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COVER STORY PAGE 24

RACE TECH
Motorsport Engineering

Volume 24 Issue 1
Published November 2016
The next issue will be published in early December 2016
ISSN 1356-2975

SUBSCRIPTIONS
Subscriptions from Kimberley Media Group Ltd
841 High Road, Finchley, London N12 8PT
Tel +44 (0)20 8446 2100
Fax +44 (0)20 8446 2191

Overseas copies are sent via air mail
Special offer 12 issues for the price of 10
12 issue subscription UK: £45.00
Europe: €97.50, US/Canada: US$127.40
Rest of World: £75.00
All major credit cards accepted. Cheques and money orders only in Pounds Sterling payable to Kimberley Media Group Ltd.

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Price including post & packing:
UK: £5.50, Europe: £6.50, Rest of World: £7.55
You can pay by cheque or credit card but please note the minimum on Switch & Delta is £14

Race Tech (ISSN: 1356-2975) is published monthly by Kimberley Media Group Ltd.

Cover image: FIA/Formula E

Design & Production:
Maluma Design Associates,

Printed by Warners Midlands plc

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THE AUDI EARTHQUAKE

THE rumour mill had been at full pitch for a week or two and I personally was hoping that it would all prove to be nothing, but it was not to be case – Audi will no longer be competing in the World Endurance Championship, which obviously includes Le Mans. The reason given is that the Volkswagen Audi Group is now concentrating on developing production electric vehicles and that its current racing programme does not meet the new requirements. Not actually said, but obviously in the background, was the Volkswagen (and Audi) diesel emissions scandal in the US which is costing the group billions of euros on an ongoing basis. There is no end to the pain.

Being involved in motor racing has always been precarious, though. There is absolutely no guarantee of a long term future, whether it's the one-man band operation or a factory team employing hundreds of people. For the smaller operations, money and cash flow are usually the arbiter of success or otherwise while for the factory teams it is usually decisions taken at main board level that can be the most devastating. A change of chairman or the marketing strategy or a main board member who's anti motor racing can change the lives of people at a stroke. Many will remember when the Peugeot WEC team was doing some pre-season testing at Sebring in January 2012 when the word came through that the project had been cancelled with immediate effect. Then there was the Dodge Viper programme in the US that was terminated just as brutally immediately after winning a championship in the US – and then there was Nissan's brutal termination of its WEC programme. The list is long and it makes painful reading.

It just to happened that I was visiting Honda Performance Development in Santa Clarita, California on the day the Audi news broke, and talking to Steve Eriksen, president and chief operating officer, about Audi, there was no sense of gloating, but rather one of sympathy for everyone involved with the team. He said that he was lucky in that the support from American Honda, the parent company, was fully supportive in the programmes that HPD was running, but it was not something he or anyone at HPD ever took for granted despite the decades of success they have had.

It was Max Mosley when FIA president who rang the warning bells about a championship being too reliant on manufacturer involvement. He was referring to Formula 1 at the time but the principle is the same for any series. If you make it too expensive for privateers to compete in – and the figures I have read were that Audi and Porsche were annually spending up to €200 million each – then you leave yourself exposed. Personally I loved the times when privateer teams could take on the factory teams as it made the racing so much more exciting. I do understand that in pushing the hybrid technology in the way that the ACO has that it precluded privateer involvement, but it's a shame that a third party hybrid powertrain manufacturer could not have been encouraged to develop one for customer teams. I know they would still have been eye-wateringly expensive, but perhaps a cost cap hand in hand with some aero performance gain, for example, might have helped. However, that's water under the bridge now.

With Audi now departing for the green pastures of Formula E, along with Jaguar and BMW as well, it would seem that the real threat to the World Endurance Championship and also Formula 1 is suprisingly Formula E. I say surprisingly because the racing is an acquired taste but hats off to Alejandro Agag and everyone involved in the series because it is proving to be a winner and is ticking the box for so many car manufacturers and suppliers. It is also providing a global series at a fraction of the cost of other international championships.

When it comes to the WEC and Le Mans at least Toyota Motorsport GmbH has come straight out and given an assurance that it will be competing in the championship next year and it is highly unlikely that the plug will also be pulled on the Porsche team, so at least four cars will be competing for overall honours. However, there is no question that Audi's withdrawal leaves a big hole. The series has been there before and I am sure will recover from the shock and manage to entice new manufacturers in – Peugeot has been known to be considering a return but cannot justify the cost – but it's just unfortunate that the way the regulations are currently written that it's not possible for a private team to come in, as would have happened a long time ago, to fill the space. In fact, Rebellion Racing, the stalwart privateer team has now committed to compete in LMP2.

It's just a shame that Audi has not been allowed to have one more shot at both the championship and also Le Mans. It will be missed. RT

William Kimberley
EDITOR

Audi WEC axe is warning to F1 and WEC

Mark Skewis

INGOLSTADT, Germany: AUDI'S decision to axe its sportscar racing programme in favour of Formula E should alarm both Formula 1 and the World Endurance Championship, according to *Race Tech*'s F1 insider.

"Both series should be looking over their shoulders at Formula E right now," said our 'Expert Witness', who must retain anonymity. "Critics might have made fun of the cars when they first began whistling around, but nobody's laughing now. With five OEMs confirmed for Formula E, that's now more than in Formula 1, isn't it?

"Let's not forget F1 courted Audi extremely hard, but instead they have decided to officially move their brand to Formula E and they are not alone: Jaguar Land Rover and BMW were in F1 before too; Mercedes and Renault are doing both, for now…"

In the wake of its revelation that it is terminating its WEC campaign, Audi told its 300-strong workforce that they will now be split between racing and production development.

"One manufacturer is leaving, others will soon be arriving," insisted Gérard Neveu, CEO of the FIA World Endurance Championship. "This is the life of a championship." Nevertheless, following the Rebellion team's defection from the LMP1 privateer ranks to LMP2, Audi's news is a huge blow to the series.

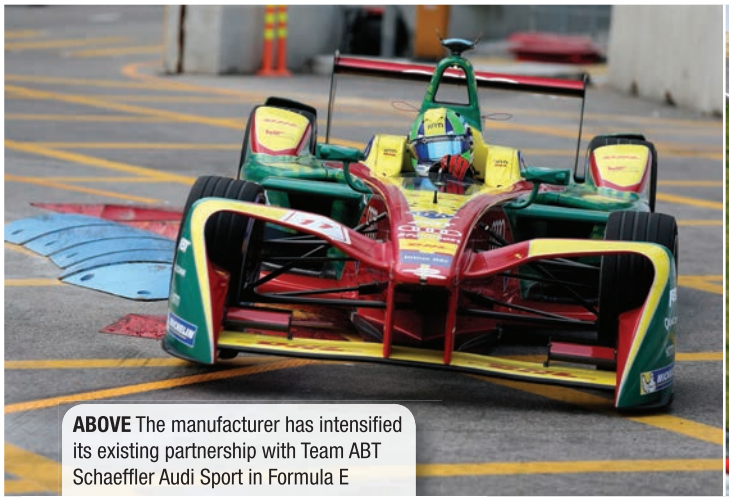
"Losing not just one of the three manufacturers, but the most longstanding one, leaves the category extremely vulnerable," commented our Expert Witness. "With changes to regulations imminent for both LMP1 and LMP2 there is a high risk now that the number of cars and strength in depth could diminish to a serious new low. The FIA and ACO should be concerned and urgently looking at how to turn this situation around before it is too late."

Audi's departure confirmed the worst nightmares of its supply chain, which had for months been puzzled by the lack of forward planning that is normally a hallmark of the company's LMP1 campaign. The decision to leave endurance racing was motivated not only by the need to cut costs in the wake of last year's 'Dieselgate' emissions scandal – "the current burdens on the brand," were alluded to by Rupert Stadler, Chairman of the Board of Management, in its announcement – but by a change in direction in its road car range.

With the VW Group setting aside billions of

BELOW Audi has won the Le Mans 24 Hours 13 times in 18 years, setting numerous technical milestones at the race: the first win for a TFSI engine (2001), TDI engine (2006), and hybrid powertrain (2012)

Photos: Audi



ABOVE The manufacturer has intensified its existing partnership with Team ABT Schaeffler Audi Sport in Formula E

ABOVE Audi bids farewell to endurance racing with the R18 e-tron quattro

dollars to cover the fallout of the affair, some questioned the wisdom of Audi and Porsche, sister brands, continuing to go head-to-head in the WEC. Since 2006 Audi has used that battleground as a laboratory and a showcase for its diesel technology. Now, though, there is a shift in the brand's philosophy.

The VW Group's electrification strategy is scheduled to introduce up to 25 electric cars by 2025. By that point, every fourth Audi is planned to be an electric vehicle.

"Formula E coincides perfectly with Audi's automotive strategy for the next 10 to 15 years," Dr. Stefan Knirsch, Member of the Board of Management, Technical Development, Audi AG, told *Race Tech*. "It fits in conjunction with our future engineering ethos. Until now, it's all been about the electrification of the internal combustion engine. Now, it's about the electrification of the drivetrain and the development of the battery. There is a very strong link between the automotive and motorsport sectors, and there is definitely an overlap between the technologies you'll find piloting the two."

The rising costs of the WEC will have counted against a continuation of Audi's involvement. It, like Porsche, whittled down its Le Mans entry to just two cars this season to save money, but future WEC rules will require further investment in both safety and the driveline. Audi moved up to the six-megajoule category this season, swapping its flywheel storage system for a battery. You can see in our feature elsewhere in this magazine the far-reaching impact of that change.

For 2018, however, major revisions would be required to its existing turbocharged 3.7-litre V6 diesel engine and insiders at Audi are known to be unhappy with the introduction of a second kinetic energy recuperation system. The all-electric Formula E series will be the beneficiary of that unease: Audi has intensified the existing partnership with Team ABT Schaeffler Audi Sport in the current 2016/2017 season, working toward towards a full factory commitment

Audi's commitment in the DTM, where it will be competing with the successor of the Audi RS 5 DTM in 2017, will remain untouched. No final decision has yet been made concerning a future involvement in the FIA World Rallycross Championship. However, the presence of electrification on the agenda might persuade it to continue its backing of the title-winning EKS team. RT

Diesel pioneer

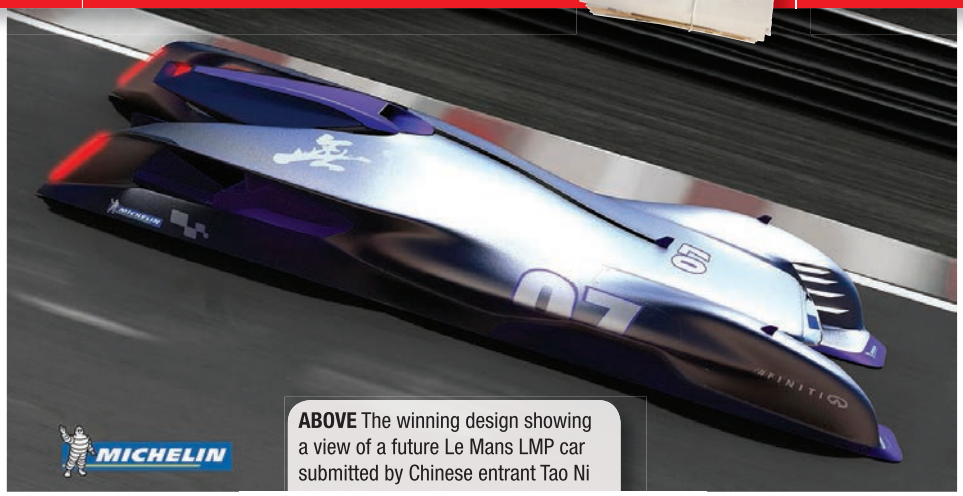
AUDI has raised the bar in sportscar racing's modern era.

"Pioneers of diesel as the best choice in combustion efficiency racing, the strength of their engineering, preparation and driving line-up changed the game," said *Race Tech*'s Expert witness. "They have simply been consistently the dominant force in sportscar racing since they entered and will be sadly missed.

"Diesel might not look like the fuel of the future any longer but, as an engineer, I couldn't help but be impressed by what Audi's engineering team achieved. Like any innovative technical solution that goes against the norm, diesel seemed completely incongruous at first, but was completely in keeping with the Audi brand.

"When the numbers add up and it becomes an integral part of a dominant winning package, it is easy to say 'Of course!' in hindsight. What looked like a very brave solution was actually a very sound data-driven one." RT

BELOW After making history with its V12 and V10 diesel engines, Audi turned to a V6



ABOVE The winning design showing a view of a future Le Mans LMP car submitted by Chinese entrant Tao Ni

Michelin Design competition looks to Le Mans future

William Kimberley

GREENVILLE, SC: In collaboration with the Automobile Club de l'Ouest, Michelin has announced the winners of the global 2017 Michelin Challenge Design, "Le Mans 2030: Design for the Win." Judged by a distinguished jury of the world's top automotive designers and industry experts, the competition was won by Tao Ni of Wuhu from China for his design entry "Infiniti Le Mans 2030" with runner-up being Daniel Bacelar Pereira of Vila Real, Portugal, for "Bentley 9 Plus Michelin Battery Slick" while Kurt Scanlan of Toronto, Canada took third place for "Cierzo C1".

These three winning designs, seven finalists and 10 honorable mentions were chosen from more than 1,600 registrants representing 80 countries. Over 16 years, Michelin Challenge Design has received a total of 9,901 entries from 123 countries.

"The winners of our 2017 Michelin Challenge Design presented numerous highly innovative features for the Le Mans race in the year 2030 and the quality of work from this year's entries was truly outstanding," said Thom Roach, vice president of original-equipment marketing for Michelin North America. "We congratulate the winners for their thought-provoking, visually captivating designs for the world's greatest endurance race, Le Mans 24 Hours."

BELOW If Bentley returned to Le Mans it could look like this, according to the runner-up design

BELOW The dramatic looking Cierzo C1 which won third place in the design competition

THEATRE OF INNOVATION

"The Le Mans 24 Hours race has always been the theatre of the greatest innovations for the motor car that are tried and tested during the mythical race for series production vehicles," said Pierre Fillon, president of Automobile Club de l'Ouest. "The Michelin Challenge Design fits perfectly into our ongoing innovative process with Michelin, one of the Le Mans 24 Hours' historic partners. I can understand how difficult it was for the judges to decide among the candidates given the quality of work sent in for the competition, which aims to predict what kind of car will race in the 2030 Le Mans 24 Hours."

"There is a phenomenal array of creativity on display," said Tom Peters, General Motors' director of design for rear drive vehicles, performance, who was one of the jurors. "The quality level, the thought, the understanding and the interpretation of the technology and how that folds into the aesthetics from a design perspective from all over the world is what Le Mans is all about."

"Michelin Challenge Design is an insight into what the landscape of the world is towards some specific automotive related subject," said fellow juror Dave Marek, division director at Honda R&D Americas. "Many of these designs showed how you could improve the brand of racing and look for alternative ways. Part of the spirit of competition is the human aspect. The enjoyment of driving will never go away." RT

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BELOW Spot the spoiler: The rear spoiler was reduced in both height and width for the Michigan race on 28 August, to the degree that is was invisible from the front of the car. It will return to its original 61-inch width in 2017 but be cut further in height

Photos: BTCC.net

NASCAR teams learn of their lower-downforce future

Andrew Charman

DAYTONA BEACH, FL: NASCAR has informed Sprint Cup teams of the rules package that will be mandatory for the 2017 season, as expected further reducing aerodynamic downforce.

"The idea is to give the drivers more of a feel and making the driving a bit more challenging," commented Gene Stefanyshyn, NASCAR's innovation and racing development head, "so we want to reduce downforce by 500 lb and will be doing this by making adjustments to the splitter at the front of the car as well as the spoiler. What's important is that if we reduce the size of the splitter then we need to do something to the spoiler if we want the car's balance to be correct."

The sanctioning body has been working on a reduction in aero grip for the past two seasons. The 2016 aero package was considered to cut downforce from 2,700 to around 2,000 lb and the development has continued in this season – lower downforce packages were raced in the Sprint Cup events at Michigan International and Kentucky speedways.

The 2017 package is based around these, though with a further reduction in rear spoiler height – the Michigan/Kentucky specification mandated a rear spoiler of 53 inches width by 2.5 in height, compared to the 2016 standard of 61 x 3.5in. For 2017 the height will be 2.375 in though the width returns to 61 inches.

The front splitters raced at Michigan and Kentucky will be adopted for the 2017 season, these including a three-inch reduction in width of the side sections. Similarly, a tapered rear deck fin will be mandated while no rear steer setting will be permitted. As a result of these changes NASCAR believes the cars' aero downforce will fall to around 1,500 lb.

The changes will be mandatory for all oval races except those at the 'restrictor plate' tracks of Daytona and Talladega. The aero packages for the four races at these tracks is unchanged from 2016, but the inlet manifold restrictor plate will be reduced in diameter from 0.8906 in to 0.875 in in a further bid to arrest increasing lap speeds.

"It may not seem like a lot, but when you are going at something like 200 mph it does create quite a bit of downforce," says Stefanyshyn, "and the aim is to maintain the car's balance through the downforce reduction process. The result is that the car will slide around a bit more, more off-throttle time and lower apex speed. What it means is that the driver will have to back off a bit earlier or pick a different point and he can't stay on the throttle as long. The drivers have said that they prefer this is it makes the driving a bit more challenging and promotes more passing. The objective here is to make the racing quality better." RT

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Road To Le Mans programme further defined

LE MANS, France: From next year the Michelin Le Mans Cup will be open to both GT3 cars and LMP3 prototypes together. There will be two different classifications, separate podiums and titles on offer. For both GT3 and LMP3 entrants this move is a logical step, and provides access towards the increasingly higher levels of competition in LM GTE and LM 2. Furthermore, the Road To Le Mans model, which ran with great success this year, will now be transformed into a two-hour race version race for the entire Michelin Le Mans Cup season.

The series will consist of five rounds alongside the European Le Mans Series at Monza, Red Bull Ring, Le Castellet, Spa-Francorchamps and Portimão. Additionally, the second round will be the support race at the Le Mans 24 Hours.

The three categories of competition in the European Le Mans Series (ELMS), LMP2, LMP3 and LMGTE, will remain, but the addition of the new arena for LMP3 offers more flexibility in terms of calendars, budgets and levels of competition for teams and drivers. No big changes to the 2017 sporting regulations are expected, and these regulations will be available soon.

At the end of the season, the first LMP3 cars in the Michelin Le Mans Cup will receive an invitation to join the European Le Mans Series the following season, while the lowest placed LMP3 cars in the ELMS classification will be transferred to the Michelin Le Mans Cup.

"It has been very satisfying to see this first season of the new championship come to fruition, and to know that it corresponds fully with the Spirit of Le Mans," commented ACO president Pierre Fillon. "There has been a high level of sporting success, and 2016 has formed a good basis on which to grow and develop this first step on the endurance ladder. The final results are a demonstration of the performance, enthusiasm and commitment to these European Le Mans Series and Michelin GT3 Le Mans Cup events."

"In Europe there is a growing demand for LMP3 cars and we have recognised this by extending the options for entrants and providing the perfect stage for them on which to compete," said Gérard Neveu, CEO of the European Le Mans Series and Michelin GT3 Le Mans Cup. "We should not forget that this prototype category was created and developed by the ACO and it is the first step on this fantastic adventure that is endurance racing. 2017 promises to be even better, but first we must celebrate the end of the 2016 season!"

As the winners of the 2016 ELMS LMP3 championship, United Autosports has received an automatic invitation to compete in LMP2 next season, something it is hoping to do as long as it can successfully put a programme together to do so. However, it is already committed to LMP3 next season anyway as it has proved to be so successful for the Anglo-American team. RT

BELOW So successful has the LMP3 category been that it has now been further reinforced as the first step in an endurance ladder that goes all the way to LMP1

United Autosports

NASCAR to increase cockpit protection

Andrew Charman

DAYTONA BEACH, FL: As reported in *Race Tech* 191, increased cockpit protection will also become mandatory for 2017 superspeedway races, and optional for others, before being fully adopted in 2018.

The floor, anti-intrusion plating, firewall and footbox sections of the cars will all be strengthened by using thicker materials with less welding, and providing significantly more surface area where welds are required. The steering column will also gain an extra mount to reduce the level it can move backwards in a frontal impact, while there will be energy-absorbing foam added around the footwell area in a bid to reduce the likelihood of lower leg and foot injuries.

A roof hatch, allowing the driver to escape upwards from the cockpit, will be mandated at superspeedways and optional at other tracks.

"It's all about managing the crash energy coming into the front and side of the car and the other is managing the energy in case the side of the vehicle is hit," commented Gene Stefanyshyn, NASCAR's innovation and racing development head. RT

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Chris Owens/IndyCar

ABOVE Heading east: The Sonoma season finale on 18 September was the last race for Chip Ganassi Racing with Chevrolet power before the team returns to Honda for 2017

Ganassi takes IndyCar team back to Honda

INDIANAPOLIS, IN: Leading IndyCar team Chip Ganassi Racing is to return to Honda power for the 2017 season. The switch by Ganassi from Chevrolet, in what is being described as a multi-year agreement, reunites one of the most successful partnerships in US motorsport, a year after a Chevrolet-powered Ganassi car won the 2015 Verizon IndyCar title with driver Scott Dixon.

The Ganassi team came to prominence in the late 1990s when a tie-up with Honda led to four successive CART championship titles between 1996 and 1999. In total nine of Ganassi's 11 CART/IndyCar titles, and 77 of the team's 102 race vicitories, have been with Honda power.

"We've had a long and successful relationship with Honda over the years and we look forward to getting it back on track," said Chip Ganassi when announcing the agreement. "I feel a little like I am going home after having previously spent 12 years with them," he added.

President of Honda's US motorsport arm Honda Performance Development, Art St Cyr, described the Honda-Ganassi association as "one of the most successful in the history of Honda's North American racing programmes."

Honda has struggled in the 2016 Verizon IndyCar Series, winning just two of the 16 races, with its aerodynamic kit for the Dallara chassis considered less effective than that of rival Chevrolet.

Aerodynamic development has now been frozen for the 2017 season prior to a return to a single kit for all cars in 2018. The extensive engineering resources of the Ganassi operation, one of the largest in the sport, is thought essential to improving the Japanese manufacturer's results in coming seasons.

