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– so why does this car divide opinion?

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GEN3

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– so why does this car divide opinion?



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ELECTRIC RACING? THAT WILL NEVER LAST!

THERE is so very much to admire about Formula E's new Gen3 racecar. But there is an elephant in the room... And it's an ugly one.

When the wraps first came off the car, it made for a 'Do not adjust your TV set' moment. There was no escaping the fact that the more you examined those angled front wing endplates (inset), the more certain you became that an unhappy test driver had emerged from the prototype, kicked the front wing in disgust and stalked away from the bent item!

The reaction to the new car on social media was certainly a lively one. I didn't even realise there was a vomit emoji until the Gen3 was launched.

The publicity material suggested the car's striking looks had been inspired by the design of a fighter jet. Consensus among fans was that it was more akin to a paper dart aeroplane than a fighter jet.

Maybe that response was merely a case of mission accomplished? After all, the intention was to provoke a reaction, to challenge the conventional. Why else choose Monte Carlo, so steeped in motorsport history, for the launch of a car that flouted that tradition!

The reality is that for a generation of engineers and fans alike, the term 'electric racing' referred only to those beloved Scalextric sets. Formula E represented an unwanted imposter that would surely flicker



and die faster than you could type the words "range anxiety"?

Those early cars *were* crude, their credibility undermined by the limitations of the battery technology. It meant race fans used to split-second pitstops were instead now subjected to whole car swaps mid-race, in order to make the distance. This was surely a joke?

Eight seasons on, nobody is laughing. Back then, we couldn't have dreamed of the EV performance the Gen3 cars will offer, never mind the sustainability credentials that underpin the new design. To go from initially being unable to complete a whole race distance in Gen1, to soon having the ability to produce 40% of a race's energy usage through regenerative braking alone, is a remarkable feat. And there's more to come.

The look of the Gen3 could easily be changed. If not, we'd better get used to it. Because electric racing is here to stay. **RT**



Mark Skewis
CONSULTANT EDITOR

Move over, aerodynamics – software engineering is the new battleground for motorsport innovation!

Third-generation Formula E car designed to demonstrate that high performance and sustainability can successfully co-exist

FORMULA E has unveiled its new Gen3 car which will, it claims, challenge the conventions of motorsport.

“The Gen3 disrupts and challenges the conventions of motorsport, setting the benchmark for performance, efficiency and sustainability without compromise,” suggested Jamie Reigle, Chief Executive Officer, Formula E.

“Together with the FIA, we are proud to reveal the Gen3 to Formula E fans and demonstrate to the wider sports industry how elite sport, high performance and sustainability can successfully co-exist in the ABB FIA Formula E World Championship.”

Billed as the pinnacle of high performance, efficiency and sustainability, the Gen3 was officially revealed by Formula E and the Fédération Internationale de l'Automobile (FIA) at the Yacht Club de Monaco.

Developed by engineers and sustainability experts, the Gen3 is the world's first race car designed and optimised specifically for street racing. It will

“Technologically and environmentally, Gen3 sets new standards in the sport”

debut in Season 9 of the ABB FIA Formula E World Championship, with pre-season testing this winter.

While aerodynamic development programs have been central to driving incremental improvement in motorsport for decades, the launch of the Gen3 propels software engineering forwards as a new battleground for motorsport innovation and competition. Performance upgrades to the Gen3 will be delivered as software updates directly to the advanced operating system built into the car.

Design, engineering and production innovations for the Gen3 race car include:

- Fastest Formula E car yet with a top speed over 322 kph / 200 mph.
- Most efficient formula racing car ever with more than 40% of the energy used within a race produced by regenerative braking.
- Around 95% power efficiency from an electric motor delivering up to 350 kW of power (470 BHP), compared to approximately 40% for an internal combustion engine.
- First-ever formula car with both front and rear powertrains. A new front powertrain adds 250 kW to the 350 kW at the rear, more than doubling the regenerative capability of the current Gen2 to


ABOVE The new car's disruptive design has been inspired by the aerodynamic form of a fighter jet





Champion of Sustainability

EVERY aspect of Gen3 production has been rethought, redesigned and rebuilt to ensure the car sets the benchmark for high-performance, sustainable racing without compromise. For example, natural materials have been introduced to tyres, batteries and bodywork construction with life cycle thinking at the core.


- **Gen3 batteries are among the most advanced, sustainable batteries ever made** consisting of sustainably-sourced minerals while battery cells will be reused and recycled at end of life.
- **Linen and recycled carbon fibre will be used in bodywork construction for the first time in a formula car** featuring recycled carbon fibre from retired Gen2 cars and reducing the overall amount of virgin carbon fibre used. This will reduce the carbon footprint of the production of the Gen3 bodywork more than 10%. All waste carbon fibre will be reused for new applications through adoption of an innovative process from the aviation industry.
- **Natural rubber and recycled fibres will make up 26% of new Gen3 tyres** and all tyres will be fully recycled after racing.
- **The carbon footprint of the Gen3 has been measured from the design phase** to inform all reduction measures taken to reduce environmental impact, while all unavoidable emissions will be offset as part of Formula E's net zero carbon commitment.
- **All Gen3 suppliers will operate in line with top international standards** to reduce environmental impacts of manufacturing (ISO 14001) and be FIA Environmental Accreditation 3-Star rated. 

a total of 600 kW.

- Ultra-high speed charging capability of 600 kW for additional energy during a race, almost double the power of the most advanced commercial chargers in the world.
- The first formula car that will not feature rear hydraulic brakes with the addition of the front powertrain and its regenerative capability.

Mohammed Ben Sulayem, FIA President, said: "Both technologically and environmentally, Gen3 sets new standards in the sport."

Seven of the world's leading automotive manufacturers have registered with the FIA to race the new Gen3 in Season 9 of the ABB FIA Formula E World Championship with pre-season testing this winter. They are: DS Automobiles (France); Jaguar (UK); Mahindra Racing (India); Maserati (Italy); NIO 333 (UK/China); Nissan (Japan); Porsche (Germany).

Alejandro Agag, Founder and Chairman, Formula E, said: "The Gen3 represents the ambitious third age of Formula E and the ABB FIA Formula E World Championship. With every generation of race car we push the boundaries of possibility in EV technology further and the Gen3 is our most ambitious project to date. The future of all-electric racing is bright." 

Bridgestone to debut race tyre made with natural rubber

Why this year's Indy 500 will be the most sustainable event in the great race's history. By **Mark Skewis**

BRIDGESTONE Americas is to introduce Firestone Firehawk race tyres made with guayule natural rubber, grown and extracted at the company's guayule R&D facilities in Arizona.

The guayule tyre, featuring a new green sidewall, will be showcased during the Indy 500 Pit Stop Challenge, streamed live during the build up to this month's Indy 500, the jewel in the IndyCar crown.

The Firestone Firehawk alternate race tyres, part of a broader initiative to accelerate the use of sustainable technologies in the NTT IndyCar Series, will make their competition debut at the Big Machine Music City Grand Prix in Nashville on August 6-7.

Firestone is a trailblazer in the charge for alternative and renewable sources of natural rubber. Parent company Bridgestone aims to commercialize use of sustainable guayule natural rubber in tyres by 2030, creating a promising new domestic industry.



The company believes guayule rubber has the potential to have a lasting economic impact, while reducing the energy and other environmental impacts associated with the transportation of rubber sourced overseas.

Guayule is a heat-tolerant, woody shrub that thrives in America's desert southwest. It can therefore be grown in environments totally different from those suited for Para rubber trees, the current primary source of natural rubber. The shrub can be farmed with existing row crop equipment, saving costs for farmers.

Guayule creates up to 10 new industrial processing jobs per 1,000 acres of harvested crop.

Bridgestone launched its guayule research initiative in 2012, when it broke ground on a guayule processing and research centre in Mesa, Arizona. Today, the company operates the research centre in Mesa, as well as a 281-acre guayule farm in Eloy, Arizona. Bridgestone has invested more than \$100 million in its efforts to commercialize guayule, achieving major milestones such as producing the first tyre made from guayule-derived natural rubber in 2015, and continued expansion of its guayule molecular breeding programme.

"It will take partnership and collaboration to combat the impacts of global climate change, and we are proud to partner with Penske, IndyCar and IMS to

advance the future of sustainable mobility," said Nizar Trigui, chief technology officer and group president, Solutions Businesses, Bridgestone Americas, Inc. "The introduction of guayule natural rubber to America's pre-eminent open-wheel racing series speaks to the confidence we have in the technology and its promise as a scalable, sustainable and domestic raw material."

Guayule is part of the Bridgestone plan to achieve carbon neutrality and make tyres from 100% renewable materials by 2050. The company is actively researching a range of solutions to support the recycling of materials from end-of-life tyres and promote the replacement of non-renewable materials such as oil, silica and virgin carbon black in new tyres.

Environmental initiatives

In addition to the Firestone announcement, Penske Entertainment, owner of Indianapolis Motor Speedway, as well as the IndyCar Series, has revealed a robust and innovative line-up of environmental impact initiatives. They are aimed at dramatically reducing the carbon footprint for this year's Indianapolis 500 presented by Gainbridge and significantly boosting sustainability efforts within the sport of IndyCar. ►

BELOW The introduction of eco-friendly tyres spearheads a range of sustainability initiatives

“Promise as a scalable, sustainable and domestic raw material”



"This will be the most sustainable Indy 500 in our 100-plus year history," Penske Entertainment Corp. President & CEO Mark Miles said. "Moreover, through excellent coordination and teamwork with partners who are true innovators in this field, we're moving IndyCar toward industry leadership when it comes to environmental awareness and impact."

Firestone, IMS, the state of Indiana and veteran motorsports partner Shell also announced that all race tyres being supplied for Indy 500 practice, qualifications and Race Day will be delivered to the Racing Capital of the World from their Central Indiana warehouse using the Freightliner eCascadia from Penske Truck Leasing's fleet of electric vehicles. To assist with the effort, a 150 kW, high-power electric charger is being installed on the IMS grounds, in coordination with the Indiana Economic Development Corporation and Shell Recharge Solutions. The EV charging station is manufactured by BTC Power (Broadband TelCom Power, Inc.).

“We’re moving IndyCar toward industry leadership when it comes to environmental awareness and impact”

"We're working every day to make sure Indiana is a leader when it comes to renewable energy solutions," Indiana Governor Eric J. Holcomb said. "I can't think of a better way to show our commitment to cleaner energy than by putting it on display during the largest sporting event in the world."

The Indianapolis Motor Speedway also will take significant steps toward cleaner energy consumption and a lowered carbon footprint across the Month of May. As in 2021, all electricity consumed throughout the facility in May will continue being purchased via 100 percent renewable energy credits.

In addition, IMS has teamed up with Shell and climate technology company CHOOOSE on the implementation of a new customer programme that allows fans to offset their travel footprint through a nominal contribution to the GreenTrees reforestation project. IMS also will offset its entire operational carbon footprint during the Month of May through its contributions to GreenTrees, a vital effort that restores natural habitats in more than one million acres across seven states in the Mississippi Alluvial Valley.

"At Shell, we aim to provide more and cleaner energy solutions in a responsible manner – in a way that balances short- and long-term interests," explained Dani Silva, Shell vice president of Enterprise Accounts. "We are very pleased to be a part of Penske Entertainment Corp's efforts in increasing the sustainability of motorsports and the off-track potential it also enables."

Other initiatives of note during the Month of May



ABOVE Guayule can be grown in arid regions

include increased waste diversion efforts throughout the facility with expanded recycling and food recovery programmes. Legends, the official IMS retail partner, will open a fully sustainable store inside an electric truck. All items sold in the truck will be reusable or designed from recycled plastic bottles.

Last year, the Indy 500 was certified at the Silver level by the Council for Responsible Sport after achieving 37 social and environmental standards of good practice. The venue implemented facility upgrades to increase both energy and water-use efficiency, calculated a robust greenhouse gas emissions inventory and enhanced its "Bike to the 500" programme. IMS is working toward becoming the first sports facility in the world to become a Responsible Sport Certified venue.

Alongside work with Firestone on expanded use of the guayule natural rubber, IndyCar also announced that starting with the Chevrolet Detroit Grand Prix presented by Lear in June, all 26 IndyCar Series cars will be transported by trucks that are fuelled by renewable diesel, which significantly reduces travel-related emissions. **RT**

BELOW Tyres will be transported with a fleet of electric vehicles





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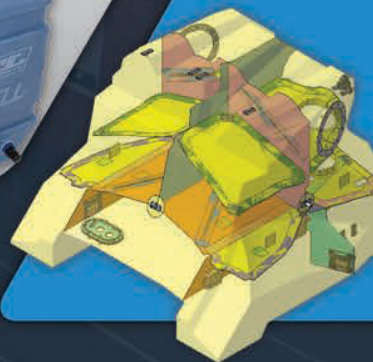
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BTCC's hybrid gamble pays off

ALAN GOW, the British Touring Car Championship's Chief Executive, has praised the "herculean effort" of all involved in the series' successful transition to hybrid power.

The BTCC became the first major touring car series in the world to integrate hybrid power into all of its race cars when its new era commenced at Donington Park at the end of last month.

"I think we can all be extremely proud of the introduction of hybrid energy in the BTCC," said Gow. "It has been a herculean effort since announcing the project back in 2019 and everything that the world has thrown at us since has dramatically added to the challenge.

"What we saw at Donington Park was nothing short of phenomenal. The racing was fantastic, and the drivers have unanimously confirmed that hybrid has added to and improved the overall dynamic. There will be lots of hard work ahead of course, but I have no doubt the introduction of hybrid energy in the BTCC will be a huge success."

In 2019, when series organiser TOCA appointed Cosworth Electronics to design and develop the new TOCA Hybrid system, the trailblazing project looked a big ask. The decision was deemed necessary, however, in order to future-proof the UK's premier motorsport championship.

"When we announced in 2018 that we would be integrating hybrid power for this year, nobody knew the enormous headwinds that would confront us," said Gow.

"The pandemic, the ongoing global supply chain issues (particularly with microchips and electronics), the further disruptions as a result of the terrible invasion of Ukraine and the significant price increases of just about everything across the board have all provided huge challenges to the project.

"So, it's important that I acknowledge and thank the outstanding work that Cosworth, the teams,

our suppliers and my TOCA Technical Team have put in to get where we are today. Yes, we were all up against it – we still are in some other areas – but the great effort that everyone has made against all those obstacles is something that we should all be incredibly proud of. So, my sincere appreciation goes out to everyone that really put their shoulders to the wheel and got this programme done."

Whilst going hybrid is the headline news this season, the BTCC has also introduced a completely new TOCA engine by M-Sport, a new 20% sustainable fuel and a whole new Cosworth ECU and electronics system.


"It's been a massive undertaking and we shouldn't underestimate for a moment everything that went into this," said Gow. "Being the first touring car championship in the world to go hybrid meant there were no learnings that we could take from others, but I'm delighted that we've achieved this important milestone in the long and proud history of this championship."

"I had my doubts"

Although a degree of trepidation always accompanies technical upheaval of this sort, many BTCC observers and protagonists praised the outcome of the ground-breaking weekend.

Tim Harvey, ITV commentator and a former tin-top star, said: "I thought it was really good, genuinely. I had my doubts, but the reality is the cars were faster overall, and we're only two events away from when they last raced at Donington.

"It seemed like the drivers worked out quickly where to use it for an optimum lap for qualifying, but then it all changed in the races in terms of you use it in specific targeted points to overtake or put pressure on people.

"For example, you might do a large burst out of the Old Hairpin where you'd do only a couple of seconds in qualifying. It definitely worked, and it made the racing interesting." 

ABOVE The introduction of hybrid tech at Donington drew widespread praise from the drivers

Audi and Porsche to enter F1 in "technology window"



VOLKSWAGEN'S premium brands Audi and Porsche will join Formula 1 after convincing the German automaking group that the move will bring in more money than it will cost, VW Chief Executive Herbert Diess has revealed.

Discussions by the board of directors about the two brands' plans had created some divisions, Diess acknowledged at an event in Wolfsburg, where the German carmaker is headquartered.

Ultimately, though, next to VW's China business the two brands are the group's most important income suppliers. According to Diess, they made the case that they would pull in more money for Wolfsburg with a Formula 1 commitment than without one. The forthcoming new powertrain rules played a key role in the argument, creating a "technology window" that might not open up again for another decade.

Diess said that the boom F1 is enjoying in key markets like the USA, plus the opportunities an all-new ruleset offered in 2026, means an opportunity has arisen to make the move that will not be repeated for a while.

F1 on the right track

"Formula 1 is developing extremely positively worldwide," he said.

"The marketing that is happening there, plus Netflix, has led to Formula 1's following growing significantly in the US as well. Asia is growing significantly, including among young customer groups.

"If you look at the major sporting events or events in the world, it's the case that in motorsport, it's really only Formula 1 that counts and is becoming increasingly differentiated.

"If you do motorsport, you should do Formula 1 as that's where the impact is greatest.

"What's more, you can't enter Formula 1 unless a technology window opens up which means, in order to get in there, a rule change: so that everyone starts again from the same place.

"As Markus Duesman [chairman of Audi and former

BMW F1 head of powertrains] always tells me, you usually make up one second per season on a medium-sized racetrack simply by optimising details.

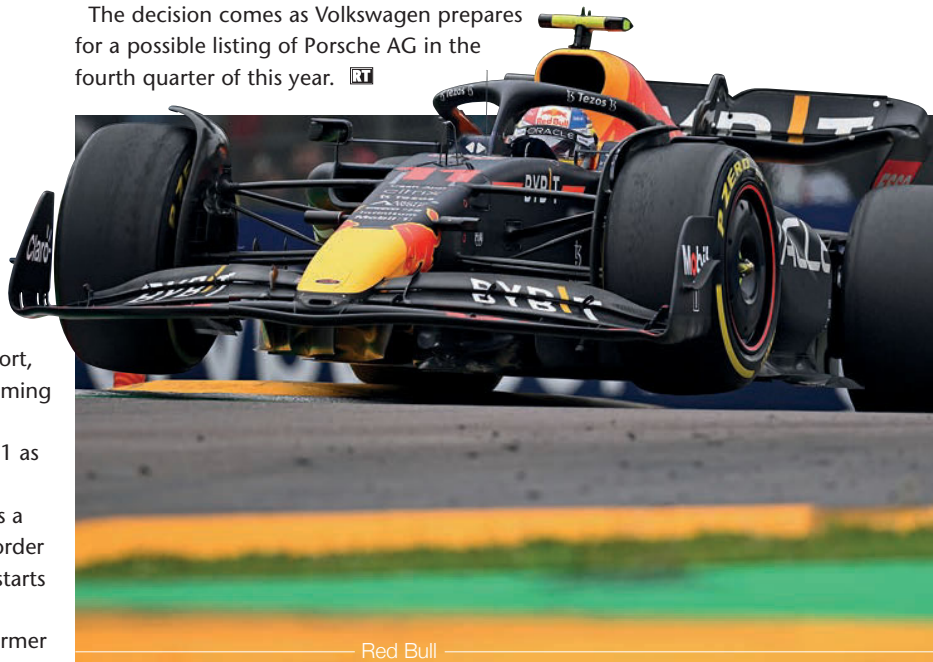
"But you can't catch up on that when you join a new team: you need five or 10 years to be among the front-runners. In other words, you can only get onboard if you have a major rule change.

"That's coming now, and it will also come in the direction of 2026, when the engines will be electrified to a much greater extent, including with synthetic fuels. That means you need a new engine development and you need three or four years to develop a new engine.

"That means you can decide now to do Formula 1 – or then probably not again for 10 years. And our two premium brands think that's the right thing to do, and are prioritising it."

Porsche has been heavily linked with joining Red Bull as a powertrain partner. Audi's plans are said to be less advanced. It has had discussions with McLaren, but a deal with Sauber has also been mooted.

