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## RACE TECH Motorsport Engineering

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He's started his own Extreme E team to fight climate change, champions the Black Lives Matter campaign and has just been named in the world's most influential 100 people by *Time* magazine. So what's driving Lewis Hamilton?

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# A LONG HISTORY OF EFFICIENCY

**CONGRATULATIONS** to World Champion Lewis Hamilton for using his authority and influence to promote sustainability, not just in motorsport, but in all walks of life. While this is really an admirable initiative – as is Formula E's announcement that it has achieved a zero carbon footprint (see News) – motorsport from the beginning has been about total efficiency, but only in the very recent past has it become fashionable to promote this aspect.

The FIA is in the process of formulating new F1 regulations that will include biofuels playing a more important role as F1 targets a net-zero carbon footprint by 2030. NASCAR already has a huge green initiative. It is busy with recycling, emissions reduction, tree planting and many other aspects of sustainability. Many NASCAR teams and tracks also rely on solar power as an energy source, including Daytona International Speedway, Indianapolis Motor Speedway, Michigan International Speedway, Pocono Raceway, Sonoma Raceway, IR Motorsports and RoushFenway Racing. IndyCar, meanwhile, is embracing a "Shift to Green with Biogas" initiative with Biogas Americas, with Andretti Harding Steinbrenner Racing waving the banner.

International Motor Sports Association (IMSA) announced earlier this year it has further expanded initiatives for its IMSA Green Racing programme. This includes increased involvement in the US Environmental Protection Agency's (EPA) SmartWay Program, discovery and implementation of solar energy within its paddocks and progress in the current move to electric and hybrid technologies in the mobility field.

However, it is the Automobile Club de l'Ouest (ACO) that has the longest history in this area. It has always been in the vanguard of sustainable initiatives, although it was not always fashionable. "Racing improves the breed" was what Charles Faroux – one of the foremost French motor journalists and engineers of the past century, as well as the 24 Hours race director for over three decades – had in mind when in 1922 he contacted Georges Durand, the ACO president. Faroux's idea was that a 24hour continuous race for production cars would test their entire equipment.

In 1924 the "index of performance" classification was introduced, the winner being the car having exceeded the minimum distance required for its class by the highest percentage. It was meant to favour and attract French manufacturers as they mostly built only smallcapacity cars, and the prize money offered was higher than for the overall winner. The index was abandoned in 1981.

In February 2019, the ACO really pushed the boundaries when it announced H24Racing with GreenGT. The goal was to lead the way with hydrogen-electric-powered cars that will join the combustion engine grid as part of a new class in the 2024 Le Mans 24 Hours. The plan is to showcase and promote the hydrogen-electric powertrain as the mobility of the future.

Since its launch the project has moved on with alacrity. On the Friday preceding this year's race, the new hydrogen-powered H24, which is lighter, technologically more evolved and quicker than the current LMPH2G, was unveiled by the H24Racing team. ACO president Pierre Fillon also officially opened a hydrogen filling station prior to the race, which is located near the aerodrome, opposite the circuit. It is open to the city's buses and will soon be serving trucks and fleet vehicles. The initiative is part of the ACO's ongoing commitment to zeroemission transport.

Innovations made in racing eventually benefit us all as the technology tried in the white heat of top-level motorsport filters down into the vehicles we drive every day. So don't be an apologist for liking and supporting the sport.

William Kimberley **EDITOR** 



# Boyhood hero drives Hamilton's mission

## Mark Skewis examines Lewis Hamilton's first steps into life after Formula 1

**LEWIS HAMILTON** will this season equal Michael Schumacher's feat of winning seven world titles. In the process, he will surpass the German's once-impregnable record of 91 wins. But it is Ayrton Senna, not Schumacher, who has been the catalyst for Hamilton's achievements – and also his approach to life after Formula 1.

Hamilton has talked of picking up the baton from Senna, his boyhood hero. Yet the Brazilian's influence on his career extends way beyond mere race statistics, as evidenced by Hamilton's venture into the fight against climate change with the formation of his own Extreme E team.

That growing awareness of the platform he has at his command from which to influence people – which extends to a formidable Instagram following of more than 20 million – has transformed Hamilton into a figure who increasingly divides opinion. His admirers applaud the fact that he cares enough to venture outside of the Formula 1 'bubble', fighting for what he believes, as he has for the Black Lives Matter campaign – also forming his own commission to investigate F1's lack of diversity –and now for the environment. Critics, meanwhile, contend that sport and politics do not mix well, recoiling from his attempts to impose his own views on others.

Hamilton talks of "an awakening" and sporting stars are playing an increasingly vocal role in shaping perceptions, not to mention government policies. 'Taking the knee' originated in American Football, but has become the signature move across the sporting world for the campaign against racism. In the UK, meanwhile, soccer player Marcus Rashford succeeded in reversing the government's stance on free school meals.

Hamilton's growing influence was underlined last month when *Time* magazine named him as one of the 100 Most Influential People of 2020. That achievement was recognized by Bubba Wallace, the only black driver in NASCAR's top level.

"Lewis Hamilton is someone I've idolized," Wallace said. "His activism has moved the world.

"Lewis' mental preparation, his aura, his

LEFT Hamilton won't race the Extreme E car on events, but confesses he is excited about driving it in private

**ABOVE RIGHT** Not since Senna, Lewis's boyhood hero, has a driver transcended F1 in this manner

RIGHT He is dismayed but undeterred by adverse comments over his promotion of the Black Lives Matter campaign





ability to capitalize on every opportunity to use his platform to drive out racism are more than just a model for racecar drivers and other athletes. He's an inspiration for everyone."

In Formula 1, no driver has transcended the sport since Senna like Hamilton.

Growing up in Stevenage, Hamilton used to come home from school and watch videos of Senna driving. He admits that his hero fuelled not only his ambition to race in F1, but shaped his driving style and behaviour. Hamilton acknowledges that the Senna connection runs deeper than a bulging trophy cabinet and indelible marks on F1's record books: "He was also such a magnetic personality. I particularly loved his vulnerability and his openness. I only met him once, the year before he died, but it left a lasting impression on me.

"As a kid, you see these people and you think they're super-heroes. But everyone has weaknesses. And for all Senna's brilliance and achievements, so did he.

"It was fascinating how he overcame those, and how he was able to talk so eloquently about what he did, including the dangers involved. I was also impressed how open he was about his relationship with God and his beliefs.

"As a kid I couldn't understand or appreciate where Ayrton was, because I hadn't been there. But he touched me so deeply. He had such a huge impact. He moved a whole nation. And people around the world."

In the later years of his career, Senna

## A team that is going to change the world for the better"

became an increasingly political figure. Not just in his relationships with teams and suppliers, but in the world beyond F1. Some speculate that he would have become a candidate for Brazilian president; of more substance is the fact that his legacy lives on in the work of the Senna Foundation. It reaches around a million and a half to two million children each year and trains around 60,000 teachers – more than all the teaching schools in Brazil train in one year.

It is no coincidence that the same desire to make things count now fuels Hamilton, a man so influenced by the Brazilian's mystique.

"We don't know how many days we have left – I don't assume I'm gonna live to 90 years-old – so I want to maximise every single day that I have. I live in *the* world, not just the F1 world," Hamilton insists.

"When I say something, it travels so far.

That's an unbelievable power we have with today's media. That we can push for change. If I didn't, I'd wake up and think, 'Yes, it's great to have those world titles, but what does that really mean?' It doesn't mean anything. It's about what you do with it. I want to be part of changing things."

If Senna moved people around the world, Hamilton's latest mission is, in essence, to help *save* the world.

His new team – named X44 after a racing number he has made iconic since his karting days – will race its electric SUVs in five remote locations to raise awareness of climate change. Those settings – arctic, desert, rainforest, glacier, and coastal – are already damaged or severely under threat of climate change from a range of serious issues including melting ice caps, deforestation, desertification and rising sea levels.

"X44 is a new kind of racing team – a team that is going to change the world for the better," says Hamilton of a series "that brings my vision for a more sustainable and equal world to life".

"My goal is one day to own a company, so it is part of that, but it is more than that," he stresses. "Extreme ►





E really appealed to me because of its environmental focus. I was really impressed with their aims, with their goals; they are very much aligned with what I am focused on right now. Every single one of us has the power to make a difference, and it means so much to me that I can use my love of racing, together with my love for our planet, to have a positive impact."

#### **NO PASSING FAD**

It's trendy, of course, for the stars to flaunt their 'green' credentials when it suits them, often only to disappear on their private jet once the cameras have departed. But Hamilton is earnest when he talks about his efforts to help the environment. His once-trademark £25 million red private jet is long gone and he no longer drives any of the fleet of supercars he owns.

Instead, his main run-around is an electric Mercedes-Benz EQC and he insists that where possible an electric car is his mode of transport from the airports to the racetrack. He has made other changes to his life, which are said to include having offset the carbon footprint of his entire F1 career. "None of us is perfect," he

## The time for platitudes and token gestures is over"

acknowledges, but he is making an effort.

That's why he began working with the Royal Academy of Engineering, in London, discussing scholarship programmes and how X44 can best provide opportunities to the next generation of engineers and technicians. That collaboration has now resulted in in the formation of The Hamilton Commission.

The research partnership will be dedicated "to exploring how motorsport can be used as a vehicle to engage more young people from black backgrounds with Science, Technology, Engineering and Mathematics (STEM) subjects and, ultimately, employ them on our teams or in other engineering sectors," says Hamilton.

"The time for platitudes and token gestures is over. I hope that The Hamilton Commission enables real, tangible and measurable change. When I look back in 20 years, I want to see the sport that gave a shy, working-class black kid from Stevenage so much opportunity, become as diverse as the complex and multicultural world we live in."

With the formation of his own team Hamilton is looking to the future, yes, but not just his own...



ABOVE & RIGHT Hamilton wants to be a force for change while he still has the F1 platform from which to influence people







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# **Ex-Ferrari boss is new head of F1**

**THE** appointment of former Ferrari team principal Stefano Domenicali as the next CEO and president of Formula 1 gives the sport's hierarchy a very Ferrari-heavy look.

Given that the FIA has for years been known by F1 insiders as 'Ferrari International Assistance', you might imagine that news of Chase Carey's successor could have caused waves. Instead, former rival Christian Horner, team principal of Red Bull, has been quick to leap to Domenicali's defence.

"I think it's great for the sport. He's one

of the good guys," said Horner. "Having competed against him, when he was the team principal of Ferrari, he has a lot of integrity – he was a racer, a competitor, he understands the business.

"He's spent life in a commercial world outside of Formula 1 for the last few years. He's done a great job at Lamborghini and I think that he will be a real asset to Formula 1.

"Obviously you would look at the make-up at the top end of the sport with Jean Todt, Ross Brawn and Stefano and it looks like a mid-1990s or early 2000s Formula 1 setup, but I don't think that there's any particular bias or love towards Ferrari from any of those individuals, so I'm sure Stefano would be scrutinous in his impartiality."

Domenicali's arrival sees Carey become non-executive chairman. Liberty Media president and CEO Greg Maffei paid tribute to the 66-year-old for his work.

"Chase has done a phenomenal job leading F1," Maffei said. "He assembled a first-class commercial and sporting organization that has a long list of achievements, including broadening the appeal of the sport, growing its digital presence, establishing new technical regulations, securing a cost cap for the first time and reaching a new more equitable Concorde Agreement with the teams.

"His actions have reinforced F1 as the pinnacle of motorsport."

"I am thrilled to join the Formula 1 organization, a sport that has always been part of my life," Domenicali said. "I was born in Imola and live in Monza. I've remained connected to the sport through my work with the Single-Seater Commission at the FIA and I look forward to connecting with the teams, promoters, sponsors and many partners in Formula 1 as we continue to drive the business ahead.

"The past six years at Audi and then leading Lamborghini have given me broader perspective and experience that I will bring to Formula 1."

# 'Pink Merc' copycat saga ends

**FORMULA 1's** 'copycat' storm has abated, for now, after Ferrari, Renault and Racing Point withdrew their appeals against the latter's penalty.

The issue arose over a complication in the rules following the change of status of brake ducts between 2019 and 2020. For this year, brake ducts were added to the category of 'listed parts' that teams have to design themselves to be regarded as constructors. These are fundamental performance-defining parts of the car such as the monocoque and aerodynamic surfaces.

Crucially, it was not illegal last year for teams to share the details of these parts.

So, while it was legal for Mercedes to supply the design of its brake ducts to Racing Point last year, stewards decided it was illegal for Racing Point to copy them for use on its 2020 car. The team was fined 400,000 euros and docked 15 points in the Constructors' series.

Racing Point will continue to receive an official reprimand each race that it uses the copied ducts, but the spectre of a lengthy legal process has now been averted.

In a statement issued after the Italian GP, Ferrari said: "In recent weeks, the collaboration between FIA, F1 and the teams has produced a series of acts – amendments to the 2021 technical and

sporting regulations, approved by the F1 Commission and the FIA World Motor Sport Council, and technical directives – which clarify the responsibilities of each championship participant in the design of the components of a single-seater and implement specific monitoring procedures to ensure that both the letter and the spirit of the regulations are fully respected.

"Scuderia Ferrari expresses its appreciation for the timeliness with which the FIA and F1 have effectively tackled a fundamental aspect of the DNA of this highly competitive sport."



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**PEUGEOT** will enter endurance racing's new era with a car built to the ACO's LMH 'Hypercar' regulations.

The LMH route enables it to produce a bespoke chassis and in-house-developed hybrid powertrain, rather than IMSA's LMP2-based LMDh ruleset which requires a spec hybrid unit. Peugeot's technical partner Total, with which it celebrates 25 years of collaboration this season, is believed to have been instrumental in the LMH decision.

In its announcement, at last month's Le Mans 24 Hours, Peugeot said the choice was dictated by several criteria, including that of aerodynamic freedom.