* With the four-car Ganassi operation returning to Honda it was inevitable that the Japanese manufacturer would lose one or two of its current teams, and it appears that veteran squad A J Foyt Racing will be returning its two cars to Chevrolet power in 2017 for the first time since 2005. RT

Audi unveils TCR-spec RS 3 in Paris

Andrew Charman

PARIS, France: Audi has become the third VW Group manufacturer to produce a car to TCR International Series specification, unveiling its RS 3 LMS at the Paris Motor Show on 29 September. According to its creators, the car is intended as an entry-level model for customer motor sport. In TCR specification its 2-litre TSI four cylinder petrol engine develops around 330 hp.

Audi is selling the car at €129,000 (plus VAT) for the TCR version with a sequential six-speed racing transmission and €99,000 for a club sport version.

The TCR concept has received a major vote of confidence from Audi Sport customer racing head Chris Reinke, who previously has been mainly concerned with programmes in GT3 sports cars. "The TCR market has even larger potential than that of the GT3 category," he said. "In 2016, there were 10 TCR series with races in 18 countries, and more and more series are being added.

"With the TCR version of the RS 3 we're also reaching countries where no GT3 races are held, while the costs for a TCR race car are very low. As a result, we're going to win new customers for Audi Sport as well."

TCR founder Marcello Lotti has welcomed the arrival of Audi to the category. "I think the decision to build and develop the RS 3 car demonstrates a clear belief in the TCR concept and I would like to thank Audi Sport Customer Racing for their commitment and enthusiasm in the project," he said. "The decision to reveal the car at the Paris Motor Show is also significant, as it presents the car in front of the world's automotive media," he added. RT

ABOVE Audi is TCR-bound

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Tech Talk and more at Autosport International

BIRMINGHAM, UK: For over a quarter of a century the Autosport International show has been a fixture on the motorsport calendar for both enthusiasts and the industry alike. Now under new ownership – Haymarket Exhibitions having sold the show to the Miami-based company behind motorsport.com, along with the Haymarket magazines *Autosport*, *Motorsport News* and *F1 Racing* – much of the same team remains in place to ensure continuity.

One of the prime areas for those companies that both deal with the industry as well as having a strong aftermarket presence, the Trade & Technical area, which is supported by *Race Tech* magazine, is open for the four days of the show. One of the features that was introduced in the 2016 exhibition is Tech Talk that offers exhibitors the opportunity of presenting and promoting their products to those attending the show.

While visiting the Tech Talk feature on stand 7410 in Hall 7, come and visit the bigger and better *Race Tech* Magazine stand right across the passage (stand 7520) and meet the team.

The engineering hall, which is open on just the Thursday and Friday, is geared for those companies that wish to interface only with the motorsport professional. For 2017, though, a new feature will be a "meet the buyer" location which is in addition to the Motorsport Industry Association's international business lounge, the traditional venue for all business activities, in Hall 7. The MIA will also be hosting a number of its popular business workshops over two days. Topics include simulation of the complete race car to improve efficiency, motorsport R&D tax credit guidelines launch and how to make R&D work for the motorsport sector amongst may other subjects.

As is the custom, there will be a number of new products to be found at the show, in both the Trade & Technical hall as well as in the engineering hall.

Doors open at the National Exhibition Centre, Birmingham each day at 9.00am from Thursday, 12 January with the show closing at 6.00pm on Sunday, 15 January. RT

ABOVE Tech Talk allows exhibitors to talk about and promote their products to a wider audience

PERSONNEL

The Sauber Formula 1 team has appointed **Nicolas Hennel de Beaupreau** as its new head of aerodynamics. The 43-year-old, who has previously worked in the same role at Lotus, started work at Sauber's factory in Hinwill at the start of September. Head of aerodynamic development **Mariano Alperin-Bruvera** and **Seamus Mullarkey**, who leads aerodynamic research, had split the role on an interim basis. The move comes after Sauber appointed **Xevi Pujolar** as its head of track engineering. RT

Craig Hampson, who engineered **Sebastien Bourdais** to four Champ Car series titles with Newman/Haas Racing between 2004-07 before joining Andretti Autosport in the IndyCar Series, is to be reunited with Bourdais at Dale Coyne Racing. Hampson will resume his engineer role with Bourdais while the strengthened DCR engineering squad also includes the appointment of **Olivier Boisson**, who engineered Bourdais to four race wins at KVSH Racing between 2014-16. RT

IndyCar race engineer **Jeremy Milless** has moved from Ed Carpenter Racing to replace **Tom German** at Andretti Autosport, where we will oversee the car of **Alexander Rossi**. Andretti has also appointed former Ganassi race engineer **Eric Bretzman** as the team's technical director. RT

Andretti Autosport has named **Jody Bennett** as the new vice president of marketing and strategic partnerships for the company. In September, *SportsBusiness* Journal recognised Bennett as a Game Changer, an award that honours women who are spearheading key initiatives and contributing to the success of the sports business industry in multiple ways. She will oversee client services, marketing, sponsorship activation, licensing and partner strategy. RT

Curt Cavin, an *Indianapolis Star* sportswriter who has covered motorsports for three decades, has been appointed IndyCar's vice president of communications. RT

US motorsport is mourning safety expert **Lon Bromley**, who was killed on 1 October in a boating accident. Between the 1980s and 2007 he headed the CART/Champ Car safety team that also included **Dr Terry Trammell**, **Dr Steve Olvey** and **Wally Dallenbach**. He was one of those responsible for saving the life of driver **Alex Zanardi** after the latter lost both his legs in an accident at the Lausitzring in Germany in 2001. RT

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Oreca reveals new LMP2 car

ABOVE The Oreca 07 has broken cover

FRENCH sportscar constructor Oreca has released images of its 2017 LMP2 chassis, the Oreca 07, ahead of its first track tests.

The new LMP2 car will be eligible for entry in the European Le Mans Series, IMSA WeatherTech SportsCar Championship and FIA World Endurance Championship.

Minneapolis-based JDC-Miller Motorsports has confirmed it has placed an order for the new car and will enter the IMSA WeatherTech SportsCar Championship.

The chassis supplier will be offering teams using the previous generation '05' an upgrade kit as its latest offering is an evolution of its predecessor. RT

BMW returns to Le Mans

BMW is returning to Le Mans in the GTE class, according to a statement by BMW Motorsport director Jens Marquardt. "Starting with the 2018 season, we want to further expand our activities in GT racing and compete in the FIA World Endurance Championship, as well as the IMSA WeatherTech SportsCar Championship.

"This obviously also includes our return to Le Mans, which we are particularly looking forward to. The way the WEC has developed so well makes us confident that there is a big future for GT racing."

The decision is part of what BMW is calling a strategic realignment of its motorsports programme. RT

ABOVE BMW has confirmed that it is returning to endurance racing in 2018, not in LMP1 but in the GT class which sees it compete with Aston Martin, Corvette, Ferrari, Ford and Porsche

IN BRIEF

A ROW surrounding pre-season Formula 1 tyre testing has come to a conclusion with both sessions taking place at Barcelona as originally planned rather than one of the tests taking place in Bahrain as requested by Pirelli with the support of the Mercedes and Ferrari teams. Adamantly opposed to the idea, though, were Red Bull Racing and Williams, the additional £400,000 needed to go to the Middle East circuit being one of the factors cited. Following a meeting between the teams, FIA F1 race director Charlie Whiting and F1 supremo Bernie Ecclestone in the Austin paddock, it was agreed that both tests – that will run 27 February 27- 2March 2 and 7-10 March – will be at Barcelona. RT

REPORTS in the US suggest that NASCAR is considering a further reduction in the number of pit crew that service cars in the pit lane, from six to five. The move is said to be under consideration both for safety reasons and a means of cutting costs. The dropped crew member would most likely be one of the tyre carriers and the change could be made as early as the 2017 season. RT

THE Martinsville flat oval, at 0.526-mile the shortest track on the NASCAR Sprint Cup schedule, is to invest $5m in adding LED lighting. The Virginia track claims to be the first major motorsports facility to adopt the LED system, which promises more efficient illumination and more flexibility compared to traditional metal halide lights. The availability of lights will also extend the period a race can be delayed for track drying before a rain-out is called. RT

NASCAR track Kentucky Speedway is to add an extra layer of asphalt to its racing surface before the 2017 season. The changes to the 1.5-mile oval are to improve parts of the resurfacing carried out earlier this year as part of a major revamp that also saw the angle of the banking increased in turns one and two. While not affecting the racing, the affected areas would not have lasted as long as the remainder of the surface. RT

PADDOCK speculation in the DTM Series suggests it could be set to drop from 24 cars to just 18 in 2017. The cutting of two cars from each of the three competing manufacturers, Audi, BMW and Mercedes-Benz, would reduce costs for them while also making the series more attractive for a new manufacturer. However, a 21-car field has also been rumoured as a compromise measure. RT

AS *Race Tech* went to press reports suggested that the World Touring Car Championship could be planning to replace its current TC1 technical regulations with Class One regulations, possibly as early as the 2018 season. Class One has been developed from the current DTM and Super GT regulations but is yet to be introduced in either series. WTCC organisers Eurosport Events have refused to confirm any plan to change the rules, which would effectively make the majority of the current competing cars redundant. We hope to have more on this next month. RT

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Tues 29th & Weds 30th November 2016

We are delighted that both Ulrich Baretzky, Head of Engine Technology at Audi Sport, and Formula 1 consultant John Iley have both agreed to be our Chairmen again, chairing what should yet again be a fascinating debate.

CHAIRMEN

John Iley
Formula 1 consultant

Ulrich Baretzky
Head of Engine Technology at Audi Sport

KEYNOTE SPEAKERS

Ian Constance
Chief Executive Officer, Advanced Propulsion Centre UK

Prof David Greenwood
Advanced Propulsion Systems, WMG

SPEAKERS

Dialma Zinelli
Chief Aerodynamicist, Dallara Automobili

Craig Wilson
Managing Director, Williams Advanced Engineering

Nick Carpenter
Engineering Director, Delta Motorsport Ltd

Steve Sapsford
Director, Business Strategy, Ricardo

Albert Klein
CFO, FIT AG

Kristan Rivers
Head of Business Development, Eden Games

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Technical Director, Toyota Motorsport GmbH

Gilles Simon
Engineering Consultant

Vincent Beaumesnil
Sporting Director, Automobile Club de l'Ouest

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Technology Change and How to Deal with it - a Motorsport Perspective

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The theme of the next Symposium is
Technology change and how to deal with It - a motorsport perspective.
Motorsport technology has always pushed boundaries, but those boundaries are rapidly changing in the modern world, and just what are those boundaries anyway and are they relevant to motorsport? So the question is whether motorsport is blazing a trail, playing catch up or does it have anything to offer in the new digital era?

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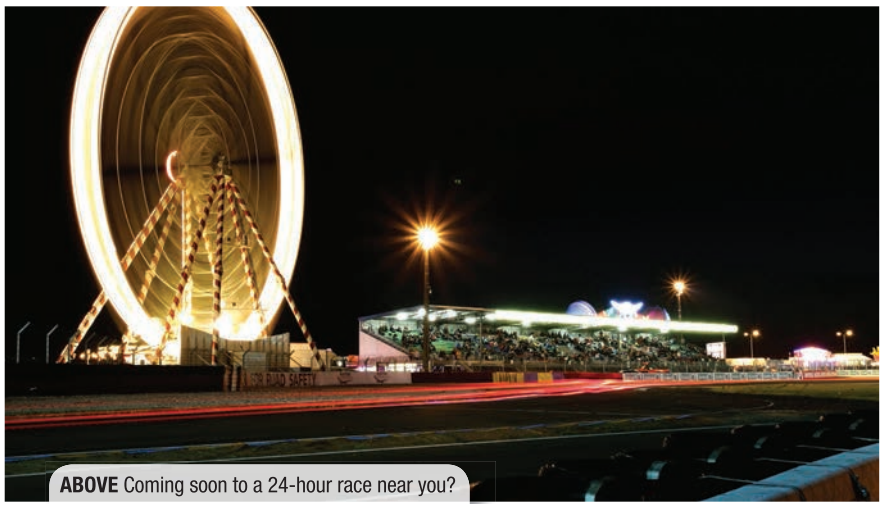
F1 meets WEC: Mercedes' Andy Cowell and Audi Sport's Ulrich Baretzky

LOW ENERGY NUCLEAR RACING

Chris Ellis reports on a disruptive technology that could revolutionize energy production and storage for almost everything, including most racing cars



ABOVE Coming soon to a 24-hour race near you?

BY September 22, the U.S. Department of Defence was supposed to have reported to Congress on the state of low energy nuclear reactions (LENR) research in the U.S. LENR is the current label for what was once called 'cold fusion'.

For more than 20 years, most nuclear physicists have dismissed cold fusion as an illusion, if not a scam, because it proved almost impossible to replicate the effect under test conditions. However, the Department of Defence recently published a report, originally distributed internally back in 2012, which shows that the U.S. government has been taking LENR very seriously since at least 2006. By now, you may be wondering what this has got to do with motorsport. Simply put, *if* (note the big if) LENR proves practical, it will become the power source of choice for almost everything, including most racing cars. Eventually… The DoD has missed the deadline; when you have read the following, I will leave you to guess why.

So what is a low-energy nuclear reaction? Actually it's a bit of a misnomer, because it might be better to label it a low-temperature nuclear reaction, as the heat output per gram is very high. In this case, 'low' is relative, merely thousands of degrees, rather than the millions of 'conventional' fusion. Argument still rages over the nature of the reaction. The energy output is way too high for it to be a chemical effect, and the radiation levels are much too low for a true fusion reaction, which is excellent news because minimal shielding will be required.

The key elements identified so far are deuterium reacting with palladium. Roughly 50% of the world's palladium production is already used by the automotive industry, in catalytic converters. As these won't be needed any more, and can be recycled, there should be no significant supply problems. So this potentially makes every other energy source redundant. Maybe…

Because of the scepticism of most physicists, we may have lost at least 10 years of engineering development. However, Pons and Fleischmann's original 1989 announcement led to the U.S. navy's Stanislaw Szpak developing an experimental LENR system for torpedo drives, which proved capable of replication.

Imagine now a Stirling engine with an LENR unit providing a continuous source of heat, fuelled by a few litres of 'heavy water' (deuterium oxide). Here comes the amazing bit: this should provide enough deuterium to give a large SUV a range of over 5,000 miles! So forget half a ton of batteries.

Now consider some of the military applications. In the Iraq war, only 20% of the total fuel used on the ground was consumed by the fighting vehicles; the rest was needed to get fuel and supplies to the combat area. And what price Mk II Ospreys that can stay airborne for 12 hours at 300 mph? The DoD is probably struggling to tell Congress only enough to convince its members that the matter is in hand, without revealing just how aggressively it is being pursued. But this formal acknowledgement by Congress that LENR is real will now stimulate a whole range of industries to investigate and invest. And countries like China, India and Japan already are.

So what will this mean for motorsport? Taking an optimistic view on timescales, imagine Le Mans 2025, with several teams running LENR-based hybrids. These HWH (heavy-water hybrids) will have an effective range only limited by the need to change drivers every two hours or so. This will give them an obvious performance advantage over the conventional LMP1s, which can stay out for only 50 minutes, given the regulations which severely limit their fuel capacity. And think how much safer *all* cars will be, when the fuel is only (heavy) water.

A few years further on, F1 might decide to follow suit, but I think that would be a mistake. At the risk of sounding like a stuck record, there is no point in focussing F1 on pseudo-economy – the cars are essentially profligate, given drag coefficients that would look bad for a bus. So keep the aural entertainment inherent in the 'end game' internal combustion engines, but run them on bio-ethanol derived from CO2, water, and LENR/renewables. OK, the 2030 F1 cars might seem rather old-fashioned, but that's like claiming Shakespeare's plays are anachronistic. Not 'Much Ado About Nothing', more 'All's Well That Ends Well', methinks. RT

AUDI JOINS "RACE FOR THE FUTURE"

Audi's pioneering experiments with battery technology and energy storage systems for the WEC give it a head start in its transition to Formula E. **William Kimberley** and **Sophie Williamson-Stothert** report

All photos: Audi

"WE'RE going to contest the race for the future on electric power," says Rupert Stadler, chairman of the Audi AG Board of Management, of the manufacturer's decision to abandon the WEC in favour of what will become a works programme in Formula E.

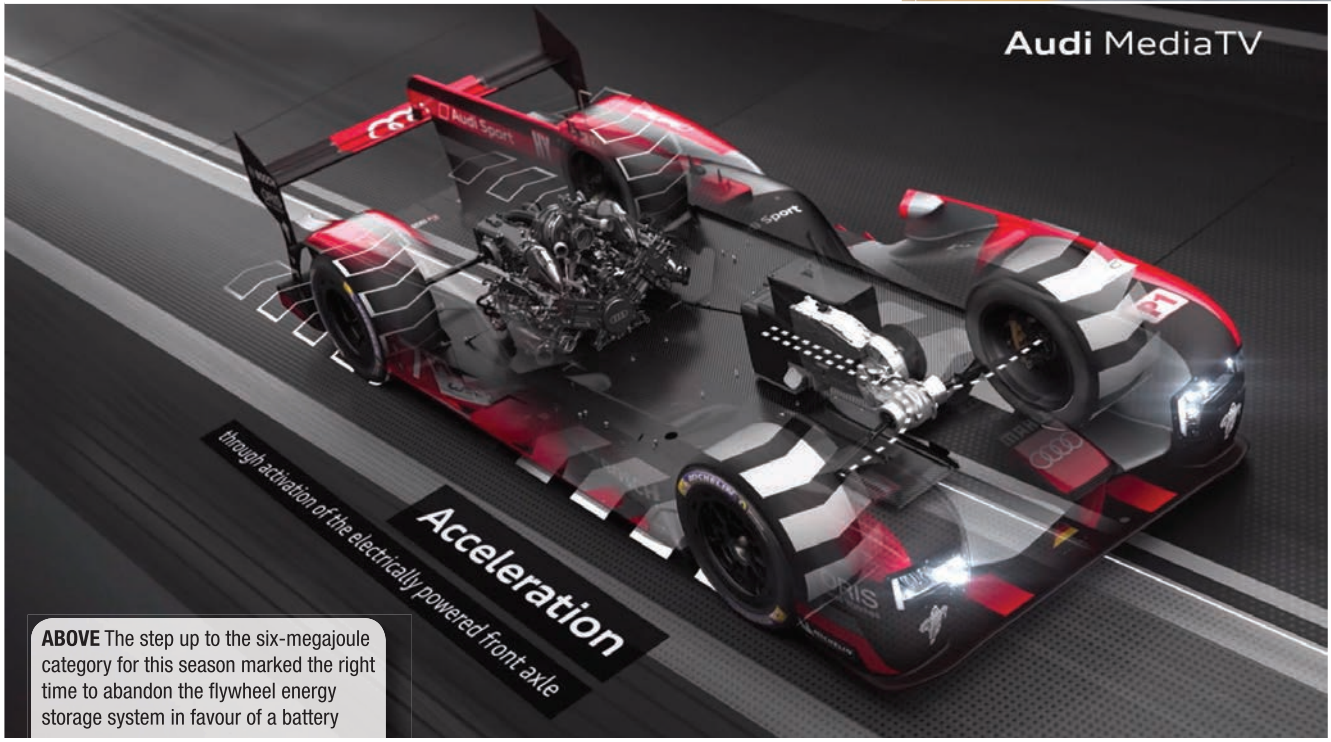
"As our production cars are becoming increasingly electric, our motorsport cars, as Audi's technological spearheads, have to even more so," he explains.

Stadler argues that Audi is "in the greatest transformation stage in the company's history". Formula E, he says, perfectly matches the strategy of offering fully battery-electric road car models year-by-year starting in 2018.

The German marque has been supporting the ABT Schaeffler Audi Sport squad ever since the inaugural 2014/15 Formula E season, enabling the team to use the manufacturer's infrastructure in Neuburg. Working towards a fully-fledged factory commitment, Audi has announced it will intensify this existing collaboration with ABT next season with additional financial and technical support.

"Electric mobility is one of the key topics in our industry," says Dr. Stefan Knirsch, member of the Board of Management for Technical Development at Audi AG. "We intend to evolve into one of the leading premium car manufacturers in this field.

"This is certainly huge and very exciting news for us – we're at the beginning of a new journey. It's going to be a big challenge, of course, but it coincides perfectly with Audi's automotive strategy for the next 10 to 15 years. By 2025, every fourth Audi should be an electric vehicle. In light of these plans, adapting our motorsport programme and taking up a commitment in a fully-electric



ABOVE The step up to the six-megajoule category for this season marked the right time to abandon the flywheel energy storage system in favour of a battery

ABOVE Audi has now actively joined the technical development of Team ABT Schaeffler's Formula E car, on the road to a full factory commitment

> *"The greatest transformation stage in the company's history"*

racing series is only a logical move."

Audi is no stranger to energy harvesting or electrical powertrains, having developed its R18 e-tron quattro LMP1 challenger, which has been utilising hybrid technology since 2012. Nevertheless, a new era in Formula E is causing a great deal of excitement at the Audi headquarters.

"As an engineer, I can't imagine anything better," explains Dr. Knirsch. "The new developments and technologies we're working on and using to drive Formula E into the future are very exciting and the freedom we have to push this technology forward is very inspiring.

He adds: "The competition in Formula E is getting stronger and stronger. No other series has as much manufacturer involvement. I'm not surprised that Formula E has taken off at the pace it has. The electrification of the powertrain on our road cars is the future, and the motorsport industry has a job to support that.

"If you would have asked me two years ago whether I was expecting Formula E to develop this quickly, I wouldn't have been 100% sure – city racing, after all, is an expensive business. But I'm so glad it has developed into what it is today – there's much to look forward to."

Though Audi is terminating its WEC activities sooner than initially rumoured, Dr. Knirsch suggests that the lessons learnt in its groundbreaking endurance racing programme will stand it in good stead: "Until now, it's all been about the electrification of the internal combustion engine. Now, it's about the electrification of the drivetrain. We already have a lot of experience in developing battery technology and have, therefore, learned to handle high voltage systems in the World Endurance Championship.

"A key focus for Formula E is our control system, which is effectively like the ECU for the car – again, we can draw links with WEC. We're working in partnership with Schaeffler to develop a package that will at least withstand the next four years."

