sprint Cup car of Micheal Waltrip Racing was found to have been running too low at the front of the car following the race at Texas. As a result of this violation, crew chief Chad Johnston has been fined \$25,000 and placed on NASCAR probation until June 5. The team has also been docked six championship driver (Martin Truex Jr.) and six championship owner (Michael Waltrip) points.

The number 98 Truck was found to have an illegal fuel tank in technical inspection at the Camping World Series race at Kansas speedway. As a result of this violation, crew chief Joel Shear was fined \$10,000 and suspended from NASCAR competition for four events. He was also placed on NASCAR probation until December 31. The team has also been docked 25 championship driver (Johnny Sauter) and 25 championship owner (Mike Curb) points.



THE SHAPE OF THINGS TO COME?

The arrival of the Generation 6 Sprint Cup car has opened the door to speculation about what Generation 7 will bring





The V8 Supercars in Australia are fitted with working headlights but they spend most of the time taped over. The smaller more modern design could be a pointer for the Generation 7 car

With teams and drivers still familiarising themselves with the Generation 6 cars, many have already turned their minds to the future of NASCAR, a sport likely to undergo a drastic change in the coming years. The introduction of 2013's new cars highlighted NASCAR's untapped potential, and has given rise to speculation over Generation 7.

'The period between Generation 5 and Generation 6 took everyone - including ourselves - out of their comfort zone in terms of how much of the car we had to work with,' admits Pat Suhy, NASCAR group manager for Chevrolet Racing. 'The thing we learned during that process was that we could have cars that look quite different to each other and still maintain the aerodynamic parity that NASCAR requires. I think if we take ourselves out of our comfort zone again the way we did with the Generation 6 car we should be able to do a great job with the Generation 7 car. We can make cars that look vastly different and even more like their production counterparts than they do today, and along with that there are some technology items in terms of relevance that are on the radar screen now.'

What those differences are is still a matter for speculation, but the subject of working lights keeps coming to the fore. 'We've talked

about it internally and with NASCAR about all sorts of different things to bring more brand identity to the cars,' reveals Pat DiMarco, NASCAR program manager at Ford Racing. 'We talked about real headlights, tail-lights, things like that to make them even more like the cars off the showroom. NASCAR said nothing is off the table. So we will continue to develop it.'

Headlights were under consideration for inclusion on 2013's Generation 6 cars, but not everyone was totally convinced of their benefits. 'Working headlights are nice if you need them, but if you look at all of the cars that have working headlights, such as the V8 Supercars, when they race in the daylight they are all taped over with sponsor logos,' says Suhy. 'But on the other hand, with night races it would certainly look cool. It is something we did discuss with NASCAR when we were developing Generation 6, but there was really too much else going on to have the teams having to develop an electrical architecture to support all of that. We talked about headlights, tail-lights and running lights, all that kind of stuff. I don't think it is off the table yet, but it is something that comes along with Generation 6.5, or it could be a Generation 7 thing. It's really about having enough time for the teams to react to it and working out if it improves the fans' response to the cars. There has to be some payback for

the investment.'

That return on investment is very much the debate when it comes to another proposed element of the Generation 7 cars: the much discussed digital dashboard, which will be representative of the instrumentation found on production cars.

'It is on the table, but if you want to create a common digital dash layout it's a challenge within the three OEMs, as we each have different designs on our cars,' muses Suhy. 'On top of that, I think every driver has his own different layout of gauges and switches, so it's a very sensitive subject. It's like rearranging their office, where they sit down to work. If someone told me where my keyboard and mouse had to be and the exact size spec and location of my monitor, I wouldn't like it much! That's something the sanctioning body and the teams need to understand - what would be the payback for doing that?'

According to Jeff Burton, some of the drivers are far from keen on using digital instrumentation unless the new cars feature other - less fundamental - changes. 'I think every car should have in-car audio and cameras and video, making it very interactive so fans can watch the race, have a computer next to them or watch on the smartphone and see it from a lot of different angles,'



'We've talked about it internally and with NASCAR about all sorts of different things to bring more brand identity to the cars ... NASCAR said nothing is off the table.' - Pat DiMarco



Burton says. 'Anything to make the races more interactive, that's where our sport is going. These are things we can do that don't impact our fans in a negative way. If they don't want to use things like that, they don't have to. They can embrace it or not. Just offering it is a win-win. ... Cool dashboards don't mean anything if no one can see it.'

Unlike the Generation 6 cars, the Generation 7 machines will not be a matter of improvements to the cars' external styling elements. Instead, the fundamental concept of what makes a stock car is being questioned openly, with the heart of the car up for total revision. The next breed of NASCAR engines will almost certainly feature direct injection, bringing them into line with current production cars.

'Direct injection is probably the biggest of the things we are looking at to increase the relevance of the cars,' Suhy reveals. 'While I'm in favour of it technically, we have to look at the level of investment to get from where we are now, having just introduced EFI, to full direct injection. We have to understand what it means for the sport: can the teams afford it? Can the manufacturers afford to do it? We need to work out if it pays back and results in more sales of cars and parts basically, that's why we race in NASCAR.'

But the Generation 7 Sprint Cup cars may not be the first stock cars to feature the technology, which could make its debut via a late model running at one of NASCAR's Home Tracks or in a grass roots class.

'I think whatever we do in Generation 7 will eventually trickle down the chain,' Suhy says. 'If you take crate motors, for example, in our production portfolio, our V8's will all be direct injection by 2016. All the full-size trucks will have DI motors, and the new Corvette has one, so it would not surprise me to see the DI stuff roll out into our crate motors too. 'It's possible for direct injection motors to appear as crate motors in stock cars before they appear in NASCAR, but I don't know what the plan is. We still supply the Generation 1 cast iron block engine to a lot of series, so it may not happen. There is still a market for that stuff, so it's up to the various sanctioning bodies to work out what they can afford. Clearly a direct injection crate motor is going to cost a lot more than a carburetted engine of the same general architecture. But over time everything will evolve to direct injection - it's just a matter of when not if.'

With the world at large pursuing more efficient engines, NASCAR too is considering the need to downsize. The big capacity eight-cylinder motors stock cars use today

could become a thing of the past. 'It's a good question to ask how many V8-engined cars we will sell in the future,' Suhy admits. 'I think there will be a place for V8s at least in the medium term in our products, especially in larger vehicles like pickup trucks, vehicles that need the kind of horsepower that the V8 makes, but passenger cars? I assume, like most people do, that the time remaining for the V8 is limited. So those are the questions we are asking ourselves right now: what does the Generation 7 engine look like? Is it a direct injection engine? Is it a V8? Is it a V6? Is it turbocharged? All of that stuff. While we are not talking in great detail at the moment, we will be starting to discuss it seriously soon and I don't think anything is off the table.'

Engine life may be extended in an attempt to reduce costs. There are few classes of racing in the world currently burning through as many engines as the NASCAR Sprint Cup, which is why NASCAR has already implemented a minimum life for the V8s used in the Nationwide and Truck series. 'I would not be surprised to see that make it into Cup even before we have a new engine,' admits Suhy. 'It's something that has been under consideration. I think NASCAR has looked at how it might work - would you be able to change the valve springs, or would the engine



be totally sealed? In Nationwide and Trucks they are totally sealed, but in Cup the races are longer and there are some questions about how it would work. The engine builders need to work out how far they could push it without messing up the show.'


