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OFF-ROAD BUT ON-MESSAGE

BRITISH Formula 1 World Champion grabbed the headlines this month. But it was Jenson Button, not Lewis Hamilton, and the genesis of the story owed more to the spartan surroundings of Lydden Hill in Kent than it did the magic of Monte Carlo. Jenson's decision to enter (and drive for) his own team in Extreme E is the culmination of a long-held love of off-road competition, inspired by the rallycross feats of his father, John, in a VW Beetle. The car used to terrify Jenson whenever it started up.

Lydden was a cold, muddy and sodden theatre of dreams, but it was where Jenson's racing passion was fired. Now it will lead him not to an ageing 200 bhp Beetle, but to a single-speed ODYSSEY 21 SUV powered by identical 275 kW electric motors front and rear – enough to accelerate on the loose from 0-62 mph in 4.5 seconds.

Button's deal is another major coup for an Extreme E series that now boasts no fewer than 10 World Champions from different disciplines among a star-studded entry list. Proof once more that Alejandro Agag, also the creator of Formula E, has a magic touch.

The 'green' credentials of Extreme E are beyond dispute, so it was intriguing to see another off-road competition, the epic Dakar Rally, announce its own plans for a more sustainable future.

When Extreme E's latest team owner was winning his F1 World Championship in 2009, complete with the contentious double diffuser, the Dakar Rally was experiencing its own technical breakthrough: the first victory for a diesel engine.

VW's success was a remarkable technical achievement at the time. Now,

looking back through the fallout from 'Dieselgate' and the stampede from ICE to EV technology, it's hard to believe that of 2009's two technical landmarks, it was the double diffuser that was the controversial one!

But times change, and so do attitudes.

Our excellent feature this issue on the BRX Hunter rally-raid car reveals that when Prodrive's engineers considered what powerplant to use, 10 of the previous 11 Dakar events had been won by turbodiesel engines. So perhaps it's little wonder that the event's organisers are at last embracing a greener future.

Their plans are ambitious: the creation of a specific "alternative energy" category by '22, to put the focus on competitors racing in hybrid, electric or hydrogenpowered cars and trucks; all Elite competitors in the car and truck categories to meet ultra-low emission standards by '26; amateur competitors to meet the same standards from 2030.

Can they keep to that timeframe? How do they devise a Balance of Performance that juggles those different technologies? How do they adapt to the whims of manufacturers who can be here today, gone tomorrow?

Many questions remain, then, but one thing is beyond doubt: it's fantastic that one of motorsport's last great adventures is at last moving with the times.

William Kimberley **EDITOR**







MCLAREN DELVERS FORMULA E "VOTE OF CONFIDENCE"

McLaren elevated Formula E technology to new levels as a supplier. Now it could enter as a team. By **Mark Skewis**

cLaren Racing's interest in Formula E has handed the all-electric series a huge boost as it bids to recover from the loss of Audi and BMW.

McLaren Racing and Formula E have signed an agreement granting the iconic team an option to enter the ABB FIA Formula E World Championship when Formula E's Gen3 kicks off in Season 9. Part of McLaren Racing's ongoing evaluation of potential new motorsport platforms, the agreement provides McLaren the option to enter the championship as one of a maximum 12 entries for the 2022/23 season.

"McLaren Racing securing an option to join the Formula E grid from Gen3 is testament to the ongoing impact of our sport," suggested Alejandro Agag, founder and chairman of Formula E. While McLaren's entry is by no means a done deal, the agreement carries echoes of the manner in which Mercedes eased its way into the series. It offers the perfect opportunity for Formula E to bounce back from a turbulent period before Christmas that saw it rocked by the withdrawal of two major manufacturers in as many days.

Although this would mark McLaren's first official entry into the series as a team, it has been instrumental in developing the technology that has enabled the championship to prosper. And perhaps therein lies the rub: think of the names people associate with the series – Techeetah, BMW, Audi, Mercedes, Porsche, Williams, Mahindra etc – and how far down the order would McLaren come? **ABOVE** The Gen2 battery supplier is poised to enter the series as a team when its fourseason contract concludes at the end of the 2021/22 season

RIGHT There are more than 5,000 cells within the Gen2 battery pack produced by McLaren and Atieva



MOTORSPORTS protessional

By contrast, success on the city centre streets as a team in its own right could offer immediate kudos and a 'halo' effect for the McLaren brand.

SILICON VALLEY

McLaren Applied Technologies (MAT) was part of the first generation of the FIA Formula E car supply chain. It developed the Motor, Inverter and ECU for the Season1 car and the TAG400i ECU remained a widely adopted unit thereafter.

However, it was MAT's development of the battery pack for the Gen2 car – in collaboration with Atieva, based in Silicon Valley, and Murata – which provided Formula E with its biggest technical breakthrough (see sidebar).

"The scale of the task was daunting," admitted Rodi Basso, MAT motorsport director at the time. "The state-of-theart technology allowed us to achieve the result, but the known unknowns were quite big, so the level of risk we were undertaking was exciting and quite frightening at times!"

Arguably, McLaren's pivotal role in

carrying the category to a new level has been confined to the shadows as the series itself gained an ever-higher profile.

Williams Advanced Engineering is developing the battery for the championship's Gen3 car, which takes to the track from the 2022/23 season. This frees McLaren to pursue the opportunity of entering a team in its own name.

"We've been closely observing Formula E for some time and monitoring the series' progress and future direction," said Zak Brown, chief executive officer of McLaren Racing. "The opportunity to take an option on an entry and the completion of the McLaren Applied supplier contract with the FIA at the end of Gen2, gives us the necessary time to decide if Formula E is right for McLaren as a future competition platform."

So what requirements would make Formula E "right" for McLaren?

When he first raised the prospect of McLaren considering an entry as a team, Brown said: "[It is] the same criteria that we have on IndyCar: do we think we can be competitive? Do we think it's commercially and fiscally sustainable?

How McLaren revolutionised Formula E

WIN or lose if it enters the series as a team, McLaren has already played a key role in the Formula E success story.

A supplier from the very start of the series, it was instrumental in the game-changing introduction of the Gen2 package that more than doubled the energy of the battery.

Range anxiety has dogged the introduction of EV technology across the globe, and motorsport was no different. But McLaren's Gen2 battery – delivered in collaboration with Atieva in Silicon Valley, California and with Murata – enabled drivers to complete a full 45-minute race distance for the first time without an embarrassing car swap.

Furthermore, where WAE's Gen1 batteries suffered reliability problems in the face of vibration, heat and degradation, its McLaren-inspired successor achieved a 100% reliability record in its first season.

The exact cell specification in the 54 kWh 880v battery pack is a sensitive subject. However, the cell is known to be a small format cylindrical unit, around the size of a 'AA' battery, hence the significant number -+5,000 – of cells inside the battery pack.

Cooling was an important aspect achieved with a Bosch electric pump and a radiator cooling circuit featuring a dielectric fluid, Novec - but so too was the software. "The real secret sauce is the Battery Management System (BMS) and the software behind that," revealed Atieva CEO Peter Rawlinson in an interview with RACE TECH. "All this coding is really the veins and arteries of the system." "A large part of the battery pack is the science of integration," said Rawlinson. "You'd think it's mainly an

electrical engineering discipline; actually, 80% of it is mechanical engineering!"



Can McLaren be competitive? With efficiency the performance differentiator in a series laden with manufacturers, and a field in which all 24 cars were split by less than 0.8 seconds on the final day of preseason testing, it would be hard to establish a new team and immediately hit the ground running.

However, there is potentially a way to fast-track the process. In Formula E's sister series, Extreme E, Brown's United Autosports team has partnered with Andretti Autosport to form Andretti United. Andretti perhaps provides the most likely route for McLaren to enter FE too. The squad has run BMW's works operation, but repeatedly stressed its ambition to remain in the series after the manufacturer's departure at the end of the season.

That Formula E fits the McLaren brand is beyond dispute. The company has always prided itself on its innovative technologies and sustainability credentials, so would appear the perfect fit. Furthermore, McLaren Automotive is adopting hybridisation for its road cars.

That leaves the "commercially and fiscally sustainable" clause as perhaps the greatest obstacle to McLaren's entry. However, Formula E had already instigated cost-cutting measures when COVID

McLaren has contributed immensely to Formula E's success"

shortened its last campaign, with the planned Gen2 Evo facelift becoming a casualty.

NEWS

The need to address escalating budgets was further highlighted when Audi and BMW withdrew. While the Gen3 era promises lighter cars with improved performance and rapid charging, greater fiscal controls will go hand-in-hand with that new era.

"McLaren has contributed immensely to Formula E's success as suppliers of our Gen2 battery systems," acknowledged Jamie Reigle, chief executive officer of Formula E. "We now look forward to working with McLaren Racing to demonstrate the sporting and commercial potential of Formula E and devise ways to elevate the series to a new level, as part of their evaluation."

Reigle referred to McLaren's interest as "a vote of confidence in the championship".

The ABB FIA Formula E World Championship will make its Season 7 debut in Diriyah, Saudi Arabia with two night races on February 26/27.

BELOW McLaren's expertise helped get the Gen1 powertrain up and running in the first place





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HEWS



THE Envision Virgin Racing Formula E squad has been announced as an Official Partner of the UK Government's climate change campaign.

The collaboration, ahead of the COP26 Summit in Glasgow this November, is part of a plan to make EV vehicles more 'mainstream' as the UK counts down to the end of the sale of petrol and diesel vehicles by 2030.

The team's two race cars will carry the 'Together for Our Planet' and UK Government branding in this year's Formula E World Championship.

The Silverstone-based outfit, owned by greentech company Envision Group, will be involved in several key initiatives across the year under its 'Race Against Climate Change' sustainability programme. These include a series of digital events in the run up to COP26, a children's competition to design an environmentallyinspired race suit to be worn by the team's drivers, plus activities at the Formula E race locations around the world.

Alok Sharma, COP26 President Designate, said: "I am delighted Envision Virgin Racing are taking the Together for Our Planet campaign 'on tour' and inspiring people around the world to take urgent climate action ahead of COP26.

"We know that electric vehicles are greener, cleaner, and better for the planet. To meet the targets of the Paris Climate Agreement, we need to clean up the air we breathe by doubling the pace of transition to zero emission vehicles."

Envision Virgin Racing's Managing Director Sylvain Filippi commented: "Envision Virgin Racing, Formula E and the UK Government are all at the forefront of the EV revolution, especially with so many personnel, vehicles and infrastructure based and built right here in the UK. As such, we are honoured to be joining forces with what is the most important climate event of the year and playing a pivotal role in encouraging motorists to make the switch and, more importantly, tackle ABOVE & BELOW The collaboration with the race team is intended to encourage the switch to zeroemission vehicles climate change before it is too late.

"Through the exciting platform of motorsport, we're able to showcase the true potential of electric vehicles as we compete in cities across the globe, developing innovative technology that will filter from the track to the road and accelerating the adoption of EVs."

He added: "Now, after just a few seasons of competition, we are seeing the impact of this with global EV sales rising from 330,000 from when the championship first began to 2.17 million in 2019. Even during the bleakest of economic times,

> sales rose 185% last year in the UK alone and EVs have outsold petrol and diesel cars in Norway, for example, showing that EVs are about to become mainstream and play a key role in reducing carbon emissions."

The Envision Group's pioneering innovation work in areas such as smart wind

technology, battery development and AloT infrastructure has seen it earn an array of sustainability credentials. It is the first company in mainland China to commit to 100% renewable electricity by 2025.

Franz Jung, Vice President of Envision Group and Chairman of the Board at Envision Virgin Racing, added: "As with Envision Group, the team has sustainability running through its DNA, so we are fully supportive of this initiative. As well as being certified carbon neutral, we were also the first motorsport team to sign the UN's Framework Convention on Climate Change and are one of just a handful of teams to have achieved the FIA's three-star environmental accreditation."



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Dakar pledges 'green' rally raids

THE Dakar Rally, an event built on pioneering spirit, is to venture once more into uncharted territory: it will redefine the rally raid discipline with its ambitious "DakarFuture" energy transition plan.

The plan has two main planks: the engines powering the cars and trucks in the race; and the emissions related to the logistics of the organisation.

By 2026, all the vehicles driven by Elite competitors in the car and truck categories of the Dakar will be subject to new ultralow emission standards. By 2030, both car and truck categories will fully be powered by alternative energy with zero emissions.

Organisers will also focus on event logistics. The aim is to create a bivouac powered exclusively by renewable energy.

Since its inception in 1979, the Dakar has carved a reputation for innovation without sacrificing its sense of adventure and passion for exploration. In recent years developments have included a ban on GPS devices to emphasise the role of navigation, as well as the introduction of engine displacement limits. Safety

measures have likewise evolved, leveraging the technological advances that have led to the use of Iritrack devices, SARSAT beacons, the Sentinel system and, starting this year, airbag vests for bikers. At a press conference held after stage nine of the 2021 edition in NEOM, the organisers set out the Dakar's vision for fostering green innovation in the world of rally raids.

"The Dakar is determined to fully exploit its role as an open-air lab to stimulate, test and validate the technical advances made by the constructors in the knowledge that the race vehicles of today are the production vehicles of tomorrow," it said in a statement.