MAN OF THE MOMENT

As head of energy systems at Audi Sport, Thomas Laudenbach is the man of the moment with the announcement that Audi is officially entering Formula E. His background might be in engines and powertrain, but since ▶

leaving Porsche for the Ingolstadt company, his focus has been more on 'energy'.

Audi was forced to develop hybrid technology for WEC in 2012 - following an alternative route to that of Porsche and Toyota - opting for the flywheel that was originally developed by Williams Advanced Engineering. That was fine for the two and four-megajoule classes but 2016 marked a step change as the team opted to go to six megajoules.

"It was clear to us that we had to step up in the hybrid class to be competitive," says Laudenbach. "We knew we had to go into the six megajoule class for 2016 while eight megajoules was out of the question for us as the diesel engine is heavier than a gasoline one and it would have been impossible to stay within the car's weight limit.

"It was clear that we were going to keep the concept of the MGU in the front for weight distribution and four-wheel drive, so we didn't change that. However, we did make it much more powerful so that it would be able to handle far more energy and while the regulations only allow us to output 300 kW, it's possible to recuperate more than that."

The much bigger change, though, was the storage system: "It was clear that in stepping up the energy content there was going to be a trade-off between the flywheel and the battery and for us that was the right point to go to a battery. With that we were able to switch to a far more road-relevant technology. A flywheel is good in terms of power density, but it struggles a bit concerning weight if you need higher energy content."

UNKNOWN TERRITORY

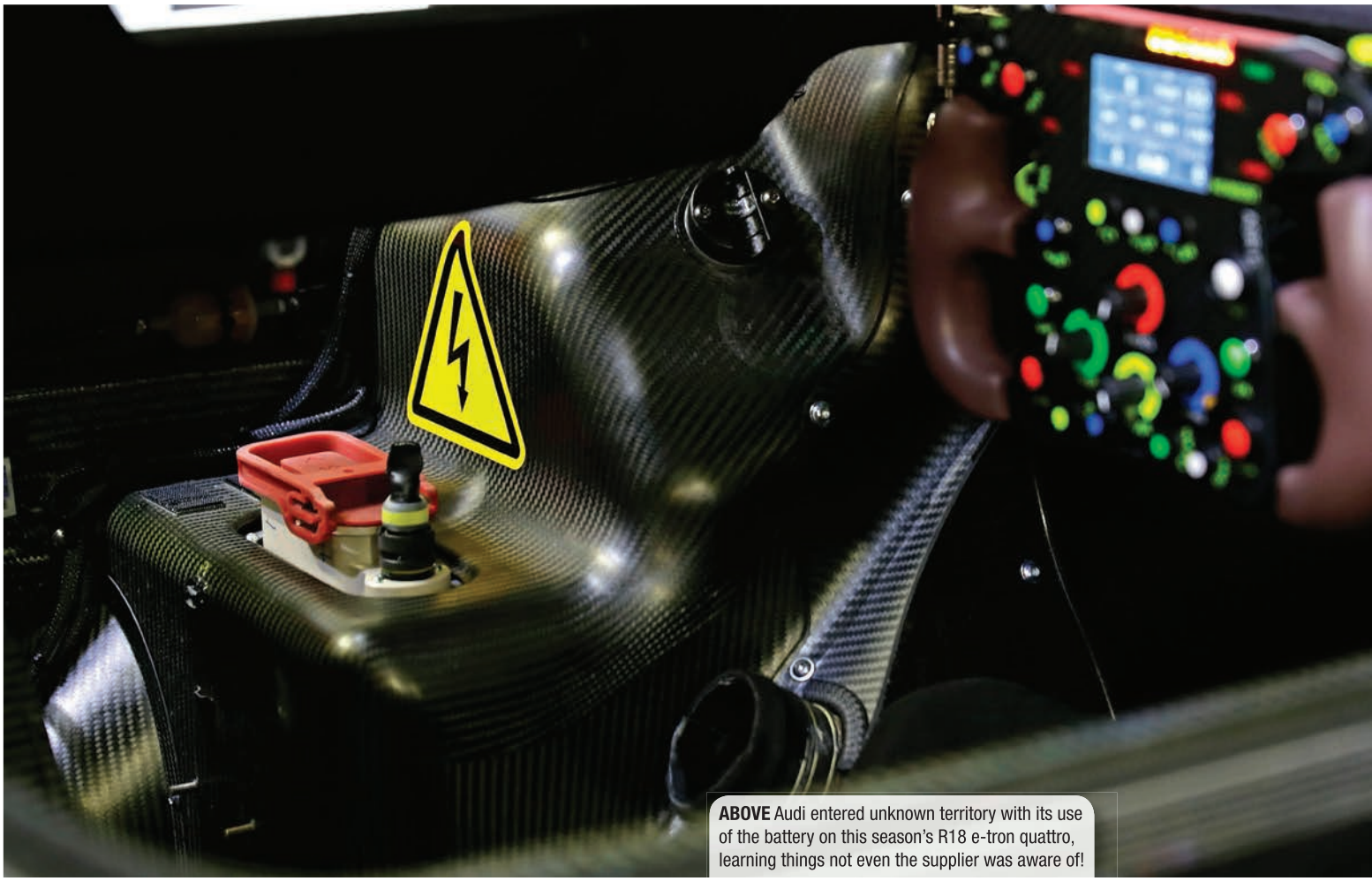
Conceding that they were entering unknown territory, Laudenbach turned for help from his production car colleagues: "What we wanted from the system was of course quite different to the demands of a road car, but we tried to base everything on their experience and then modified it into what we needed. For example, we need much higher power demands, but then we only use the system for a maximum of 30 hours and can put much more effort into controlling everything. On road cars there's a cost issue to take into account as they have to be sold at an acceptable price but we have the freedom to measure the temperature of every cell for example."

The cell concept is determined through a multitude of calculations, and there are three cell concepts: prismatic, soft pouch or round. Porsche uses round cells while Audi uses the prismatic.

"We evaluated various design concepts for different cell geometry. The packaging and cooling solutions are very much dependent on the cell type you use, especially for a LMP1 battery with high power density, reliable and efficient cooling is a crucial point. This might be the limiting factor concerning performance towards the end of the race.

"This is then the fundamental building block that everything is built around. We tested single cells to define their characteristic because the conditions they operate under in our cars are so very different to that of road cars.

"We tried to create something that suited motorsport. For example, what acceleration profiles should be used in a crash test? Is it 30G, 40G, 60G, 80G? Our conclusion was to have intensive analyses of the crashes from the last few years and try to ▶



ABOVE Audi entered unknown territory with its use of the battery on this season's R18 e-tron quattro, learning things not even the supplier was aware of!

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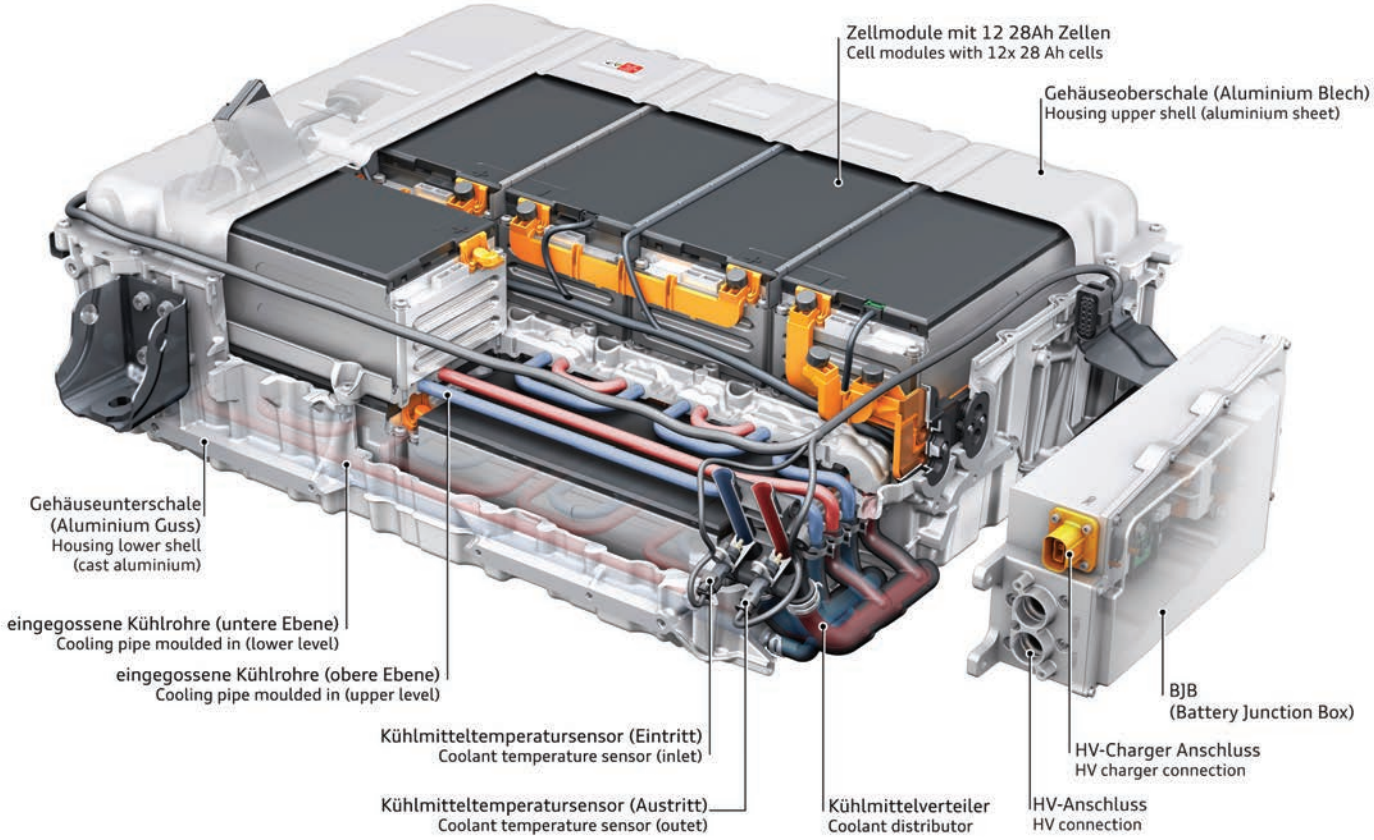

ABOVE The road car approach to a high voltage battery, demonstrated in Audi's Q7 e-tron 3.0 TDI Quattro. The experience of road car colleagues helped the race team shortcut the learning curve, but their groundbreaking research has more than repaid the favour

find the worst case scenario if everything came together. From this we created an acceleration profile and then went to the facilities where we could test it in all three directions, plus, minus."

As the programme developed everything was subjected to severe tests including crash and misuse tests which at times were very interesting. "Sometimes we had to accept that batteries were destroyed, but we needed to know what happens in such an event," he concedes. "We had to examine the safety parameters and what would happen if the safety systems failed. We also needed to know what happens if there's a short circuit and whether the driver's safe. The results were extremely helpful to optimise the design of the battery in details. So we had a certain safety concept that needed to be proved.

"We also analysed worst case scenarios so that if the battery did blow up, the driver was still safe. In the misuse tests we took out all of the safety devices and then looked at what happened. Most unlikely it might lead to the point where we lose the car, which is bad enough, but we had to make sure that the driver remained safe even in nearly impossible cases. The concept was therefore to build a cover and battery so that even if it ever happened, there was always enough time for the driver to get out of the car.

"In real time this might only take a few minutes but it was a process that took time to learn because there aren't any standards. We did talk to the FIA and they are very open to it, but there aren't proven standards which cover all safety aspects. Yes, there's a test, which is rather easy to fulfil, but our in-house tests are at a much higher level. We take the safety aspects very seriously and, therefore we even look at almost impossible scenarios. All in all we are finally sure to have a well proven and safe energy storage system in our race car.

"What was funny was that, by doing such comprehensive tests, we found out a lot of things about the cell that not even the manufacturer knew, although it wasn't really surprising given there wasn't the demand to use them in such a way. In fact, before we tested the cells, the manufacturer was really nervous about things, but we nevertheless went ahead and carried them out anyway although we would never have raced it before they had tested it themselves and agreed.

"As it turned out, it was beneficial for all concerned because we learned things that we could begin to feed back to the production car guys which they didn't already know – so it was a full circle. By this time we were reaching the point where we understood how many cells we needed, what we could do with the power, the safety aspects and the weight which meant that we could finalise the design."

Another of the lessons learnt was that a completely different type of cooling system was required compared to that of a road car to meet the extra energy being squeezed out of each cell.

"As I said, it still is a very close relationship with our production car colleagues. You start with cell tests on a certain dyno then you go to module tests before going to entire battery tests, everything out of the car. When you've done that then you do the whole system for the first time on a transient dyno. Together with the engine, the electric motor and everything, if you've fulfilled everything there, then you go onto the car.

PIONEERING THE WAY

"The demanding thing was that we had to define everything ourselves. On one hand as an engineer it was very interesting because it was new territory, but on the other, we sometimes had a little headache, especially as we were handling such technology for the first time in such an environment. However, our philosophy was clear: even at the end of the 24 hours of Le Mans, there could be no restriction in the battery's performance even though its behaviour might change. Our aim was to give the driver a completely consistent behaviour of a hybrid system. Imagine you're ▶

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ABOVE Audi has opted for the prismatic cell concept. This image gives an indication of what they look like and how they can be stacked in a module for road car application

really fighting for victory at the end after 24 hours and then you lose basically because your degradation is too high. I wouldn't want to be the one to have to explain that!"

According to Laudenbach, the battery can go through a form of degradation similar to that of a phone battery, which after one or two years is not as good as it was following 200 charge cycles.

"The state of charge window changes a bit and this is what you have to take into account when you design it. It depends on which philosophy you follow. You might want to really go to the limit at the beginning of its life and not use the full battery performance range at the end of the race. Yes it changes from chemistry, from inside the cell and you have to account for this. That's one of the reasons why you do the single cell tests very early because you need to know the behaviour throughout the whole life cycle. You also need to decide how many cells are needed, along with the voltage level.

UNDER ANALYSIS

"Then it's how the battery is used. If you use it at a lower power level, the degradation will be less. It also depends in which temperature range it's used. All these parameters have an influence on how the battery changes throughout its lifetime and are what has to be controlled and what you're testing and trying to figure out. The better you know your battery, the better you can handle it on a track and the better you can go to the limit. That's why large amounts of intensive tests are needed: to know exactly how it behaves then hopefully you'll know where you will end up after 30 hours or 24 hours.

"Doing the endurance runs wasn't that difficult to define, though, because we had all the simulations from the World Endurance Championship and Le Mans, so we knew how the profile might be, not everything in great detail but in general. Out of all these tracks we created something like a reference profile that we ran for hours at different temperatures and with different energy strategies.

"That was a massive workload which I didn't expect. It's not just a question of running it and if it works, installing it into the car. You have to address different cooling situations, different energy strategies and different single boost demands because the driver has a manual boost option where he can interfere with the automatic program because he needs to overtake. However, the control side consequently needs to adapt because you're only allowed to use a certain amount of energy per lap. We tried to create some kind of most demanding reference profile. That is basically our endurance test.

"The special tests were far more difficult because you don't really know what to expect in a race. For example, we fully sensored the car up in order to create a representative vibration profile. We then vibration-tested

ABOVE It's the end of the road for the R18 e-tron quattro after 106 victories, 80 pole positions and 94 fastest race laps

BELOW Formula E's concept of racing in the city, bringing the show to the people, has captured manufacturers' imagination

the system on a rig to ensure nothing inside the battery, MGU or a connector broke or came loose. If you have high voltage and high energy you do not want any part to become loose because it might cause a short circuit. It took many hours to define it, but in the end it gave us a base."

Something else that needed to be taken into consideration was the packaging demands. "If you look at it without additional background information, you'd never build it like it is," says Laudenbach with a smile. "This is clearly because you want to have it in the right place in the car for weight distribution reasons and you will never find the space to do it like you want from a component perspective. So you end up with a certain geometry which is given by the package boundary conditions and then you decide how to position the cell stacks, how to clamp them along with dealing with the electronics, cell and stack connection, isolation and the cooling.

"One thing is clear and that is if you locate it inside the monocoque it doesn't have airflow so everything is therefore liquid cooled. We worked very closely with the aero guys, who also do the thermo side and they require very precise data to ascertain the average energy that needs to be cooled, even if it is run in Bahrain at 35°C. One thing that's clear is that if we can't keep the cooling at the required level, then this will cost performance because we then have to bring the power down, it won't collect the energy you're allowed to use and this is lap time. So we specify that this is the energy that needs to be cooled down, the amount of flow we need and the maximum pressure loss allowed in each component of the system.

CAREFUL OPTIMISATION

"We do the pump ourselves but on the cooling side our colleagues in the aero department handle that. It's additional cooling demand for the hybrid system which doesn't make life easy for them but from the packaging point of view it wasn't too bad.

"Designing the battery was tricky because we had to follow the front of the monocoque, which is quite a 'funny' shape. We wanted to place it as far forward and as low as we could then we had to decide if we were prepared to accept a small weight penalty. That's because this is heavier than if you do it like a rectangular box, but this is a regular way of developing a car. We need to bring the weight, they put it into the calculation and simulation for the whole car and then we decide if it's okay to spend half a kilo more on the weight because we gain a significant benefit concerning weight distribution or centre of gravity. These are the normal loops you do when optimising a car.

"It was difficult for us because we'd never done this before, and we had to give precise figures to the simulation guys as they wanted to know its weight and location. You do it the first time and you have an idea, but you don't know if it will work. If it doesn't then you modify it. Then you might not come along with the package you've got. Looking at an engine or a gearbox, I wouldn't say it's easier, it's just we have far more experience with it. Then you make your first calculation, your first assumption and your first concept, then you're pretty sure this is somewhere in the range of where you will end up. With the battery and the MGU we didn't have the experience because everything was new."

It has been quite a learning curve for Laudenbach and his team at Audi Sport but the knowledge gained can now also be applied to the Formula E car that will be taking to the city streets in season four. Quite a jump for someone who spent so many years developing engines and gearboxes. RT

Its flagship brand might change hands for billions, but motorsport faces more challenges than ever before. We ask our **Expert Witness** – an F1 insider – to remove his blinkers for a second and answer the question: 'Where next?'

FROM LIBERTY TO AUTONOMY?

IT is a political time on both sides of the Atlantic: leadership battles for power; high profile televised debate; inclusion or exclusion from the European Union – how soon, under what terms, and who gets the best deal? Or are we faced with tactical voting: not a show of support, but choosing the lowest risk, least bad option?

Wherever you look, the opinion polls are increasingly dominating our lives these days. Race Tech therefore takes its own opportunity to peer into the future, interrogating our Expert Witness for his views on the current health of motorsport, its evolution and direction.

RACE TECH ***Who is getting it right at the moment?***
EXPERT WITNESS "I think you need to be careful as much depends on where you are viewing from and what unit of measurement of health or success you use. Longevity? Grid size? Revenue? Profile and promotion?"

RT ***Let's focus on grid size and promotion.***
EW "Mmmm. In my opinion, the first category that springs to mind is GT. It still has slightly different forms around the globe, but it is continuing to attract all the major manufacturers with large fields. These are aspirational brands, exciting cars providing good close racing and increasingly a career path for up and coming drivers. Blancpain, Open, US, UK, Australia, sprint and endurance, the footprint seems to be far-reaching, racing on classic tracks around the world."

RT ***What are they doing well?***
EW "Put simply, they offer good ingredients. Racing the very top, fastest road cars available, upgraded for racing, at the best tracks you have a public engagement because they identify with the product. All the manufacturers are encouraged to showcase and compete, despite their differences, along with both professional and amateur levels of drivers. The format is inviting and aspirational."

RT ***Traditionally in series it has been difficult to keep all the manufacturers happy, even to the point of encouraging privateers for when the car giants come and go.***
EW "I think the organisers must be doing something right here. Blancpain alone has at least 11 different manufacturers: McLaren, Ferrari, Aston Martin, BMW, Bentley, Mercedes, Jaguar, Audi, Lamborghini, Nissan and Porsche. With varying car models within that, you have diversity, something that means different combinations suit different circumstances. With such disparate starting car types, they also apply a balance of performance to make sure there is an opportunity for everyone to compete – a crucial factor for a category."

RT ***Could you just outline the balance of performance process?***
EW "Each car has to go through a periodic homologation process where its specification is first assessed, balanced and then frozen. Don't forget, the base models from different manufacturers can be fundamentally different, in terms of engine size, position and type to name just one aspect. The fundamentals of weight, power and aerodynamics have to fall within boundaries so that parameters can be different, but balanced amongst the criteria. Restrictors, ballast, geometry and ride height are used to tune the cars so that they remain diverse, authentic to the brand, but close enough to compete effectively together, encouraging manufacturers to stay."

RT ***As an engineer, who spends their entire life engaged in the quest for an unfair advantage, isn't this your worst nightmare?***
EW "I admit I do have a few problems with producing a fantastic car only for it to be ballasted, the engine restricted and its aero wings clipped. However, this changes the emphasis towards making the best car within the windows, while ▶

Cleary/LAT USA

Blancpain

ABOVE & LEFT The GT format, regulated with Balance of Performance, is in the ascendancy. Blancpain (above) and the Pirelli World Challenge (left) offer aspirational machinery on either side of the Atlantic

still maintaining the brand and product identity. It is also an effective cost and development control method, making spend engineering less effective."

RT *Not exactly a one-make series then?*
EW "Urghhh. Words and a concept I truly loathe. Where is the diversity and innovation to produce interesting alternative solutions, train engineers and achieve good racing? A grid of photocopied cars, all able to achieve an identical lap time… yawn! For drivers or race engineers to learn, or even control costs, yes okay, maybe up to a point, but you still tend to get the biggest, best, well-funded teams getting a little bit more out of a standard car. Oh the excitement. Reversing grids, DRS and tyre choice can alleviate it, but only somewhat."

RT *What about other categories currently showing progress?*
EW "Formula E is at a really interesting point. It started with some unique selling points: the first electric car series, racing around the world in a down-town model of bringing the racing to the people. ▶

LAT/FIA/Formula E


Dunbar/LAT

ABOVE & BELOW Purists deride Formula E's FanBoost (above), yet in the age of DRS (in operation below) it is the first handicapping system to engage the fan

FIA/Formula E

ABOVE OEMs have decided that Formula E, with its 'bring the show to the people' philosophy, is where they need to be

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However yes, with new technology and short lead times, another spec series, albeit a substantially different one. The critics did say the cars were quite slow and the car change mid-race, due to lack of range, was awkward. However, they had a plan to allow progressively more freedom on the cars and technology as seasons progressed, which has over the last season just started to take place.

