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# How Jaguar's single-seater breakthrough is shaping future road cars

# **RACE TECH** Motorsport Engineering Volume 31 Issue 4

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Rally revolt

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### **COVER STORY PAGE 46**

# ON THE COVER 22 AI: A NEW INDUSTRIAL REVOLUTION

Al will change the world, so what role will motorsport play? Chris Pickering talks to the experts behind PhysicsX, a company exploring the replacement of simulation by deep learning

### 46 THE CAT ROARS

Anthony Peacock reports on the leaping cat's single-seater breakthrough – and its implications for a new generation of road cars

### 54 RALLY REVOLT!

Cometh the hour, cometh the car? Toyota's Rally2 machine was unleashed in Monte Carlo just as momentum grew behind calls for Rally2 to become the World Rally Championship's top category. By Hal Ridge

### **6** INDUSTRY NEWS

FIA tells COP there is no one-sizefits-all solution to decarbonisation; Historic Racing & Technology returns; 2024 Festival of Speed to tackle power revolution; International Race of Champions to be revived; wave of departures hits FIA; Audi makes Dakar history; Formula E still leading sustainability race; Indy Autonomous Challenge to attack Goodwood hill; Extreme E extends Continental deal; Saudi PIF bonanza hits electric motorsport

### 74 COMMENT: Sergio Rinland

Sergio Rinland says we can squabble over the F1 business model all we like, but some things will never change

### 30 SPORTSCAR RACING A tale of money and muscle

Gary Watkins reports from the Rolex 24 at Daytona, where new cars from Corvette and Mustang joined the boisterous GT3 party

### **38 HOW AUDI MADE DAKAR HISTORY**

Audi's electrically-driven RS Q e-tron took on – and beat – traditional technology in the most extreme environment in the world. Chris Pickering finds out how they did it

# 62 100 YEARS OF LE MANS INNOVATION

A glimpse of 100 years of technical innovation and curiosities at Le Mans in an extract from '100 Years Of Legends', the official book to celebrate the centenary of the world's greatest sports car race





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# ANOTHER EPISODE OF CROSSROADS

**OME** things in life can be resisted, no matter how much momentum they appear to possess. An Andretti-Cadillac Formula 1 entry, anybody?

Other forces simply cannot, perhaps *should* not, be repelled. I am guessing the inexorable march of Artificial Intelligence falls into that category.

As you might notice from the strapline atop our cover, there are some pretty remarkable claims being made about the technology. Then again, the leading figure we have interviewed this issue on the subject, PhysicsX founder Robin Tuluie, has a pretty remarkable track record himself, having participated in a number of Formula 1 technical breakthroughs. So he is wellplaced to offer opinions on where the technology might lead.

As Robin points out, motorsport used to lead the way in advances like traction control, seamless shift gearboxes and the use of virtual development. Why not AI?

As you can see in our news section, Goodwood's Festival of Speed is also peering into the crystal ball at the moment, as well as glancing in the rear-view mirror. This year's theme, 'Horseless to Hybrid – Revolutions in Power', evokes memories of the 1894 Paris-Rouen event that is often considered the birth of motorsport competition. The entry list that day included vehicles powered by everything from steam, petrol and electricity, to gravity, compressed air and hydraulics.

After a century dominated by the internal combustion engine, we appear to have arrived back at the technological crossroads

again, with no obvious consensus on which direction to head.

Electric, hybrid, hydrogen and sustainable fuel are all in the mix – unless you are a blinkered politician. That's why the FIA stressed at COP28 (see our news story) that there is no one-size-fits-all solution.

That dilemma is one of the catalysts for the enduring popularity of Race Tech's World Motorsport Symposium. It's a safe haven where engineers can meet and exchange information, without fear of finding themselves quoted in the newspapers or called in front of their boss on Monday morning!

Intriguingly, it's also an event from which Artificial Intelligence was one of the big takeaways last year.

The WMS celebrates its 20th anniversary this year, so it is apt that an event sometimes dubbed 'The Davos of Motorsport' will be hosted at a prestigious and spectacular venue: the Royal Automobile Club in Pall Mall at the heart of London. It will offer more space, the ability to stay at the same location overnight, and our awards dinner will be held at the same site. We intend to deliver an array of subjects and speakers befitting the occasion. Save the date: Tuesday 26 and Wednesday 27 November.

As for that Andretti-Cadillac F1 entry, I hope one day to see it come to fruition. But AI? That's coming, ready or not! I



Mark Skewis EDITOR

# FIA tells COP there is no one-size-fits-all solution to decarbonisation

# FIA reveals details of its role at Climate Conference. By Mark Skewis

**HE** Fédération Internationale de l'Automobile (FIA) attempted to inject some science and the voice of experience into the sound bites that flew thick and fast at the recent United Nations Climate Conference in Dubai.

The FIA Formula E World Championship has acted as something of a poster child for sustainable sport at successive COP events now. However, the FIA – which represents 80 million road users worldwide and is the voice of global motorsport – encouraged politicians and influencers to explore all technologies in the quest to counter climate change.

In an opening statement, FIA President Mohammed Ben Sulayem said: "At the FIA, we are committed to doing our part and making the most of our strengths. Thanks to our global network, we know there is no one-size-fits-all approach to decarbonisation. We are championing innovation, exploring all technologies with the aim to transfer advances from the track to the road, implementing sustainable practices within our federation, and pushing the limits for a low carbon future. We have set ambitious targets. We know this is just the beginning and we are embarking all our motorsport and mobility stakeholders on this journey."

# Agent of change

During a packed fortnight at COP28, the FIA ran a dedicated stand in the Blue Zone, hosted a motorsport and mobility sustainability event on Transport Day, launched Drive Change Today, a dedicated FIA Smart Driving Challenge for COP28, and participated in the promotion of ISO Net Zero Guidelines.

As the only sport represented in both the COP28 Green and Blue Zones, motorsport was highlighted as an agent of change in the fight against climate change with the FIA's activities being completed by events hosted by Formula E and Envision Racing Team.

With its unique position, the FIA asserted the importance of sport and mobility representation at the United Nations Climate Conferences and the pressing need for these to take centre stage in the global conversation.

COP28 was the opportunity for the federation to connect with stakeholders and policymakers from across the world, as it continues to pursue a safer, more sustainable, just and accessible mobility and motorsport future.  and set out their visions for this complete rethink – during the two panel sessions 'Determination in Action: Accelerating the Uptake of Sustainable Transport Solutions' and 'From Policy to Action: Leveraging the Power of Consumer Voices'.

In the first panel session, after an introduction by FIA Social Responsibility Manager Barbara Silva, FIA Formula E World Champion and UNEP Ambassador and Zero Summit Co-Founder Lucas di Grassi, Head of Japan Automotive Manufacturing Association (JAMA) delegate to COP28 Takao Aiba, and Professor of Mechanical Engineering at KAUST University Dr James Turner gathered to discuss sustainable

Motorsport has always been a catalyst for technological development, eventually transferring these advancements to consumer vehicles" Lucas di Grassi

The FIA hosted its own dedicated speaker events in the Green Zone for Transport Day. Hosted by Sky Sports' David Garrido, the events gathered inspiring and influential speakers from the worlds of motorsport and mobility.

A video on the FIA's commitment to building a sustainable future for motorsport and mobility was shared with the audience.

SAE Sustainable Mobility Solution President Frank Menchaca then took the floor for a keynote speech during which he set the tone for the event. He pointed out that "we are on the cusp of a new era in transportation" and urged audiences to participate in "a complete rethink of our engineering processes, supply chains, and regulatory standards."

Other speakers built on these arguments

technology development.

di Grassi highlighted the importance of transferring sustainability learnings from the track to the road. He said: "In my career, I have witnessed a rapid transformation in powertrain technologies. Motorsport has always been a catalyst for technological development, pushing the boundaries of what is possible and eventually transferring these advancements to consumer vehicles."

Takao Aiba agreed, and suggested that brands should also work together to accelerate the green transition. He noted: "Our journey in developing hydrogen technology is not solitary. We are seeing increasing interest and participation from various companies, indicating a growing collective commitment to sustainable automotive technology. This rapid

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ABOVE At COP28 the FIA's aim was to further discussion about the future of sustainable motorsport and mobility and foster collaboration with governments, businesses, NGOs, and other stakeholders development spearheaded by motorsport is paving the way for broader technological advancements."

Dr Turner warned that: "The path to sustainability is not straightforward. It involves a comprehensive approach, considering lifecycle analysis to achieve true tech neutrality. While electric and hybrid technologies are vital, they should not overshadow the potential of e-fuels and biofuels in our quest for a sustainable future."

During the second panel session introduced by FIA Sustainability Manager Asuka Ito, FIA Mobility Policy Commission President and Vice President Public Affairs of the Canadian Automobile Association (CAA) Ian

**Generation Stoday will define the trajectory** of our planet's health" Felipe Calderón

exploratory approach to ensure our success, rather than focusing on existing or accepted solutions, saying: "We must look beyond traditional methods and embrace a range of solutions, from electrification to alternative fuels, to effectively combat the looming threat of climate change."

### We need strong leadership

But Forseke cautioned that this kind of bold progress would require strong leadership. She noted: "To achieve meaningful change, we need leaders who are committed to sustainability. Their vision and determination will be pivotal in driving the sector

> towards a more ecofriendly and responsible future."

Audiences then heard from Ethara CEO Saif Al Noami who spoke

Jack, Sustainable Mobility Unit Head, Industry and Economy Division at the United Nations Environment Programme (UNEP) Rob De Jong and Chief Business Officer and Deputy CEO at Greater Than Johanna Forseke spoke about the importance of consumer contributions to this sustainable transition.

Jack emphasised the fact that: "This is a global challenge that calls for a unified response. By pooling our resources, knowledge, and expertise, we can accelerate the development of sustainable transport solutions that are both efficient and accessible to all." De Jong agreed. He urged audiences to take a more about his vision for a sustainable future, inspired by creativity and innovation. During an engaging session, he argued that: "In the quest for a sustainable transport future, innovation and adaptation are key. Our goal should be to create a system that not only reduces emissions but also enhances the efficiency and accessibility of transport for everyone."

FIA Environment and Sustainability Commission President Felipe Calderón concluded the session. He pointed out that: "We are standing at a crossroads where our decisions today will define the trajectory of our planet's health and our economic resilience."

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# **Historic Racing & Technology returns**

**HISTORIC** Racing & Technology, Race Tech's sister magazine, will return to print this month.

First launched in 2014, HRT brings a fresh perspective to classic and vintage motorsport, showcasing today's technology in yesterday's cars.

The magazine has been on hold for two years following the death of its founder and editor, William Kimberley.

"It is an honour to be publishing Historic Racing Technology for the first time in over two years. This magazine was founded and nurtured by the late, great William Kimberley, and now feels like the right time to bring back William's pride and joy," commented Peter Innes, the magazine's new editor.

"The historic scene has long faced

challenges adapting to ever-evolving materials – and attitudes – yet it keeps going from strength to strength. We will be bringing you insights into all its many beautiful, noisy guises."

Innes, former Grand Prix Editor for *Motoring News*, has worked for a number of Formula 1 teams. In recent years he has been involved in book publishing, whilst also working in motorsport at events like the Race of Champions.

"I've always wanted to revive HRT because William was passionate about historic motorsport," said Soheila Kimberley, Kimberley Media Group Publishing Director. "Peter cares deeply about the sport too and I am confident that the magazine is in good hands as we move forward."

### HRT ISSUE 28

- Le Mans-winning Porsche 962C
- Aston Martin Bulldog
- Sustainable fuels
- Jordan NASCAR Toleman F1

# E Technology



# Horseless to Hybrid: 2024 Festival of Speed to tackle power revolution

**THE** theme for Goodwood's 2024 Festival of Speed is to reflect the crossroads at which the motorsport industry finds itself regarding future methods of propulsion.

'Horseless to Hybrid – Revolutions in Power' will celebrate the essence of our love affair with motorsport. From the birth of organised competition, 130 years ago, with the Paris-Rouen Trial of 1894, the quest for speed has gone hand-inhand with developments in engines, propulsion and power. The 2024 Festival of Speed, from Thursday 11 – Sunday 14 July, will celebrate the many advances that have propelled us to where we are today, and look at what new ideas may drive us into the future.

The entry list for that Paris-Rouen event, on Sunday 22 July 1894, included vehicles powered by everything from steam, petrol and electricity, to gravity, compressed air and hydraulics, reflecting the fact that, in the early years of the 'horseless carriage', there was no consensus as to the best power source. After a century dominated by the internal combustion engine, we once again find ourselves at a crossroads, with electric, hydrogen, hybrid and sustainable fuels all offering potential solutions for a greener future. In 2024 the Goodwood Revival will serve as a landmark moment in motorsport history, as the entire weekend of historic racing is set to take place using sustainable fuel.

As well as remembering how far the automotive and motor racing industries have come in the past 130 years, 'Horseless



**ABOVE** The record-breaking pure electric McMurtry Spéirling is one of the machines that has highlighted the debate on future propulsion technology

to Hybrid' will, crucially, look ahead at what comes next. The theme will be reflected throughout the event, from the cars and drivers taking to the renowned Goodwood hill to immersive experiences in Future Lab presented by Randox, exhibiting some of the most innovative new technology. The Festival of Speed has long championed emerging technologies. In 2023 it welcomed four-time Formula 1 World Champion Sebastian Vettel as he drove his ex-Nigel Mansell 1992 Williams FW14B and ex-Ayrton Senna 1993 McLaren MP4/8 on sustainable fuel. Vettel brought his "Race Without Trace" campaign to Goodwood, encouraging the adoption of alternative fuels by both the motorsport industry and wider world.

The theme for this year's Festival of Speed presented by Mastercard emphasises Goodwood's commitment to the future of mobility at its headline motorsport events. Alongside this central theme, the 2024 Festival will mark a number of other significant anniversaries. It will remember the incomparable Niki Lauda, in the year he would have celebrated his 75th birthday, as well as 50 years since his first grand prix victory and 40 years since the last of his three World Championships.

The event will also honour the legendary Shadow team, 50 years after it won the final Can-Am championship, and Joest Racing, 40 years after its first Le Mans win, with many more celebrations to be announced in the coming months.

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# International Race of Champions to be revived

BELOW IROC

attracted the top

stars in its heyday

ASCAR Hall of Famer Ray Evernham is leading a bid to revive the iconic International Race of Champions (IROC) brand. Evernham and former Cup Series team co-owner Rob Kauffman have formed IROC Holdings, LLC and acquired the rights to the IROC brand, which went out of business in 2006.

Although best-known for his success as a NASCAR crew chief and team owner, Evernham owes his start in motorsport to IROC, which was put together in 1973 by Roger Penske, Les Richter and Mike Phelps, with Jay Signore running the day-to-day operations.

The successful IROC concept was for drivers from multiple forms of racing to compete in equally prepared cars. Evernham sought to revive that format when he co-formed the Superstar Racing Experience (SRX) with Tony Stewart three years ago.

SRX has completed three successful six-race, mid-summer seasons, although Evernham stepped back from any hands-on operation after the first campaign. Now, in the wake of his acquisition of IROC, it can be no coincidence that SRX has suddenly announced the cancellation of its fourth season.

"We entered the next phase of our racing series with great anticipation and excitement for what was ahead," said SRX in a statement. "Our expectations, however, have been tempered by market factors that have proven to be too much to overcome. Time has run out to put forth the kind of events our fans, partners, drivers and tracks deserve."

SRX's loss seems likely to be the reborn IROC's gain, but what's in store for the revived brand? The initial focus is on gathering the cars and drivers that competed during the series' history between 1974 and 2006, with an exhibition race said to be in the works.