Fuel is also under scrutiny, with proposals allowing diesels to take part looking like a long shot aimed at attracting European manufacturers, such as Audi, who are keen on marketing themselves in the United States. As NASCAR told the teams, 'everything is on the table', and biofuels have already made a limited appearance in Cup teams' fuel churns. 'I think E15 was a great start for NASCAR to get their toes in the water,' Suhy enthuses. 'I think increasing the bio content in the fuel is the way to go in several fronts; we sell E85-capable vehicles, and we have done so since

1999. I think it would decrease the number of races that we see turn into fuel economy races if they let the range go down with the increased ethanol.'

The concept of a smaller-capacity turbo-charged engine with fewer than eight cylinders running on fermented sugar cane fitted to the cars racing in the Daytona 500 and on the high banks at Bristol could cause the South, NASCAR's core market, to rise up in rebellion again. But both NASCAR and the manufacturers seem aware of this, while they are also aware of the business need to develop new markets.

'Right now I don't think NASCAR's core fans will accept a car that was not a V8,' concedes Suhy. 'There is something about the sound of the car and its speed that is intoxicating. The problem with reducing the displacement

is that you will likely reduce the output and in turn the speed. The fans want to see the cars go 200mph, and once you have reduced the output you then have to look at the aerodynamic performance of the car to match the engine power, then you are looking at the whole Generation 7 package. That raises the issue of the timing. We could introduce both a new car and a new engine together and make it more relevant to the products we are selling today: smaller, lighter cars with lower displacement higher specific output engines.'

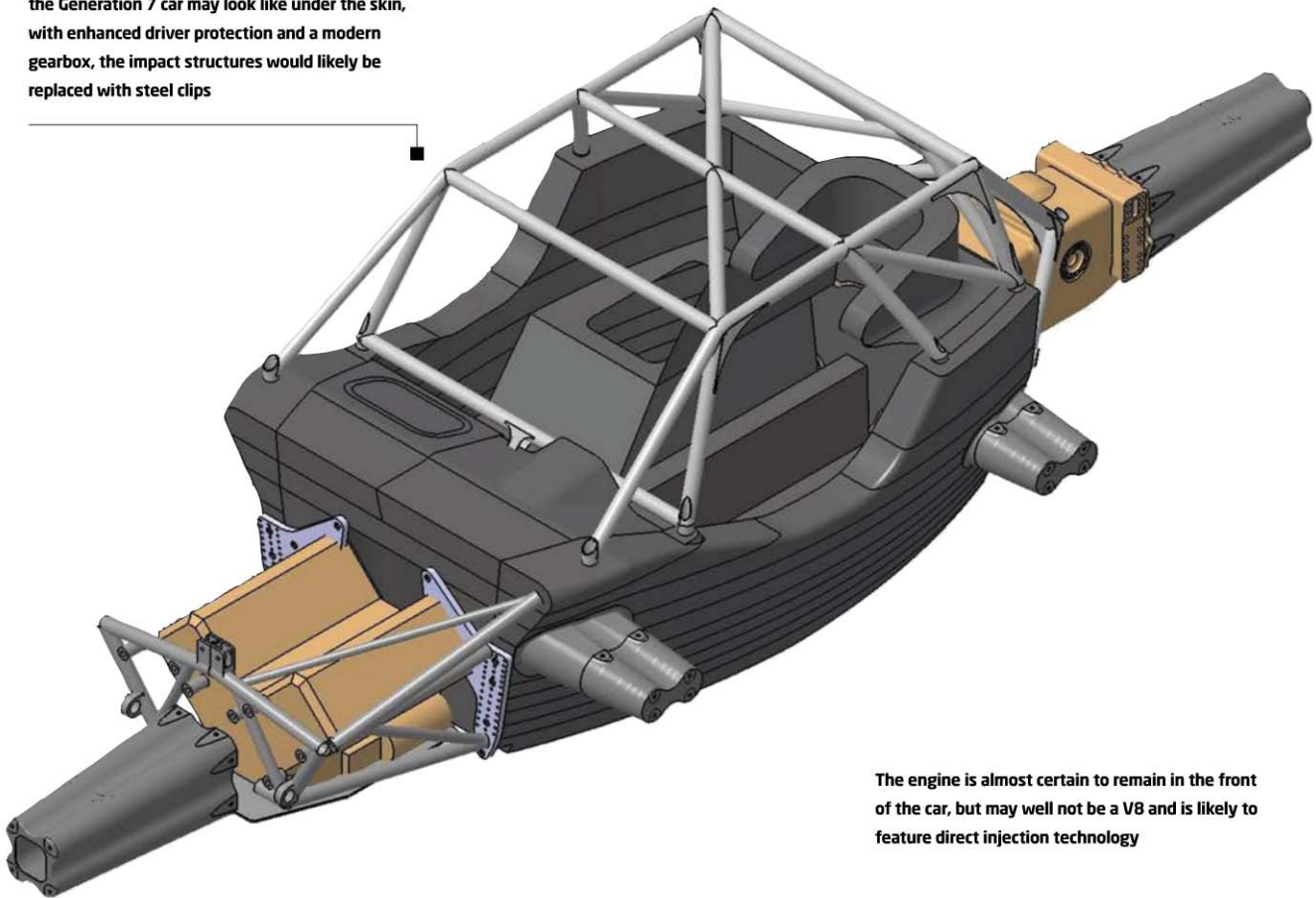
This could see another staple of the stock car concept revised: the extensive use of steel for pretty much everything from the body to the tubular chassis. With V8 Supercars setting its sights squarely on North America, the look and design of those cars could influence the development of the Generation 7 concept. 

Reducing the mass of the car could see the arrival of a chassis very similar to the one found in DTM and the GT500 class of Super GT



'I think every car should have in-car audio and cameras and video, so fans can watch the race, have a computer next to them or watch on the smartphone and see it from a lot of different angles.' - Jeff Burton

The 2013 DTM car gives a good indication of what the Generation 7 car may look like under the skin, with enhanced driver protection and a modern gearbox, the impact structures would likely be replaced with steel clips



The engine is almost certain to remain in the front of the car, but may well not be a V8 and is likely to feature direct injection technology

‘A more sophisticated drivetrain is also on the radar. A four-speed manual is probably OK for oval tracks, but I think it would be interesting to see a proper gearbox on the road courses.’ - Pat Suhy

‘The cars could be lower mass with more tyre and more brake,’ Suhy explains. ‘Right now, the cars are tyre-limited. I think more modern wheel and tyre packages would be on our radar screen. That might not be a Generation 7 thing; that might come sooner if everyone feels the same way. There are plenty of other ways we can reduce the mass of the cars, like using composite materials, using other materials other than steel for body panels. It changes the demand on the car too: if you reduce the mass of the vehicle do you need as much roll cage? There are a whole bunch of knock-on effects like that.’