"With Renault, then recently Audi, Jaguar Land Rover, BMW and now Mercedes all joining, it is clear this development of electric powertrains is an area that is of interest to major manufacturers. Applicable technology and a format they feel is useful."

RT ***Do you see this as a potential problem for what have previously been seen as the high profile championships?***
EW "I think we are talking about F1, WEC and I would even include the WRC in this. All these categories are in transition at the moment. Rule changes are being implemented that you would hope increase both manufacturer and privateer interest, plus outside investment and fan engagement. However, I believe the jury is firmly out on how well these developments resonate and whether the health, participation and reach of these classes improves as a result.

"What is an irrefutable fact is that OEMs, four from F1 – two present, two past – and a leading one from WEC, much courted by F1, have all decided Formula E is where they have to be in the future."

RT ***How important do you feel it is that motorsport is used as an R&D area for technology?***
EW "With new series, or a class that embraces future development or rule changes, they must. I believe it's essential. That's not to say there isn't fantastic racing to be found in the Historic or Classic series where once ground-breaking designs can be appreciated in the right context, the Goodwood Revival going furthest to supply a format most similar to a time machine."

RT ***Going forward, though, who is watching and why?***
EW "That's where we start to face some large challenges. There are clues even from those two series which I have quoted as showing growth: how many people are actually in the stands or tuning in to the TV coverage of the races? Formula E's website has claimed an incredibly high number of hits, but does this guarantee the sustainability or business model of the programme? What is clear though is that the demographic of who is watching and the type of event being presented is evolving to be different; you only have to look at FanBoost as a concept to realise.

"It is originally a video game principle, perhaps most fitting for a pioneering electric car series for the participants to vote for which driver should receive a performance benefit during a race. An option previously reserved only if you were struggling during a racing game, a self-handicapping system, but in this age of DRS and push to pass, the first one to engage the fan – it is called 'FanBoost', after all." ▶


Toyota

ABOVE World rallying, like F1, embarks on a new rules package in 2017. The jury is out on whether either series has made the right decision

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Tee/LAT

ABOVE & BELOW Rosberg flashes past German fans in the grandstand. But will autonomous racing (which inched closer with the Roborace 'Devbot', below) really win supporters' hearts?

FIA/Formula E

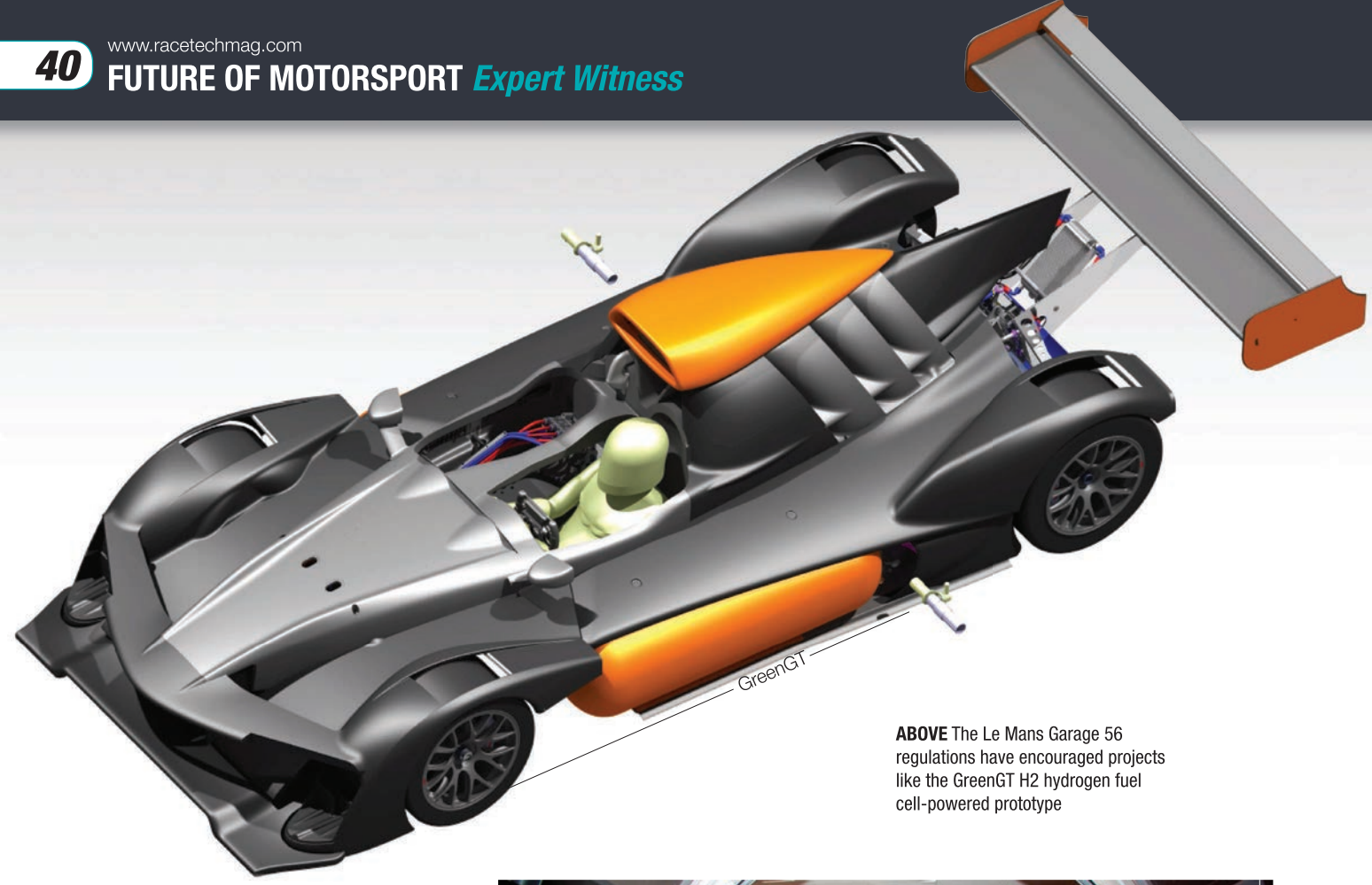
RT ***If manufacturers are engaging in these series, what will bring in the fans?***
EW "I think the promoters know the answers best to this question if they are able to influence the process. There is a great Russell Crowe line in the film 'Gladiator' where he throws his sword into the Emperor's box and shouts from the Colosseum floor, "Are you not entertained?" People want action, not procession; they don't want to know the result the day or weeks before the event. The format must sustain interest, fans must have favourites, a team or driver, rider to follow, engagement. It also must present value: a great show and entertainment still has a price and if people can get a much better spectacle elsewhere for less, they will.

"It has to be a concern when you find yourself with a group of top staff in an F1 team on a Monday morning but nobody is discussing the Grand Prix that took place at the weekend. Instead, the events of that weekend's Moto GP race – the last lap contact and overtakes, the incredibly obvious show of skill and bravery – dominate, or the details of their own virtual racing against each other: who had triggered the chain reaction incident in the NASCAR race on the banking at turn two and, later, the four-way slipstreaming fight for the lead in 1967 F1 cars at Monza."

RT ***You spoke about fans having engagement and being partisan for a team or person. Doesn't that change or even disappear with autonomy and the proposed Roborace series?***
EW "Historically we have seen, with Alonso in Spain, Hamilton at Silverstone and most recently Verstappen at Spa (not Holland, but the closest race they have), how fans will turn out and support their drivers at home races. Autonomy is coming, but I remain unconvinced it has an entertainment or, by definition, human engagement in a motorsport forum. I cannot imagine having a favourite software engineer or control system, not on the track anyway. When autonomy gets to the stage where journeys on the road are driverless, I might have a preferred system then, but it will be based on safety and reliability, not on how quickly it can go around a circuit.

"However, I can imagine a future environment where the racing is either completely virtual or boundaries are crossed in between, producing a drone style of competition, but still with human skills and control. In the opposite direction, Jann Mardenborough famously won the virtual Nissan Gran Turismo racing scheme to then transfer those skills successfully to real track GT3, LMP1, GP3, GP2 and F3.

"Virtual racing has particular appeal in this more convenience-orientated society. You can choose what car, track, conditions, time, standard, against human or AI opponents and race from the comfort of your own home at a fraction of the cost. If you get it wrong, it doesn't require days in the workshop or remortgaging your home – a simple restart or reset will suffice." ▶



ABOVE The Le Mans Garage 56 regulations have encouraged projects like the GreenGT H2 hydrogen fuel cell-powered prototype

RT ***So do you think we should be worried? Is the attention moving on to other things?***
EW "F1 and WRC have just undergone rule changes to make the cars significantly faster. I remain unconvinced this is the safe or attractive way forward. Change regulations, Sporting and Technical, to improve the closeness of competition and make the racing format more spectacular to watch, then that will sell and increase fan, sponsor engagement and revenue.

"I believe to be successful motorsport still must have space to innovate, evolve, create and improve the breed of vehicle, but you have to be allowed to do it, either through legality or financial frameworks. Garage 56 at Le Mans allows unique, alternative vehicle formats to participate in the great 24-hour race so long as they are safe, but these freedoms to explore technologies or ideas are being more prescribed out just at a time where environmental challenges need ever better vehicle solutions.

"Perhaps a balance of performance based on good racing and efficiency. Entertainment, fan engagement, new concepts for controlled budget, resources, energy and emissions, that's what I would vote for. Probably what a lot of fans would vote for too, but then can opinion polls and a public vote really be trusted? Maybe not, but they will end up voting with their feet, remote controls and money in their pocket anyway." RT

Photos: Nissan

ABOVE & BELOW From the virtual world to real life stardom: Jann Mardenborough's achievements since winning Nissan's GT Academy saw him named as one of the 50 most marketable athletes in the world by Sports Pro Media

ON TRACK TO IMPROVE OUR CLIMATE

John Glenn, formerly of the U.S. Environmental Protection Agency and the man behind the Green Racing programme, says time is running out for motorsport to change its ways

IN 2005, when I worked for the U.S. Environmental Protection Agency, I wrote a paper titled *Green Racing*. Its purpose was to address the role motorsport could play in reducing carbon emissions, the leading cause of climate change. The original idea was to get motorsport's sanctioning bodies to voluntarily substitute engine displacement as a metric, which emphasizes power density, with miles per gallon classes to emphasize energy efficiency instead. The idea was that this single change would modernize the sport and turn it into "a laboratory for energy efficiency."

My office at EPA worked with different industries to create voluntary programmes to reduce greenhouse gasses. We only succeeded with industries that believed it was in their best interest to work with us; no one did it for altruistic reasons. As a racing fan, I knew motorsport was in a unique position: while soccer, baseball and football are all great, motor racing was the only sport that had the technological core we were looking for. It was also clear to me that motor racing had to address energy and climate issues in order to protect its long-term viability so it was in the sport's best interest to work with us and be seen as developing solutions to climate change rather than, in the public's eye, being part of the problem.

I'd been a racing fan since the early '60s and grew up with 125 cc, 250 cc and 500 cc racing classes for motorcycles, five-litre Trans-Am and Formula 5000 cars, and 1.5 then 3-litre Formula 1 classes. I witnessed just how relentless motorsport could be at increasing power density. When I was a teenager, normally aspirated 3-litre Formula 1 engines made about 100 horsepower per litre; by the end of their reign in 2005 they were making over 300.

I also witnessed how racing technology passed from race cars to road cars with the adoption of double overhead cam, four valves per cylinder engines – wonderful, small, power dense, spark ignition powerplants. Successful engines on the track were emulated on the road. I first convinced EPA then the Department of Energy that motorsport could do the same thing for energy efficiency.

The original proposal was simply to swap engine displacement for energy restrictions. We believed that rules designed around engine displacement emphasized power density over energy efficiency. The shift to fuel consumption classes – 4 mpg, 5 mpg, 6 mpg, etc – may not sound earth-shattering, but we believed the benefits over time would turn out to be enormous.

Just think of what we would be driving today if Formula 1 had restricted the amount of fuel competitors could use instead of engine displacement in the '50s. It would have literally changed the path that automobile technology took for the last 60 years. We would have started decades ago developing the turbocharged, hybrid powerplants we are only seeing today. Limiting engine displacement instead encouraged the development of V10 and V12 engines to increase power density.

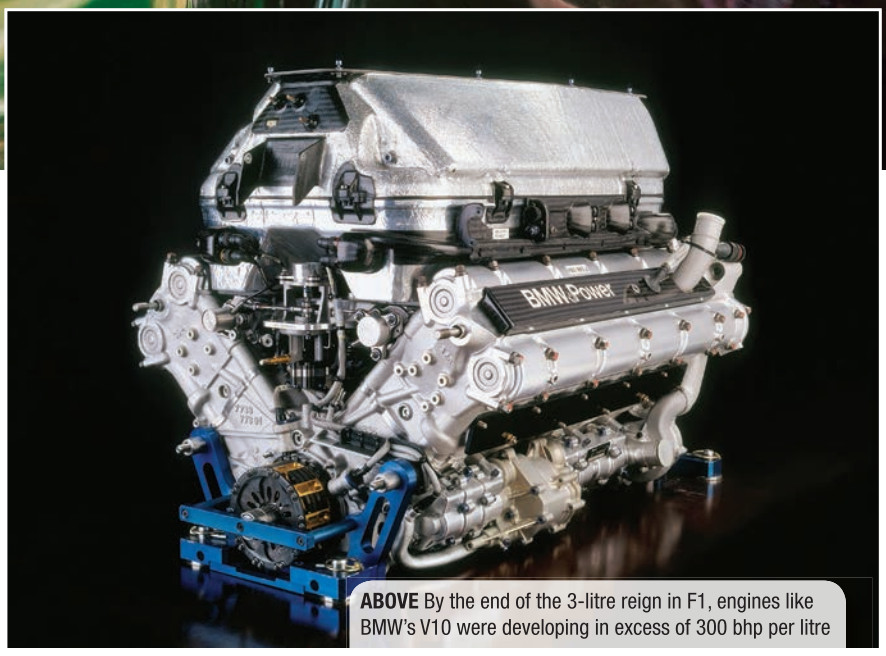
Both agencies were very pleased with the positive response Green Racing received from the racing community, especially from the American Le Mans Series that immediately partnered with us. But for many reasons, the Green Racing programme ended up moving away from our original idea to a much more complicated one that required pages of spreadsheets to determine which competitor used its energy most efficiently. Races were won on paper, not on the track. So 11 years later, as a private citizen, I once again suggest that the sport go through its rules and regulations and every time it sees the words engine displacement, CCs or cubic inches, replace them with an energy restriction metric.

BELOW The creation of nominal miles per gallon classes was to ensure that the car using its fuel most efficiently would win the race

ENERGY EFFICIENCY METRIC

I have to admit that when I came up with the idea for Green Racing I thought it would be easy to develop powerplants that would get the four or five miles per gallon regardless of what car they were in or track they were on. It took a good engineering friend of mine a couple of hours one morning to convince me I was wrong, how difficult it was for engineers to develop engines to get a specific gas mileage; there were just too many variables – lap speeds could vary from under 100 mph to over 200 mph and cars using the same powerplants could weigh from under 1500 to over 3500 lbs. He persuaded me it was a lot easier for an engineer to design engines for specific maximum fuel flow rates – then it wouldn't matter what track they were on or car they were in.

For my part, this significantly changed the way we had to look at our project. The project had always been based on energy over distance, not energy over time. This worried me because I was concerned that a metric in Btu/sec would be too complicated for most people to grasp and would substantially reduce the public's interest. It would be fine for hardcore race fans but not the general public that thinks in terms of MPG or L/100K.



ABOVE By the end of the 3-litre reign in F1, engines like BMW's V10 were developing in excess of 300 bhp per litre

NOMINAL FUEL CLASSES

My solution for solving this dilemma was to create nominal miles per gallon classes based on maximum BTUs/sec flow rates. Nominal classes are good at making sure each competitor gets the same fuel flow restrictions and the car or motorcycle that ▶

ABOVE & BELOW The Green Racing initiative received support from the American Le Mans Series

uses its fuel most efficiently, all other things being equal, wins the race. The problem with nominal classes is they are also by definition inexact. For example, a nominal 5 MPG class might allocate a maximum energy flow of 1,339 Btu per second (see chart), defining exactly how much energy is available to each competitor, but you cannot guarantee that over the period of a race any particular competitor will get exactly 5 mpg. The best you can do is to develop energy classes that give you a reasonable approximation of how far competitors will go on a gallon of gas or other fuel.

The following example is for discussion purposes only, but it illustrates the three decisions required to develop nominal fuel classes. The first is the name of the nominal classes, which would be MPG or L/100K classes. The second is what fuel or Btu value you are going to use as the basis for classes. The third is distance travelled over time.

For this example I am going to use MPG classes. To determine the amount of energy available, I decided to use the U.S. Energy Information Administration Btu values for retail gasoline sold in America, 120,524 Btu. To determine the energy available for a 5 MPG Class, you would divide 120,524 by five to get 24,105 Btu per mile. To determine the maximum fuel flow *rate* you have to know how many miles the benchmark racer will travel over a specified period of time, let's say for discussion purposes an hour – in most professional car and motorcycle racing series that could be anywhere from 100 to 200 miles depending on the circuit. So, a competitor getting 5 MPG would use anywhere from 20 to 40 gallons of gasoline or 2,410,480 Btu/hr to 4,820,960 Btu/hr depending how fast the track was and how much of the time they were on full throttle. But, because we are trying to determine the *maximum fuel flow rate*, not the average fuel flow rate, which includes periods when competitors are not at full throttle or even in the pits, we'll use the higher number, 4,820,960 Btu/Hr or 1,339 Btu/sec. In other words, if the car were going 200 mph at full throttle for an hour, using 1,339 Btu/sec it would get exactly 5 mpg. The mileage should also be reasonably close on slower tracks where the cars are at full throttle less of the time. This chart shows what our example maximum fuel flow rates would be for classes ranging from 4 to 10 mpg: ▶

HOW THE FUEL CLASSES MIGHT SHAPE UP

Fuel Class	Max. Btu/hr	Max. Btu/sec
4 MPG	6,026,200	1,674
5 MPG	4,820,960	1,339
6 MPG	4,017,477	1,116
7 MPG	3,443,543	957
8 MPG	3,013,100	837
9 MPG	2,678,311	744
10 MPG	2,410,480	670

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> *"The shift to fuel consumption classes may not sound earth-shattering, but we believed the benefits would be enormous"*

In some respects developing nominal fuel mileage classes is similar to James Watt developing the concept of horsepower and will have similar results. James Watt needed a measurement for steam engines that 19th century Britons could relate to, so he chose horsepower; in our case we need a measurement for energy consumption that 21st century people can relate to and chose MPG or L/100K. Watt's use of horsepower provides a universal tool for comparing the power of different cars and motorcycles and MPG or L/100 K provides a universal tool for comparing their energy consumption.

Adopting fuel classes makes a strong statement that motorsport is now restricting the amount of energy available to competitors. The competitor that makes the most power out of the available energy wins. And, it also goes without saying that the car or motorcycle manufacturer with the most energy efficient vehicle also wins. This makes a clear public statement that the sport is focusing on developing energy efficient technologies to help reduce climate change and save energy.

ADOPTING FUEL FLOW REGULATIONS

Another attribute of MPG or Litres/100K classes is that they are flexible – any race series can adapt them to meet their specific needs. For example F1 might choose a 6 MPG fuel class (1,116 Btu/sec) and require each competitor to develop powerplants to meet that limitation. Sportscar racing series, on the other hand, may want to develop broader classes, for instance a 6-4 MPG class that would allow maximum fuel flow rates of anywhere from 1,116 Btu/sec to 1,674 Btu/sec to equalize the performance of vastly different cars into one class. The Pirelli World Challenge series, for example, balances the performance of cars as disparate as a KTM XBOW and a Ford Mustang in a single class.

Dunbar/LAT

ABOVE & BELOW Formula 1 has made steps in the right direction with the advent of hybrid engines and fuel flow meters, but its improved efficiency is largely hidden from the public

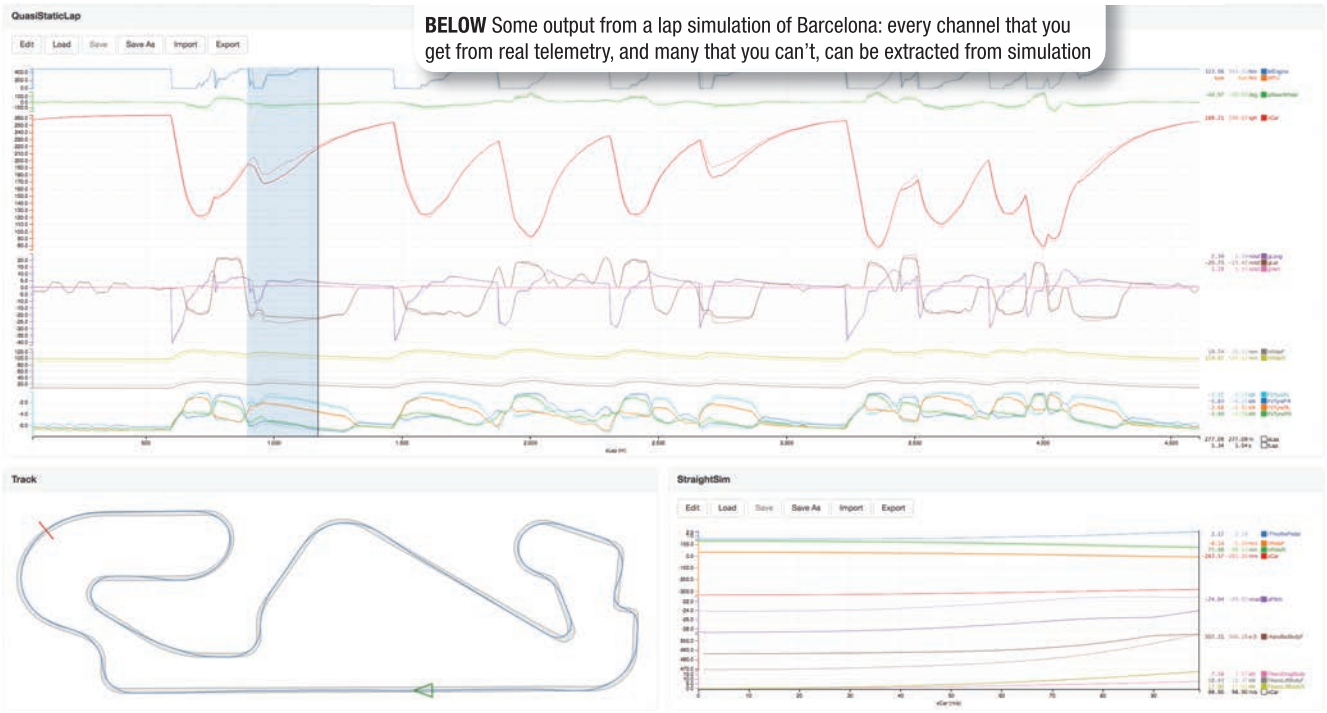
NASCAR could either use a specific fuel flow rate as it does engine displacement today, or because the series depends upon such close competition, use a 5-6 MPG class to give them the option to minutely adjust the amount of fuel available to different competitors. Last but not least, flow rates because they are based on energy can easily be used to balance the available energy in different kind of fuels including diesel, gas, hydrogen, electricity, etc.