"The new Le Mans Hypercar category offers an unprecedented opportunity for collaboration between sports and design teams," commented Matthias Hossann, Peugeot Design Director. "The appearance of the vehicles will no longer only be the result of a purely technical optimization in the wind tunnel, we will truly have the space to create a unique, iconic object, combining performance and expressiveness. We intend to make the best use of the leeway offered. Currently, we are at the pre-project, study and concept stage."

Hossann said there would be close collaboration between the race team and automotive stylists, adding: "Our light signature is one of the strong identity signs present on our production vehicles that we want to find in the racecar."

Similar ambitions marked the initial stages of Peugeot's first Le Mans-winning car, the 3.5-litre 905 prototype, in 1990. Then, the interference of the stylists completely compromised the first iteration of the car. That prompted Jean Todt to immediately order the design of an 'Evo 2' version when he was appointed team principal, keeping the interference of the road car division at bay. The new car went on to dominate both Le Mans and the Sportscar World Championship.

This time around however, Balance of Performance regulations will accommodate any styling excess.

"In comparison with what we currently know in LMP1, the car will be closer to road vehicles, therefore with a higher mass and larger dimension," noted Olivier Jansonnie, Peugeot Sport Technical Director, WEC programme. "This regulation is also very different because it incorporates a performance balance (BoP). It certainly sets limits but also opens up many technical possibilities for development, particularly on general shapes as long as a certain overall aerodynamic efficiency is not exceeded."

"This Le Mans Hypercar project opens up new possibilities for joint development on the entire car's energy system: on the efficiency of our fuels, or for lubricants, specifically designed for hybrid vehicles," said

Philippe Montantême, Director of Total Marketing & Research Strategy. "It will also enable the Total and Saft teams to study new opportunities in the battery sector with Peugeot."



# LMDh hybrid suppliers revealed

**BOSCH**, Xtrac and Williams Advanced Engineering have been selected as the suppliers for the new LMDh hybrid powertrain.

LMDh regulations, a common vehicle platform created by the ACO and IMSA which will compete in both the WEC and IMSA race series, were confirmed during the course of the Le Mans press conference.

"The top level of endurance sportscar racing has now a very clear, tangible and very bright future," said IMSA President John Doonan. "This is, quite frankly, very good news in this difficult global context." From the e-machine, inverter, and vehicle

control unit to the brake by wire system

and other peripheral electronics, Bosch will supply the key e-mobility hardware for the LMDh programme. Additionally, it will provide intelligent hybrid-power management software which controls the distribution of torque between the ICE,



**ABOVE** LMDh will use Xtrac's P1359 gearbox

e-machine, and brake-by-wire system based on the driver demand.

The P1359 gearbox developed for the new class is a 7-speed transverse arrangement. It uses Xtrac's well-proven P1254 integrated valve actuator (IVA) gearchange system. It houses full form ground and Xtrem polished gears and shafts in a magnesium RZ5 casing, which is a structural part of the car.

Williams Advanced Engineering, which will supply the battery, has its roots in hybridisation and endurance racing. The company was formed around the team that created the Jaguar C-X75 hybrid supercar. It provided the flywheel energy store to the Audi LMP1 car and aerodynamic testing to the all-conquering Porsche. In addition, WAE also supplied the complete KERS hybrid system to the Marussia Formula 1 team.





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# CUPRA coup for Extreme E

**SPORTY** Spanish brand CUPRA has become the first automotive manufacturer to enter Extreme E.

The involvement of SEAT, a VW Group brand, was announced hot on the heels of the news that F1 World Champion Lewis Hamilton is to enter a team in the series.

CUPRA will partner with ABT Sportsline for engineering support, drawing on that company's extensive EV racing experience in Formula E. It has revealed that former DTM and World RX champion Mattias Ekström will be its male driver.

The announcement was made at the official opening of the first CUPRA Garage in Europe in Hamburg, Germany, where the team's ODYSSEY 21 show car – bearing its striking CUPRA design – made its world premiere.

Alejandro Agag, Founder and CEO of Extreme E, commented: "We're delighted to welcome CUPRA on-board as Extreme E's first automotive partner, an announcement that truly underscores ABT Sportsline's commitment to the series. Both brands are trailblazers in the domain of electrification, and this marks another step in the right direction towards sparking a genuine change in the wider automotive market." Dr Werner Tietz, SEAT Executive Vice-President for R&D, added: "The decision to become the first automotive manufacturer to participate in Extreme E and reinforce our co-operation with ABT is proof of both partners' shared vision of reinventing the world of high-performance cars through electrification."

HEHIS

The co-operation between CUPRA and ABT Sportsline began in 2018, focusing

initially on the refinement of road cars, and both brands have considerable experience and expertise in electric motorsport. CUPRA developed the world's first all-electric touring car, the CUPRA e-Racer, while ABT was a founding member of the FIA Formula E Championship, winning the Drivers' title with Lucas di Grassi in 2016/17 and the Teams' title for Audi the following season.

"We love innovation, competition, e-mobility and the feeling of being a pioneer in something completely new," said Hans-Jürgen Abt, Managing Partner of ABT Sportsline "With CUPRA, we now have a partner at our side who, just like us, firmly believes in the revolutionary concept, both in the sporting field and in terms of marketing off the track."



# **Team TECHEETAH joins the party**



**ABOVE** FE champ TECHEETAH was attracted by the opportunity to engage a young audience in a series that mixes racing, care for the environment and travel and adventure

**TECHEETAH**, Formula E double champion for the past two seasons, is to enter Extreme E.

Team TECHEETAH Extreme E becomes the first entry to represent Asia in the series, scheduled to start in 2021. It will be owned by the Indover Group and will race under the TECHEETAH brand. The team will be managed by SECA, the owner of DS TECHEETAH and led by Edmund Chu (President) and Mark Preston (Team Principal). SECA is a leading Chinese sports management and marketing company. Indover Group is an Indonesian owned investment and private equity company focused on green and emerging technologies. The team will be based in Jakarta, Indonesia. TECHEETAH has competed in Formula E since 2016. It has achieved tremendous success, first winning the Drivers' Championship in 2018, and then in partnership with DS Automobiles won both the Drivers' Championship and Teams' Championship the past two seasons.

Alejandro Agag, Founder and CEO of Extreme E, said: "Extreme E offers an entirely unique proposition in motor racing, with cutting-edge E-SUVs racing head-to-head across five of the most remote locations on the planet with a brand-new engineering challenge for teams and drivers to overcome.

"The sporting offering is turning heads, and the race for the inaugural title is already shaping up nicely."

# STARD launches Citroën C3 ERX

**STARD** has launched the world's first R5-based electric race car, the Citroën C3 ERX, developed with support from Citroën Racing.

The car utilises the R5 rally machine's rolling chassis. It is now equipped with STARD's REVelution powertrain kit as used in the FIA World Rallycross Championship's official electric support category, Projekt E. Adapted to incorporate the REVelution powertrain at STARD's base near Vienna in Austria, the C3 ERX uses three electric motors. They produce 450 kW (613 bhp) combined power and 1,002 Nm of instantaneous torque with a top speed of 240 km/h, using a four-wheel drive system and two-speed transmission fitted to both axles.



"Since the commercial launch of the C3 R5 in 2018, our car has become one of the references of its class," said Didier Clément, Citroën Racing Head of Customer Racing Promotion Activities. "It has proved its potential on the rally roads which has provided a solid basis for STARD to develop the C3 R5 ERX. We are delighted to support STARD on this ambitious project and will follow it closely.

"Motorsport is at a turning point and we see more and more extremely competitive electric cars. The C3R5 ERX shows that our C3R5 family continues to grow, with a new product that looks promising."

The C3 ERX retains around 80% of the rolling chassis components from the C3 R5, and conforms with all Projekt E technical regulations. It is supported both technically and commercially by Citroën Racing. C3 ERX customers will be able to purchase spare parts directly from the Citroën Racing Shop.

Designed to be used for rallycross and other disciplines such as hillclimbs, city races, sprint rallies and racing, the C3 ERX made its competitive debut in the opening round of the 2020 Projekt E series at Holjes, Sweden.

"Our FIA-certified STARD EV powertrain system is unique globally and offers an unchallenged ratio of cost to performance, with minimised running costs," said Manfred Stohl, Stohl Group President. "Installing this into a Citroën Racing C3 R5 rolling chassis results in a very powerful combination in terms of performance, but also in customer friendliness." The C3 ERX is available for a turn-key price

of €374.000. III

# **Praga Cars announces expansion plans**

**PRAGA** Cars has revealed the first steps in an ambitious expansion programme, beginning with the appointment of ex-BMW and McLaren Automotive executive Mark Harrison to head up the newlyformed Praga Cars UK.

Praga has made the strategic decision to increase its presence in the UK, a key motorsport market. Harrison, who also leads commercial operations globally for Praga Cars, will initially oversee the launch of the new, fifth generation, allcarbon R1 racing car.

Alongside news of the new car, Praga

Cars has also agreed with Britcar a new all-Praga category within the 2021 Endurance championship. At least 10 cars are already committed to the series, providing



**ABOVE** A dedicated Praga class in Britcar supports a plan for an international one-make series in 2022

competitive multi-class racing for Praga owners and guest drivers that will pave the way for a one-make series in 2022.

Details of the fifth generation R1 will be revealed at Silverstone's MotorsportDays Live in November. The car will feature a larger fuel cell, revised aero package, improved safety features and enhanced driver adjustment to make it even better suited to endurance racing.

Harrison, Managing Director at Praga Cars UK, said: "Praga Cars is an exciting place to be right now. The dedicated Praga category will lead to exciting racing and a great spectacle for racegoers as well as a platform for a onemake series in 2022."



# PRI and PMW shows axed in COVID chaos

**AN EVENTS** industry dealt repeated blows by the COVID-19 pandemic took another hit last month when the 2020 Performance Racing Industry (PRI) and Professional MotorSport World Expo (PMW) trade shows were cancelled.

PRI, scheduled for December in Indianapolis, is regarded as the centrepiece of the industry's show season. In a typical year the show – the world's largest gathering of motorsports professionals



**ABOVE** The PRI trade show is the latest high-profile casualty of the pandemic

brings upwards of 67,000 people to the Indiana Convention
Center and generates an economic impact of \$65 million. Last
year's event had 1,100 exhibitors and 3,300 booths.
PRI had said repeatedly that it hoped to move ahead with the

Dec 10-12 event and had close to 1,000 exhibitors signed up. The announcement came after months of working closely with the Visit Indy team, the Indiana Convention Center staff, and other Indianapolis officials to develop a plan for a safe and productive PRI Trade Show. Despite health and safety guidelines that would have been in place, it said "mounting uncertainty related to the Coronavirus resulted in an environment that would not be conducive to a productive trade show."

"It is with great disappointment that we announce that the 2020 PRI Trade Show will not take place," said PRI President Dr Jamie Meyer. "Our goal is to always do what is best for the motorsports industry, and PRI will continue to lead with business solutions for an ever-changing future.

"While this is quite a setback for the racing industry, getting this far was only possible through the hard work of our partners at Visit Indy and the Indiana Convention Center, as well as the people of Indianapolis. And while we certainly respect the tough job that local public health officials have in keeping their community safe, it became clear that we wouldn't be able to provide a trade show environment in 2020 with the business and networking opportunities you've come to expect." Full refunds for PRI Trade Show exhibitor booth deposits will be issued.

PRI is based in Laguna Beach, California, but has hosted its trade show in Indianapolis every year since 2013. Indianapolis also hosted the event from 1998 to 2004. It is under contract to hold its trade show in Indianapolis through to 2025. "As a longstanding annual convention, we have worked with PRI for more than three months on plans to hold a pared-down trade show in Indy in December," said Chris Gahl, vice president of Visit Indy. "Ultimately, we understand PRI's thoughtful decision and we look forward to welcome their international visitors back in 2021."

# FE achieves net zero carbon footprint

**THE** ABB FIA Formula E Championship has become the first sport to have a net zero carbon footprint since inception, investing in internationally certified projects in all race markets to offset emissions from six seasons of electric racing.

The series has followed three key steps to achieve a net zero carbon footprint: effective measurement of carbon output; prioritising reducing its footprint; and offsetting remaining unavoidable emissions.

Working closely with Quantis, the leading life cycle assessment and sustainability experts, Formula E has been calculating the overall footprint of the championship since its inaugural season, with a continual focus on lowering emissions.

Its emission reduction measures, including optimising transport and logistics, extending end-of-life options for lithium-ion battery cells and cutting out single-use plastics on site, led to Formula E becoming the first and only racing category to receive third-party ISO 20121



**ABOVE** A founding purpose of FE was to counteract climate change

certification for sustainable events. Jamie Reigle, Chief Executive Officer of Formula E, said: "The ABB FIA Formula E Championship aims to deliver better futures through racing, and we are committed to play a leading role in counteracting the effects of climate change. We have actively measured and reduced our emissions since our inception and are proud to have achieved a net zero carbon footprint by offsetting our remaining emissions.

"We have a responsibility to minimise the environmental impact of our global sport and are pleased to support vital environmental projects in each of our race markets. As a sport built on purpose, we remain committed to grow our sustainable practices and hope to inspire others to join us on our journey."

### MOTORSPORTS professional



# TOCA seals new fiveyear ITV contract

**THE** longest TV partnership in UK motorsport history will continue until at least 2026.

TOCA, the organiser of the British Touring Car Championship, has confirmed that a new five-year television contract has been signed with the ITV network, extending the current UK-wide free-to-air broadcasting arrangement **ABOVE** TOCA and ITV are extending the BTCC's free-toair footprint

through to the end of the 2026 season. Whilst other forms of major motorsport are being lost behind a paywall, it is notable that TOCA's policy is to continually expand its mainstream freeto-air television coverage.

ITV has broadcast the UK's elite motorsport series since 2002 – with this latest agreement taking the relationship through to a 25th consecutive year. The series will be live and exclusive on the ITV4 and ITV4HD channels, with at least seven hours of coverage from each race day. This will provide at least 340 hours of coverage each season: 180 hours of broadcast time across the ITV channels (live and highlights), plus another 160 hours of online streaming and highlights.