The decision comes as Volkswagen prepares for a possible listing of Porsche AG in the fourth quarter of this year. **RT**



ABOVE VW Chief Executive Herbert Diess admitted that a compelling commercial case for F1 had led the board to "run out of arguments"

BELOW Both Porsche and Audi have commenced engine research, with the former of the two seemingly destined to do a deal with Red Bull



Bcomp/Johannes Nollmeyer

Mercedes-AMG GT4 to race with natural fibre composite bumpers

SWISS sustainable lightweighting company, Bcomp, is now supplying its high-performance natural fibre technologies to HWA AG – development partner of Mercedes-AMG – for the new front bumpers on Mercedes-AMG GT4 race cars.

Set to be phased in over the coming weeks, Bcomp's bodywork solutions will provide a sustainable alternative to the GT4's existing carbon fibre panels, offering equivalent mechanical performance in stiffness and weight and improving safety.

The new bumper uses Bcomp's innovative ampliTex and powerRibbs technologies, which harness the natural advantages of flax fibre. The powerRibbs reinforcement grid uses the high specific bending stiffness of flax to build up height very efficiently, boosting the flexural stiffness of thin-walled shell elements significantly.

The new bumpers are also safer in the event of a crash or collision, significantly decreasing the risk of punctures. Unlike the sharp fracturing and splintering of carbon

fibre, ampliTex technical fabrics are far more ductile in an impact, whereas the powerRibbs confine the damage zone, minimising debris.

Environmental impact

A full sustainability analysis concluded that the new bumper offered a total material emission reduction of 90% when compared to the carbon fibre part as well as an 85% reduction of CO2 emissions from cradle-to-gate, considering all production steps from raw material to final part.

Not only do Bcomp's materials reduce the part's carbon cost, but they also introduce the option of thermal energy recovery. Since the new bumper is full natural fibre, it can be used for thermal energy recovery, turning approximately 80% of the energy stored in the part into renewable energy, resulting in a process without hazardous carbon waste or parts that need to go into landfill.

Anne Mink, Manager Technical Development, HWA AG, commented: "The topic of

sustainability plays a major role in our company. Several awards for our efforts in the area of environmental protection are proof of this. Part of our sustainability concept is to evaluate and optimise the product life cycle with regard to environmental aspects as early as in the product development stage.

"Furthermore, it is our aspiration to constantly adapt our long-standing engineering know-how to current environmental requirements in order to be able to offer our customers sustainable products at the highest technological level. In Bcomp, we have got a development partner with extensive experience in sustainable materials. The result of our cooperation shows that technologically equivalent components can be created from alternative materials."

Reverse engineered

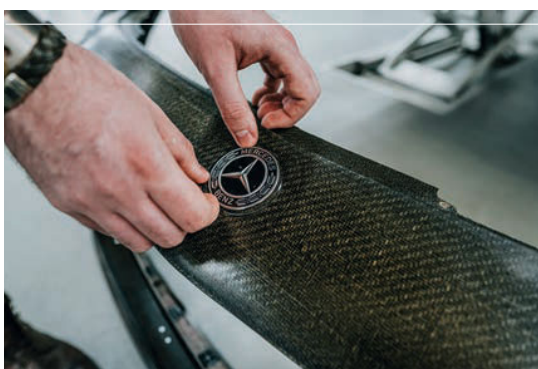
Reverse engineered from HWA's original carbon part, the natural fibre bumper's design has been collaboratively optimised over the past 12 months. To ensure that the bumper met all racing regulations and requirements, the HWA team performed extensive mechanical testing and validation. On the HWA testbench, the stiffness of the complete front end of the Mercedes-AMG GT4 was measured, simulating the aerodynamic drag and front diffuser downforce. The tests were conducted with a carbon fibre bumper as benchmark and afterwards with the new natural fibre bumper, validating that the newly designed part performs on the same high-performance level.

Production of the old carbon fibre bumpers has now ceased, and all customer teams will receive the new Bcomp version with their next orders.

"We are incredibly excited to see HWA and the Mercedes-AMG GT4 race car programme embracing sustainable, natural fibre bodywork. With equivalent stiffness and weight, increased safety and an 85% reduction in carbon emissions, it is a fantastic improvement that we reached together," commented Christian Fischer, CEO and Co-Founder of Bcomp.

"Development coincided with the height of the pandemic, and it was challenging at times. In fact, our first bumper build, design fitting, optimisations and revisions were all achieved during the pandemic – a testimony to the hard work and persistence of all involved." **RT**

ABOVE & RIGHT The new natural fibre parts enable an 85 per cent reduction in CO2 emissions



Bcomp/Johannes Nollmeyer

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“

The WMS presents a rare opportunity for like-minded engineers to discuss areas of the sport that they may not be so familiar with, thereby expanding each other's knowledge for mutual benefit. It is also an excellent networking opportunity.”

Pat Symonds, Chief Technical Officer,
Motorsport Division | Formula 1



Nissan acquires e.dams Formula E race team



NISSAN has acquired the e.dams race team, taking full ownership of its involvement in the ABB FIA Formula E World Championship. The team is currently based in Le Mans, France, and will continue to race as planned in Season 8.

Nissan's participation in Formula E supports the company's long-term commitment to electrification and sustainability laid out in Nissan's Ambition 2030 plan. This acquisition is therefore a natural step for the Japanese OEM to take full control of its Formula E project.

Nissan entered the series in 2018 in partnership with e.dams, with both companies racing together in the all-electric championship as the Nissan e.dams Formula E team. In March 2021, the Japanese automaker announced its commitment to the Formula E Gen3 era, which will run from Season 9 (2022/23) through to the end of Season 12 (2025/26) of the series.

The change in ownership and new management structure will take place with immediate effect.

Tommaso Volpe, general manager Nissan Formula E,

ABOVE Nissan has taken full control of the e.dams squad, which has three teams' titles to its credit

will also become managing director at e.dams.

"This acquisition will further empower us in the strategic electrification objectives of our business," said Ashwani Gupta, Nissan's chief operating officer. "We have been on the grid for over 85 years, and our desire to win continuously accelerates us forward. We learn as we race, and the relentless pace of technological progression that drives the Formula E championship will provide us with many opportunities to inform and develop even better cars for customers."

"The acquisition of the e.dams team not only reconfirms our long-term commitment to Formula E, but also to the exciting, high-performance world of motorsports competition as a whole. But we don't only love to compete. We're also passionate about delivering innovative and exciting driving experiences while demonstrating our commitment to zero emission and sustainable solutions."

Carbon neutrality

Nissan is a world-leading expert in the design and manufacture of all-electric vehicles, with more than 500,000 Nissan LEAF vehicles sold since the model debuted in 2010. As part of its goal to achieve carbon neutrality across its operations and the life cycle of its products by 2050, Nissan intends to electrify all its new vehicle offerings by the early 2030s in key markets. The Japanese automaker aims to bring its expertise in transferring knowledge and technology between the Formula E racetrack and road for better electric vehicles for customers.

The e.dams race team was established in 2014 to compete in Formula E by Jean-Paul Driot, founder of DAMS. Partnering with four-time Formula 1 world champion Alain Prost and Renault to create Renault e.dams, the outfit claimed three teams' titles as well as one drivers' title with Sébastien Buemi in the 2015/16 season.

Nissan became a partner and shareholder of e.dams in 2018 at the start of the fifth season to create Nissan e.dams. After Driot's passing in 2019, Olivier and Grégory Driot took over and made sure the legacy of their father's success would continue.

Olivier and Grégory Driot commented: "We are very proud to hand over the e.dams team to such a committed and innovative company as Nissan. We've had several open discussions in recent months with Nissan and we decided that it was the right time for them to take the reins and continue the legacy of our family and secure the long-term future of the employees." 



LEFT ROKiT Venturi Racing will partner with Maserati

Maserati joins forces with Venturi for FE entry

MASERATI and ROKiT Venturi Racing have announced a multi-year partnership that will see the iconic brand make its debut on the Formula E starting grid next season with the new Gen3 car.

Jean-Marc Finot, Senior VP, STELLANTIS Motorsport, said: "It is a real asset for Maserati to rely on Venturi expertise. We think that the collaboration of Maserati design skills and Venturi racing capabilities and experience will deliver a very efficient package. Our common DNA and passion for performance will unite the team."

Maserati is now part of the STELLANTIS automotive group, which is to invest €30bn through to the end of 2025 to develop its interests in electrification.

Formula E will be Maserati's technological laboratory to accelerate the development of high-efficiency electrified powertrains and intelligent software. The Formula E campaign will be the trailblazer for 'Folgore', its full electric range. All new Maserati models will also be available in 100% electric solutions.

Susie Wolff, CEO & Managing Partner,

ROKiT Venturi Racing, stated: "Uniting with Maserati marks the start of a new chapter and represents the best possible outcome for the team following our successful partnership with Mercedes. Being entrusted with the return of one of motorsport's most recognisable brands to international single-seater competition underlines our success in recent seasons in which we have firmly established ourselves as a commercially viable, race-winning team that can seriously contend for championships." **RT**

GKN ramps up Jaguar support

GKN Automotive is strengthening its partnership with the Jaguar TCS Racing team by contributing engineering support for the development of the Gen3 Formula E powertrain.

Alex Davies, Software Engineer at GKN Automotive, will be involved in critical testing and support development of powertrain software ahead of Season 9.

Davies has worked at GKN Automotive's Abingdon Innovation Centre in the Software & Controls department for two years, having graduated from Queen Mary University of London with an MSc in Electronic and Electrical Engineering. His work at GKN Automotive has predominantly been software development, integration and support for the AceDrive unit, as well as motor control support.

"This is an exciting opportunity to work with engineers at one of the best Formula E teams on the grid," said Davies. "I've already contributed to some cutting-edge software projects through my work with GKN Automotive and I'm confident my placement will give me opportunities to test ideas and gain invaluable experience. I'm relishing the chance to help

Jaguar TCS Racing for next season and applying the knowledge gained when I resume working at the GKN Automotive Innovation Centre."

Phil Charles, Jaguar TCS Racing Technical Manager, said: "We're delighted to have GKN Automotive's support, as a key partner for us, as we begin development of our Gen3 powertrain. Alex's software expertise

will be invaluable as he supports the Jaguar TCS Racing team as we become familiar with the new technologies and regulations of the Gen3 era. The next-gen cars for season nine will be the most complex, powerful and technologically advanced racing cars that Formula E has seen, so it's great we can pool together knowledge and expertise." **RT**



LEFT GKN support will help Jaguar's transition to the Gen3 car



M-Sport to pursue Dakar ambition

WORLD Rally Championship squad M-Sport is to pursue its ambition to conquer the Dakar Rally through a joint venture with a rally raid car manufacturer, Neil Woolridge Motorsport (NWM).

The partnership sees M-Sport become NWM's European HQ and global distributor for the NWM Ford Ranger T1+ vehicle. The two companies share a long-term goal of taking on the Dakar Rally while developing a world-class rally raid customer programme.

NWM is a rally raid manufacturer based in Pietermaritzburg, South Africa. Like M-Sport, it has a long and storied association with Ford, with both M-Sport and NWM celebrating 25 years of collaboration with the blue oval in 2022.

While the goal of a Dakar assault is on the horizon, both companies acknowledge that

years of work and development lie ahead, including developing the right infrastructure.

M-Sport will collaborate with NWM on the development of the NWM Ford Ranger T1+ and operate a customer support programme based at its HQ in Dovenby, Cumbria. The first NWM Ford Ranger T1+ is expected to arrive in Europe at the end of this month.

Malcolm Wilson, M-Sport Managing Director, said: "Myself and Matthew [Wilson] have recently been out to South Africa to meet Neil Woolridge and his sons and discuss their Ford Ranger T1+. It's a momentous and exciting prospect for me, after almost 45 years in the rally business: rally raid and Dakar has always piqued my interest. It is a discipline that I do not underestimate though, and I am all too aware it requires years of

experience and expertise.

"M-Sport and NWM have a shared vision. We feel that our respective outfits complement each other in a way that would create an unrivalled rally raid outfit. The NWM Ranger has definite potential – it is built on a very solid foundation. Matthew tested the car during our visit and was very positive about his experience.

"It's fair to say I'm not one to stray away from a challenge; it's what I love about motorsport and it's no secret we have some work to do to contend for the prestigious Dakar Rally. That said, I am confident that M-Sport and NWM have the tools and know-how to push the Ford Ranger T1+ to new heights."

Matthew Wilson, M-Sport Director and Development Driver, said: "I don't have any prior experience of driving or operating a T1+ vehicle, but the first impression was really good, which is very significant as we have got a good base to go from. We feel from the collaboration, we will be able to push on the vehicle's development programme in conjunction with Neil and his team.

"Fundamentally, we are encouraged about the strong basis that the car is built around and it was great for us to get a real feel for what the car is like. It's the start of a very new era for M-Sport, one which we are excited to learn from and see what our knowledge could bring to the development cycle."

"This is a landmark moment for NWM and a proud moment for me personally," said Neil Woolridge. "I have always admired Malcolm from afar and M-Sport is an outfit I've always wanted to collaborate with for a variety of reasons. Our Ranger T1+ is a vehicle we are looking forward to developing and building a strong customer line-up with, which is something M-Sport has demonstrated it can create and strengthen. Our T1+ Ranger is built on the reliable and well-tested foundation of our previous generation Ranger and as such, places our new vehicle on a great starting level of performance in comparison to the competition. Consequently, we can use the South African Rally Raid Championship as a test bed for our vehicle directly against our competitors, which gives us the confidence to take our vehicle to the world stage." 

ABOVE Matthew Wilson tested the NWM Ford Ranger T1+ in South Africa

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Ferrari reveals new GT3 challenger



FERRARI'S 296 GT3, heir to the most successful car in Prancing Horse history, has commenced track testing ahead of its 2023 competition debut.

Based on the 296 GTB, the next-generation GT3 has been developed in association with ORECA and assembled at the French constructor's di Signes plants. The car draws on the experience gained with the 488 GT3 which, in its standard and Evo configurations, has won an unprecedented 107 titles.

Ferrari's global GT3 programme has focused on the V8 twin-turbo 488 GTB road car since 2016. The GT3 car was updated with Evo kits in 2018 and 2020. The 296 GT3 marks the return to the track of a Ferrari equipped with a 6-cylinder engine. The road-going 296 is powered by a 2.9-litre, 120-degree internal combustion engine producing 663 hp, which is similar to the output of the 488's twin-turbo V8.

The main engine is linked to a 167 hp electric motor. However, GT3 does not allow hybrid technology, so this motor will be removed for a 296-based racing model.

The car's first kilometres, taken at the Fiorano test track, ran smoothly, with runs of just a few laps alternating with longer sequences interspersed with the usual pit stop checks. Two-time world champion Alessandro Pier Guidi and Andrea Bertolini were at the wheel. Ferrari's Chief Executive Officer, Benedetto Vigna, also attended the tests.

"I am delighted with how the testing went. The Ferrari 296 GT3 proved to be a delightful and precise car to drive," said Guidi. "Obviously, at this stage the work focused on testing the systems and essential reliability, and we are pleased with the data we gathered."

"I can't hide the fact that it has been a very exciting couple of days because expectations are high for this

ABOVE & BELOW

After many hours spent on the simulator, the 296 GT3 finally took to the track

car," echoed Bertolini. "Right from the early stages of development, it is crucial to ensure that the car can meet both the needs of the pros and the gentleman drivers who will be competing in it."

Bertolini added: "I have been called on many times to test drive new cars but, taking stock of this first test, I was surprised by the levels of reliability and performance with which we took to the track."

The 296 GT3 will be introduced to competition in the GTE classes next year in a parallel programme to the new Le Mans Hypercar in the World Endurance Championship, which heralds Ferrari's return to the top class at the Le Mans 24 Hours – a race it has won overall on nine occasions, the last coming in 1965. **RT**



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ROKiT British F4 engine equalisation boosted by Motul



MOTUL'S high-performance racing oils have provided a further boost to the ROKiT F4 British Championship certified by FIA's technical infrastructure for the 2022 season.

After agreeing a deal to come on board as the championship's Official Lubricants Partner, the iconic brand's Motul 8100 X-Power 10w/60 oil will be introduced as the controlled engine oil within the regulations and used consistently across each car on the grid throughout the 2022 season.

This has a positive impact on the work Neil Brown Engineering conducts alongside the championship's technical and scrutineering teams to ensure parity of performance between all cars, in particular engine

ABOVE Motul's performance oils will help engine parity in British F4

equalisation, to put driver ability front and centre as the determining factor in achieving success in the series.

"We are pleased to welcome Motul on board as the Official Lubricants Partner to ROKiT British F4," said Hugh Chambers, Motorsport UK's Chief Executive Officer.

"Our vision is to build Britain's FIA Formula 4 series into a global leader at this level of the sport, and at the bedrock of that ambition is a strong technical infrastructure, both in terms of scrutineering and the quality of the components and products that we use.

"Motul's 8100 X-Power 10w/60 engine oil forms a key cornerstone of that setup and will be a useful tool for Neil Brown Engineering as they continue to ensure parity of performance throughout the grid."

Motul's involvement comes through its official UK distributor for motorsport, Witham Motorsport.

"To be a part of the technical framework that provides a platform for the rising stars of tomorrow to showcase their talents is incredibly important and fits perfectly with Motul's rich heritage for supporting all forms of motorsport throughout its history," said Richard Scarborough, Sales Director at Witham Motorsport.

"The window we operate in for parity of performance on the engines in ROKiT British F4 is exceptionally tight," explained Neil Brown Engineering Workshop Manager Wayne Mathurin.

"On a performance graph, no two individual competitors are discernible from one another.

"To have a world-renowned brand such as Motul on board is only an advantage in pursuit of that goal, and away from British F4, we use their products extensively in our workshop."

2022 marks a new era in the championship's history, with new organisers in Motorsport UK and a brand-new chassis in the Tatuus T-421, complete with state-of-the-art safety features such as a Halo-style cockpit protection device, reinforced side anti-intrusion panels and on-board safety signalling systems. Teams will also have a brand new Abarth engine and Pirelli control tyres to get to grips with. **RT**

Alfa Romeo F1 opts for Seagate Lyve Cloud

FACED with the challenge of scaling its factory data beyond an on-premise storage appliance, Alfa Romeo F1 Team ORLEN has chosen to deploy Seagate Lyve Cloud, announcing a partnership with Seagate Technology.

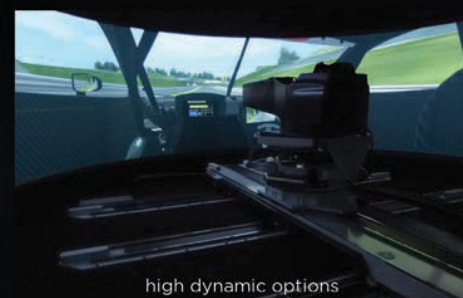
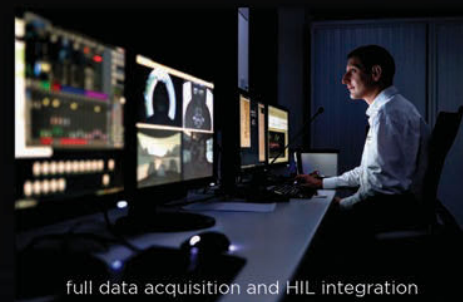
Seagate Lyve Cloud is the always-on mass capacity object storage platform designed to enable multi-cloud freedom at the metro edge.

In a sport generating gigabytes on gigabytes of data from sensors on the cars

and at the factory, data storage presents ongoing issues such as increasing cloud storage costs, unpredictable total cost of ownership (TCO) and data management complexity in the cloud. Seagate Lyve Cloud will offer the team data privacy, no vendor lock-in, no API charges and no egress fees, allowing the team to retain full control of data while lowering barriers for storing, moving and activating data at scale.

Frédéric Vasseur, Team Principal of Alfa Romeo F1 Team ORLEN, said: "The

data generated by our team has been growing on an exponential scale in the last few years and managing, storing and accessing this information in a reliable and secure manner has become an increasing challenge for our team. Seagate Lyve Cloud allows us to fulfil all our needs in this regard without having to worry about the how: Seagate Lyve Cloud gives our team the freedom to focus our resources, time and attention on what we do best – delivering results on track." **RT**



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Porsche strengthens commitment to industrial production of eFuels

THE Haru Oni eFuel pilot plant in Punta Arenas, Chile, the go-to point for many debates surrounding the use of sustainable fuels in motorsport, is to receive further investment from Porsche.