Regulating energy instead of engine displacement would make the sport appealing to a new environmentally-friendly audience. It would also attract a whole new set of sponsors that they appeal to. My experience as an environmental regulator and as a race fan leaves me no doubt that there is a synergistic effect between creating energy efficient products that benefit society and increased interest in the sport by society.

LAST CHANCE

Eleven years ago when EPA started its green racing programme we said that motorsport had a window of opportunity to redefine itself as "a laboratory for energy efficiency". That window is much smaller today. The sport is clearly aware it needs to improve its environmental image and is already committed to that, experimenting with state of the art energy efficient technologies, especially F1 and Le Mans P1 prototypes. But unfortunately, the message is not getting through: how many people know that a Mercedes Formula 1 car is more energy efficient than a Toyota Prius? I can tell you that unless you already know what you are looking for, it's hard to find that information on the Internet.

If the sport is going to get the credit it deserves and desperately needs, it is going to have to make a dramatic statement to change its image. If the FIA could get the major racing series to act in unison and adopt energy consumption classes, it would clearly define the sport's intent to become that "laboratory for energy efficiency". RT



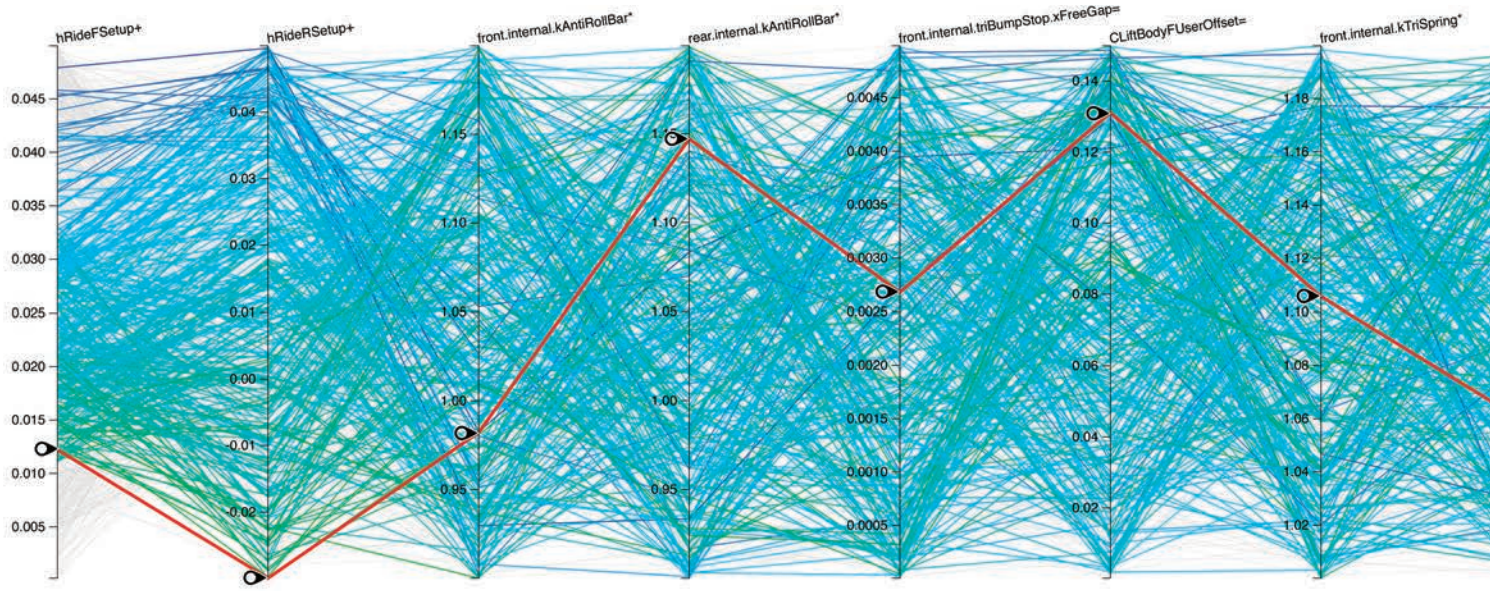
BELOW Some output from a lap simulation of Barcelona: every channel that you get from real telemetry, and many that you can't, can be extracted from simulation

THE *REALITY* OF SIMULATION

Dr Mark Catherall examines the manner in which simulations have transformed F1, pinpointing the day the world changed

IN 2009, Lewis Hamilton hit the track for the first practice session of the Singapore Grand Prix weekend and was a whole second faster than the next fastest car. During the course of that session, as other cars dialled in their setups, that second was eroded. The question then is this: why was Lewis's car so much faster than any other on its opening lap? The answer: simulation, or more accurately, *thousands* of simulations.

When people in the F1 world use the world 'simulat*or*', they're talking about the expensive computer-game-on-stilts in some darkened room at HQ that the drivers complain about all the time. When they talk about 'simulat*ion*', they're talking about a



computer program that runs on a normal workstation in about 30 seconds; finding the maximum performance of the car and driving it around a track right on the limit of its envelope, truly reflecting the maximum capability of the car. It is these simulat*ions* which are used to drive every aspect of F1 car development and optimization.

SETUP OPTIMIZATION: THEN AND NOW

The traditional pattern of simulation use for setup optimization goes something like this: race engineer wants to find a setup, she takes the setup from the last race, and last year's setup for this race and mixes them together. She then does a simulation – giving her the lap-time, end of straight speed, brake energy, fuel consumption etc.

Seeing an opportunity for improvement, she tweaks a parameter (maybe a spring stiffness or a ride height) and runs another simulation. And so on and so forth until she has to stop because the car is leaving the garage in 10 minutes and real setup changes take longer than simulated setup changes.

This was how it was done in F1 for many years, with an increasing number of backroom staff devoted to configuring and running these setup investigations, and it worked to some extent. The problem is that when there are eight or 10 primary setup variables (2x ride heights, 2x tri-springs, 2x ARBs, front wing flap angle, front bump gap…) you can be sure that incremental changes applied by a human with a one-minute turnaround time are not going to get you very far from where you started in the time available.

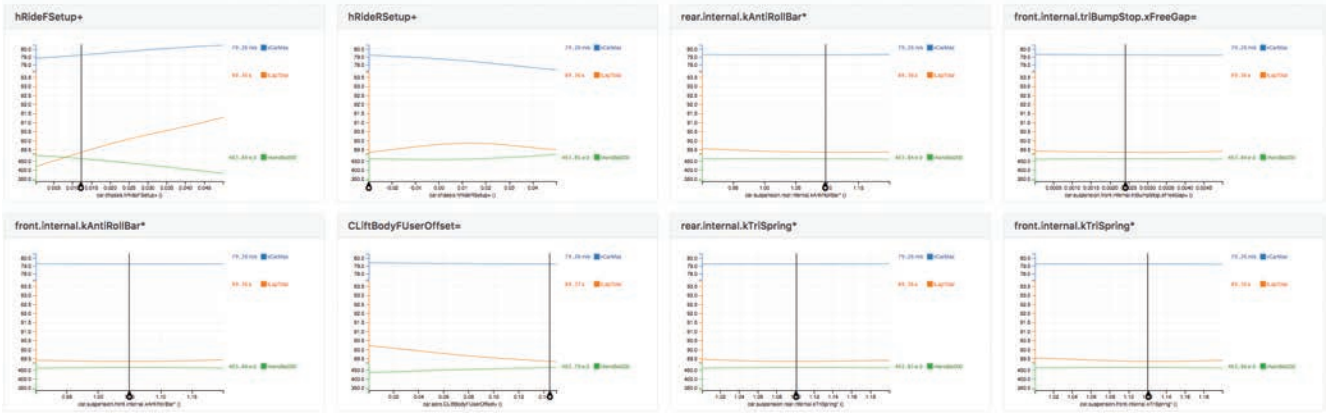
The new pattern of simulation for setup optimization goes more like this: race engineer makes baseline car in the same way as before, then she defines a maximum and minimum deviation from that baseline for every setup parameter that she has the power to vary. Having done this she launches a 'setup study', a set of thousands of simulations randomly dotted around the allowed setup-space that she's defined.

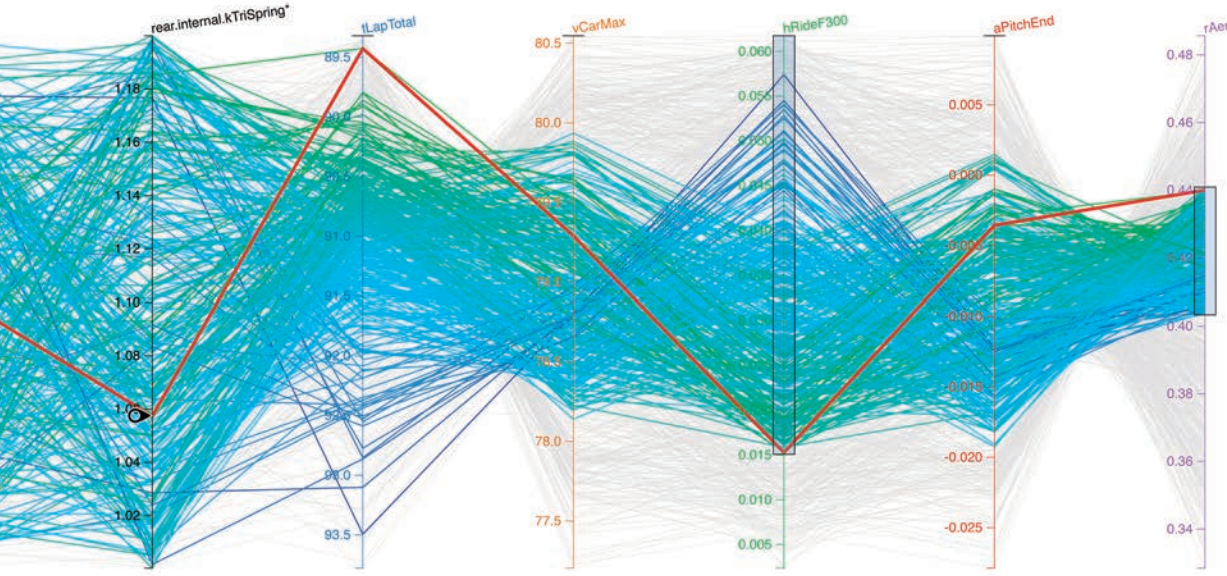
Once these simulations have completed (typically an overnight job with current in-house technology) she can fit a response-surface to the results and then tune the knobs to find the optimal lap-time just as before – the difference being that now the results have been modelled with a response-surface she can see the effects of her adjustments instantly, allowing many more iterations of setup. In fact, now that the problem has been reduced to finding the lowest point on a response-surface, she can plug the problem into an optimizer. This will do the work for her, finding the minimum lap-time setup in seconds.

It was precisely this kind of large-scale running of simulations which put Lewis ahead of the competition in Singapore. Other teams started with a setup which was a long way from optimal for the track and used precious track time to iterate towards better setup; McLaren started very close to the actual optimum, an advantage which persisted throughout the weekend and resulted in Lewis winning the race.

DESIGNING FASTER CARS

Of course the use of simulations to find the best setup is actually the last in a long line of decisions about the car which were ▶





ABOVE & LEFT Results of large simulation studies (>1000 simulations) can be fitted with a multi-dimensional response surface and explored interactively, giving engineers a tangible sense of the behaviour of their car

Hone/LAT

ABOVE By the time the cars make it to the grid, a lengthy list of informed decisions have been based on simulations

informed by simulation. A week before the race a vehicle dynamicist will have run a similar set of simulations with varying aero configurations (front wing, rear wing, Gurney flaps, brake ducts, etc) to identify which would be the fastest at that particular circuit.

Weeks before that another set of simulations will have been done to determine what direction the aerodynamicists should aim to develop in: a number called the isochronal ratio tells aerodynamicists how many points (100ths of a coefficient) of downforce have to be added to cancel out one point of drag for a particular track or set of tracks.

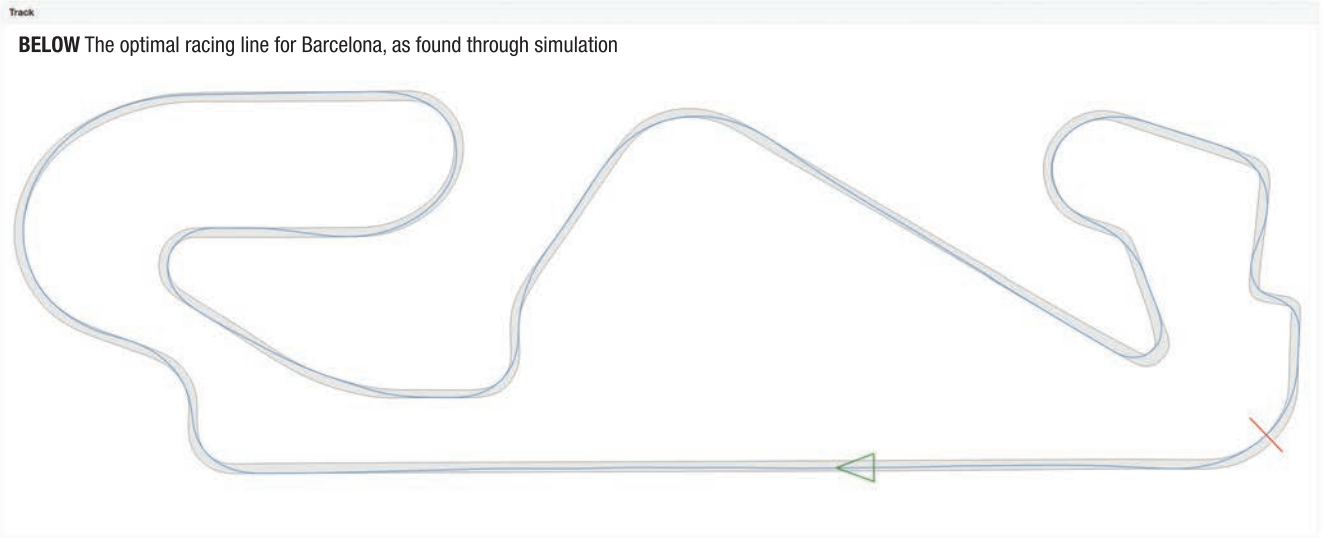
Months even before that, when the car itself was but a glint in its designer's eye, hundreds upon thousands of simulations will have been run in what's referred to as a 'fundamentals study': a set of simulations revealing the fundamental trade-offs of that year's car. How much is 1 mm of reduction in centre-of-gravity height worth? What's the trade-off between chassis stiffness and weight? What loads can we expect in the pushrods at end of straight? All of these questions are answered by simulating laps with thousands of different car configurations, each one adding to the overall picture of how the car will behave and which is the stronger side of each trade-off each year.

FINDING OUT WHAT YOU'VE BUILT

Even after the car has been designed, built, and set-up for a particular track, the work of simulation is not over. Aerodynamicists feed information measured on the actual car, such as ride heights or pushrod loads, into the same vehicle model that's used for the predictive simulations to reverse engineer the aerodynamic loads that have been actually experienced by the car on track. These loads can then be compared to the loads predicted by the wind tunnel and discrepancies investigated. A similar process is continually applied to the model of the tyres that each team refines and updates in light of every bit of new information from the track. ▶

Red Bull Content Pool

ABOVE Long before an F1 car sees the light of day, hundreds of thousands of simulations will have weighed up the trade-offs involved in that year's design



BELOW The optimal racing line for Barcelona, as found through simulation

BELOW Lap simulations for 1200 different setups completed in under four minutes

Name	Created	Jobs	Time	Type	Owner
Barca Setup 8D	2 minutes ago	1001	3:29.29	Quasi-Static Lap	new.user

RULES AND TRACKS

As we have seen, simulation is used to inform decisions throughout every stage of the life of an F1 car. In fact simulation has uses beyond developing the car itself; reaching into the development of the sport. In 2009 Formula 1 moved to narrow rear wings and wide front wings with the aim of reducing the impact of wake from a car in front on a car following behind. This of course was decided only after the new wing shapes and their effect on following cars was simulated by the teams. A year or so later the simulationists of F1 were again called upon to evaluate new measures to increase overtaking, this time the winning solution was DRS, which was introduced in 2011.

Even the designers of the tracks themselves use simulation to refine turn profiles and estimate speeds and lap-times. From Hermann Tilke's recent comments regarding his surprise at the top speeds seen in Baku, though, it's clear that the simulations he and his team are using are a long way behind those found in the Formula 1 teams themselves.

Once the teams have the track definition from the designers, they will use simulation to find the optimal racing line around that circuit for their particular car. This will then be used in lap simulations to refine the car and its setup, including finding the optimal aero configuration and gear ratios, thus being able to predict top speeds very accurately.

A CHANGE IN THE LANDSCAPE

The reality is that every top F1 squad has its own in-house team of four or five experts in modelling, optimization and simulation developing simulations specifically for them. Having their own in-house simulation development team has historically been the only way for teams to ensure that they had the quality of simulation that they require.

Simulation used to be a real performance differentiator in F1: teams with simulation beat those without. Now everyone has simulation to a relatively high level, it's *how much you can extract from the results* that differentiates performance; being able to

ABOVE Thousands of simulations can be conducted over hundreds of cores in the cloud

run more simulations in *less time* is the key. That's what McLaren realised before anyone else, and that's what put Lewis one second ahead of his rivals during the opening laps of P1 in Singapore.

Doing one simulation is nice, it tells you how fast you can expect your car to go; doing two simulations is better, it tells you whether a change is an improvement or not; running 1000 simulations is a whole new ball game, it tells you how your car *behaves* and how that behaviour changes with different factors. A 1000-simulation study can tell you how your optimum ride height will change as the track rubbers-in during the weekend; it can tell you how to make the best trade-off for stability in different weather conditions.

The problem is that running 1000 simulations at 30 seconds each is an eight-hour job on a single computer. The answer of course is to use more computers, however this brings up another problem for the incumbent teams: having built their simulation infrastructure using proprietary software, each new machine running simulations needs its own licences for that software. This makes it prohibitively expensive for teams to simply buy 100 computers and have them sitting there, waiting until someone wants to run a big set of simulations.

The answer might lie in something that F1 teams have only recently started to realise the value of: outsourcing. Now that the technology of simulation is relatively mature, it's no longer important for teams to use their own special brand of simulation. What is important is the capacity to run huge numbers of simulations in as short a time as possible. This capacity can only come from distributing the computation of these simulations over hundreds of cores in The Cloud.

That means not only re-writing existing simulations with non-proprietary technologies, but developing and maintaining the infrastructure required to configure, generate, and federate thousands of simulations over hundreds of cores in the cloud. Unfortunately this is not something that we can expect any F1 team to undertake exclusively for their own use, and even if they did, what good would it do the rest of us? Only an independent simulation supplier/developer can provide motorsport with the final word in simulation and unleash an awesome wave of rich understanding in its wake. RT

MARK CATHERALL spent three years at McLaren Racing before leaving to do a PhD, during which he did five years consulting for Ferrari. He has experience in everything from lap time simulations to high-dimensional metamodels. Together with Dr Oliver Watkins and James Thurley (both ex-McLaren) he formed Canopy Simulations to create the world's most advanced motorsport simulations platform, powered by cloud computing. RT

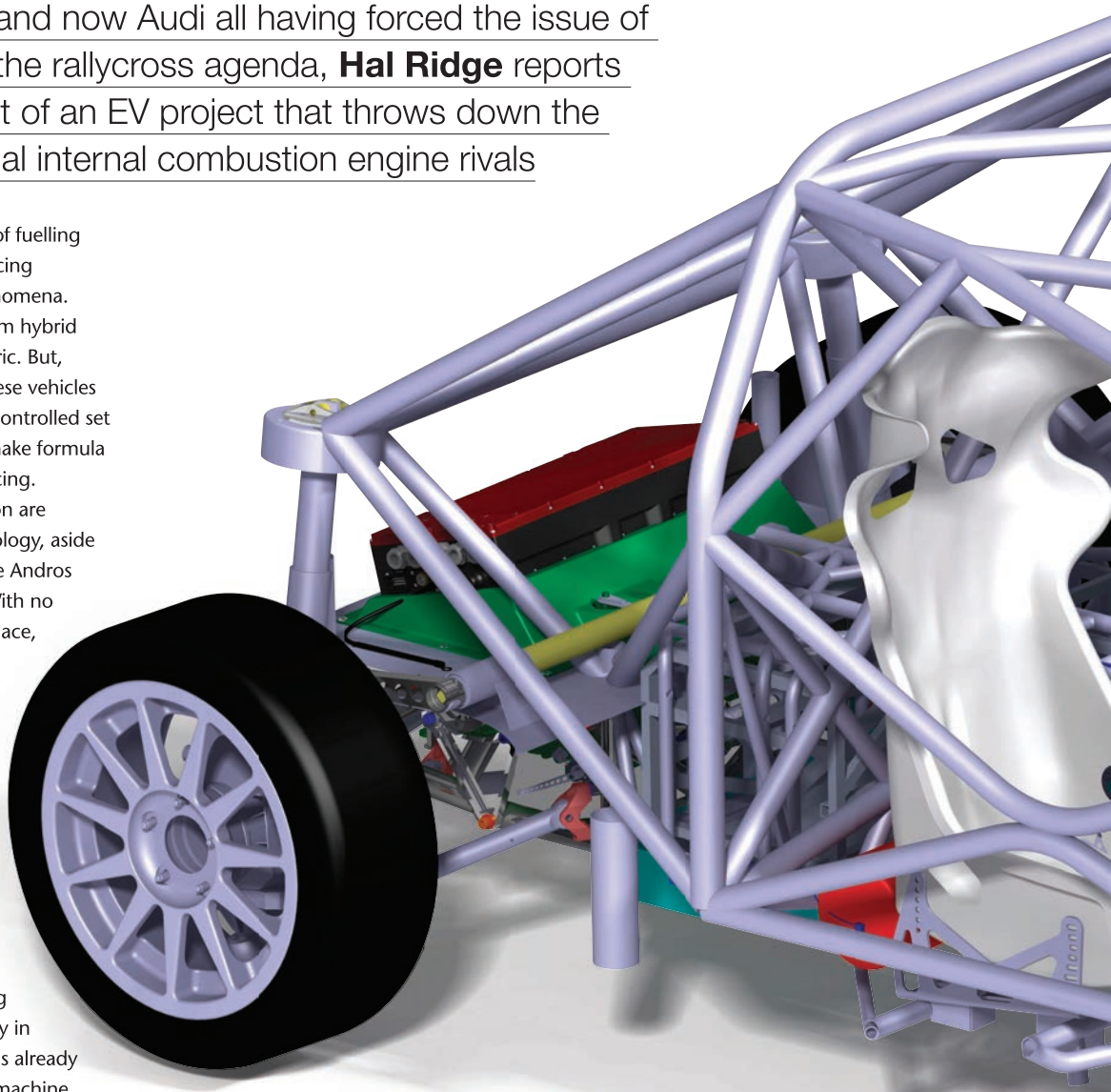
"Rivals used precious track time to iterate towards better setup; McLaren started very close to the actual optimum"

Etherington/LAT

ABOVE Lewis Hamilton takes the Singapore circuit by storm – changing the way F1 works in the process

COME AND PLAY *IF YOU DARE!*

With VW, Peugeot and now Audi all having forced the issue of electrification onto the rallycross agenda, **Hal Ridge** reports on the development of an EV project that throws down the gauntlet to traditional internal combustion engine rivals



ALTERNATIVE methods of fuelling and propelling motor racing vehicles aren't new phenomena. Revolutionary concepts range from hybrid technology to fuel cells and electric. But, with EV motorsport especially, these vehicles usually compete under a strictly controlled set of regulations, often in a single-make formula and most commonly in circuit racing.