Road courses could see Generation 7 cars running sequential transmission with more than the current four cogs, Suhy says. ‘A more sophisticated drivetrain is also on the radar,’ he says. ‘A four-speed manual is probably OK for oval tracks, but I think it would be

interesting to see a proper racing gearbox on the road courses.’ This could conceivably see the arrival of paddle shifting and auto blipping appearing in Sprint Cup, something that currently seems very far-fetched. But most of the current transmission suppliers to Cup teams are more than capable of offering a product off the shelf.

Generation 7 will almost certainly bring in new manufacturers, when the Australian V8 Supercar series changed its rules to give the auto makers more freedom it attracted both Mercedes and Nissan, the USA is crucial to both and NASCAR could be of interest.

To some, the Generation 7 cars may seem far-fetched, almost like a science fiction version of NASCAR. They will almost certainly not see the light of day until at least 2017, but how far could the concept be taken by then, with some manufacturers predicting

self-driving cars by 2020? In 2012, Google released a video of a self-driving Cup car for an April Fools’ prank. It was nonsense, of course, but demonstrates just how far automotive technology has come, and how drastic future changes will have to be to keep the cars road relevant.

Self-driving cars will not be on the NASCAR agenda, but perhaps surprisingly to some nor is an increase in on-board electronics and data systems. ‘Part of NASCAR is that it is a human effort,’ Suhy asserts. ‘It is the driver communicating with the crew chief and the spotter, not a bunch of engineers sitting back in the pits looking at data in real time. That’s what makes NASCAR a different kind of challenge. Stock car racing’s reliance on the relationship between the driver and the crew is pretty unique, and it really is part of the show.’

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NASCAR'S CARBON TUB

How a Formula 1 car designer and an Indycar chassis maker nearly changed everything

IAN WAGSTAFF





“The average NASCAR driver was then much larger than the guys in Champ Car. We had to make all new moulds.”

Dale Jr allegedly used the Reynard PPI tub throughout 2002. It could potentially have increased the stiffness of the car

Dale Earnhardt's fatal accident at the 2001 Daytona 500 rammed home the fact that the primitive nature of NASCAR racecars extended to their safety. But Gordon Coppuck, designer of the McLaren M8, M16 and M23 cars, points out that a 'lot of erroneous things' were said with regard to the accident in the days that followed, and he believes that the full story is still not in the public domain. 'We knew that it was something to do with the seat or the seat belts but we did not know the nitty gritty,' he recalls ruefully.

In the late '90s Coppuck was working for the Arciero-Wells Champ Car team, but when Cal Wells decided to move into the even more demanding world of NASCAR in 2000, he decided that - now approaching his mid-60s - it was perhaps time to virtually retire, working only on short-term projects. But when Wells noted that single seater drivers were surviving massive accidents, he asked Coppuck to research

improvements to NASCAR cabins by looking at open wheel technology. Coppuck returned to the UK to develop a prototype solution to the problem.

'Traditionally, NASCAR had a seat not that unlike those found in a road car but shaped to suit the driver,' Coppuck recalls. 'Even by Formula 3 standards, they were crude; they were really death traps. With single seater carbon chassis we were able to do far more to protect the driver.'

Financed by Wells and working with Reynard, Coppuck looked at the way in which its Champ Car was constructed to see if an answer could be found. 'They were so different, though. Only the principles could be used, none of the components.' By that time, though, the single seater industry had well over a decade's worth of experience in using carbon for crash resistance.

'We measured the seat pedal, steering and gear shift positions in Cal's NASCAR, all the critical dimensions that we could,' Coppuck remembers. 'They were so very different to a formula car.

In NASCAR the driver sat upright, his elbows stuck out to enable him to cope with a large steering wheel and the gearshift had a classic H-box pattern. Then there was the width across the driver's hips - the average NASCAR competitor was then much larger than the Champ Car driver. We had to make all new moulds.'

The manufacturing of the first seat - or cocoon, as some called it - was carried out at by Reynard at Brackley, now the home of the Mercedes F1 team. It was referred to as a 'seat', but there was obviously much more to it. Coppuck best describes the cocoon as being like 'the cavity in any racecar in which the seat is positioned, a complete structure that retained the driver in which the seat itself was only a comfort thing. We called them 'seats' but as they were monocoques they were more like an integral chassis.'

The prototype was taken USA for sled testing with an instrumented manikin at Detroit University. The first test was carried out with a traditional NASCAR seat for purposes





A Dallara GP2 monocoque is very similar in shape and design to the Reynard / PPI NASCAR concept, albeit much narrower. Coppuck (below) was a leading figure in the project. The 'Tide ride' driven by Ricky Craven (bottom) featured the Reynard seat

of comparison, and the crash simulated was shown to be unsurvivable. The test was then repeated with Coppuck's prototype using the same forces, and the 'driver' survived. 'We had shown that we had crossed the bar,' says Coppuck.

The results were shown to NASCAR, which was understandably impressed, 'We felt that we had something that could contribute to making the sport a bit safer,' says Coppuck. At the time, the regulations did not dictate which suppliers the teams used, and Coppuck hoped that Reynard would be included in a recommended list. But NASCAR would only do this if the seats were made in the southern states of the USA. 'They couldn't see what a massive undertaking it was to set up a composite carbon fibre workshop. You can't just use carbon fibre as if it were fibreglass, but they would not understand that. In Britain we had a choice of suppliers and the correct facilities.'

Adding to the lack of willingness to deploy the seat was Jeff Burton, who studied the Reynard/PPI concept. After being initially supportive, Burton later told the media that he felt that it was possible to meet the same safety goals with an aluminium seat. The aluminium had two advantages according to Burton - NASCAR teams had worked with it before, and the sanctioning body would immediately allow it to be used. 'NASCAR was concerned

with it from the beginning because we don't have a history with composites,' Burton said at the time. 'Let's don't wait for the composite thing because the composite thing might not ever happen. I'm convinced more than that we can get to where we want to be with aluminium.'

Without NASCAR approval, the project was commercially dead. However, about half a dozen of the seats were made to be used in Wells' own PPI Motorsports car. There was one other, perhaps understandable, customer: the Dale Earnhardt, Inc. team, who

bought them for Dale Junior.

The all-carbon fibre seats offered protection for the driver from the heels to the back of the neck. They could also have been used, recalls Coppuck, to make the car stiffer. Strength was taken from the inner panels, with careful design consideration going into the location of the load points. Nothing unusual in that, except that this was for NASCAR.

No additional regulations were required to enable the seats to be fitted, and Craven and Earnhardt Junior thus ran with them that year. Coppuck believes that they were in use for a second season, but his involvement ended when Wells put in his order to Reynard. Coppuck has not attended a NASCAR race since the development phase ended.

Without NASCAR blessing the project had no real future, while the 'Car of Tomorrow' was already on the horizon. The NASCAR carbon tub concept remains one of motor racing's 'what ifs'. Today, composite seats are commonplace in stock cars. But none are quite as comprehensive as the monocoque-like seat proposed by Coppuck, Wells and Reynard.