Highlights programmes will continue to be aired on ITV4 and ITV, whilst qualifying will be shown via ITV's dedicated BTCC website – www.itv. com/btcc. All transmissions will also be streamed free 'as live' via the ITV Hub with all programmes being available to watch 'on demand' via the same service. Race clips will also be made available via social media.

The BTCC support series will also continue to enjoy live coverage and dedicated highlights programmes on the ITV network.

Alan Gow, BTCC Chief Executive, said: "I'm immensely proud of the great and close partnership that we have with ITV. Their commitment and enthusiasm to bring the BTCC to as wide an audience as possible is absolutely unrivalled.

"It was vital to me that the BTCC maintained its vast live free-to-air coverage. Simply, we want the maximum amount of people to be able to watch our great racing – it's the bedrock of our enormous popularity. So hiding our championship away behind a paywall would only have the exact opposite effect."

# **Team HARD brings Cupra to BTCC**

**THE** Cupra name will enter the BTCC for the first time next season when Team HARD Racing builds a minimum of two brand new Cupra Leons to attack the Independents' crown.

The Kent-based outfit has made no secret of its desire to develop new machinery to replace the ageing Volkswagen CC, which has been in the championship since it debuted with the squad in 2013. The team used the recent COVID-19 lockdown period to assess various car models from a range of manufacturers, before committing to the new Cupra Leon, which is due to hit the market later this year.

The design process is already underway

for the car. With hybrid technology being introduced to the BTCC in 2022, Team HARD Racing has been in communication with Cosworth Electronics to ensure that the BTCC-spec Cupra Leon is future-proof



**ABOVE** Team HARD switches to the Cupra Leon after 14 race victories with its VWs

and capable of making the most of the new technology.

"We have done a lot of research and we believe that the dimensions and overall shape of the Cupra Leon will work perfectly with the current NGTC regulations," said Tony Gilham, Managing Director, Team HARD. "A lot of hard work and countless hours lie ahead, but we are confident that we can turn this new car into a competitive beast that will be mixing it at the front from the get-go next season."

"We set out the NGTC regulations to allow for great diversity and having the Cupra Leon on the grid is further proof of the strength of those regulations," said BTCC Chief Executive Alan Gow. "This new project should help this popular team advance up the grid in 2021."

# RACE TECH WORLD STAINABLE DEVELOPMENT



The world is currently moving very fast. To shape the future of motorsport it is essential that all people involved put their thoughts together and show that motorsport can be the enabler for new sustainable technical inventions. The World Motorsport Symposium offers the platform to be part of creating that future! It is great to see how the WMS has accelerated over the last few years and it was stunning to see that the ACO, FIA and F1 Liberty Media were using the platform to announce their new programmes and regulations!"

THOMAS KRAEMER, Director Motorsport Quality Management, Porsche Motorsport

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BRYN BALCOMBE, Chief Strategy Officer, Roborace In a changing world it is important to get unbiased thoughts from leading suppliers. manufacturers. engineers and trendsetters... The World Motorsport Symposium offers insight into different technologies from many different angles – it is a great initiative by RACE TECH to bring key people into the same room to share information and thoughts – this is extremely important for the continuing development of future energy for vehicles."

ANDERS HILDEBRAND, Managing Director, Anglo American Oil Company

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# The Davos of Motorsport Engineering & Technology



It was a pleasure to attend the WMS this year. As always, the quality of delegates and papers was excellent. This combined with the ever-professional running of the event made it a great success."

RICHARD BARDWELL, Director, SHARC MARK GALLAGHER, Director, SHARC We really enjoyed the event and have thought a lot about it during the last few weeks. It is one of the best events of the year to strengthen our network and to be a part of shaping the future of the motorsport industry – very valuable!"

> KIMBERL MEDIA GROUP

**PETER WIRTZ**, Customer Account, Bosch Engineering GmbH Motorsport



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# HYDROGEN? TSNOTSCENCE FICTON

Significant changes to GreenGT's experimental racecar underpin ACO president Pierre Fillon's confidence that hydrogen is viable for the 2024 Le Mans 24 Hours. By **Chris Pickering** 

**F** all the technologies vying to become the power source of the future, hydrogen fuel cells represent perhaps the biggest shift.

Engineering a car around one of these miniature onboard power stations is a huge mountain to climb – especially if you're building it to lap one of the world's most demanding race circuits for 24 hours at a time.

By any normal standards, the GreenGT H24 has been a long time coming. It's the third in a line of experimental prototypes that dates back to 2012, and despite some high-speed practice laps, the team has yet to compete in a race. But you'd be wrong

to underestimate the importance of this car. It's a world away from the heavy and ungainly GreenGT H2 that set the first ever hydrogen-fuelled lap of Le Mans in 2016, and a significant stepping stone towards the ACO's goal of having fuel cell vehicles competing in 2024.

In between we've had the LMPH2G, which carried out a series of demonstration runs at Spa and a parade lap at this year's Le Mans 24 Hours. Like that car, the H24 is built around a modified LMP3 tub from ADESS, but pretty much everything on it is new or revised.

"The LMPH2G was mostly about testing the fuel cell," explains Hugues Lardy, technical coordinator for GreenGT. "We've focused a lot more on performance gains with the H24."

You can tell just by looking at it. This may still be an experimental vehicle rather than a true competition car, but its deeply chiselled nose, giant splitter and biplane winglets scream intent. GreenGT has yet to release any performance figures, but the eventual hope is that this car will be able to lap Le Mans at a similar rate to a GT3 machine and capable of 45-minute stints between fuel stops.

The new bodywork is linked to significant changes to the car's packaging, Lardy explains: "Last year



LEFT The switch from four motors to two has enabled the team to revise the rear suspension system and reduce the height of the rear bodywork



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we had the fuel cell radiators mounted on the nose – that freed up space at the back of the car, but it wasn't ideal for cooling, and more importantly it meant that we couldn't optimise the flow around the front splitter. We also had some heat exchangers for the ancillaries that were mounted under the rear wing, which compromised the aerodynamics in that area. With that in mind, we decided to move all the heat exchangers towards the middle of the car, into the space between the front and rear wheels. This helps to clean up the air flow right back to the rear wing and the diffuser."

Look closely at the sidepods and you can make out the slightly bulbous shape of the hydrogen tanks that sit either side of the monocoque (with a third tank behind the driver). The large air intakes for these radiators sit just above the rear of these pods, while the heat exchangers themselves have been enlarged to allow for extra cooling capacity as the powertrain evolves.

Under the skin, the most significant change is the switch from four motors to two. This has allowed the development of a far more compact transmission design, with each rear wheel powered by its own motor, through a single-speed gearbox. As before, the internals for these units come from French transmission specialist Sadev, while the casing has been designed in-house by GreenGT. These smaller transmission units have led GreenGT to design a revised rear suspension system, which in turn allowed the height of the rear bodywork to be reduced, enabling some of **>**  **ABOVE** The aggressive new bodywork is enabled by significant changes to the car's packaging

> Developing a fuel cellpowered racecar really is a leap into the unknown"

RIGHT The LMPH2G laps Le Mans ahead of this year's race

BELOW The H24 (right) is 150 kg lighter than its predecessor, the

a greater focus on aero efficiency





the bodywork changes.

Stepping from four motors down to two also halves the number of DC-DC converters and reduces the amount of wiring, setting off a chain reaction of weight reduction throughout the powertrain. Likewise, bringing the radiators into the centre of the car significantly reduces the length (and mass) of the cooling circuits. GreenGT has also worked with ADESS to reduce the weight in the suspension and driveshafts. The dampers are off-theshelf items from French firm PKM Consulting, but these too have been revised for the new car.

This all adds up to a reduction of around 150 kg, bringing the total weight of the H24 down to just under 1,400 kg. That's still relatively heavy by motorsport standards, but it puts it within 150 kg or so of a typical GT3 car. Where the H24 should make up for that extra mass is its LMP-style aerodynamics package and the use of a sophisticated torque vectoring system.

### FUELLED FOR SUCCESS

As on the LMPH2G, the fuel cell is mounted at the rear of the car, behind the third fuel tank. It's a new design that has been developed with Symbio – a joint venture between Michelin and Faurecia. This acts as an onboard generator, supplying electricity to a bank of lithium ion cells from Saft - a battery specialist that's been involved in Formula 1 since the days of KERS.

Unlike the previous battery, which sat behind the driver, this one is mounted in the passenger compartment, which helps to improve the weight distribution. This has been achieved without any changes to the monocoque, although it has required a new mounting system, which was tested along with the new battery itself at the CSI laboratory in Milan under the watchful eye of the FIA.

As we speak to the GreenGT engineers, the ACO is in the process of laying down the rules for its forthcoming hydrogen racing category. The H24's primary role is to serve as a testbed, building up data that will help to set the technical regulations for the class. It's also being used to assess the requirements for the circuit, including new hydrogen refuelling facilities that the ACO plans to install at Le Mans as part of a new pit complex due in 2023.

"We can refill the hydrogen tanks far quicker than it would be possible to recharge a battery, but at present it's still slower than refuelling a combustion- >



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engined car," says Lardy. "Part of the challenge is that filling the tanks increases the temperature of the hydrogen, while emptying them (as the fuel cell consumes the gas) reduces it. Our tanks can operate over a range of +80 to -35 deg C, which limits how fast we can refill the system. We're working with Total on how we can optimise that process."

Currently the team is refuelling at 450 bar, but they're working with new sponsors Plastic Omnium on revised tanks that are rated to 700 bar. The target is to refuel in a similar duration to a combustionengined car, which will feed directly into the plans for the new pit facilities.

The exact format of the new hydrogen category has yet to be finalised, but it's likely to follow a similar concept to Formula E, with teams free to develop parts of the car around a shared chassis. "We're looking to determine things like the best size for the buffer battery, the size of the fuel cell," comments Lardy. "Once this is done we will be able to give the chassis manufacturer [for the 2024 cars] the packaging volumes that they need to know."

#### **FOUR-WHEEL DRIVE?**

The requirements for the fuel cell will be driven partly by the car's ability to harvest energy through its regenerative braking system. At present, the car only has motors on the rear. A four-wheel drive configuration with motors on both ends would allow it to harvest more energy under braking, which Lardy says is likely to be a prerequisite for competing successfully in 2024. Already, a lot of work has gone into the H24's brake-by-wire system, which



combines regenerative braking with carbon discs and pads from Brembo.

"Managing the energy is really important," says Lardy. "We want the brake-by-wire system to be seamless to the driver. The brake pressure at the front is always directly proportional to the pedal input. At the back, we give priority to the regenerative braking whenever possible, and then we use the mechanical braking on top of that to maintain the same overall brake balance front-to-rear."

It sounds simple in theory, but the reality soon becomes complex. For a start, the amount of regenerative braking that you can extract is limited by available battery capacity; if the buffer battery is completely full, then it's not possible to provide any regenerative braking at all. To complicate matters, ► **ABOVE** Mounting the battery in the passenger compartment, rather than behind the driver, has improved the weight distribution

BELOW The sidepods reveal the slightly bulbous shape of the hydrogen tanks either side of the monocoque. A third sits behind the driver







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# What they said

## **Pierre Fillon**

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<u>President of the Automobile Club de l'Ouest, co-President of MissionH24</u> "By launching MissionH24 in 2018, our ambition was to show step by step that hydrogen technology was not science fiction, but a concrete efficient promising solution, and above all a guarantor of competition and zero emission mobility.

"We've been following this road map as we've already concretised different stages. First of all with the LMPH2G, the first electric-hydrogen racing prototype of its kind, then with the first H2 Mobile station by Total, and finally this weekend at Le Mans the presentation of the H24, the fruit of valuable testing carried out with the LMPH2G, and also the arrival of new partners, Plastic Omnium and Richard Mille, alongside Total and Michelin-Symbio: each in its own sphere of activity, is going to contribute to the pursuit of MissionH24 and its objective – a dedicated hydrogen category at the 2024 24 Hours of Le Mans."

## Jean-Michel Bouresche

<u>MissionH24 Operations Manager and Team Principal of the H24Racing team</u> "This weekend at Le Mans and the LMPH2G's lap of the track mark the end of a cycle. Since the launch of the MissionH24 project at Spa two years ago, this prototype has covered almost 10,000 km in private testing and during race weekends. In the coming weeks the H24 will take over.

"Our aim? To do more running at higher speeds for longer periods and then test this level of performance again in competition. Our new partners, Richard Mille and Plastic Omnium, which are joining Total and Michelin-Symbio in the programme, share the same ambition: namely, to show together with us that electric-hydrogen is a tangible solution for motor sport in endurance and beyond that for mobility."



LEFT The ACO believes 2024 is a viable start date for hydrogen competition

LEFT FIA President Jean Todt was among those taking a close interest at Le Mans

the friction coefficient of the brake material varies with temperature. The GreenGT engineers have mapped this on a test rig, but they also use infrared sensors to provide real-time feedback.

The battery itself is also heavily temperature dependent. As the temperature increases, the amount of brake regeneration will have to be reduced. Plus, there's always the possibility that regenerative system may fail, which means that the car needs to be able to stop safely on mechanical braking alone.

It's a tricky balancing act to manage, Lardy explains: "The strategy will vary from corner to corner. For example, if you're at Le Mans, you'll use up all of your buffer battery between Mulsanne and Indianapolis, so you will want to regenerate as much as possible. But you won't have time to empty the buffer battery on the short run down to Arnage, so you will have to use more mechanical braking."

It's theoretically possible that the cars could use GPS as one of the inputs to this



system. GreenGT has no plans at present to do so (and the technology is currently banned in other categories) but it's not out of the question. During the GT1 era, some cars used corner-specific traction control settings governed by GPS, so the technology does exist. However, it would still have to be balanced against other data, such as battery temperature.

"As well as variations from one section of the track to another, the temperature of the battery and the brakes will vary during the course of the race," Lardy points out. "At Le Mans, it could be less than 10 deg C at night, whereas the same location could be 40 deg C during the day. That means on the same braking zone you might be restricted by the battery **RIGHT** The target is to refuel in a similar duration to a combustionengined car

BELOW The ambition is that the LMPH2G's successors will lap Le Mans at a similar rate to a GT3 machine and be capable of 45-minute stints between fuel stops

**Stepping from four motors down to** two, sets off a chain reaction of weight reduction throughout the powertrain"





temperature during the day but not during the night."