Rallying and off-road competition are untapped disciplines in EV technology, aside from a supporting category in the Andros Trophy winter ice racing series. With no rules or regulations currently in place, the sheet of paper for interested parties to work their magic on is clean, and thus the creation covered in the following pages is about extracting the maximum possible from the available technology.

Volkswagen made noises earlier this year about being interested in the introduction of electric propulsion into rallycross. Although the use of EVs in rallying or rallycross may still be some way in the future, an Austrian company is already ahead of the game in creating a machine capable of outperforming headline-making conventional rallycross Supercars.

STARD is the research and development arm of former World Rally Championship podium finisher Manfred Stohl's group, and has been working on the EV topic for some considerable time.

It was initially conceived for rallying. However, since STARD has been involved in the World Rallycross Championship in recent seasons (with the development of Ford Fiesta Supercars for World RX Team Austria), the EV project is now a concept for rallycross too. If anything, it is currently weighted more towards the multi-surface racing discipline.

"In 2006 we developed a CNG (compressed natural gas) rally car, that was our first experience of alternative propulsion in motorsport. We found how great it is to be involved in R&D that nobody else has done," explains Michael Sakowicz, CEO of STARD. "It's fairly simple to build a race car for a specific formula. It's just a question of time, effort and budget as to how good the results are. If you really want to do something that nobody else has done, it's tough because you need to take risks to find good solutions to make ideas work, to be the first."

The firm's CNG project wasn't without success in the Austrian Rally Championship – second in 2009 with a Group N car against Super2000 opposition – but in 2008, inspired by some Japanese concepts, the idea was formed to create an electric rally car.

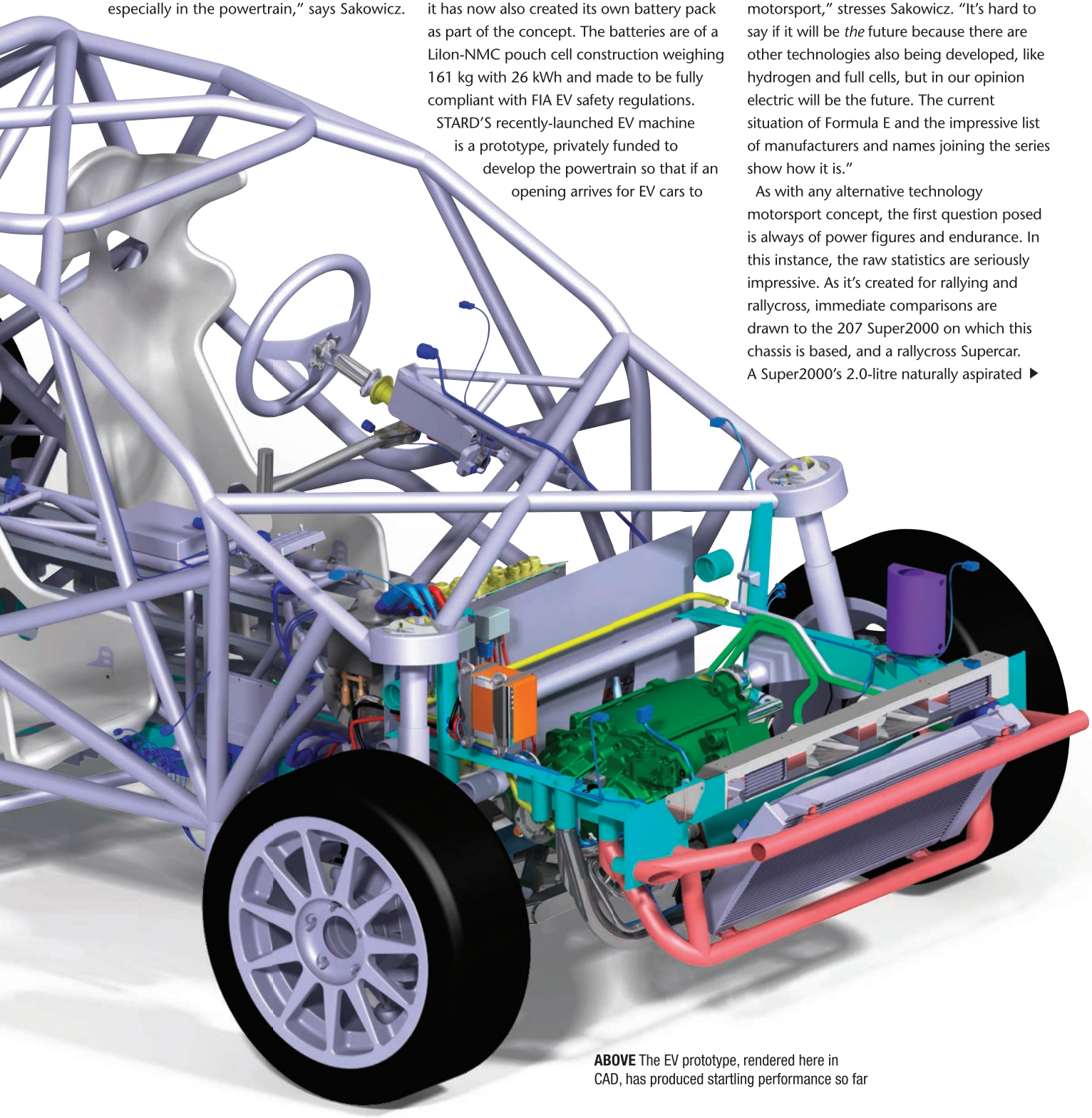
"It took a long time to get off the ground, especially from a finance side. The components were also very difficult to source, to handle the power requests we had. But, the timescale means we have had a big view of the project and learned a lot. In the end, hardly any of the third-party components we use have remained unmodified to how we sourced them, especially in the powertrain," says Sakowicz.

> *"If you really want to do something that nobody else has done, you need to take risks"*

Using an existing chassis, a Peugeot 207 Super2000, STARD quickly discovered that batteries available on the market were too costly and not capable of its requirements, so it has now also created its own battery pack as part of the concept. The batteries are of a LiIon-NMC pouch cell construction weighing 161 kg with 26 kWh and made to be fully compliant with FIA EV safety regulations.

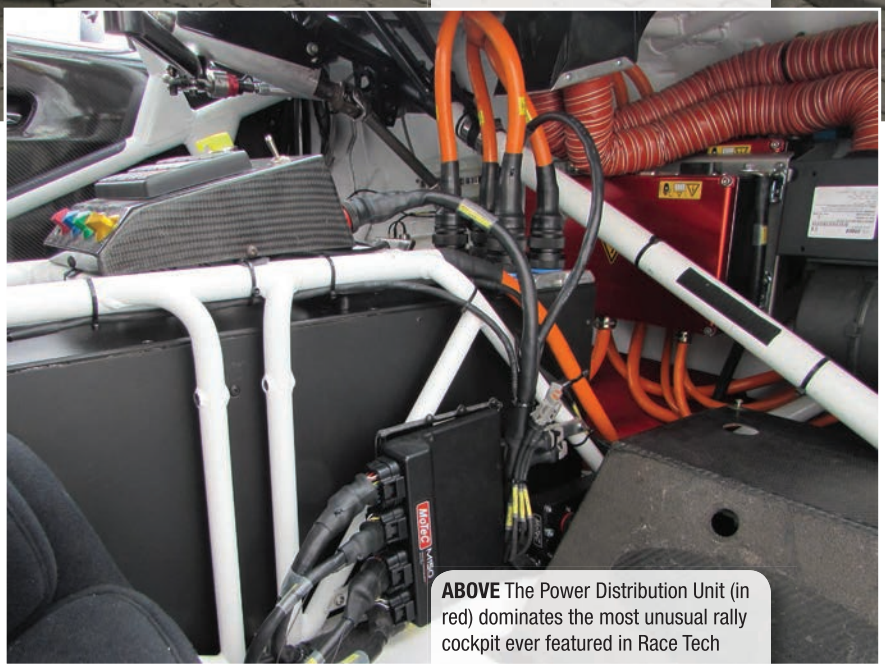
STARD'S recently-launched EV machine is a prototype, privately funded to develop the powertrain so that if an opening arrives for EV cars to compete in unconventional circumstances, the Austrians are already a long way ahead of the competition. "This is an investment into what we see as at least part of the future of motorsport," stresses Sakowicz. "It's hard to say if it will be *the* future because there are other technologies also being developed, like hydrogen and full cells, but in our opinion electric will be the future. The current situation of Formula E and the impressive list of manufacturers and names joining the series show how it is."

As with any alternative technology motorsport concept, the first question posed is always of power figures and endurance. In this instance, the raw statistics are seriously impressive. As it's created for rallying and rallycross, immediate comparisons are drawn to the 207 Super2000 on which this chassis is based, and a rallycross Supercar. A Super2000's 2.0-litre naturally aspirated ▶



ABOVE The EV prototype, rendered here in CAD, has produced startling performance so far

ABOVE The chassis, based on a Peugeot Super2000, is not tailor-made for rallycross. Given the green light, the team is confident it could out-perform conventional rivals within months



ABOVE The Power Distribution Unit (in red) dominates the most unusual rally cockpit ever featured in Race Tech

engine produces around 280 bhp and 260 Nm torque, while a Supercar produces in the region of 600 bhp and 800 Nm torque.

"An S2000 or R5 rally car is way below the performance we are currently running," says Sakowicz. "We have a two-motor setup, where each motor (one per axle) has 200 kilowatts of power, meaning a combined horsepower of 544 and 760 Nm torque. There's no mechanical connection front to rear, so we have a fully sequential torque distribution. Our battery system is superior to the power capabilities of the motor at the moment; the powertrain has been fixed for about two and a half years, but in that time technology has moved forward quite a lot.

UNLEASHING POTENTIAL

"We have 390 kilowatts of continuous power from the battery pack, without any necessity to have any modulation of on and off throttle, so we can really drain it in one run with the full power. We could draw a peak power of around 700 kilowatts from the battery, but the limitation is the drivetrain. We could unleash much more potential with a chassis that was purpose-built for EV four-wheel drive too. I would say that we're on a par with a rallycross Supercar in performance figures, but the focus has been entirely on the EV side and packaging it into the existing chassis."

The scenario in Formula E, where drivers have to swap cars mid-race, highlights the technical challenge in achieving long distances with electric-only power. For that reason alone, EV motorsport and rallycross are a match made in heaven. World RX qualifying races are run over four laps, with finals over and done with in just six. "We have been through cycles which represent a rallycross duration and it's absolutely no problem," says Sakowicz. "Using the full 544 horsepower, our endurance of race-condition driving is about 15 minutes and charging from 100% DOD to 100% SOC takes around an hour. We are still testing the amount of battery cycles – from full charge to discharge – to see when we see a significant influence on the capacity and on the power capability, but we expect it to be around 1000 cycles."

While rallycross is now high on STARD's agenda, it is still working hard to overcome the endurance hurdle to enable its creation to compete in rallying too, by regenerating power through braking energy, a concept already at large in LMP1 endurance racing and Formula 1. "There is a separate recuperation pedal (where a clutch pedal would conventionally be located). The driver can activate the recuperation brake manually or have the recuperation working automatically in addition to the hydraulic brake system," he says.

"We are constantly developing functions specifically for use on off-road and mixed conditions. It's very difficult to have automatic recuperation under braking when the road conditions are always changing. Obviously you need to ensure the driver's brake feeling stays equal in various conditions too. That's a big area of development and would definitely help for rallying, but we have also made the battery change as easy as possible, for between special stages."

One of the key calling cards of rallycross Supercars, aside from their impressive power and ability to race door-to-door on a range of surfaces, is the acceleration: 0-60 mph in less than two seconds is the figure bandied about ▶

ABOVE & BELOW EV technology would add a new dimension to the rally stages or rallycross circuits

most commonly, but electric propulsion blows that kind of stat out of the water. With torque delivery almost faster than the blink of an eye, the limiting factor is the strength of the drivetrain and the ability to put that power onto the ground.

"In 0.043 seconds from the torque demand, we reach about 90% of the torque requested. The build-up time from driver command to final torque on the drivetrain is extremely fast," says an excited Sakowicz. "Because the basic powertrain wasn't initially tailor-made for motorsport, we were breaking gearing internals, so we've had to reinforce and redesign. The performance of the electric motor is far more sophisticated and much better for motorsport purposes than internal combustion. Of course the battery is where the most development is required but as far as the powertrain is concerned, it's incredible. We've had very experienced rallycross Supercar drivers experience the car and they have been fascinated by the performance, the way it's delivered and the control you have."

Modern day Supercars are seriously complicated beasts, especially the engine management systems, where engineers are constantly discovering more effective ways of the turbocharged power being deployed to propel the cars forwards as quickly as possible. With an EV, that control is far superior. "With an internal combustion engine there's a lot of sub systems," points out Sakowicz. "To have effective torque control [as covered in detail in RT186] there are so many influencing factors: boost, throttle position, cam position, injection, ignition, air temperature, fuel temperature and all those things. With an electric motor you can exactly regulate the torque, relatively simply."

HIPER PERFORMANCE

STARD's car, known as HIPER (High Performance Electric Race Car), has a single gear with a top speed of 195 kph. A mechanical limited slip differential is used on each axle, but that is another area that is being focused on as the next stage of development. "At lower speeds we are about level with a current Supercar, whereas at higher speeds the acceleration is slightly below. But, clearly above a WRC car, which could only keep up in first gear," says Sakowicz. "We have also developed an integrated drivetrain solution which has two motors per axle without any mechanical connection."

In future, use of two such integrated units will result in one motor powering each wheel, with full sequential torque distribution. Uniquely, the inverters will be part of the drivetrain. Currently, the car has an individual drivetrain and inverter front and rear. But, with the four-motor system in the pipeline, the two drivetrains with planetary gears and inverters will be amalgamated: "We will have just one HV interface (positive and negative high-voltage DC), one communication interface and one cooling interface for the two motors, the two inverters and even the gearing in a compact unit. While of course we will use it for race applications, it is also meant to be immediately available for road car applications. This target was part of the requirement from day one. That isn't fitted to the car yet, it's the next step, which brings new technology possibilities and also necessities – you have the possibility to apply independent torque values to each of the four wheels, meaning you can accelerate or brake any wheel at any time.

DRIVING THE FUTURE

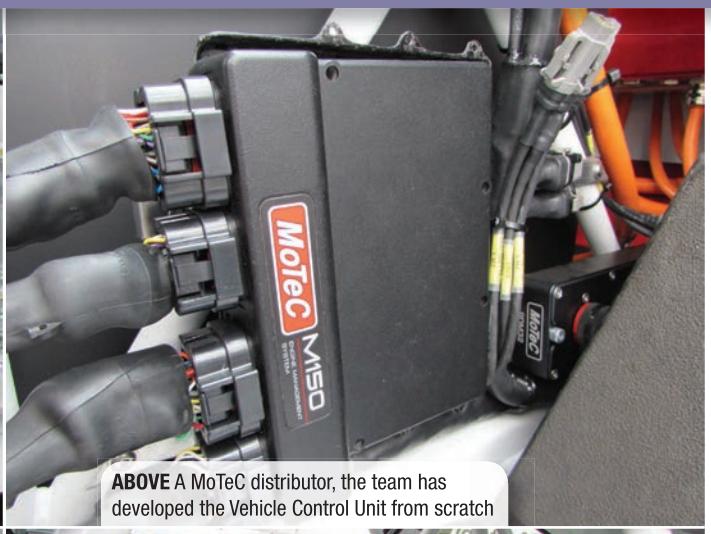
"It's something being developed in other places too, but we don't expect there are many people out there developing such systems for 'very low mu' road conditions. It's an important concept for automotive applications such as autonomous driving and safety systems, like stability control. We see huge potential for very interesting developments, especially on the vehicle dynamics side with things like yaw control. Things get very interesting when you can control the torque of each wheel independently."

The motors and inverters currently used on HIPER are cooled by two parallel lines, one each for front and rear, connected to the ▶

BELOW Peugeot has thrown its support behind VW's call for rallycross organisers to consider permitting electric cars to come on board

FIAWorldRallycross.com

ABOVE The car currently features one motor each axle, but plans are in the pipeline for a motor to power each wheel



ABOVE A MoTeC distributor, the team has developed the Vehicle Control Unit from scratch

ABOVE The batteries are in a 'T' shape, between and behind the crew

ABOVE The roll cage and safety cell remain unaltered in order not to nullify the car's homologation

front-mounted radiator. "Each line passes through the high voltage inverter, which temperature-wise is the most critical part as it heats up most quickly," says Sakowicz. "It's very important to have the water as cold as possible there, as the problematic thing with the inverters is that you have live HV power electronic components which cannot be mixed with water, thus resulting in limited heat transfer values. The lines then run to the motors.

"The heat capacity of the motors is high because of the big mass; they weigh around 79 kilograms, so the temperature rises relatively slowly." The small oil coolers above the front radiator are with individual pumps to cool the oil of the two drivetrains.

As it stands, the car appears like a Super2000 207 externally, but has been modified to accommodate the alternative equipment and also to ensure it reacts in a more appropriate way to the relative performance. "The CV joints and driveline are new developments, especially on the rear axle where the entire drivetrain is integrated into a new rear subframe, explains Sakowicz. "That and the rear kinematics are a totally different design. We have also adapted the suspension system too as the weight distribution is very different to the S2000 (which has about 56/44 to the front).

"We are almost 50/50 exactly, which despite the lower COG combined with a bigger load transfer under full power, results in quite high axle load on the rear. The damper and spring setup have had to be altered completely."

The kinematic principle of the suspension at each corner (McPherson strut with lower A-arm) remains as originally designed by Peugeot Sport. The weight of the car in rally trim remains similar at 1340 kilograms, while in rallycross specification it weighs in at around 1250 kgs. The boot floor has been adapted with the motor sitting higher than the original floor, capped by a pre-preg carbon fibre cover bracket that holds the rear inverter.

BATTERY PACK

The batteries are located between the driver and co-driver, where the propshaft would originally have been housed, although the area has been significantly strengthened for safety, the batteries weighing 161 kgs. "The batteries are in a 'T' shape, between and behind the driver and co-driver," explains Sakowicz. "It was very important for us to not alter the FIA safety cage as it is in the S2000, but just to add a carrying and safety structure for the battery pack."

Rallycross Supercars are renowned for being difficult to launch away from the startline, with choosing the correct rpm for the launch procedure left to the driver. However, the electric version is no less complicated; if anything, it's more so. Using a MoTeC M1 system, STARD has developed the control ▶

HIPER Spec List

Bodyshell	STARD, based on Peugeot 207 S2000
Batteries	STARD
Radiator	STARD
VCU	MoTeC
Dash	MoTeC
Steering wheel	OMP
Pedal box	STARD
Steering rack	Peugeot Sport
Brakes	Brembo
Dampers	Peugeot Sport
Wheels	Speedline/OZ Racing
Tyres	Michelin/Cooper Tires
Seats	OMP
Harnesses	OMP

ABOVE The driver can control the amount of torque he requests from the motors

ABOVE The sneak preview video of the HIPER car in action divided motorsport fans, with many complaining about the lack of noise

system software in-house.

"As a closely-linked MoTeC distributor we have full access to the firmware and have developed a "VCU" (vehicle control unit) software from scratch, including the control of the battery and high voltage system, safety monitoring, torque control, torque split and driver control functions," says Sakowicz.

The translucent yellow switch on the top left of the control panel is the simplest, controlling the drive: forwards, reverse and neutral, much like in an automatic car. The toggle switch on the right is to turn the power on and off, with the keypad below being standard in motorsport terms, with functions for 'comfort' as Sakowicz describes them. As an accomplished engineer, the Austrian is far more interested in the performance of the vehicle than how bright his driver would like the LCD display screen to be: "It gets interesting with the rotary switches at the bottom. The left switch defines the maximum torque; the driver can control the amount of torque he asks from the motors. You can limit the torque in slippery conditions, for instance.