As early as 2022, a specific "alternative energy" category will be created to put the focus on competitors racing in hybrid, electric or hydrogenpowered cars and trucks, as well as those who implement other emissionslashing technologies. Crucially, a form of Balance of Performance will be employed: the sporting rules will be

RIGHT GCK Energy pioneered the Dakar Rally's green energy transformation by installing a 'green bivouac', featuring an array of solar panels, as part of this year's rally infrastructure

BELOW GCK Motorsport's fully electric e-Blast 1 was put through its paces around NEOM ahead of the 2021 Dakar Rally's arrival. The team intends to field a hydrogen assault for 2023



LEFT Stéphane Peterhansel's 14th win at the Dakar tore up the record books. The Frenchman led the rally from Stage Two and now has eight victories behind the wheel of a car to add to the six wins he claimed in the bike category





adjusted to strike the right balance and make sure every project is competitive. By 2026, all Elite competitors in the car and truck categories of the Dakar will be required to enter the race with vehicles that meet new ultralow emission standards.

After a few years, the development of these technologies is expected to enable amateur competitors to procure vehicles that meet the same standards in order to sign up for the Dakar from 2030.

> As important as it is, fostering the evolution of the vehicles in the Dakar Rally will not be the only leap forward in the use of clean energy sources. Building on its financial support for an anti-deforestation programme in the Amazon since 2009 (as part of its carbon offset scheme) and its rigorous approach to waste management, the Dakar is poised to undertake a wide-ranging transformation project with a view to creating a bivouac 100 per cent powered by renewable energy.

The Pioneers

Four projects embracing the Dakar's ambitious green goal are currently ongoing.

 Sven Quandt, whose X-raid squad notched up its sixth Dakar victory last month, will lend his expertise to Audi Sport's fully electric challenger for 2022 as CEO of Q Motorsport, the team running the cars.

"With Q Motorsport, we want to break new ground in cross-country motorsport independently of and parallel to X-raid," said Quandt. "The world is changing and the Dakar must also prove that it can be sustainable and continue to point the way forward. This is exactly what Q Motorsport wants to demonstrate together with Audi."

 Green Corp Konnection's CEO, Eric Boudot, has pledged to field a hydrogen-powered car in the 2023 Dakar with GCK Motorsport.

"The presentation of the GCK e-Blast 1 is the first step towards what we believe to be the future of rally-raid: hydrogen vehicles," said Boudot.

• Cyril Despres and Mike Horn have chosen the same year to enter the race with their own hydrogen-powered car, Gen-Z. They used this year's event to collect data for that purpose.

"We could have comfortably waited until 2025, 2028, 2030 to start making a first hydrogen-powered car. But we believe that we have to speed things up," underlined Despres.

 Christophe Gaussin, CEO of Gaussin Group, revealed the H2 Road Truck, a hydrogen-powered truck intended to be on the start line of the 2022 Dakar.

"Gaussin recognises itself in values like overcoming and passionate commitment, that are reflected by the Dakar. Let's be tomorrow's adventurers," said Gaussin.

otorsport



THE launch of Toyota GAZOO Racing's new Le Mans Hypercar last month saw endurance racing move into a new and very different era.

The rules are different and so is the philosophy governing regulations that give maximum figures for downforce, minimum figures for drag and specify a power curve for the powertrain.

"There has been not only a regulation change, but a regulation principle change," said Technical Director Pascal Vasselon. "In LMH, what is specified is a performance target. We are told you can do what you want, but you have to fit in a very precise performance window. This gives freedom, and with this freedom we can integrate some styling elements of road cars. This is why these cars will look great and different."

The reigning World Champions' GR010 HYBRID is a prototype racer developed over the last 18 months in partnership by engineers at the team's headquarters in Cologne, Germany and the electric hybrid powertrain experts at Higashi-Fuji in Japan.

The car incorporates a four-wheel drive racing hybrid powertrain, with a 3.5-litre V6 twin turbo engine, providing 680 PS to the rear wheels and combining with a 272 PS motor generator unit, developed by AISIN AW and DENSO, on the front axle. Total output is capped at 500 kW (680 PS), meaning the GR010 HYBRID's sophisticated electronics reduce engine power according to the amount of hybrid boost deployed.

As part of a cost-cutting initiative incorporated in the regulations, the new GR010 HYBRID is 162 kg heavier and with 32% less power than its TS050 HYBRID predecessor, with Le Mans lap times expected to be around 10 secs slower. It also has bigger dimensions: it is 250 mm longer, 100 mm wider and 100 mm higher.

For the first time since the beginning of its WEC project, the team will participate without a rear motor generator unit (MGU), with the single permitted MGU located on the front axle. This means a starter motor must be fitted on the GR010 HYBRID while fully hydraulic rear brakes are also required. Although both CFD and the wind tunnel were used to refine the car's aerodynamics, the new technical regulations permit only a single homologated bodywork package, with only one adjustable aerodynamic device. The GR010 HYBRID will therefore compete in the same specification at both low and high downforce circuits, with an adjustable rear wing modifying the updated safety standards.

"Additionally, the combustion engine is more powerful on the GR010 HYBRID compared to the TS050 HYBRID. So it is a very different car both in appearance and in how it sounds."

"The new Le Mans Hypercar regulations mean the GR010 HYBRID is a completely new car, designed to a different philosophy," said Vasselon. "A major difference is the architecture of the hybrid system; we will have one kinetic energy recovery system and brake-by-wire, on the front axle. This means we had to install a starter motor and fully hydraulic rear brakes for the first time in our WEC project. "Following the regulations, our car will



ABOVE The GR010 takes its inspiration from the GR Super Sport

aerodynamic characteristics.

For the first time, the top class of WEC and Le Mans will feature a balance of performance, meaning organisers will modify the performance of each car on a race-by-race basis, regulating energy usage and weight, targeting identical performance potential from each Le Mans Hypercar.

"The biggest difference between the GR010 HYBRID and its predecessor is in terms of the aerodynamics," explained John Litjens, Project Leader Chassis: "In the past, the regulations limited what was allowed in many areas but under the Le Mans Hypercar rules, all cars have to be within certain performance windows in terms of downforce and drag, but there is more freedom allowed for the bodywork shapes and concepts. You can see the result of this freedom very clearly on the GR010 HYBRID.

"There is a similar principle on the powertrain side as well, with a given power curve but a lot of freedom in terms of configuration. The biggest change for us here was to move to only a front motor generator unit after five years with hybrid on both the front and rear axles. The packaging for the hybrid system was more challenging on this car because of have one bodywork specification to handle all circuits, so we needed to provide a wider working window for this car. These are just examples; there have been many such differences and challenges to address during development, so it has been an interesting engineering challenge."

The scheduled opening round of the 2021 World Endurance Championship, at Sebring in March, has been replaced by a new fixture at the Algarve circuit in April after fears over the spread of the Coronavirus in the US. The new cars are now expected to race for the first time at the Portuguese Portimao circuit on 4 April.



See Page 22



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Joest to help Glickenhaus Hypercar aśsau

JOEST Racing, a team synonymous with success in endurance racing, is to help niche manufacturer Glickenhaus with its assault on the World Endurance Championship.

The German team has won Le Mans 11 times with Porsche, Audi and Bentley. It has most recently been involved with Mazda's Daytona Prototype international programme in IMSA's WeatherTech SportsCar Championship.

Joest will work together with Podium Advanced Technologies to run the new Glickenhaus 007 Le Mans Hypercar under development at the Italian

ABOVE Joest deal is a coup for Glickenhaus as it readies its 007 LMH

organisation's headquarters.

Marque founder Jim Glickenhaus said: "We, as Glickenhaus, decided to enter into WEC and the Le Mans 24 Hours to prove that a niche manufacturer can deliver product to the highest technology level.

"It has been a huge effort to concept and design a car like our 007 LMH but, looking at the big names that will enter the Hypercar category, this is a big accomplishment for our brand.

"I am not a big fan of going quietly and having Joest Racing support shows how seriously we took this challenge."

Luca Ciancetti, head of automotive engineering and motorsport business at Podium, added: "Having the chance to work with one of the most winning teams in endurance race history strengthens our

line-up and finalises our strategy to be a strong competitor in our first year in the WEC and at Le Mans.

"The recent cooperation is already giving us great results and we are looking forward to the first shakedown of the 007 LMH."

Jan Lange, Joest Racing's head of projects, said: "We are particularly happy about returning to Le Mans, which is somewhat home ground for Joest Racing and where we've been able to take overall victories multiple times."

The new Glickenhaus 007 LMH will be powered by a 3.5-litre twin-turbo V8 developed by rally specialist Pipo Moteurs in France. The car will not race in the opening rounds of this year's series, giving the engineers more development time before homologation.

Next Gen NASCAR tests

NASCAR has professed itself happy after recent tests on its Next Gen car at Daytona and Charlotte.

"Daytona was an important test for us, because when we come back here in 2022 we have to make sure we hit the speed targets that we're looking for," said John Probst, NASCAR's senior vice president of racing innovation.

"We came here with one car, obviously we would like to come here with 15 or 20, but we just don't have that many right now. "So, we played with a lot of horsepower levels and drag levels to

hit our target speed, which we were able to do pretty easily." The car hen returned to Charlotte Motor Speedway to validate

recent work and for direct comparisons of data and driver feedback. "It's great to see the progress from November to January and know that we're headed in the right direction," said driver Kurt Busch.

RIGHT The Next Gen car is on track after recent tests



RBAT/ORECA H24 deal

A PARTNERSHIP between Red Bull Advanced Technologies (RBAT) and ORECA has been awarded the tender to supply the chassis for the Automobile Club de l'Ouest's Mission H24 hydrogen-powered class, due to arrive in 2024.

RBAT and ORECA decided to pool their resources, the former bringing its expertise in aerodynamics, simulation and energy recovery systems, while the latter will lean on its considerable experience building and running sports prototypes. Following the award of the tender, the ACO's first requirement is a detailed feasibility study of a potential vehicle concept.

To date, the ACO has been working with Swiss outfit Green GT, which has been developing hydrogen fuel cell-powered track machines for the best part of a decade. It has recently run a pair of prototypes based on an LMP3 chassis. These are fitted with the company's latest fuel cell, which features four stacks and provides a net output of 250 kW. However, the use of a buffer battery between the cell and the car's four electric motors allows for a peak output of 420 kW.

Alongside the new partners and Green GT, the ACO also has an agreement with French firm Plastic Omnium, which will be supplying hydrogen tanks for the project.

Pierre Fillon, President of the ACO, commented: "Having these top-flight automotive firms on board is likely to draw even more interest from car manufacturers."





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Alpine and Lotus eye Formula E

ALPINE and Lotus are evaluating a collaboration for a Formula E team entry in addition to a World Endurance Championship programme.

The two groups have signed a memorandum of understanding to "study a number of areas of cooperation".

A feasibility study for the joint engineering, design and development of an EV sports car is their headline project, but they are also studying, "A collaboration to leverage Alpine's motorsport platform covering Formula 1 to Formula E and Endurance."

Laurent Rossi, CEO Alpine, said: "The signing of this MoU with Lotus shows the lean and smart approach we're

ABOVE Alpine's marketing strategy could lead the Renault group back into Formula E alongside its F1 involvement implementing as part of the new Alpine brand strategy. Both brands have an amazing legacy and we are most excited to start this work together, from engineering tailored solutions to developing a next-generation EV sports car.

"This collaboration along with our transformation mark the beginning of a new era in which we'll be taking the Alpine name and line-up to the future. We're putting F1 at the heart of our business, leveraging our in-house expertise and best-inclass partners such as Lotus to inject our cars with leading-edge performance, technology and motorisation."

Phil Popham, CEO, Lotus Cars, added: "Today's announcement is the first step in what is set to be a hugely rewarding collaboration between our iconic brands. We are proud to be working with Groupe Renault in this collaboration – sharing Lotus' technical expertise and abilities, and leveraging our long track record of successful collaborations. Our companies have much in common – from a pioneering pedigree in light-weighting, to championship-winning sports cars which perform as impressively on the road as they do in the motorsports arena."

The F1 team remains the flagship project. As part of the restructure, Cyril Abiteboul, who has headed up Renault's F1 team since 2014, has left Groupe Renault. Alpine will now be led by Rossi, who was formerly director of strategy and business development at Groupe Renault, and Renault CEO Luce de Meo said Abiteboul leaves the team in a strong position.

"I would like to warmly thank Cyril for his tireless involvement, which notably led the Renault F1 Team from the penultimate place in 2016 to the podiums last season," de Meo said. "His remarkable work in F1 since 2007 allows us to look to the future, with a strong team and the new Alpine F1 Team identity to conquer the podiums this year."

The aggressive Alpine branding strategy, which has already led to an LMP2 involvement in the WEC, was evident on the World Rally Championship's season-opening Monte Carlo event. Renault F1 driver Esteban Ocon drove an Alpine A110S course car, admitting he now had even more respect for the WRC "heroes".

Merc alliance strengthened

WILLIAMS Racing has forged a closer technical alliance with Mercedes-Benz that will see the latter provide gearboxes and related hydraulic components.

Williams has been powered by Mercedes since the start of the V6 hybrid era in 2014, but has made all other parts in-house and remained fiercely proud of its status as an independent constructor.

The move is the biggest sign yet of a switch of strategy since a takeover by Dorilton Capital in August and a change in management.