GreenGT has another trick up its sleeve in the form of torque vectoring. With no physical differential between the two wheels, some degree of torque management is essential. Plus, this is another area where the hydrogen vehicles could potentially offset their greater mass compared to the combustion-engined cars.

### **TORQUE VECTORING**

"We started looking into torque vectoring with the LMPH2G," says Lardy. "That proved its potential, and I think it's going to need to be used, along with traction control, to improve performance. One of the things we're looking at is the possibility of using sensors within the driveshafts to give more accurate information on the wheel torque." This technology is a world away from the Group C prototypes that Lardy began his career working on in the 1980s. As one of the most experienced engineers in the business, there's not much he hasn't come across, but developing a fuel cell-powered racecar really is a leap into the unknown. "It's a very exciting project to work on," he says. "There are a lot of things that we wouldn't encounter in a traditional racecar, like the energy management with the fuel cell and the torque vectoring system." And yet for all the questions that still surround hydrogen racing, it's clear

that progress is being made. As an experimental prototype, the H24 might never actually race, but it may still prove to be a landmark achievement.

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# GLIMMER OF LIGHT EMERGES FROM THE DARKNESS

The Le Mans 24 Hours marked a sad end to an endurance racing era, but Automobile Club de l'Ouest president Pierre Fillon tells **William Kimberley** why there are many reasons for optimism **HE** 88th running of the Le Mans 24 Hours was possibly the strangest in its long history.

There were no spectators present at the circuit and rather than being held in mid-June, with the longer days, it was held in mid-September. However, it was not the first time that the race was not held in mid-June. The inaugural event in 1923, for instance, took place at the end of May. In 1956, it was held on 28-29 July due to major safety improvement work and in 1968, the political and social unrest in May resulted in postponement to 28-29 September.

With night-time action this year accounting for almost half of the race – 11 hours and 46 minutes to be exact, 3 hours 40 minutes more than mid-June – and different weather conditions, lower temperatures and visibility, it was a whole new level of focus for the competitors.

For Automobile Club de l'Ouest (ACO) president Pierre Fillon and his team, it also represented altogether quite a challenge. "For sure it was very difficult for us," says Fillon. "As early as March, we realised that it wasn't going to be possible

THE MERIE

to have the race in June, but we never considered cancelling it. I think if we had done so, we would have lost half the grid and that would possibly have had severe implications for the future."

There was also the question of spectators. Typically attracting crowds of hundreds of thousands over the week, this year it was very different due to the COVID pandemic.

"When we postponed the race until September, we expected to have some spectators, albeit limited as in July in France all events were limited to 5,000 people until the end of August," admits Fillon. "So we planned to have five independent zones of 5,000 people with their own parking and catering facilities around the circuit.

"We put a lot of work into that but were then informed by the local authorities that the gathering of 5,000 people would be rescinded until the end of October. That still left 8,000 people, including teams and administration officials to manage.

"The most challenging aspect was complying with the COVID protocol that we had to put in place, which we began to work on in July. We need to comply with both the French and the

> LEFT Nearly four more hours of the race were run in darkness than would have been the case in June

We planned to have five independent zones of 5,000 people with their own parking and catering facilities around the circuit"



FIA's protocol, which meant that everyone had to have a PCR test 96 hours before attending the event, so all the paperwork needed was a huge challenge. We also organised some bubbles that included race control, the press room and the support races such as the Porsche Cup and the Road to Le Mans, but there could not be any link between them. We took a lot of time to work on that."

More than ever, the 2020 race was an event that was about more than merely motorsport. "We launched an appeal for funds in aid of the French Intensive Care Society," explains Fillon. "It was important to us to show our support for the healthcare workers who have been working tirelessly these past few months to combat the COVID-19 virus."

### DAWN OF A NEW ERA

In one sense, it was a sad end to what had been a very successful era for endurance racing and Le Mans, but the future looks healthy with the convergence of the WEC and IMSA regulations.

"I think we have a very attractive programme for manufacturers and we are in discussions with a number of them, including American ones, so we are on an upwards trajectory at the moment," says Fillon. "We are working a lot on the cost so that even privateer teams have a chance of winning."

There will be two classes – LMH (Le Mans Hypercar) and LMDh (Le Mans Daytona h) – that will see the two classes of cars running together and competing for overall victory. LMH has been jointly conceived by the ACO and the FIA as a







**ABOVE** Fillon kept faith with the new Hypercar plans while others wavered

LEFT A Le Mans 24 Hours without spectators was a sad way to celebrate Toyota's hat-trick of victories and the end of a successful era for the outgoing LMP1 cars

**BELOW** Toyota's new GR Super Sport hypercar made its first public outing with a cameo appearance at Le Mans. It will be used as the basis for a racing version that will run in the new Le Mans Hypercar class next year successor to LMP1 from 2021 onwards. Unlike its predecessor class, where bespoke prototypes were created to race in the category, cars entered in the Le Mans Hypercar class can either be race-ready versions of existing hypercars, or specially designed prototypes with hybrid power being optional for manufacturers. In a nod to WEC, competitors in Hypercar must build at least 20 road cars based on their prototypes within two years of joining the series.

The two salient points of the LMDh regulations – which were revealed by MSA technical director Matt Kurdock and ACO technical director Thierry Bouvet at the pre-race press conference – are that the cars will feature hybrid engine technology, while 32

the estimated cost of a complete LMDh car, without the engine, is one million Euro (\$1.1-1.2 million).

Major automotive manufacturers will work together with one of four approved chassis constructors - Dallara, Ligier, Multimatic or ORECA - to develop their LMDh race cars. Between the manufacturer's internal combustion engine and a spec hybrid powertrain system, each LMDh car will have a combined power output of 500 kW (670 hp). Bosch, Williams Advanced Engineering and Xtrac were introduced as hybrid powertrain suppliers for all LMDh cars. The Bosch motor is integrated with the Xtrac gearbox, while the Williams Advanced Engineering battery will be integrated with the Bosch motor controller. This is all in a compact assembly, which is installed underneath the survival cell in a compartment isolated from the driver.

Minimum car weight will be 1,030 kg (2,270 lb), with a maximum width of two metres, a maximum length of 5.1 metres and a common wheelbase for all cars of 3.15 metres.

Each LMDh car will allow freedom for enhanced upper body styling, enabling each automotive manufacturer to bring their own identity and styling cues, while the cars will have a controlled underfloor.

"I think this demonstrates effective work and collaboration between ACO and IMSA," says Fillon. "Actually, we should have announced this in June had we not had the health crisis."

The Le Mans weekend was marked by announcements that both Peugeot and Alpine were committing to the new rules. The latter will compete next year in the non-hybrid LMP1 class, while the Peugeot hybrid-electric hypercar will enter in 2022.

The car will produce 670 horsepower, Peugeot says, and be all-wheel drive, conforming with the Hypercar regulations. ► **ABOVE & BELOW** Glickenhaus and ByKolles have both registered their intent to be on the 2021 grid with hypercars

**ABOVE** Fillon is excited by the announcement that the Alpine brand will step up from LMP2, running an LMP1 car for a season as the prelude to a hypercar project

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# **CONVERGENCE** What they said

**ENDURANCE** racing's new convergence rules have taken more than two years to thrash out. But they have been very well accepted by the US manufacturers who now see they have a chance of outright victory at Le Mans, and are widely welcomed.

"Cadillac congratulates ACO and IMSA on their announcement of convergence in the premier class of prototype racing," said Mark Kent, director of Cadillac Racing. "Since the introduction of the Cadillac DPi-V.R in 2017, we have had tremendous success in North America in the IMSA WeatherTech SportsCar Championship and are encouraged by the prospect of an international format. Once we get more details, we will evaluate whether our participation is consistent with our company's future vision."

"It's super exciting for motorsport in general," commented Nelson Cosgrove, director of Mazda Motorsports. "This gives us a wonderful prospect for the next 10 years to run competitively and globally."

"We have been asking for this merger for several years," said Roger Penske, owner of Acura Team Penske. "The Le Mans 24 Hours is one of the races we have never won. We have to go there to try to win."

"This is positive and major news for the world endurance races carried by the ACO and IMSA," said Zak Brown, president and CEO of McLaren. "It's a great vision and collaboration to create better races and therefore better entertainment for fans. We are at the dawn of a new era."

"This is a fantastic opportunity to enter a programme that allows a car to be designed from an already proven LMP2 chassis that can race at Le Mans and Daytona, both in IMSA and WEC," commented Richard Dean, co-founder of United Autosports.

"It is heartening to see the support for the championship as we head into a new set of technical regulations from next year onwards, that is the new top class which we are calling Hypercar," said FIA president Jean Todt.

This means a maximum output of 500 kW – 670.5 hp, down from 750 hp first set for the Hypercar class – and a minimum weight of 1,030 kg (2,271 lb), down from 1,100 kg (2,425 lb). With that established, LMDh and LMH cars will still need to run together in order to determine the beginning of a Balance of Performance formula.

## HYDROGEN

The ACO has long been an advocate of hydrogen in cars, Fillon saying that the plan is still to race hydrogen cars in 2024. On the Friday preceding the race, the new H24, which is lighter, technologically more evolved and quicker that the current LMPH2G, was unveiled by the H24Racing team.

Plastic Omnium will be the exclusive supplier of hydrogen gas storage systems for all teams competing in this new hydrogen category.

The high-pressure hydrogen storage systems developed by Plastic Omnium will be subjected to highly demanding operating conditions in terms of speed, refuelling frequency and temperature. They will be certified to automotive standards and will enable the company to showcase its expertise in Type 4 tanks – carbon-fibre shells with a plastic liner – and strengthen its links with the car manufacturers pioneering this technology.



35



"For this project, we'll be developing systems subject to extreme operating conditions. Motorsport and large-scale auto industry both require performance, safety and innovation, and MissionH24 is more than that. We are working with Total on that technological demonstration - it's an amazing laboratory in which to accelerate our hydrogen storage innovations, working closely with auto manufacturers," says Christian Kopp, president and CEO of Plastic Omnium Clean Energy Systems.

Another partner in the project is Michelin. Through the intermediary of Symbio, the joint venture it has formed with the automotive equipment manufacturer Faurecia, it seeks to accelerate hydrogen and fuel cell technology. By taking its technology forward in stages in the course of the H24 development, Symbio stands to glean valuable experience over a relatively short timeframe, while the data it harvests will accelerate the development of efficient technical solutions likely to move on to the production phase. It expects to forge a competitive advantage in its field as it seeks to establish itself as a major player in the world of fuel-cell mobility over the coming years.

Fillon explained during the Le Mans weekend that the viability of hydrogen was no longer a case of "science fiction" and he has high hopes for the H24 project.

"The idea is that this car will be able to compete against the Hypercars," he says of the H24 category. "The goal today is for them to lap Le Mans in 3m 30s, developing an expertise and knowledge that can be used in trucks, boats and planes. When it comes to refuelling, the goal is to put in 12 kg of hydrogen in one minute and a half, which is a big challenge to achieve."

The ACO is going ahead with the installation of a permanent multi-vehicle hydrogen refuelling station on the area of the 24 Hours of Le Mans circuit as an expansion of its aim to promote hydrogen in motorsport. It will serve private cars, vehicles transporting personnel and merchandise as well as racing prototypes developed in the context of MissionH24.

"We really believe in this technology and are working with seven manufacturers for 2024," he says. 🛄



the future as Toyota's TS050 Hybrid-based hypercar shares the Le Mans grid with the Mission H24 hydrogen prototype

RIGHT LMDh's hybrid powertrain suppliers have been revealed to be Bosch, Xtrac and Williams Advanced Engineering, the latter contributing its battery expertise

# **TO CHARGE OR** *NOT* **TO CHARGE**

Motorsport simulation expert **Rowland Jowett** looks ahead to the Gen3 Formula E car and attempts to solve some of the puzzles it will create

**HE** racing format of Formula E provides incredible interest. Like other series, the cars qualify and line up on the grid in descending order of speed, but tight tracks, close racing and energy strategy decisions ensure that overtaking is frequent.

The right mix of regulations and circuits mean that the result is far from predictable. Season 6, truncated by the Coronavirus pandemic, was of necessity concluded with a flurry of six races in just nine days in Berlin. But in Season 5, across a 'normal' calendar, nine teams managed a podium position during the 13 rounds of the Formula E championship. By way of comparison with FE's older and more predictable relative, Formula 1 saw only five teams share the podium over 21 races that year.

It is for this reason we at Canopy Simulations were intrigued to see how things might change with the recent FIA tender for the 2022–2025 Gen3 FE chassis and front powertrain kit.

### **250 KW FRONT HARVEST-ONLY MOTOR**

The most notable change is the inclusion of a 250 kW front e-powertrain regen. This won't allow four-wheel drive, because it provides regen power only. We have run some simulations around Marrakesh to look at the effect of this, along with the other changes to the Gen3 car. The overlay in Figure 1 (opposite page) shows qualifying.

The main difference is in the acceleration down the straights caused by the increase in rear motor power from 250 kW to 350 kW and reduction in weight from 900 kg down to 780 kg. There are slight differences during braking and corner exit (see Turn 1 in Figure 2) as the more powerful car takes a different racing line to straighten the exits to allow the extra power to be applied. Overall, the Gen3 car is 3.5 seconds quicker. The rapid acceleration causes it to back off the throttle to make it around the high speed corner shown by the blue marker below. ►



**BELOW** Tight tracks and energy strategy decisions make for close racing in Formula E




FIGURE 1 Qualifying overlay for Gen2 Season 5 2019 and Gen3 car



In qualy mode we can see that even with the extra power, the net energy deployment is reduced by 0.21 kWh thanks to the front motor harvest (PFrontMotor). It makes good sense to recover energy from the front axle, because as cars brake, the weight transfers forwards, causing an increase in the front tyre load. This gives the front axle more potential for braking.

