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RACE TECH Motorsport Engineering

Volume 30 Issue 11
Published September 2023
The next issue will be published in early October 2023
ISSN 1356-2975

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

Overseas copies are sent via air mail
12 issue subscription UK: £71.40
Europe: £118, USA/Rest of World: £149
All major credit cards accepted. Cheques and money orders only in Pounds Sterling payable to Kimberley Media Group Ltd.

**BACK ISSUES AVAILABLE:**
8,9,10,11,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,52,53,54,55,56,57,58,59,60,61,62,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,97,98,99,100,101,102,103,104,105,106,107,108,109,110,111,112,113,114,115,116,117,118,119,120,121,122,123,124,125,126,127,128,129,130,131,132,133,134,135,136,137,138,139,140,141,142,143,144,145,146,148,149,150,151,152,153,154,155,156,157,158,159,160,161,162,163,164,165,166,167,168,169,170,171,172,173,174,175,176,177,178,179,180,181,182,183,184,185,186,187,188,189,190,191,192,193,194,195,196,197,198,199,200,201,202,203,204,205,206,207,208,209,210,211,212,213,214,215,216,217,218,219,220,221,222,223,224,225,226,227,228,229,230,231,232,233,240,241,242,243,244,245,246,247,248,249,250,251,252,253,254,255,256,257,258,259,260,261,262,263,264,265,266,267,268,269,270,271,272,273,274

Price including post & packing:
UK: £5.95, Europe: £6.50, Rest of World: £7.55
You can pay by cheque or credit card but please note the minimum on Switch & Delta is £14

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

**Cover image:** Porsche

**Design & Production:** Paul Bullock, Maluma




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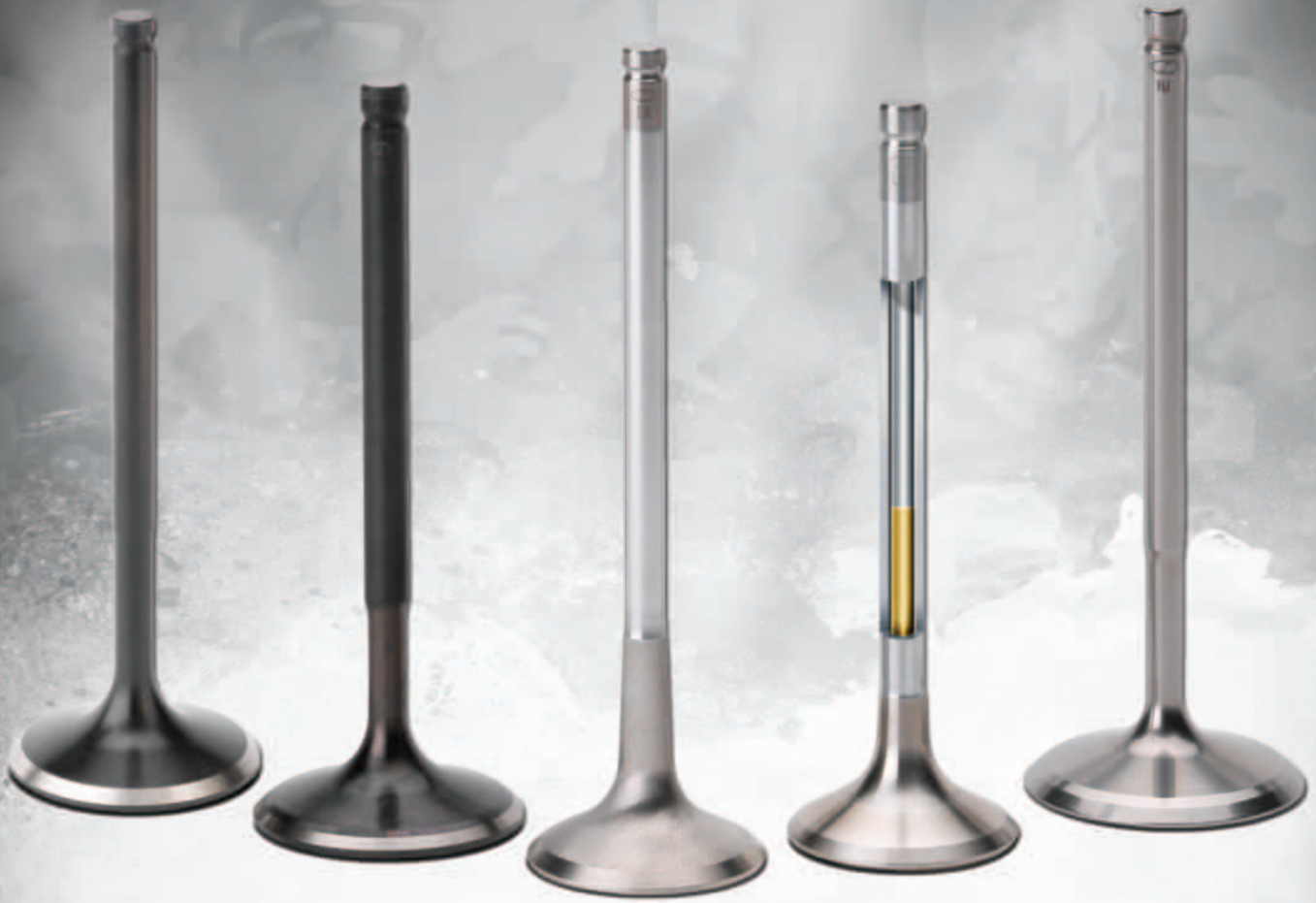