Toto Wolff, CEO and Team Principal of the Mercedes-AMG Petronas Formula One Team, said: "For Williams, it makes sense to acquire the integrated powertrain after running our power units since 2014 and for our team, it makes sense in terms of economies of scale to supply another team under the new rules. This is a project we



ABOVE The relationship between Williams and Merc extends to the Ioan of young ace George Russell

have been discussing with Williams for some time and I am glad we have been able to bring this extension to fruition."

Simon Roberts, Team Principal, Williams Racing, commented: "Williams is an independent team, but Formula 1 is always evolving, and as a team we must be agile to react to the current climate in order to put the team in the best position to be competitive on track.

"This long-term agreement with Mercedes is a positive step and forms part of our strategic objectives for the future whilst we will still retain our design and manufacturing capabilities in-house."

Teams are permitted to share certain nonlisted parts with other teams, with existing relationships in place between Mercedes and Racing Point, Ferrari and Haas, and Red Bull and AlphaTauri.





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FORMER World Champion Jenson Button has rejoined Williams Racing as a Senior Advisor in a multi-year agreement – 21 years after first signing with the team as a little-known 20-year-old.

"Back when I was 19 it was a moment that changed my life and, despite the fact it was over 20 years ago, I already feel like I never really left," said Button. "Sir Frank Williams showed faith in me which I will be eternally grateful for and I am incredibly excited to have the chance to come back and help the team as it strives once more for success."

Jost Capito, CEO, Williams Racing, added: "Bringing Jenson back on board is another positive step to help us move forward as a team both on and off track. Jenson has always been a friend of the team and so it is great to welcome him back into the Williams family.

"Back in 2000, Sir Frank saw the promising talent Jenson had as a driver and gave him his first opportunity in F1. He more than fulfilled that initial promise throughout a glittering career that culminated in world championship glory.

"More recently, he has shown his acumen in both the business and broadcasting worlds and **BELOW** Button brings experience of six different F1 teams

HEHIS

remains a widely respected figure in the paddock. All this experience will add another layer to our transformation both technically and as a business." Button brings valuable experience from having served with six different F1 teams. He will dovetail his new Williams duties with his ongoing role as a Sky F1 expert analyst – not to mention racing with his own team in Extreme E. He will provide guidance to Williams, attending a number of races, as well as working with its race drivers, George Russell and Nicholas Latifi, and academy drivers.



BTCC extends AP Racing brake and clutch contract

AP RACING has been chosen by TOCA and the British Touring Car Championship (BTCC) to supply critical performance components for a further six years. Through to 2026, all racecars on the BTCC grid will feature an AP Racing Radi-CAL brake package, pedal box, air jacks and highperformance carbon clutch.

The deal marks the continuation of a relationship that stretches back to 2002 when AP Racing was first chosen to be the BTCC's single source of brake and clutch components.

TOCA, the organisation behind the BTCC, has been a long-time supporter of British motorsport businesses. Peter Riches, Technical Director at TOCA, said: "The BTCC is an important part of UK motorsport and, as best we can, we like to support British engineering, innovation and manufacturing. Conveniently for us, AP Racing is also at the international forefront of brake and clutch design and production. Covering everything from Formula 1 to high-performance road cars, its systems are trusted by everyone. "With a well-deserved reputation that has been earned at the pinnacle of motorsport on tracks across the globe, we are extremely pleased that AP Racing will continue to equip our BTCC teams. With incredible stopping power and robust race clutches, we know that our drivers have what they need for the next six years of wheel-to-wheel action."

David Hamblin, Managing Director at AP Racing, commented: "The BTCC is a cornerstone of British motorsport and to



ABOVE AP Racing is one of the BTCC's valued suppliers

be such an integral part of each and every car means a lot to our business, but also to us as individuals. We are proud of what we have achieved together over the last 18 years and are excited to see where the relationship takes us."

The announcement capped a busy start to the year for AP Racing, which supplied its braking and clutch system components to 39 of the 73 car category entrants on the Dakar Rally, one of motorsport's last great adventures. The overall winner of the event, the X-Raid MINI of Stephane Peterhansel, used one of the company's Ø7¼" (184 mm) triple plate clutches.

Meanwhile, AP Racing's NVH Dyno has completed the final stage of commissioning and has started operating. Hamblin commented: "The next step has been completed in AP Racing's growth plan with this installation, reinforcing our vision to create a world class Research and Development facility at our Coventry headquarters."



Button to satisfy off-road passion in Extreme E

WHEN it comes to the future of motorsport, off-road is, it seems, very much on-message. In a month when the Dakar Rally set out its plans for low emissions competition, Extreme E – a series conceived to highlight the climate change crisis – welcomed a third Formula 1 World Champion to the ranks of its team owners.

Jenson Button will not only own a team – JBXE – but will also be one of the squad's two drivers.

Over the past three years, the Briton has successfully tried his hand at many other disciplines and championships, including the FIA World Endurance Championship, the Le Mans 24 Hours, British GT and Super GT, which he won with Team Kunimitsu in 2018.

FAST AND LOOSE

While much of his racing career has been spent on the smooth asphalt of the racetrack, Button has always had a passion for off-road racing. His late father, John Button, was a leading rallycross driver in the 1970s and '80s, claiming the runnerup spot in both the British Rallycross Championship and Lydden Hill Rallycross Championship in 1976. Jenson actually tried a rallycross Beetle for himself, at Lydden Hill, after the car had been restored. He found it to be a wild ride, professing it to be "the maddest thing I've ever done!"

Always a driver looking to explore different racing challenges, Button went on to officially experience off-road racing himself in 2019 while contesting the Baja 1000, one of the most gruelling events of all-time, where competitors take on the Baja California Peninsula and its tough terrain and extreme heat.

His venture into Extreme E will be the 2009 World Champion's biggest task since quitting F1 in 2016.

"Jenson is one of the most popular drivers in the business and Extreme E will give him the opportunity to live out one of his longheld passions, to compete at the highest level in off-road racing," said Alejandro Agag, Founder and CEO of Extreme E.

"Jenson, alongside his peers, will give further weight to our mission to raise awareness of the global climate crisis, while doing what we love – racing. It's going to be fantastic to see the biggest names in motorsport on the starting line in Saudi Arabia in April – it is set to be an incredible form of entertainment, but with a strong and purposeful message around our planet."

Extreme E, starting in April 2021, will see electric SUVs competing in extreme environments around the world which have already been damaged or affected by climate and environmental issues. The fiverace global voyage highlights the impact of climate change and human interference in some of the world's most remote locations and promotes the adoption of electric vehicles in the quest for a lower carbon future for the planet.

"JBXE has been a long time coming and I'm both delighted and proud to announce its formation and entry into the inaugural Extreme E Championship," said Button. "I caught the off-road bug a few years back, which led to me entering my own team in a few races including the Mint 400 and even the Baja 1000 and I absolutely loved it!

"It was around the same time I first heard about the plans for Extreme E which I've followed with great interest and what Alejandro Agag, Ali Russell and the team have managed to create is nothing short of incredible, and thanks to them and our partners Apater Capital and Pipt we get to be a part of it.

"In Extreme E they've created a product that will offer first class racing and entertainment to the fans, but also serves to highlight the impact of climate change. Whilst we will of course compete to win on track, as a collective we will also work to maximise awareness whilst racing in places that have been damaged or affected by climate change over the years."

Alongside raising public awareness, Extreme E is committing to legacy initiatives at each destination to help protect already damaged ecosystems impacted by climate change.

Extreme E is now home to 10 World Champions, including Button's fellow Formula 1 World Champion team owners Lewis Hamilton and Nico Rosberg, and in its drivers Extreme E has three World Rallycross Champions (Johan Kristoffersson, Timmy Hansen and Mattias Ekström), two World Rally Champions (Sébastien Loeb and Carlos Sainz), a Women's Trial World Champion (Laia Sanz) and a Pro-4 World Champion (Kyle LeDuc). They collectively hold over 40 World Championship titles.

In addition to this list, Jamie Chadwick is the reigning W Series Champion, and Molly Taylor is a former Australian Rally Champion.

JBXE is the tenth team in Extreme E, joining Chip Ganassi Racing and Andretti United (USA), ABT CUPRA XE and Rosberg Xtreme Racing (Germany), Team TECHEETAH (Indonesia), Hispano Suiza Xite Energy Team and ACCIONA/Sainz XE Team (Spain), and fellow British teams Veloce Racing, and X44.

Extreme E's first season kicks-off in Saudi Arabia from April 3-4, 2021.



The new Le Mans Hypercar regulations suffered a painful gestation period, but could cars like Toyota GAZOO Racing's GR010 HYBRID lead endurance racing into a golden era? By **Chris Pickering**

ERHAPS it's just the familiar red, white and black paint scheme, but at first glance, you'd be forgiven for mistaking Toyota's all-new GR010 HYBRID hypercar for its LMP1 predecessor. And yet, in reality, this marks not just the switch to a new rules package, but a whole new philosophy, with the top category of the World Endurance Championship (WEC) entering a brave new world of performance balancing.

As for the differences between the GR010 and the outgoing TS050, it's easier to list what hasn't changed. The only carryover parts are generic components such as switches and sensors.

In terms of headline stats, the new car is both bigger (250 mm longer, 100 mm wider and 100 mm higher) and substantially heavier (the weight is provisionally set at 1,040 kg compared with the 878 kg base weight for the LMP1). As part of a major drive towards cost reduction in the Hypercar class, it's also slower, with lap times expected to be around 10 seconds slower at Le Mans (and four to five seconds slower on a regular WEC track).

The heart of the car remains a twin turbocharged V6, but this too has changed in both concept and

ABOVE The only carryover parts between the GR010 and its TS050 predecessor are switches and sensors

execution. Now increased to 3.5 litres, the combustion engine drives the rear wheels on its own, while a single electric motor generator unit (MGU) developed by Aisin AW and Denso drives the front axle (there is no hybrid assistance on the back anymore).

As per the LMH regulations, the total system output is capped at 500 kW (671 hp) under normal operating conditions, with a maximum of 200 kW (268 hp) coming from the MGU.

BESPOKE DESIGN

MICHEL

AIST

IGH

Toyota describes the GR010 as a racing version of its forthcoming road-legal GR

Cars must now be designed to sit within a small range of lift and drag figures, but teams are free to do virtually whatever they want within that window"

SRIAGINA 7

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Super Sport hypercar and there is said to be a genuine link between the two, including some shared parts. Despite this, the plan was always to enter the competition car as a bespoke prototype rather than a production-based hypercar. The production-based rules differ slightly – notably around the specification of the MGU – but it was felt that homologating the car as a prototype design would be a better option.

"The road car would need to be ready for us to homologate it as the basis for our racecar, but even ignoring that, we would have stuck with a prototype," explains Toyota GAZOO Racing technical director Pascal Vasselon. "It's cheaper and more effective to create a purposebuilt racecar than it is to convert a road car. Eventually there will be three different ways to enter the WEC: an LMH prototype, an LMDh prototype or a production-based hypercar. So far, every manufacturer has gone for one of the prototype options."

This, of course, raises the question of whether or not it will be possible to reach a satisfactory balance of performance between multiple designs covering two or perhaps three different categories. The maximum power, minimum weight and aerodynamic performance targets of LMH and LMDh are identical, but there are significant differences in the two sets of regulations. Notably, the LMH cars have the option of running a front-mounted hybrid system as part of a bespoke drivetrain, whereas the LMDh cars all use the same Bosch hybrid system, driving the rear wheels via a standard 7-speed Xtrac transmission.

In theory, the traction benefit of fourwheel drive will be cancelled out by the so-called '120 rule', which prevents torque being applied to the front axle until the car reaches a speed of 120 kph (or an as-yet unconfirmed figure of 140 kph to 160 kph when fitted with wet tyres). This clause was originally introduced when Aston Martin was planning to contest the series with a production-based hypercar that would have been non-hybrid and

Suddenly dropping 70 kg was a major curveball when you've planned the whole car design to a significantly heavier minimum weight limit"

two-wheel drive, although it applies equally well to the LMDh entries. What that doesn't account for, however, are the differences in things like tyre usage, weight distribution and differential behaviour on a four-wheel drive car.

"Equating LMH and LMDh is going to be a difficult exercise, but it's certainly possible," says Vasselon. "Four-wheel drive cars and two-wheel drive cars have different strengths. We're working now to balance those with other handicaps like weight, for example."



ABOVE The shift in the rules from open competition to a Balance of Performance formula required a significant change in design priorities, with reliability becoming even more important

scaled up to 3.5 litres



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THEORY OF EVOLUTION

The finished car is the product of a set of regulations that have been evolving almost continuously since 2018. This has been a necessary evil to accommodate the shifting requirements of various manufacturers and different categories, but the lack of stability has also led to a certain amount of frustration.

"We started and re-started the project maybe 10 times," says Vasselon. "There have been several major changes in the rules over the last three years, which has led to a lot of stop and go."

The original rules, officially announced in 2018, would have allowed open competition between different designs. Then in February 2019, the focus shifted towards a balance of performance formula, which changed the whole approach to the project.

"When you go from [open competition] to a performance-balanced formula you don't push so much for outright performance,"

For an effective balance of performance, the total acceleration profile was a 'must-have' box to be ticked"

says Vasselon. "It's not worth spending a lot of resources on that, so your priorities change. Reliability is even more important when you can't use performance as a differentiator. At the same time, you have more opportunity to reduce design cost and construction cost."