Another observation is that the rear brakes on the Gen3 car are barely touched (max 4Bar, compared to 130Bar seen on an F1 car) due to the extra motor harvest power available. This is just as well because the Gen3 car might see the deletion of the rear friction brakes and rear brake-by-wire (BBW) system which applies retardation from the electric motor first before the friction brakes are applied. This is an excellent weight-saving opportunity.

#### **IMPROVED CAR BALANCE**

With the Gen2 FE car, all energy harvest is done using the rear axle. This leads to a car setup nightmare: on corner entry the car needs as much rear grip as possible to convert kinetic energy into electrical energy. We can see this by looking at the Secondary Lap Sensitivities (SLS) to grip. The channels dTLap\_drGripFactorF & R tell us how much the laptime would be improved if we increased front or A crazy situation: drivers are using the regen paddle to do the majority of braking instead of the actual brake pedal"

rear grip at this particular point around the circuit. At the cursor position in Figure 3 below (late corner entry), dTLap\_drGripFactorF goes negative while dTLap\_drGripFactorR peaks for the Gen2 car (in bold). This is telling us that the car is in such desperate need for rear grip in order to maximise regen that it would actually go quicker if we sacrificed some front grip at this point to make the car less oversteery.

When the car gets to mid-corner, it needs front grip in order to get the car turned. This can be seen by the orange





**ABOVE** The Gen3 car might see the deletion of the rear friction brakes



dTLap\_drGripFactorF channel peaking at mid-corner. On exit, rear grip is required for traction, so the green dTLap\_ drGripFactorR channel has a second peak.

This leads to a car with entry oversteer, mid-corner understeer and exit oversteer: a problem known as poor through corner balance and one which frustrates the drivers and requires considerable engineering effort to solve.

Adding front regen means the car is no longer in desperate need of rear grip on entry in order to maximise regen. This can be seen by looking at the fainter lines in Figure 3 for the Gen3 car: dTLap\_ drGripFactorF is no longer negative at the cursor position, and our sensitivity to rear grip dTLap\_drGripFactorR doesn't peak as high.

While this might look like a small difference on a graph, in terms of driver confidence it is important: if the rear is trying to break loose, it stops the driver being able to attack the corners as hard.

#### **REMOVAL OF THE REGEN PADDLE**

It is this change that we are most excited about. To explain why, first we must understand why the Gen2 cars have a regen paddle. To complete a race with limited battery capacity, the optimal energy deployment found by Dynamic Lap is shown in Figure 4 for 1.68 kWh net deployment per lap (the energy level required to complete 31 laps of the Marrakesh race with a 52 kWh battery): The optimal deployment strategy can be broken down as follows:

- Accelerate as hard as you can out of the corner.
- Lift off the throttle near the end of straight to save energy (PMotor drops to zero, and car slows gradually).

"Braking" is then performed in two steps:

- Pull the regen paddle (rRegenPaddle) to recover electrical energy from the rear axle and start slowing the car.
- Use the brake pedal for the final part of retardation to apply the front brakes in order to get the correct corner entry speed.

It is an annoyance for drivers and engineers alike to split braking into two phases. With the Gen2 car teams have to do this in order to maximise energy recovery. Any energy that goes into the front friction brakes is wasted as heat so the front brakes are only used in the final few metres before the corner. This is a crazy situation because drivers are using the regen paddle to do the majority of braking instead of the actual brake pedal, which is only used in the second part of braking to finesse the final car speed.

By adding front regen, the Gen3 car gets rid of the need for a regen paddle. The brake pedal is wired up to both the front and rear motors, which are applied simultaneously. There is no longer a need to use the rear regen first, followed later







by the front brakes, because both axles now recover energy so nothing is wasted by applying them together (assuming they have similar efficiency).

This means that drivers can brake harder, using both axles. It allows them to attack the corners, and more importantly they can use the actual brake pedal to do this. Good riddance to the regen paddle!

#### **30-SEC CHARGING PITSTOP**

As part of the tender, the spec includes the provision to do an optional pitstop for 30 seconds of fast charging. We were keen to simulate whether it is better to use more energy, then stop to recharge, or conserve energy and stay out on the track.

First we need to make some assumptions



about the battery capacity and charging rate. The current technical regs state a 280 kg maximum battery weight, while the target weight for the new battery is 284 kg. The increased charging power might put additional demands on the battery in terms of heat dissipation and cooling, so for argument sake, let's assume a similar race energy limit of 52 kWh. Since the battery system is designed for 350 kW regen from the rear axle and 250 kW from the front, i.e. 600 kW total during racing, we assume that pitstop charging would occur at a similar rate. Some power would be lost to battery efficiency, and rounding down for simplicity means that teams can top up their cars by 4 kWh.

If we run an energy sweep, we can see how the laptime varies for different levels of energy saving. The current race format is 45 min + 1 lap. We can use the laptime at each energy level to calculate the number of laps (plus 1) that can be completed (NLapsTimeLimit). We can also calculate how many laps can be completed at this energy level before the battery runs out (NLapsEnergyLimit).

Where the two lines meet in Figure 5 (at the cursor) represents the quickest the car can be driven without that battery running

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A big step forwards in terms of racing, simplicity and developing road-relevant technology"

out. Without a pitstop it can complete 34 laps with the Gen3 car (3 laps more than at Marrakesh in Season 5).

To look at the pitstop scenario, let's assume that for Marrakesh the pitlane time loss (versus staying on the circuit) is 15 sec, so cars would lose a total of 45 sec by stopping to charge. If we repeat the NLapsTimeLimit (red line in Figure 5) calculation with 45 sec taken off, and add 4 kW to the NLapsEnergyLimit (green line) calculation then the curves intersect again at 34 laps. It's too close to call, so we need to drill down into the laptimes.

With no pitstop, the best laptime for 34 laps is 1m 20.71s. With the extra energy from a pitstop this improves to 1m 19.40s, i.e. 1.31 sec faster. Over a 34-lap race the stint time with pitstop is 44.54 sec quicker, however if a pitstop takes 45 sec, then it will be a very close call indeed.

#### **ANYTHING TO WATCH OUT FOR?**

Overall we think the changes represent a big step forwards in terms of racing, simplicity and developing road-relevant technology. All those involved at the FIA and FE teams in shaping this specification deserve to be congratulated for designing what appears to be a well thought out future.

There are a couple of things that we would keep an eye on: with 300 kW motors, the cars consume energy much quicker, so the drivers have to lift off the throttle earlier (around halfway down the straight). Perhaps this is why the tender includes a scenario B for 250 kW rear motors which would run for longer down the straights. Teams might also have to watch out for battery overheating with the massive increase in power going into and out of the battery. As well as balancing energy usage, battery thermal management might once again become a crucial part of the championship battle.

The spec is likely to evolve as it becomes apparent what is possible from a technological standpoint. We can't wait to find out what will happen, and will be ready to provide simulations to FE teams to arm them with the knowledge required to extract maximum performance from the Gen3 cars.

 Rowland Jowett is a motorsport simulation expert with over 12 years of experience in F1 vehicle dynamics. He is working with Canopy Simulations, which provides lap time simulation, vehicle modelling and setup exploration using the power of cloud computing.





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Frank Williams was the last of a heroic breed of racers who risked all to take on the big boys in Formula 1. **Tony Dodgins** looks back on the spectacular tale of triumph and disaster that led to the demise of F1's last family-run team

**OR** many, the news that Williams had sold out to an investment company, Dorilton Capital, was as sad as it was inevitable: the end of an era. But what an era! One can only imagine the thoughts of 78-year-old Frank (the board's support for the sale was unanimous) as the ink dried on the contracts. It was almost 45 years since he sold out the first time to Walter Wolf for £140,000

- and regretted it. This time, the sum was rather more, almost a thousand times more, at  $\pounds$ 136.5m. It cleared debt, secured the futures of Frank's family and, importantly too, the futures of the Williams employees after two seasons bringing up the F1 rear.

The new Williams board is Matthew Savage, the chairman of Dorilton Capital, Darren Fultz, the investment fund's CEO, and James Matthews. Both Savage and Fultz previously served at Rothschild, and played a role in founding Dorilton in 2009. Matthews (aged 45 and married three years to Pippa Middleton), is the CEO of Eden Rock Group.

Matthews is a former driver. He was 1994 British Formula Renault champion, a championship won by Kimi Raikkonen in 2000 and Lewis Hamilton in 2003. He did two years of British F3 in 1995/6, finishing 10th run by David Sears the first year, and **ABOVE** Glory days: The team was at its zenith when Nigel Mansell romped to the '92 title in the active ride FW14B, one of the most technically advanced cars in F1 history

**RIGHT** Williams finally sold out – for nearly a thousand times more money than he had the first time around



ninth, run by Promatecme in year two. So, a proper, well-connected racing man.

Frank was always good with his connections. Born in South Shields in 1942, his father was an RAF Wellington pilot, who left when Frank was 11 months old. His mother was a schoolteacher and much of his early years were spent with his grandparents until, just before four, he was sent to a Catholic convent school at Blundellsands, near Liverpool. At seven, he was sent as a boarder to the Catholic Marist Brothers' School in Dumfries, Scotland.

#### PASSION FOR CARS

It was there that he developed his passion for cars and racing. In the mid-fifties there was keen motor racing rivalry and Frank's school was split into a Scots faction supporting Ecurie Ecosse and their private Jaguars and the English who got behind the works Jaguar team.

The father of a school friend was a well-heeled motor trader based in Newcastle and the company would buy stock from auctions in Glasgow, taking a bevy of drivers with them. Frank would go along for the ride, just to spend time in the passenger seat of a Jaguar. And, soon, in holidays, he was hitch-hiking all over the country to racing circuits. One of the first races he attended was the 1958 British GP at Silverstone, the scene of Williams Grand Prix Engineering's first victory some 21 years later! Ironically, it was the first season of a separate championship for constructors, although initially it was as a driver that Frank saw himself.

The only problem, he wasn't wealthy, and it was also

Asked what the biggest problem he faced as a driver was, he responded, 'The corners!'"

an ambition to one day put that right. In 1960 he left school and took a management trainee course with Cripps Brothers, a Rootes Group car distributor. After learning to drive in his mother's Morris Minor, she helped buy his first car – an ex-Graham Hill Austin A35.

The club racing scene offered a number of classes for tuned road cars and Frank was soon in action. In his third race, at Mallory Park, he rolled the A35, scrambled out and sat on the bank watching the race, where he met a guy called Jonathan Williams, who'd also crashed. In the paddock, Jonathan introduced Frank to a well-spoken friend, who had come to help out. It was Piers Courage, of the Courage brewery dynasty.

Meanwhile, things weren't going too well at Cripps Bros. Although Frank was enjoying the technical side, the course also comprised studying basic English one

XPB Images/Williams Racing

day a week at the local tech, which, considering he had an A-level in the subject, got up Frank's nose. He decided not to bother, so Cripps fired him.

There followed a spell delivering crumpets around England and Wales and then a period as a trainee Campbell's soup salesman, which came with £10 a week and a Ford Anglia! But also, lots of bluff Yorkshire shopkeepers telling him where to stick his soup...

Frank was a racer at heart. His schooling had bred independence and an exposure to the well-heeled and their attitudes. Jonathan Williams and Piers Courage were sharing a London flat in Lower Sloane St with Sheridan Thynne, who would later work for Frank on sponsorship liaison. In October '63, aged 21, Frank moved in, renting their sofa.

He became Jonathan Williams' mechanic and from May to September they lived a gypsy existence around Europe following the Formula Junior (which became F3) circuit. They lived in the pick-up used to transport the Lotus 22, stayed in a hotel one night a week to freshen up, and survived on start/prize money.

When they ran short of cash, Jonathan returned home to get hold of some more and Frank stayed in Europe. At the first ever race at Zolder he spannered for Picko Troberg, and sent the Swede out for first practice with one forward gear and four reverse. "I thought I could change ratios, but I couldn't..." Frank admitted.

But what he could do was speak languages. His education had seen him excel at French, German, Italian and Latin. He now put that to great use talking to continentals who wanted parts for their British-built race cars. Frank would happily sort them out and stick on a tenner as a handling charge. He was on his way as a wheeler-dealer racer.

The dealing soon took over, with Frank realising he wasn't going to make it as a driver, the highlight of his on-circuit exploits being a minor F3 international win at Knutsdorp, Sweden, in 1966. Asked what the biggest problem he faced as a driver was, he responded, "The corners!"

#### WHO IS FRANK WILLIAMS?

Williams set up Frank Williams (Racing Cars) Ltd and in the March 3, 1967 issue of Autosport could be found a full-page advert. Under a picture of Frank driving his Brabham, the text read: "Who is Frank Williams? He sells racing cars... and guarantees them. Telephone Harrow 0460/7854 (Middlesex).

What, exactly, was the guarantee?

"I guaranteed that they would get delivery and I wouldn't scarper with their money!" Frank smiled, many years later.

Based in Bath Rd, Slough, a Formula 2 Brabham was run for Piers Courage in 1968 before the combination moved up to the big time, F1, in '69. Using a Brabham BT26 with a Ford Cosworth DFV, Piers scored 16 points (9-6-4-3-2-1 to the top six in those days), with second



places in Monaco and at Watkins Glen. It was the season that saw Jackie Stewart win his first world championship.

Contrast that with, 50 years on, Frank's daughter Claire supporting the argument that being a 'constructor' was part of F1's DNA, during the vexed issue of Racing Point 'reverse-engineering' the championshipwinning 2019 Mercedes W10.

Obviously, you could see the point. Why go to the expense of hiring hundreds (in some cases thousands) of **ABOVE** Williams, seen here on the Brands Hatch pit wall in 1984, was a wheeler-dealer racer

**BELOW** Patrick Head founded Williams Grand Prix Engineering Ltd in 1977 with Frank, after the failure of the latter's first two ventures. The team designed a car for the '78 championship with a staff of just 17 people, then found Middle Eastern backers to take the squad to the next level



staff if it's possible to copy another car to such an extent and still retain the financial benefits of being a constructor?