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# CREDIBILITY OF F1 HANGS IN THE BALANCE

**I HATE** losing. Always have.

When you grow up in a house with Competitive Dad, as many of my racing friends did, you learn to savour the fact that when you do eventually win, it is because you *deserved* to. Not because somebody let you.

That School of Hard Knocks probably explains why I am so vexed by the use of Balance of Performance. Like Sergio Rinland, who is typically forthright in his column (see Last Lap), I love Balance of Technology. Am excited by its ability to usher in a golden era of sportscar racing as IMSA's LMDh category takes on the Le Mans Hypercar field. But BoP? Yes, I accept it has a valuable role to play, but surely only when production-based cars – with their inherent production-based disadvantages – are involved?

Like many, I am horrified at the prospect of Balance of Performance somehow squirming its way into Formula 1. For that's certainly the spectre raised by the current debate about the Renault engine's power deficit (see Mercedes boss Toto Wolff's comments in our news section). I get the fact that the engine freeze makes it hard to catch up. I understand too, that ideally we don't want manufacturers humiliated every Sunday.

But there is a reason why everybody – be it the media, suppliers, teams, drivers or fans – want to make it to Formula 1. It's because it is the pinnacle.

We already have an incredibly restrictive set of rules. And an aero testing handicap system devised to favour the teams with less success and fewer resources. If that's not sufficient, don't get Balance of Performance. Get better. Or get out of the top category!

Sounds harsh, perhaps, but most of us grew up hero-worshipping the visionaries. Not the beneficiaries.

We've already experienced a glimpse of artificial racing, at that infamous Abu Dhabi title-decider that cost Michael Massi his job and Lewis Hamilton the world championship. It did admittedly get people talking, but most of them weren't saying complimentary things.

I do accept that times are changing. Younger fans, having grown up on 'Drive to Survive', may view the remaining purists as dinosaurs. Like all dinosaurs, we will eventually be banished back to Jurassic Park.

And when we are there, I bet we all bicker and complain that T-Rex has an unfair advantage! RT

Mark Skewis
**EDITOR**

# MOTORSPORT MOURNS LOSS OF ENGINE EXPERT

Neil Brown's race engines redefined Formula 3 and touring car racing, but it's the man we'll miss most. By **Mark Skewis**


Jakob Ebrey

**MOTORSPORT** lost one of its most respected engine experts last month when Neil Brown passed away a few days short of his 75th birthday, shortly after suffering a massive stroke.

Brown's engines blazed a trail of success in the junior ranks, touring car racing, Formula 3 and the DTM. They helped propel a host of young drivers, including JJ Lehto, Mika Hakkinen, Rubens Barrichello, Ralph Firman, Antonio Pizzonia and Takuma Sato, into Formula 1. At the other end of the racing spectrum, his twin-cam engines also set new benchmarks in historic racing.