THE RISE OF NEW MATERIALS

Composites were once seen as strange and alien in the NASCAR garage, but they are increasingly commonplace, with the hood and deck lid of the Generation 6 cars made from carbon fibre instead of the traditional sheet metal.

'The deck lid is an area that is very important to the car,' Robin Pemberton, NASCAR VP of competition, said. 'Over the past few years, it was becoming a science project, if a deck lid can distort a certain way during a run, during the afternoon, it generates more downforce. It became a piece that was only made for a race or two races, then was thrown out. It was labour intensive, was not predictable and it wasn't fair for some teams that had more resources than others that could afford to do that week in and week out when other teams could not.'

The composite deck lids now all come from a single supplier, Composite Resources of South Carolina and are made to a specific design, reducing the scope for 'creativity outside of the rule book'. Reshaping a Kevlar-coated carbon fibre part is a challenging task, and one the teams are unlikely to attempt. At the front of the car the hoods are also restricted, and each manufacturer has been allowed to nominate just one supplier: Five Star Race Bodies supply the GM teams, Roush for the Fords, and Toyota teams get parts from Crawford Composites.

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Stockcar racing originated in Britain and it looks very different to what is found in North America, but cutting edge technology is making its mark here too





Ceramic thermal barriers are common in the Formula 1 World Championship, but now they are being employed in F1 stock cars

There is Formula 1 is more than just an open wheel racing series. There is Formula 1 powerboat racing, Formula 1 air racing, and - in Europe - there is also Formula 1 stock car racing. Those who know the history of the sport will already be aware that stock car racing originated in the UK, where it has developed for more than a century into a sport very different to the racing in North America.

The British tracks are small, typically around 350 - 400 metres in length, and they come in two varieties: asphalt (pavement) and shale (dirt). Built to entertain working class spectators, promoters realised in the '50s that the fans wanted to see action, powerful cars and full contact racing. BRISCA F1 was born. The series continues to this day, and has stayed largely true to its working class roots. Full contact racing remains. With reverse grids,

the fastest drivers literally have to push their way to the front. But this is no destruction derby: the cars each cost around £50,000 (USD\$76,000). Most drivers have a different car for shale and asphalt and often a back up car. In engineering terms, the series is underdeveloped and the box section steel chassis appear crude to the eye, but there is lots of scope for ingenuity. But

“In engineering terms, F1 stock car racing is underdeveloped and appears crude to the eye”

this is old fashioned engineering, motorsport the way NASCAR was many years ago - more Smokey Yunick than Chad Knaus.

Current points leader Tom Harris is a typical example; he has been around F1 stock cars all of his life, his father raced for years and once 16 he started to race the cars as well. 'I rebuilt one

of my dad's old cars and moved into racing,' Harris explains. 'I won some races in that first year. I learned a lot about the car just by doing it. I wanted to work as a fabricator, but I got a job as a panel beater because people I knew thought that a panel beater [sheet metal worker] will make a nicer job of finishing a stock car than a fabricator will. A fabricator will just do something that works

regardless of whether it is neat'

Harris does not have a giant budget and his cars are prepared in a working cattle shed on his father's farm. But he builds almost the entire car himself, as well as supplying rivals with his products. The only thing that he does not do is the engine. There is no maximum capacity or output limit

in F1 stock cars, Harris explains. 'The engines are unlimited; mine is a 434 ci small block putting out 650bhp. In my shale car I have a dry sumped engine built by Gaerte in the USA that puts out 767bhp. We are getting into NASCAR Sprint Cup territory, and revving over 8,000rpm, but the regulations say that we have to use a cast iron block which limits us.'

The cars all use two-speed manual transmissions, such as the purpose-built F1-2sd from Elite Racing Transmission. It is an inline, two-speed, dog or Synchro gearbox which utilises standard Winter 10 spline drop gears to quickly alter overall gearing without needing to change the differential. The F1-2sd has been designed to withstand the unique vigours of F1 stock car racing, and features gears that are REM super finished to increase life and reduce friction. Elite claims that the material used has a core strength of approximately





and running to a minimum weight of 1350kg,' he explains. 'We have plenty of weight spare; one of my cars has 300kg of ballast in it. We corner weight the car on the flat patch here before every race, but then we have to go and check on the scales at the tracks and sometimes they are not that well calibrated, so we can be legal on our flat patch but illegal on theirs and sometimes the opposite. Sometimes it works in our favour though! We are unusual in that

ovals, the suspension is highly staggered, meaning the damper sits very close to the brake disc on the nearside,' Harris explains. 'We have to constantly rebuild and replace them due to the heat. On the European tracks, which are slightly faster, they are getting through a damper a race on one corner of the car, with the oil overheating. There isn't time for everything to cool down between the heats and feature race which means the handling starts to

"The races are short and intense. I have to start at the back of a field of around 40 cars and literally push my way to the front"

30% greater than that of most manufactured gears.

Teams are not restricted on ratios, but most boxes - like the Elite - come with fixed first and second ratios which can be altered with drop gears to suit tracks and track conditions. There are no rain delays in this series - with the notoriously wet British climate, rain delays would prevent racing from ever taking place at all.

Harris has been stirring things up in recent years as his analytical approach to racing has been yielding results, including a number of championships and a huge points haul. 'There are people in stock car racing too worried about what I am doing, and not thinking about what they are doing themselves,' Harris says. 'They think we are cheating, but we just understand what it is the car is doing. It's not rocket science, is it? You just have to think about it. They sometimes walk past my car, look at how I have set my suspension on one corner, and go and copy it. Of course they then can't make it work because they haven't realised that it changes.'

The approach Harris takes to setting up his car is straight out of the textbook: with his own flat patch in the corner of the barn he tries to get as close to the optimum setup as the strict regulations allow.

'We are limited to a side to side weight distribution of 52.9% maximum on the inside, 55% rear

we check tyre temperatures after every race. We check to see if the tyres have grown, if they have grown together and we record everything so we have a good set of references.'

BRISCA F1's rulebook is full of regulations intended to keep the cars cheap, with the use of composites tightly restricted and a control Goodyear tyre used. Some parts are even cost capped, such as the dampers, which are limited to just £125 a corner. This means that in reality very few products on the market can meet the teams' requirements, due only partly to the rough and tumble racing style typical in BRISCA F1.