But in the early days of F1 history, men like Frank and Ken Tyrrell existed by buying someone else's chassis, bolting in a Cosworth DFV and contending for the world championship. In fact, there's an argument that such a concept is arguably more in a racer's DNA than the unattainable cost requirements of Formula 1 when the money was driven exponentially skywards by major motor manufacturers.

Initially, the sport was populated by more niche manufacturers, like Ferrari and Alfa Romeo and, briefly in the fifties, by Mercedes. Indeed, by the end of the seventies, Enzo Ferrari viewed himself, Alfa and, by now Renault, as the *Grande Costruttori*, while Williams and their ilk were mere *Assemblatori*.

It was such a divide that led to the FISA/FOCA war of 1980, in which the major manufacturers, aligned with FISA, the sport's governing body, took on the British-based 'garagistes' – teams like Lotus, Brabham, McLaren, Tyrrell and Williams – Frank ran his affairs from the local phone box, the inspiration for Arthur Daley in an episode of Minder!"

over money, influence and governance. Williams had become a true 'constructor' in 1971 when, disillusioned with running supplier cars, Frank undertook the build of a Politoys F1 car with £40,000 from the Italian model manufacturer.

Without any manufacturing capability at Bath Rd, Williams recruited Maurice Gomm, who had a sheet metal business in Old Woking and Len Bailey, a design engineer who had worked on the Ford GT40 project. The team moved into new premises in Bennett Rd, Reading.

Frank spent his every penny – and quite a few of soon-to-be-wife Ginny Sawyer-Hoare's – on racing as they set up home together in a Windsor ► **BELOW** Alan Jones won the team's first Drivers' and Constructors' titles in 1980 with the FW07B. The tough-talking Aussie was the kind of racer the team loved



cottage rented from Gordon Spice after Frank had been lodging with long-time friend Dave Brodie.

The marriage to Ginny, who was three months pregnant with Jonathan Piers Williams, took place three days after the '74 Austrian GP when Frank was 32. He, of course, had no money.

#### MARRIED - TO HIS WORK

'The Brode' paid £8 for the ceremony, Ginny bought her own ring for £30 and Frank excused himself from a pre-wedding lunch because he was tied up at work. He left Bennett Rd at 10 minutes to two, arrived at the church one minute before the ceremony, kissed the bride and was back at work by 2.30 pm. It was not until the following year that Frank first had a bank account, so that he had a cheque book to pay the £120/month rent on their house.

After eventually being evicted and following an interview with a country estate owner, they were selected as tenants of a beautiful but run-down old laundry house needing renovation outside Basingstoke. At around this time, non-payment of the telephone bill saw the Bennett Rd phone cut off... and Frank running his affairs from the local phone box outside Reading Speedway, the inspiration apparently, for Arthur Daley in an episode of *Minder*!

Frank credits racing enthusiast the late Ted Ward, who owned a machine tools business, as a tower of strength in those days, estimating that over a seven-year association he put up around £200,000 – about half as sponsorship and the other half as loan capital which he subsequently wrote off.

He didn't abandon his principles, even if it cost his team the best power unit in F1"

"He died in 1978 but I will never forget him," Frank says. "He gave us the chance to build a team that would win a world championship."

With his energy, charm and ready smile – which had swept Ginny Williams off her feet on first acquaintance – Frank made many friends, and no enemies. People wanted to help him.

As an example, the major racing cost was engines. And, mid-seventies, Williams was blowing them up without knowing why. Finally, they discovered it was due to a kinked oil line restricting flow. So Ken Tyrrell allowed them down to his Ockham factory to study his system and copy it. It probably helped that, at that stage, nobody regarded Frank as a threat. He was universally known as 'Wan\*\*\* Williams'.

The US GP of 1975 with the rather ordinary Williams FW04 was an example of the sort of thing that would happen to him. In a race of attrition in Germany, Jacques Laffite had finished second, ensuring Frank's lucrative FOCA benefits for '76. But they still very much needed the money for starting the season's most lucrative race at Watkins Glen.

In the other car, Lella Lombardi, the only female to score F1 championship points (albeit two laps behind in the tragic Spanish GP that year) broke a valve spring in practice, didn't notice, and carried on until the DFV dropped a valve and lunched itself at a cost of £9,000.

Then, just before the race, Laffite's wife Bernadette mixed up his Optrex eye drops with a bottle of visor cleaning fluid and almost blinded him. Laffite was rushed to hospital, missed the race, and was so slim that Lella couldn't fit into his car...

It was during this period of constant financial struggle that Frank met Canadian **>** 





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oil millionaire Walter Wolf, who offered to pay off the team's £140,000 liabilities for a 60% interest. Frank turned it over and over in his mind before finally accepting.

"Why?" he reflected later. "Because it seemed an awful lot of money to have available at the time. I had never had more than £20,000 in my hand at any one time during seven seasons in F1."

Wolf had also bought Lord Hesketh's liquidated stock when the team closed its doors, taking the old 308Cs and Harvey Postlethwaite as chief engineer as part of the deal, just weeks after Frank had offered Patrick Head that position.

The cars were a disaster, with driver Jacky Ickx barely able to qualify at most races. For the following season, the disgruntled Wolf brought in Peter Warr to run the team and although he doubled Frank's salary, he would work from home, chasing sponsorship on commission.

Rubbing salt in his wounds, Postlethwaite designed a simple, effective car, the Wolf WR1, which Jody Scheckter took to victory first time out in the season-opening Argentine GP, with Frank not there to see it. He was now effectively a high-powered flunky, sent somewhere first class to pick up **ABOVE** Keke Rosberg won the Drivers' World Championship in 1982, fending off the inexorable rise of the turbo cars with a single victory with the Cosworth-engined FW08 at Dijon Wolf's Mercedes, drive it to Geneva, pick up his Lamborghini, drive that to Paris, then fly first class somewhere else. Depression set in, a new experience for such a live-wire, disciplined worker who did his thinking as he pounded the running trails six-minute miling.

The final straw came when Wolf's wife phoned and asked Frank to advertise for and select a married couple to live in one of their many houses. It was time to move on...

And so began Williams Grand Prix Engineering, with Patrick Head joining him. Roger Penske was shutting his F1 operation at the end of '76 but wanted £20,000 per car, less engine/gearbox. That was too much but, with his severance money from Wolf, and cash from Ted Ward and Personal steering wheels, Frank bought March 761/7 for £14,000 plus two low mileage Cosworths from Italian Tyrrell private entrant Alessandro Pesenti-Rossi and a third from Bernie Ecclestone. He was approached by Peter Mackintosh who was promoting Belgian Patrick Neve, with support from the Belgian Belle-Vue brewery. Williams GPE moved into Unit 10, Station Rd Industrial Estate, Didcot on March 28, 1977.

#### **HITTING THE BIG-TIME**

It's worth remembering that Williams had now been a constant trier for eight years in F1 without any success. Courage's brace of second places in that debut '69 season, a year before he was killed at Zandvoort, to Frank's great distress, were still his finest hours. But that was all about to change.

While it's true that Frank had a car fully liveried and delivered to a Saudi company while touting for middle-eastern backing, the first contact came because the Saudi Arabian state airline's British **>** 



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**BELOW** Frank's search for "an antidote" to Michael Schumacher's domination led him to employ the German's former team-mate, Heinz-Harald Frentzen, then even Michael's brother, Ralf (below). BMW power (bottom) inspired a purple patch, but titles were elusive advertising agency was Gordon Procter & Co and Frank had a friend working there.

Tony Harris appreciated that Saudia was a fastexpanding airline wanting to promote its name in the west. He thought motor racing would be ideal and introduced Frank to Mohammed Al Fawzan of Saudia. Williams took him to Silverstone to see Neve in Formula 2. A few days later it was agreed that WGPE would run Fly Saudia on Neve's rear wing for £30,000 sponsorship.

When the paint was stripped off for the new livery, it became apparent through the orange 'Beta Tools' identification beneath that Frank's March 761/7 had probably actually started its life as early as 1974! Patrick Head's first Williams chassis for 1978, the neat FW06, put the team on the map even if Head had





shied away from copying the Lotus '78 of 1977, which had been the car to beat in the hands of Mario Andretti. Head hadn't fully understood how ground-effect aerodynamics worked but, a year later, certainly had a handle on it.

Alan Jones had impressed both Frank and Patrick by winning the '77 Austrian GP for Shadow and, with an offer of £40,000, they got Jones's signature on a contract for 1978. He ran an amazing second at Long Beach before a front wing failure dropped him back, but he finished there in the US GP at Watkins Glen.

Patrick's ground-effect FW07 was superquick on its debut at the '79 Spanish GP and Clay Regazzoni took it to second place in Monaco. When Head and Frank Dernie produced an underbody engine fairing to tidy up the rear aerodynamics, the car was blisteringly fast, stunning the opposition at Silverstone as Jones took pole. In the race though, the car broke, and it was left to Regga to give Frank his first F1 victory, those 21 years after he'd hitched to the '58 British GP. In their little white team caravan in the paddock, Frank and Ginny just sat taking in the moment as darkness fell and the paddock emptied around them.

The rest, as they say...

#### TEAM-MATES AT WAR

Frank had always believed that with the right funding, he was as capable as anyone of getting the job done. And now he was in a position to prove it.

Jones won the championship in 1980 but fell out with team-mate Carlos Reutemann in '81 when the Argentinian chose to ignore a 'Jones-Reut' board hung out at the Brazilian GP, and won the race. The title that year went to Brabham's Nelson Piquet after Reutemann failed to convert the series lead at the Las Vegas season finale after taking pole, when fifth would have been sufficient. Both drivers then retired, which opened the door for Keke Rosberg to take full advantage and win the '82 title against the rapidlyadvancing turbo opposition with just a single victory at Dijon.

Williams entered F1's first turbo era with Honda in 1984. The FW09 was not the greatest chassis and the power delivery was a little on/off, but both team and engine supplier progressed rapidly. The team's first carbon car, FW10, allowed ►





Rosberg to set F1's first 160 mph lap on the way to the '85 Silverstone pole, and new team-mate Nigel Mansell to win his first grand prix in the European GP at Brands Hatch.

By that stage, Rosberg had announced his departure to McLaren for '86, his final season in F1, and Williams had replaced him with twice world champion Nelson Piquet, who assumed he would be de facto number one driver.

In terms of access to the spare car, he was, but Mansell's pace and tenacity assured that on the track, he was the

quicker driver. Before the season even started though, Frank Williams had suffered his catastrophic paralysing car accident as he drove too quickly on his return from a pre-season Paul Ricard test.

Mansell and Piquet took wins from each other and although one or other was expected to win the title in the Adelaide season-closer, Mansell's blown left-rear Goodyear robbed him with 18 laps to go. The team pitted Piquet on safety grounds and Alain Prost who, by good fortune had already changed tyres after an early race contact, stole the title.

The watching Soichiro Honda was unimpressed and believed that Williams

was lacking in management savvy by being unable to control its drivers. Frank though, was not about to abandon his principles of fair play even if, ultimately, it may have cost his team the best power unit in F1.

After Honda followed Ayrton Senna to McLaren in '88, Mansell was left to compete with a normally-aspirated Judd engine in '88 before moving to Ferrari for a couple of seasons. In 1991 though, he was back, just as Williams, with Rothmans support and ground-breaking active ride development, was about to hit a purple patch.

F1 in the nineties was dominated by Williams and McLaren, with intervention from Benetton and, latterly, Ferrari. It was Frank and Ron; Ron and Frank, both with

Rothman



Marlhoro

Shell

**RIGHT** Williams Racing's new directors gather at the Tuscan GP (above): James Matthews, Eden Rock Group CEO; Stephanie Dattilo, Dorilton Capital Chief Legal Officer and Group General Counsel; Simon Roberts, Acting Team Principal; and Matthew Savage, Dorilton Capital Chairman. Below, outgoing Deputy Team Principal Claire Williams at her final race, Monza, chatting with FIA President Jean Todt

**BELOW** The last of the team's 16 Drivers' and Constructors' titles were won in 1997, despite Michael Schumacher's doomed bid to drive Jacques Villeneuve's Renault-powered FW19 off the track at Jerez





lucrative tobacco backing. Mansell finally won the title in '92 with the dominant FW14B, with Alain Prost following up the year after.

After the dark days surrounding the death of Ayrton Senna in 1994, the team bounced back with Damon Hill, who won the championship in '96, followed by team-mate Jacques Villeneuve the following season.

#### END OF A DREAM

Arguably, the back end of the nineties was the last time that a specialist racing constructor, rather than one with major motor manufacturer backing, could really hope to win world titles. Since the new millennium, Formula 1 has seen lengthy domination by, in-turn, Ferrari, Renault, Red Bull and Mercedes, with a specific set of the most unusual circumstances permitting the fairy story that was Brawn GP in 2009. With top team budgets approaching half a billion dollars, it is hardly surprising. People suggest that Red Bull is an anomaly and proves it's still possible. But then, when Forbes has owner Dietrich Mateschitz's net worth at \$26.9 bn, making him the world's 40th wealthiest person, how much of an anomaly is it?

It is ironic that the Williams sale comes just as F1 is imposing budget caps and seems intent on levelling the playing field as much as possible between the haves and the have-nots. The kind of conditions that Claire Williams had been insisting was a prerequisite for the team's future survival.

One can only hope that Frank's feelings on selling out were better second time around. Hopefully ones of fulfilment. They deserve to be. No longer just a racer, he's had a life living his passion and bows out a multiple champion. Oh, and a wealthy man. Bravo.



With the dawn of the British Touring Car Championship's hybrid era drawing closer, an official testing partner was required for Cosworth's all-new TOCA hybrid system. **Chris Pickering** finds out how Speedworks Motorsport is adapting to its new role

**HE** British Touring Car Championship (BTCC) is gearing up for the start of a new hybrid era in 2022.

Back in the September issue of Race Tech we spoke to the series organisers TOCA, and the Cosworthled consortium of companies responsible for the design of the hybrid system. But that was only half the story. With the fundamentals of the system laid down, the next step was to build a prototype and put theory into practice.