Still, however, the changes kept coming: "In spring 2020 – well into the development programme – we suddenly had to drop 70 kg from the weight of the car. That was quite a major curveball when you've planned the whole car design to a significantly heavier minimum weight limit." Along the way, the power requirements have also changed. The combined maximum power was dropped from 585 kW to 500 kW last summer to bring LMH in line with LMDh, for instance. However, the basic concept has remained the same.

The thought process behind the specifications laid down for the combustion engine was relatively straightforward, Vasselon explains. Although the total power of the old hybrid LMP1 cars was around 1,000 hp (745 kW), nearly half of that came from the hybrid system, with the combustion engine said to be rated at around 380 kW to 390 kW (510 to 523 hp). The current target output – which will have to be delivered by the combustion engine alone at times – is 500 kW, which represents a 30 per cent increase. Hence, the new engine would have to be scaled up to 3.2 litres to match the specific output of the 2.4-litre unit in the TS050. Given the substantial increase in vehicle weight, plus the reliability benefits of a larger, lower stressed engine, the decision was taken to round it up to 3.5 litres.

Alongside the development of the engine came the hybrid system. The first decision the team faced was where to put the MGU. They had the option of going for two-wheel drive, with a rearmounted system that would have been theoretically unlimited within the 500 kW combined power output allowed by the regulations. In the end, however, it was a ▶

BELOW Readying the new car has been made even more challenging by COVID restrictions





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GR010 HYBRID Technical Specifications

Bodywork	Carbon fibre composite
Gearbox	Transversal with 7 gears sequential
Driveshafts	Constant velocity tripod plunge-joint driveshafts
Clutch	Multidisc
Differential	Mechanical locking differential
Suspension	Independent front and rear double wishbone, pushrod-system
Springs	Torsion bars
Anti-roll bars	Front and rear
Steering	Hydraulically-assisted
Brakes	Akebono mono-block alloy callipers with carbon ventilated discs
Rims	RAYS magnesium alloy, 13 x 18 inch
Tyres	Michelin radial (31/71-18)
Length	4900 mm
Width	2000 mm
Height	1150 mm
Weight	1040 kg
Fuel capacity	90 litres
Engine	V6 direct injection twin-turbo
Valves	4 per cylinder
Engine capacity	3.5-litre
Fuel	Petrol
Engine power	500 kW / 680 PS
Hybrid power	200 kW / 272 PS
Battery	High-powered Toyota lithium-ion
Front motor/Inverter	AISIN AW/DENSO

clear choice, Vasselon explains: "A frontmounted hybrid system makes much more sense from a vehicle dynamics perspective. And perhaps surprisingly, it's also cheaper to integrate an MGU at the front than it is to put it in the gearbox."

The next question was the energy storage system. In the early days of the LMP1 hybrid era, Toyota had favoured supercapacitors for their high power density, but lithium ion batteries can now deliver similar power densities, with far greater energy densities. This made a lithium ion battery pack the default choice, although the details still needed to be fleshed out.

"The sizing of the battery required some quite detailed simulation," comments Vasselon. "It's all about the cycle: how much energy you can recover; how much you can boost; when you can boost; and how long you have to store the recovered energy. All the while, you have to maintain the battery's state of charge between precise values. When you have all this information it's quite straightforward to work it back to find the required battery size."

RIGHT Traditionally the Le Mans 24 Hours has dominated aero design. But now a single aero package, combined with a narrow target window for lift and drag, prevents manufacturers from focusing on just the one race

HYBRID CONTROL

At first glance, the rules are quite prescriptive as to how and when the hybrid system can be deployed. In addition to the '120 rule' and the 200 kW limit for the MGU, there's a graph that lays out the maximum combined power for any given engine speed (expressed as a fraction of rpm over maximum rpm).

You might think that all the engineers then have to do is fill in the gaps, but the key word here is *maximum*; within those limits, they have free rein to utilise each power source as they see fit (it even explicitly states in the rules that "power unit usage is free [with regards to] modes and settings").

"We can do almost whatever we want providing we don't exceed 500 kW in total and 200 kW from the hybrid system," confirms Vasselon. "For example, we could have a small amount of power sent to the front axle that lasts for a very long time or we could have a short, strong boost at the corner exit. One thing we can't do is a push-to-pass function [although the split between the two halves of the powertrain can vary, the total acceleration profile will ►







be broadly similar for all cars]. Nonetheless, I'd say this was an important box to be ticked for an effective balance of performance, so it was a 'must-have'."

There is no specified limit on the energy storage capacity of the hybrid system. In theory, it would be possible to go for laps at a time without even deploying the hybrid boost. On a practical level, however, there is no reason to do so, as the hybrid system is sized to suit the amount of energy it can recover and deploy over a single lap. Plus, the car relies on its regenerative braking capability to manage the temperature of the mechanical brakes.

The principle of balancing two separate braking systems is something that's now fairly well understood, but the execution remains critical, Vasselon explains: "We've been working with these sorts of concepts since 2012, but the handover between the two is still problematic, because the friction characteristics of the mechanical brakes aren't always consistent. That's something we can compensate for in the software to a certain extent, but there's still a fundamental difficulty in estimating the friction coefficient of the disc and the pads."

FIXED AERO

The philosophy behind the aerodynamics on the new car represents another fundamental shift. While LMP1

was a bit like Formula 1, in that it set out a series of dimensional constraints and boxes within which the teams had to obey certain rules, the new regulations have taken a very different tack. All cars must now be designed to sit within a small range of lift and drag figures (verified across a range of ride heights in the FIA's official wind tunnel) but the teams are free to do virtually whatever they want within that window.

"Hitting that window isn't especially difficult to achieve in terms of absolute figures," comments Vasselon. "We're targeting an aerodynamic efficiency [I/d] of approximately 4, whereas we could hit 6.5 in LMP1. What is difficult is to be precisely at these figures, so that changes the nature of the game."

One of the benefits of the comparatively relaxed target figures is that it gives the designers more freedom to integrate styling cues from road cars, giving a clearer brand identity. You can already see this in the nose of the GR010 in relation to the test mules seen carrying out work on the forthcoming GR Super Sport.

Similarly, the target figures take a little bit of pressure off the engineers if they need to add additional cooling vents or other features that might otherwise compromise the aerodynamic efficiency. In the case of the GR010, the cooling demands are said to have gone up roughly in proportion with the increase in engine capacity, but **ABOVE** No team has more expertise than Toyota when it comes to the design and development of a hybrid prototype

RIGHT An aerodynamic efficiency [I/d] of approximately 4 was the target for the new car, where that figure could be as high as 6.5 in LMP1 it hasn't presented any great issues.

Another significant change is that the new technical regulations only permit a single homologated bodywork package, with only one adjustable aerodynamic device. This means that the GR010 will compete in the same specification at both low and high downforce circuits, with an adjustable rear wing modifying the aerodynamic characteristics.

Le Mans, with its long straights and fast corners, remains the jewel in the crown of international endurance racing. However, As part of the cost reduction measures, the FIA and the ACO have also banned the use of hydraulically interlinked suspension, as seen on the TS050, but this is a detail change rather than a significant shift, says Vasselon: "Without the possibility to control the pitch of the car we have to approach our aero maps in a different way, but that's the same for everyone; it's just a new challenge in terms of the setup."

And that's just the start of the challenge. The GR010 is due to make its race debut at the 8 Hours of Portimão



the single aero package, combined with the narrow target window for lift and drag, prevents manufacturers from focusing on this one particular event, we're told. Instead, the targets are set to provide a good compromise for all the circuits on the WEC calendar. (following the cancellation of the Sebring WEC round). All being well, it will go head-to-head there with the

grandfathered Alpine A480 (formerly the Rebellion R13). Another new hypercar, the Glickenhaus SCG 007, is expected to join the fray soon. Beyond that, next year should see the arrival of Peugeot's new Hypercar, while 2023 promises LMDh entries from both Audi and Porsche. Having been the sole manufacturer entry in the WEC's top class since 2018, you get the impression that the team is quietly relishing the chance to prove itself against world class opposition once more.

"Every time a future competitor has confirmed their entry it was very good news," comments Vasselon. "The painful process that we went through with the rule changes and the balance of performance revisions was all driven by the desire to bring more competitors to the series and we're very pleased to see that paying off. It justifies the compromises we've had to make along the way."

As for how Toyota will fare in this brave new world, we'll have to wait just a little bit longer to find out. But the Cologne-based team now has more experience than anyone else in operating hybrid prototypes. The rules may have changed, but the processes and methodologies picked up over the course of nearly a decade in LMP1 will stand it in good stead. It promises to be an almighty showdown when the old adversaries return.



Photos: Peugeot Sport

OLD FOES IN *NEW* TERRITORY

Chris Pickering asks Peugeot Sport's WEC programme powertrain director, François Coudrain, about the challenges of the new Hypercar category HINGS are about to get serious in the Le Mans Hypercar (LMH) category. It feels like a lifetime has passed since the new formula was announced as the replacement for the ailing LMP1 class. But the hypercar category is finally here. COVID permitting, the first race of the new era is scheduled to take place with the 8 Hours of Portimão, at the Algarve International Circuit in Portimão, Portugal, from 2-4 April.

As if to add further credence to the category, Peugeot Sport – one of the true heavyweights of endurance racing – will be returning in 2022 with the aptly named Hypercar. At its heart there'll be a sophisticated hybrid powertrain, comprised of a 2.6-litre, twin-turbo, 90-degree V6 driving the rear wheels, along with an electric motor generator unit (MGU) driving the front wheels.

Total power is capped at 500 kW (671 bhp) to maintain equivalence with IMSA's forthcoming LMDh machines, while the hybrid assistance is limited to 200 kW. Apart from that, though, just about anything goes, as Peugeot Sport's WEC programme powertrain director François Coudrain explains: "In

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TOTAL

the past we had a lot of organic design constraints. With the 908, for instance, we had to run a specific displacement and a specific air restrictor size imposed by the regulations. Today, it's a very different philosophy. We have a functional design concept, which limits the power, but aside from that, we have a lot of freedom in the design. This is a totally new philosophy and we're very happy with it."

The development work began in January last year, with Coudrain and his colleagues poring over the new powertrain regulations. It was a true clean-

sheet exercise with options considered ranging from two litres to upwards of three litres, including the possibility of a V8. A single turbo configuration was also

analysed, but dismissed due to its impact on the centre of gravity height. Overall, the 2.6-litre twin turbo V6 was thought to give the best balance of performance, reliability, packaging constraints and weight, tipping the scales at a modest 165 kg.

"This is a completely new design to a very different set of regulations, but we factored in a lot of lessons learned from the 908 programme," comments Coudrain. "Our experience in endurance racing with the 908 is part of the reason that Oliver [Jansonnie] and myself are involved with the new programme." A lot of these lessons focus on the engineering methodologies that were developed to test and validate the 908. Another obvious synergy is the use of hybrid propulsion. Peugeot Sport created a working prototype for a hybrid 908 in 2008,

We have a lot of freedom in the design. This is a totally new philosophy"

anticipating a potential rule change that never happened. The idea was then revived in the run up to the 2012 season, with the 908 Hybrid4, which was fully functional and ready to race at the point when the French manufacturer was forced to abandon its

BELOW A 2.6-litre, twinturbo, 90-degree V6 will drive the rear wheels, an electric MGU the front





motorsport programmes due to financial pressures. Elsewhere, Peugeot's sister brands within the PSA group have contributed expertise from Formula E and the World Rally Championship, looking at control systems, software and energy management. Likewise, there are said to be synergies with the company's hybrid road cars – Coudrain, like many of his colleagues, has worked on both in recent years.

A BALANCING ACT

One of the most complex aspects of the project is balancing the power and torque between the two axles. The 500 kW limit applies to the sum of the two power sources, so when the front-mounted electric motor generator unit (MGU) is deploying its full 200 kW, the internal combustion engine is capped at 300 kW (around 400 bhp). ABOVE & BELOW The manufacturer has leveraged its experience with the 908 (V12 and V8 engines) and in the World Rally Championship (four cylinders) to develop a new 2.6-litre, twin-turbo, 90-degree V6

RIGHT Having experimented with a hybrid as early as 2008, Peugeot revived the concept for 2012. Its Hybrid4 was ready to race at Sebring when the plug was pulled on the project





An unusually broad range of operating conditions, ranging from 100 per cent electric to 100 per cent combustionpowered" Conversely, there are also times when the combustion engine will have to do all the work itself. Notably, the front MGU cannot be used under 120 kph under normal conditions (or under 140 kph when wet tyres are fitted). This clause was introduced to neutralise the potential traction advantage in case anyone should enter a two-wheel drive production-based hypercar (several of which were planned originally). The only exceptions to this are when the car is in the pit lane or if it stays below 120 kph for the remainder of the lap (potentially if it has a problem and needs to limp home).

For much of the lap, however, the

powertrain split will be constantly varying, depending on the throttle and brake application, the vehicle speed and the battery capacity. It makes for an unusually broad range of operating conditions, ranging from 100 per cent electric to 100 per cent combustion-powered.