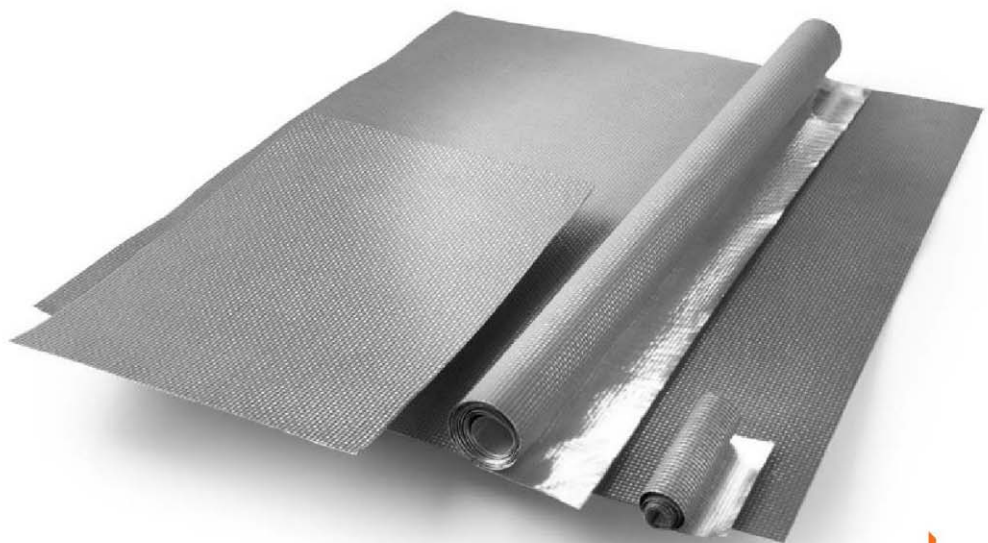
'As F1 stock cars only race on

degrade as the meeting goes on and things get hotter.'

To counter this, Harris turned to a technology which is common place in the other Formula 1, and to an extent was specifically designed for that market: he has wrapped the damper in Zircoflex, a flexible ceramic heat shield material from British firm Zircotec. Encouraged by the results, Harris has gone on to use thermal barriers on other marginal components and areas.

'The optimum location for the battery for weight balance is unfortunately right next to the hot exhaust,' explains Harris. 'With at least three races per night and numerous stoppages, I rely on the

Zircotec's innovative ceramic thermal barrier wrap helps the dampers (above) work more consistently and last longer



battery to start the car every time. ZircoFlex can be cut and folded around the battery to keep the heat away.'

Harris is equally keen to keep himself cool in the central cockpit, sitting literally astride the transmission just centimetres from the engine in front. 'The races are short and intense,' says Harris. 'I have to start at the back of a field of around 40 cars and literally push my way to the front. If we race on shale, we also have to contend with being sprayed with that. Anything that helps improve my concentration is well worth having.' He has also coated a set of exhaust manifolds with the same firm's plasma-sprayed exhaust coating in the hope it will further help manage the heat issues around the car and potentially give him a performance increase.

Harris makes his living from racing F1 stock cars and supplying cars and parts, particularly wings, to other competitors. The aerodynamic regulations in F1 stock car racing are very loose indeed, and most cars sport very large wings, but the dynamics are not well understood.

'The regulations state that the wings must be "substantial" but the wings are free in profile and overall shape' explains Harris. 'They are not mandatory, but if you have one there is maximum size, width and length. The mounting is restricted, as are the endplates, but the angles and shapes are free. I'm working on some new shapes and materials for wings that may be more effective aerodynamically'

In a future issue of Stockcar Engineering we hope to explore the full aerodynamic characteristics of both Sprint Cars, Dirt Late Models and BRISCA F1 stock cars. Harris has expressed an interest in showing off his skills as a driver and an engineer in North America in the future. Could it be that the 21st century Smokey Yunick doesn't learn the ropes in Midgets, Sprint Cars and Late Models, but at the British short tracks.

"The wings are not mandatory, they are free in profile and overall shape, the rules say they have to be substantial"



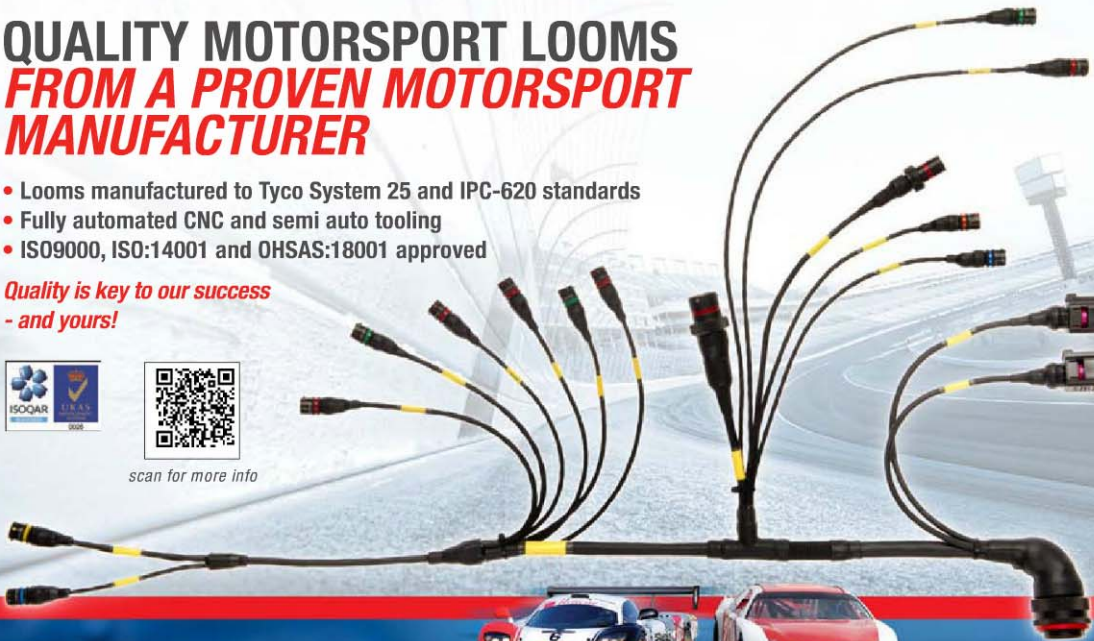
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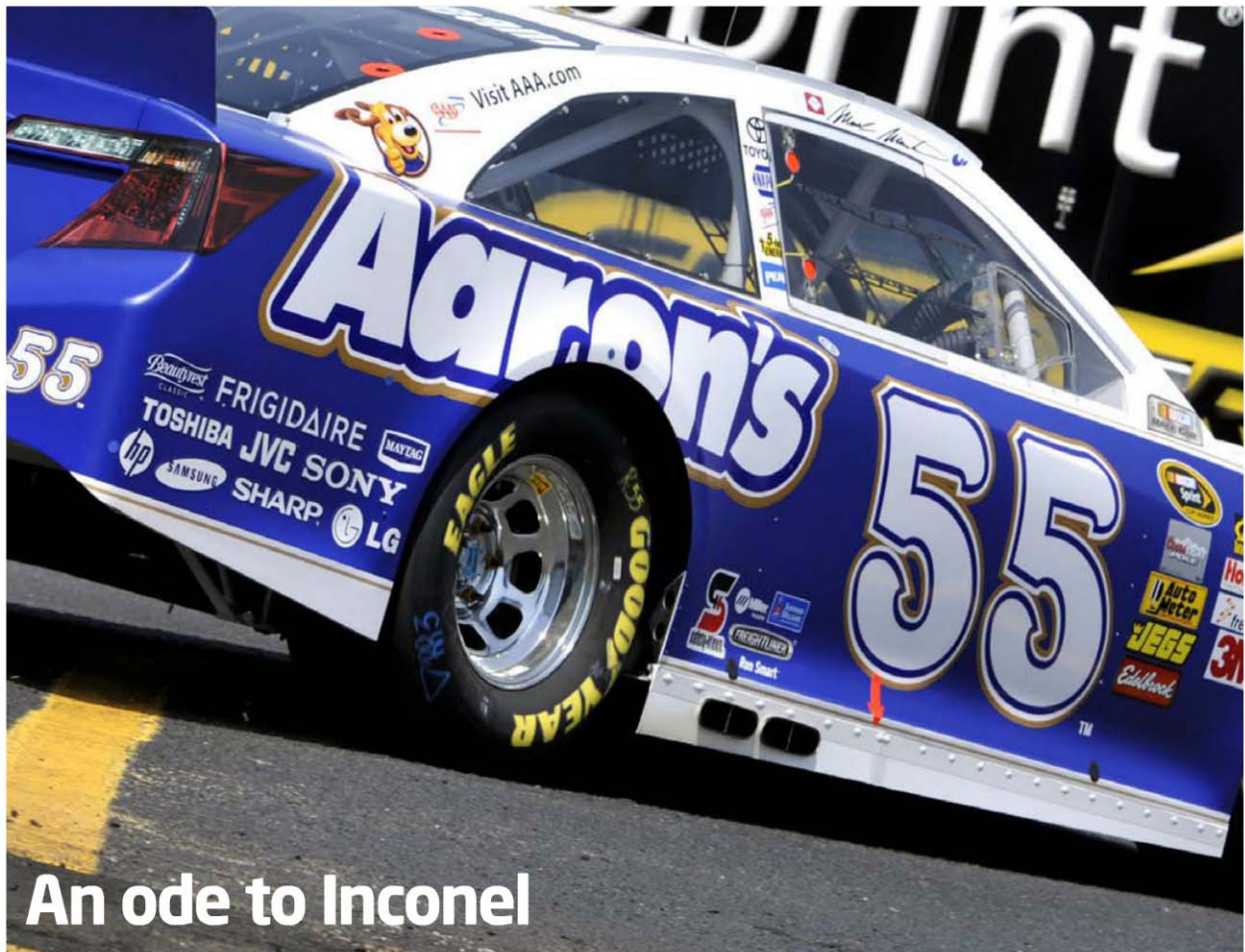
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An ode to Inconel