The sports car manufacturer is investing US\$ 75 million in HIF Global LLC. In return, Porsche is acquiring a long-term stake in HIF Global LLC, a holding company of internationally active project developers of eFuel production facilities.

Among other projects, the Santiago de Chile-based company is building the Haru Oni eFuel pilot plant in Punta Arenas. Initiated by Porsche and implemented with partners including Siemens Energy and ExxonMobil, production of eFuels from hydrogen and CO₂ using wind energy is expected to start there in mid-2022. These electricity-based synthetic fuels allow combustion engines to be operated in a potentially almost CO₂-neutral manner.

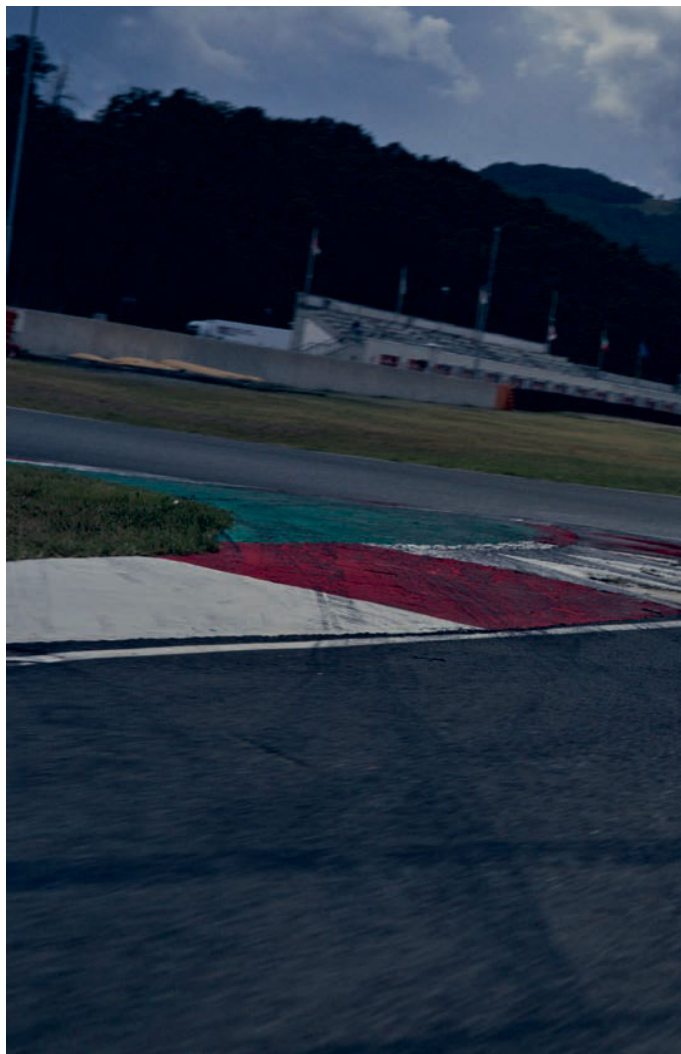
BELOW & RIGHT

The eFuel produced at Chile's Haru Oni site will initially be used in flagship motorsport projects

The sports car manufacturer initially plans to use the eFuel from Chile in motorsport flagship projects. In the future, it is also conceivable that they will be used to fuel the company's own vehicles with combustion engines during initial fuelling at the factory, and at Porsche Experience Centres.

Porsche has been researching the use of renewable fuels for some time. Tests in the laboratory and on the racetrack are proceeding successfully. "We see ourselves as pioneers in eFuels and want to drive the technology. This is one building block in our clear, overall sustainability strategy," emphasised Michael Steiner, Member of the Executive Board for Research and Development at Porsche AG.

With its investment in HIF Global LLC Porsche is participating in an international financing round alongside the Chilean company Andes Mining & Energy (AME) and the American companies EIG, Baker Hughes Company and Gemstone Investments. In total, an amount in the low nine-figure US\$ range is flowing into HIF Global LLC. AME remains the majority shareholder of HIF Global LLC. The additional capital will be used to develop industrial eFuel facilities in Chile, the US and Australia, which



have large supplies of renewable energy.

"eFuels make an important contribution to climate protection and complement our electromobility in a meaningful way. By investing in industrial eFuel production, Porsche is further expanding its commitment to sustainable mobility. In total, our investment in the development and provision of this innovative technology amounts to more than US\$ 100 million," said Barbara Frenkel, Member of the Executive Board for Procurement at Porsche AG.

"Porsche is investing in an attractive business area with its stake in HIF Global LLC. Synthetic fuels offer attractive prospects across transportation sectors, from the automotive industry to the aviation and shipping sectors. In addition, e-methanol is an important raw material for other applications, such as in the chemical industry, where it can replace raw materials of fossil origin. e-methanol is an intermediate product



ABOVE Steiner says eFuels are of interest for automotive, aviation and shipping industries

“We see ourselves as pioneers in eFuels and want to drive the technology”

that is produced during the generation of eFuel,” explained Steiner.

HIF Global, the world leader in eFuels development, has secured approximately US\$ 260 million in equity investments to fund the global expansion of its decarbonization business.

Meg Gentle, Executive Director of HIF Global, said, “Produced from green hydrogen and recycled CO₂, eFuels provide a real decarbonization solution for cars, ships, and planes that are in use today without any modification to existing engines. Expanding on the success of our pioneering Haru Oni project in Magallanes, Chile, we expect to begin construction of HIF’s first commercial scale eFuels plant in the United States in 2023, followed quickly by similar facilities in Chile and Australia in 2024. Together with our strong partners, EIG, Porsche, and Baker Hughes, we will transition to a cleaner earth.”



BEYOND CONVENTION

If you're a fan of conventional racing cars, look away now!

Craig Scarborough reports from the launch of Formula E's controversial Gen3 racecar in Monaco

EVERY formula in motorsport has different eras of technology. New generations come along: for most, these are spaced over decades. Such is the pace of development in the electric arena, FIA Formula E is now onto its third generation with the launch of the Gen3 car in Monaco. The dramatic-looking car makes a huge step forward in having more power, less weight, being smaller in size and even more sustainable.

The headline figures for the new car really set out the huge leap that has been made with the electric powertrain. Maximum power from the rear wheels now peaks at 350 kW (470 hp), giving the car a realistic top speed of 200 mph (322 kph). This is still with the format of a non-stop race of 45 minutes plus one lap. Put into context, that's more power and endurance than an F1 car!

In contrast to other formulae, the car has become smaller in every dimension: shorter, narrower and even a little lower, with an overall weight reduction despite the addition of new features. The aim is to make the car more suited to street circuits;

it's important to note that Formula E isn't aiming to run at permanent racetracks, preferring to run in city centres, where non-motorsport fans can be exposed to racing, whilst using its USP of low noise/emissions in a one-day ePrix format.

Underlying the power boost is an increase in recoverable energy. Already the car exploits 350 kW regenerative braking from the rear axle. Now that is bolstered by the addition of a front generator package, providing another 250 kW around the lap. This adds up to the total 600 kW regen, which allows the car to run the full race even with the new smaller/lighter battery from Williams Advanced Engineering. Simulations suggest the energy used during the race will be made up of 40% recovered energy.

Overall, the car is now much more suited to the street circuits it inhabits. FIA predictions are that the Gen3 will be faster off the line than its predecessor and lap times will tumble by some 2-4 seconds!

But that's far from the full story. Formula E – like any walk of life in this day and age – focuses a lot on sustainability. Its





LEFT The ugly truth: the Gen3's looks provoked an initial wave of protest on social media

all-electric format had already given it a head start, but some innovations with the Gen3 have pushed this agenda even further.

One bugbear of battery technology is the environmental issues thrown up by the materials used in the cells. The new Williams Advanced Engineering battery – which utilises the latest pouch cells designed by Total Saft – features sustainably sourced materials and will be recycled at the end of its life. Equally green are the new tyres, again with a new partner, Hankook. These will feature 26% recycled fibres and natural rubber. The all-weather grooved tread format will be retained, negating the need to create the carbon footprint of shipping wet tyres to races where they rarely get used.

Some teams were already using natural composites, such as Andretti working with Bcomp's flax material on its radiator duct. Now the spec chassis features more natural composites, including linen fibres and also recycled carbon fibres. ►



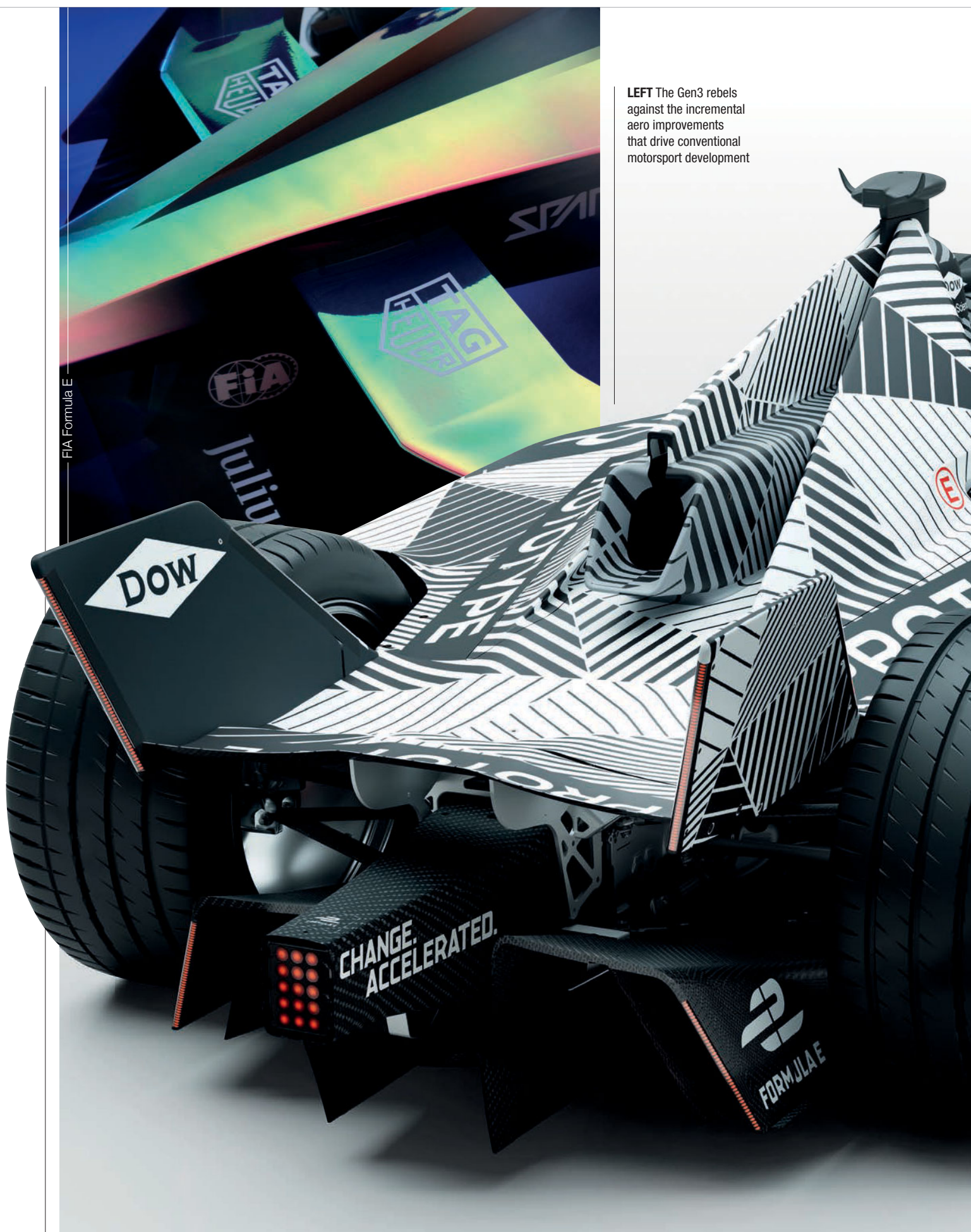
LEFT Those inwardly-angled front wing endplates are hard to ignore!



LEFT The front suspension is redesigned to package the front generator and narrower track

“ The paper dart-shaped deck and inwardly-angled front wing endplates both appear to be unsympathetically positioned **”**

LEFT The Gen3 rebels against the incremental aero improvements that drive conventional motorsport development



Elephant in the room

There's no doubt that the progressive technology involved in the Gen3 is impressive, but there's one aspect of the car that doesn't sit within either technological or environmental parameters: its looks! This is perhaps the most controversial and debated facet of the car.

Formula E has always trod its own path when it comes to aero and styling, trying not to look like an F1 car, whilst also happy to enclose the wheels on an

open-wheel single-seater. The Gen2 car was launched to acclaim for its batmobile styling and the unraced Gen2+ bodywork was perhaps even more attractive.

What we've seen of the Gen3 so far are some artistic renders in a colourful livery, a brief view of the car on a pedestal in Monaco in a more 'traditional' livery and some renders of the teams' current liveries on the car. Response has been mixed. It's certainly futuristic, perhaps matching some of the angular styling appearing on some of the new electric road

cars. Almost unnoticed is the lack of a high-mounted rear wing; instead, a low 'beam'-style wing is fitted between the vertical fins. A pointed fairing rises up from the sidepod to shroud the roll structure.

Even with the large surface area of bodywork, the car structure beneath remains as narrow as any other single-seater. The bonded-on bodywork makes for an easy-to-change set of radical body panels.

However, the most vocal response has been negative, admittedly from fans with a motorsport background, used to the logical and organic shapes in the top tiers of other single-seaters and LMP-style cars.

Two things appear to jar the fan's eye when looking at the car: the paper dart-shaped deck, angled back from the nose to form the sidepods, then the inwardly-angled front wing endplates. Both appear to be unsympathetically positioned around the front tyres and work against the overall shape of the car.

Equally, both could be made more aesthetically pleasing with a few reflex angles put in the surfaces, like a Concorde-style double delta to the deck to clear the front tyres more pleasingly.

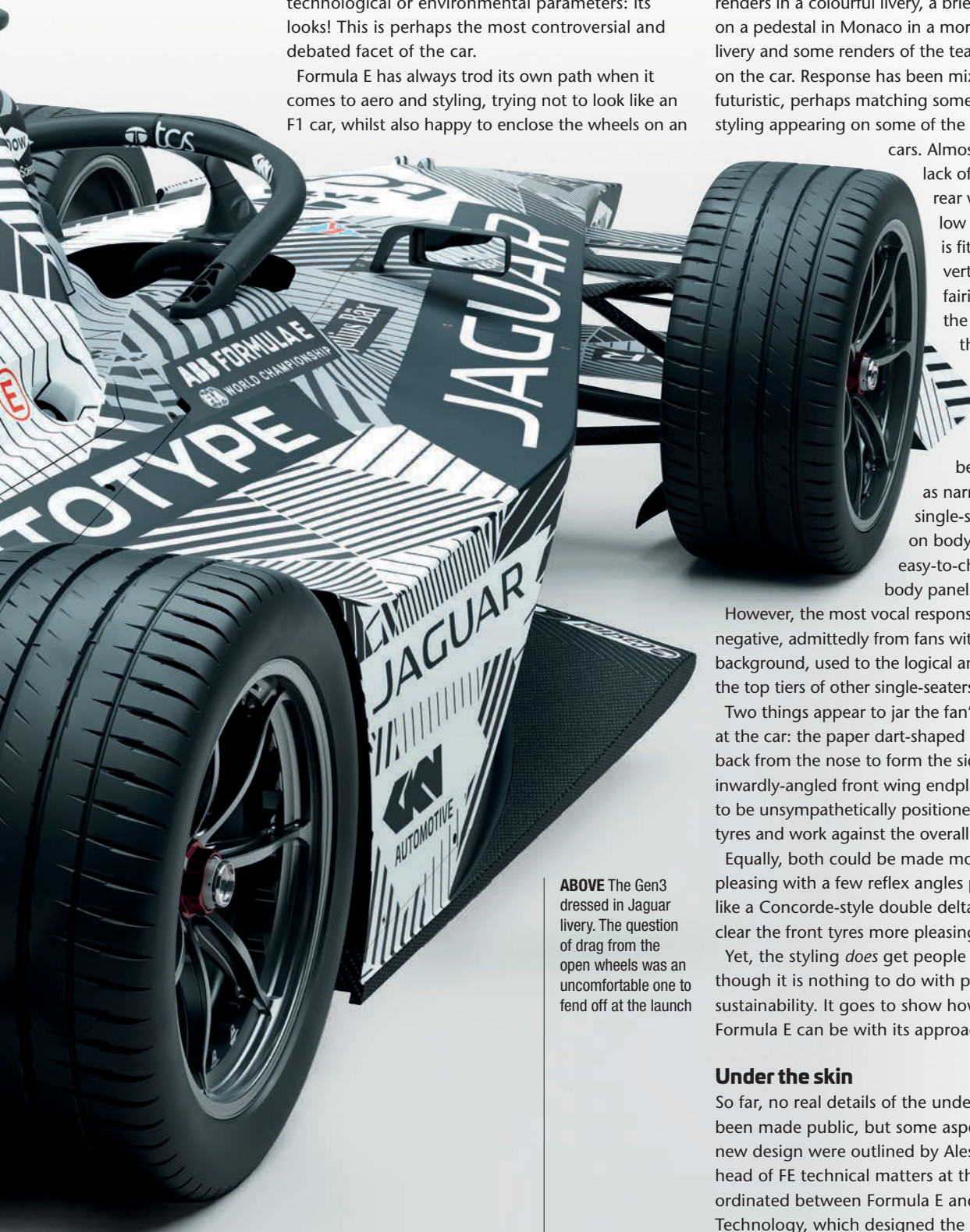
Yet, the styling *does* get people talking, even though it is nothing to do with performance or sustainability. It goes to show how disruptive Formula E can be with its approach to motorsport.

Under the skin

So far, no real details of the underlying tech have been made public, but some aspects of the car's new design were outlined by Alessandra Ciliberti, head of FE technical matters at the FIA. She co-ordinated between Formula E and Spark Racing Technology, which designed the car.

This is obviously an all-new car, the altered dimensions tell us that on paper, but the change ►

ABOVE The Gen3 dressed in Jaguar livery. The question of drag from the open wheels was an uncomfortable one to fend off at the launch



in layout is clearly evident. The car is smaller in all dimensions: some 130 mm shorter in the wheelbase and 100 mm narrower, as well as shorter in overall length by some 183 mm. The reduction in battery size and addition of the front generator package pushes the cockpit towards the rear wheels. Overall, the car is lighter by some 60 kg, despite the front generator, largely due to the 100 kg shed from the battery.

It's the front generator package that is most interesting. It's not new technology, as LMP1H cars have run front hybrid units for years, but for a single-seater the addition is a first.

It's important to point out that this is a generator-only setup: currently there are no announced plans to also run it as a traction device. However, should that be the case – and Formula E are investigating that scenario – the car will be equipped with some 600 kW of traction power, that's 800 hp in an all-wheel drive format! How that would affect the battery endurance in a race is debatable, but the prospect is tantalising around a tight street circuit.

Compact solution

The installation of the front generator unit sits inside the monocoque, behind the front bulkhead. It is connected to the front hubs via short driveshafts. The mechanism between them is described by Ciliberti: "It's a planetary gearbox with a differential inside it. It's a very compact solution that was developed by our partner Atieva. It's been efficiently integrated into the front of the monocoque."