From a hardware perspective, this means that the two systems are designed quite independently. They're not intrinsically interlinked like a Formula 1 engine and its electrically boosted turbocharger. The power demands on the combustion engine are also comparatively relaxed – at 258 bhp/litre, the maximum specific output of the Hypercar's V6 will be around half that of a current Formula 1 engine, which leaves the engineers free to focus on reliability and driveability. ►





"We don't need to go into exotic technologies for the combustion system," comments Coudrain. "The fundamentals are very safe [in terms of reliability] and not too expensive. Where we've focused a lot of our energy is developing the software to control the overall powertrain."

The battery can be charged in the pits before the race, but thereafter the electrical system is entirely dependent on harvesting its own kinetic energy. To make things a little more complicated, the power output from the combustion engine can be raised by a further three per cent to 515 kW (700 bhp) when the battery is empty. This allows the front MGU to syphon energy at a rate of 15 kW, acting as a 'through the road' hybrid. That's just 7.5 per

ABOVE Saft, which has been racking up wins in F1 since this first success with Ferrari in 2009, is developing the cells for the battery cent of its full 200 kW capacity, but it should help to top things up.

"Managing the energy is an area where we will have the opportunity to find some performance," comments Coudrain. "The idea of this tolerance at the end of the straight is to manage the state of charge. We did a lot of offline simulation last year to investigate the best way of doing that. We're still doing that, and a few weeks ago we started using the driver-in-the-loop simulator at our workshop in Satory. We're installing new dynos to test the engine in April and we should have a new fourwheel drive rolling road around September to test the complete system."

The switchover between the various modes, and the power split between the engine and the MGU, is controlled automatically by the car's software. However, the driver will be able to adjust the level of regenerative braking provided by the MGU under deceleration and the pressure applied to the hydraulic brakes to achieve the optimum balance between electrical and mechanical braking. This means there will be a strong strategic element to the energy management.

Meanwhile, the power output will be monitored in real-time by the FIA using standardised torque sensors on all four driveshafts. This will also be used to enforce the balance of performance (BoP) system between hybrid and non-hybrid LMH entries, as well as the forthcoming LMDh class. "We are fully aligned with this system," notes Coudrain. "We think this is **>**


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the only way to be able to manage the BoP. And [a BoP system] is the best way to manage the cost cap."

EFFICIENCY OPTIMISATION

Peugeot Sport's experience with the 908 hybrid projects will no doubt come in useful, but the Hypercar regulations represent a significant step up in hybridisation, not to mention a new philosophy.

"The 908 HYbrid4 used an electric motor that was integrated with the combustion engine, supplying an extra 60 kW to the rear wheels. We now have 200 kW, but the biggest difference from an engineering perspective is that it's now all-wheel drive," comments Coudrain. "Controlling the split between the two halves of the system under all conditions is a big challenge. Specifically, the transition between the various use cases is quite tricky to manage – that's somewhere you can lose energy if you're not careful."

Peugeot Sport has looked carefully at ways to maximise efficiency, making the most of the energy flowing in and out of the system. Previous programmes, for instance, have used a hydraulic Managing the energy is an area where we will have the opportunity to find some performance"

BELOW A lot of effort has

been focused on developing

the software to control the

overall powertrain

paddleshift, but the 7-speed unit on the Hypercar will be electrically actuated to save energy and reduce weight.

Friction reduction will play a big role in areas such as wheel bearings (notably these are downstream of the FIA torque sensors, which means any efficiency improvements beyond this point are potentially free power). Likewise, the cooling fluids and lubricants will have a significant role to play. Peugeot Sport's long-time partner Total will supply specially developed oils and greases, along with trackside support to monitor the status of the fluids.

Total will also supply the cells for the Hypercar's battery via its wholly owned subsidiary, Saft, which has more than a decade's experience of working with Formula 1 KERS systems. Its cells have been developed to prioritise power density over energy density, providing fast charge and discharge times.

"The main parameter will be to optimise how the energy stored in the battery is used," explains Saft's chief technology officer, Kamen Nechev. "To achieve this, you need an extremely short chargetime combined with high-capacity storage cells to form a package that enables maximum power to be delivered as rapidly as possible. The most competitive solution resides in the management of charge optimisation and the amount of power available in real time."

The battery will be located in a carbon casing inside the car's monocoque structure, behind the **•**



Giorgio Piola FORMULA 1 2016-2018 Technical Analysis (with 2019 preview)











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driver and underneath the fuel tank. It has been designed to combine optimal durability with consistent performance for upwards of 24 hours. Peugeot Sport will work with Total to secure homologation for the battery, which will be assembled in a new workshop at the team's Satory base.

"Saft has designed the cells for us based on a dedicated specification from Peugeot Sport. That was based on the weight of the car and the mission profile for Le Mans," notes Coudrain. "We are co-designing the module with Saft, and Peugeot Sport has designed the battery pack to integrate within the monocoque."

OLD ADVERSARIES

Developing a relatively large capacity V6 from scratch could be seen as a measure of Peugeot's commitment to the hypercar class at a time other forms of motorsport are increasingly moving to downsized four-cylinder engines. Coudrain confirms that there are no Wheel bearings are downstream of the FIA torque sensors, which means any efficiency improvements beyond this point are potentially free power"



plans currently to use this engine in any other application, but the hope is that it will be a long-term project.

"To limit the cost we need to limit the amount of development," he comments. "That's why we're taking plenty of time to develop the car before it's homologated. After that there will only be a small opportunity to change the design using a token system. We hope to be able to race with this car for as long as possible [without having to develop a new design]."



LEFT & ABOVE The group's motorsport experience of Formula E and the WRC has contributed to the development of the software employed to manage the energy systems This year should see the introduction of the Hypercar category, with Peugeot's return scheduled for some time in 2022, but it might not be until 2023 that things really start to hot up. Alongside the possibility of more hypercar entries (in addition to the current line-up of Toyota, ByKolles and Scuderia Cameron Glickenhaus) there's also the prospect of the LMDh cars arriving in the WEC that year. That would see Peugeot going up against the might of Porsche, plus the French firm's arch-rival from the diesel era, Audi.

It's been a long time coming, but it's just possible that endurance racing could be on the verge of a new golden age.



BELOW Hypercar's convergence with LMDh raises the tantalising prospect of Peugeot renewing its Le Mans rivalry with old foe Audi

HUNTER UNLEASHED IN PURSUIT OF DAKAR GLORY

Chris Pickering reports on Prodrive's quest to design what it hopes will become the ultimate rally-raid car

HIS year's Dakar Rally was a baptism of fire for the BRX Hunter. Prodrive's new T1-class contender arrived with considerable expectations, fuelled by the company's formidable history in rallying and endurance events, not to mention the talents of its drivers – Dakar legend Nani Roma and nine times World Rally Champion Sébastien Loeb (himself no stranger to the event with five appearances and two podiums to his name).

Loeb endured a pretty torrid time in the desert. He was plagued by punctures, waylaid by navigational errors (as experienced by a lot of crews this year) and struck by several small reliability issues, including a broken wishbone. He finally retired due to multiple punctures, after surrendering part of his spare tyre allocation to his team-mate.

Roma fared better, but even the Dakar veteran struggled at times, finishing fifth overall in the end. Nonetheless, his Hunter showed good pace – reportedly keeping up with the MINI buggy of Carlos Sainz while the two were running side by side early on in the rally. It's an achievement not to be sniffed at for a manufacturer taking on the world's toughest motorsport event for the first time.

Just before the rally kicked off, Race Tech spoke to the project's chief engineer for chassis development, Paul Doe, to find out what goes into developing a car for such an arduous challenge.

LONG-HELD AMBITION

Fielding a team at the Dakar has been a longheld ambition for Prodrive chairman David Richards, who spent much of his early career in the Middle East. But despite the Oxfordshire company's name being forever remembered for its development of the Rothmans-liveried Porsche 911 SC RS, it has never actually competed in the event until now.

Around two years ago, Richards asked his engineers to look into areas of motorsport that the company had yet to explore. Various options were considered, but long-distance off-road events stood out as a discipline that would work well with Prodrive's experience in endurance racing and rallying.

A small team was put together to begin concept development, looking at the ingredients that would go into 'the ultimate Dakar car'. Shortly afterwards, a chance meeting between Richards and the Crown Prince of Bahrain led to the creation of a joint venture known as Prodrive

3

PI2 BR

International, and the establishment of the Bahrain Raid Xtreme (BRX) team.

"We spent quite a long time evaluating the different options – not just in terms of performance and off-road capability, but reliability and cost," explains Doe. "This is something we see as a longterm project, so we also spoke at length with the FIA and the ASO [the organisers of the Dakar] about where they saw the category heading in the future."

There was no shortage of options to consider. Entries can be petrol or diesel and two-wheel drive or four-wheel drive, with relatively few constraints on the fundamental architecture. This year also saw turbocharged petrol engines allowed for the first time, alongside naturally aspirated units. Not surprisingly, the preliminary investigations BELOW Four-wheel drive was thought to be the lower risk configuration from an engineering perspective, as well as being more userfriendly for the driver concluded that different setups would suit different types of terrain. At that time [mid-2019], the exact nature of the stages on the 'new' Dakar in Saudi Arabia weren't known, so an educated guess was required.

A lot of that came down to the regulations used to balance the various vehicle types. Two-wheel drive cars are allowed essentially unlimited suspension travel, as well as larger wheel diameters. This helps them to maintain a higher minimum speed over obstacles like rocks and camel grass, while the fourwheel drive cars are generally limited to a modest 280 mm of travel – less than a World Rally car (although the bigger tyres help). On the other hand, four-wheel drive cars find more traction on tight, twisty stages.

The different configurations play a role over the dunes too. Two-wheel drive cars are allowed to adjust their tyre pressures to avoid getting bogged down in the sand, but this means they require constant tyre pressure management from the co-driver, which is an additional workload/distraction not present in the cockpits of the four-wheel drive machines.

The COVID situation heavily disrupted the build, but effectively extended the development time"

"In the end we came to the conclusion that four-wheel drive represented a lower risk from an engineering perspective, as well as being rather more user-friendly for the driver," comments Doe. "A key thing for us was also an indication from the FIA and the ASO that buggies aren't really seen as the future of the sport. Peugeot did a fantastic job with a very well developed two-wheel drive car – and X-Raid then had to follow them – but there's always been a bit of a feeling that the loopholes for two-wheel drive cars were really there to help out privateer entries and that manufacturers should be competing with four-wheel drive."

The concessions given to two-wheel drive vehicles in the rules aren't without their challenges. There's no doubt that the reduced minimum weight limit of 1,580 kg – as opposed to 1,850 kg for the four-wheel drive cars (dry and unladen) – can be beneficial under the right conditions. However, getting the weight down to that target figure isn't as easy as it sounds when you're dealing with a long-range desert racer with 37-inch tyres and nearly half a metre of suspension travel.

"When you look at the two types of car, they have virtually all the same components, but there's a 330 kg weight difference," notes Doe. "All you're really missing on a two-wheel drive design is the front differential and the front driveshafts, which means you have to really push the design and the materials elsewhere to get down to that weight limit. In



contrast, a four-wheel drive car has to be ballasted to get up to 1,850 kg, so if you put, say, another 200 grams into the driveshaft to make it stronger it's unlikely to compromise the performance noticeably.

> It also makes the four-wheel drive cars significantly less expensive as they don't have to use exotic materials." The drivetrain configuration also has a direct impact on the structural design of the car. Two-wheel drive T1 cars tend to run a transaxle layout with the engine in the back to place as much weight as possible over the driven wheels. Typically, the fuel cell on these cars sits in front of the engine and runs underneath the crew compartment, close to the centre of gravity, which minimises the balance change due to fuel load.

In contrast, four-wheel drive designs stick with a traditional front-engined configuration, which gives a more even weight distribution, but the regulations require their fuel cells to be positioned aft of the rear roll hoop, which leads to a more pronounced balance change. Fully fuelled, the tank contains close to 400 kg of fuel, which means that the ballast location, roll stiffness distribution, ride heights and damping are always a compromise between the conditions at the start and end of the stage.

"You can have a competitive section that starts almost as soon as the cars leave the bivouac, fully fuelled, or you could have a long road section first, which means that they reach the start of the competitive

Bahrain

LEFT The team was able to hit the ground running with 98 per cent of the mapping work performed on the dyno

RIGHT Functionality dictates some aspects of the car's design, with panels needing to be easily removed to enable servicing

BELOW lan Callum and his design team were brought in to create a unique silhouette that differentiates the Hunter from rivals

PIO BRX

hrain

SAMSUNG



section quite light," notes Doe. "Another difference is that the four-wheel drive layout tends to leave less space for the cockpit. Despite being large cars, the engines are placed well back with the gearbox running down the centre of the structure, which results in a surprisingly cramped environment."

All these considerations mean that the choice of two-wheel drive or four-wheel drive was far from straightforward. On balance, however, four-wheel drive was considered the better option.

PETROL POWER

The other big question was what type of powertrain to use. At that point, in mid-2019, turbo diesel engines had powered 10 of the last 11 winners in the T1 class, but the FIA and the ASO were understood to be keen to move away from the technology.

With turbocharged petrol engines allowed for the first time in 2021, diesels would no longer be the only ones to benefit from forced induction (although this is perhaps less of a factor now than it was on the high-altitude South American events). Plus, diesel has traditionally been less popular in the Middle East – home of the Bahrain team – than it is in Europe.