One of the most important engine tuning tools, and an area all too often overlooked, exhausts can make the difference between winning a race and not finishing at all. For NASCAR Sprint Cup teams, exhausts are not only all about engine performance - they are also about weight, or rather the lack of it. Despite the fact that cars are built below the minimum weight and ballasted back up to it there is still gain to be had from reducing weight. The more shaved off parts like the exhaust, the more the engineers have to play with to adjust the car.

Some years ago almost all of the exhausts in Cup were made from stainless steel tubing with a wall thickness of around 0.065in, but that fell to a wall thickness of 0.035in and in recent years things have changed substantially. The arrival of European engineers - many with F1 experience - in the Cup garage heralded the arrival of a new alloy, Inconel. On paper, Inconel is no lighter than stainless steel, but it has properties that allow it

to withstand very high temperatures. Such is Inconel's tolerance that the wall thickness on an exhaust system can be cut down to 0.020in, which is where the weight savings come in. While an old fashioned pair of Sprint Cup headers could tip the scales at over 10kg, a pair made in Inconel could weigh less than 6.5kg.

Penske Racing and Joe Gibbs were the first teams to run the European-style exhausts. Others were slow on the uptake, concerned both by the prospect of something new and - more significantly - the increased cost of Inconel headers. A team could buy in a pair of stainless steel headers for around \$3500 (£2299), while Inconel versions would cost upwards of \$7000 (£4597). But with the margins in Cup becoming ever smaller, teams have to bear the cost burden more frequently. To save money and difficulty, some teams use headers with tubes made from Inconel and flanges from stainless steel.

But lead times are an issue, as the exhaust fabricators need to order in very specific sizes of tube, which -

naturally - are sizes that the metals suppliers don't stock in large quantities. Thirty-six week waits were not unheard of, so some of the fabricators have started to roll their own tubing, despite the fact that the metal is difficult to machine as it work hardens very rapidly, requiring specialist skills to get the best results. Other teams are now starting to buy in the headers from the UK, with companies like Primary Designs (a major F1 supplier) now working with some teams in the Sprint Cup garage.

In Formula 1 teams use Inconel exhausts with very thin wall thicknesses, but they have shorter races and throw them away after each meeting. Such wastage is financially prohibitive for Cup teams, who try to get their exhausts to last for as many as five races. After that they tend to fail, not through the endless heat cycling but from wear: as the metal is very thin it starts to wear at the joints and will eventually crack.

NASCAR currently mandates steel tail pipes, but with a new engine formula on the horizon perhaps that will change.

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The problem that never was



Much was made of the arrival of electronic fuel injection into NASCAR Sprint

Cup in 2012, and at the Daytona 500 there were many expecting cars to come coasting to a halt as the new technology failed.

'When you do something like this where you're going to have 20 or 30 million people watching on television, 200,000-plus in attendance, and all of a sudden we're going to run it in every single car?' said Steve Nelson, director of marketing for Freescale, the official automotive semiconductor of NASCAR. 'You can be sure that

Ever since 2012 Sprint Cup engines have featured electronic fuel injection, and modern wiring looms



DC Electronics has introduced a range of new European style products into NASCAR, as a result of the introduction of EFI



This carbon fibre coil pack is an example of the kind of products being introduced into NASCAR

there was, I'm not going to say consternation, but we sure wanted it to go well, without question. We knew if we got to April or May (2012) and you were still talking about this system, it is not good. We wanted to be a non-story; we wanted it to be about competition.'

In April most people had largely forgotten EFI was even fitted to the cars. There was nothing to report - with a few exceptions, mainly hiccups in tuning and fuel pick-up - the new EFI system remained out of the spotlight. In the 40-plus races since the implementation of the system, not

one engine failure has been traced back to the ECU.

One group of companies has almost been entirely overlooked during the introduction of EFI into Cup: the wiring loom suppliers. When NASCAR decided to introduce EFI it also opened up the electrical systems to a range of companies beyond main supplier McLaren Electronics, a move that heralded the arrival of a group of highly experienced electronics companies into the sport.

Modern wiring looms are quite different to the old style cabling and interconnection

found on the cars pre EFI, some of which can still be found in the cockpits of the Generation 6 cars. The looms use military aerospace-grade connectors which offer both a weight saving and reliability. Cheaper automotive plastic connectors can literally be shaken apart by the vibration of a competition car, and over time the vibrations can cause connector pins to resonate and erode away the contacts.

The arrival of these connectors in Cup garages allegedly caused some problems in testing in late 2011. A number of cars were

coming to a stop on track with clear electrical problems, but nobody could figure out why. The looms were removed, tested, and found to be fine, and once re-fitted to the car worked without further problems. It appeared to be a matter of loose connections.