The detail of this unit will become clearer as the cars start to test, but there is no team engineering in this part, according to the FIA Coordinator: "It's a common part, everyone will have the same challenges to adjust the braking balance and use the regen at the front to the maximum without losing too much efficiency." ►



— FIA Formula E —

TOP The lack of hydraulic brakes at the rear isn't a feature that went down well with the purists

ABOVE & LEFT The lack of conventional rear wing went almost unnoticed. A low 'beam'-style wing is fitted between vertical fins

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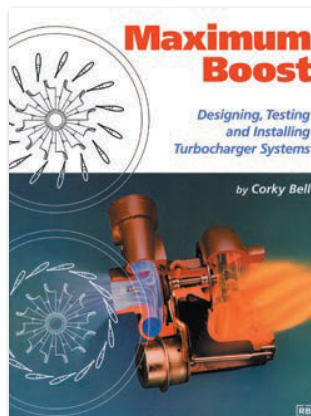
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As the unit can't be adjusted, the teams and drivers will have to learn to get the best from the setup. "It's a mechanical differential, so there will be a lot of challenges there, they will have to adapt," says Ciliberti.

With the addition of much of the front and rear braking effort coming from the generator units, the brakes are underused. At the rear, there are no hydraulic brakes at all! The rear braking effort is wholly managed by regen from the rear MGU. This raises the obvious question of what happens if the rear generator fails? Well, the front brakes take over, as according to Ciliberti they have been "dimensioned to stop the car in emergency situations". Thus, at the front the car retains the Brembo caliper and carbon discs. These will be under-utilised, as already the Gen2 cars use so much regen and lift and coast in races that they lose temperature, with the spec front brake ducts often taped up for the race!

Add-on vanes

Wrapped around the brakes are bespoke OZ wheels. These 18" rims have small mounting features in-between the spokes for add-on vanes. The launch car sported fan-like 3D printed vanes, which are probably

“The front generator package is not new technology, but it's a first for a single-seater”



ABOVE Monaco, steeped in racing tradition, was the venue for a car seeking to depart from convention

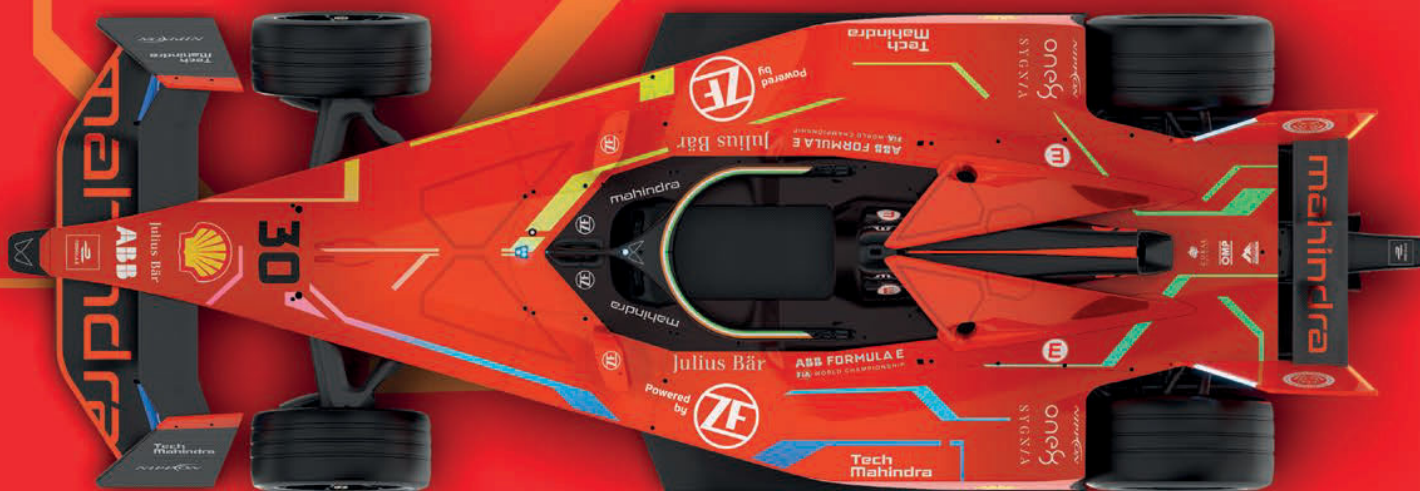
more for obscuring the large gap between brake disc and wheel, or perhaps even reducing brake cooling, than their visually apparent function of cooling.

The Front Generator Unit (FGU) sits inside the front of the tub, which has required additional safety considerations. "We have taken all the safety measures so that the driver is safe in their environment," we are told.

Safety, as with any FIA series, is an ongoing incremental process, Ciliberti affirms: "The FIA's rules cascade down through all the categories, so there's a lot of additional safety tests to make the cockpit even stronger in a crash."

The front suspension is redesigned to package the FGU and narrower track, while the spring/damper ►

BELOW The team renderings, such as this one from Mahindra, portray the new car in a much better light



Mahindra

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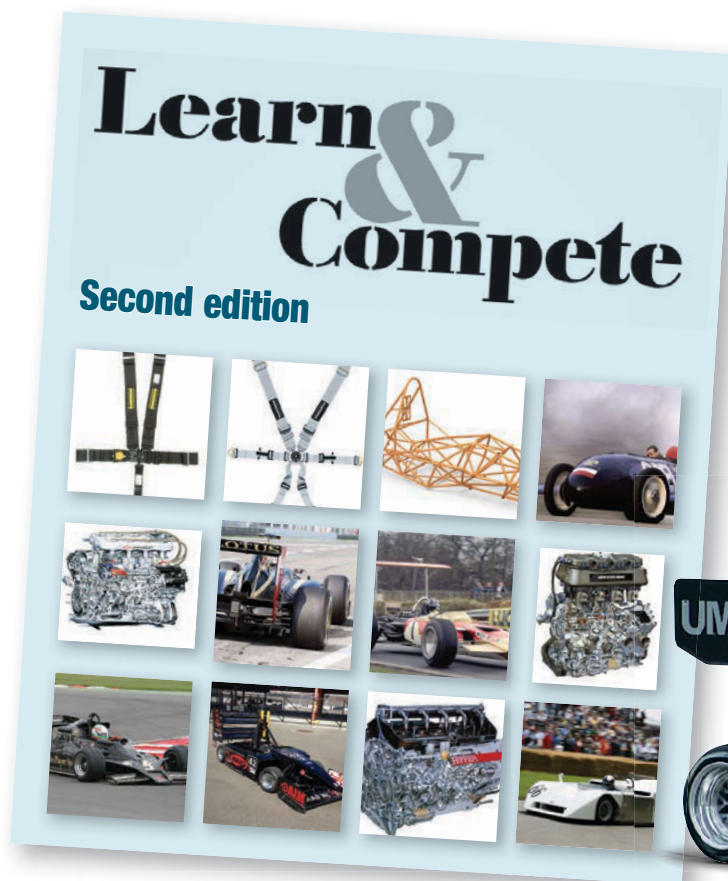
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BELOW Linen and recycled carbon fibre will be used in bodywork construction for the first time in a formula car. The Gen3 will feature recycled carbon fibre from retired Gen2 cars



FIA Formula E

units are arranged differently internally. Only the steering rack is said to be carried over from the Gen2 car.

After racing with a McLaren Applied/Atieva battery for Gen2, the series returns to Williams for the new car. The unit has a lower storage capacity than the Gen2, which is at 54 kWh, despite the same race length and greater power output, as the 600 kW regen accounts for lost capacity. This allows the unit to be even smaller and lighter, according to Ciliberti: "Battery weight is reduced by 100 kg. Although we are running and braking at high power levels, in terms of volume it is much more reduced."

cooling is a major topic we have been investigating while on track in testing."

Teams will still have the same envelope in which to develop their powertrains: mounting the outer carbon carrier to the monocoque's rear bulkhead and the rear impact structure, then installing the MGU, Inverter, DCDC, ECU and transmission inside. Rear suspension remains the inboard springs/dampers and the rear wishbones, track rods and driveshafts out to the spec rear upright.

The bodywork package, looks aside, is an extension of the previous generations of Formula E car. The front wing carries

despite the open wheels." She adds: "That was a challenge!"

Perhaps the loss of a high-mounted rear wing offset the losses at the front? Some additional aero changes are a large inner front wheel blanking plate and reshaped T-Tray splitter, while at the rear the diffuser is still huge, and gains a smaller diffuser trailing off the lower, stepped floor surface.

Distinctive dart shape

Sidepods now feature the distinctive dart shape, the inlets being low down to the side of the front splitter. There again is no coke bottle shape: no external airflow

RIGHT The new car will be the first designed specifically for the rigours of racing on street circuits



“Rear braking effort is wholly managed by regen from the rear MGU. This raises the question of what happens if the rear generator fails?”

This change allows for the car being shorter and lighter overall. The battery's as-yet-unannounced capacity will also allow for some overhead to enable the FGP to regen even on Lap 1, when the battery useable SOC is at nearly 100%. But all of this added power and regen raises the big issue of cooling. While a challenge, this has been countered along the development path according to the FIA: "The cells inside the battery are very efficient, so the heat you will generate will not be as much;

to small adjustable flaps. Along with ride height, they are the only way to tune the car's overall lift/drag figures for each circuit. But gone are the large streamlining front fenders and front wheel bodywork. This seems at odds with the series' aims of efficiency, as the front tyre drag isn't greatly mitigated by the inward-tilted front wing endplate. However, when challenged if the Gen3 car had more drag, Ciliberti refuted this: "No, we had some drag targets and we achieved those,

passes inside the rear wheels, while just inboard are the new vertical fins, largely there as a styling cue and a place to mount the rear-facing LED lights.

It seems that with the Gen3 car Formula E is at the same time both trying to appease any critics with a smaller, lighter, more powerful car, while doubling down on the individuality of the series, remaining steadfastly attached to the city centre street racing theme and radical if challenging styling cues.

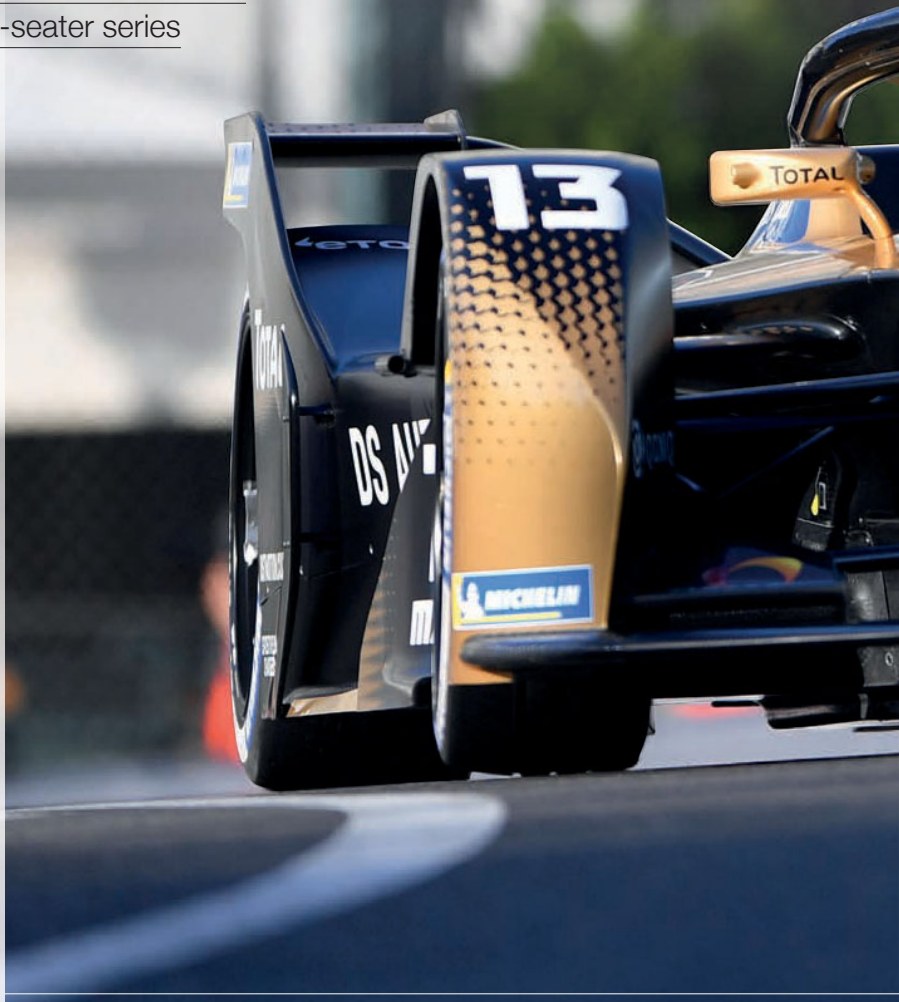
From a driver's and fan's perspective, these more nimble, more powerful cars will be a handful to drive. Given the hard and fast racing we have seen in the series' first eight years, this can only improve the spectacle. **IT**

THE REGENERATION GAME

Formula E's all-new car promises greater efficiency and the equivalent of almost 470 bhp, a figure that would have been considered competitive during the Cosworth DFV era of F1. **Simon Arron** talks to Mark Preston, CEO of the successful Techeetah team, which has been involved from the start in the world's first electric single-seater series

PURISTS cast a cynical eye when the idea of an all-electric single-seater championship was conceived in 2011. When the concept became a reality – with a race around a temporary course in Beijing, China, on September 13, 2014 – the cars didn't look especially fast and made relatively little noise, with the exception of tyre squeal, the distinctive click-clack of the Hewland paddle-shift gearbox and, in a couple of instances, the sound of metal and carbon ricocheting from the concrete retaining walls. And when drivers entered the pits, it wasn't for a two-second tyre swap but to leap into a secondary car, because the battery technology of the day wasn't capable of lasting a 45-minute race distance.

It was motor racing, just not as we'd ever known it. But Formula E has survived – and flourished. For most of its existence it has attracted more mainstream manufacturers than F1. When Audi and BMW withdrew at the end of the 2020-21 campaign (though both remain involved as powertrain suppliers), that still left Nissan, Porsche, Jaguar, DS and Mahindra, plus EV specialists such as NIO and Venturi. And while Mercedes has confirmed that the current season will be its last, McLaren has an option to join the series in 2022-23 (possibly acquiring the Mercedes team's assets) and Maserati has confirmed an entry. ►



BELOW & RIGHT The Gen2 car (below) has taken drivers further and faster than its predecessor. The Gen3 (right) will carry the series to new heights



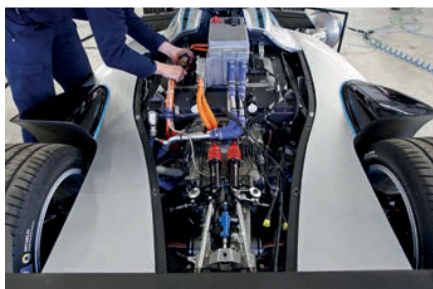
Mahindra



LAT Images/Formula E



FIA/Formula E



The ancient art of car-swapping was cast aside after four seasons, when Formula E switched to its 'Gen2' chassis, which was faster, more powerful and had sufficient battery energy to do what its predecessor couldn't. That will in turn be phased out after this year's season-ending Seoul e-Prix in August, to make way for something yet more potent.

A first for single-seaters

While teams rely on a variety of powertrains, the chassis will continue to be built by French company Spark and batteries by Williams Advanced Engineering. It will be the first single-seater racer to have separate front and rear powertrains, which will combine to produce a total regenerative braking capability of 600 kW, and that in turn means the car will have no hydraulic brakes at the rear. It will be faster and lighter than either of its forebears, with a motor generating the equivalent of about

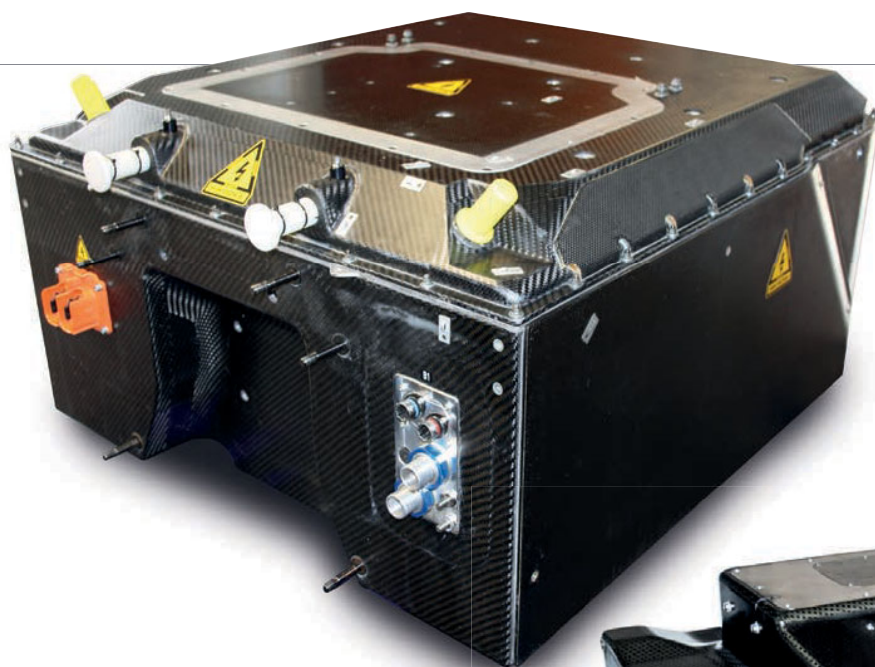
“Working on a car with no hydraulic rear brakes takes us to another world in terms of development”

470 bhp, and it is anticipated that performance will fit somewhere between FIA F2 and FIA F3 on motor racing's traditional internal combustion stepladder. It is estimated that at least 40 per cent of the energy required to complete a race distance will be self-generated.

To discuss Formula E's past, present and future, RACE TECH spoke to Mark Preston, CEO of the Techeetah team that won three straight titles with Jean-Eric Vergne (2017-18, 2018-19) and Antonio Felix da Costa (2019-20) and became champion

ABOVE The technology in the Gen1 car was relatively crude, with teams encountering thermal issues

RIGHT The new series initially reflected the outside world's range anxiety, with car swaps the only way of completing the race distance. Here Jean-Eric Vergne scrambles between chassis



LEFT & BELOW Battery technology for EVs was in its infancy when WAE conceived the first unit for Formula E (left). As technology evolved, so did the cars. The McLaren/Atieva battery (below) enabled the Gen2 car to run the full race distance



team in both 2018-19 and 2019-20. It has been the official partner of French manufacturer DS since 2018-19, though that deal is scheduled to conclude at the current season's end.

Preston might not be an obvious Formula E disciple. An Australian who relocated to Europe to pursue his dream of working in grand prix racing, he spent several seasons with the Arrows F1 team before switching to McLaren when the former folded. He then branched out on his own, with an eye on creating a new team.

"I went to Oxford University to do my MBA (Master of Business Administration) in 2005," he says, "and ▶



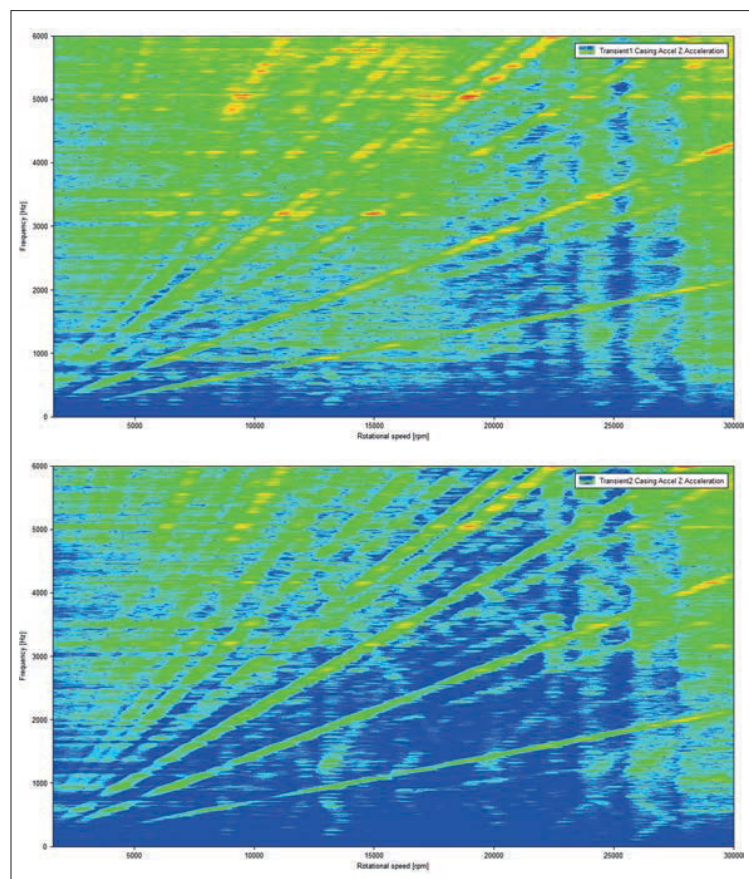
during that time I set up what became the Super Aguri F1 team [in partnership with former grand prix driver Aguri Suzuki]. That stopped when Honda withdrew its support [early in the 2008 season] and after that Oxford University asked me to look at spinning out an electric motor company, YASA, which was taken over fairly recently by Mercedes. That got me involved in all the business planning for electric vehicles and I took the opportunity to have a look at what I thought might help to sustain my favourite business in the long term.