A native of Lincolnshire, Brown started out as an apprentice at BRM. There he was responsible for building the Lotus Ford Twin Cam engines for the Lotus Cortinas raced by Jim Clark and Graham Hill, amongst others, in the British Saloon Car Championship.

Following a spell at Vegantune, one of the top Ford twin-cam engine tuners of the 1600 cc Formula 3 era, he set up on his own in 1973. His company, Neil Brown Engineering, won a contract from Ford in 1978 to prepare the 3.0-litre Group 1 engines for its Capris, winning repeatedly in the British Saloon Car Championship and Spa 24 Hours, but it was the Pinto-engined Formula Ford 2000 category that provided the real breakthrough in single-seaters.

> *"He wasn't just a great engineer, a meticulous engineer; he could think outside of the box"*

After Pacific Racing and JJ Lehto won the European and British FF2000 crowns with NBE power in 1987, they graduated to the British F3 Championship in 1988. Team boss Keith Wiggins chose the promising Toyota engine, asking Brown to prepare it, and his Finnish charge won the crown.

West Surrey Racing responded with a deal to replace its Alfa Romeo F3 engines with Mugen Hondas, leading to a defining moment. The Japanese manufacturer opted to establish a preparation house for European motorsport, but who to choose?

"Neil was a special bloke," recalls WSR founder Dick Bennetts. "I used to build racing engines myself, so we had a good rapport: we could understand each other's lingo.

"When Mr Hirotoshi Honda junior said he wanted to set up a UK base, I took him to Neil Brown Engineering, Mountune and Nicholson McLaren. After we had visited all three, he said to me, 'Which one do you want?'

"I said, 'It's not my money, it's yours!'

"'But who would you choose?' he persisted.

"Through the Marlboro young driver programme I knew that Keith Wiggins spoke very highly of Neil's Formula Ford 2000 engine. 'Wiggy' had also just beaten our Alfa Romeo in F3 with Neil's Toyota engine, so I said, 'Maybe Neil Brown…'"

It was a decision with big ramifications not only for WSR – which won the 1990 F3 title with Mika Hakkinen and would become the most successful team in British F3 history – but for NBE and the sport as a whole. NBE-supplied Mugen engines went on to win an incredible 15 of the next 16 British F3 titles.

But Brown was far from a one-trick pony. "He wasn't just a great engineer, a meticulous engineer; he could think outside of the box too," explains Bennetts. That was demonstrated when in 2001 Brown was contracted to build Abt Sportsline's 4.0-litre, 90-degree Audi V8 powerplants for the DTM. NBE continued its role once the

**LEFT** Brown's engines carried many drivers to success but he was actually a good racing driver himself too

Ingolstadt marque returned to the series in an official capacity in 2004, triggering an era of glory. To this day, Brown is still revered by many of the German manufacturer's engineers.

In the UK, NBE's engines have become synonymous with Honda's BTCC success, also powering WSR's BMWs to glory under the NGTC ruleset.

"Neil was a clever guy," recalls former BTCC tech chief Peter Riches. "He was very professional, very methodical; always to the letter of the rulebook. He also had the useful knack of employing the right people.

"His customers were very loyal and I think it says a lot about an engine builder when people go back to them time and time again."

## Perfectionist

Approachable and friendly, Neil was, as the British Racing Drivers' Club noted in its own tribute, a perfectionist whether in his approach to engine design, building and maintenance or when racing. The standards which he set have laid the foundations for the growth of Neil Brown Engineering into a company in which major manufacturers such as Honda, Audi and Ford put their trust.

Until his final illness, Neil remained fully involved in the business which will be carried on by his daughter Fiona, son Matthew and by sales and workshop manager Wayne Mathurin.

RACE TECH extends its sincere condolences to Carole, Neil's wife of 25 years, his family, many friends and colleagues.

**BELOW** Neil's BTCC title-winning Honda K20C engine scooped the race engine design of the year award at the 2016 RACE TECH World Motorsport Symposium. It marked the first time an integrated exhaust management engine design had been evolved and raced in the series

## "An intuition for engines"

### A tribute from a friend and rival

"**MY** abiding memory of Neil will always be of him with his head poking out the top of an aeroplane, smiling and laughing," says close friend David Mountain.