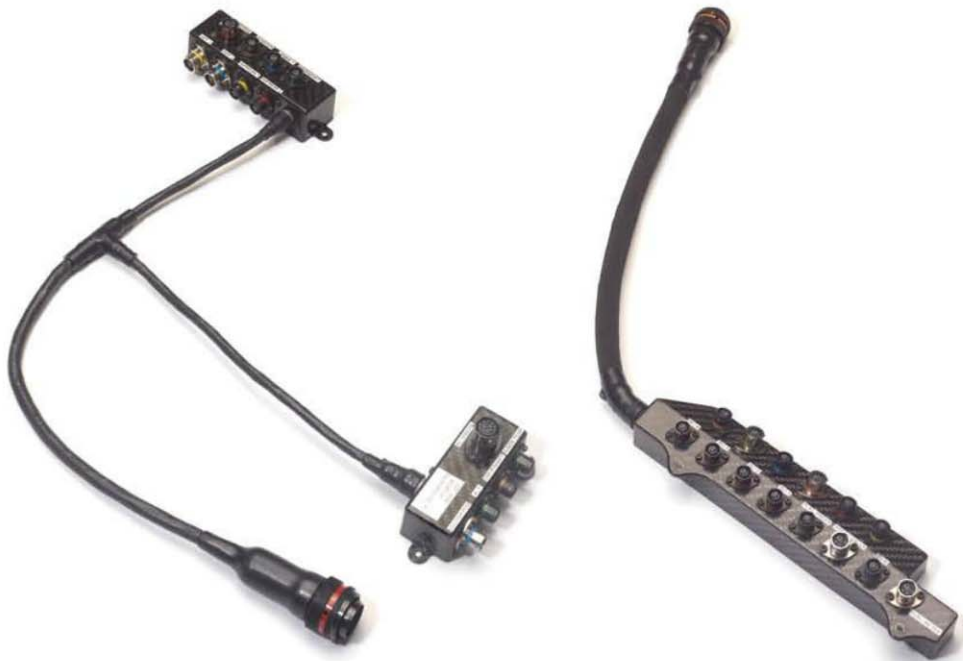
It transpired that some of the mechanics fitting the looms to the cars were unaware that the connectors had to be turned until they clicked and locked in place. The wiring company had assumed that it was common knowledge, as it was in Europe, but in the Cup garages it wasn't.

'In the 40-plus races since the implementation of the system, not one engine failure has been traced back to the ECU.'





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'We have not supplied many looms at all for 2013 - everyone seems to be running last year's harnesses; maybe we made them too well!' - Dax Ward, St Cross Electronics

Most of the companies supplying wiring harnesses to Cup teams are British or are using British expertise. St Cross Electronics, a wiring harness specialist, decided to partner with established NASCAR suppliers BMRS to access the new American market. 'We could have set up our own facility and did consider it, but we decided that it was better to work with people who knew the market well,' explains St Cross managing director Dax Ward. 'When I arrived in North Carolina, just after the IMIS show to see the teams and how things were going, I expected complete panic, but the teams were doing a great job of working with the looms.'

The St. Cross and BMRS loom-makers worked flat out to prepare for the 2012 season. 'The thing I'm most proud of was that during the winter of 2011 to 2012 we managed to supply 72 complete car sets in just four weeks, and one of those weeks was Christmas,' Ward remembers. This high output was achieved by the staff at BMRS' facility in Concord, NC, and those at St Cross on England's south coast, with both teams working to the same plans using the same equipment. 'There is kind of a mini St. Cross at BMRS,' Ward jokes. BMRS and St Cross saw a dream debut for their products in the NASCAR market, with a front row lock-out and eventual race victory with Roush Fenway Racing in the first Daytona 500 to feature EFI.

Another English firm, DC Electronics - better known for the looms it makes in Formula 1

and the WRC - took a different approach, opening up a dedicated facility on Poplar Pointe Drive in Mooresville, North Carolina, AKA the 'European Row' of buildings also home to Alcon and CRP Group. DC's looms were as successful as St Cross', winning the Sprint Cup with Penske.

Unlike St. Cross, DC also decided to develop a range of complementary electronic products such as its lightweight carbon fibre four channel coil packs, designed around the Bosch P50 ignition coil. Each unit contains four coils and is designed to be a factory serviceable item should one coil need replacing. The case has been constructed to form a 'faraday cage' which helps reduce electrical emissions, giving less electrical noise which can be picked up by the vehicle's wiring harness. But the pioneering English electronics company in NASCAR was in fact bf1 Systems, which has for years been supplying a range of sensors, including its highly popular load cells. Like the other British companies supplying the US series, the firm found few issues selling its wiring looms into Cup Teams and continues to do so with the Generation 6 cars..

NASCAR's electronics suppliers do now have a problem, however, and one that they really do not know how to solve. 'One thing I have found really surprising is how quiet we are now,' concedes Ward. 'We have not supplied many looms at all for 2013 - everyone seems to be running last year's harnesses; maybe we made them too well!'



BLACK BOX MYSTERY REVEALED

At the 2012 PRI show in Orlando DC Electronics showed off a new product, a small black box made by CRP Group but did not reveal its purpose other than that it was for the NASCAR market and awaiting approval. The purpose of that box, pictured above, can now be explained.

It is a Power Junction Box (PJB) and has now been approved by NASCAR R&D in Concord, North Carolina, for competition use in the NASCAR Sprint Cup series.

The PJB is used to distribute power to various electrical circuits used within the EFI system including the engine and fuel pumps. This innovative device is different to similar products currently on the market because there are seven individual circuits in total which each have over current and short circuit protection. This technology ensures that no harm will come to the wiring harnesses connected to the PJB in the event of a circuit overload, either through faulty components or accident damage.

Each output is also linked to a status LED on the face of the box which is used to display whether the circuit is off, on, or in fault condition. As a result, this helps reduce the time which is wasted finding faults on the pit road. The PJB's internal circuitry does not contain any relays or circuit breakers and is all solid state so there are no moving parts. This in turn increases the reliability and lifespan of the product.

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Swedish composites win at Daytona

Cars using TeXtreme Spread Tow carbon reinforcements finished in four out of the top five positions in the Daytona 500 this year, including the winning car.

Spread Tow carbon reinforcements are a unique kind of composite reinforcement popular in Formula 1 and increasingly so in stock cars. They are suitable when looking to reduce weight and improve mechanical properties. In Cup it is currently used by some teams in applications such as bumpers and hoods.

"In similarity with customers from other racing series and industries the NASCAR teams have been able to take a substantial amount of weight out of the parts by using TeXtreme and it is great to see that it is helping not only F1 teams to win races. In F1 we have experienced as much as 30% of weight savings on their parts using TeXtreme and it will be interesting to see how the progress in NASCAR will be. This is a good start, showing that there is great potential for making even lighter and better cars" says Andreas Martsman, VP - Marketing & Sales of Oxeon. www.oxeon.se



Cruden upgrades

Driver in the loop simulator specialist Cruden has recently released two new software modules to compliment their range of simulators; a setup tool and a telemetry analyser package. The set-up tool allows engineers to change vehicle settings such as shock absorbers, dampers, wing settings and throttle mapping amongst many other parameters, whilst the simulator is being driven, avoiding the need to stop the test and reset the simulator each time. The 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



NASCAR technology heading for outer space



The shift in recent years from state funded space programmes to those conducted by private companies has started something of a new space race, and it has opened the door to a new market for some motorsport engineering firms. CRP Group which has a facility in Mooresville, North Carolina has had a number of its Windform materials evaluated for use in space. Windform LX 2.0, Windform XT 2.0, Windform GT and Windform SP were tested in accordance to the ASTM E-595-07 standard and passed with flying colours.