BELOW Such was IROC's lure that Chevrolet even built an IROC Z production variant



The original series used Porsche Carreras in Year 1, but IROC went with American muscle cars thereafter: Chevy Camaro, Dodge Daytona, Pontiac Trans Am.

"Right now, we're looking at the historical part of the IROC series," said Evernham. "Stage one is to get an IROC reunion in place. Then we are going to reassess to see how much excitement there is, where we go with it.

"Initially it's about finding out where a lot of these cars have gone, bringing back some of the original drivers to get together and build excitement about



the series. Do some static and on-track displays before the end of the year.

"Get some IROC reunions going, get the cars back out, find out where they're at, see if they're track worthy, and work towards getting some kind of ontrack competition going with these vintage cars or cars that are built like the vintage cars.

"The most important thing we want to do is get all of the people who have these IROC cars around the country and around the world, get them together in one spot."

When news of the IROC acquisition first broke, SRX was a potential rival given the 'Thursday Thunder' TV audience it had acquired. But news of its cancellation could potentially accelerate Evernham's plans.

At its height, the original IROC series attracted the sport's biggest names. Each of the four races would be part of a NASCAR weekend, starting at Daytona and then three other high-profile tracks through the season.

Mark Donohue was the first season's champion, with Mario Andretti, A.J. Foyt (twice), Bobby Unser and both Al Unsers also winning championships.





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# Wave of departures hits FIA

**HE** growing unease between Formula 1 and the FIA was further highlighted last month by a flurry of departures from the governing body. Leading engineer Tim Goss, who was single-seater technical director, became the third senior figure to quit the FIA in quick succession. A well-respected figure in F1, Goss most recently laid his steadying hands on the flexi-aero dispute that rose to the surface at the Singapore GP. He is destined to rejoin an F1 team.

His resignation follows that of sporting director Steve Nielsen and the departure of the head of the FIA's commission for women, Deborah Mayer.

Sources told the BBC that Goss shared the same frustration with the internal operations of the FIA as Nielsen, as well as unhappiness over the process of creating the new technical rules that will be introduced in F1 in 2026.

The Fédération Internationale de l'Automobile has appointed Tim Malyon as Sporting Director within the Single-Seater Department. In his role, Malyon will oversee all sporting matters, including Race Direction and the Remote Operations Centre (ROC) in Geneva.

Malyon has a distinguished career in motorsport. He contributed to Red Bull's four Constructors' and Drivers' championships in the period 2010-2013, before spells at Sauber and BMW. He joined the FIA In 2019 as Head of Research and was subsequently appointed to the position of Safety Director in 2021. He was also integral to the establishment of the ROC and has performed the operational duties of ROC Project Leader since May 2022.

In confirming Malyon's appointment to the role

of Sporting Director, Nikolas Tombazis, the FIA's Single-Seater Director, said: "Tim has a wealth of motorsport experience and expertise at the highest level. He will play a major role as we continue to bring rigour to our sporting and regulatory practices and procedures, and he will drive the innovation we have brought to our Race Control operation.

"Tim has been pivotal in creating a strong synergy between Race Control and the ROC with the introduction of new technology including artificial intelligence and state-of-the-art data analysis and processing systems. He will continue to oversee advances in that area as well as taking the lead on the evolution of FIA sporting regulations."

Under Malyon's direction, Niels Wittich will continue in the role of Race Director.

Addressing the departure of Goss, Tombazis commented: "We are disappointed to lose a person of Tim's calibre from the organisation. Tim has played a major part in the Technical Department and has always operated to the highest level. We understand that his career is taking a new direction going forward and we support and respect his desire to pursue another path, and wish him luck for his future endeavours."

Of the loss of Nielsen, Tombazis said: "Steve has been a fantastic asset to the Single-Seater Department over the course of the 2023 Formula 1 season and has been part of a crucial year of development and positive steps forward in our activities. There is, of course, still a lot to do, and we will be building on these strong foundations over the coming years. We wish Steve the best for his next challenge." **ABOVE** The exodus complicates matters so close to the new ruleset for 2026 Advance Beyond CFD With On-car Aerodynamic Testing EvoScann® miniature pressure scanner range deliver:

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# Audi makes Dakar history

**AUDI** carved another motorsport technology milestone last month when its Audi RS Q e-tron became the first low-emission prototype with an electric drive ever to conquer the Dakar Rally.

From its conception, three years ago, the project has often been compared by the company's engineers to a "moonshot": nobody involved knew quite what to expect.

Where conventional rivals featured one engine, one gearbox and one cooling system, the complex RS Q e-tron has separate motor generator units (MGUs) front and rear, each with its own gearbox. There's then a lithium-ion battery with the associated power electronics and management system, a DTM-based combustion engine and a third MGU acting as a generator, plus cooling systems for each of those modules.

Much though the team chiefs played down expectations ahead of the event, with the programme due to conclude in this, its third year, ahead of Audi's F1 entry in 2026, the pressure was truly on. Little wonder, then, that emotions were running high after Carlos Sainz/Lucas Cruz secured Audi's first victory in the Dakar Rally after around 7,900 kilometres with a lead of 1 h 20 min.

Sven Quandt, Team Principal Q Motorsport, said: "It was a sporting competition that lasted three years.



We have made history with this concept and prevailed against the previous drive systems. It shows that Audi is ahead of the competition. This electric drive concept, which we spent three years improving, was exactly right."

"It is difficult to put this victory into words," admitted Rolf Michl, Head of Audi Motorsport. "We have written a piece of motorsport history. It will take a few more days for this to really sink in.

"This sport is also about luck. We lacked that last year. We had an amazing team that never gave up, even when we had setbacks. If you trust your team, they can even achieve the seemingly impossible. We overcame this challenge with long and hard work.

"Our winners Carlos and Lucas are both exceptional. Carlos is not only a top driver, but a legend with a big heart who cares about people, immerses himself in every detail and is never satisfied with himself." **ABOVE** Sainz and Cruz celebrate after dominating the rally marathon



# Formula E's India race axed

**INDIA** has lost what would have been its only FIA World Championship event this year after Formula E was forced to pull the plug on the Hyderabad E-Prix.

The move accompanies a legal wrangle that has erupted after a change to the local government.

The Municipal Administration and Urban Development Department (MAUD), under the control of the newly-elected government in the Indian state of Telangana, had made Formula E aware that it would not be fulfilling an agreement made last October to host the race. The event had been scheduled to run on Feb 10 and was part of a multi-year deal.

Formula E confirmed that it will not be replacing the Hyderabad E-Prix, reducing the season to 16 races across 10 events. The series also said that it has "been left with no choice other than to formally give notice to MAUD that it is in breach of contract," and that it is "considering its position and what steps it may take under the Host City Agreement and applicable laws."

"It is deeply frustrating that we cannot build on the success of the inaugural race last year, which delivered almost \$84m USD in positive economic impact to the region," said Formula E CEO Jeff Dodds. "We are also disappointed for our major Indian partners, particularly Mahindra and Tata Communications.



**ABOVE** Hyderabad's E-Prix was the country's highest profile race

"Racing in Hyderabad was important to showcase the benefits of adopting electric vehicles in a market where pollution from vehicle engines has a massive impact on public health and the environment."

Alberto Longo, co-founder and chief championship officer at Formula E, added, "We are extremely disappointed for the huge motorsport fan base in India. We know that hosting an official motorsport world championship race is an important and prestigious occasion for Hyderabad and the whole country.

"The president of the Federation of Motor Sports Clubs of India (FMSCI), Akbar Ebrahim, and his team have been incredibly supportive in bringing Formula E back to Hyderabad. They share our disappointment in the decision of the Government of Telangana, which means that will not happen."

The 2024 Hyderabad E-Prix would have been the second Formula E race in India in as many years. India previously held Formula 1 grands prix at the Buddh International Circuit near Greater Noida between 2011-13.





PoorValve

Good Valve

# Formula E still setting the pace in global sustainability rankings

**ORMULA E** has maintained its position as global leader for sustainability in sport, topping the Global Sustainability Benchmark in Sport (GSBS) report, the Sustainable Championships Index (SChI), and the Sustainable Motorsport Index (SMI) once again.

GSBS, the independent sustainability rating organisation, named Formula E top in four of the five award categories for sustainable performance from amongst the world's leading elite sporting organisations, published in its recent annual report.

The report included a comprehensive analysis of 55 of the most influential organisations in the sports industry, including: FC Barcelona, Manchester City FC, Real Madrid, the Premier League, Formula 1, NFL, WWE, Chicago Bulls, Boston Celtics, NY Yankees, Los Angeles Lakers, and UFC.

The GSBS assessment drew from nearly 500 organisations worldwide invited to participate in the initial assessment – including motorsport, football, tennis, American football, baseball, basketball, ice hockey, handball, and contact sports – representing the highest levels of Corporate, Environmental, Social and Governance (CESG) activity across professional sports.

Formula E was awarded Best Total Performance 2023 (jointly with Borussia Dortmund) for the second year running and was ranked highest in Best Corporate Performance, Best Social Performance, and Best Governance Performance.

Formula E also built on further success in the third edition of the SChI, being crowned the most sustainable global motorsport for the third consecutive year.

The SChl, an initiative run by Enovation Consulting, supported by University College London, assesses the sustainable performance of 106 motorsport championships. Assessments are carried out against six key markers of sustainability: Certifications, accreditations and awards, environmental criteria, social criteria, engagement and partnerships, and approaches to sustainability.

The ABB FIA Formula E World Championship significantly outperformed its competitors, securing four prestigious cups and clinching the leading position in the Index, surpassing the FIA Formula One World Championship.

Julia Pallé, Vice President, Sustainability, Formula E, said: "We are proud to keep raising the bar in the

global standard for sustainability in sport. Sustainability has been at the core of our championship since its inception, and we are determined to build on our commitment and capabilities year after year.

"Topping the charts once again reinforces that entertainment and sustainability can coexist without compromise."

• Of the top 55 influential organisations of the professional sports industry that were ranked by GSBS, Extreme E was joint-fifth overall and joint-second in motorsport disciplines - just behind frontrunners Formula E. The pioneering off-road series was ranked ahead of other worldwide championships and organisations, including sporting giants UEFA, FIFA, NFL and Formula 1. Ali Russell, Managing Director at Extreme E, said: "It is hugely important for us to have our sustainability efforts recognised by our peers, and so to receive this GSBS rating and recognition once more is a great achievement for Extreme E. As a series about to embark on only our fourth season, to be ranked above long-standing global brands in motorsport and beyond is testament to our ethos and core value as a sustainable championship for purpose. It also demonstrates that our environmental and sustainability actions have remained consistent as we have scored highly across the sports industry more widely."

**BELOW** Independent evaluations reinforce Formula E's position as global leader of sustainability in sport



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# Indy Autonomous Challenge to attack Goodwood hill

**THE** Indy Autonomous Challenge (IAC) announced at the Consumer Electronics Show (CES) that it will return to the Goodwood Festival of Speed this summer.

At the 2024 event, the IAC will extend its presence from the Future Lab, to the iconic Goodwood Hill to undertake a special hillclimb challenge that will be revealed in the coming months.

IAC is a competition designed to advance technology that accelerates the commercialization of fully autonomous vehicles and the deployment of advanced driver-assistance systems (ADAS), as well as a platform for students to excel in Science, Technology, Engineering, and Math (STEM) and inspire the next generation of innovators. Its ambitions fit the Festival of Speed's evolving FOS TECH strategy to bring together technology and future mobility content. FOS TECH aims to serve visitors, press, brands and digital viewers with immersive and accessible content, reinforcing the Festival of Speed as the platform to explore and celebrate a vision for tomorrow's world.

The Indy Autonomous Challenge first appeared at the 2023 Goodwood Festival of Speed in Future Lab, an exhibit which brings together inspiring innovators who are at the very forefront of creating 'Technology for a Better World'. The IAC exhibited as part of the 'Mobility on a Mission' showcase, with their car on display to promote the capability of autonomous racecars to event goers.



At the same time, members of three IAC university teams conducted numerous ground scans and digitally mapped the Goodwood hillclimb in preparation for this year's exciting challenge.

Speaking at the CES press conference in Las Vegas, Paul Mitchell, IAC President, said: "We can't wait to head back to Goodwood in July with the world's fastest and most advanced autonomous racecar. Goodwood provides a historic venue to showcase the future of high-speed autonomous mobility and connect a global audience to the talented university teams developing cutting edge AI driver software. We're excited to be a part of the Festival of Speed's growing FOS TECH content and let people get up close to the latest and greatest in innovation and technology." **ABOVE** The IAC's autonomous assault if part of the Festival's ambitions to diversify content

# Extreme E extends Continental deal

**EXTREME E**, the pioneering electric off-road racing championship, has renewed its partnership with Continental, the championship's official tyre supplier and Founding Partner.

Continental is one of the world's leading tyre manufacturers and employs over 56,000 people globally.

The German tyre brand developed its most advanced CrossContact off-road race tyre yet last year, boasting 43 per cent recycled and renewable materials. Among the materials used in its manufacture, is silica obtained from the ash of rice husks, waste material of agriculture as well as polyester yarn from recycled PET plastic bottles.

Ali Russell, Extreme E Managing Director, said: "Continental shares our commitment to environmental sustainability and innovation. Continental's continued dedication to creating bespoke tyres that perform exceptionally in the world's harshest terrains aligns perfectly with our mission to drive change through motorsport. Their unwavering support plays a pivotal role in the success of Extreme E and the message we aim to convey." III

**BELOW** Continental's CrossContact off-road race tyre features 43 per cent recycled and renewable materials





# Saudi PIF bonanza hits electric motorsport

FROM soccer to golf, and boxing to snooker, Saudi Arabia's influence is transforming sport. Formula 1 has already felt its lure and now electric motorsport is firmly in its sights.

Saudi Arabia's Public Investment Fund (PIF) has unveiled a multi-year partnership, Electric 360, with Formula E, Extreme E and E1 to support the growth of electric motorsports and their role in advancing the future of electric mobility.

A statement said the new partnership will 'draw together initiatives that underscore the power of electric motorsports to drive technological innovation, and revolutionize sustainable transport and future mobility while leading the way in carbon reduction.' Bloomberg has revealed that PIF already owns significant shares in the three electric series, with motorsport's increasing sustainability credentials

resonating with Saudi Sarabia's ambition to become the giant of renewable energy. The PIF said the partnership will support the mission-driven objectives of all three series by enhancing Formula E's proven race-to-road transfer model and reinforcing its position as the world's most sustainable sport, enabling Extreme E to forge new frontiers and spearheading E1's

LEFT The PIF has

a hand in all three electric series



revolutionary drive around marine mobility. Alejandro Agag, Founder and Chairman of Formula E, Extreme E and E1, said: "This one-of-a-kind partnership with PIF is a huge milestone for us in our journey to pioneer the most cutting-edge sustainable transport technology. With so many examples of the positive real-world impact of each series, this 360-partnership takes our potential to the next level.

"PIF will not only play a strategic role in helping us leverage our unique technological platforms, but also foster global collaboration, education and skills development for the next generation worldwide."

Mohamed AlSayyad, Head of Corporate Brand at PIF, said: "Together with these championship series, Electric 360 will redefine electric sport and supercharge its growth, delivering tangible impact aligned with our broader business strategy as PIF drives new green technological innovation that will be the cornerstone of future electric mobility."

# Changing of the guard at **Gibson Technology Ltd**

**GIBSON** Technology Ltd, the engine throughout 2024 and beyond. manufacturer at the heart of the LMP2 success story, has made a change to its senior leadership team.

In order to focus on his recouperation following a period of ill health, company founder and Chairman Dr Bill Gibson has appointed Mark Brittan as interim Managing Director.

Brittan has a long-term involvement within the Gibson family business, and currently holds the position of Managing Director of Gibson Power Systems Ltd.