"We would have needed to see a 🕨

Designed for the Dakar

THE intention with the BRX Hunter was to create a car that was visually dramatic as well as carefully optimised for the specific demands of rally raid competitions. To this end, celebrated car designer lan Callum and his design team were brought in to create a unique silhouette that would differentiate the Hunter from the existing T1 designs.

"We wanted to give the car a unique shape that we felt was suited to an extreme vehicle," Callum recalls. "It was the packaging that was new to me. To start, the car is huge – 1.8 metres tall. We wanted to disguise the height of the car through graphics and form.

"So much air gets underneath these high-mounted vehicles; we had to work hard with the engineers to make sure we got the downforce right. That was a science we had to learn about. The overall airflow had to avoid creating lift and we had to find ways to extract air through various apertures, all of which had to be accommodated elegantly into the shape of the car."

Respecting the ramp angles and sight lines was challenging, he explains: "A car like this spends a lot of time in the air, so downward vision becomes very important. Then there are wheel clearances. Working on sports cars, you instinctively want the wheels wrapped tightly into the body. These kinds of clearances are alien to me, to all of the team. There were also functionality requirements, such as easily being able to remove panels to give access for engineering work. You design to accommodate the natural aesthetics that come with the function of the car, rather than fight against them."

The lower portion of the body was defined by Prodrive, but Callum was given considerable freedom above the top line of the wheel. This has resulted in a distinctive coupé-like shape, complete with some of Callum's trademark styling cues.

"I think this is the most fun, pragmatic yet idiosyncratic car I've worked on," he concludes. "It's gratifying to have created something that accommodates all the functional requirements but still has appeal. David [Richards] was clear that he wanted something that looked quite different and special, and I think we've achieved that."



significant performance advantage to make us go with diesel," comments Doe. "In terms of petrol engines, there are several naturally aspirated V8s out there that we could have used, but we have a lot of experience with turbocharged engines, so we decided to go down that route. It does bring some additional complexity in terms of turbo control and cooling, but that's something we're used to dealing with; every single one of our GT cars is now turbocharged, along with our World Rallycross car and the decades of World Rally experience that we've got going back before that."

Initially, the idea of a very small capacity four-cylinder turbo was considered. Mercedes, for instance, now offers a 2-litre turbocharged production car with well over 400 bhp, making it in line with most T1 cars. Conditions on the Dakar, however, are rather different to those faced by a typical road car and it was eventually decided that a larger unit would be a better option for 7,000 kilometres of competitive mileage. With that in mind, the Prodrive engineers turned to Ford's 3.5-litre twin turbo EcoBoost V6.

"We wanted something that could be run with a minimum amount of support," explains Doe. "The regulations don't allow you to do a great deal to the base engine, but we have looked very carefully at the details. These cars can find themselves at some quite strange angles for prolonged periods when they're going over the dunes, so we've fitted a dry sump. We've also engineered our own enclosed belt system on the front because we have slightly different ancillaries to the production engine."

The option of using the production turbochargers was

ABOVE The car uses brake callipers and discs from AP Racing considered, but Prodrive has swapped them for another BorgWarner road car design, which is better suited to the Dakar duty cycle. This led to a repackaging of the exhaust manifold, but the intake manifold is standard and a production-based intercooler is used, as per the regulations.

The biggest challenges with the modified engine were calibration and control. Prodrive has adopted a Bosch electrical system and carried out most of the mapping using the new transient dyno at its Oxfordshire HQ.

"What's been great with this project is that we've been able to hit the ground running with 98 per cent of the mapping work done on the dyno," says Doe. "That calibration process can take a long time with a turbo car, so I think the drivers were quite shocked when they got in and the car felt more or less sorted from day one."

CHASSIS DESIGN

As the design concept began to take shape, attention switched to the details. The tubular steel spaceframe chassis features double wishbone suspension allround. A live axle setup – not uncommon on off-road cars – was considered, but independent suspension was thought to be the better option.

"You get to run a bit more suspension travel with a live axle [330 mm as opposed to 280 mm], but the packaging is better with independent suspension. You can

FF The Dakar is one of the last great adventures left in motorsport"

integrate wishbones into the spaceframe quite neatly," notes Doe.

The structure is built around a central safety cell, which contains the passenger compartment and the massive 500-litre fuel cell. Combined with this, there are front and rear sub sections that can be fabricated separately to start with before they are welded onto the main structure. This design philosophy helps to cut time and cost during manufacturing, but it also results in two sub-assemblies that are virtually identical: the left front and rear are identical, as are the right front and rear (although they can only be fitted to one side of the vehicle, as the **>**

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FF A hydrogen fuel cell with electric drive is something that's on our strategic view"

ABOVE Designing every aspect of the car from scratch to survive the rigours of the Dakar was a huge challenge

RIGHT A tubular steel spaceframe chassis underpins the Hunter

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centre of gravity height. "We wanted to bring the whole height of the car down and not place the spare wheels under the crew as they are on some vehicles. This ties in with the coupé-style shape designed by lan Callum, which gives us a low front end that helps with driver vision over the dunes. Dropping the damper height [by mounting them to the lower wishbone] helps us to do that by lowering the whole front structure of the car."

service crews later discovered to their cost when the wrong pattern was dispatched to repair

Somewhat unusually for a Dakar car, the

any major risks, our philosophy has been to go with a relatively conventional concept, but optimise every aspect as thoroughly as we can. That includes pushing really hard to reduce the

Reiger twin damper units are mounted to the lower wishbones. There are a number of reasons for doing this, Doe explains: "Rather than take

Loeb's car in the desert).

The other main reason is the structural design of the suspension. It's usually the lower wishbone that takes the highest load. This leads to them being sturdier than the upper wishbone, so the Prodrive engineers reasoned that it made sense to feed the damper loads through this area as well. That meant they could reduce the size and weight of the upper wishbone, plus the simplified design could then be used on all four corners, which wouldn't be feasible if it was also engineered to accept the damper loads. The downside is that it complicates packaging, due to the positioning of the driveshafts ("but we've got a very clever suspension designer who's managed to accommodate all of that," notes Doe).

The upper wishbone, he explains, is basically a 🕨

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scaled up version of the company's World Rallycross design. It's a concept that puts the complexity into the machining of the bearing housing and leaves the remaining fabrication quite straightforward in case it needs to be repaired. Similarly, the Hunter uses bespoke wheel bearings that are built into a removable cartridge (in contrast to the GT wheel bearings that are built direct into the upright). This enables the hubs to be assembled as standard units that can be swapped quickly and used on all four corners. The driveshafts, too, are identical all-round.

"We applied a lot of analysis to the design of the suspension and the spaceframe," recalls Doe. "We'd had warnings from people with a lot of Dakar experience that it was common for teams to spend a lot of time welding spaceframes up during testing, but we only had one small issue during the development work.

"The lower wishbones were possibly the hardest part to get right with all the bending loads from the damper. We also wanted to create a 'fuse' in the wishbone, so if it had a really hard impact it would give way and bend in a controlled manner rather than collapsing and damaging the frame. We have managed to bend one of these fuse elements in testing and the car was still driveable, so we were

> **ABOVE LEFT** The Reiger twin damper units are, unusually, mounted to the

lower wishbones

RIGHT Every aspect of the BRX Hunter's design has been optimised

LEFT The company's first full spaceframe car and the demands of a rally-raid led to challenges Prodrive hadn't encountered in traditional forms of motorsport



quite happy with the way that worked out."

It was one of these lower wishbones that later failed on the Dakar, but the initial assessment is that the breakage was caused by the car striking an obstacle such as a rock (rather than the suspension loads). This seems to have been an unfortunate blip in what was otherwise a reasonably successful debut from a durability perspective.

EXHAUSTIVE ANALYSIS

The team carried out a vast amount of stress analysis on the chassis and the suspension, which resulted in a relatively complex spaceframe design, Doe explains: "We must have done close to 100 iterations of the design in FEA. There were certain load cases that were really tricky and it took a long time to get a balance between something that was sensible to manufacture and something with a low risk of failure. The area that turned out to be the hardest to engineer was not one that we'd actually anticipated – bizarrely it was the inertial loads on the spare wheel carrier. More understandably, the connections between the front and rear sub-assemblies and the main safety cell also took a lot of work."

As with the powertrain calibration work carried out on the dyno, Doe says that the structural design actually benefited from a rather unlikely source: "The COVID situation heavily disrupted the build and the original test plan. We should **>**

Future powertrains

WHILE the BRX Hunter's turbocharged V6 may be relatively conventional, there are signs that times are changing in the Dakar. In 2017, the Spanish Acciona squad became the first team to complete the Dakar with a battery electric vehicle (albeit finishing in last place). More recently, Audi has announced its intention to compete in the Dakar using a full electric drive with range extender engine in 2022.

Further ahead, several companies have already announced plans to compete using hydrogen fuel cells. With large, heavy vehicles – including trucks – driving for up to 800 km at a time, there's a good argument for choosing this technology over batteries, and it's something that's already on Prodrive's radar.

During the course of this year's event, the organisers revealed ambitious plans for an "alternative energy" category as early as 2022. By 2026, all Elite competitors will be required to enter the race with vehicles that meet new ultra-low emission standards.

"We're in regular dialogue with the FIA and the ASO and they have an interest in developing future powertrains," comments Doe. "A hydrogen fuel cell with electric drive is something that's on our strategic view. It's certainly an area that we'd be interested to move into."



BRX Hunter Tech Spec

Spaceframe	Prodrive
Spacenaine	
Composites	Prodrive (plus others)
Body styling	Callum
ECU and electronics	Bosch Motorsport
Wiring harnesses	Prodrive
Dampers	Reiger
Springs	H&R
Brake calipers and discs	AP Racing
Exhaust	Akrapovic
Transmission	Sadev
Differentials	Sadev
Driveshafts	GKN
CFD provider	TotalSim
Fuel tank	Proflex
Seats	Sparco
Fire suppression system	Lifeline
Intercom	Stilo
Lights	Wipac
Wheels	EvoCorse
Tyres	BF Goodrich
3D printers	MakerBot
3D printing material	DSM

have had the car out and testing in July, but that was delayed by three months, which is always a concern. However, the flip side to that was that our design and engineering teams continued working from home while the production facility was closed, which effectively extended the development time.

"That enabled us to go into the next level of detail on some of the more complex areas rather than releasing designs for manufacture. We've had a lot less time for testing, but we've been really surprised how smoothly the test programme has gone as a result of that extra development time."

AERO DEVELOPMENT

Simulation was also used extensively in the development of the car's aerodynamics. With the T1 vehicles now limited to 180 kph and average speeds down to 50 kph in some of the dune sections, bodywork aero is not as critical as it would be on a circuit racer, but cooling can still be a real challenge. "You get some odd temperature cases on the

Dakar," comments Doe. "The ambient conditions aren't too extreme in Saudi Arabia at this time of year – the average daytime temperatures are in the low 20s [deg C] – but if you're stuck in a dune you could be using most of your power at **RIGHT** The project comes together in the workshop

BELOW The coupéstyle shape helps with driver vision over the dunes







benefit of the higher weight limit on the four-wheel drive cars – if we were right on the limit we probably wouldn't have had the option of adding that extra margin," comments Doe.

close to zero speed, so it's very much a fan-driven

There's also a traditional lift and drag perspective to consider. Although the speeds aren't huge, conventional T1 cars tend to develop quite a lot of lift from the big front arches, so Prodrive says that a lot of effort went into optimising high-speed stability over a range of yaw angles.

THE HUMAN ASPECT

Speaking before the event, you got the sense that the Prodrive engineers are very confident in the design of their car, but also realistic about their chances for a first attempt at the Dakar.

"If everything goes well, we don't see why it shouldn't be one of the fastest cars there, but we're under no illusions about the scale of this event," cautioned Doe. "We're up against teams with decades of experience, so it's not going to be easy. "The feedback from the drivers during testing has been very good – they say it feels like a mature programme rather than a car that's about to do its first event. Sébastien – who's done several Dakars now, but always in two-wheel drive buggies – commented that this drives far more like a World Rally car. Obviously, the power to weight ratio is very different, but it can be driven with the same sort of precision."

The BRX team personnel includes veterans from Prodrive's World Rally days, so they're no strangers to working in extreme environments. However, a fortnight on the Dakar is an entirely different proposition.

"The Dakar is one of the last great adventures left in motorsport," warned Doe. "For the team out there working on the car it will be a completely different mental and physical challenge. The closest we'd normally come to that is Le Mans week, where we're out there for a full week, with a 36-hour day during the race itself, but in reality this is a completely different level. It's two and a half weeks of following the crews across the desert, sleeping in tents beside the cars and travelling as much as 800 km each day before you repeat the whole thing again. We have a fairly small team, so people have to pitch in and do everything. Some days are going to be very long, which is fine for one day or a couple of days, but for two weeks - on top of the preparations leading up to the event - it's a massive test."

It's also been a new challenge for the engineers back in Banbury, Doe points out. To his knowledge, it's the first full spaceframe car ever produced by the company and the demands of a rally-raid lead to all sorts of challenges that aren't encountered in other forms of motorsport. There's no doubt it's been a learning curve, but Prodrive is in this for the long haul. It's understood that the company is looking at producing customer cars, and even considering a road version. As for the Dakar, fifth place is comfortably better than the legendary Peugeot squad managed upon its return in 2015, only to dominate for the next three years after that. Whether Prodrive can do the same remains to be seen, but you certainly wouldn't bet against a competitor with the Banbury-based team's pedigree.