This test method uses a screening technique to determine volatile content of materials when exposed to a vacuum environment. This analysis is crucial especially in space applications as the outgassing of the material can change its

mechanical and structural properties. The good result has allowed Windform to be proposed and incorporated into the burgeoning CubeSat industry. Recently Experimental Propulsion Laboratory has released information on its Additive Manufactured Propulsion System (AMPS) Rocket designed for use in Micro and CubeSat industries. This compact system utilises 3D Printing to produce a high pressure liquid oxidiser tank, combustion chamber, and integrated fuel grain composed of the s/s material acting as both structure and fuel for the propulsion system. The result was the patent-pending Additive Manufactured Propulsion Systems (AMPS) for use as a high impulse thruster for small to micro Cubical Satellites. 3D Printing in aerospace and NASCAR applications

has presented both opportunity and challenges to engineers in the field. The ability to produce parts and components with Windform gives the possibility to avoid the restriction of tooling through the additive process representing fundamental opportunities. Several teams have decided to adopt this technology on track as functional parts, small volume production runs that can be obtained in a few days, instead of weeks. CRP has built different parts for stockcar racing teams for example alternator shrouds. More and more often this world is looking for interesting technologies as well it happens in space application. NASCAR designers have found in Windform a reliable material that is now able to move from Race Track to "Space Race". www.windform.eu

Torque sense

"Ideal for internal combustion engines and test rigs."



Kistler Instruments has added three new measuring ranges to its KiTorq torque measuring system. The new ranges of 100, 200, and 5 000 Nm have been added to the existing ranges of 500, 1,000, 2,000 or 3,000 Nm 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.



Begin with the end in mind

Lake Speed Jr explores motor racing's chicken/egg scenario: which should come first, the engine or the oil?

To maximize machine performance, every component must be carefully selected. The interplay and interdependence of the parts contributes to the overall performance of a machine. To that end, engineers spend countless hours evaluating materials and designs. But in engine development, one area of consideration is often an afterthought - the lubricant.

This is not to say that engineering and testing does not go into lubricants. Modern lubricant development

programmes consist of rigorous testing to determine which oil is best for the machine. Turning that notion on its head creates an opportunity for teams.

The typical engine development program builds an engine, and then sets about testing various lubricants of differing viscosity and additive packages to find the elixir that will produce maximum power with durability. At the end of the process, the best lubricant for the machine has been selected, but the machine has not been optimised for the lubricant. There

are no semantics at play here: determining design parameters such as surface roughness, surface area, capacity, pump and oiling system either rule out or allow in certain lubricants.

Years ago, championship winning engine builder Terry Elledge said, 'every engine builder builds his engines around the oil. Some engine builders realise they are doing it, but most do not. Their choice of bearing clearances are a result of the oil viscosity they choose.'

A modern automotive OEM example of this can be found in the bearing clearances found in production engines. To gain the fuel economy benefits of a 5W-30, GM builds V8s like their 6.2L engine with main bearing clearances under .0015. In fact, GM explicitly says to not use higher viscosity oils in these engines. This highlights two concepts: the relationship between viscosity and bearing clearances and the notion of building an engine to the oil. Now that we have established that high horsepower engines are not the eminent domain of high viscosity oils, let's examine an idea more powerful than just 'running a lower-viscosity grade oil': designing an oil alongside the engine. It is one thing to develop an oil for an engine, and it is another matter entirely



Back in the 1990's teams were under pressure to use over the counter oils in the cars, but they were not up to the job





to develop an engine around an oil. Consider the concept of developing the oil as part of the engine development - just like any other 'hard part' of the engine. This is the route that Mark Cronquist took.

Cronquist is the head engine builder at Joe Gibbs Racing and also contributes to engine development for Toyota Racing Development. According to Cronquist, the revolutionary idea was born of necessity. 'Back in 1999, the oil companies were big on wanting their Cup teams to run off-the-shelf oil in our engines so that they could say, "Look, they are running our oil." But our horsepower levels had gotten beyond what those oils could handle, and the EPA was forcing the oil companies to take stuff out of their street oils. Street vehicles could survive without the stuff they were taking out like zinc, but it was stuff we needed.

'And while the oil companies were telling us that we needed to run their street oils to help their marketing, it had gotten to the point where we were having trouble just getting engines to survive break-in on the dyno,' Cronquist continued. 'So finally we decided that we had to go out

and make our own oil.'

The idea, Cronquist says, was to create a motor oil without compromise. The only aim was to win NASCAR Sprint Cup races, and with that in mind the JGR engine department sought out the top scientists who could help them achieve their goal.

'It had gotten to the point where we were having trouble just getting engines to survive break-in on the dyno.'
- Mark Cronquist

'As an engine builder,' Cronquist says, 'my only concern is power and eliminating failures that can cause a DNF. So we told the chemists what we wanted to achieve and gave them some baselines from oils we had tried in the past. All I care about is results, so I didn't get in their way

about what to put into the blend. We let them make the chemistry choices, and they came back with recommendations concerning things like surface finish. We took all of those recommendations, and I started testing them to see what worked best.'

Success came almost instantly. The very next year Joe Gibbs Racing claimed the NASCAR Sprint Cup Series championship with driver Bobby Labonte. Of course, it takes an entire organization working together to win a championship, but Cronquist says the process of developing the oil as part of the engine specification led to improved performance. Joe Gibbs Racing has used Driven Oil exclusively since then, and has claimed two more Sprint Cups and a further four championships in the Nationwide Series.

'Since we won that first championship a lot of other teams realised they need to run their own specialised motor oil. Many buy their oil from us, but some also have their own. So to stay on top we've continued to test new blends and improve our racing oil season after season,' Cronquist says. 'It definitely has changed a lot since that first batch. We can run a lot thinner

oil now than I ever thought we'd be able to back then. That frees up a lot of horsepower, but the chemistry is so much better that the protection it provides the engine is also improved, even at the lower viscosity.'

These improvements gave the development engineers a new tool, lubricant. Considering bearing area and surface speed in relationship to the oil and oil temperature will allow for optimisation of the viscosity of the oil. Using the oil as a coolant is an option, especially when car packaging is a concern. Fortunately, the design engineer need not become a tribologist in order to use lubricants to their maximum advantage, as the top suppliers with direct racing experience, like Driven's role with JGR, provide the level of engineering support required to take that next step. From viscosity versus temperature data to used oil analysis, data drives the integration of lubricant engineering into the engine development process.

Both Cronquist and Elledge demonstrated the on-track advantage of this holistic approach to engines and their lubricants, and it's an approach that merits further exploration.