As Bill Gibson's son-in-law, Brittan's appointment to this new role fits perfectly with the Gibson family business ethos, and along with the support of the longstanding directors and Senior Management Team, should ensure a seamless transition of business activities

The company recently won the FIA tender to provide the engines for a five-year period from the beginning of the new LMP2 rules cycle in 2026. The powerplant will be a 4.2-litre normally-aspirated V8, the same configuration as the spec GK428 unit it has supplied for the current P2 formula that began in 2017.

The FIA statement confirming Gibson's continuing role in the P2 prototype category read: "The tendering procedure took several factors into account, such as performance, weight and reliability, running and maintenance costs of the unit, spare parts cost as well as the bidding company's infrastructure and customer service abilities, its sustainability, plus its environmental and carbon footprint."

• TOYOTA Gazoo Racing Europe technical director **Pascal Vasselon** will be stepping back from operational duties for the 2024 season as the Cologne, Germany-based team reviews its management organization.

Vasselon's role will be filled for the season by David Floury, who dovetailed race engineering roles with Toyota while serving as ORECA technical director for several years before moving to Toyota full-time in 2021. Vasselon's technical leadership delivered Toyota six World Manufacturers' Championship wins and five consecutive Le Mans 24 Hours victories between 2018–2022.

• **GUENTHER STEINER**, Haas Team Principal for the past 10 years, insists his celebrity status on 'Drive to Survive' did the team more good than harm but admits he was surprised when he was informed by Gene Haas that his contract was not being renewed. Steiner had argued for more investment to be made as the team's business model was being left behind by the pace of change within F1. The new Haas team principal is former director of engineering Ayao Komatsu.

• MERCEDES technical director James Allison has signed a long-term contract extension with a view to helping the team back to the top of Formula 1.

19



# At the prestigious Royal Automobile Club London



The best I have participated in. Very interesting topics; I especially welcome the Al subjects, which were highly innovative. I like the spirit and the ambience of this symposium: friendly in the form, serious in the way the subjects are treated; where questions, answers and discussions are really open and where the debates are real. It is also a good opportunity to network and really useful to see a mix of young and more experienced engineers sharing their ideas."

# Bernard Niclot, ACO Consultant









# **Get ready for... A NEW A NEW**

Al will change the world, so what role will motorsport play? **Chris Pickering** talks to the experts behind PhysicsX, a company using deep learning to replace simulation

**HE** world may be on the brink of a new industrial revolution. As mankind attempts to harness the power of artificial intelligence, there are predictions that it could be used to solve climate change, resolve conflicts and cure cancer.

Others see it taking an altogether more dystopian path. More Skynet than saviour. What most seem to agree on is that the potential for this new technology is huge.

"This is an unavoidable transformation that's coming in industry. It's happening already. The question is, can motorsport be part of this or not?" asks Robin Tuluie, founder and co-CEO of PhysicsX.

Headquartered in London, the company is home to more than 50 scientists and engineers building Al software to replace advanced simulation. Tuluie is perhaps best known for his time in Formula 1, where he led the R&D team that took Renault and Fernando Alonso to back-to-back world championships in 2005 and 2006. In 2011, he joined Mercedes F1 as head of R&D and chief scientist, adding another two world championships to his resume. A stint at Bentley Motors as vehicle technology director followed, which included working with Ducati's MotoGP team, before he founded PhysicsX with fellow simulation specialist Nicolas Haag, later joined by computer scientist Jacomo Corbo as co-founder and co-CEO.

But Tuluie's first window into the power of simulation came a long time ago and (in a manner of speaking) from a galaxy far, far away. He began as a theoretical physicist researching general relativity and its effects on the cosmic microwave background radiation – the cooled remnants of the first light that spread through the universe following the Big Bang.

Pretty soon it became apparent that theoretical methods weren't sufficient to solve some of the equations that



### BELOW Artificial Intelligence is emerging as the next big battleground in Formula 1, where the top teams already have technical

partners in this field

Tuluie and his contemporaries were dealing with, so computer simulations using finite difference methods became the next step.

"One of my simulations predicted that there should be small-scale dipole moments in the cosmic microwave background radiation. Nobody had postulated that at the time, so I thought my simulation was wrong," Tuluie recalls. "I kept debugging the simulation and working on it, but the effect did not disappear. And then finally the insight came as to the physical cause. The simulation correctly predicted new physics, even though it went against our understanding of the physics at the time, and that realization was extremely powerful."

After academia, Tuluie joined US engineering giant MTS Systems. It was there, in 2002, that

he first encountered artificial intelligence, with shallow neural networks used to represent damper and tyre models. Later, at Renault F1, the team started incorporating machine learning optimisation into its physics models. Notably, this helped to develop the tuned mass damper system that the team used to such great effect in 2005, as well as concepts for hydraulic ride height control and interlinked suspension.

### Machine learning meets simulation

More work on multi-physics simulation and machine learning optimization followed at Mercedes and then at Bentley. The results were compelling, and PhysicsX was founded in 2019 to exploit the synergies between machine learning and simulation ►

**FF** This is an unavoidable transformation that's coming. The question is, can motorsport be part of this or not?"



If you can make a synthetic fuel generation process more efficient – which we've done by a factor of three in one project – then it can really help the climate transition"

- and eventually the wholesale replacement of simulation by deep learning.

"It's almost sacrilegious as a physicist to ignore the equations and start living off the data without having solved the underlying physics," comments Tuluie. "But we approached this with a healthy degree of scepticism, and over time, as more proof points emerged, that scepticism disappeared and turned into an opportunity."

The PhysicsX engineers weren't the only ones who were sceptical. The company's head of customer success, Amir Vaziri, recalls working with customers who were new to the technology: "We were working with a group of top tier engineers who would go through simulations that would take maybe 20 hours on 100 cores. And then, with AI, they eventually got to a point that they would be able to see the performance of the system they'd designed in less than a second. It was like magic. Initially they were a little hesitant, but having discovered how it works, they are now big proponents of AI in engineering."

# **Machine intuition**

Part of the reason that AI can seem so mysterious is that it doesn't rely on fundamental physics or predetermined logic to reason through problems. In a pure AI model, the system builds its predictive capability by spotting subtle patterns in training data and learning to interpret them. The process is



LEFT & BELOW Tuluie led the R&D team that took Renault and Fernando Alonso to back-to-back world championships in 2005 and 2006. The squad started incorporating machine learning optimisation into its physics models, a technique harnessed to develop the tuned mass damper it used to such great effect akin to human intuition. For want of a better term, it just *knows*.

The right algorithm trained on the right data can be remarkably accurate and far faster than crunching through the numbers in a traditional simulation. However, one of the downsides is that it's impossible to reverse engineer the AI model and understand how it's reaching its conclusions. Initially, this can seem like a leap of faith compared to traditional techniques, but Tuluie points out that the situation is not actually that different.

"In reality, this dichotomy already exists in numerical simulation," he comments. "While we may have the physics, there are many adjustable factors. If I do a CFD simulation, I have to choose my turbulence model, which is approximate, I may have to choose source terms, I have to choose my meshing strategy ... There's so much that an engineer has to decide on, and there's no fundamentally right or wrong way to do it."

Usually, the way this is optimised is by comparing the CFD model to wind tunnel data and then tuning the simulation variables until the two correlate.

"The results that you get from a CFD simulation are valid within the data set [from the correlation exercise] and a bit beyond. But the validity range can be quite limited, especially if the air flow is transitional," says Tuluie. "So, as scientists, from day ►





one we are used to the fact that our simulation isn't perfect. If it throws up something new you have to question it and investigate whether it's real."

The same is true for data-driven models, he points out: "Perhaps they don't extend quite as far into extrapolation as a simulation does, but they still deserve to be validated against good data, and that's what we do."

### Withholding data

One of the ways this is achieved is to deliberately withhold parts of the data set from the training process. Tuluie says that 80 to 85 per cent of the available data is used to train a typical model, but the points that are withheld – which could be alternative geometries or operating conditions – are then used to test the model on scenarios that it's never seen before. "Using this approach we can understand whether our models are accurate or not and establish that trust on a statistically fair basis," he notes.

It's almost sacrilegious to ignore the equations and start living off the data without having solved the underlying physics" ABOVE There will be a scramble among teams to find applications for Al. Computational Fluid Dynamics, one of the most computationally costly areas of motorsport, will inevitably be a target Given suitable training data, Al can replace conventional simulation completely. It could even be argued that it's simpler, because you don't need to understand the exact physics that's taking place to predict the outcome. However, it doesn't need to be an all-or-nothing approach. Traditional simulation models, experimental results and Al can all be combined.

"If you have enough of the right type of data, you can completely replace a numerical physics model by a data-driven, deep learning model. In that scenario, the model doesn't need to know anything about the physics," comments Tuluie. "In another approach, you can exploit knowledge of the underlying physics equations, together with some data, and use a deep learning model to find the solution, with what's referred to as a physics-informed neural network. Those two solutions are the two bookends of this approach, but then there's everything in between."

### Hamstrung

And so we return to the opening question. Can motorsport embrace AI and even help to accelerate its development?

"Motorsport is hamstrung by the desire to provide a level playing field and there's a concern that a new technology like AI could stretch the gaps between the slow teams and the fast teams," comments Tuluie. "But the fact is that motorsport has to recognise these

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developments and it should not just adapt to them but lead them. That's what motorsport used to do. It used to lead things like traction control, seamless shift gearboxes and the use of virtual development. The best thing is to have an urgent discussion around AI and how we should manage that."

That's not to say that Al is completely absent from motorsport. It already has a presence in the sport – notably in race strategy, where it's been playing a part for nearly 20 years. But Tuluie believes there is the potential to go a lot further.

The most computationally costly area of motorsport at present is CFD simulation. There are certainly applications for AI here, but Tuluie questions whether it would be the most beneficial area to apply them: "Under the current regulations, you can't extract the full potential of replacing CFD simulations with deep learning models, because the number of geometries that you can evaluate is limited by regulations and the amount of computational time you have to generate the training data for the models is also limited."

There's also a more fundamental question of its industrial relevance, he points out: "Some areas of Formula 1 aerodynamics are really quite specific to those particular vehicles. On the other hand,



ABOVE & BELOW As Chief Scientist and Head of R&D at the Mercedes F1 team, developing innovations with multi-physics simulation tools and machine learning optimizations, Tuluie helped build one of the most successful F1 teams of all-time







Formula 1 has taken some great steps with things like hybrid powertrains and synthetic fuels for 2026. Here, Formula 1 is pushing the frontiers in areas that are very relevant to wider industry, and it does so on a very fast development cycle. In the automotive world, it takes you five years to develop a new platform; in Formula 1, it's a year."

This pace of development clearly appeals to the ever-inquisitive Tuluie. "The best thing about motorsport is that you have a theory one day, and you'll find out on Sunday if it works," he enthuses. "It's just a fantastic laboratory to iterate things quickly, whether that's AI or conventional simulation or advanced manufacturing techniques."

### Angels and demons

Al relies on high performance computing facilities, which can be costly and energy-intensive to access. Nonetheless, once a model is properly trained it is four or five orders of magnitude more efficient than conventional simulation techniques such as CFD, let alone physical testing in a wind tunnel. As such, ABOVE Beyond the scare stories, AI will be a force for good in many sectors, including the medical profession there's a strong argument for encouraging its use in motorsport, albeit with a framework to ensure that the resources are within reach of all teams across the grid.

Few people would argue that the use of AI in motorsport poses any great danger to the outside world – quite the opposite if it could accelerate the development of low carbon powertrain technologies or safer vehicles. But not all of its potential applications are quite so altruistic.

"My view is that there are certain AI technologies that definitely merit being regulated," comments Vaziri. "Things like deep fakes and GenAI have the potential to change so much and to create so much misinformation that it could really impact society in a negative way if it's not controlled.

"But then there are also areas where we think it could do a lot of good. If you can make a wind farm more efficient by just one per cent then that's a lot of free power. Likewise, if you can make a synthetic fuel generation process more efficient – which we have done by a factor of three in a project with one of our customers – then it can really help the climate transition. The huge potential to use Al for good sometimes gets lost a little bit in these discussions."

Quite how the world will be able to maximise the constructive use of AI without taking any risks around its more malevolent applications remains to be seen. What is clear is that we're not just peering into the future. This technology is real, and the revolution may already be here.



# **Gary Watkins** reports from the Rolex 24 at Daytona, where the new Corvette and Mustang joined the boisterous GT3 party

**O OTHER** category in the modern era of motorsport has enjoyed such a global reach as GT3. That reach has grown yet further in 2024, and not just because it has been adopted by World Endurance Championship and therefore the Le Mans 24 Hours.

Two of the biggest manufacturers in the world, both with rich competition pedigrees, have belatedly joined the party in season 19 of the class. General Motors has arrived with the Chevrolet brand's Corvette Z06 GT3.R and Ford with the Mustang GT3.

It is no coincidence that they have finally jumped into a crowded arena in which Ferrari, Porsche, Lamborghini, Mercedes and more compete at the very same juncture, both cars making their debuts in January's Daytona 24 Hours IMSA SportsCar Championship curtain-raiser. And it made sense for the two manufacturers to join the category for many of the same reasons.

The scope of GT3 has expanded with its adoption by the WEC after a two-year phase-out of GTE: GTE Pro disappeared at the end of 2022 and regular GTE for pro-am line-ups at the climax of last season. It means, crucially, that Chevrolet, Ford and their new rivals can take on the challenge of the most important sportscar race of them all at Le Mans using the customer team model that is at the heart of the category. Factory teams are not permitted in what will be known as LMGT3 in the WEC and its sister European Le Mans Series, but they are in the North American IMSA SportsCar Championship in the GT Daytona Pro division. That was a significant factor in the decision-making process for both Chevrolet and Ford.

Manufacturers, of course, go racing to showcase their products and the shift in the sands of sportscar **>** 







racing more of less coincided with the launch of new models from both manufacturers: the latest Corvette to wear the halo Z06 badge, the mid-engined C8 version, went on sale in 2022, while the seventh-generation Mustang has arrived in the 2024 model year.

Yet there are key differences in how Chevy and Ford got to this point. The Mustang programme is all-new, Corvette's an extension of an existing one that had already stretched into the latest era in North America. It was allowed to race on against GT3 machinery with its GTE-rules C8.R Corvette in down-specced form in GTD Pro for the first two seasons of the class in 2022 and '23.

It would be wrong to interpret Chevy's decision to build the Z06 GT3.R as a like-for-like continuation of Corvette Racing campaigns that began back in 1999 with

**GG** Disquiet about the costs of the American cars feeding inflation in the category"

the debut of the C5-R GTS racer at Daytona and then got up to full steam the following year with an American Le Mans Series attack and the first of its appearances at Le Mans. That run continued unbroken until last season, with the exception of the 2020 COVID year. But it wouldn't be quite correct to say that the Z06 GT3.R is a direct replacement for the C8-R.

### Iconic muscle car

The Corvette programme, as was, straddled four generations of the iconic American muscle car, two different classes (GTS/GT1 and GT2/GTE) and five distinct racing cars. It was a full-on works engagement. Corvette Racing, run by the Michigan-based Pratt Miller organisation, developed the cars and went racing. The sale of Corvettes to customers was never anything more than an afterthought for Chevrolet. With one exception, the cars raced by the likes of GLPK/Carsport Holland and Phoenix in the FIA GT Championship in the 2000s and in the 2010s by Larbre Competition in the WEC's GTE Am division were factory chassis that were surplus to requirements. This time, it's quite different.