Moment of realisation

"My feeling about motor racing is that it's got to be relevant – and the biggest element is the powertrain's relevance to the real world. As I started doing the electric stuff, I began to look at the changing environmental aspects of the world and the way they were starting to become important. People were playing around with alternative energies and for me there was a realisation: I didn't think things were going to become fully electric, but it was starting to head down that road."

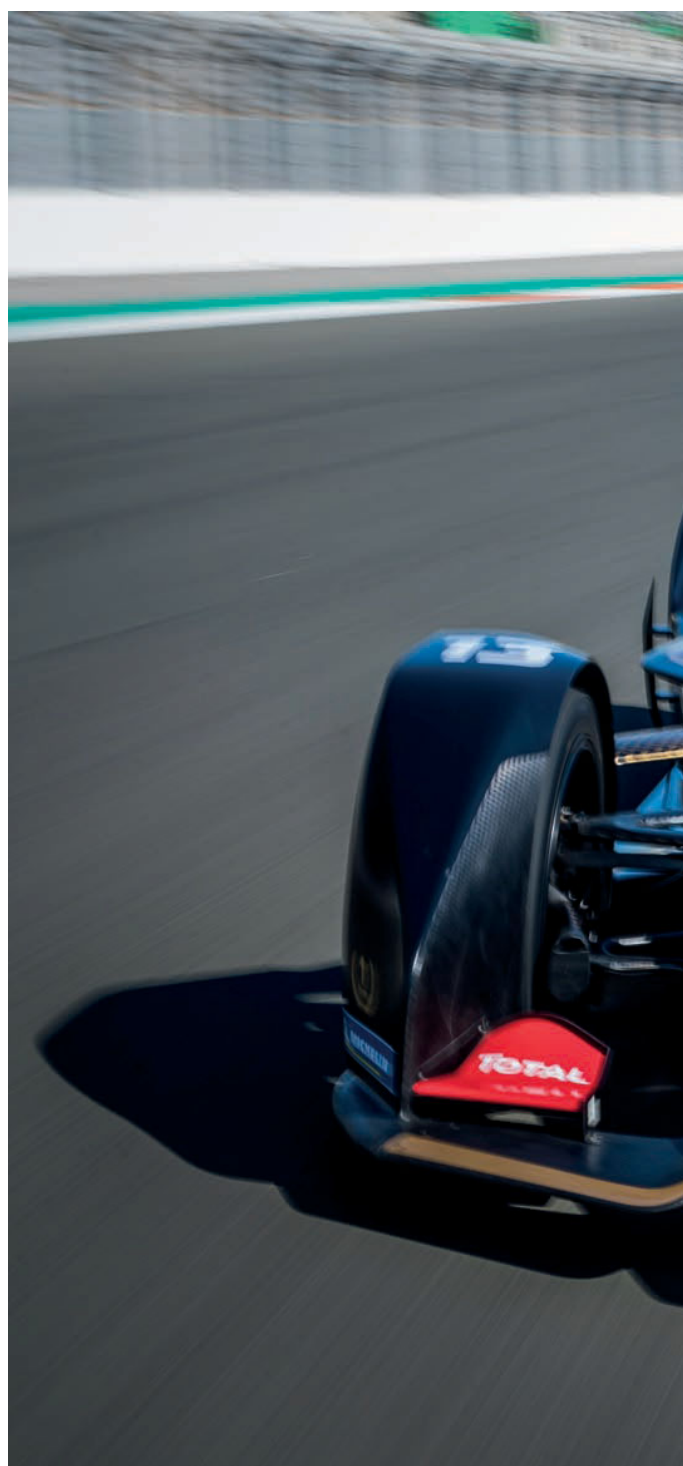
For the second time in less than a decade, Preston went into partnership with Aguri Suzuki, setting up Team Aguri for the inaugural Formula E season – and he stayed beyond 2016, when the team was sold to China Media Capital and renamed Techeetah as Suzuki stepped down.

BELOW Simulation tools have evolved swiftly. Transmission partner Ricardo's GEAR and SABR software enable it to analyse vibration across the casing at different shaft speeds. The colours (from blue to red) show the extent of the vibration, with the natural harmonics of the gears clearly visible as a series of diagonal lines



"Things have moved on quite a lot since those days," Preston says. "If I remember rightly, all our energy calculations were done on a spreadsheet back then and adjusted lap by lap. We probably weren't the worst; some teams might have had fancier spreadsheets, while others didn't have them at all. And we had to be careful not to overheat the stator in the motor whenever we did a qualifying lap – there were all sorts of limitations we don't have now."

"There weren't many changes we could make, either, but every time you delve into more detail you



“All our energy calculations were done on a spreadsheet back then. Some teams might have had fancier spreadsheets; others didn’t have them at all”

learn something that helps make you quicker, so even when things feel as though they’re constrained, you can still find small gains here, there and everywhere.”

Preston believes Formula E’s technical evolution has been “incremental”. Nissan came up with an innovative two-motor powertrain for 2018-19, but the FIA banned it at the season’s end, citing the need to reduce potentially costly architectural complexity rather than stifle innovation.

“In Formula E we have people from many different backgrounds,” Preston says. “Some, like me, have worked in F1, while others have come from DTM, IndyCar, F2 or ►

BELOW Performance and efficiency took a quantum leap as areas of the rules were opened up. A five-year development programme in the real world, aiming to create a 10 per cent efficiency saving from the motors, was completed in just a year of competition in Formula E

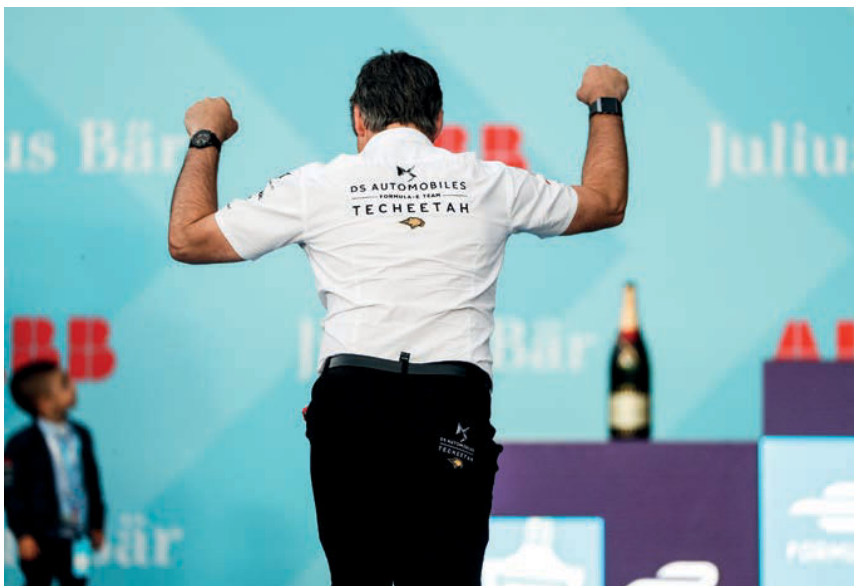


DS Techeetia

wherever. It means we have lots of different ideas we can discuss about stuff that has been tried, successfully or otherwise, in other categories – and that perhaps gives us more confidence to experiment with things such as ‘attack mode’ [which gives drivers a brief shot of extra power] and other elements to make races more interesting.

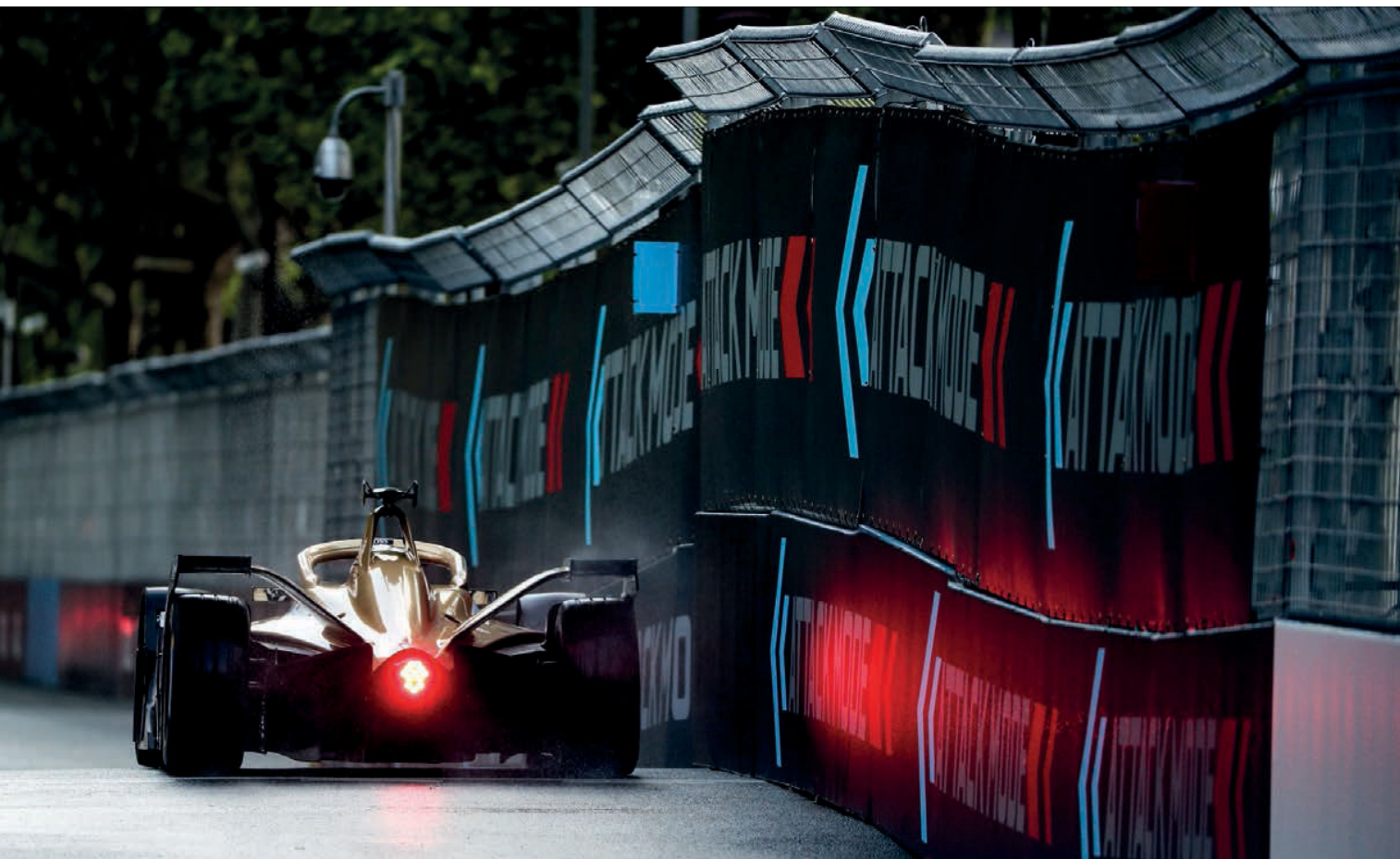
“This could get crazy”

“I don’t think there has been one big game-changer. Progress has been steady, we have developed some good simulation tools and the vehicles are now very, very efficient. We’ve tried to make sure limits are imposed as soon as we see a potential loophole in the rules. We’re the ones that point out, ‘Guys, this could get crazy if we’re not careful.’ Some people will say this should be all about the technology, but you have to remember that Formula E has been around for only a few years – it’s not like F1, which has existed for more than half a century: their budgets are higher, their TV audience is higher and



“Even when things feel as though they’re constrained, you can still find small gains here, there and everywhere”





ABOVE Preston believes the influx of talent from other categories has given the team confidence to experiment with things such as 'attack mode'

ABOVE LEFT Mark Preston steered Techeetah to an unprecedented run of success

LEFT In a series where every last drop of energy counts, transmission efficiency is one of the most significant development areas

their revenues are higher. The best way to kill the series would be to go crazy on technology, because somebody or other would simply come in and spend to the max."

Pragmatism remains the watchword, then, but the 'Gen3' car will be significantly different and throw up a fresh set of challenges

"Working on a car with no hydraulic rear brakes takes us to another world in terms of development," Preston says. "You know, when

I started watching F1 the cars all had turbos – and lo and behold, lots of road cars had 'turbo' badges on the back. Motorsport can generate interest in technology that's good for the road – and what we're doing in Formula E, with power at each corner, could yield competitive advantages for electric cars on the road. I hope one of the manufacturers comes out with a road-going version with those same capabilities, because that will be fascinating." **RT**



RIGHT Simulators have played a vital role in perfecting energy deployment strategies

IS THIS A TEMPLATE FOR NATIONAL MOTORSPORT TO GO GREEN?

The BTCC's new fuel may offer a seemingly modest 20 per cent renewable content but, as **Chris Pickering** explains, the move has potentially big ramifications for the sport





Jakob Ebrey Photographic / BTCC

ABOVE The new fuel offers an 18 per cent reduction in greenhouse gas emissions but also, crucially, a template that could be used in almost any series

LEFT Allen Trusty, senior development chemist at Haltermann Carless, at work in the refinery

THERE'S something of a Wild West feel to road car design at the moment. Fossil fuels look like they're about to be run out of town by an angry mob. The young pretender, tipped to take control, is battery electric propulsion. But biofuels, fuel cells, hydrogen combustion, compressed natural gas and half a dozen others are all riding into town to stake their claim.

Motorsport, on the whole, is simpler. If a car is going to go very fast for a prolonged period, it needs the energy density and rapid refuelling capability of a liquid fuel – at least for the foreseeable future. Of those, biofuels are the easiest option right now, in terms of cost and availability. The fully-sustainable fuel used in the World Endurance Championship, for instance, is 100 per cent bio-derived, while the

World Rally Championship now uses a blend of biofuel and e-fuel.

For these big-budget international series, 2022 is very much the year that fully-sustainable fuels arrived. But in some respects, the challenges are harder when it comes to a domestic series like the British Touring Car Championship (BTCC).

Here, a large percentage of the grid is comprised of independent teams. Even those that do have factory backing aren't operating on a blank cheque. If sustainable fuel is going to work here, it needs to pay for itself, and it needs to be absolutely compatible with the existing infrastructure.

That's why the BTCC's new Hiperflo R20 fuel is significant. Developed by the series' longstanding fuel supplier Haltermann Carless, it may only offer ►

a modest 20 per cent renewable content – said to translate to an 18 per cent reduction in greenhouse gas emissions – but it's a concept that could be extended to almost any level of motorsport. And this is only the beginning.

"As the premier motorsport series in the UK it is only right that the BTCC continues to navigate a more sustainable pathway with introducing a

“A good balance between CO2 reduction and cost control”

cleaner fuel from this season," says Alan Gow, BTCC Chief Executive. "As one would expect from a company so experienced in top-level motorsport, Carless have got this new fuel spot-on and our change to the new R20 Hiperflo has been absolutely seamless."

"The tender process for the new fuel went out in March 2021," recalls Adrian Stuart, performance and sustainable fuels specialist at Haltermann Carless UK. "It was looking ahead to the

introduction of hybrid engines to the BTCC in 2022, and also the roll out of E10 [10 per cent renewable ethanol] pump fuel in the UK. A key part of the brief was to offer a higher percentage of renewable content than you'd get in the pump fuel."

Blends with as much as 70 per cent renewable content were offered as part of a range of options put forward by Carless in the tender. In the end, 20 per cent was chosen as a good balance between CO2 reduction and cost control.

"The BTCC is the pinnacle of British motorsport, but cost is still a bigger factor than it would be in an international championship, and the teams already had the switch to hybrid engines to contend with for 2022," notes Stuart. "This has set a pathway for the championship to become more sustainable at a manageable cost. And we envisage that this sort of technology will become more affordable in the coming years, allowing us to increase the amount of sustainable content."

Fuel specifications

The starting point for the tender issued by TOCA was the FIA's Appendix J regulations. This document defines most of the fuel's basic properties, including

BELOW Haltermann Carless has supplied the control fuel and trackside fuel analysis service to the BTCC for nearly three decades, but the start of the 2022 campaign marked a watershed moment with the focus switching to sustainability



Jakob Ebrey Photographic / BTCC

RON and MON, densities, nitrogen content, sulphur, aromatics, olefins and oxidation stability. TOCA's brief was to base the fuel around these specifications, but to increase the bio content.

One notable caveat was that the concentration of bioethanol was not to exceed 15 per cent. This figure had been chosen as a result of preliminary investigations by TOCA, which suggested it would be a safe limit for the existing engines and fuel systems without modifications.

It made sense to use the full allowance of 15 per cent bioethanol, as this is relatively affordable and easy to source. The remaining bio content in the fuel starts off from ethanol as well, but it is converted into gasoline using the ETG (ethanol to gasoline) process. This results in a series of hydrocarbons that the engine could theoretically run on – minus the additives that are used to optimise performance. But it's an expensive process, at present, which is ►

THE FUEL CELL MANUFACTURER

The headlines promised doom...

THE switch to an E10 ethanol blend in the UK's road car fuel has generated a significant number of headlines, with warnings of perished fuel hoses, metal corrosion and blocked injectors. Ironically, the BTCC's 20 per cent sustainable blend hasn't posed any such issues, although its impact on the fuel system has been thoroughly evaluated.

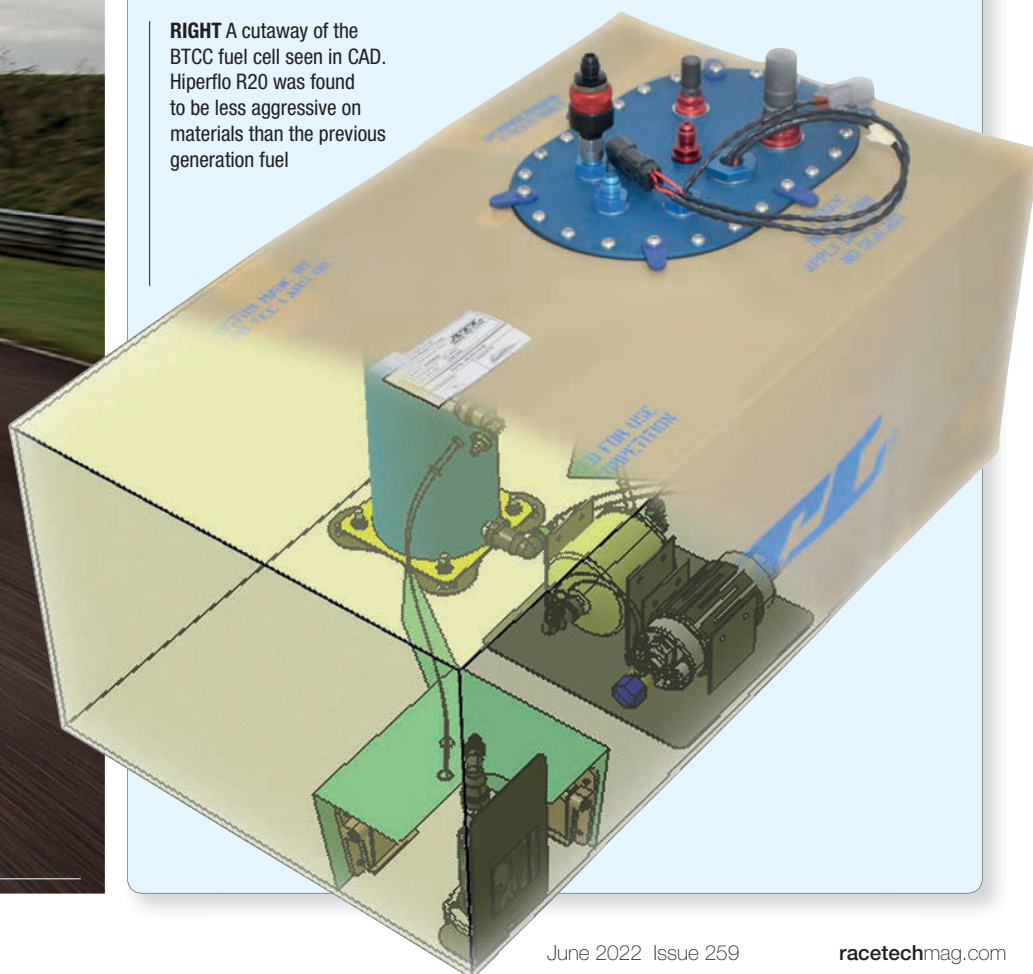
Fuel cell manufacturer ATL carried out an extensive investigation on the tank and the associated fuel system. This included tests on the pumps, filters and seals within the tank.