Cosworth and TOCA looked at two options – either adapting a current car and testing it between races or building a dedicated prototype. With lockdown looming, it seemed likely that the calendar would be compressed once racing resumed, plus the test car would have to run the BTCC's forthcoming 2022 electronics package to support the hybrid system, so a purpose-built test vehicle became the favoured option. The project was put out to tender and it was Cheshire-based Speedworks Motorsport that was

TIDEA Hybrid

HYBRID TECHNOLOGIES

δ

the plumbing side; looking at the flow rates and the pressure drops across the lines and how they would be laid out."

The idea was to produce a schematic diagram that the other teams could follow, with all the hoses and connection sizes already specified. Goodridge provided input on the industry-standard fluid couplings and supplied parts for the prototype, although the pipework itself is not part of the official package.

Careful consideration went into the layout of the cooling system, Aldridge recalls: "We needed to look at where to mount the low temperature radiators and how to get ducting through from a suitable high pressure area to feed them. We used some CFD there to ensure that we'd got the flow pattern right. There was also the practical side to consider when mounting the radiators: how do we limit the vibration and minimise the amount of damage if we have a front-end impact?"

One of the advantages of using the Toyota Corolla as a test car is that it is the smallest vehicle currently on the BTCC grid. In particular, the front overhang is shorter than any

ABOVE Xtrac performed a lot of analysis on the mounting of the motor (seen here in CAD, in black) to ensure the same engineering

approach applied

to FWD and RWD configurations

all aspects of the system and iron out any potential pitfalls before it gets released to the teams. It's likely that the first step for many of them will be to install the system in an existing car, so Speedworks set out to do just that – creating a carbon copy of the Corolla that it runs for Tom Ingram in the series, but with the new

"We made a deliberate attempt to

keep everything as close as possible

to that original build to ensure that

other teams would be able to install

the system in an existing car without

any major challenges," comments Speedworks Motorsport team owner

The first job was to liaise with

plumbing for the cooling system, as

Spencer Aldridge, design engineer

"We began by working with PWR

cores and the design of the end

tanks. We then had to look at the

positioning of those and how they

would mount to the car. Next came

to work out the size of the radiator

at Speedworks Motorsport, explains:

various suppliers to spec the

The purpose of the build was to test

given the green light.

hardware installed.

Christian Dick.

#### DURONN EEFT

LEFT As the smallest car on the grid, the Corolla is likely to represent the worst-case scenario in terms of packaging space

## It's important that the installation is as plugand-play as it can possibly be for everyone"

of its competitors, which means it's likely to represent the worst-case scenario in terms of packaging space. In other respects, though, it is very much a typical Next Generation Touring Car (NGTC), which makes it ideal as a generic testbed.

No two NGTC cars are entirely alike, however. The most significant mechanical difference is that some are front-wheel drive and some are rear-wheel drive, and there are some subtle differences in the hybrid system installation between the two. Notably, the motor is mounted externally in front-wheel drive setup, while the rear-wheel drive configuration places it inside the bellhousing. In terms of the installation process for the teams,



LEFT & BELOW CAD of the Swindon engine, hybrid gearbox and motor in the RML subframe

BELOW LEFT The motor is mounted externally in front-wheel drive configuration, as on the Toyota, but will sit inside the bellhousing in rearwheel drive layout

however, a concerted effort has been made to keep the cooling connections and the general layout the same. "The only real layout difference is likely to be the cooling connection around the motor," notes Clive Dopson, chair of TOCA's engine technical review panel. "They will have to go in through the transmission tunnel [on the rear-wheel drive installation] instead of the bulkhead."

"We know what the differences between

the two installations will be, and most of that has been taken care of in the design side," comments Dopson. "For instance, the mounting of the electric motor is different, but Xtrac has put a lot of analysis into it and we're confident that the same engineering approach will be valid for both options. The purpose of running this car is primarily to look at things like the software and the cooling, which will be universal between the two."





#### **NO NASTY SURPRISES**

The verdict from Speedworks is that its front-wheel drive installation was a reasonably straightforward process. Aside from a slight modification to the casing, the gearbox is effectively unchanged and we're told the motor fits on without any interference with the subframe. A slight shell modification was required to accommodate the battery in the case of the Corolla, for which Speedworks sought advice from TOCA and battery supplier Delta Motorsport.

"The battery will sit in approximately the same position as the current ballast box, but we're still finalising its location," comments Dopson. "The electric motor is about a metre further back in the car and somewhat lower down in the rear-wheeldriven installation, so we're planning to use the position of the battery pack to offset that. There will be minimum heights for both installations and different fore-and-aft positions."



**C** Often the critical thing with electrical systems is placing them in circumstances that they haven't encountered before"

The overall NGTC concept has always been about ensuring that each model has the same potential to be turned into a successful racing car, while still allowing enough flexibility in the build and setup for the smartest teams to engineer a competitive advantage. However, the hybrid system is controlled rather more tightly, with the motor and battery positions mandated for each installation, the electronics package fixed and a build manual supplied for the cooling installation.

"From a team's perspective, I think it's important that the installation is as plug-and-play as it can possibly be for everyone," says Dick. "Initially, I think the deployment strategy will create enough

challenges to spice things up a lot. Further down the line, perhaps TOCA might look at opening it up, but right now I think it needs to be as simple as possible."

#### LOCKDOWN CHALLENGES

Work on the shell began at the end of May. Much of the build was carried out under lockdown conditions, which led to some challenges with component suppliers, but a tireless effort on the part of the Speedworks engineers saw it ready for the BTCC tyre test at Snetterton at the beginning of July.

Before that the car had already been for a shakedown test on an airfield as part of a comprehensive test programme laid >



**RIGHT** The BTCC is moving into new territory with its hybrid era, with safety for all the teams' personnel paramount

60

down by Cosworth. This doubled as the first dynamic test for the new electronics package that will be introduced alongside the hybrid system in 2022.

"The first half of the day was spent getting the car running in IC-only form and then the hybrid system was introduced in the afternoon," recalls Neal Bateman, Head of Support at Cosworth. "The area we had access to on the airfield was fairly limited, so those massive straights at Snetterton were our first chance to test full deployment throughout the gears. It also gave us a chance to look at regen in a realistic racing environment. The hotter weather we had at Snetterton and the other cars on the track gave us a good test of the cooling system too."

#### **DELIVERING BOOST**

BELOW Could the hybrid test car run alongside the competitive field at some events, as the Box 56 programme does at Le Mans? Testing duties have been entrusted to sports car ace and former BTCC driver, Darren Turner. On track at Snetterton he was able to confirm that the hybrid system delivered a perceptible boost. Next, the test programme moved to Donington (just before we caught up with the team). This is the circuit that Cosworth had used for its simulation work, so Bateman and his colleagues are delving into the real-world data as we speak to assess



how well it compares with the predictions.

The next step will be to put more miles on the car, with the target being to cover the equivalent of a season of BTCC running between now and the spring. Alongside this, Cosworth has been conducting dyno testing and Delta Motorsport has been carrying out load cycling on the battery. Around 2,000 kilometres of track testing remains to be done, but Dopson points out that it's not simply a question of mileage accumulation: "The difference between the durability sign-off process for the hybrid system and what you might do with an IC engine on its own is the range of



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different scenarios you need to evaluate. We did calculate that we could carry out all the electric motor cycling that you'd get in a season of racing in just 24 hours on the dyno, but that's not what we're trying to do. Often the critical thing with electrical systems is placing them in circumstances that they haven't encountered before and making sure that the software responds appropriately."

Dopson describes the philosophy behind the test programme as being halfway between a traditional motorsport approach and a highvolume automotive approach: "Between Cosworth and TOCA we've done quite a lot of analysis of the potential failures that could take place. That's identified a very detailed validation plan, designed to take the system to each possible set of circumstances and ensure that both the software and the hardware functions as intended. There are still important scenarios that we haven't even tested yet, like the option of bump-starting the IC engine when the car reaches the end of the pit lane."

In terms of strategic use of the system, it's thought that there will be two main options: deployment for track position or deployment for lap time. These could potentially be quite different, and it still remains to be seen whether there might be a degree of automation or whether it will be entirely driver-controlled.

At present, all options remain on the table, as TOCA technical director Peter Riches explains: "We haven't decided how much freedom the teams will have to modify the control strategy just yet. Usually with a new system like this we have to restrict it more initially and then broaden it out as the teams get to grips with it. We had a similar experience when we went over to the current RML suspension system; too much adjustment wasn't beneficial to anybody."

TOCA and Cosworth have pledged to make the hybrid kits available by the end of the 2021 season (in preparation for the following year). It's possible that the two electronics packages might ABOVE The 'Hybrid' and 'Push to Pass' buttons testify to the exciting range of options that will add an extra strategic edge to the hybrid era

RIGHT Speedworks created a carbon copy of the car it runs in the BTCC for Tom Ingram under the Toyota Gazoo Racing UK with Ginsters banner overlap, with teams that are building new cars next year allowed to equip them with the 2022-spec electronics. As such, TOCA says it's open to discussion with any teams that are interested in trialling the hybrid system on test days in 2021.

There's also been a suggestion that a hybrid car could run alongside the competitive field at some events (in a similar manner to the Box 56 programme at Le Mans). What we know for sure is that the hybrid cars' competitive debut will come at the start of the 2022 season. And that truly will be the start of a new era for the BTCC.

**RIGHT** It was a historic moment for the series when the hybrid car left the pitlane at the first test. It represented the culmination of months of hard work and years of planning

**FF** Deployment for track position or deployment for lap time could potentially be quite different"





If the Coronavirus crisis delivered a financially crippling hit to motorsport – with even successful grandee teams like Williams and McLaren requiring urgent financial investment – it dealt a potentially mortal blow to the aviation industry.

The virus lockdown transformed bustling airports into ghostly 'aircraft parks'. And this isn't temporary, because even the most optimistic airline CEOs have stated publicly they don't expect traffic to return to normal until at least 2023. So I wonder what they are saying in private?

The massive layoffs by most of the major companies involved in manufacturing airliners indicate they already realise the impact on them will be even worse, and last longer. One key reason for a slow recovery is the stigma of aviation's key

The aerospace industry helped shape the development of motorsport as we know it. Now, as the aviation sector faces its darkest hour, **Chris Ellis** argues that Formula 1 can repay that debt

**OTORSPORT** and the aerospace industry represent two jewels in the crown of UK manufacturing.

When MPs in the House of Commons were commissioned to report on the synergies between the two sectors, they were told: "A Formula 1 racing car is only a low-flying aeroplane, except that the aerodynamics are to keep them down rather than up."

Their report noted that: "The UK is a world leader in the motorsport industry, and boasts the world's second largest aerospace sector after the USA. They have many common characteristics and often work closely on shared challenges. Both industries are knowledge-intensive, utilise a highly skilled workforce and are constantly investing in Research and Development to improve their product and to maintain their edge over international competition."

Initially, motorsport would piggyback the aerospace industry's expertise. That

was the case from the 1960s, when Donald Campbell's Land and Water World Speed Record attempts were shaped in the wind tunnel, through to the discovery of ground-effect in the '70s and pioneering use of composite materials in the '80s. Today, though, that balance has shifted.

Many major aerospace companies now enjoy a close relationship with Formula 1 teams – and the flow of information is now truly a two-way affair. During the course of their report, the MPs were shown several examples of technologies and production methods that had been tested in the motorsport sector prior to their adoption by aerospace companies.

#### **MULTIPLE HITS**

Today, the two sectors once again face a common challenge: how to rebuild themselves in the 'new normal' emerging from the COVID-19 pandemic.

**BELOW & RIGHT** The aviation industry was brought to a standstill by the pandemic, with airports suddenly becoming plane graveyards

**RIGHT** It is estimated that hydrogen has the potential to reduce aviation's CO2 emissions by up to 50%. F1 offers a powerful shop window to demonstrate the technology that could help many other industries, as well as aviation, meet their climate targets



role in turning a national epidemic into a global pandemic. This is bound to depress seat sales until everyone is confident track-and-trace works reliably at all key destinations, particularly for return flights. Who wants to be the one who brought the next epidemic home? Another reason is business travel will recover



**The goal of producing the world's first** zero emission long haul passenger plane" only partially, because many companies have been forced to become competent at videoconferencing, and now realise how much money they can save by becoming even better at it. Especially when money is tight, as it will be for years, for so many businesses.

Crucially, though, it's not just COVID-19 that threatens the airlines. Climate protesters have increasingly targeted the sector and now they have more ammunition than ever: recent research shows that the planes' contrails have a larger impact on climate warming than previously thought, particularly at night.

The British government's initial response to the problem has been to set up the 'Jet Zero Council', which will probably have the unfortunate effect of delaying any decisions for at least six months. Which is a shame, because its objectives are ambitious. "As part of our mission to reach Net Zero CO2 emissions by 2050, we should set ourselves the goal now of producing the world's first zero emission long haul passenger plane," explained UK Prime ►



Minister Boris Johnson. "The UK now has a huge opportunity to cement its place at the vanguard of green innovation."

We know *already* how to get large zerocarbon airliners into long-haul service before 2030. Or at least a few people do. "There is a role for batteries and fuel cells in small, short-range aircraft, but long-range aviation can only be done cleanly with hydrogen-fuelled turbo-fans, such as the Rolls-Royce Trent," suggests Professor John Coplin.

The chief designer of the RB211 aeroengine that turned Rolls-Royce from a significant player in the aero-engine industry into a global leader, Coplin's words carry weight. What is urgently needed, however, is a way of showcasing the existence of this technology. And that's where motorsport enters the equation.

#### WHAT'S IN THIS FOR F1?

Formula 1 is already committed to becoming fully sustainable by 2030. To be clear, it's not just about running the cars on the right fuel: this represents less than one per cent of the total problem. Formula 1's own estimates suggest 47% of its direct emissions come from moving the cars and supporting equipment around, plus another 19% for personnel. Consequently, my guess is that flying, alone, is responsible for almost half of Formula 1's direct impact on the environment. So an obvious first step is for all of the teams to insist on the use of SAF (Sustainable Aviation Fuels) for their freight flights, and for Liberty Media to flaunt this when they do.