That explains why Laura Wontrop Klauser, whose responsibilities as sportscar racing programme manager at



ABOVE LEFT & RIGHT Although the new cars were entrusted to factory drivers at Daytona, both the Mustang and Corvette development programmes have focused on the driveability required for the customer teams

**RIGHT** A works Corvette, along with the eventual class-winning Ferrari, fights for real estate in the midst of a packed GT3 field

GM encompass its activities with the Corvette and Cadillac's V-Series.R LMDh prototype that competes in both IMSA and the WEC, says the decision announced in November 2021 to make the leap into GT3 "wasn't taken lightly". Chevrolet isn't just going racing as a factory in the GTD Pro; it is also building cars for customer teams that will race around the globe. It has to. The requirement to sell 20 cars over the first two seasons of a new GT3 contender was firmed up in the new ruleset introduced in 2022. GT3, its architect-in-chief Stephane Ratel has always insisted, is first and foremost a customer racing platform.

"We were really excited by the opportunity as the Corvette road car goes more global to have a race programme that complements that," explains Klauser. "Was the time right to go to the customer GT3 platform? The answer was yes. There was clearly the influence that our core programme in GTE, and GT2 and GT1 before that, was no longer available, but what IMSA did by having the GTD Pro class was really great. We could keep a presence with a factory-supported team with Pratt Miller, which was important so they can continue to hone the car – and that only makes our customer programme stronger.

"It was kind of perfect timing given where >





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we were with the production car and how close the tie-in is with the Z06 road car. It seemed like the stars aligned."

Ford offers a similar response to the question, 'why now?' Mark Rushbrook, director of Ford Performance Motorsport, explains that the chance to go racing around the globe with the new Mustang, which he points out is the world's best-selling sportscar, presents an "opportunity to tell a very compelling story about our product".

The Mustang GT3 follows on from the Ford GT GTE/GT LM class racer of 2016 to '19. That car and the successes it achieved whet the Ford appetite for GT racing at the highest level, says Rushbrook. The 2016 Le Mans GTE Pro class winner that subsequently took top honours in GT LM at Daytona – but never took a championship title in either WEC or IMSA – laid the ground for the GT3 entry.

"We loved the race programme with the Ford GT," says Rushbrook. "At the time with the two separate GT classes it limited what we were able to do. We were always watching for or hoping to see the global

# Do Ferrari and Lamborghini want to be beaten by cars that cost just a fraction of their road car?"

convergence of the classes. We were looking for the right opportunity to continue in global sportscar racing. When we saw that convergence would be happening, when we saw GTE/GTLM would be ending and there would be an opportunity with GT3 to race around the world in so many great series, including as a factory in IMSA and customer racing everywhere else, it made it a very interesting place.

"It was very good timing in the sense that we had the all-new seventh-generation Mustang coming out. It all did come together. I wouldn't say it was necessarily a no-brainer, because there was a lot of hard work to get it approved. But it was approved,

### **RIGHT & BELOW**

Both brands have class-winning history at Le Mans. Ford's emotional success in the GTE Pro class in 2016 (right), on the 50th anniversary of its 1-2-3 triumph in 1966, whet its appetite for GT racing, while the Corvette dynasty captured its ninth class win in the C8.R's final race at Le Mans last season





and here we are."

Ford took the lid off its GT3 entry with the Mustang at the Daytona 24 Hours, the opening round of the IMSA series, two Januarys ago. Just over a year later came the revelation that it would be partnering with Red Bull Racing to return to Formula 1 in 2026 for the first time since the end of its five-year involvement with the Jaguar brand in 2000-04. F1 and customer-led GT3 racing at the opposite end of the spectrum are part of a wide portfolio of motorsport activities undertaken by Ford that mean it has all the bases covered.

The Blue Oval has what he describes as a "quadrant strategy" when it comes to motorsport. F1 is one quarter of that plan, its rallying activities in the World Rally Championship with M-Sport and now also at the Dakar Rally and a line of electric demonstrators – SuperVan 4 that debuted at the 2022 Goodwood Festival of Speed included – represent two more.

Going racing with the Mustang makes up the final 25%: the sportscar is not only racing in GT3, but also in GT4 with a new-for-2024 machine, V8 Supercars in Australia and in NASCAR, where the company has swapped to the Mustang silhouette for 2024. Then there's also an involvement in National Hot Rod Association drag racing and a new onemake series sanctioned by IMSA.

### **Multimatic magic**

Ford has again partnered with Canadianheadquartered Multimatic Motorsports for the project. It developed both road and race versions of the Ford GT and ran the car in WEC. It was a Multimatic team running out of workshops near Silverstone even if the name on the entry was Ford Chip Ganassi Team UK; the 'real' Ganassi team ran only the IMSA cars.

Now, Multimatic has been responsible for turning the latest Mustang into a GT3 car and will run the factory GTD Pro team in IMSA from its facility in Mooresville, North Carolina. The race version of the Coyote V8 in the GT3 car has been the responsibility of M-Sport, a company well versed in GT3 from its days developing, building and running two generations of Bentley's Continental. It is also a partner in the Dakar programme along with the South African organisation Neil Woolridge Motorsport.

"Ford really is a family company, so when you are starting a new programme you naturally go to the people who've worked really well with you in the past and have delivered," explains Rushbrook. "We have such a great relationship with Mutlimatic as a company and the individuals involved that goes across a lot of motorsport programmes but also a lot of road programmes. Larry [Holt, Multimatic's Motorsport boss] and his team were the first call."

And the call did go that way: from Ford HQ in Detroit to Multimatic in Toronto. Just like it did with the Ford GT, recalls Holt.

"I was thinking coming up to the 50th anniversary of Ford's 1966 Le Mans victory that the time was right for them to do something, but it wasn't actually my idea – they came to me," says Holt of the project that resulted in the Ford GT after a brief look at what could be done with the Mustang to the GTE rules. "This time it wasn't me saying we should do a GT3 on the new Mustang, they came knocking on my door again."

Multimatic, it should be pointed out, >



had always had a keen interest in both the GT3 class and going racing with the Mustang. Multimatic has previously built two versions of the car to GT3 regulations with Ford blessing rather than backing, one developed out of its FR500C involved in what was then known as the Grand-Am Cup raced the FIA GT3 European Championship in '08 complete with a live rear axle and then a much more advanced car commissioned by the Belgian Marc VDS operation that took to the track in 2011. He reckons there have been something approaching 10 Multimatic Mustang racers from a first car that raced domestically in Canada to the GT4 variant based on the generation-six car that took class honours in last year's British GT Championship.

The sale of Corvettes to customers was never anything more than an afterthought for Chevrolet"

The arrival of the Mustang and the Corvette in GT3 hasn't been without controversy, just like that drawn to another American car built for the category in the mid-2010s. Cadillac's ATS-V.R GT3, built by Pratt Miller back in the days when it still had an ampersand in its name, played an important role in Ratel's drive to introduce the 20-car rule. That was another overt factory programme aimed at the Pirelli World Challenge in the days it was still run under the auspices of the Sports Car Club of America before its takeover by Ratel's eponymous organisation. Fastforward 10 years, and Ratel admits to some disquiet about the costs of the American cars, which he believes is feeding inflation in the category.

The list prices of the two US-built machines are some way above the price point of the machinery from many of the European manufacturers. Ford doesn't list a price for its car, though it is known to be on a par with the US\$735,000 less taxes quoted by Chevrolet. By comparison, BMW's M4 GT3 comes in at €479,900 (\$518,000), with €523,000 (\$563,000) for the 992-shape Porsche 911 GT3 R. The new-for-2024 evolution version of the Aston Vantage GT3, it should be pointed out, is on a par with Mustang and the Corvette : it is listed at £575,000, which equates to \$716,000 or €674,000. "The majority of the cars we had on the grid last year at the Spa 24 Hours were sold for somewhere around €400,000, so these new cars from America are definitely significantly more expensive," he says. "My question is whether, and how long for, the market can support that.

"We've seen so many times before that as the cars get more complex and expensive, grids go down, but at the moment our grids are oversubscribed. So maybe I am wrong to be worried."

Klauser is choosing not to get involved in this debate on rising costs, but Holt insists that the Ford is competitive on price and that a like-for-like comparison has to be made. He explains that the \$US700,000-plus cost of a Mustang includes the spares and engineering support necessary to run it for a season.

Ratel also has a concern that the Mustang is 'the wrong kind of car' for GT3. One of the other pillars of which he talks is that the category should be for premium machinery – he has used the term "dream ABOVE The GT3 Mustang's Daytona debut is the latest development in a plan that sees the sports car race in multiple categories and on different continents

# ABOVE RIGHT

Charismatic Multimatic boss Larry Holt has been instrumental in the Mustang program. Multimatic will run the factory GTD Pro team from its North Carolina facility

**RIGHT** The Pratt Miller Motorsports Z06 GT3.Rs ran strongly, but both had hit trouble by the 19-hour mark


cars" many times over the years. He argues that a Mustang, which retails for around \$30,000 in its base form – with a four-litre turbo rather than a V8 – doesn't conform to that idea. He compares it with BMW's use of the M4 – which is effectively the new M3 – as another example of what might be described as a dubbing down or downgrading of GT3.

#### **Risk for GT3**

"For 20-odd years, we said the M3 was not eligible because it was a touring car and now suddenly we have the M4," he says. "I'm not a fan, because do Ferrari and Lamborghini want to be beaten by cars that cost just a fraction of their road car? You could imagine someone at board level asking, 'Do we really need to be beaten by a Mustang or a BMW? That is a risk for GT3." Rushbrook points out that there is a premium Mustang costing in excess of \$300,000. It is known as the Mustang GTD and is effectively a road version of the GT3 car. (Ford couldn't call the car a GT3 because that name is trademarked by Porsche.)

Yet Ford and Chevrolet do appear to be eager participants in GT3 and ready, willing and enthusiastic to sell cars to customers. Both will be represented in WEC this year, with Proton Competition and TF Sport respectively, and have already announced additional customers. Further announcements, both say, will be made over the course of this year.

"We've got nothing to announce just yet," says Rushbrook, "but if we had 20 cars sitting here today we could sell every one of them."



# HON WE NON DAKAR

Audi's electrically-driven RS Q e-tron took on – and beat – traditional technology in the most extreme environment in the world. **Chris Pickering** finds out how they did it

**OR** drivers, the most elusive title in motorsport is the celebrated Triple Crown – winning the Le Mans 24 Hours, the Monaco Grand Prix and the Indy 500. Even stretching back to the 1960s, when top drivers regularly swapped seats from one series to the next, only one person has ever managed to achieve it (Graham Hill) and only one current driver (Fernando Alonso) has a realistic chance of joining him on this hallowed, if entirely hypothetical, podium.

But what if there was an alternative triple crown for manufacturers? One that focused on the more innovative and unusual corners of motorsport. Le Mans would surely still be in there as one of the supreme tests of speed and endurance. Perhaps the original Pikes Peak Hillclimb too with its dizzying altitude, mixed surfaces and 156 bends. And to finish, the 14-day 8,000 km marathon that is the Dakar Rally.

At one point, Carlos was just 14 minutes ahead of Loeb. He said, 'Tomorrow we need to push; we can't afford to be conservative'. The following day, he was a rocket!"

Audi has done all these things, and in some style. It shattered the Pikes Peak record with the four-wheel drive Sport Quattro S1 in 1985, ushering in a period of Group B dominance at the American event; it rendered the petrol-powered opposition obsolete overnight when it brought diesel to Le Mans; and now it has become the first manufacturer ever to win a major international event with an electrically-driven vehicle competing against IC-only opposition.

It's true that the Bavarian manufacturer has brought a vast wealth of expertise and the not-inconsiderable resources of the Volkswagen Group to all of these victories – sometimes against much smaller independent teams. But rather than choose the



easy way out, it has consistently challenged itself to do things differently. To push beyond the status quo.

That was certainly the philosophy with the recent Dakar victory, as the team's technical director for the project, Dr Leonardo Pascali, explains: "Winning the Dakar meant a huge amount to the team. It's a demonstration that an electrically-driven vehicle can compete against – and beat – traditional technology in the most extreme environment in the world. To do that is a tremendous achievement – not just for the team that was there this year, but also for those who defined the concept and developed it previously."

It's often said that winning a major international motorsport event is a three-year programme,

and so it's proved for Audi at the Dakar. The RS Q e-tron showed promise on its debut in 2022, but it was hampered by weight, navigational issues and suspension durability. A heavily revised version arrived in 2023 but bad luck struck again, forcing Carlos Sainz and Stéphane Peterhansel to retire, while Mattias Ekström got waylaid by punctures and suspension damage, eventually finishing in a distant 14th place.

With Audi's 2026 Formula 1 entry gathering pace and absorbing an increasing amount of the team's resources, it looked like this year would be now or never for the Dakar. The tried and tested driver line up of Sainz, Peterhansel and Ekström was called up ►

**BELOW** The threeyear programme culminated in perfect fashion



again, and preparations began in earnest.

40

"We were surprised just how little wear and tear there was on the cars when they came back into the bivouac [service area] each time. A large part of that is down to the crews – they were more conservative and precise in the way they drove compared to last year," comments Pascali. "But the other thing was that we had the opportunity to do a lot of preparation last year, including tests in Saudi, Morocco, Spain and France, improving car performance and handling, allowing all crews to drive faster with less risk ."

Rather than rolling up with shiny new cars, the team used parts that had already seen a considerable amount of mileage and services, subjecting them to a further stress test in these evaluations.

"The aim was to understand the weaknesses of the

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#### **ABOVE & LEFT**

Audi has secured itself a remarkable triple crown of its own, winning Pikes Peak, Le Mans and the Dakar Rally with spectacular machines that dared to challenge conventional technical thinking system before the rally. Based on that, we defined a series of containments and countermeasures for all the systems on the car, so we could prevent problems in the first place rather than having to react to them," says Pascali. "We drew up a service plan for all three vehicles, and this proved to be one of the key points. Although we did have a couple of issues with standard mechanical parts of the car, we did not have any problems at all with the new powertrain and battery technology."

#### **Toughest event**

In the end, it was a relatively trouble-free run for Sainz, despite taking on what was widely regarded as the toughest Dakar in recent years. Things didn't go quite so smoothly for his team-mates, however. Peterhansel was caught out on the new 48-hour marathon stage, when he pulled over to change a tyre and the hydraulic jack exploded. This left the integrated jack hanging down beneath the car, which took several hours to remove, while the loss of hydraulic fluid also forced him to drive the remainder of the stage with a not perfect power steering assist.

The time lost to this failure put Dakar legend Peterhansel out of contention for a major result. With a unique team spirit, he and his co-driver Edouard Boulanger spontaneously became the guardian angel. Their car was effectively relegated to a rolling donor vehicle, in case spare parts or assistance were required for the other two crews. He didn't have long to wait as part of Ekström's rear-left suspension failed a few days later. The Frenchman stopped to lend assistance, but in the end it was Audi's support truck following on behind that provided the spare parts after it was deemed too time-consuming to strip them from Peterhansel's car. Both crews made it to the finish, but despite both capturing stage wins earlier in the event, ▶

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March 2024 Issue 280 racetechmag.com 41

![](_page_41_Picture_1.jpeg)

neither were able to trouble the top 10.

Two relatively small failures with big repercussions, then, but the rival teams had it far worse. Serious mechanical failures put many of the big names out of contention.

"This was my first Dakar, but the feedback that I received from colleagues who have much more experience in this event was that an unusually high number of the cars dropped out," comments Pascali. "At the beginning, the bivouac was full, but by the closing stages of the event it was looking quite empty. And one of the most difficult things for the support crews was the distance and the amount of movement we had to do each day to follow the event."

One of the most frequent issues experienced by all the teams last year was punctures. In order to reduce the risks of losing time to a wheel change, Audi studied the various scenarios that can lead to a puncture and how to prevent them. This process extended right into the setup of the car itself, Pascali explains.