"LIKE AN ACTIVE WRC CAR"

"The blue switch is to control the torque spilt, though here we also have constantly changing programme features, where in the beginning we just had a fixed rate dependant on speed and throttle pedal position and it altered front and rear torque accordingly. It's much more complex now, also taking into account steering and brake position, wheel slip, body movement. These can be altered by the driver – basically how aggressive the torque is on the rear axle, like an active WRC car. The green switch is for changing the ramp, how aggressively the torque reacts to the throttle. The gold switch is for backups or special functions."

The technology implemented into STARD's project is undeniably impressive, and something Sakowicz is clearly proud of. Although he won't be drawn on precise details, the Austrians are in talks with other parties about what they have achieved to date and where they hope to take the project going forward. A major concern like a manufacturer would be foolish not to consider the STARD option if it has even the slightest interest in rally or rallycross EV tech. Much of the hard work is already done here.

"The topics that Volkswagen brought up a few months ago are cruising around in the paddocks," admits Sakowicz. "We know that and we've raised some heads with our project. We've had some discussions, but for the moment nothing is fixed; electric vehicles in rallycross certainly is a delicate and polarising topic. One thing is for sure, the format of the racing and electric power is a perfect match. Our car fully complies to FIA rules, including the RESS (battery system), which means that we are ready should we need to be. Personally I would love to see the competition between electric and conventional: that would be very interesting."

> *"In 0.043 seconds from the torque demand, we reach about 90% of the torque requested"*

Sakowicz is right: running conventional and EV competition vehicles together would indeed be a polarising subject. It would be incredibly difficult to ensure parity, notwithstanding the potentially controversial scenarios if electric technology was to immediately outperform existing highly-developed equipment. At the same time, a straight race between the two would be a technically fascinating prospect.

In a head-to-head fight, Sakowicz believes HIPER would stand a good chance against the established rallycross Supercar order: "I'm very confident from a powertrain side, but there are a lot of details on our chassis which are not tailor-made for rallycross. That means traction and start optimisation, especially with mixed surface conditions. It's an EV powertrain development prototype, which is why the chassis wasn't the focus and is a bit behind current Supercars. But, if say we started today, in a few months we could have a fully electric car that could easily outperform the current conventionally-powered rallycross Supercars. We'd love to take that challenge."

Regardless of which way the sport's governing bodies will evolve regulations in years to come, to include EV or not, STARD is ahead of the trend in a subject that just like in F1 and Formula E, divides opinion for the most rudimentary of reasons. When the firm launched a 'sneak preview' video of HIPER on its Facebook page in early October, the reaction from viewers largely focused on the lack of noise.

"Our project is polarising, we know that," says Sakowicz. "We've had very positive reactions but there are many people who've said that without sound it is killing the fundamentals of motorsport. Here at STARD we are also motorsport passionate people. We love the sound of a V12; we love the Group B cars. But on the other hand technology is changing and, like it or not, it's part of the future.

"The possibilities with an electric motor are incredible: the power density, the capability and controllability are way above the internal combustion engine. And in the end, if mankind ignored new technologies with obvious technical advantages, we'd probably still be riding horses." RT

BELOW New world order: the Tesla Model S, seen here at the championship's Ibiza launch

FROM ZERO TO HERO? ELECTRIC GT IS BORN!

Gimmick or game-changer? **Chris Pickering** quizzes one of the founders of the world's first zero emissions all-electric GT series

SINCE the advent of Formula E – now entering its third season – it almost seems strange to think that electric racing was once regarded as an alien concept. And yet one question remains: With electric road cars now knocking on the door of a range of 300 miles and supercar-scaring performance from the likes of the Tesla Model S, why can't we just race those?

That's exactly what the founders of the Electric GT series asked themselves. Tesla-owning IT entrepreneur Mark Gemmell and professional racing driver Agustín Payá aren't perhaps the typical championship promoters. But in a world where Google is developing cars and Apple is reportedly in talks to buy McLaren, they may very well represent the future.

"It's always good to look at business with fresh eyes," comments Gemmell. "If the automotive industry wanted to create another electric racing series it would already be doing it. You find people like us coming in because that's not happening."

The two co-founders got to know each other a few years ago and began seriously discussing the possibility of an electric GT championship in the spring of 2015. Payá already has considerable form in the world of electric motorsport, having used battery-powered vehicles in everything from stage rallying to ice racing. He's even taken on the Dakar Rally in the only all-electric vehicle ever to do so, the aptly-named Acciona 100% Ecopowered.

Clearly, Formula E is something of a benchmark for the new series, but its creators have set out to do things a little differently. The series will kick off next summer, with 20 identical track-prepared Tesla saloons. These will be run by 10 international teams and driven by professional drivers with a diverse range of backgrounds. British IndyCar driver Stefan Wilson has been confirmed, alongside GP3 racer Vicky Piria, former F1 test driver Dani Clos, plus NASCAR racer and environmental activist Leilani Münter.

Not only will they be using production-based cars with a relatively mild degree of modification, but they plan to race on conventional circuits. The championship will call at seven European venues, including the Nürburgring, Paul Ricard and Barcelona. There are also plans to hold three non-championship events in the Americas.

Each race weekend will consist of a 20-minute practice session, a 30-minute qualifying session, a day race (60 km) and a dusk race (60 km) with recharging periods in between. The events are billed as 'a weekend-long festival of technology and innovation for sustainability'. ▶

"By using purpose-built motorsport venues rather than temporary street circuits you can reduce your costs greatly and you can take advantage of the infrastructure and public access they provide," says Gemmell. "It would be fantastic to take the championship to somewhere like Long Beach or Monaco. For that matter, it would be good to set up our own circuits like Formula E does, but you need deep pockets for that."

Another factor to consider, he points out, is safety. Even with weight reduction measures in place, the Electric GT-spec Tesla Model S is three quarters of a tonne heavier than a Formula E car and should reach a comparable top speed. That means there's a lot more energy to dissipate, so gravel traps and larger run off areas might come in handy.

SPRINT FORMAT

The relative energy densities of liquid fuel and lithium ion batteries still prevent electric vehicles from expending anything like the same amount of energy as their IC-engined counterparts on track. Essentially that gives race organises the choice of two options: go slower or go shorter.

That may sound rather bleak, but Gemmell sees no problem with running a series of short, sprint races: "I think the appetite for long races is waning. As far as putting on a spectacle is concerned, we're aiming for a similar duration to something like the DTM. There the racing lasts for roughly half an hour in most formats – we will maybe concede some range to that but we won't be far off. The perception we've got is that most of the public simply don't want to sit for much longer than that watching a race." ▶

ABOVE & BELOW Work has focused on safety and weight reduction. The safety gear, including the race seats and harnesses, is provided by series partner OMP

> *"A weekend-long festival of technology and innovation for sustainability"*

ABOVE Campos Racing created an adjustable rear wing as part of an aerodynamics package that certainly looks the part

ABOVE Payá is the only man to have taken on the challenge of the Dakar Rally in an all-electric vehicle

Tests have reportedly shown that Electric GT's Tesla Model S development car is capable of running at racing speeds for more than 30 minutes. Gemmell concedes that this may depend on driving style to a certain extent, but he expects most drivers would be able to complete the race with around 20 per cent charge remaining.

There are no plans to include car swaps or mandatory pit stops, although the pit lane will be open to change from slicks to wets if the heavens open.

Gemmell says he's not against the idea of a strategic element and in fact he's considering some pretty radical options: "Pit stops can add to the spectacle and they bring the whole team into the equation. If we could get approval from the FIA and the teams to artificially wet the tracks – possibly under fan request – that's something we'd look at."

He has no intention of following Formula E's FanBoost system, he says: "I'm in two minds about that. I think it was a good thing to try in Formula E, but it's not one of the features we'd seek to emulate. There are some similar ideas that we're exploring, but it's early days yet."

Fans will be able to stream races via Periscope, Twitch and YouTube, as well as interacting directly with the teams using social media platforms, Gemmell explains: "It's important to engage younger fans. Streaming will be one aspect of that, alongside social engagement and perhaps tie-ins with gaming platforms. I think that's something that a lot of sporting events will be embracing over the next few years."

Uniquely, however, this will be a two-way link. The cars will be connected to the web and they will retain the giant central touchscreen system found in Tesla's road cars.

"We want to give the driver some sensation that the audience is cheering them on," says Gemmell. "It's a new opportunity to have a big screen in front of them and we're open to ways we could exploit that."

LUDICROUS MODE

Testing has so far centred on the now-discontinued P85+ variant of the Tesla Model S. This uses a single 350 kW (470 hp) electric motor driving the rear wheels with a 310 kW (416 hp) battery pack. It can store up to 85 kWh on a full charge, hence the P85 tag (the 'plus', in case anyone's wondering, is essentially a sports pack applied to the production car, which doesn't alter the power output).

In standard form, the P85+ is good for 0 to 60 mph in 4.2 seconds with an electronically-limited top speed of 130 mph (210 kph). Electric GT's tweaks have raised the limiter slightly to 220 kph (138 mph) and the 0 to 60 mph sprint is now estimated at around three seconds.

Gemmell and his colleagues chose the P85+ because it was the fastest Model S available in rear-wheel drive. The thinking was that this would make the racing more spectacular for drivers and spectators alike, but Tesla now appears to be moving towards four-wheel drive for its higher powered models, which presents something of a dilemma.

"Our conversations with Tesla are ongoing about this," Gemmell admits. "If we could continue to get hold of the P85+ we would use them, but Tesla is moving more towards the four-wheel drive versions and it's vital that we showcase the best technology out there." ▶

ABOVE The success of Formula E, which kicked off its third season in Hong Kong, has proved an inspiration for the GT series

FIA/Formula E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ABOVE The car features a prominent front splitter and a number of new cooling vents around the wheel arches

Tesla's latest model, the P100DL, comes with a 100 kWh battery, which would offer a useful increase in performance and range. Converting this to two-wheel drive goes somewhat against the series' ethos of using standard powertrain equipment, however. There are also practical challenges to consider, like how to send the increased power to a single rear motor without frying it.

"Suspension tuning and weight reduction is relatively easy, but making any changes to the powertrain opens up a big can of worms on any electric car," he says. "We're keen to stick with a production powertrain as much as possible. We certainly wouldn't rule out four-wheel drive – perhaps with more of a rearward bias – if that looked like the way to go."

The fact that such fundamental decisions are still open to debate may ring alarm bells. In practice, though, it doesn't come across as arrogance or naivety, but simply the relaxed confidence that comes from working within the ever-shifting boundaries of the digital world. It's faintly reminiscent of Tesla founder Elon Musk, who has an impressive (if somewhat hit and miss) history of turning sci-fi schemes into reality.

BEHIND THE SCENES

Behind the vision, there is also reassuring substance to the Electric GT championship. The development work has been carried out by the series' technical partner Campos Racing. Based in Montmeló, just down the road from the Barcelona-Catalunya grand prix circuit, the company brings a wealth of experience to the project from time spent in Formula 1, the World Touring Car Championship and Formula E.

So far, work has largely focused on safety and weight reduction. The Model S's immensely strong 'Skateboard' chassis remains the backbone of the car. It's a combination of aluminium stampings, castings and extrusions, which is almost completely flat between the axles (hence the nickname).

An FIA-approved roll cage provides additional stiffness and protection, while the rest of the safety gear, including a plumbed-in fire extinguisher, race seats and safety harness come from OMP. There's also an FIA-approved battery isolator, with a warning light system which signals if the car is safe for the driver or marshals to handle in the event of an accident.

Aside from simply stripping the road car of all unnecessary equipment, the aluminium body panels have been replaced with carbon fibre. They've also been sculpted to fit over the new, wider wheels – 18-inch OZ Racing aluminium items shod with 265 mm tyres on the front and 305 mm on the back. In total, nearly half a tonne has been shed from the 2,087 kg kerb weight of the road-going P85+, taking it down to 1,627 kg. It's worth bearing in mind that some 534 kg of the remaining mass comes from the batteries alone.

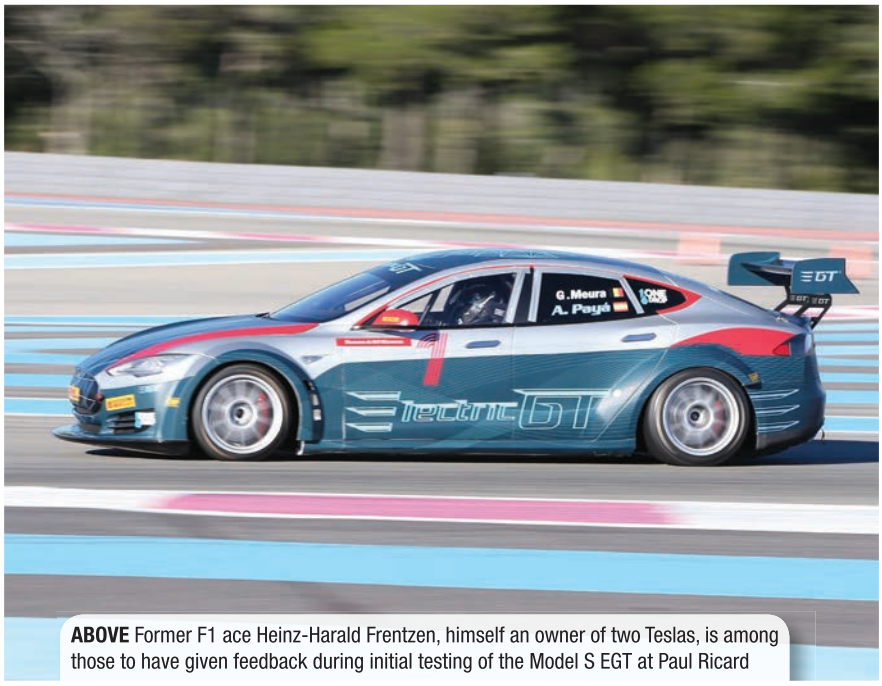
"We were pleasantly surprised how much weight we could remove without changing any of the fundamentals," says Gemmell. "We could probably go further, but we want to remain faithful to the production car as much as possible."

The development car began life with Tesla's optional air suspension system, but this has been replaced by a pushrod-operated spring and damper arrangement developed in-house by Campos. It now uses fabricated steel wishbones, providing adjustment for ride height, camber and toe.

The job of developing tyres for this rather

> *"A platform for anyone who thinks they've produced a Tesla-killer to come and demonstrate their mettle"*

unusual machine falls to Pirelli, which was announced as an official partner to the series earlier this year. It's believed to be the first time that racing tyres have been developed specifically for an electric GT car. They're said to take inspiration from the tyres used in the GT3 series, although even the Bentleys and V12 Astons are some way short of the Tesla's mass. That's also going to provide a challenge for the braking system too, which uses a dual circuit hydraulic setup from Brembo, alongside the Tesla's energy recovery system.



ABOVE Former F1 ace Heinz-Harald Frentzen, himself an owner of two Teslas, is among those to have given feedback during initial testing of the Model S EGT at Paul Ricard

The Model S certainly now looks the part. Campos has gone to work on the aerodynamics, creating a prominent front splitter and an adjustable rear wing. It's also sprouted a number of new cooling vents around the front end and the wheel arches.

With so much electrical power, it's particularly important to keep the batteries and electronics cool. Several independent attempts to set a lap time at the Nürburgring Nordschleife using privately-owned production-spec Teslas have resulted in the cars de-rating due to temperature issues. (Even so, one apparently set a Bridge to Gantry time of 8:50 with an amateur driver on an open track.)

"Agustin's experience in the Dakar Rally, where temperatures hit over 50 deg C, has stood us in good stead with the cooling," says Gemmell. "One of the benefits of removing a lot of the inner fittings is that you can re-route the air and you've got plenty of freedom to change the design of the system.

"We can improve it further if needed, but I don't think it's an issue if the car requires a degree of thermal management. That's going to be part of the skill – a bit like the pioneering days of motor racing in the '20s and '30s when the cars did sometimes require a bit of nurturing."

Although the series is not officially factory-backed, it has had input from Tesla's engineering team in the US, including advice on pumps, radiator sizes and cooling fluids. Electric GT is also understood to be working on electronics and software with engineers from the company's European assembly at Tilburg in the Netherlands.

TESTING TIMES

Testing is already well underway. An early evolution of the Electric GT-spec Tesla reportedly set times of 1:53:15 at Jarama and 1:55:87 at Barcelona. For comparison, the Spanish version of *Car and Driver* set an almost identical lap time with an E46 BMW M3 road car when it visited Jarama in 2002. While that may be somewhat behind what you'd expect of a conventional slick-shod touring car, it should prove fast enough to generate excitement with a field of identical machines all jostling for position.

"I think the cars will surprise people," says Gemmell. "Pirelli is supplying acres of rubber and the Model S has an extremely low centre of gravity, with virtually perfect weight distribution, so the cornering is impressive. Where they struggle a little bit at the moment is top speed, but we're planning to use the twistier variants of the circuits we visit and the lap times should be very competitive."

Electric vehicle technology is evolving at a phenomenal rate, he points out: "We're going to see energy density going up, weight going down and power electronics that can deliver multiple megawatts (1,300+ hp). Before long we expect the lap times to beat that of comparable combustion engined cars – perhaps as early as the second season."

And that, perhaps, is where the plans for the Electric GT series get really interesting. As soon as it's practical to do so, Gemmell and his colleagues say they plan to open the championship up to other electric vehicles.

"The limiting factor at the moment is simply that the Tesla is the only high-performance electric car sold in any numbers, but I think that will change soon," he says. "Any new additions would have to be production vehicles, though, as that's an important aspect of this championship. It'll be a platform for anyone who thinks they've produced a Tesla-killer to come and demonstrate their mettle."

Quite how any performance balancing system would work remains to be seen. Gemmell admits this would be a challenge, but says they'd plan to go with a simple system based on factors like power to weight ratio and tyre dimensions.

In the meantime, the team is about to embark on an intensive series of tests at Paul Ricard, focusing on tyre development and durability. It's one of the more down to earth aspects of a project that currently poses almost as many questions as it answers. But there again, that's what electric racing is all about at the moment. Nobody really knew if Formula E would work until Alejandro Agag and his colleagues decided to stick their neck out. With a bit of luck, Electric GT could be about to follow.

From Le Mans to Lydden... INNOVATION TRIUMPHS

William Kimberley reveals the contenders nominated for *Race Tech*'s coveted technical awards, to be presented at this month's World Motorsport Symposium

IT'S that time of year when we consider what has caught the eye over the 2016 racing season in terms of powertrain and aerodynamics. It is all too easy to be fixated on the higher echelons of the sport, but there is a great deal happening in terms of innovation and lateral thinking in all areas which is reflected in this year's shortlist.

RACE ENGINE DESIGNER OF THE YEAR

Ford Performance/RoushYates shortlisted for the Ford GT

FORD made a bold statement when it announced that it had developed a V6 engine for endurance racing. Initially it was seen in Daytona Prototypes in the US, but this year it made the leap into the manufacturer's GT cars in both IMSA and the World Endurance Championship, powering the GTs.

Due to the Balance of Performance regulations it has not had it all its own way in either championship, but it did win the most important race of the year, the Le Mans 24 Hours, celebrating the Blue Oval's 50th anniversary victory in the process.

Working with its engine partner RoushYates, a mid-engine design was decided from the very start of the programme, as was the choice to use the twin-turbocharged 3.5-litre V6 EcoBoost engine as it endorsed Ford's global message with this family of engines.

The block and heads were production castings while a number of the valvetrain components were also shared with the road car. However, the racing engines used a bespoke cam drive as the variable valve timing used in the production engine is outlawed in GTE and GTLM; there was a slight revision to that used on the Daytona Prototype engine, even if the profiles were very similar.

Ford

ABOVE Fuji victory capped a memorable return to the world stage for Ford, which is nominated for both awards

"We effectively used the DP engine as a base, refining it to make it lighter and more responsive," says Dave Simon, lead engineer for engine development and Ford Performance. "There were some packaging differences, coming from the Riley chassis of the DP, which meant we had to change a number of things to fit, but it's really an evolution of the same unit."

However, while the road car uses a mixture of port and direct injection, the GTE engine is pure direct injection. To make this possible, Ford runs two high-pressure Bosch Motorsport fuel injection pumps feeding standard Bosch injectors. Elsewhere much of the development work focused on the reciprocating assembly and the induction system. Part of that was driven by necessity, with the packaging of the GTE car requiring substantial changes to the intake manifolds, while the turbocharger is completely different.

While Ford has lagged behind Ferrari and Aston Martin in the FIA World Endurance Cup for GT Manufacturers – despite its Le Mans win, followed by a 1-2 victory later in the season at Fuji – the car and powertrain development had done enough to catch the jury's eye.

Team Dynamics/Neil Brown Engineering for the Honda BTCC engine

THE Subaru Levorg's powerplant might have grabbed many of the headlines but it was another engine new to the British Touring Car Championship, in Team Dynamics' Honda Civic Type-R, that captured the title.

Where the flat-four Boxer configuration that Mountune developed for Team BMR is familiar technology, the Honda, introduced at the start of the year, is not. "The biggest difference between the old Honda redtop engine, the K20-A, and the K20-C is the new engine has an integrated exhaust manifold, which means it has no separate exhaust manifold," explains Team Dynamics technical director Barry Plowman. "All the ports in the head join in to one and the exhaust pipe will just go straight on to that, whereas the old engine would have an exhaust manifold. There's improvements in some areas and not in others; it's very much swings and roundabouts."

The project, conducted by Neil Brown Engineering, was technically challenging, not least because it involved dissipating the extra heat created in the cylinder head and passed into the water system of the four-cylinder, 16-valve engine.

The cooling package was increased pre- ▶

ABOVE The K20-C's integrated exhaust manifold posed technical challenges

season and PWR developed a special radiator core for the purpose, but Plowman says adapting the road car technology for the demands of motorsport is still work in progress: "In a road scenario you aren't looking to cool both the water and charge temperature at the same time; if the charge temperature went up 10 degrees, would the man on the street notice it? For us, those temperatures are critical. It sounds bizarre, but even an increase of two or three degrees, when running in traffic for instance, can harm performance."

There were initial teething problems with the unit, but not sufficient to prevent defending champion Gordon Shedden hitting the ground running with a win at the first meeting. Nevertheless, a lean spell and some bad luck meant that he was languishing ninth at the midway point of the season.