"The BTCC was one of the first championships proactively testing a fuel with truly renewable components. That allowed us time to really understand the fuel and any potential effects and changes we may need to make to the fuel system supplied to the championship," explains Giles Dawson, managing director of ATL.

The first priority was to check the fuel's compatibility with the bladder material. In comparison, the other lifed elements of the system, such as pumps, filters and seals, could be adapted relatively easily. But the bladder itself is a long lead time component that's critical to the design of the tank.

"Our initial focus was accelerated age testing of the proposed fuels using a test method based around the Arrhenius equation," notes Dawson. "This is an increased temperature soak test that simulates the physical and chemical aging process of long-term fuel exposure. The Hiperflo R20 was actually seen to be less aggressive on all materials than the previous generation BTCC fuel. That was great news for TOCA and the teams, as it meant that nothing needed changing. The Hiperflo R20 has proved to be a true drop-in fuel from the outset." **RT**

RIGHT A cutaway of the BTCC fuel cell seen in CAD. Hiperflo R20 was found to be less aggressive on materials than the previous generation fuel





LEFT In 1859, the chemist Eugene Carless set himself up in Hackney Wick, in what is now Central London, as a distiller and refiner of mineral oils. He founded the company Carless, Capel & Leonard and developed a new volatile product which was marketed under the name "Petrol". The company was acquired by Petrochem in 2000 and renamed Petrochem Carless before being merged with Haltermann in 2013

have options like toluene and xylene that are available on the market. There's a similar flexibility when it comes to olefins. So we have the freedom to achieve the same specifications in perhaps 10 or 15 different ways, but they won't all perform as well in reality. It's up to the formulator to really find the chemicals that give the best RON, the best distillation profile and so on."

Perhaps not surprisingly given the adherence to Appendix J, the fundamental characteristics of the new Hiperflo R20 fuel are said to be very similar to its predecessor, Hiperflo 300. The RON, MON, aromatic content and ▶

why it accounts for just five per cent of the overall fuel blend.

Running an increased percentage of ethanol brings its own challenges too. Ethanol has a higher oxygen content than standard gasoline, allowing more fuel to be burnt (and more energy to be released). The effect is similar in principle to nitrous oxide injection, and it's sometimes dubbed 'chemical supercharging'. However, the downsides are increased fuel consumption and the additional calibration work that's necessary to adjust to the new blend.

"We have the freedom to achieve the same specifications in perhaps 10 or 15 different ways"

The remainder of the fuel is comprised of various ready-formed gasoline components, along with an array of additional hydrocarbons, including aromatics and olefins that are blended to achieve the properties laid down in TOCA's brief.

Engineering freedom

Although the Appendix J specifications might sound prescriptive, the reality is that they still offer plenty of room for engineering freedom, as Allen Trusty, senior development chemist at Haltermann Carless, explains: "Within the pure aromatics, for instance, we



ABOVE The introduction of the new fuel could result in a reshuffling of the competitive order down the pit lane, as would a switch of fossil fuels

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THE ENGINE BUILDER




Keeping IC engines racing

ENGINE builders are an innovative bunch. But they are also acutely aware of the cost implications that can come with change, so news of TOCA's plans to introduce a sustainable fuel capable of reducing greenhouse gas emissions by 18 per cent was received with a degree of apprehension, according to Mountune managing director David Mountain.

"We've previously used some other fuels containing ethanol that have exhibited some real issues relating to the fuel system and the seals on the engine itself," he explains. "We were also concerned that we didn't have much headroom for extra fuel-flow on our direct injection engine."

The Mountune engineers began dyno testing last year and they were immediately impressed by an increase in mid-range power, he says: "One of the first things we noticed was that the knock limit had been raised, so we could increase the ignition. We also found the increase in fuel flow to be much smaller than expected, so it's looking very promising at this stage."

Since the original dyno test work, Mountune has continued its explorative work with the fuel, testing further on both the dyno and in the car.

"We're pleased to report we've seen none of the usual issues we had seen in the past, with either the fuel system, or the engine seals," comments Mountain. "We fully understand why the BTCC wanted to move forward with a more sustainable fuel – ultimately, we all need to do our bit in reducing greenhouse gases while keeping IC engines racing for many years to come. To that end, we'd like to congratulate Carless fuels for being able to produce an excellent fuel that does just that." 

olefins, for instance, are understood to be very close. Typically, the significantly higher oxygen content of a bioethanol blend leads to a richer stoichiometric ratio, but there's said to be little difference to the older blend.

Testing times

Once an initial blend had been formulated, Carless sent samples out to the engine suppliers – Mountune, Swindon Powertrain, Neil Brown Engineering and M-Sport – as well as fuel cell manufacturer ATL. The feedback was universally positive, and the new fuel was actually found to be less chemically aggressive on fuel system components than some ethanol-free blends. "We think that was due to some of the more exotic components we'd used, especially the aromatics," notes Stuart.

This draws on knowledge from an ongoing research programme at Carless, which had alerted the chemists to potential pitfalls when blending renewable fuels. In previous projects, for example, they had identified certain components that could lead to oil dilution issues in direct injection turbocharged engines when used in high concentrations.

"We have an ever-growing portfolio



LEFT Mountune engineers were immediately impressed by an increase in mid-range power on the dyno

RIGHT The new fuel will be manufactured for the BTCC by Haltermann Carless at its refinery in Harwich, Essex, UK

BELOW Haltermann Carless is working hard on the development and implementation of renewable and sustainable fuels in all areas of its business



“If sustainable fuel is going to work here, it needs to be absolutely compatible with the existing infrastructure”




of sustainable fuels, and as part of the BTCC tender we've already submitted a fuel which is up to 70 per cent sustainable," comments Stuart. "We will be in constant dialogue with TOCA throughout this year and the next, and it will all be about weighing up the costs versus the benefit of the higher sustainability content."

The next few years could be transformative for the fuel industry, Trusty points out: "It's a very interesting time when it comes to buying fuel components. A lot of manufacturers are increasing their production capabilities, and also working on new sustainable components. In, say, five years' time, we expect the availability and cost of those components to be very different to today."

Faster burn rate

As for the current season in the BTCC, the new fuel has the potential to cause a shake up between the constructors, Stuart

believes: "The feedback we've had from one of the engine builders is that they've found the new fuel has a faster burn rate, despite the increased oxygen content, so they've been able to add more ignition into the engine. Others might choose to raise the static compression ratio instead. The differences aren't huge, but it does sound like it's given enough scope for the individual engine builders to pursue different options – just as they would if the series switched from one fossil fuel blend to another."

The TOCA engine balancing process is designed to provide a level playing field, giving each engine design the same theoretical potential to produce power. But as Stuart says, the job of realising that potential falls to the individual engine builders. Some may adapt to the new fuel more effectively than others. And with an ongoing push towards greater sustainability, it's likely that they will face similar challenges again in the future. 

BANDWIDTH BATTLEGROUND

Simulation and digital technology are playing a bigger role than ever before as squads race to understand the new generation of Formula 1 cars. **Chris Pickering** talks to the team behind the design of Ferrari's new simulator

NOT even Mattia Binotto, Ferrari's Team Principal & Managing Director, could have predicted the Prancing Horse's change in fortunes so far in this year's Formula 1 World Championship.

As we go to press, the Scuderia has a commanding lead in both the Drivers' and Constructors' championships, earned firmly on merit with the new F1-75.

As early as the Barcelona test in February, it was clear that the car had potential. With such a dramatic departure for the rules this season, Binotto spoke after the test about the importance of collecting data on track and establishing correlation with the wind tunnel

and the simulator. It's this correlation that ensures the advancements made by Ferrari's engineers back at Maranello translate to performance gains on the track.

"Since the morning of day one we were collecting data, which I think is important because the cars are so different," he told the media at the Barcelona press conference. "The objective of the session was to try to map the car in all the conditions, to try to understand the correlation with the wind tunnel and the simulator."

The simulator in question is rumoured to be the most sophisticated in Formula 1. And it comes not from the hills of Modena or



“It’s nuts to try to conduct useful experiments with a machine that adds maybe 50 per cent to the driver’s reaction time”

ABOVE Where horsepower and suspension used to be the differentiators on the racetrack, factors such as latency, bandwidth and smoothness are increasingly becoming the key battlegrounds

from Silicon Valley, but from a small company on the outskirts of Bristol.

Dynisma was founded in 2017 by ex-F1 engineer Ash Warne. His motorsport career began in 2007 when he joined McLaren Racing as an aero modeller. A stint in performance engineering soon followed before he moved onto the team’s simulator programme.

“I remember the first time I saw a driving simulator in action, back in 2007. It was this futuristic robotic system, and my jaw just dropped,” he recalls. “The thing I found

fascinating was the complexity of it. You’re trying to trick as many of the human senses as possible into believing that they’re involved in the driving process.”

Warne was promoted to team leader of the programme in 2011 and held the post for more than two years before leaving to join Ferrari as a senior vehicle dynamics engineer. It was there that he met Nik Garrett, now Dynisma’s head of driving simulation, who was running the simulator team in Maranello at the time. ►

Three pillars

Warne claims that Dynisma's simulators offer a step change in realism over the other systems on the market. But this is less a revolution, and more a case of re-evaluating three core aspects that are already hot topics among simulator manufacturers: latency, bandwidth and smoothness.

It's sometimes suggested that modern professional simulators react fast enough to render any remaining lag between the software, the hardware and the driver insignificant, but Warne believes a lot of providers are still underestimating this effect.

"We're able to provide feedback to the driver within three to five milliseconds, which is literally an order

“You're trying to trick as many of the human senses as possible into believing that they're involved in the driving process”

of magnitude less than some of the competition," he says. "At that level, it's literally indiscernible, but you don't need much more than that for a skilled individual to pick up on it."

Elite athletes can react in around 150 milliseconds. So although the latency of most professional simulators is now comfortably below that level, they can still perceptibly add to the response time, Warne argues: "If you've got 50 or 60 milliseconds of latency, and some simulators do, then you're adding that to their reaction time. It's nuts that anyone would expect to put a world champion racing driver inside a simulator and try to conduct useful experiments with a machine that adds maybe 50 per cent to their reaction time."

In the past, Warne comments, some teams have taken to dialling understeer into their simulator setups, because even professional test drivers have struggled to maintain control with a more aggressive setup.

The next challenge is capturing the full range of frequency content that would be experienced in the real vehicle, he says: "Increasing the bandwidth means that you can transfer more information through to the ►

BELOW & RIGHT

Ferrari's flying start to the new season has been aided by a simulator it claims offers a "generational leap"





driver. A lot of simulators cover a range of 15 to 20 Hz. That's enough to capture the natural body modes of the car itself, but what people overlook is that there's a lot of high frequency content in there too – it's attenuated by the suspension, but it's still there and humans are incredibly sensitive to it."

Delivering this additional frequency content comes down to the design of the actuators, the simulator chassis and the control system. The actual displacement can be very small – too small for someone watching the simulator to perceive – but the frequency is key to giving information on surface texture and vehicle ride.

Accurate cueing up to 100 Hz

Dynisma's simulators are said to provide accurate cueing up to 100 Hz (with up to 400 Hz said to be possible at lower precision). It means that when the driver crosses from an older part of the circuit to a newly surfaced section, for instance, they can feel the difference.

When it comes to simulator motion, Warne emphasises the need for quality rather than quantity: "A lot of simulator manufacturers seem to be focusing on offering bigger and bigger motion ranges. But

the feedback we're getting is that the amount of displacement is not as important as the quality of motion in terms of the fidelity offered by the simulator."

This is also where the third factor, smoothness, comes in. Dynisma says it has gone to great lengths to eliminate sources of coarseness or mechanical noise. This encompasses the whole mechanical and electrical design of the system, including the motion control algorithms, the actuators and the joints.

"Cars are inherently very precise instruments. If you had suspension that kept binding up every few degrees, it would feel horribly jerky and the car would become unpredictable," comments Warne. "We've taken the same design cues and philosophy in the ►

BELOW & INSET

Ferrari's first objective with the new car was to map it in all conditions to better understand the correlation with the wind tunnel and simulator



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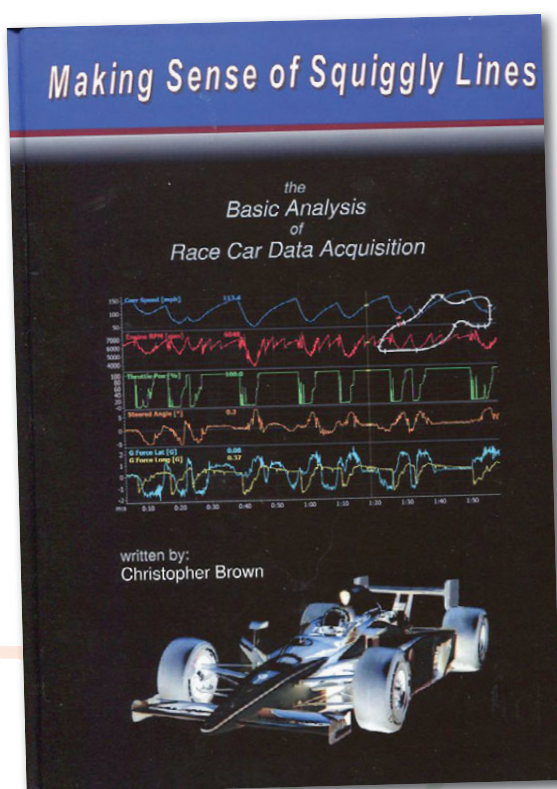


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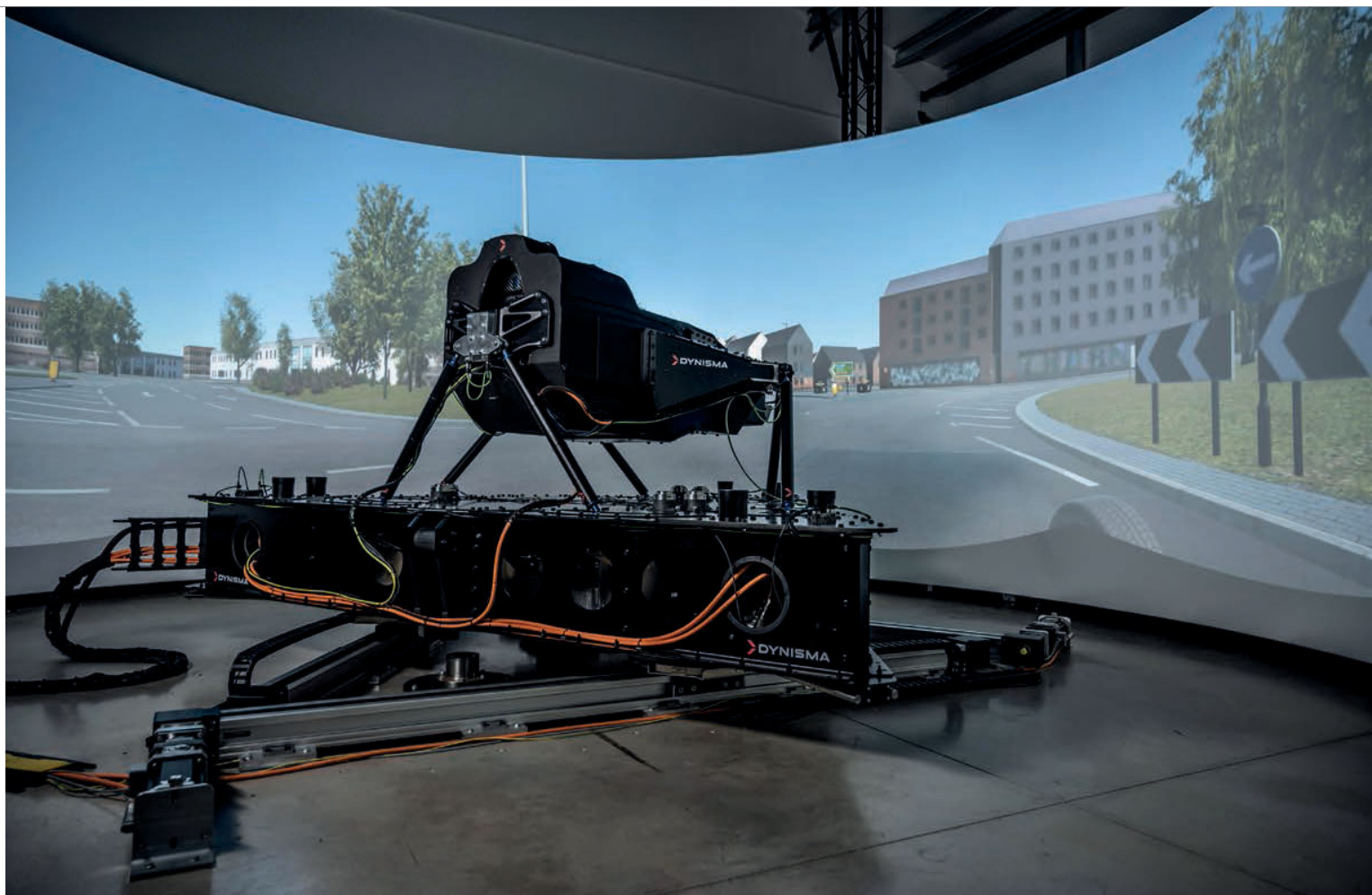
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mechanical design of our simulator, so it moves in a very smooth way. That way there's no background chatter to mask small details in the feedback."

The end result of optimising these three key areas, Warne claims, is that drivers receive a broader range of information, with a higher degree of fidelity and no perceptible lag.

"The bandwidth of the signals and the smoothness of the motion means that drivers can detect smaller changes in the car's balance. So, for instance, they can feel the onset of oversteer sooner, while the lack of latency means they can respond to it quicker," he comments. "As a result, they can now run a setup in

ABOVE Where the trend is for OEMs to use multiple simulators, optimised for different aspects of driving, motorsport versions have to deliver good all-round performance

BELOW The arrival of the new simulator has helped free up resources to aid the young talent in the Ferrari Driver Academy

the simulator that's every bit as oversteery as the real car and they can do lap after lap without spinning off. That makes the experiments much more valid for motorsport applications, where you're dealing with cars that respond very quickly."

Scalable concept

Dynisma designs and builds its motion platforms in-house. The two other major components that go into a simulator are the terrain model, which defines the simulated environment (often based on lidar scans of real roads or circuits) and a vehicle model, which simulates the physics of the car itself.

The terrain model generally comes from an external provider such as rFpro, which is one of Dynisma's official partners. The physics models are often built in dedicated vehicle simulation packages such as Adams Car or Canopy. The latter is another partner of Dynisma, founded around the same time as the Bristol firm by three ex-McLaren Racing engineers. Formula 1 teams and large automotive OEMs, however, tend to develop their own models in-house using a general purpose simulation package such as Simulink or Modelica.