"Our target was to minimize vertical load variation on all corners. To reach that we had a more compliant suspension setup this year," he comments, "which reduces the risk of a puncture on the tread pattern. Punctures on the sidewall are more related to the driving style, so that comes back to getting the drivers to be more precise in driving thanks to the better performance setup achieved.

"Generally, having a car that's more stable and easier to drive also contributes to reducing the risk of punctures, so it's win-win. The only exception to that sometimes is with the tyre pressures. You might want to run the tyres a little softer to increase the grip, which can increase the risk of punctures. But **ABOVE** Running tyres softer can increase grip but raises the spectre of punctures

BELOW Throughout the project, much attention has been paid to making the car easier to maintain having improved so much on the suspension setup in testing before the event, we had a broad window that we could operate in for the tyre pressure."

A careful inspection of the cars was carried out by the mechanics and engineers each time they reached the bivouac (with the exception of the marathon stage, where the crews were on their own). The first thing was to get feedback from the drivers on any unusual events, such as heavy landings or unexpected vehicle behaviour. Data would also be taken off the cars and analysed to flag up any anomalies, while the mechanics carried out physical checks. Particular attention was paid to the coolant pump of the MGUs, the gearbox, the driveshafts and the suspension.

The most critical phase of the rally in terms of mechanical reliability is generally the opening stages, Pascali explains. Here, so-called young failures can crop up on new parts. Confidence grew as the rally progressed – even with Sainz as the sole remaining Audi vying for the win.

"At one point, Carlos [Sainz] was just 14 minutes ahead of Loeb, and I remember him saying, 'Tomorrow we need to push, we can't afford to be conservative anymore'," Pascali recalls. "The following day, he was a rocket, able to increase the gap quite easily, which gave us confidence not only in terms of the reliability but also in the performance of the car. So, I was never really nervous [when Sainz was out there on his own]. I was sad that we didn't have a chance to compete for a podium with the two other cars... but that's the Dakar."

#### Series-hybrid powertrain

Despite its complexity, one area that has performed faultlessly through the whole three years of the ►

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RS Q e-tron programme is the novel series-hybrid powertrain. It's powered by a four-cylinder DTM engine charging a 52-kWh lithium-ion battery pack through one Formula E motor generator unit, while two more MGUs supply drive to the front and rear wheels. Although these elements are all well-proven technology, there's a formidably complicated set of heat exchangers, control systems and ancillaries to integrate.

#### **Getting started**

"It's not an easy car to set up in the morning," admits Pascali. "For the standard warm-up procedure, we would map the cooling system before starting the engine. The MGU and the battery are on different cooling systems and they each need to be at the right temperature and pressure before you start the car. As an example, sometimes when it's cold the pressure is really low in the cooling system for the battery, so it's necessary to pressurise that. Before the internal combustion engine is fired up in the pits, we use an external heater to make a warm-up."

The energy management strategy used by the teams was fundamentally unchanged from last year. All recharging had to be done via the combustion engine as there are currently no charging facilities in the Dakar bivouacs. One small change for this year was the 48-hour marathon stage, for which the crews set off with a slightly higher state of charge – around 90 per cent instead of the usual 80 per cent.

Depending on the power demand and the battery state of charge, the car can run on electricity alone or in parallel with the combustion engine, which operates at anywhere from 4,000 rpm to 6,000 rpm, giving a total battery charging power of 220 kW (300 hp), to guarantee the target state of charge.

This is an inherently efficient setup, allowing the combustion engine to operate in its optimal range

ABOVE Carlos Sainz and Dr Leonardo Pascali consult. The project's technical director was full of praise for the drivers' intelligent approach

**RIGHT** Mission accomplished, the next objective is success in Formula 1

**RIGHT** Sharp rocks

awaiting the crews

were just one of

many hazards

![](_page_43_Picture_10.jpeg)

Most of the people that have developed the RS Q e-tron from the beginning are now working in the Formula 1 team"

of speed and load, but it also runs on a blended fuel that contains 80 per cent sustainable content, giving a further CO2 saving of more than 60 per cent.

The sustainable content in the fuel includes a mixture of bioethanol and e-methanol. Rivals Prodrive and Toyota Gazoo Racing used similar fuel technology on the Dakar this year, but it may turn out to have a particular relevance for Audi, which is gearing up to use fully sustainable fuel in its 2026 Formula 1 effort.

The two categories may be worlds apart, but Pascali feels that Audi's landmark victory in the Dakar will stand the team in good stead for its next big challenge: "Most of the people that have

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developed the RS Q e-tron from the beginning are now working in the Formula 1 project. This Dakar project has given us a lot of confidence in what Audi will be able to do in Formula 1."

Formula 1 will be a step into the unknown for Audi. The company was part of the Auto Union group that dominated grand prix racing in the mid-1930s with its startlingly modern mid-engined designs. Its only taste of single-seater racing in the modern era so far has been in the tightly-constrained world of Formula E, but the Dakar victory reinforces the message that this is not a brand that does things by halves.

#### Monte Carlo beckons...

Of course, Formula 1 brings a whole new set of goals. Of the individual events, the most celebrated remains the Monaco Grand Prix that winds its way through the tight and twisty streets of Monte Carlo. A win there would be a huge accolade for the new team. And then it would just be the small question of conquering Indianapolis if Audi wanted to claim motorsport's 'other' Triple Crown. But maybe we're getting ahead of ourselves.

# JAGUAR READY TO POUNCE IN FORMULA E SEASON 10

Anthony Peacock reports on the leaping cat's single-seater breakthrough – and its implications for a new generation of road cars

**O** back to the romantic era of motorsport and a Jaguar was the car to have: both on the track and on the road. From the legendary C-Type of the 1950s – the first car to feature onboard disc brakes, and the first model to win at Le Mans for Jaguar - to the equally iconic 'Silk Cut' XJR-9 of the 1980s, the big cat roared.

And then, of course, there was Jaguar's Formula 1 campaign announced in 1999, which was effectively the Ford works team (after it purchased Stewart Grand Prix). That didn't go guite as successfully, with the chairman of Ford at the time allegedly asking: 'who the hell is this Edmund Irvine anyway?' when reviewing the company's wage bill at a board meeting...

After four years of trying and just a couple of podiums to show for it, Ford decided to call it a day, but the Jaguar Formula 1 programme hadn't been a complete waste of time: it went on to become Red Bull Racing, which did considerably better...

Nonetheless, Jaguar had been bitten badly, and there was some degree of corporate reluctance to return to motorsport, especially as the manufacturer was restructured under another change of ownership and was busy redefining its identity.

![](_page_46_Picture_5.jpeg)

**BELOW** Four years after being trialled in the Formula E car's inverter, Silicon Carbide technology - seen here through a bespoke art installation - is to feature on all JLR cars

LEFT Jaguar's I-TYPE

6 began Formula E's season-opener in

Mexico Citv as the

car to beat

But in 2015, the announcement came that Jaguar would be making its debut in Formula E's third season from 2016-2017, despite having no motorsport department at the time. Right from the beginning, James Barclay was appointed team director, and there he has remained ever since: overseeing the first win in 2019, as well as the first one-two in Germany last year.

The start of the complex Gen3 era proved to be the most successful season yet for Jaguar in Formula E, as the marque finished first and second in the championship, with customer team Envision beating the factory squad in the teams' standings, after the title went down to the final round in London. The drivers' title was also settled during the final round, but it was Andretti-Porsche driver Jake Dennis who eventually beat Envision's Nick Cassidy and Jaguar

![](_page_46_Picture_9.jpeg)

We started racing silicon carbide back in 2018. Now we will use silicon carbide technology in all future JLR vehicles"

TCS Racing's Mitch Evans to the title.

So a good result for the brand, but not quite perfect. Having recruited Cassidy to join Evans in the factory squad for 2024, ambitions are higher than ever, with a move to a state-of-the-art facility in Oxfordshire. The recent first race in Mexico started off promisingly enough, with Evans and Cassidy both qualifying in the top four and finishing in the top five.

Is this going to be enough to transform Jaguar into Formula E's new superteam, with the series being closer than ever and a limited pool of areas in which teams can make a difference?

Barclay is upbeat, yet pragmatic. "Like everything ▶

47

#### **FF** Technology evolved on the racetrack that will go on to benefit future customer cars"

in life, it's not one silver bullet, right? We have a power limit, so you can't produce a car that's more powerful than the competition. Instead you have to produce a car that's more efficient: that's the first key point. The second point is that you need a car that dynamically allows you to extract the best out of the powertrain: which is fundamental too. So it's a question of optimising all areas to make sure we continue to maximise the potential. We can't change the hardware, but we can evolve the car from a software and set-up point of view, and that's what we've aimed to constantly improve."

One of the most fascinating insights on this comes from Cassidy, who has jumped into the Jaguar TCS car from the (championship-winning) customer team, so has a direct opportunity to benchmark it. Using the same Gen3 architecture and the same powertrain as last year, you would expect the feeling to be pretty similar, but as Cassidy points out: "I was quite surprised by how different it was."

He doesn't go into detail about the extent of those differences, but says that they were all positive, and this certainly underlines how tuneable the current generation of Formula E cars are, despite the fact that they look identical. There's still something of a misconception about the level of manufacturer competition in modern Formula E, which Barclay is keen to set right.

"Last year was a great result for us because we interpreted the technical regulations better than anyone else, with a winning product in the I-TYPE 6," **ABOVE & RIGHT** Could the I-TYPE 6 join a pantheon that includes the C-Type, D-Type and XJR-9?

TITITITITITITITI

RIGHT James Barclay, Managing Director of JLR Motorsport and Jaguar TCS Racing Team Principal, has overseen the squad's rise to the head of the Formula E field he points out. "From the beginning, the Gen3 era car represented a really significant step up technically: a brand new chassis, brand new battery, brand new tyre manufacturer, and very little carry over from the previous generation. Then you add in the complexity of no rear brakes, just using the rear powertrain to slow the rear axle, and brake-by-wire on the front axle. One of the first things every driver noticed last year was that the braking feel was very different to what they'd had with previous generation Formula E cars and indeed other racing cars.

#### **Energy management**

"Then we saw a reduction in mechanical grip with the new Hankook tyre in place of the previous Michelin – a baseline change – on a car that went up in power from 250 kW to 350 kW [around 470 horsepower]. So we had a car with a lot more power but less mechanical grip, which obviously affects the core concept of the manufacturer parts that we have to produce. In terms of getting everything ready, the single biggest challenge was probably timeline and integration of all these different aspects."

Despite that, at Portland in the United States, teams were hitting nearly 180 mph on the straight. And that

![](_page_48_Picture_6.jpeg)

was with a reduced battery capacity compared to the previous generation of car, which basically means that the battery provides less energy than is needed to actually finish the race. Only around 60% of the electrical energy needed for the race is stored: the rest has to be regenerated along the way. Consequently, the way drivers attack and conserve energy is absolutely crucial to race strategy and success – and that's where energy management software comes ►

![](_page_48_Picture_8.jpeg)

in. This is the main battleground where the 16-round championship will be fought this year.

"We can't change the hardware but we can evolve the software to make energy usage more efficient," confirms Barclay. "In Formula 1, they talk about saving tyres, here the skill is in saving energy."

#### From racetrack to road

The reason why this is so important is that it is directly relevant to roadgoing technology, and there is arguably no other brand in Formula E to which this is more pertinent than Jaguar at the moment.

Jaguar's charismatic Chief Creative Officer, Professor Gerry McGovern, controversially claimed in a recent interview that there was "no brand equity" in Jaguar, referring to how the whole brand is being completely redesigned from the ground up. The entire Formula E programme was built around this premise. This year we'll see some first glimpses of a totally new family of Jaguar road cars that will begin to make their debuts in 2025, but the rationale for this was set in motion 10 years earlier, when Jaguar first embarked on its Formula E campaign.

"One of the reasons we chose Formula E, as well of course as brand awareness, is because the technology at the core of what we're racing is critical

![](_page_49_Picture_8.jpeg)

to the future, and our products that we're going to be selling," adds Barclay.

"There's quite a few really strong examples. One would be silicon carbide. We started racing silicon carbide back in 2018, as one of the first manufacturers to use that technology in our inverters. And four years later, in 2022, we announced that we will use silicon carbide technology in all future JLR vehicles. The team's official partner is Wolfspeed, and they'll be one of our suppliers for silicon carbide semiconductors. So that's technology evolved on the racetrack that will go on to benefit future customer cars." ▶ **ABOVE** Celebrating the team's first onetwo in Berlin last year

**BELOW** Jaguar TCS Racing's recent success in the Diriyah desert races underlined the Cat's ascendancy

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# Starting from €62, £54, \$66

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## "You see this facility, and you think: 'this team is here to win'"

**UNFORTUNATELY** for Mitch Evans, there are no flights from Nice to Oxford Airport – as this would reduce his commute from Monaco to the new Jaguar TCS Racing base considerably. It's almost right next to the runway, underlining the international status of a world-class facility that would almost do justice to any Formula 1 outfit.

"It's a massive step forwards," says Evans, who has been with the team from the beginning. "Having everything under one roof for the first time is going to streamline all our operations, and it's things like that which make the difference throughout a championship campaign."

Coincidentally, the new HQ is just down the road from where Tom Walkinshaw Racing – which ran Jaguars for the first time in the 1982 European Touring Car Championship – was based from 1976.

With a new simulator, operations room, and other in-house facilities, Jaguar TCS Racing (the title sponsor – Tata Consultancy Services – being in deference to Jaguar's owners) now has everything on paper that it needs to succeed. The simulator is so secretive that visitors aren't allowed to see it, and that's located right next to the state of the art 'mission control' operations room, which is like a virtual pit wall that allows engineers to work remotely. This helps to reduce the carbon footprint of the entire operation: a cornerstone of Formula E's philosophy.

"I think this place gives everyone that bit of extra motivation: me included," says Evans. "You walk in here, you see this facility, and you think: 'this team is here for a long time, and it's here to win'. The facility has been a few years in the making, and now it's down to us to make the most of it."

![](_page_51_Picture_7.jpeg)

Naturally, this future research puts an accent on sustainability as well. "Last year, we announced through our partnership with Castrol, that not only have we produced really efficient lubricants together to use as a racing team, but we've actually found a way of re-using those lubricants by re-refining them," explains Barclay. "So in Monaco last year, we used re-refined base oils from our gearbox oil for the first time, with no drop-off in performance. We wouldn't put it in the car otherwise. That's a great way to prove how sustainability doesn't have to compromise performance, and it's something we'll also see in future production vehicles."

Broadly speaking, each of the recent

![](_page_51_Picture_11.jpeg)

generations of Formula E car has improved lap times by about three seconds, despite being more efficient. The current Gen3 car will be in place until the 2026/2027 season, but before then a Gen3.5 car is set to make its debut next year, which will make the cars yet faster and is likely to incorporate front traction power as well, by using the front MGU not just for re-generation, but also for traction power when needed. Effectively, this will make Formula E four-wheel drive at certain points in the race. Then from 2026 Bridgestone will take over as control tyre supplier - which could bring an extra second per lap through the tyres alone, according to Barclay.

"I don't think you'll ever find a driver now who would describe Formula E as being slow," concludes Barclay. "Gen4 – where we're finalising the regulations now – will be faster still, so these cars are a proper test of man and machine."

![](_page_52_Picture_1.jpeg)

From a Jaguar point of view, it's been a battle that has been played out before, nearly 40 years ago. "We were really proud to be able to race against great brands like Porsche, Maserati, McLaren, Nissan, Stellantis, to name but a few," says Barclay. "With Porsche, there's a bit of history there too from the Group C days – but it's a rivalry with respect on both sides. We're privileged to have some very good, **ABOVE** The Formula E journey from that first I-TYPE 1, seen here testing back in 2016, has been a voyage of discovery

![](_page_52_Picture_4.jpeg)

With Jaguar propelling itself to the top of Formula E, will the trajectory of the championship and its protagonists eventually cross over with that of Formula 1 – which is increasing its electrified element – and perhaps finish the business that Jaguar started nearly 25 years ago, with Irvine and Johnny Herbert?