Three wins and four podiums in the second half of the campaign clawed back the deficit to BMW's Sam Tordoff, setting up a thrilling title finale at Brands Hatch in which Shedden prevailed by just two points. In so doing, he became the first man to successfully defend his crown since Fabrizio Giovanardi in 2008.

EKS and Lehmann for the WRX-winning engine

IN only its third year of World Rallycross Championship competition, Mattias Ekstrom's EKS Audi S1 propelled the DTM title-winning Swede to the World RX crown with four victories before the penultimate round. As Race Tech goes to print, EKS also leads the Teams' Championship ahead of the season finale.

EKS's Audi S1 quattro is powered by a two-litre four-cylinder turbocharged engine, built by Lichtenstein-based tuner Lehmann. It is a brand synonymous with Audi competition engines, with rallycross success dating back to the early Quattro S1s raced by Olle Arnesson and Sven Lestander in the 1980s.

While rallycross teams are coy about exact figures, Supercar engines produce in the region of 600 bhp and 800 Nm torque. The EKS Audi utilises a sophisticated Bosch ALS (anti-lag) system that means the car can accelerate to 60 mph in approximately 2.0 seconds, driving all four wheels. A rear-mounted radiator allows for the largest possible intercooler to be fitted to the front of the car, with an FIA-regulation 45 mm restrictor in the turbo.

The base engine, which is mounted transversely in the Audi's chassis, is based on a cast-iron block from the Audi range and is similar to that used by other Volkswagen-Audi competition cars in recent times, but is privately funded by Ekstrom's team. The current spread of events in the World RX calendar means that engines have to feature ample high-end power for the faster circuits, but still maintain low end torque for the slow, often loose-surface corners. With door-to-door quick-fire racing on sealed and unsealed surfaces, drivability is key to success with a World RX motor, which coupled with good reliability has been a factor in Ekstrom's FIA World title success in 2016.

BELOW Drivability is key to the Lehmann engine's success

EKS

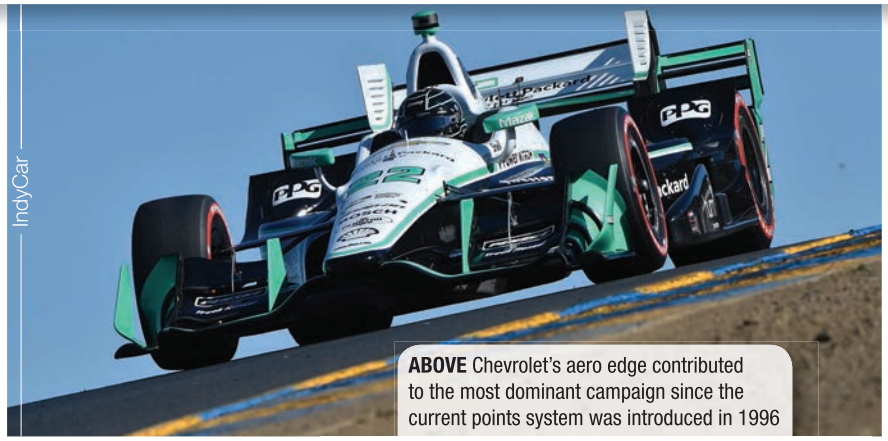
The Dino Toso award for the RACECAR AERODYNAMICIST OF THE YEAR

Ford/Multimatic nominated for the Ford GT

THE Ford GT aero development was a jont effort led by Multimatic's Mark Handford and Ford Performance's Bernie Marcus; Multimatic's Peter Gibbons also played a massively important role to ensure that the car remained good looking while having some theme of the original GT in it.

Designed as a mid-engined car from the start, it meant that the aero and styling teams could focus on the car's frontal area – and in particular the greenhouse volume – which tends to be smaller for mid-engined cars, leading to reduced drag. The narrow cockpit profile was part of a teardrop-shaped fuselage that tapered almost to a point at the rear. One of the most striking elements of this futuristic design were the twin sidepods housing the rear wheels. Following current LMP practice, the bodywork reduces to almost nothing between the fuselage and the sidepods, carving out a deep pair of channels.

As commented by George Howard-Chappell, the Ford GT programme manager for Multimatic, "The guys in the studio did a fabulous job of making something that works aerodynamically, is beautiful and you can see the old car in it. At the same time, everything that was done on the car – every curve, every shape, every circle – has been done with the intent of reducing drag and ▶


IndyCar

ABOVE Chevrolet's aero edge contributed to the most dominant campaign since the current points system was introduced in 1996

improving fownforce."

The 40 per cent modellng was done at ARC in Indianapolis led by Marcus while Handford and his team did a huge amount of CFD work, the two sides working hand-in-hand to finesse the shape and lines. The next stages were full-scale wind tunnel tests at the Ganassi Laurel Hill underground facility in Pennsylvania and also at Windshear in North Carolina, followed by a lot of track testing. Then there was a massive programme to examine how all of that correlated.

According to Larry Holt, Multimatic's vice president of engineering, the aerodynamic lessons learnt from the car are being proliferated across the production car range as aerodynamic efficency is a Ford theme.

Pratt & Miller for the Chevrolet IndyCar aero kit

EVEN if it did not win the jewel in the crown, the Indy 500, 2016 will still go down as a truly dominant year for Chevrolet in the Verizon IndyCar series. Its cars won 14 of the 16 races, notched up 13 pole positions and led 71 per cent of the race laps. While champion Simon Pagenaud and Team Penske were the driver and team to beat, the combination winning a series-best five races and seven Verizon P1 awards, a very significant factor was the aero kit that had been developed for Chevrolet by Pratt & Miller.

At the end of the 2015 season, the Chevy and Honda aero kits were tested in the Windshear full-size wind tunnel with cars supplied by teams in six configurations: high downforce road track; low downforce road track; Indy race; Indy qualifying; and two intermediate Indy trims. While Honda left no stone unturned to give the teams the best overall package, Chevrolet still had the upper hand on the road tracks and short ovals.

The kit was developed using CFD, 50 per cent wind tunnel testing and track testing. "We used an optimal blend of these tools and that differs depending on what type of car and the scale of the project," says Arron Melvin, chief aerodynamicist at Pratt & Miller who was responsible for developing the kits. "We are all about efficiency, not just aerodynamic lift to drag ratio, but how we convert money into lap time."

Melvin was also part of the team that comprised Dallara's Alex Timmerrmans and IndyCar's Tino Belli in applying the NASCAR roof flap concept to the IndyCar rear 'beam' – the lower mainplane tied in with the aerodynamics of the under wing diffuser – that would be deployed on a spinning car. Wind tunnel tests showed that 500 lb of extra downforce and 650 lb of drag would help more quickly bring the car under control and stop it from coming airborne. Along with Timmerrmans and Belli, Melvin won the prestigious Louis Schwitzer award at this year's Indianapolis 500.

Mercedes AMG Petronas Formula 1 Team

A PREVIOUS winner of the Dino Toso award, Mike Elliot, head of aero at the Mercedes AMG Petronas F1 squad, and his aero team have not relented in their quest to be the best.

While this year's cars may at first glance appear to have followed the same philosophy as every other team on the grid, the devil was in the detail and they were quite different, as noted bv Craig Scarborough in his article 'Diminishing Returns' in the October issue of *Race Tech*.

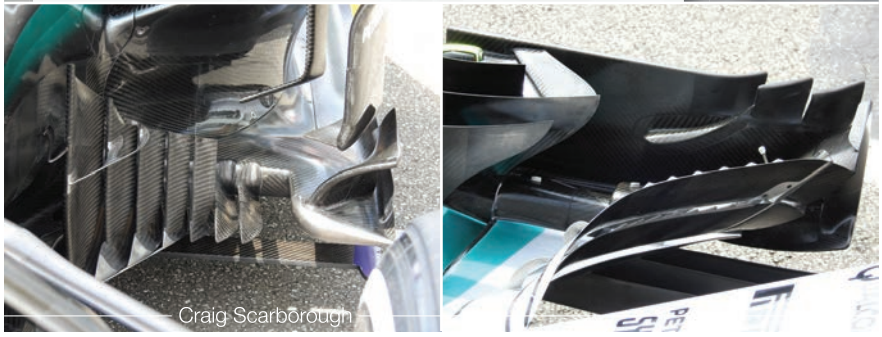
He wrote that the cars were shorter, which promoted a slightly different flow structure compared to rivals, and that the W07 did not have the complex wing mounts, the sticking-out nose tip, but that it was rather kept slim and streamlined, the wing mounts being short and simple. This meant that the divergent airflow wasn't started at the nose but begun further downstream, being turned later and more aggressively by complex multipart turning vanes and bargeboards, a small but critical difference, allowing a shorter car and relying far more on harder-worked aero surfaces.

Scarborough noted that this complex aero philosophy extended to many areas of the car: the front and rear wings' serrated trailing edges; the bargeboards broken up to 13 separate aero surfaces; and the front wing endplate split into three vane-like surfaces.

Despite its dominance, the team continued to push hard with its in-season development, even the front inboard hydraulic heave element being changed mid-season. With this level of progress, the car remained far quicker around a single lap than its rivals and it is for this that Elliot and the aero team have been shortlisted for this award. RT


Daimler

ABOVE & BELOW Mercedes fought hard to maintain the W07's advantage, introducing the likes of its complex turning vanes and serrated wings (below)


Craig Scarborough

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The secret is out!

How do you develop a winning formula? Precision Technologies International holds the key to one of F1's best kept secrets. **Sophie Williamson-Stothert** reports

BEFORE MD Kevin Parkin took over the reins of Precision Technologies International, its identity was a closely guarded secret, known only to a select and blue ribbon customer base.

An experienced turnaround specialist with an impressive track record of success, Parkin said he knew instinctively that he had found a hidden jewel; a business that produces "high precision products" for the most demanding of clients, including major championship-winning teams across the world.

Founded in 1960, the company, based at the heart of the UK's manufacturing region in Tamworth, Staffordshire, is run by experienced, highly-skilled engineers who specialise in resolving complex problems using a wide variety of sophisticated equipment and advanced metrology, which enables the firm to produce and measure products to extreme degrees of accuracy.

Parkin is a Freeman of the Company of Cutlers and has a background in metallurgy. As you might expect of a proud son of Sheffield, he was quick to realise that Precision Technologies International needed to be brought to the attention of a much wider audience, and one that would gain value from such an advanced set of skills.

One of his first tasks was to approach Chris Aylett, CEO of the Motorsport Industries Association (MIA), which offers support for British SME's striving to grow in this challenging sector. Aylett and fellow committee member Alistair Fergusson, managing director of near neighbours Alcon Components Ltd, jumped at the invitation to visit the Precision Technologies factory in Tamworth.

ABOVE Chris Aylett, CEO of the MIA, congratulating the directors of Precision Technologies Ltd on the reveal of their new corporate logo. Left to right: Kevin Parkin (MD), Patrick Walker (technical director), and Colin Palin (technical sales director).

Aylett gave the company a ringing endorsement: "Keeping World Championship-level customers happy in the unrelenting, demanding world of motorsport engineering is hard-won, and the very best accreditation the company can achieve.

"I was privileged to unveil the new brand identity for Precision Technologies and to witness the extensive changes that the new leadership team is implementing at this great British engineering company."

Alistair Fergusson from Alcon was equally impressed in what he saw, stating that "the quality of what they achieve through a clever blend of craftsmanship and modern techniques, together with the focus on customer response is clear; I have no doubt that under the newly revitalised senior team the company will flourish."

> *"Its identity was a closely guarded secret"*

In the coming months, Precision Technologies aims to build upon the success it has already achieved with some selective clients, while also seeking new customers in Europe and, in due course, the USA.

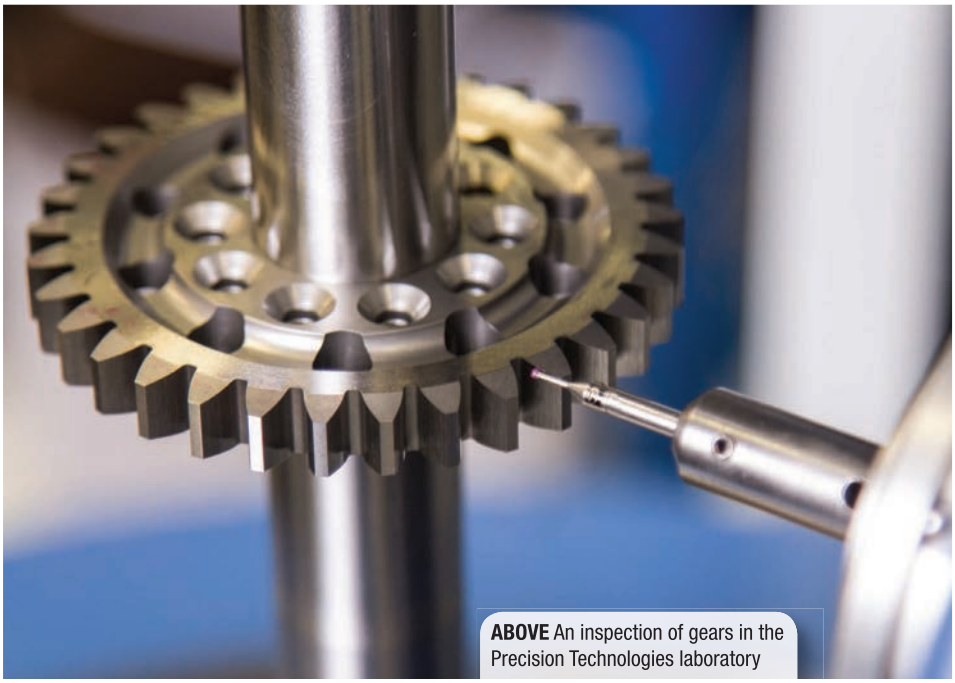
Parkin has other priorities in mind, too. He plans to continue developing the skillset of the Precision Technologies team, in order to bring in fresh young blood who can formally learn at the feet of the masters.

The plan is to form a world class graduate apprentice scheme focusing on a blend of formal engineering tuition and hands-on experience to ensure the continuation of the high skill levels required.

"Too many talented young people do not consider the apprentice route," explained Parkin. "Yet apprenticeships offer a debt-free alternative to University with a guaranteed income and the opportunity to learn practical, professionally marketable skills which will be theirs for life."

As a passionate believer in engaging with seats of learning, Parkin has established strong links to the university research departments in Sheffield and Warwick and explained how he "can see fantastic opportunities for this great British company.

"This country is rediscovering its proud engineering roots and we need to realise that wealth generation has to be across the board and not just in the City of London". RT



ABOVE An inspection of gears in the Precision Technologies laboratory

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Variohm EuroSensor adds "puck and magnet" option to range

VARIOHM EuroSensor, one of the UK's leading sensor manufacturers and distributors, has added a "puck and magnet" option to its Euro-X programmable angle sensor range.

The new Euro-XPK is a fully non-contacting, two-part design, consisting of a high-accuracy Hall Effect sensor element. This is encapsulated in a high-grade sealed plastic housing and a separate magnet, available in three size options.

The 38 mm PCD radial slot mounting, and the magnet offset tolerance of +/- 3 mm, allows generous installation flexibility. Meanwhile, the overall compact design – with sensor thickness less than 8 mm – allows use in very space restricted areas.

With no bearings or mechanical coupling and a minimum IP68 environmental rating plus IEC 60068-2-6 vibration resistance, the robust sensor's working life is specified in excess of 100 million cycles. The Euro-XPK adds more flexibility to the Euro XP series, which is also available as housed shafted/bearing versions in aluminium or high-grade plastic or as a non-contacting D-shaft option.

Throughout the Euro-XP range, the specification includes dual-redundant factory programmed angles from 20 to 360 degrees in 10-degree steps, with a ratiometric output from a 5V DC supply (+/- 0.5V) for both measurement range and characteristic curve. The absolute output does not require position resetting after power loss or start-up. Independent linearity is specified at +/- 0.5% of the signal range, and repeatability is up to 0.2%.

Aimed at motorsport, construction and agricultural angle sensing applications such as steering, sequential gearbox and throttle, the Euro XP series also suits industrial high duty cycle angle sensing for harsh environments.

Magnet options for the Euro-XPK include small and large rectangular designs as well as an encapsulated M10 bolt version. The puck sensor may also be supplied separately for use with the customer's own magnet design preference. Standard versions are supplied with cable connection but custom options with connectors, or with adapted mountings etc are available on request.

Variohm EuroSensor manufactures the complete Euro XP product range and can ship fully programmed models within 24 hours of order receipt. RT

ABOVE Euro-XPK Puck: The robust sensor's working life is specified as in excess of 100 million cycles

Lentus Composites develops new propshaft range

COMPOSITES expert Lentus Composites has developed a new range of CFRP propshafts in tandem with its flexible drive couplings.

With a particular focus placed on fatigue performance, the company specialises in composite sleeves used on motors, generators and flywheels.

The filament wound CFRP accumulators and pressure vessels are manufactured around short turnaround times while still offering healthy weight savings.

Typical applications of the new line-up include Super GT, DTM and FIA GT categories. RT

Driven markets new power steering fluid

ANGLO American Oil's Driven Racing Oil has released a new high temperature power steering fluid that is still able to maintain good flow at low temperatures.

The power steering fluid is a specially formulated synthetic substance that resists high temperature foam and enables improved steering precision.

Despite its ability to maintain low temperature flow performance, the fluid has a high viscosity index that ensures consistent flow behaviour at extremely high temperatures. RT

Turning up the heat

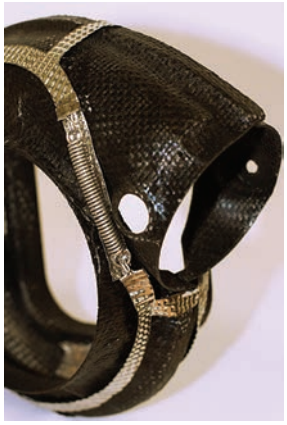
SS TUBE Technology (SSTT) has introduced a composite insulation product that is able to maintain performance for a sustained period of time in harsh 1000 degrees Celsius environments.

CeramicLite is a ceramic matrix composite material that is primarily available as a lightweight heat shield and insulator, without sacrificing any thermal performance.

A multitude of CeramicLite materials have been made available, each tailored to cater for different requirements such as weight reduction or thermal loading. Applications include, but are not limited to, protection of epoxy composite components, standalone heat deflection or heat retention applications.

CeramicLite materials can be manufactured quickly and cost effectively with conventional composite manufacturing techniques at the heart of the CeramicLite manufacturing process.

The SSTT development engineering team is able to assist customers in applying CeramicLite by developing bespoke installation solutions. RT



LEFT CeramicLite is a ceramic matrix composite material that is primarily available as a lightweight heat shield and insulator

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BOOM TO BUST!

Sergio Rinland says Audi's WEC exit raises an old problem for sportscar racing

ABOVE Audi's withdrawal deprives the WEC not only of two entries, but its driving force

SPORTSCAR racing has always lurched from boom to bust, without finding a stable platform.

We wrote a few issues ago what we thought ought to be done with the regulations to entice privateers to venture into LMP1 Lite (no hybrid system) but it seems it was too little, too late. Now the leading privateer, Rebellion, has stepped down to LMP2. Worse still, Audi – the driving force of the series and champion of revolutionary diesel technology – is pulling out. It's a blow.

Not so long ago, LMP1 was hailed as the most advanced racing series, even above F1. It was introducing new technologies, which subsequently find their way into production cars, and had fantastic racing. So how did we come to this? Governing bodies have the bad habit, historically, of underestimating competitors from both a technical and political point of view.

If we go back to the 1960s, the governing body (then CSI, today FIA) realised the performance of Group 6 prototypes (Ferrari 330 P4 plus Ford GT40 and Mk IV with 7-litre engines) was getting out of hand. So they decided to change the rules, limiting engine capacity to 3 litres, the same as Formula 1, in the hope that manufacturers building F1 engines would also be enticed to enter endurance racing.

But in their wisdom – and to protect the many privateers who had Ford GT40s and Lola T70s with production-derived 5-litre engines – the CSI decided to accept Group 4 cars of which a minimum of 50 units had to be manufactured. However, after some deliberations (and not many cars on the grid), they reduced that to 25 units. In so doing, they opened a 'Pandora's Box', underestimating Porsche and Ferrari who built 25 prototypes of their new 917 and 512 respectively, homologated under Group 4.

Goes without saying that the performance of those beautiful prototypes was way over whatever the 7-litre Ford Mk IVs were achieving! Therefore, after only two years, those were banned and only 3-litre engines were allowed with no restriction on units produced (called Group 5). That was the end of the golden era of world endurance racing.

What followed were three years of beautiful 3-litre banquettes (Ferrari 312, Alfa Romeo 33, Matra 670) and then six seasons of heavily tuned and modified sports cars (Porsche 935, Lancia Beta, Ferrari Daytona and others) until 1982. This was the first 'bust' of sportscar racing, where gradually manufacturers lost interest.

A new golden era was predicted in 1982 with the creation of the Group C regulations, which again attracted manufacturers such as Porsche, Jaguar, Mercedes-Benz, Nissan, Toyota, Mazda, Aston Martin and Peugeot. And golden it was: huge crowds and oversubscribed entries put even F1 in the shadows.

When the FIA intervened again, it created another 'bust' by limiting engines to 3.5 litres, the same as F1 again. As cynics had predicted, Mercedes and Peugeot opted for F1 instead, with the total collapse of the WSC in 1993.

This situation where the FIA would create and dissolve championships for GT and prototypes would continue until 2003 when the Automobile Club de l'Ouest (ACO) took the reins of sportscar racing, prompting another 'boom' with the creation of LMP1. This has attracted manufacturers and privateers with well balanced regulations where teams could compete with a realistic chance of success in both Europe and the USA, at classic racetracks, if budgets allowed. Those years saw Audi, Peugeot, Dome, Pescarolo, Courage, Epsilon and many others mix with well-subscribed LMP2 and GT ranks.

But, because good things cannot last, in 2012 the FIA decided to intervene again. The WEC that it forged adopted what the ACO and IMSA were running so successfully. By mandating a World Championship where teams had to attend races around the globe, costs escalated beyond privateers' budgets. On top of that, LMP1 was divided into LMP1H (Hybrid) and LMP1L (Lite) where the privateers did not have even a theoretical chance to compete. To complete the 'recipe for disaster', LMP2 will be from 2017 a controlled formula not dissimilar to GP2 or GP3. Is this the beginning of the end of LMP1 as we know it? Another 'bust'? RT

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