"We're totally agnostic in terms of the software that people use," comments Warne. "It does present more of an integration challenge when customers use their own bespoke models, but they tend to be people who have a very deep understanding of vehicle modelling, ▶



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As real as it gets

OUR visit to Dynisma wouldn't be complete without a chance to sample the firm's DMG-1 simulator. Pitched predominantly as a motorsport machine, it sits roughly in the middle of the company's range, with a 45-degree yaw capability, 4 to 5 milliseconds of latency and a bandwidth of 55 to 100 Hz across all degrees of freedom.

You climb in via a removable set of steps and drop down into the cockpit – in this case a Formula 4 tub from Italian constructor Tatuus. It's predictably snug and you sit heavily reclined, both of which feel slightly at odds with the fully-rendered cockpit of the road car model that we begin with.

The giant wraparound projector screen occupies your entire field of vision, bringing rFpro's model of the Spa Francorchamps circuit vividly to life. We accelerate off the line with the growl of a simulated V8 and the pitwall flashing by at increasing speed.

As with all simulators, there's a slight disconnect between the acceleration that you can see (and hear) and that which you can feel when accelerating hard in a straight line. That comes down to the inherent limitation of modelling sustained acceleration in a finite space – you can only accelerate for so long before you run out of room.

This can lead to some simulators feeling downright disorientating, but the DMG-1 manages to reconcile these conflicting cues more effectively than most. Nonetheless, it still feels like someone has flicked a switch the first few times you enter a corner – suddenly the immersion is absolute. Go in too quickly and you can feel the nose washing wide; ride the kerbs and their texture fizzes back through both the steering and the seat; get on the gas too early and the tail will flick out with a vicious spike of oversteer.

After a few laps learning the circuit, we swap to a Formula 1 vehicle model. It feels like the world has gone



into fast forward, and the bumps in the track now hit home with greater ferocity. But what's surprising is how approachable it is when driven with a degree of prudence.

Through the long sweeping corners you can edge up to the limits of front-

end grip progressively. Accelerate too hard out of La Source or the chicane and the revs will flare and the rear end snaps sideways, but it's still possible to catch. The fact that a (very) amateur driver can do this after 15 minutes of practice is testament to the immediacy of the simulator's responses. At home on the Xbox, I have no doubt I would have been in the wall many times already.

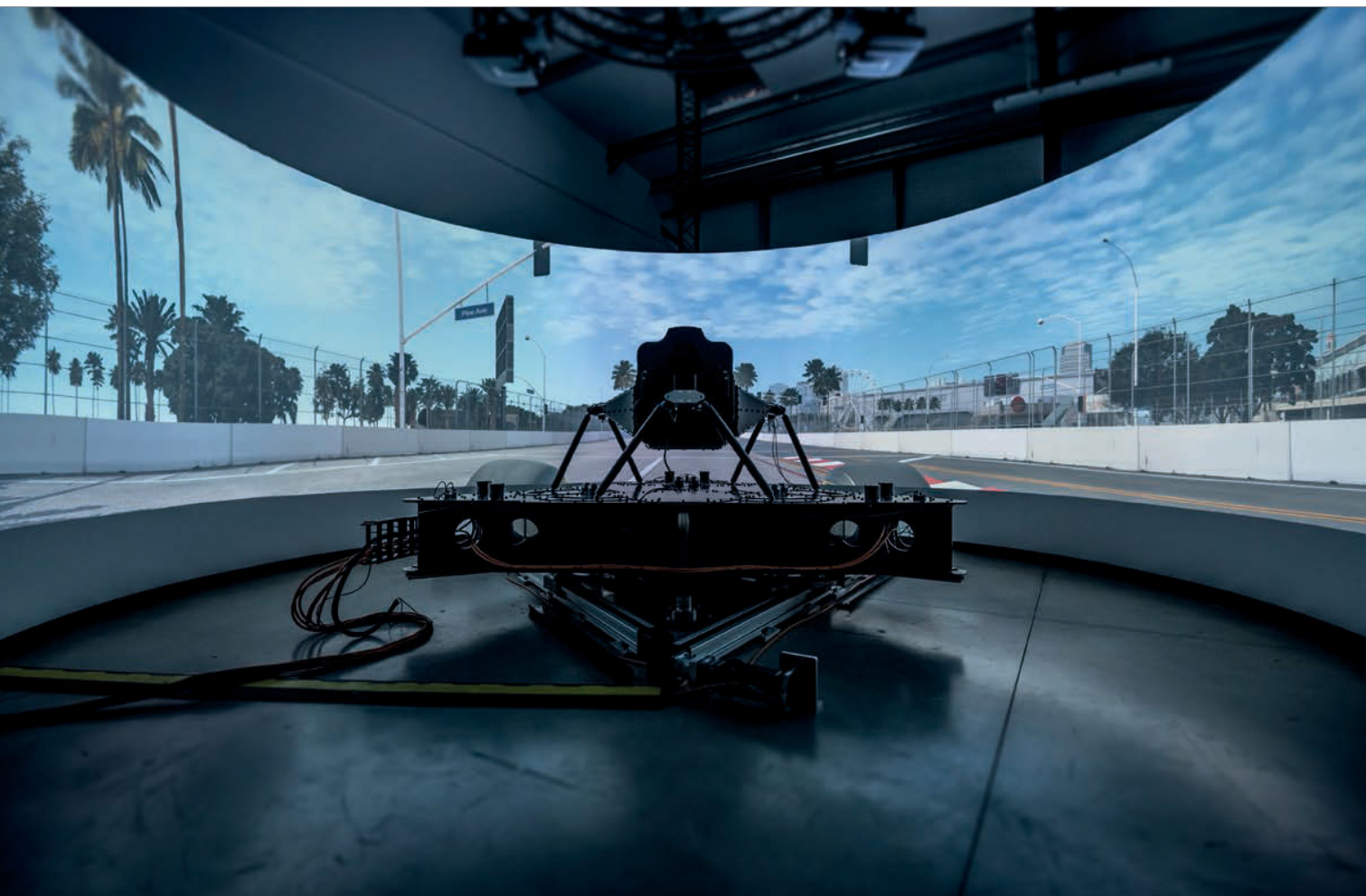
A funny thing starts to happen as the session progresses. Having got comfortable in the simulator, I attempt to chip away at the 20-second deficit between my own times and those of a proper racing driver. I don't get very far, but the more I commit to the task, the less I seem to lose immersion going down the straights.

By the end of the session, I'm concentrating too hard to register any awareness of the fact that I'm in a computer simulation. Short of strapping someone into an actual Formula 1 car, this is about as real as it gets. **RT**

ABOVE Dynisma was founded by ex-F1 engineer Ash Warne



ABOVE Dynisma makes extensive use of composites in the development of its Dynisma Motion Generators and custom payloads for its customers



ABOVE The technology in Dynisma's new simulators is hailed as a game-changer

so the expertise is there to support that integration."

While most driving simulators were once developed primarily for motorsport, the last few years have seen road and race systems diverge somewhat. The three core elements of bandwidth, smoothness and latency are common between both disciplines, Warne notes, but the exact capabilities of the motion platform are increasingly tailored to its intended usage.

"There's a trend in motorsport for unlimited yaw

“A step-change in realism”

capability – allowing the simulator to spin right round without recentring itself. That's something we can do with our technology," he comments. "There's also a difference in payload capacity, going from maybe 250 kg for the tub on a motorsport simulator to 750 kg for a high-end road car system."

Dynisma's hardware is designed to scale through these various applications. Plus, as Warne points out, road car simulators generally require lower acceleration rates, which means that the actuator loads can be very similar for the heavier systems.

Another point of differentiation is that motorsport simulators have to deliver a good all-round representation of all the cues fed to the driver over the course of a lap, from riding the kerbs and cresting inclines to limit handling. Automotive OEMs,

however, are increasingly purchasing more than one system (BMW, at the last count, had 14 in its new simulator centre Munich, all optimised for different aspects of the driving experience).

Level of accessibility

Dynisma's modular approach and scalable architecture is designed to help the company respond to these various different requirements. Warne believes it is also helping to make world-class simulators more accessible.

"In the past, the best motorsport simulators were developed in-house by the top Formula 1 teams. But now anyone can buy a machine that features the same actuation concept and the same control system that's used in F1," he comments. "We're also building some – using those same concepts – for customers in lower levels of motorsport, so it's opening up a level of accessibility that wasn't there in the past."

The exact details of the simulator sold to Ferrari have not been disclosed, but a press release on the team's website describes it as having 'the lowest latency and the widest bandwidth of anything currently on the market'. Someone at Maranello clearly agrees that these are key to capturing that all-important correlation to the real car. And if current form is anything to go by, the work that the Italian engineers are carrying out in their simulator is certainly paying off. **ti**

MEET THE GUVNOR

Anthony Peacock quizzes the man tasked with delivering the long-term vision for a sport embarking on the biggest sustainability push in its history

ANDREW WHEATLEY is the proud owner of a Ford Puma rally car, with which he's enjoyed some success. But not the state-of-the-art M-Sport Rally1 car that won Monte Carlo this year. Instead, it's a 20-year-old 1.4 example. And that makes him perfectly placed to take on the biggest job in rallying, which he's been occupying since just after the start of this year.

So what does the FIA Rally Director do? "That's what I'm finding out!" he jokes. And this underlines one of the Welshman's biggest strengths in his new and often delicate role: a lightness of touch, allied to a gentle humour, that puts people instantly at ease and enables a productive exchange of views without the heated opinions that can often come to the surface in a high-pressure, big money, sporting environment.

Radical change

"What I believe the job involves is taking one step back and taking a general look at the direction in which we're headed," he says. "It's very easy to get caught in the day-to-day, and not be able to take the time to consider what's coming in the future months and years. So, for me, it's all about looking at that long-term vision, with as wide as possible a view."

Wheatley takes over the role from Yves Matton, formerly head of Citroen Racing, who presided over the introduction of the current rules during his tenure of nearly four years. The Belgian left before they came to fruition, but Wheatley is experiencing a period of even more radical change: within the sport, within the automotive industry as a whole, and also



FIA/DPPI

LEFT New FIA Rally Director Andrew Wheatley

within the FIA itself – as Mohammed ben Sulayem and Robert Reid (both former rally champions) take over at the top of the federation.

So it's hard to say what will come next, even though the FIA is more emotionally invested in rallying than it has ever been, and there's currently a bit of breathing space with the latest technical rules introduced this year, which will remain in place until 2024. But, in regulatory and planning terms, that's tomorrow.

By the end of this year, the teams will need to know what the future holds, to fit in with a two-year development cycle. And the main issue is, as

“Should the technology shape the sport or the sport shape the technology?”

Wheatley points out: “Nobody is really sure what the energy source will be in 10 years' time.”

This means that he is shooting at a moving target. Is the future fully electric? Hybrid? Hydrogen? Or something completely different, like e-fuel? That's actually happened already, with the WRC adopting fossil-free fuel this year: a big change

for the engineers, which nonetheless nobody has really noticed from the outside. This is the sort of evolutionary approach that Wheatley favours, because above all, the sport has to give manufacturers and teams what they want. That rarely equates to radical change.

Luckily, Wheatley knows exactly what the priorities are, because for nearly 20 years he worked at M-Sport, ending up as business development manager: a company that relies on customer business to survive. It's an experience that had a profound effect on him, because he's firmly focussed on building the FIA 'pyramid' of progression in a way that benefits those at the bottom in particular, as well as those on the top.

Next big step

“That's the next big step,” Wheatley says. “Rally1 is more or less where we want it to be, but now we have to look further down. If I have an opportunity to use my previous experience it's because I've been very lucky in my previous roles to have quite a wide view. I've worked directly with the teams, where all you're really interested in is what affects you in that very minute, and also on the wider commercial side to understand how to maximise the business opportunities of rallying.

“But I've looked at the sport through the eyes ▶

BELOW The three current manufacturers run very different cars, yet with close levels of performance



WRC/Red Bull

Will a WRC driver save your life one day?

THE intention behind the latest regulations is to make rallying more road-relevant and the series more accessible – and therefore more affordable – for manufacturers, but also to act as a genuine test bed for new technology. Toyota, the current championship leader, is making full use of these new opportunities by using the World Rally Championship to help develop its autonomous driving systems, for example.

Tom Fowler, Toyota's technical director, points out: "Most autonomous systems at the moment can process data up to a certain point until the vehicle is out of control, and then they will say 'I can't do this anymore' and hand back control to the driver. That's actually how normal humans work: in many road accidents, the driver isn't doing anything at all in the final moments.

"That's not how a rally driver operates, though. We collect a huge amount of data from the drivers on all the events, in terms of their thought processes and how they physically drive the vehicles. In many situations, the vehicle goes beyond what it is physically capable of but is then returned to a stable state thanks to the inputs of the driver. These same inputs could be used by autonomous vehicles in order to make sure that the vehicle does absolutely everything possible to recover a situation on the road right up to the point an accident is inevitable."

So you never know. One day in the future, Sebastien Ogier might just save your life. **RT**

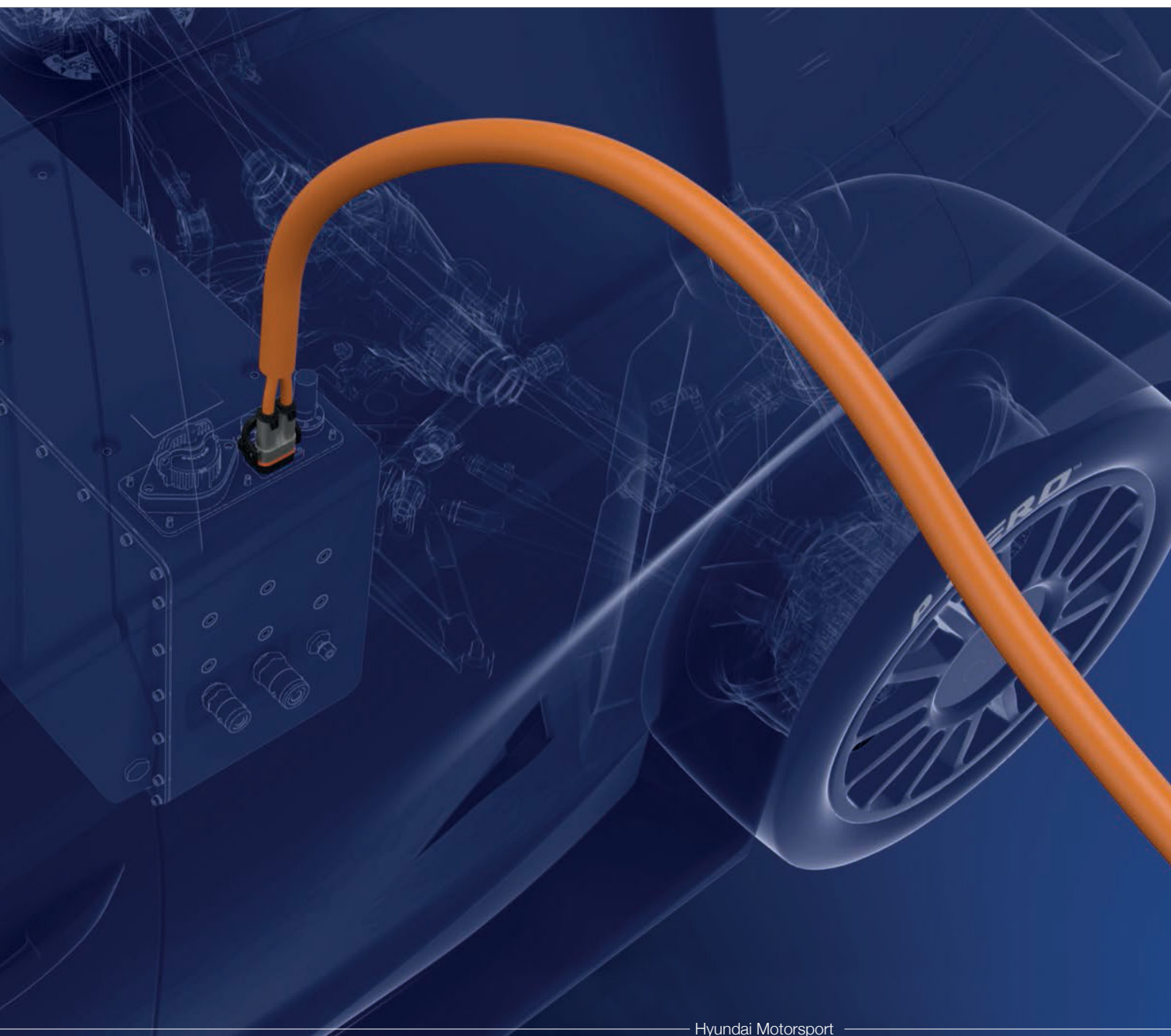
BELOW Data from the WRC pilots, used to recovering from unusual angles, is helping drive Toyota's autonomous advances



Toyota GAZOO Racing

ABOVE Charging is just one of the new technologies changing the service park in the WRC's sustainability push

RIGHT The fact that the battle for the WRC3 class went to the last stage of the final rally last season underlined the health of the junior ranks



Hyundai Motorsport



WRC/Red Bull

“Is the future fully electric? Hybrid? Hydrogen? Or something completely different?”

of a budding competitor as well, experiencing the thrill and the joy of competing – which I still feel now. Rallies don’t exist for just 20 cars. They’re there for much bigger numbers. And that’s what I really hope to maintain and build. The health at the bottom of the sport reflects that of the top, because that’s where you find the next generation of national heroes.”

After leaving M-Sport in 2019, he joined the FIA as category

manager: so this was a ladder of talent that he personally helped to put in place.

Wheatley’s own success is also a triumph for the FIA itself, as he too is the product of a home-grown system, just like the structure it is putting in place to enable talented young drivers to rise to the top.

Wheatley’s style is considered and consultative; he has weekly meetings to discuss the future formula – because this is the ►

inexorable rate at which technology is evolving. But the teams have already proved that they are capable of adapting to the challenge, after a successful debut for the latest formula this year – in which everything was brand new and more open.

“You’ve got the Toyota Yaris city car, the Hyundai that is a C-segment car, and the Ford Puma that’s a crossover SUV,” Wheatley points out. “Right from the very beginning of the year, we had these very different types of car fighting within the same second. People underestimate how difficult that is to achieve.

Health check

“Go down a class, and we saw Kajetan Kajetanowicz and Yohan Rossel fighting to decide the WRC3 championship on the very last stage of the very last rally in Monza last year. The fact we have ►

RIGHT The new rules cut costs for the manufacturers, without dumbing down the technology



Hyundai Motorsport

BELOW How we interact with the sport is one of the aspects likely to change the most over the coming years

“The FIA is more emotionally invested in rallying than it has ever been”



WRC/Red Bull

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such close competition all the way through the field is an indicator of the health of the sport.”

But you can't take that for granted. Wheatley is determined to continue pushing and keep fighting to secure the long-term future of world rallying.

Less drag

The new rules for WRC this year were widely anticipated to make the cars slower, but that's not actually turned out to be the case, if you take a holistic view. Yes, it's true that in some places the cars are slower, but in other areas they are actually quicker – the decreased reliance on aerodynamics has led to less drag, for example, making the cars quicker on the

“The latest technical rules remain in place until 2024. But, in regulatory and planning terms, that's tomorrow”

BELOW The frenzied Group B era demonstrated the immense global fandom that world rallying could command

straights (despite being heavier).

Averaging it all out, the first three WRC events were run at about the same speeds as last year: but we're only at the beginning of the development cycle. And these new Rally1 cars are taking over from where the previous WRC family – the fastest rally cars in history – left off, despite being an entirely new technical concept.

There are some very big decisions ahead. If, for example, the sport wants a fully-electric championship, then the format of the events will have to change dramatically.

But is that right when many of the markets visited by the WRC have still to embrace electric power? If you wanted to charge an electric car in the media centre car park on Rally Croatia, for example, you'd need around 300 metres of cabling to the nearest power point.