#### Formula E vs Formula 1

Barclay is a man who likes to keep all options open. "I think Formula 1 is obviously locked into that hybrid approach, whereas Formula E has the benefit of having the battery electric strategy. The reality is there's a relevance to Formula 1 for some time to come. But the future relevance of Formula E is probably greater to production cars, whereas Formula 1 might need to look at what its strategy is and differentiate."

The motto for JLR's bold electric vision of the future is 'Reimagine'. And with its new headquarters and innovative technology, that's exactly what the Jaguar TCS Racing team has done.

![](_page_52_Picture_9.jpeg)

Cometh the hour, cometh the car? Toyota's Rally2 machine was unleashed in Monte Carlo just as momentum grew behind calls for Rally2 to become the World Rally Championship's top category. By **Hal Ridge** 

**EEDED** outside the top 10 on the opening round of the World Rally Championship, the famous Monte Carlo Rally last month, and with number 23 on the door, casual onlookers may well have taken little notice of a car driven by rising Finnish star Sami Pajari.

But, the Toyota Yaris Rally2 the 22-yearold was piloting, one of four GR Rally2s in the event, was arguably one of the most highly anticipated new rally machines for years, certainly outside of the top flight.

R5, as it was first known, now Rally2 in the FIA Rally pyramid, has been one of the most successful rally concepts of all-time. It has tempted multiple manufacturers to replace the Rally1 spaceframe, hybridpowered machines.

Meanwhile, rumblings of Toyota delivering a car outside its top-flight WRC programmes have gone on for years, almost since the Japanese marque returned to rallying for 2017. But Technical Director Tom Fowler says the timing had to be absolutely correct for such a project.

"We've been interested in doing one (a Rally2 car) really since the beginning," he admits. "But of course there's a time and a place for that kind of work to happen, and I would say there were two key factors around when the project started. "First of all, the priority had to be to

![](_page_53_Picture_8.jpeg)

create machines to compete on the WRC's undercard and throughout the lower levels, right down to the clubman events around the world with amateur drivers. Hundreds of four-wheel drive, steel body Rally2 machines have been sold in the last decade, making it a true customer formula.

While Toyota's step into the class is customer-focused, it could perhaps not have come at a better time, with the technological future direction of the WRC a hot topic.

A new FIA working group was created last year to define rallying's top-flight future. Headed by two former WRC title-winning co-drivers – ex-FIA Deputy President Robert Reid, and former Prodrive boss and chair of Motorsport UK David Richards – it is strongly believed the group could recommend that a Rally2-based concept get our WRC campaign into a good position. Obviously the first couple of years of competing are very busy, with lots of development on the WRC car, and we really needed to establish ourselves as a contender.

"Then there's the added complication that Rally2 went through a period, regulation-wise, of discussion if it was going to go hybrid, if there was going to be a new Rally2 category, so we wanted to also make sure that there was a stable regulation to come into.

"In the last couple of years it's been decided that Rally2 will remain an internal combustion category. It will keep the same regulations as before, albeit the name has changed from R5 to Rally2. Once we knew it was stabilised, two years ago we started to seriously think about developing the car." ►

![](_page_53_Picture_15.jpeg)

Getty Images/Red Bull Conten

**BELOW** Toyota's bid to join the customer rally car market was ignited when its new GR Yaris Rally2 made its World Rally Championship debut at the Monte Carlo Rally

PRINTSPORT

"That term is not quite fitting the car," he contends. "Historically, a homologation special is something that was produced for use in competition but, in many cases in the past, to the detriment of its actual ability to be a road car, and only sold in exactly the right numbers to be able to be used as a basis for homologation."

The remark refers to the likes of Ford's Group B RS200, for which only the required 200 road vehicles were ever built.

"The GR Yaris was, I wouldn't say completely the other way round, but at least meeting in the middle," he insists. "There is some crossover but the primary goal of the car was to recreate the excitement of driving cars which are similar to what you can compete in, so producing

**ABOVE** The three-cylinder base engine is taken direct from the manufacturer's production line, then rebuilt in-house by the works outfit

When the R5 concept was conceived and the first car, from Ford-associated British firm M-Sport, hit the stages just over a decade ago, the machines were little brothers to the top-tier WRC machinery. Now, with spaceframe chassis and hybrid powertrains in Rally1, the concepts have diverged, but the basic technical rules of the Rally2 class have remained fundamentally stable.

Toyota has been canny, though. M-Sport (Ford Fiesta), Skoda (Fabia), Volkswagen (Polo), Citroen (C3) and other Rally2 marques have gone the 'normal' route of re-engineering a production road machine into a rally creation. By contrast, Toyota delivered the Yaris GR to the road car market in 2020 initially to help with the creation of its GR WRC machine. That car underwent testing but remained still-born as the top-flight switched to Rally1 rules for 2021. The groundwork done on making a production vehicle that would aid a rally car footprint has no doubt helped the Rally2 process.

Fowler, however, refutes any suggestion that the Yaris GR road machine could ever be considered a Homologation Special.

a new era of four-wheel drive turbocharged cars like we used to enjoy in the early 2000s.

"Recreating this kind of fun-to-drive, exciting car that is based on a car which can practically be used every day by normal people was the main target of GR Yaris."

But the intention was also to make it the basis for a good rally car. In the first instance, that meant a good WRC car. Then, secondarily, there have been knock-on benefits to the Rally1 and now Rally2 machines.

#### **Test mules**

Various Rally2 test mules have been running in earnest over the last 12 months to evaluate components over different terrain ahead of homologation and the Monte debut with customer teams. In that period, almost 15,000 kilometres of running were RIGHT The works squad contested domestic rallies in Japan with various drivers, including team principal and multiple WRC rally winner Jari-Matti Latvala

BELOW Almost 15,000 kilometres of testing were conducted before Monte Carlo

![](_page_56_Picture_8.jpeg)

undertaken. The squad also ventured to Toyota's homeland, Japan, to contest domestic rallies with various drivers, including team principal and multiple WRC rally winner Jari-Matti Latvala at the wheel.

"The events side of it was really interesting," notes Fowler. "If you were developing a WRC car or Rally1 car, to do that kind of activity during the development phase would not be strictly productive enough to make it worth your while. But when you look at a customer car or a Rally2 car in particular, the way in which the car will be used is so broad

#### The engine follows the industry direction of those OEMs still developing ICEs, by downsizing and reducing the number of cylinders"

from different customers that this kind of event testing gives you something different to just driving up and down the same test road.

"We ourselves as a team, which has only operated in the manufacturer competition environment, needed to learn what are the needs of the customer, and what do the customer activities involve? So doing these different kinds of events throughout the world, with different kinds of drivers, different kinds of teams, really gave us an insight into how the car needs to be developed as a whole package, not just as a rally car."

Also new for the outfit was the task of creating a car within the Rally2 regulations. From the outset of the R5 concept, as it was then, the cost cap nature of the regulations has meant parts had to be sourced from production machines. As an official arm of one of the worlds' biggest automotive giants, Toyota's rally programme has been far from visiting the local parts store every day to try different components. It will also no doubt have had access to endless amounts of component data. But even then, selecting the best parts for the job is both time-consuming and challenging.

"There's a lot of OEM parts which either have to >

![](_page_56_Picture_16.jpeg)

be used as they are or modified from," says Fowler. "Nearly all of the main functional parts need to have a provenance in some kind of production, so we're talking about radiator, intercooler, driveshafts, hubs, joints, all of these kind of typical expensive parts need to come from some vehicle; whereas in Rally1, we make completely our own driveshaft joints, intercooler and so on.

"Actually, this makes the project quite a lot more complicated in many ways. If you could make whatever you want, then you know it's going to do what you want according to your specification; whereas when you need to utilise something from production, you don't really know exactly that it's going to do everything that you expect.

"There's obviously thousands of different parts available throughout different models, so to select the very best one is not straightforward. That's a huge part of the project."

#### Departure

Equally, making a car fit for customer use, rather than honing a machine in its top-flight programme to be driven by some of the very best drivers in the world, has been a departure from the norm for the Finland-based outfit. To help its Rally2 effort, Toyota recruited those with experience of customer programmes and with existing Rally2 knowledge.

![](_page_57_Picture_6.jpeg)

Fowler says the learning process between Rally2 and Rally1 has been two-way, but notes that making a customer car user-friendly for teams has also been important. "We've learnt a lot about the requirements of a Rally2 car, how to operate the car aside from just driving it," he says. "How to service it, how to maintain it simply; all of these are needs we've had to understand and it's also worked backwards into Rally1."

The Yaris Rally2's nod to its Rally1 cousin is arguably clearer than with the Fiesta or Hyundai i20 of the other marques with cars in both series, with the styling and aerodynamics of the Yaris Rally2 notably more aggressive, within a prescribed ruleset. Where the Yaris ABOVE The launch of two high-performance special edition models named after the team's world champion drivers, timed to coincide with the Monte Carlo Rally, underlined the crossover between the development of the race and road models

![](_page_57_Picture_10.jpeg)

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![](_page_58_Picture_10.jpeg)

![](_page_58_Picture_11.jpeg)

![](_page_58_Picture_12.jpeg)

![](_page_58_Picture_13.jpeg)

also differs from its rivals, is with using a three-cylinder turbocharged engine, albeit still 1.6-litre (1,618.2 cc to be precise), with an 87.5 mm bore and 89.7 mm stroke, the turbo restrained by a 32 mm restrictor.

The three-pot unit, although rebuilt in-house in Toyota's rally facility, is from Toyota's production line. It follows the industry direction of those OEMs still developing internal combustion engines downsizing and reducing the number of cylinders. That engine concept meant that Toyota had to negotiate its use in the class, with four-cylinder engines having been the norm until now.

The braking package for the Yaris is delivered by Alcon: 300 mm discs in gravel trim joining fourpiston calipers; the front discs are increased to 355 mm in Tarmac spec.

The car's five-speed, four-wheel drive sequential transmission is produced by French firm Sadev. "In Rally2 the transmission is actually a really complicated part of the whole deal because, with the cost cap, it can kind of make or break you in terms of the commercial viability of the project," says Fowler.

"We have homologated the units from Sadev. There's a very strict regulation that basically the transmission, although it's not a production product, the cost restrictions are so tight that actually almost all Rally2 cars have the same basis in the transmission. The parts are kind of interchangeable even between manufacturers in many ways, so it's a kind of stock transmission, let's say."

That cost cap has also been a talking point, especially in the current debate over a possible switch to Rally2, or 'Rally2+' becoming the top category. When first introduced, a Rally2 (R5) machine was €180,000 for the base car.

Today, with an 'index of inflation' added annually, the base price is around €270,000. And that's with just one surface kit. Additional dampers, brakes and the like are obviously added to that figure, although service park rumour suggests that Toyota has conceived one of the more cost-effective Rally2 machines to buy, service and operate.

Costs understandably play a significant role in the discussion around the WRC's top-flight future. The Rally1 rules haven't attracted any more manufacturers than those that were competing in the previous ruleset. Eight Rally1 machines started the Monte Carlo Rally last month, while 28 Rally2 cars featured on the start list. Twenty-five, including seven Toyotas, were set to take part in Rally Sweden as Race Tech went to press. Asked about his own thoughts on the future for

WRC, Fowler is firstly keen to praise the current Rally1

**RIGHT** Accommodating the needs of private teams and drivers in the development programme marked a fresh challenge for the WRC squad

**BELOW** With the future of rallying currently being reviewed, could Rally2 machines like the new Yaris actually be the top WRC class by the time next year's Monte gets underway?

![](_page_59_Picture_13.jpeg)

![](_page_60_Picture_1.jpeg)

machinery: "It (the future) is obviously a big story at the moment. I think that overall Rally1 doesn't get maybe the credit it deserves in many ways. Maybe (there is) a little bit too much concentration on trying to find negatives in Rally1.

"But if we think about what a Rally1 car is compared to its predecessor, it's running on 100% sustainable fuel – which no other world championship category was doing – at the same time as being a hybrid vehicle which also has the capability to be fully electric when necessary. All of that was designed, developed and went into a racing category in about an 18-month period.

"I think Rally1 has been a technological success. If we compare a WRC car to a Rally1 car, the amount of development that was done to make it up to the latest modern expectations, in a very short period of time, ended up as a successful product to watch.

#### Rally1vs Rally2

"There may not be enough of them, that's a different debate, but the actual racing that takes place is really exciting and very spectacular.

"So in that sense it would be a shame to replace that with Rally2 which, although a very good category, is a step down in performance and in terms of the spectacle of Rally1.

"On the other hand, we have to look at it pragmatically: if we want to have an inclusive top tier in rally, it might be the only option."

The WRC's current homologation cycle

Moving to Rally2 or let's say Rally2+, would solve many of the WRC's issues, especially cost-wise"

for Rally1 machines runs for five years, set to end at the close of 2026. But rumour is rife that Rally2, or a Rally2+ concept with increased aero and power, could be brought in as the top-flight from as early as next year.

Indeed, Toyota rally chief Lavala went on record with Autosport magazine on the eve of the Monte Carlo Rally saying: "At the moment from a Toyota perspective we are basically fine with both options, Rally1 or Rally2. These (Rally1 cars) are great machines. I would say they are fast, safe and they look good and they sound good, but they are very, very expensive. We don't have privateers as we used to have in the old days. Moving to Rally2 or let's say Rally2+, would solve many of the issues, especially cost-wise, which could allow privateers to come and run in the top class."

Toyota's new endeavour may have arrived at the perfect time, and is set for a whole year of data acquisition in competition whatever the future holds. In the here and now, for Fowler, taking on a range of marques, all of which with far more experience at Rally2 level, is a refreshing challenge.

"As a team and as an organisation it's kind of a milestone for us," he says. "We have been operating only as a manufacturer for so many years. To come into this category – after the cars have been running for more than 10 years – is obviously a tough call in the sense that all of those cars have been finely, finely tuned up to the last possibility within the regulations and cost cap.

"To come with something brand new and straight away be competitive, we've seen in this category it's not easy to do. So we are excited by the challenge but obviously also realistic that we're the new kids on the block. We have to manage our expectations and make sure we are delivering to all our customers, not just trying to be at the pinnacle of one race.

"We have a broad picture to look at. It's as important to us that the customers who are using the cars at national level, or at weekend entertainment level, are as satisfied with their product as the driver who could win the World Rally Championship at WRC2 level. All of the customers are important to us and we have to make sure the product is suitable for all of them."

Three of the four entered cars completed the full rally distance in the hands of customer teams on its competitive WRC debut. Sami Pajari and Enni Mälkönen (Printsport) were the best-placed crew at the finish in 12th overall and fifth in class RC2. The work has only just begun, but Toyota's record suggests that the new car will soon be a threat to the established order.

# **100 YEARS 0F LEGENDS**

Technical innovations and curiosities abound in the history of the Le Mans 24 Hours. This extract offers a glimpse of the jewels to be found in the official book to celebrate the centenary of the world's greatest sports car race

## 100 years of technical innovation

**N 1923**, the founders of the Le Mans 24 Hours (Georges Durand, Charles Faroux and Émile Coquille) expressed the wish that their Grand Prix d'Endurance would be a 'test bench for the road'. Ever since, engineers have relentlessly pursued the quest to improve performance while complying with evolving regulations: fuel, power, aerodynamics, grip, communication, ergonomics, etc. Here are some landmarks.