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DTM Switch to GT3





The implosion of Class One and a switch to GT3 machinery take the DTM into new territory this season. **Mark Skewis** talks to an experienced DTM engineer to discover what went wrong, and where the series goes from here

HE DTM hit 30 a few years ago, full of optimism. But by the turn of the decade, it had definitely taken a few of life's knocks. It is now staring down 40, older and maybe wiser, but certainly facing up to new challenges.

In those intervening years plans have changed, friends have left, long-distance relationships have fizzled out and partners have eventually broken up.

The old adage is that it's not how many times you get knocked down that counts, but how quickly you haul yourself back up again. So what remains is regrouping to tackle the decade ahead with fresh optimism and, hopefully, the same qualities that have made the DTM such a fascinating series until now.

The technical formula introduced in 2012, using a common chassis and V8 engines, peaked in 2013 to 14. There always seemed to be downward pressure on budgets after that, with reducing technical freedom – in particular in the aerodynamics. Added to this, some fraught experiments with success ballast were made as ways were sought to generate close racing and allow the participants enough success to remain involved.

There was a significant false start too with the move to an I4 turbocharged powertrain. Intended for 2017 but mothballed after considerable investment, it was then ultimately adopted two years later than planned. This certainly added cost and frustration at a time when it might have been better avoided. The fallout could be felt in 2019 and '20 when a new entrant struggled to develop one of the 'new' power units. Indeed in '19 and '20 the whole grid found the integration of an unfamiliar powertrain architecture with an already existing design quite troublesome.

Some promising moves were made with the Super GT series in Japan, including shared events, but the pandemic in 2020 raised a serious barrier to that.

Eventually 2020's full season of 18 >

data:hub

rounds, run in a condensed timescale starting just shortly after Formula 1 – albeit with only 16 cars – is still mightily impressive and to be congratulated. But engineers reported a difficult championship that didn't bode well for ongoing stability and clearly signalled the need for a change.

The competition was, as in 2019, still a little one-sided. Most thought that Audi had the faster car but sadly it had already announced an intention to step back its involvement, as did BMW which withdrew as a works squad at the end of the season.

It is possible to look back and question some of the things that happened. The sporting changes, for example, such as the radio ban, could be deeply frustrating for fans, engineers and drivers alike on occasion. Aside from this though, a lot of what was done both on the sporting and technical side is

RIGHT & BELOW

Headline acts: Team Rocket RJN, part-owned by 2009 F1 champion Jenson Button, will race a McLaren in the new formula (right), while Red Bull F1 refugee Alex Albon is likely to drive a Ferrari





now commonplace elsewhere and was always underpinned by the essential 'kompetenz' of the series.

Changes to the weekend format, a tyre blanket ban and minimum pressures, NASCAR-style safety-car resumptions and tweaks like DRS and Push to Pass did create variety in the weekends. Combined with the kind of close racing which is the DNA of the series, it was certainly true that predicting the results was always difficult.

Even in 2020, there had been five different winners after eight rounds. As a former colleague is fond of saying, "DTM is like a box of chocolates..." Tom The false start with the inline-four turbocharged powertrain added cost and frustration at a time when it might have been better avoided"

Hanks film fans will understand just what he means.

It is safe to assume that many and various solutions were considered to allow things to continue in 2021, including similar composite monocoque closed wheel cars akin to LMP2 or LMP3. Finally, though, a switch to GT3-based machinery has been announced for the coming season.

Some of the famous teams will remain (in some capacity at least) and there will be new entrants. One of the biggest fillips is the combined announcements of Red Bull Formula 1 pilot Alex Albon driving a Ferrari with F3 graduate Liam Lawson as team-mate, and Jenson Button's Rocket RJN squad running the McLaren 720S.

The GT3 format is a success story. It combines ultra-desirable cars with close racing and an >

RIGHT Audi dominated Class One with its RS 5 DTM, winning 28 of 36 races in 2019 and 2020

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DTM Switch to GT3

58

Audi AG

accessibility and diversity that is exciting. The fact that very different concepts of car are able to compete, combined with their being safe, robust and reliable machines, is well proven. There is strong support from manufacturers and promoters and direct links to the most iconic brands.

GT3 cars can still be considered relatively expensive but are several multiples cheaper



than the DTM machinery they will replace and therefore do open up entry to those without full manufacturer backing.

DTM can potentially fill an opening for sprint format events, with single drivers and pitstops, in GT3 cars. With a core of fans there's a considerable audience and hopefully in the stands as well as through the media channels. One way that this package can be enhanced

is with the support events that run alongside,

and in 2020 the DTM Trophy demonstrated there is still considerable potential. It's an area that's worth watching. In the past, with F3 being on the same bill, there was an important talent pool being honed for Formula 1 and DTM.

AKRAPOVIĜ

Another aspect of the DTM recently that has perhaps been slightly overlooked is the change of venues. It can always be argued that continuity is important, the eccentric celebration that is Norisring for example, but at the same time events returning to old venues like Zolder or visiting different circuits like Monza and Spa or the twilight races really add other elements.

As F1 showed in 2020, the classic tracks can still hold their own in terms of creating a good event. Sometimes they perhaps trade overtaking for other kinds of visual theatre, and variety really does serve to create uncertainty and renewed interest – the essential show.

It is important that costs are contained however, and that will need careful thought. ►

ABOVE RIGHT With the DTM

Me:

on the brink of imploding, Aston Martin's arrival shored up the series for a short while. But the team's struggle with an unfamiliar powertrain hampered its efforts to compete with BMW and Audi

RIGHT The V8 quattro (right) which won Audi its first DTM crown in 1990 was revolutionary, but contrast it with the aggressive aero on the Audi RS 5 DTM (left) that marked the series at its zenith



The technical regulations, homologations and rigorous stewardship of development are one thing but often a lot of the cost of going racing in the old DTM came from the consumption of parts on track: large composite bodywork panels are expensive and vulnerable. Single suppliers of spec components exploited their monopoly. There needs to be a new way to deal with this taking in all the reasons behind the costs.

DTM ELECTRIC

Part of the series support package in the future is slated to include DTM Electric. This seems a sensible recognition of the need for a sustainable propulsion initiative within the DTM umbrella and a good way to trial the concept. so it might be expected that these will be revised to fall in line with eventual rate of technology development.

Nevertheless, there are cars available now, like the Taycan S with twice the Formula E battery capacity and which could probably race at 400-500 bhp for a dozen or so laps of Hockenheim if the thermal issues could be managed.

"We are particularly working on technologies that are viable for the future," says Gerhard Berger, who has been at the helm of the DTM since 2017. "In the process, we are incorporating the most varied approaches, from hybrid technology with highly-efficient internal combustion engines via synthetic fuels or fully electric vehicles up to hydrogen technology.

RIGHT & BELOW The

five strands of the new DTM platform acknowledge both the future (the DTM Electric prototype, designed by Schaeffler, is seen below) and the past (DTM Classic is seen right)

BELOW LEFT The

tantalising prospect of a tie up with Super GT, as seen at the 'Dream Race' at Fuji Speedway, was one possible route forward. That dream died with the COVID pandemic



The GT3 format is a success story"

2023 is the target, which seems ambitious and a kind of fail-fast approach does make sense in a rapidly moving area.

Like the previous ideas around robotic battery swaps, there are some quite ambitious targets "Motorsport has always played a major role in accelerating the development of technical innovations. Therefore, it is important to be able to showcase as many technologies as possible on the DTM platform. Another





important element is to be as close as possible to the technology in order to be able to identify which technology will be leading for the future."

Those are battles for another day, though. Right now, his ambition for 2021 is clear: "To have 20 cars from at least five different brands on the grid. On top of that strong drivers, a balance of performance that is working and a battle for the title that goes down to the wire, the final race."

In periods of uncertainty, it's normal to look at the fundamentals. Investors turn to gold for security and people to the state for guidance. Basically then the new DTM is well placed to succeed, with the assets that it has always held in top level drivers, classic venues in motorsport's Eden and great cars.

It just remains to execute the gameplan at the professional level that is a trademark of the series. As that colleague again is also fond of saying "dai cazzo", if you'll forgive the expression!



FNFRG

If the transition to hybrid tech becomes merely an exercise in lip-service, where does that leave the World Rally Championship? **Hal Ridge** talks to a WRC winner whose new EV could offer some clues

HINK of competitive engineering excellence from New Zealand and two names spring to mind: Burt Munroe and Bruce McLaren. Both travelled across the globe to showcase their talents, and did things their own way. Now, another Kiwi is following in their footsteps.

But, while New Zealand is probably best known for its stunning scenery and almost 30 million sheep, former works World Rally Championship driver Hayden Paddon isn't following the flock – he's forcing a whole new route.

Having suffered an abrupt and so-far premature end to his top-flight driving career on the world stage, 2016 Rally Argentina winner Paddon headed home and hatched a plan. While his employment with Hyundai Motorsport in the WRC ceased at the close of 2018, his Paddon Rallysport (PRG) concern has maintained a relationship with Hyundai New Zealand since 2014, and it's a partnership that is not only blossoming, but could become a leading force in rallying across the globe.

At first, he laughed off the idea of an electric rally machine in early 2017. "It left a bit of a lasting thought it my mind, though," muses Paddon. "I gave it some consideration and it soon became very apparent that whenever we talked to potential corporate partners or about any sort of government support, as soon as we mentioned EV, it seemed to open up a few more doors." The plan was set, and the Cromwell team's Hyundai Kona all-electric rally car, that has been 10,000 hours in the making, was released to the public in November.

SEISMIC CHANGE

As Race Tech goes to print, it's about to begin intensive development testing. But, this isn't just a standard electric car fitted with a roll cage as a token effort towards alternative propulsion motorsport, or an existing rally car that's been retro-fitted with an electric kit. Instead, this is a ground-up bespoke machine that, Paddon hopes, will take a step towards changing the sport he loves, forever.

Paddon has been competing at home



LEFT The Paddon Rallysport EV rally car features a modernised aero package reminiscent of current World Rally Championship (WRC) cars in internal combustion engine (ICE) rally cars throughout his career, most recently in a Hyundai i20 built to AP4 regulations, rules that are more relaxed than FIA homologated regulations to allow more opportunity for competitors to take part. The PRG Kona has been based on that same ruleset, and built off the back of lessons learned from the i20 and Paddon's WRC data bank.

Austrian firm STARD, the company responsible for the world's first all-electric rally and rallycross prototype – a concept it has now developed into the REVelution three-motor system used in the Projekt E rallycross series – has supplied the battery and motors for Paddon's project. Unlike the platforms that underpin

If the switch to hybrids is a tickthe-box exercise, then the rules frozen for five years, the sport's going to be in the dark ages"

Projekt E and now World Rallycross (which will switch to electric using kits created by another Austrian firm, Kreisel), where the car is built to suit the kit, here Paddon's team has worked hand-in-hand with STARD to create a bespoke arrangement.

Limited by the number of EVs in Hyundai's range, the Kona was picked both for commercial and practical reasons: commercial, because manufacturers are intensively pushing small SUV machines; practical, as the larger cabin compared to Hyundai's loniq means more room for a bigger battery, and more range.

Armed with information about battery mass, motor weights and all the required electric paraphernalia **>**



BELOW STARD's

been adjusted to

use two 220 kW

front and rear

REVelution 'kit' has

Brusa BLDA motors,

mounted transversally

that was to arrive from Austria, Paddon's engineers set about designing the new machine with weight and suspension geometry as critical points of scrutiny.

Weight was essential because it is increased and differently orientated to a conventional ICE machine. Suspension was a focus because the team – consisting of four engineers, seven personnel in total – wanted not only to achieve the best

performance, but to limit unnecessary over-engineering.

So, while Paddon has scrabbled for budget to continue competing in order to deliver return on investment for his partners, the engineering staff took advantage of the existing car running, scrutinising every component to see where weight could be shaved.

Like all top-flight rally machines, the new Kona uses MacPherson strut dampers at each corner. The five-way adjustable EXT Racing Shox units are made by the Italian firm specifically for purpose, and are – by pure coincidence – similar to the dampers used on the works Hyundai WRC machines.

I'm already blown away with it from a handling perspective" The car is adorned with EVO Corse lightweight 15" wheels. Each corner features four-piston air-cooled Brembo brake callipers and 300 mm discs (for gravel, 355 mm for Tarmac), but "nothing too flash," says Paddon.

"We have a pretty simple brake system, then of course we're working on the software side with the brake regeneration," he notes.

Regenerative braking can have an obvious influence long-term on the endurance of electric rally cars, but Paddon is aware that it's a route that needs to be explored with trepidation. "The biggest unknown that we have to develop is brake regen on a loose surface and not have it so overpowering







ABOVE Is this what rallying's new era will look like? The Kona seen in CAD

LEFT With EV technology a disruptive influence on the world stage, could cars like the Kona EV save rallying from being left behind commercially and technically?

BELOW With centre of gravity height one of the key targets, the battery is mounted in a 'T' shape down the middle of the car, replacing the transmission tunnel and rear seats that it unsettles the car, especially if it's very slippery," he says. "We've got to have some consistency in how the car handles. Because of that fact alone, we don't want to be too reliant on the brake regen system." It's early days for the project, after all.