However, most airlines are still only comfortable using a 50:50 mix of SAF and Jet A-1. So I hope Formula 1 and the FIA might adopt my suggestion in 'Beyond Mission H24' (Race Tech, April 2020) that a 'Formula R' – "R' for 'Research' – race be run during the morning of each grand prix. Formula R could be based on the latest WEC regulations, except for the powertrain rules, with a focus on using hydrogen, including in ICEs. This would allow the Formula R teams to demonstrate the latest fuel cell, surge power and hydrogen storage technologies in front of massive audiences of influential viewers.

Another objective would be to inform the process of choosing the fuel and powertrains for F1 in 2026. Whatever the configuration – like Gordon Murray, I'm a fan of V12s, but the cost of COVID could dictate V6s being retained – the ICE powerplant could run on compressed hydrogen. There's a good theoretical case for liquid hydrogen in F1, but this will not be used in (almost) any road cars or trucks because it's not costeffective, just like exhaust energy recovery.

Harnessing hydrogen could make a reality, again, of F1's claim to be a key source of innovation for the whole car industry. This used to be true, but most people don't believe it any ►

ABOVE A hypercar-style race, demonstrating hydrogen fuel cell technology to an F1 audience, could accelerate development of a technology that is gaining momentum amongst manufacturers

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more, particularly young people. Consequently, the average age of fans is rising rapidly and their numbers are falling, not helped by the reduction in free-to-view coverage. However, if F1 presents FR as the public test bed for the powertrain regulations for Formula 1 in 2025/6, imagine the renewed interest, particularly if FR is freeto-view on the internet and major TV channels. One consequence is that racing at this level will no longer be seen as a wasteful irrelevance if it is genuinely helping to make all transport, on the ground, in the air and at sea, completely free of emissions.

Years ago, in the BRDC enclosure during a British Grand Prix, I was stunned to see Stephen Hawking sitting within 20 feet of Kofi Annan. How long will it take before Greta comes to Silverstone, to have tea with Boris?

#### **HYDROGEN MOMENTUM**

The Le Mans 24 Hours organisers' faith in Mission H24 – set to introduce hydrogen race cars to the endurance classic in 2024 – reflects the growing momentum of the technology. Only a few years ago, most European car companies



were dismissive of the idea that hydrogen fuel cells had any role in cars, but now several have openly declared an interest in using them in large SUVs.

Mercedes is in the lead, with the GLC F-CELL already in limited production; BMW is promising something similar next year. And the British government has just provided some funding for Project ZEUS, to help Jaguar Land Rover develop a fuel cell SUV. Perhaps recent research by UC Riverside claiming 'Fast-charging of electric batteries can ruin their capacity after just 25 charges' may have convinced them batteries aren't good enough?

In the UK, it costs 24 pence/kWh to use a Tesla Supercharger at more than 60 kW. Assuming three miles per kWh, that's £2.40 for 30 miles, roughly half the price of petrol. But more than the cost of the petrol, because over 60% of the price of petrol is tax! So what will happen when tax-free hydrogen becomes widely available, and is cheaper to use than diesel or petrol?

As a rough 'sanity check', assume it will cost only £5,000 to replace the battery pack in a typical large battery-only car after 50 rapid ► ABOVE Airbus and Rolls-Royce appeared to have opted for a series hybrid solution when they launched the E-Fan X demonstrator programme in late 2017. It has since been abandoned, with Airbus suggesting a focus on hydrogen might be more productive



LEFT The launch of the Mercedes-Benz GLC F-CELL, the world's first electric vehicle featuring fuel cell and plug-in hybrid technology, illustrates the swing towards hydrogen

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











EAN: 978-88-7911-684-8 / Text: English - Pages: 208 -Pictures: over 600 technical drawings in colour - Hardbound - £ 49.00

**HE** last edition of an automotive literary classic: the technical analysis of Formula 1 penned by Giorgio Piola. After 25 years of publication, the historic draughtsman brings the curtain down on this experience with a volume that examines the last three seasons, from 2016 to 2018, as always reviewing the principal technical innovations in the spheres of chassis and engine design. This three-year analysis is appropriately completed with a retrospective of some of Piola's most important drawings from a 50year career that began back in 1969.

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charges. £5,000 is probably optimistic, even in five years' time, given JLR is currently said to be paying LG Chem some \$20,000 for the pack in each I-PACE. But that still indicates a hidden extra cost of £100 per rapid charge! I wonder how cheap a 2020 Tesla Model 3 will be in 2025 if its battery has had over 30 rapid charges? Although to be fair on Tesla, rapid charging is limited automatically if used too frequently. So it obviously recognises the problem and its potential impact on battery warranties.

The fact that a Tesla Roadster 2.0 will weigh two tons(!) when Gordon Murray's T.50 will weigh less than a ton (complete with fan-assisted downforce at *all* speeds) has convinced me that hydrogen will also be the preferred energy source in high-performance cars, once it is realised



that adequate hydrogen infrastructure *must* be put in place for long-haul trucks, and when BP and Shell have achieved their recently proclaimed objective of 100 hydrogen filling stations in the UK by 2025. Meanwhile, the penny has already dropped in California, China, France, Germany, and Japan.

#### FIRST STEPS

Imagine the impact if hydrogen technology was to be demonstrated during the mornings preceding five or six of 2022's F1 races, using WEC hypercars powered by LEFT & BELOW The 'blended wing body' configuration is a disruptive aircraft design that has the potential to reduce fuel consumption by up to 20 per cent compared to current single-aisle aircraft. It also opens up new possibilities for propulsion systems type and integration. Airbus says it could pave the way for zero-emission commercial aircraft to enter service by 2035

fuel cells running on compressed hydrogen. The new-found enthusiasm of some of the leading European manufacturers for hydrogen fuel cells, rather than batteries, to power some of their large SUVs will probably have resulted in several more product announcements by then, if not deliveries. And second-generation Toyota Mirais will have received enthusiastic road test reports.

Formula R could demonstrate to F1's over 300 million fans that one-ton hypercars capable of out-accelerating two-ton Tesla Roadster 2.0s will soon be available. Just imagine how fast Gordon Murray's T.50H will be able to corner, brake and accelerate when fitted with much more powerful fans. Two versions might race, one with 200 kW of fuel cells and a 300 kW supercapacitor-based KERS

AIRBUS



replacing the 500 kW V12. Not many of us have the opportunity or desire to cruise continuously at over 180 mph. But how many would like to be sure to win track days, even up against 488 GTBs? With zero CO2 output, and much less overall environmental impact than a Tesla. Perhaps using hydrogen in cars isn't so stupid, Elon, after all...

#### **HYDROGEN IN F1**

In the next generation of F1 cars (due by 2026, perhaps earlier) I expect the engines will still have pistons, but maybe more of them. The big change will be to use hydrogen as the fuel. Almost since cars began we have known piston engines run better on hydrogen than petrol, and can produce more power. But its high price and lack of refuelling infrastructure prevented its adoption. Now this is changing, fast.

Kubagen, a UK-based start-up, has recently discovered that using manganese

hydride allows hydrogen to be stored in only a quarter of the volume of a conventional 700 bar cylinder. It works by exploiting a chemical process called Kubas-binding that distances the hydrogen atoms within an H2 molecule, without the need to split the molecule. Kubagen should have proved by the end of next year that Kubas-binding is the key to low-cost, 'light enough', hydrogen storage at ground level. Perhaps we will see it compete with 700 bar hydrogen in FR? And then be adopted by F1?

Meanwhile, the UK government's latest 'FlyZero' project should have completed its two, parallel, initial stages. One stage could be focused on taking an Airbus A330 MRTT air tanker and using some of its large kerosene tanks to house a number of liquid hydrogen cylinders, sufficient to allow the full testing and refinement of the new Rolls-Royce Advance ZC (Zero-Carbon) turbofan engine years before the first prototype BWB (Blended Wing

> **ABOVE** Little will need to be done to the MRTT's existing Rolls-Royce Trent engines to enable it to run on hydrogen

LEFT A sustainable future for air travel moved closer last month with the world's first hydrogen fuel cell-powered flight of a commercial-grade aircraft, completed by ZeroAvia's retrofitted Piper M-class six-seat plane Body) airframes can be ready to fly, providing beneficial input to the detailed design of the BWB. BWB airframes are more efficient aerodynamically than those of conventional planes and, more importantly, provide the extra volume needed for their hydrogen fuel tanks.

Even earlier, little will need to be done to the MRTT's existing Rolls-Royce Trent engines to enable them to run reliably on hydrogen rather than Jet A-1. Clearly, the sooner this can be proved, the better. This will then allow the accurate measurement of the major reduction in contrails expected when hydrogen is being used, which should help persuade Greta and Co that the establishment is actually working hard, and successfully, to fix the problem.

The other, parallel, stage will be the design, development and production of the BWB airframe. This is almost certain to prove the critical path because it will probably take close to a decade before the regulators become confident that BWBs are safe enough to carry passengers.

By 2025, societal pressure to minimise Climate Change is likely to have become intense. Who knows what severe weather will have ruined by then? Consequently, the level of commitment to zero emissions outlined above will probably have become mandatory. So my key message is: by 2030 there will be used car lots filled with old, cheap, battery vehicles because hydrogen will be seen as our main means of storing energy, in the air and on the ground, as well as *in* the ground. And F1 and FR can show the way...





Sergio Rinland explains why the 'Pink Mercedes' affair shows that F1's technical excellence is matched only by its hypocrisy!

here is an argument that art imitates nature. Is one of the most copied works of art in history, Leonardo da Vinci's 'La Gioconda', an original in itself? Or a copy of the way that mysterious woman looked like? The answer is not that clear cut.

When we were designing the Sauber C20, Peter Sauber came into the model shop to see the wind tunnel model we were putting together. His comment to me was: "This car is ugly; why don't you draw inspiration from nature, like the cheetah for example – beautiful and fast?" He was probably right, but my retort was: 'Tell this to the FIA – they tell us where we can put bodywork and where we can't."

#### **<u>'COPYCAT' PENALTY</u>**

This argument could be applied to a topic that – irrespective of the super-tight regulations – has preoccupied F1 in recent weeks: copies in Formula 1. It is a time-honoured practice for Homo Sapiens to copy and/or imitate what others do better or what we are led to believe they do better than us.

In my scale models collection, I have a 1933/34 Bugatti 59 and an Alfa Romeo 2300 Monza of 1931. The Bugatti 59 is one of the most replicated models of those



BELOW Racing Point's unapologetic copy of the 2019 Mercedes aero philosophy has forced F1 to confront some uncomfortable truths years. Those two cars looked so similar that if it wasn't for their distinctive grilles, you would be hard pushed to differentiate. Would you say that an artist and genius such as Ettore Bugatti had to copy an Alfa Romeo? Not in a million years.

In those days they did not have 3D cameras and their associated CAD software. The most likely scenario is that, with the available technology and materials, Ettore Bugatti and Vittorio Jano, another creative genius of the time, arrived at similar concepts.

In the 1960s everybody drew 'inspiration' from first the Lotus 25, then the 49. Particularly when everybody except Ferrari and BRM was using Cosworth engines and Hewland gearboxes.

In the 1970s, every team entered the '79 season having built a 'copycat' of the 1978 Lotus 79 groundeffect car. In fact, some 'copies' were better than the original! Like the Williams FW07.

On the other side of the coin, going back in history, the 1954 Lancia D50 (also designed by Vittorio Jano) was a different concept to the 1954 Mercedes W196 because at the start of a new set of regulations, engineers take different directions. But then, with rules stability, comes design convergence.

The comments of the day were that if Lancia hadn't been bankrupt, they would have been a hard competitor and probably beaten Mercedes. There was no possibility of drawing inspiration from one another, when both cars started life roughly at the same time on a clean sheet of paper with new rules. Eventually, the 2.5-litre formula never reached convergence thanks to the efforts of John Cooper's mid-engined T51. Different times... ►


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#### FOLLOW THE LEADER?

74

Is it naïve to think that the Racing Point designers, having decided to follow the same concept as the 2019 Mercedes, arrived at the same solutions? Particularly when they use the same powertrain, rear end and the same wind tunnel? I would have been surprised if they were different!

The rumour mill suggests that when Racing Point decided to follow Mercedes's concept path – because they believed they had reached a plateau with the 'Red Bull' concept they had been following – their first professional photographers can bring to the track? Will they regulate what software teams can and cannot use?

The best way to end all of this and many more headaches for the FIA, namely the excessive downforce on the Pirelli tyres, is to commission Dallara to build the same car for everybody, Cosworth a common engine and Xtrac a common gearbox. It would end all this page after page build-up of regulations and if anyone dares to build his own Gurney lip, fine them 100 million dollars and job done. After all, that figure was used some years ago to fine a team for 'intending' to copy another car... **BELOW** Rivals drew 'inspiration' from the Lotus 25 (left), 49 and ground-effect 79



wind tunnel model was 40% below the efficiency levels of their 2019 car. Only hard work, and perseverance in their beliefs, enabled them to achieve the level of performance they are demonstrating today: a feat that vindicates their initial decision.

When I read the reaction from the FIA, with their 'crack down on copycat activities' new rule, and heard the comments of some team principals and

#### Teams use 3D cameras and associated CAD software to scan their opponents' innovations"

technical directors, I could not hide a smile: what a load of rubbish and hypocrisy. Every team for as long as I can remember has had professional photographers on their payroll to deliver the close up and detailed pictures of their rivals' cars.

Now they use 3D cameras and associated CAD software to scan their opponents' innovations. How do you think that one team discovered the similarity of the rear brake ducts on the 2020 Racing Point and 2019 Mercedes in the first place? By standing behind the Racing Point and remembering vividly the 2019 Mercedes rear brake ducts? Come on! Some coherence please.

Is the FIA going to regulate what kind of cameras

**RIGHT** Had Racing Point's RP20 proved to be as slow as its initial wind tunnel models suggested, who would have complained?







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