![](_page_61_Picture_5.jpeg)

#### **Boosting power**

By this time some cars had supercharged engines, whereby an engine-driven turbine compressed the engine's supply of air in order to give increased power. The first victory by a supercharged car was achieved by Lord Howe and Sir Henry 'Tim' Birkin in their Alfa Romeo 8C-2300 in 1931.

## **1949** REAR ENGINE

#### Push rather than pull

Although Auto Union had achieved plenty of success with its Nazi-funded rear-engined grand prix cars in the 1934-39 period, Camille Hardy was the first to race at Le Mans with a rear-engined car, a humble Renault 4CV, despite Renault's objections. The tables were turned with the first victory for a rear-engined car, a Ferrari 250 P in 1963, by which time the rear-engined takeover of Formula 1 and most branches of single-seater racing was complete.

![](_page_61_Picture_11.jpeg)

#### Communicating with the pits

After big advances in radio communications during the Second World War, the first use of a radio receiver at Le Mans came in the first post-war race aboard a Simca 8 driven by Jean Mahé and Roger Crovetto. The first permanent radio link between pits and driver was pioneered by Cunningham in 1951.

# 1925 AERODYNAMICS

#### **Cleaving the air**

Given the low power of engines at this time, automotive engineers quickly realised that reducing air resistance would be beneficial. The first experiments began in 1925 with the Chenard & Walcker 'Tank Z1', a radical departure from the design of the upright bodies of the day.

# FOG LAMPS

#### Piercing the morning mist

Thanks to the addition of a central fog lamp, the drivers of the three Lorraine-Dietrich B3-6s were able to see better through the typical mist of dawn and soar onwards to achieve an historic 1–2–3 finish.

![](_page_61_Picture_20.jpeg)

![](_page_62_Picture_1.jpeg)

#### Extract taken from 100 YEARS OF LEGENDS

The official celebration of the Le Mans 24 Hours

Written by Denis Bernard, Basil Davoine, Julien Holtz & Gérard Holtz. Published by Evro Publishing. UK price: £70 hardback

![](_page_62_Picture_5.jpeg)

![](_page_62_Picture_6.jpeg)

#### **Reducing glare**

To avoid reflections, which are tiring for drivers' eyes, especially in bright sunlight, Alfa Romeo's engineers came up with the idea of covering the dashboards on the works team's four 6C-3000 coupés with a black 'crackle' paint used for photo and film sets.

## 1953 DISC BRAKES

#### Slowing down more quickly

Designed to reduce braking distance **II** when landing on aircraft carriers during the Second World War, disc brakes soon proved their worth in motor racing, notably at the Le Mans 24 Hours, with the Jaguar C-types of 1953 equipped with a system developed by Dunlop. Disc brakes, which dissipate heat more efficiently, were especially effective when braking for the slow-speed Mulsanne corner at the end of the *Hunaudières* straight.

![](_page_62_Picture_12.jpeg)

**ABOVE** Disc brakes made their breakthrough at the Le Mans 24 Hours when Jaguar's victorious C-types were equipped with a system developed by Dunlop in 1953

# 1962 HALOGEN HEADLIGHTS

#### Seeing further at night

The arrival of halogen headlights on the Ferrari 330 TRI LM cars increased vision at night from 175 to 300 metres. Innovation never stops: in recent years, LEDs have enabled Audi's LM P1 cars to illuminate the track up to 500 metres ahead (2011), and lasers up to 800 metres (2013). ► 63

![](_page_62_Picture_20.jpeg)

![](_page_63_Picture_0.jpeg)

## **1966** TELEMETRY

#### **Data collection**

Although cars now communicate with the pits and receive data in real time (with 2,000-2,500 parameters for today's Hypercars), it was Ford that pioneered on-board data gathering after investing heavily to beat Ferrari. On the Mk II model that won in 1966, sensors measured pressures and temperatures, and engine speed was recorded on an oscilloscope.

# **1967** SLICK TYRES

#### For dry-surface grip

It's the rubber on a tyre that provides grip, so a tyre without tread will offer more adhesion than one with tread. The first use of slicks – in dry conditions only of course – came in 1967 when Michelin fitted them to an Alpine A210. The decision was vindicated when Jean Vinatier and Mauro Bianchi brought the 1.6-litre car home 13th overall and first in class.

![](_page_63_Figure_8.jpeg)

# AERODYNAMIC APPENDAGES

#### Adding downforce

The use of aerodynamic aids at the Le Mans 24 Hours arrived with a bang in 1967 when two Chaparral 2Fs arrived from America with massive adjustable rear wings perched high above the car. Phil Hill and Mike Spence proved the efficacy of the devices when they planted their 2F second on the grid, although they didn't finish the race. The following year Porsche had rear wings on its new long-tail 908s, complete with adjustable fins that deflected with suspension movement. Movable aerodynamic devices like these were banned in 1969 after breakages on Lotus's Formula 1 cars at the Spanish Grand Prix caused high-speed crashes.

![](_page_63_Picture_12.jpeg)

#### Boosting power again

Having dominated the Can-Am series in America with turbocharged 917s, Porsche applied its turbo know-how at Le Mans in 1974. Entered by the factory, two 911-derived Carrera RSR Turbos proved quick and the Gijs van Lennep/ Herbert Müller car finished second. Two years later, van Lennep achieved the first turbo victory at Le Mans in a Porsche 936 shared with Jacky Ickx.

![](_page_63_Picture_15.jpeg)

#### Quicker gear changes

Faster gear changes, both up and down, can make a huge difference over the course of a 24-hour race. When Porsche began serious development of its dualclutch PDK (*Porsche Doppel Kupplung*) transmission in 1981, using it at Le Mans had always been in view. Although PDK had already been evaluated in Porsche 956s and 962Cs at other events, its Le Mans début came in 1986 in the 962C driven by Vern Schuppan/Drake Olson but the car was an early retirement with a gearbox problem.

![](_page_64_Picture_1.jpeg)

![](_page_64_Picture_2.jpeg)

#### Better than eating carrots?

The 'Night Vision' fitted in the Cadillac DeVille road car in 1999 made the American brand the first car manufacturer to employ infrared technology. The following year the four Cadillac Northstar LMP cars run at Le Mans used the system too, by means of an infra-red camera installed in the front right-hand headlight and a screen on the steering wheel.

![](_page_64_Picture_5.jpeg)

#### **Optimising braking**

Anti-lock brakes, commonly termed ABS (Anti-lock Braking System), first saw road use on the Mercedes S Class in 1978 but their début at Le Mans didn't occur until 1993, when first allowed by the rules. Porsche entered an ABS-equipped 911 Turbo S Le Mans with a top-notch driver line-up – Le Mans winners Hans-Joachim Stuck and Hurley Haywood with rally legend Walter Röhrl – but a collision eliminated the car. The first Le Mans victory for a car with ABS was achieved in 1998 by a Porsche 911 GT1-98 driven by Allan McNish, Stéphane Ortelli and Laurent Aïello.

![](_page_64_Picture_8.jpeg)

#### **Reducing fuel consumption**

Don Panoz developed the first hybrid to run at Le Mans, albeit briefly at the test day in 1998. This visionary development of the Panoz Esperante GTR-1, designated Q9 and nicknamed 'Sparky', was constructed by Panoz, Reynard and Zytek, and developed by David Price Racing for the 1998 season. In honour of its electric power, the car was given special purple livery with yellow lightning bolts on its flanks.

#### All at the fingertips

After the advent of semi-automatic gearboxes, engineers gathered more and more of the driver's controls around the steering wheel: paddles to change gear, buttons of all kinds to make adjustments (power, braking, fuel supply and more) and an LCD screen offering increasingly elaborate displays of information. ►

HIGH-TECH STEERING WHEELS

![](_page_64_Picture_13.jpeg)

## **Curiosities at Le Mans**

**VER** its 100 years, the Le Mans 24 Hours has seen all sorts of unusual cars, from true oddballs to experimental designs that were either ahead of their time or doomed to failure. Some changed the game but others were ill-conceived or simply unfit for purpose. Here is a selection of the most eye-catching curiosities, some of which receive more detailed coverage on subsequent pages.

#### **PIONEER OF FRONT-WHEEL DRIVE**

#### 1927 - TRACTA

**IT'S** always easy to look back at history and take a critical look at the experimental approaches of others. Take front-wheel drive, for example. Adopted on the road for its safety benefits, front-wheel drive has never been successful on the track. Nonetheless, a few Le Mans hopefuls have had a go.

The first, in 1927, was Jean-Albert Grégoire, a man of many talents, including racing driver and engineer, who wanted to prove the durability of front-wheel drive in his own Tracta car. His first Le Mans was fraught with setbacks, including a pre-race road crash that left him and his three race drivers injured, but he courageously took part in the race and was still going 24 hours later, albeit the last of only seven finishers. In all, Grégoire's Tracta cars made six appearances at Le Mans, the last in 1934, by which time his efforts had helped to interest various manufacturers in his patented Tracta joint, including Willys, American maker of over half a million wartime Jeeps.

#### SMALLEST ENGINE

1937 - SIMCA CINQ

**IT'S** thanks to the immense talent of Dante Giacosa that Italy owes the creation of the Fiat 500, priced inexpensively by the head of Fiat, Gianni Agnelli, so as to be affordable to the very workers who produced it. This topolino ('baby mouse') was such a success that it was imported to France by Simca and renamed the Simca Cinq. It was then that Amédée Gordini, nicknamed '*Le Sorcier*' ('Wizard'), used it to develop a racing version.

The car was equipped with the smallest engine ever entered for the Le Mans 24 Hours, just 568 cc, and took part three times, in 1937, 1938 and 1939, winning its class on each occasion and claiming the coveted Index of Performance in 1938. That year, drivers Maurice Aimé and Charles Plantivaux achieved an average speed of 52.8 mph (85.12 km/h), which was perfectly satisfactory for such a tiny engine but rather less than the winning Chenard & Walcker's 57.21 mph (92.06 km/h) in the original 1923 event.

Post-war, Amédée Gordini, a friend of ACO President Jean-Marie Lelièvre, went on to enjoy considerable success as a racing car constructor, fielding both sports cars and single-seaters. BELOW Tuned and developed by Amédée Gordini, the Simca Cinq was the smallest-engined car ever to compete in the Le Mans 24 Hours

![](_page_65_Picture_14.jpeg)

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![](_page_66_Picture_18.jpeg)

![](_page_66_Picture_19.jpeg)

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![](_page_67_Picture_2.jpeg)

#### **UGLIEST CAR?**

#### 1950 - CADILLAC SPECIAL

**DEVELOPED** by Briggs Cunningham for Le Mans in 1950 and nicknamed '*Le Monstre*' ('The Monster') by onlookers, this special-bodied Cadillac with 5.4-litre V8 engine probably deserves to be judged the ugliest car ever seen in the race.

The design of its slab-sided body involved an aerodynamicist at aircraft company Grumman, Howard Weinmann, and work was done in a wind tunnel with a clay model. Cunningham and codriver Phil Walters struggled in the race when the car became stuck in top gear but nevertheless made it to the finish, in 11th place.

#### FAIRED-IN WHEELS

#### 1951 - PORSCHE 356SL

**FOR** its very first appearance at Le Mans, Porsche entered two examples of the 356SL ('*Superleicht*' meaning 'super light'). Along with lightening measures that gave the car a weight of only 635 kg, attention to streamlining included the concealment of all four wheels behind bodywork, with the covers for the front wheels having to stick out quite some distance to allow room for steering.

Unfixing these covers to change worn or punctured tyres would have been quite a palaver, so it was just as well that the car driven by Auguste Veuillet (Porsche's Paris agent) and Edmond Mouche had a trouble-free run to win its class.

#### ANTI-FREEZE BRAKING

#### 1954 - FERRARI 375 MM

**AFTER** a Jaguar C-type with pioneering Dunlopdeveloped disc brakes won in 1953, American entrant Briggs Cunningham asked Dunlop if it could supply his cars with disc brakes for the 1954 race – but Jaguar vetoed the idea. Although Cunningham's efforts at Le Mans in this period were based on cars of his own manufacture, for 1954 he entered a Ferrari 375 MM as well, with John Fitch and Phil Walters as ABOVE For its first appearance at Le Mans, in 1951, Porsche enclosed all four wheels on its two 356SL entries

BELOW Despite its incredible appearance, the Nardi Bisiluro of 1955 was aerodynamically unstable and was literally blown off by a faster car drivers. Although the Ferrari was as fast in a straight line as a Jaguar D-type, its drum brakes were prone to overheating, so Cunningham and preparation specialist Alfred Momo tried a novel brake-cooling system filled with Glycol – more commonly known as anti-freeze – and circulated the liquid using small camshaft-driven pumps.

Whether it made any difference was never really clear because the car retired with a transmission failure, but a powerful works Ferrari 375 Plus with drum brakes in any case vanquished the sleek new Jaguars, with the winners, José Froilán González and Maurice Trintignant, leading virtually from start to finish.

#### A NOVEL AIR BRAKE

#### 1955 - MERCEDES-BENZ 300SLR

**MERCEDES-BENZ** came up with its own answer to Jaguar's disc brakes in 1955, by equipping its three drum-braked 300SLR entries with an aerodynamic flap to act as an air brake that could be raised by the driver when required.

The idea worked and Mercedes-Benz might very well have won but for the awful tragedy that unfolded when Pierre Levegh's 300SLR was launched over the back of a slower car, Lance Macklin's Austin-Healey, which had moved into its path. When, soon after midnight, Mercedes-Benz decided to withdraw its two surviving cars, the one driven by Juan Manuel Fangio and Stirling Moss was leading by two laps.

#### CATAMARAN

#### **1955 - NARDI BISILURO**

**WORKING** with driver Mario Damonte and engineerarchitect Carlo Mollino, Enrico Nardi built one of the oddest cars ever seen at Le Mans. The body was configured as two nacelles that made it look like a beached catamaran. The driver sat in one nacelle and a 735 cc Giannini four-cylinder engine occupied the other. The creators named their car the Damolnar **>** 

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![](_page_68_Picture_11.jpeg)

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HISTORIC RACING

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Bisiluro – 'Damolnar' was derived from their surnames and 'Bisiluro' means 'twin torpedoes' in Italian – but it's more commonly known as a Nardi.

With its light weight (450 kg) and unstable aerodynamics, the Nardi got into trouble in the race as soon as the bigger cars started lapping the backmarkers. On only its sixth lap, with Damonte at the wheel, the car was literally blown off course by a Jaguar D-type on the *Hunaudières* straight and ended its race in a ditch, fortunately without harm to the driver.

#### BREADVAN

#### 1962 - FERRARI 250 GT SWB

**COUNT** Volpi di Misurata, a Venetian aristocrat and long-time Ferrari customer, ordered two 250 GTOs in 1962 but Enzo Ferrari refused to supply the cars, due to Volpi having teamed up with two sacked Ferrari engineers, Carlo Chiti and Giotto Bizzarrini, to form ATS (Automobili Turismo e Sport) to build cars of their own design. So Volpi decided to create what he hoped would be a GTO beater.

Bizzarrini, who had been working on the GTO until his dismissal, set about converting a 250 GT SWB, the GTO's predecessor, by giving it many of the GTO's updates within an extraordinary body. German engineer Wunibald Kamm applied his aerodynamic theories to the body by giving it an extended flat roof with a vertical rear window – rather like a van. Come Le Mans, the 'Breadvan' – a nickname coined by an English journalist – ran ahead of all the GTOs and was lying seventh overall in the hands of Carlo Mario Abate/Colin Davis when a driveshaft failure caused its retirement.