WRC/Red Bull





ABOVE The new WRC cars are at the start of their development cycle, but already the technology of their replacements is under consideration

RIGHT Wheatley still competes himself when time allows

And should the technology shape the sport or is it the sport that should shape the technology? Being Rally Director also involves asking these very existential questions.

What's almost certain to happen is that the next generation of World Rally Cars will be a slightly more electrified version of what we have already, but nothing unrecognisable compared to what we see today. Time is also running out for new manufacturers to get involved before the next rules cycle. So don't expect anything too different at the top of the tree, but there's scope for more drastic reform at the grass roots.

Insanely popular


Instead, it's how we see and interact with the sport that might change most, just as it has already done over the last decade. We can now watch every car on every stage live via the internet. As Wheatley says: "When I first started in rallying, you still had films couriered back on motorbikes and nobody really knew what was going on."

Despite that fact, the sport was still insanely popular: so popular, in the case of Group B, that they actually had to ban it. So just imagine the audience that it could reach now, with everything being interconnected? WRC Promoter has

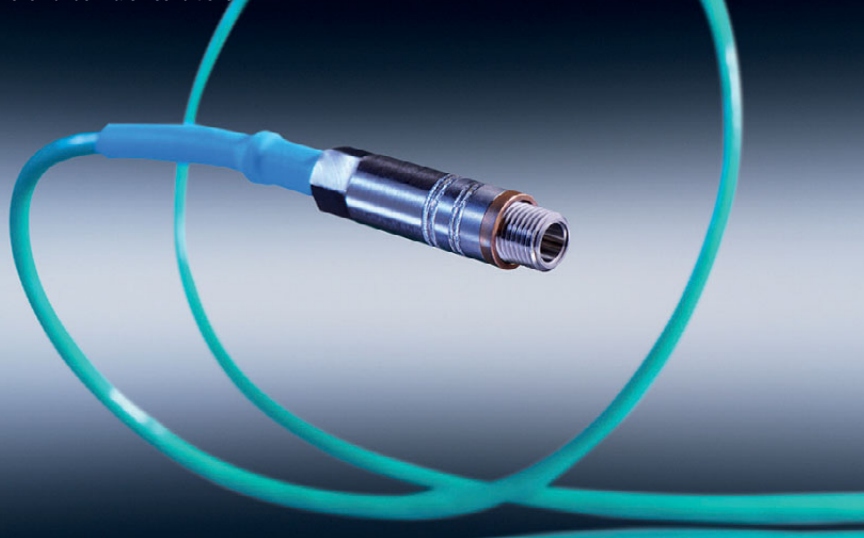


Courtesy of WRC.com/Jack Morris

taken over the promotion of the European Rally Championship this year, so expect a more joined-up and easily digestible approach to the way that the sport is marketed and presented as a whole. There might even be an intersection between live sport and gaming, for example, allowing fans to 'take part' in the actual event, at the same time that it really happens.

The Group B era showed the immense global fandom that world rallying could command. Wheatley, who grew up during that time and felt the thunder of those incredible machines, knows the sport can reach those heights again. 

BELOW The new 4017A delivers outstanding accuracy even under harsh conditions



The world's smallest piezoresistive, media-isolated pressure sensor

Kistler's latest release is all about minimal space, maximum applicability

KISTLER'S new 4017A piezoresistive absolute pressure sensor combines excellent measuring features with universal applicability. Thanks to its compactness, innovative design and outstanding media compatibility, it is optimal for use in engine development as well as hydraulic and pneumatic applications, in both hot and cold environments.

Piezoresistive (PR) pressure sensors consist of a silicon-based Wheatstone bridge which changes its electric resistance when exposed to pressure. This PR effect means that the sensing element is free of drift to a great extent – and is ideal for capturing static pressures. The PR pressure sensors can also be used for dynamic pressure measurements due to their ability to capture rapidly changing pressures even in low-pressure ranges.

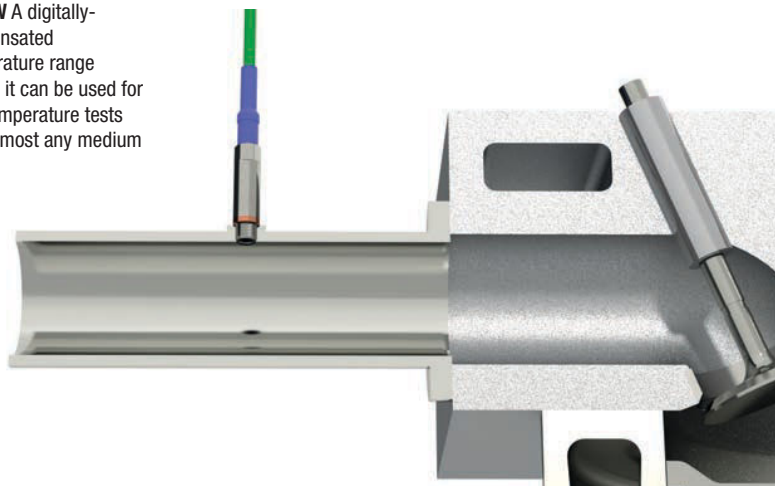
That is why such sensors became a standard choice in automotive applications, where precise measurements in the engine air and fuel path are required – but also for subsystem development

such as brakes and cooling applications, that require high precision sensing.

Precise measurements

With the new 4017A, Kistler says it is taking pressure measurement technology to the next level: the miniature absolute PR pressure sensor has a mounting size of only M5 x 0.5 and was specifically


BELOW A digitally-compensated temperature range means it can be used for low-temperature tests with almost any medium



designed for maximum robustness and accuracy. Its oil-filled measuring cell is media-isolated by a stainless-steel diaphragm and delivers a very high level of media compatibility for both gaseous and liquid media.

With a compensated temperature range from -20°C to $+140^{\circ}\text{C}$, the new sensor can also be used for low-temperature tests. The digital temperature compensation allows a high level of accuracy ($\leq 1\%$ FSO), even in harsh environments. Sensor health monitoring (operating temperature: -40 to $+180^{\circ}\text{C}$) is possible during measurements, due to the integrated temperature measuring element.

Its sophisticated design allows for a very high resistance against contamination, along with easy cleaning and maintenance. When applied in high-temperature environments, such as exhaust manifolds, the 4017A can be installed with a water-cooling adapter (deliverable as an accessory from Kistler). The new media-isolated sensor is available with different measuring ranges for pressures up to 5, 10, 20 or 50 bar. Optionally, it can be delivered with an ATEX certificate (Zone 2) suitable for applications in potentially hazardous areas.

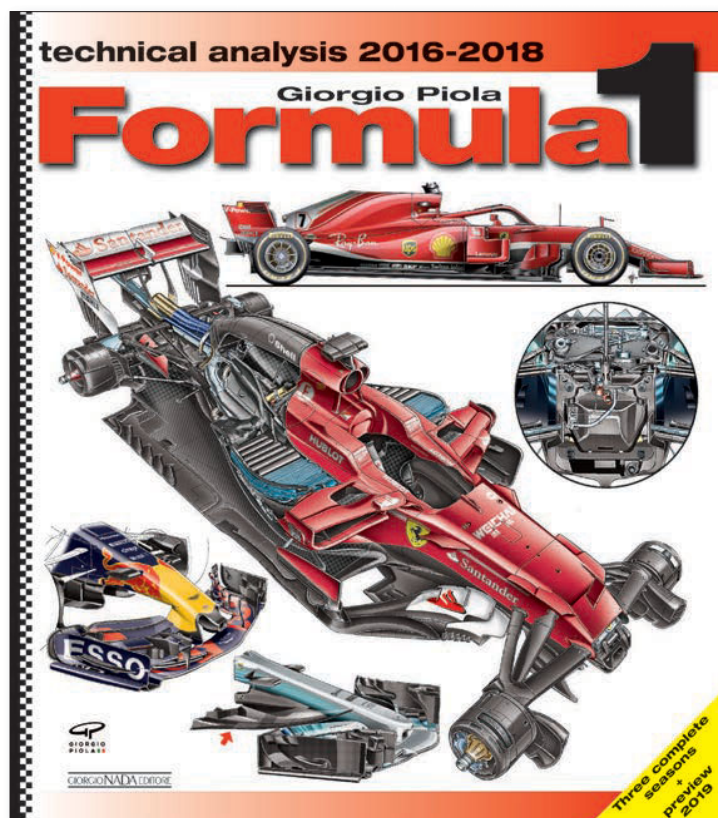
The new 4017A miniature pressure sensor is 100% compatible with its predecessors of series 4005 and 4007. The PiezoSmart technology from Kistler offers automatic sensor identification and eliminates any risk of errors due to manual setup and handling during daily use. The measuring chain can be completed with Kistler's piezoresistive amplifiers of types 4665B (module for SCP, KiBox1), 4667A (module for KiBox2) or 4624A (stand-alone one-channel unit). 

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MY 'I HAVE A DREAM' MOMENT



Why the unveiling of Formula E's ambitious Gen3 car struck a chord with **Sergio Rinland**

MONACO offered a fantastic backdrop for the launch of the long-awaited Formula E Gen3 contender. Much fanfare accompanied the unveiling of a car that left me feeling 'we are getting there'!

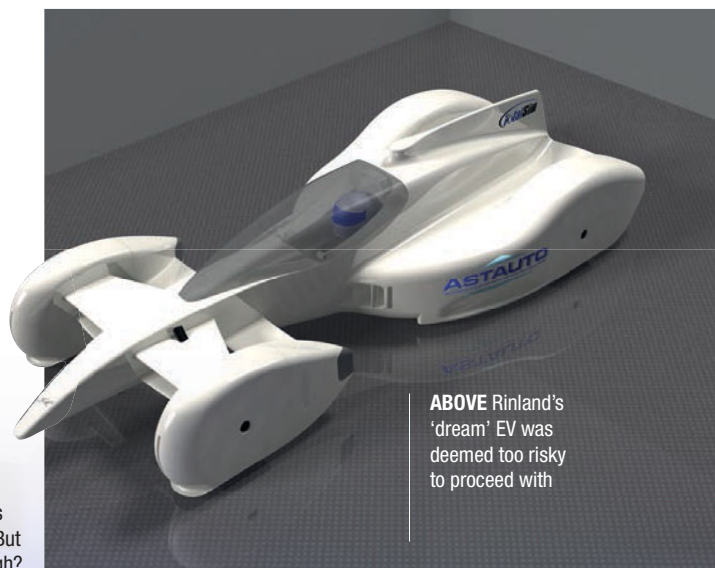
Ten years ago I experienced what was, in Martin Luther King terminology, my 'I have a dream' moment. That dream was to have an electric race car which would represent the latest and greatest technology available at the time and offer a road map for the immediate future. The road map was based on progress being made in battery technology, the main limitation of any electric

vehicle and a race car in particular.

That dream led me to research and envisage such a race car. It was the start of something that occupies most of my professional time today: EV development. After a research period a design was produced, which was then presented to some people who deemed it too ambitious. Perhaps it was!

My proposal was for a single-seater with one onboard motor per wheel, torque vectoring technology instead of a mechanical differential, 370 kW of total power, light weight (obviously) and an aero package targeted to be as low drag as possible to achieve speeds of up to 350 kph. It was designed with full ground effect and no wings. Yes, very ambitious!

But CFD studies and simulations proved it was possible. With a 45-kWh battery of the technology at the time we could have managed a very short ▶



ABOVE Rinland's 'dream' EV was deemed too risky to proceed with

BELOW Formula E's Gen3 car is brave. But does it go far enough?



“Designed with full ground effect and no wings, ‘my dream’ was very ambitious! But simulations proved it was possible”

FIA/Formula E

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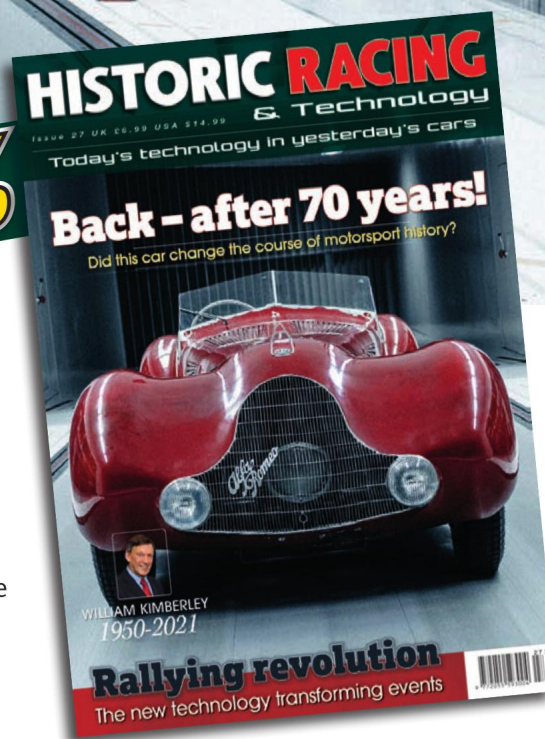
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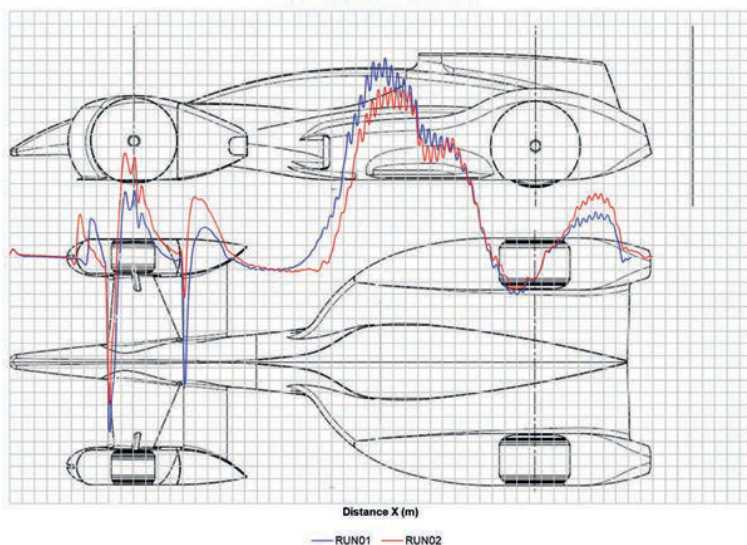
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Downforce Distribution



(15 to 18-minute) race, at similar performance to a GP2 car of the time, on a proper race circuit like Silverstone or Barcelona.

To achieve such aero performance, it had fully covered wheels (fronts would turn with the fenders) and a full canopy for drag reduction and driver safety. It had other fancy features such as cameras instead of mirrors, intelligent materials to reduce drag or increase downforce in selected places and intelligent tyres for lower rolling resistance and temperature management.

Ambitious? No doubt. Expensive? 'Tell me how much you want to spend and I will tell you how fast you can go!' as the old adage says. Of course it would have been.

So, after seeing the Gen3 specs, I say: 'We are getting there!'

ABOVE Simulations proved the wingless design would work

BELOW Jaguar's render of what the new Gen3 could look like in team livery

The Formula E rule-makers (and designers at the same time!) are still shy about allowing torque vectoring, hence one motor per wheel. But at least we will now have a motor (or perhaps better to term it a generator!) at the front axle so regeneration will take a big step forward.

Batteries have advanced in leaps and bounds in the last 10 years, so now we can have a 600-kW battery weighing what a mere 300/400 kW version would have been a decade ago. The energy recovery will therefore be much higher than 'my dream', with a power level that would render mechanical brakes almost surplus to requirements.

Why do I say 'almost' surplus? The announcement from Formula E and the FIA has a very ambitious target: no rear mechanical brakes! Is that possible? Yes, with a 350 kW MGU at the rear, it is possible. Nevertheless, is it a good idea? Not in my book.

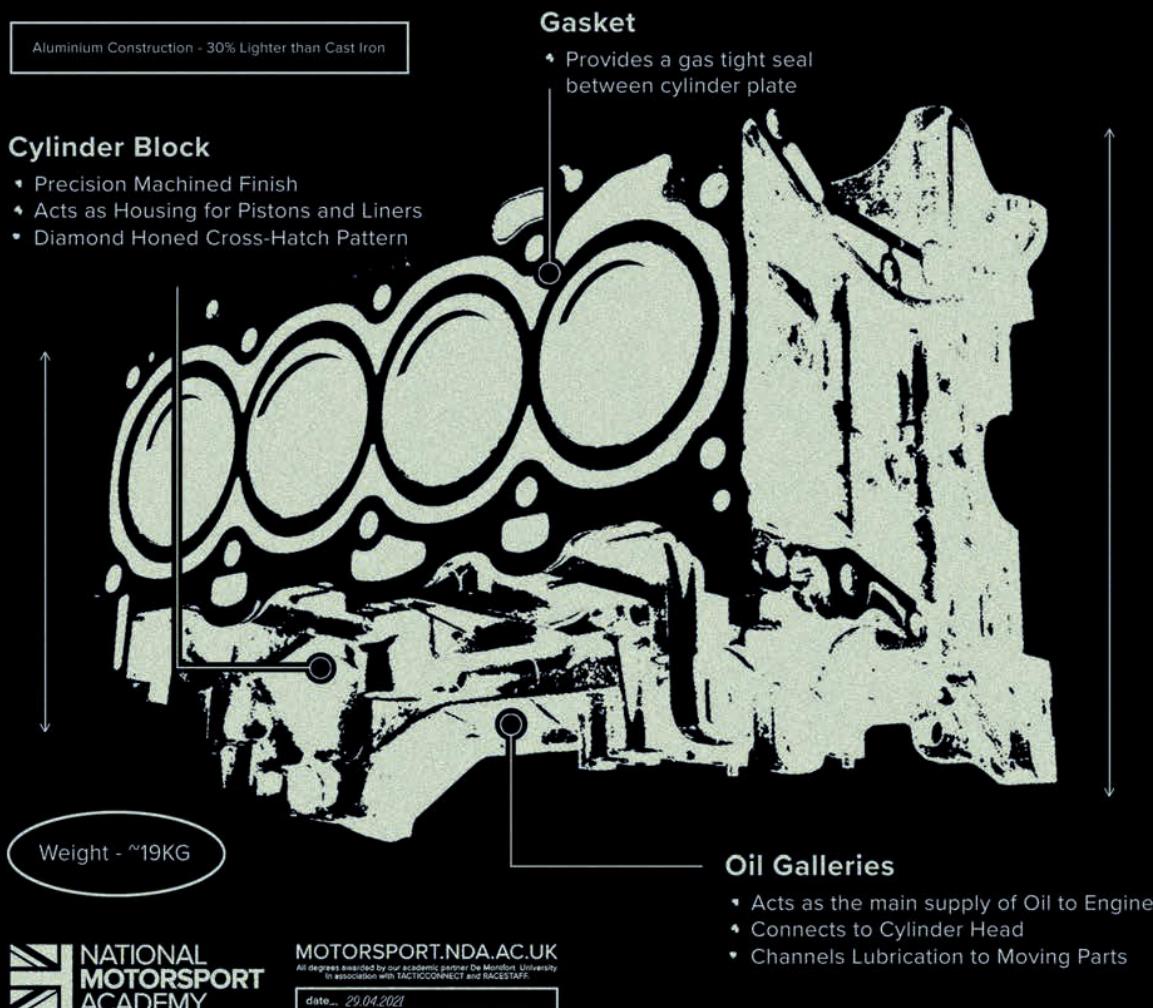
What would happen if, coming to the end of a straight at 322 kph (as they claim the car will achieve), you have an electronic black out? You will be left with just mechanical brakes at the front, none at the rear and a very unstable vehicle. Is this a smart idea? I don't think so.

Safety comes first. You don't do things 'just because you can'; you do it if it is a sensible idea and doesn't come with such a high risk. Time will tell...

Looking at what we have been shown so far of the Gen3 car, I would say again: 'We are getting there'. But still we have uncovered front and rear wheels, which would account for around 25/30% of the overall drag – too much just for a 'tradition'.

Other features looked draggy as well and visually not very attractive to my conservative eyes. Will the air like it? Time will tell.... **ti**





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