With the battery mounted in a 'T' shape down the middle of the car, where a transmission tunnel would traditionally be, and the rear seats, the REVelution 'kit' developed by STARD has been adjusted to use two 220 kW Brusa BLDA motors, mounted transversally front and rear. The car has a perfect 50:50 weight distribution and, currently, a total weight of 1,400 kgs.

That figure will change before its rally debut. The car will need a bigger battery, but can also lose in the region of 100 kg of weight that's been built into development componentry. Crucially though, the centre of gravity is 300 mm lower than it would be in the equivalent ICE machine.



"The car will definitely end up being heavier than a normal rally car but the weight distribution is completely different, which makes that weight a little irrelevant," Paddon says. "We've been very, very particular in terms of the geometry and the chassis design with the car. We had quite strict guidelines and benchmark figures we had to meet, then STARD were good to work with us to make their kit work.

"The biggest challenge for this project is budget as a small team on the other

We're trying to generate volume, but naturally; we're not trying to make a fake or audiomanipulated noise"

side of the world compared to what a lot of teams in Europe have. That's the biggest thing when you're trying to build something technologically advanced and new – not just the batteries and the motors, but the whole car from start to finish. We've tried to do them in a different way, to a very high level."

Overcoming the challenge on being on opposing sides of the planet has been made harder still by the travel complications caused by the Coronavirus pandemic. STARD's engineers were unable to travel for the install, turn-on and first roll-out for the new machine, but by adapting to time zones, the two parties made it work.

The Kona was rolled-out in secret as a bare-metal, partially unfinished machine with only the front motor functioning on the Highlands Motorsport Park circuit just metres from the PRG workshop door. Now, adorned with the full aero-efficient composite bodywork as a more finished product, the car will undertake a number of single stage events, hillclimbs, sprints and demos in 2021 as part of the two-year New Zealand-based development programme.

With all of the country's rallies run on gravel, the car will remain in gravel trim for the time being. "I think gravel presents the biggest challenges for EV technology," suggests Paddon. "There's a lot of EV motorsport around the world, mostly on Tarmac, whereas on the gravel, it just



opens up a whole new kettle of worms on torque vectoring, on grip, on tyre wear. All these other factors which we have to now manage and develop. Once we get on top of those, it's very easy to translate everything back to Tarmac."

BEHIND THE WHEEL

Few in the world of motorsport have as much loose surface experience behind the wheel in electric prototypes as STARD owner Manfred Stohl. As such, much of the base configuration of the Kona's electric systems management, using MoTeC M1 VCU, PU and driver displays, has been done, although there will always be driver and car-specific adaptation, especially in setting up the torque adjustment settings. Paddon is one of only a handful of drivers to have won at rallying's highest level in recent years, and is impressed by his first taste of being strapped into the Racetech seat in his team's creation.

"Obviously you have to adapt to the sound and the no gears side of things, but once you get your head around that, the driving sensation is very good," he says. "We're only at the start of the development of this car and I'm already blown away with it from a handling perspective. You really feel the benefits of the weight distribution and the low CoG.

"It's very nimble, even if it's big and heavy, and the biggest difference is the inputs into the throttle. In an ICE car, you're either on ►

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or off, or you have a nice transition to 100% throttle to stabilise the chassis. In the EV, you've got instant torque if you're at 20% throttle or 50% throttle or 100%, so you tend to play with the throttle a lot more. That's actually the best way to drive the car, not necessarily fully on or off the throttle. The way you use the throttle as a driver input tool is very different."

Things have been hectic for PRG in the build of the new machine, but the work rate isn't set to ease any time soon. While the squad will begin running the car in anger, the engineers are also simulating different conditions that the car might be exposed to around the world, to ensure the correct final battery is created.

While all that is going on, work is being done with Motorsport New Zealand to get the car accepted

Graeme Murray Photography

ABOVE Eighteen months of intensive work have underpinned the design and development on one of the world's first EV rally cars

BELOW The design concept for the Paddon Rallysport EV needed to combine performance, range and reliability into one package

00%

into stage rallying. Not only from a safety point of view, but parity with the existing ICE competitors, regulating the peak output of 400 kW and 1,100 Nm torgue as required.

"There's certainly a lot of challenges but we think it's possible and that's certainly what we're working towards over the next 18 months," notes Paddon.

TURN UP THE VOLUME!

Another key interest in the Cromwell workshops is noise creation from the Kona. It's something Paddon has been keen on since the start, and a point that could add to the car's safety credentials. He's also honest that PRG is on the second iteration of its volume increasing solution.

"Motorsport's entertainment and you need to entertain people," he insists. "There's also the safety element for rallying; people need to hear the car coming. The first prototype that we were hoping to launch he car with unfortunately didn't work out, so we're doing a second prototype now, basically using the same philosophy but engineering it in a totally different way. I hope over the next 24 months we'll be at a point where we can test and show people that. We're trying to generate volume, but naturally; we're not trying to make a fake or audio-manipulated noise. It won't sound like a normal car, but it will have volume."

There is logic to racing at home to begin with, and not just commercial or logistical. New Zealand stage rallies usually have two service halts a day, with a longest road section at around 30 km. Paddon calls

Gravel presents the biggest challenges for EV technology: on torque vectoring, on grip, on tyre wear"

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using the electric car in that environment "easy to meet targets" with regards to endurance. But to go further afield, or into world championship-type events if technical regulations can be adapted to suit, is far more complicated.

"The main thing that will work against this technology, in WRC events for example, is simply the touring distances," he says. "The stage distances of 50 to 60 km per loop, you can make that work, but when you have to do 200 km on the road,





ABOVE EV rallying has to appeal if it is to convert existing fans you can't make that work.

"Long-term, I really feel the sport has to come to the technology and the technology has to go to the sport. There's got to be compromise on both sides. Maybe shortterm, transporting the car on a long road section could be an option. At the end of the day, it's seldom that the road section affects the outcome of the rally. Outsidethe-box thinking is required long-term." Away from the central services on WRC rounds, rally cars sometimes visit scheduled

FF The centre of gravity is 300 mm lower than it would be in the equivalent ICE machine"

refuel points before long road sections. With PRG's Kona being designed for a five-minute battery change, Paddon sees little difference in the propulsion methods: "Instead of filling up with fuel, you're filling up the battery, or in this case changing the battery."

Further into the future than the two-year plan for the Kona, Paddon's vision is to take a New Zealand team around the world. Pikes Peak International Hill Climb and Goodwood Festival of Speed are achievable goals already on the horizon, but which discipline his team will end up in for a more concerted effort at World Championship level competition, Paddon doesn't yet know.

"Right now, it's very hard to say what that's going to be," he says. "I think the motorsports environment is going to change somewhat in the coming years, so we just have to be adaptable to go in

LEFT & ABOVE LEFT Hayden Paddon brings a wealth of experience to the project. Here he celebrates WRC victory in Argentina with codriver John Kennard



LEFT Magnificent Seven: The Paddon Rallysport team comprises Paddon, Matt Barham (project manager and electrical engineer), Mike Pittams (lead technician), Rory Callaway (mechanical engineer), Ben Fretwell (technician), Ari Pettigrew (technician) and Matt Bowater (plant manager)

BELOW The EV package is capable of over 800 kW, but is being designed with the intent of competing alongside conventional ICE machinery

whatever direction we need to go."

There's no doubt that Paddon's project is turning heads. It's also giving further ammunition to those who feel the WRC's switch to hybrid technology from 2022 is not a big enough change. That's a point the Kiwi agrees with: "If I'm brutally honest, I think it's a tick-the-box exercise. I don't think it's actually meeting the requirements of where the automotive industry is going.

"A road car you can buy off the showroom floor, a full EV, is more sophisticated with the electronics and systems than what a WRC car has. If that continues, especially if these rules for hybrid come in and they're frozen for five years, the sport's going to be in the dark ages by the time it comes out in 2027–2028," he says.

Based on what his team has already produced, that's difficult to argue with.



SPORTSCAR RACING'S UNEASY BALANCING ACT

Thrilled by a spectacular new Hypercar category, or dreading the imposition of Balance of Performance in a World Championship? Sergio Rinland reflects on sportscar racing's dilemma

IOYOTA GAZOO Racing's Jose Maria Lopez (Pechito) instantly attracted 105,000 'Likes' when he posted the first images of the new Toyota GR010 HYBRID Le Mans Hypercar on his Facebook page. He clearly liked what he saw too, referring to "The start of a new era".

The drivers are justifiably excited. It looks, from the few pictures we have seen, that the cars won't be too different to their LMP1 predecessors - despite rules that are very different, mandating the Hypercars' peak power and aerodynamic performance.

Peugeot has also released a teaser of their Hypercar, along similar lines to the Toyota: a hybrid with a front electric motor. Two more teams, ByKolles and Glickenhaus, have announced their intention to take part under those regulations, albeit with a non-hybrid



RIGHT The LMDh successor to IMSA's popular DPi template, based on LMP2 chassis, offers a cheaper alternative to Hypercar

BELOW Toyota GAZOO Racing's new GR010 HYBRID offered a glimpse of what we can expect from sportscar racing's flagship category

vehicle. But neither will be on the grid when the World Endurance Championship's brave new world dawns in Portugal at the start of April.

This is it: four teams, two OEMs. Where are all the other manufacturers going then? LMDh is the answer.

Since it was announced last year that Hypercar and LMDh would be allowed to compete together at Le Mans and in the WEC, as well as in the IMSAsanctioned WeatherTech SportsCar Championship in the US, Porsche and Audi have announced they will leave Formula E in favour of going back to prototype racing. But they both favour doing so under the LMDh regulations, rather than Hypercar.

The reason? Cost and return on investment. If your performance is going to be balanced in order to be competitive with teams spending five to 10 times more, why not?

LMDh is a great formula for OEMs, the only ones allowed to compete. The recipe is simple: they buy a chassis from one of the homologated chassis constructors, fit a common Xtrac gearbox, Williams Advanced Engineering battery and a 30 kW Bosch 'mild hybrid' system and their own engine. Then, add some brand cues to the already designed >




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bodywork from the chassis supplier, and you have a competitive alternative. Many other OEMs have already done that with success in IMSA's DPi category, which is why Acura has just announced that it too will participate in LMDh.

In terms of differences, both have the same limitation on peak power and aerodynamics, with LMDh being 70 kg lighter (first BoP). The performance differentiator will be tyre management. Everybody will use Michelin, but the French supplier will have different tyres for the hybrid Hypercars (with AWD systems) and the RWD LMDh and non-hybrid Hypercars.

It will be interesting from the spectators' point of view. But for racing purists and technically-minded fans? I am not so sure: Balance of Performance is not most enthusiasts' 'cup of tea'. Look how heavily



If your performance is going to be balanced to be competitive with teams spending five to 10 times more, what's not to like?"

penalised the Toyota was last year in order to allow privateers such as Rebellion to fight for victory. Yes, it offered the privateers the opportunity to fight for victory, but this was hardly an upset, a giant-killing feat. Instead, many fans lost interest in the 'contest'.

Motorsport is supposed to be a meritocracy, as it always has been. BoP is contrary to that concept.

It is understandable, up to a point, in GT racing, where cars are not designed with the racetrack as their priority. It ensures that everybody has a chance, as the cars more adapted to a racing concept are penalised. It makes sense. The same could be said for Touring Cars.

In the past, a long time ago, Ferrari, Porsche, Maserati, Ford, Jaguar *et al* used to design cars for racing, then adapt them to pass the road requirements. That meant Sport and GT cars were real racers, with a harsh ride, hard brakes and clutches which enthusiasts loved. It was as close to driving a race car as it could get.

A similar thing happened with some touring cars in

ABOVE The hobbling of Toyota against nonhybrid rivals in last year's WEC underlined what a turn-off BoP can be at times

BELOW The new LMDh rules raise the prospect of a new breed of turn-key racers to emulate Porsche's 962s of the late eighties the past (Ford Cortina Lotus, Mini Coopers, Honda Civic and others). Today, car buyers, save for a very few exceptions, are not boy-racers. They want to drive a comfortable and economic car. The rest does not matter. If somebody wants a sporty version, paint some stripes on, fit fancy wheels and they are satisfied.

To race with those cars is a huge undertaking, hence, to limit costs, BoP was invented. Applied to pure racing cars, designed to win races, I am not much in favour.

Nevertheless, had the ACO and FIA not come to a compromise with IMSA to fill the Le Mans grid with as many brands as possible, prototype racing as we know it would be doomed. So, 'damned if you do, damned if you don't' – at least we will have competition of some kind.

Now, if a private team wants to go to Le Mans, it could build its own car, spending a small fortune, with the pleasure this exercise entitles, or simply buy an LMDh from an OEM's racing department. In similar fashion, you could say, to the sports cars of a few decades ago when private teams would buy a Porsche 917, Ferrari 512, Lola T70 or Ford GT40 in the '70s; a decade later they could buy a Porsche 956/962 or in later years a McLaren F1 and have a chance of winning the big race.

So, not all is lost. My only fear is that once we see the true performance of all the different regulations, the powers that be will start manipulating the BoP, only to discover it can be a double-edged sword, as we saw last year.







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