#### WHISTLE WHILE YOU WORK

#### 1963 - ROVER-BRM

A COLLABORATION between one of Britain's top makers of luxury road cars and the reigning Formula 1 World Champions provided a unique sight and sound at Le Mans in 1963. The Rover-BRM was a 'jet car' that used a gas-turbine engine running on kerosene (aviation fuel) instead of a regular multi-cylinder petrol engine. For the drivers, Graham Hill and Richie Ginther, it provided a very unusual driving experience because engine response was slow and there was no gearbox. For spectators, it made an intriguing spectacle as it whistled around the track.

It ran reliably, completing the distance in what would have been seventh place had it been accepted as an official entrant rather than merely allowed to run in a 'demonstration' capacity. With new bodywork, it ran again in 1965, this time as a proper entry, and finished 10th. Nowadays, such an innovative car would be an automatic choice for Garage 56.

**BELOW** The 'Breadvan' Ferrari 250 GT SWB is the centre of attention in the Le Mans pitlane in 1962

![](_page_69_Picture_14.jpeg)

#### **THE FLEA**

**1966 - MINI MARCOS** 

**CONCEIVED** by former Royal Air Force pilot Dizzy Addicott and put into production by specialist car company Marcos, the Mini Marcos was a diminutive kit car based on Mini running gear. Among the Mini's myriad French fans was Jean-Louis Marnat, who decided to import Mini Marcos kits and even race one at Le Mans in 1966.

As an enthusiastic competitor in Mini Coopers, Marnat had good connections with BMC, manufacturer of the Mini, and managed to obtain a special 1,275 cc competition engine and gearbox for his Le Mans campaign. When this strange-looking car arrived at the track, one bystander said it looked like a flea but 'ugly duckling' might have been a better description.

Despite being by far the slowest car in the race, Marnat and his co-driver, Claude Ballot-Léna, nursed their Mini Marcos to the end, finishing a solid last, in 15th place and a mere 26 laps behind the car in 14th place.

#### **MASSIVE REAR WING**

#### 1967 - CHAPARRAL 2F

JIM HALL'S Chaparral cars were already renowned in American racing when he decided to try his hand at world championship level. For his second visit to Le Mans, with two Chaparral 2Fs in 1967, he pioneered the use of a rear wing in the most dramatic manner, with a gigantic aerofoil high above the car. What's more, the driver could control the angle of the wing, so that it provided maximum downforce when cornering but could be flattened on the straights to reduce drag.

It was a real landmark design and performed superbly, allowing Phil Hill and Mike Spence to run second before a transmission problem intervened. The following month they won the Brands Hatch round of the world sports car championship.

#### **TURBINE REVISITED**

#### 1968 - HOWMET TX

TX stands for 'Turbine eXperimental' because the Howmet, following in the Rover-BRM's vapour trail, was fitted with RIGHT This oddlooking Mini Marcos was the slowest car in the 1966 Le Mans 24 Hours but at least it reached the finish

BELOW The 'Pink Pig' was a one-off

917/20 driven at Le

Reinhold Joest and

Mans in 1971 by

Willi Kauhsen

experimental Porsche

a gas-turbine engine. Its 350 bhp was a reasonable power output for the time but the revs were stratospheric: 57,000 rpm. Neither of the two cars finished the Le Mans 24 Hours in 1968 but they were reasonably competitive - and a Howmet did win a race in America.

#### **ROTARY PIONEER**

1970 - CHEVRON B16

WITH many innovations, there can be long years of trial and error, and lots of failures and frustrations, before success is achieved. This is the case with the rotary engine, which was first used at Le Mans in 1970 but didn't win until 1991.

In both cases the engine was made by Mazda, a persistent champion of this configuration despite its strident noise in track use and lack of long-term durability in road form. The 1970 racer was a Chevron B16 entered by Belgian Julian Vernaeve but it broke down four hours into the race.

#### **PINK PIG** 1971 - PORSCHE 917/20

**PURSUING** all avenues of aerodynamic research with its fabulous 917, Porsche asked Charles Deutsch's Société d'Études et Réalisation Automobile (SERA) to design an experimental version of the 5-litre powerhouse that would combine the low-drag attributes of the long-tail 917L with the downforce provided by the shorttail 917K. The work was led by Robert Choulet, who came up with an ungainly body that was unusually wide and short. When Porsche stylist Anatole 'Tony' Lapine saw the car, he said it looked like a pig which is why, for the Le Mans 24 Hours in 1971, it was turned out in pink with cuts of pork marked out as if drawn by a butcher. Driven by Reinhold Joest and Willi Kauhsen, it qualified only seventh, behind three 917Ls and a 917K, so it wasn't that effective in terms of speed, but it ran quite well in the race, circulating as high as third place before crashing out during the night. >

![](_page_70_Picture_22.jpeg)

![](_page_71_Picture_1.jpeg)

![](_page_71_Picture_2.jpeg)

#### **ART CARS**

1975 - BMW 3.0 CSL

HERVÉ POULAIN, a French art dealer and auctioneer, decided that he would give his BMW 3.0 CSL a unique paint scheme for his début in the Le Mans 24 Hours in 1975. He chose American sculptor Alexander Calder to do it - and set a trend that evolved into the BMW Art Car Project. With Jean Guichet and Sam Posey as co-drivers, the car performed well, running as high as sixth before going out with a transmission failure.

#### THE ULTIMATE LONG-TAIL

1979 - DOME ZERO RL

DOME is Japanese for 'child's dream'. The low-drag Zero RL, conceived by Minoru Hayashi and designed by Masao Ono, looked more like a nightmare, with a uniquely angular shape and an exceedingly long tail, but it was conventional enough under the surface with a Cosworth DFV V8 engine mated to a Hewland gearbox.

Dome's two entries for the 1979 race had capable all-British driver line-ups in Chris Craft/Gordon Spice and Bob Evans/Tony Trimmer but neither car lasted beyond guarter distance. Dome returned to Le Mans twice more with the same design and managed to reach the finish in 1981, albeit 25th and last.

#### **TRULY DIFFERENT**

#### 1981 - ARDEX

FRENCH aerodynamicist Max Sardou produced a real oddball for the 1981 Le Mans 24 Hours. This was the era of 'ground-effect' aerodynamics, whereby airflow beneath a car with 'ground-effect' channels created a low-pressure area that endowed more downforce.

Sardou's aim with his design, the Ardex, was to maximise the width of the 'ground-effect' channels beneath the car and therefore achieve more downforce. To do this, he put the car's 3.5-litre BMW straight-six engine alongside the driver rather than behind him, so that the car's rear end could accommodate 'ground-effect' ducting of exaggerated size, complete with faired-in rear wheels. A very long,

ABOVE Sam Posey poses with the original BMW 'Art Car' of 1975, with paint job by American sculptor Alexander Calder

**BELOW** The Ardex

of 1981 looked eye-

catching but didn't

qualify for the race and was never seen again

shallow-angled windscreen was an eye-catching aspect of the design.

Sadly, the Ardex failed to qualify for the race, thanks to being in the same class as the quick works Porsche 936/81s. Owing to the speed of the German cars, the radical French effort missed the cut because of the ACO's 110% rule. The Ardex was never seen again.

#### FIRST 4X4 AT LE MANS

#### 1986 - PORSCHE 961

THE Porsche 961, an evolution of the 959 with which René Metge won the Paris-Dakar Rally-Raid of 1986, was the first four-wheel-drive car to take part in and finish the Le Mans 24 Hours. At ease both on the circuit and in the desert, Metge even managed the feat of setting the 10th best lap time in the race (ahead of various Group C1 and C2 prototypes) and, sharing with Claude Ballot-Léna, finished seventh overall.

#### MOST POWERFUL ENGINE

#### **1990 - NISSAN R90CK**

**WITH** a qualifying engine that briefly delivered 1,128 bhp, the Nissan R90CK of 1990 holds the record for the most powerful car ever to run at Le Mans. It was also part of the largest Japanese armada seen at Le Mans: 10 Nissans, five Toyotas and four Mazdas. Nissan allocated a T-car to the task of going for pole position, complete with a special 3.5-litre twin-turbo V8 that had shown over 1,000 bhp on the dynamometer. Team manager David Price tossed a coin to decide which of his two favoured drivers, Mark Blundell or Julian Bailey, would go for the hot lap. At dusk, it was Blundell who ventured out on qualifying tyres, only to find that the extreme power quickly chewed up the rears.

Trying again on race rubber, Blundell was told midlap by his race engineer over the radio to back off because the engine was 'overboosting', but the driver removed his earpieces and pressed on. The engine held together for the rest of the lap and Blundell

![](_page_71_Picture_24.jpeg)
73





duly claimed the first pole position for a Japanese manufacturer. Afterwards, the team established that a jammed wastegate valve had caused the power output to peak briefly at 1,128 bhp.

The race, however, brought little joy for Nissan. Just one of five works entries survived, in only fifth place.

### FORERUNNER IN DOWNSIZING

### 2012 - NISSAN DELTAWING

**THIS** innovative project led by Dan Gurney, in partnership with Panoz and Michelin, was selected in 2012 by the ACO to inaugurate 'Garage 56', which highlights an experimental car. Designed by British engineer Ben Bowlby, the DeltaWing was a 'downsizing' concept based around the idea of reducing weight and aerodynamic drag accompanied by lower power and therefore fuel consumption.

Unfortunately, on lap 76, the novel-looking car, with its narrow-track front end, was the victim of a collision, propelled into a barrier by Kazuki Nakajima's overtaking Toyota TS030.

### ZERO EMISSIONS

#### 2014 - NISSAN ZEOD RC

**WHETHER** in motorsport (with the advent of Formula E) or in private cars, electric power is now reliable and range is increasing. So, in retrospect, the misadventure experienced by Nissan in 2014 with its ZEOD RC might seem to belong to a bygone era.

This car, based on the DeltaWing chassis, was the first to complete a lap of the Le Mans circuit on an electric motor alone (during warm-up on race **TOP** The four-wheeldrive Porsche 961 was an impressive performer in the 1986 race, finishing seventh overall

**ABOVE** The over-sized prow of the frontwheel-drive Nissan GT-R LM Nismo of 2015 contained the engine and gearbox

BELOW The #84 LM P2 Morgan of 2016 was specially adapted for quadruple amputee Frédéric Sausset's needs morning driven by Wolfgang Reip) but it didn't do much for the cause. Due to a transmission problem, the ZEOD RC was forced to retire after just 20 minutes of the race.

### HARA-KIRI

### 2015 - NISSAN GT-R LM NISMO

**DESIGNED** for LM P1, the Nissan GT-R LM Nismo was unique among its peers in having its hybrid powertrain installed ahead of the driver, complete with front-wheel drive. Nissan intended to compete in the whole of the 2015 FIA World Endurance Championship but testing brought so many problems that the début was deferred until Le Mans, where three examples were entered.

They were way off the pace in qualifying, over 20 seconds down on the pole-winning Porsche 919 Hybrid. One of the Nissans survived until the chequered flag but wasn't classified because it had failed to complete 70% of the winning car's race distance. With that, the GT-R LM Nismo was consigned to history, remembered both as an intriguing technical concept and a conspicuous failure.

### **NOTHING IS IMPOSSIBLE**

### 2016 - MORGAN LM P2 #84

**IN** 2016, Frédéric Sausset became the first quadruple amputee to take part in and finish the Le Mans 24 Hours. To accommodate his needs, the car he chose for his remarkable endeavour, an LM P2 Morgan, was equipped with all sorts of modifications.

A hoist was needed to lower him into the cockpit; the seat was fitted with a spring system so that it could be ejected in the event of an accident; a prosthetic limb connected his right arm to the steering wheel; rods linked to the brake and accelerator pedals allowed him to operate them with his thighs; and the gearbox was automatic. Sausset and his two co-drivers, Christophe Tinseau and Jean-Bernard Bouvet, both able-bodied, finished 38th, to great acclaim.



# **MODEL CITIZENS**



74

Sergio Rinland says we can squabble over the F1 business model all we like, but some things will never change

**HE** hot topics of the last few weeks have been the increased influence Red Bull will have on its junior team (Visa Cash App RB), and the comments of former Haas Team Principal Guenther Steiner concerning his former team's business model.

Critics of any F1 business model are quick to justify their outrage by invoking the 'DNA' of the sport. Yet since its inception in 1950, the Formula 1 World Championship's 'business model' has passed through several iterations, so to talk of F1's DNA is such cases is tantamount to an oxymoron.

In the 1950s, Italian teams were the dominant force until Mercedes came to kick the ant's nest in '54 and '55 with the most powerful team after WWII. What was the model then? Alfa Romeo, Maserati, Ferrari, Talbot, ERA and Mercedes ran works teams, but myriad privateers also ran customer cars from those manufacturers. As Enzo Ferrari put it, "I sell GT and sports cars to fund my racing team, not the other way round".

The only teams who did not sell their cars were Mercedes and Alfa Romeo. The latter not because they did not want to, but because all the Alfettas they had were from before the war! Everybody else sold cars to privateers to pay for their works teams' racing.

### Transformation

The 'business model' evolved at the end of the '50s and from the '60s onwards. British teams became the dominant force, starting with the likes of BRM, Vanwall, Cooper, and Lotus. Cooper and Lotus had a similar philosophy to Ferrari or Maserati in the '50s, selling race cars, so you had three or four works teams filling a quarter of the grid. The rest were privateers.

But from the beginning to the end of the '60s, the game was transformed by Coventry Climax producing engines and Hewland and Colotti supplying gearboxes. This way, constructors had only to concentrate on designing and producing the chassis and bodywork. Enzo Ferrari used to disparagingly refer to such teams as 'Garagisti' because for him if you didn't make your own engines, you were not a constructor. He was not happy because these 'Garagisti' used to drive rings around his cars with only a fraction of his budget.

Cosworth's arrival to F1 in 1967 reinforced this new 'business model'. It would last for more than 30 years until the big OEMs began to create their own teams with enormous budgets. That shift, reinforced by the FIA regulations, endures until this day: no more Cosworth, Judd, or Hart; only Ferrari, Mercedes, Honda or Renault. Now the 'Garagisti' partner with the OEMs for their engine supply, effectively becoming second-class citizens.

The budgets spiralled to levels difficult to comprehend by mere mortals. By way of comparison, RAM Racing's budget in 1985 was When Gene Haas first entered F1, we already had 'independents' buying engines and sometimes gearboxes from OEMs. When he declared in 1016 that he was in F1 only to win, having opted to buy half a car from Ferrari and the rest from Dallara, I thought he was, as Murray Walker would put it, "somehow mistaken".

Now, some teams are opposing Andretti's entry; others are uncomfortable with the closer links between the Red Bull teams. But at the end of the day, will Visa Cash App RB be able to beat Red Bull or take points from Ferrari and Mercedes? With all due respect to the guys from Faenza, I don't think so.

One thing has *not* changed in F1 in the last 74 years: there is a very good reason why top teams are at the front



**ABOVE** AlphaTauri, as was, and Haas jostle for position. Both approaches to F1 have proved controversial

eight million dollars – nowadays that wouldn't cover the catering! So, after this constant metamorphosis, which business model is the 'DNA' of F1? Buying complete cars from the works teams? Building your own chassis with 'off-the-shelf' engine and gearbox? Building the whole car yourself, engine included? Or building your chassis (which today needs 500 employees, your own wind tunnel and a multi-million facility) with engine and gearbox supplied from OEMs?

Guenther Steiner was right. Things have changed, but not in the last 10 years, in the last 74 years! and minor teams at the back. If Red Bull gives its cars to any midfield team, the recipient may be in the front row for the first race. By the second race, they will be in the third row. By race five, they will be where they normally are. It is a fact of life and the Haas history is proof of that. My personal view is I would let Red Bull give their cars to Visa Cash App RB; I'd let Andretti come and contribute to the F1 cake (not the other way round, as some think); and I would tell Gene Haas to accept that with his business model he will always be from the middle to the back of the grid, with or without Guenther Steiner.





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