By rights, Mountain, as the founder and MD of Mountune, should have been bitter rivals with Brown, whose company he competed with on the racetrack. Instead, the two shared a passion not only for motor racing, but for aviation – Brown enjoyed flying helicopters for years.

"Neil was top. A real gentleman. I admired him," recalls Mountain.

So what made Brown so special?

"Neil was very hands-on as an engine builder and had what you might call an 'intuition' when it came to engines," reveals Mountain. "He had a great understanding – far better than me – of the manufacturing and machining side of things.

"But also, what a gentleman: if he could lend you something or help you, he would – even if you were a competitor. He did quite a bit for people who needed help, and you'd never hear it from Neil, only from other people.

"You never heard anyone say anything bad about Neil. Mike Jordan said to me only the other day that Neil was one of the few engine builders who never left anybody with a bad taste: if anything went wrong, as things can do sometimes, Neil would always put it right without any fuss. He was a special guy."

**ABOVE** Brown, seen here in a B17, had a real passion for aviation

# Extreme H to become first hydrogen racing World Championship

**THE** Fédération Internationale de l'Automobile (FIA) has delivered a strong statement of intent for its pursuit of a hydrogen-powered future, setting out a framework to create the first-ever hydrogen off-road racing world championship.

The non-binding Memorandum of Understanding, signed by the governing body and Extreme E, establishes a pathway for the hydrogen series, Extreme H, to become an FIA Championship from its inaugural season in 2025. The intention is for it to become an FIA World Championship from 2026, should the requisite criteria be met.

In addition, the pathway outlines that in 2024 Extreme E, currently an FIA International Series, would be recognised as an FIA Championship.

Development of the Extreme H series is underway, with plans advanced to have a prototype launched later this year.

Alejandro Agag, Founder and CEO of Extreme E, said: "Establishing alongside the FIA a world-first hydrogen racing world championship will be a momentous milestone for Extreme E and the new Extreme H series. Eventual accreditation as an FIA Championship and then an FIA World Championship means we would be amongst the top tier of global motorsport categories, and Extreme H would be the first-ever world championship racing series of its kind.

"What started as a conversation many years ago about racing in extreme environments, showcasing the incredible performance and innovation of E-SUVs, has now demonstrated enormous growth and further pioneering technical advances as we move forward with the transition to hydrogen and Extreme H – a world-first.

"This announcement is a significant first step in the development of our championship and our ground-breaking transition to hydrogen-powered racing. Sport is the most powerful and effective platform to drive innovation and our commitment to delivering sustainable motorsport championships full of excitement and with a reduced carbon footprint are testament to that."

Mohammed Ben Sulayem, President of the Fédération Internationale de l'Automobile, said: "Using sustainable power sources in motorsport is the key objective of the FIA and part of our long-term strategy, and this series is an ideal showcase for that. Hydrogen is an important part of that mix, and we have developed a set of safety regulations for hydrogen-powered vehicles which is part of the FIA's International Sporting Code.

"It is encouraging that such a major motorsport entity as Extreme E with its renowned line-up of teams sees the same potential in hydrogen technology. Their approach to equality and diversity matches ours as we push to make motorsport accessible for all.

"Motorsport competition serves as an excellent research and development platform and this new series has great potential. Having the technology tested in the harsh environment of off-road racing in all types of conditions should benefit the whole industry, and in the longer term make mobility more environmentally friendly for everyday users of the road. We are looking forward to working with Extreme E, sharing our know-how and expertise."

## Magnet for the stars

Since its inception in 2021, the Extreme E off-road SUV racing series has proved a magnet for legendary motorsport names, from team owners Lewis Hamilton, Nico Rosberg and Jenson Button, to motorsport heavyweights McLaren, Andretti and Chip Ganassi.

The first sport to be built out of a social purpose, Extreme E – and Extreme H from 2025 – aims to minimise environmental impact while maximising awareness, racing in places that have already been damaged or affected by climate change or human interference.


**BELOW** Alejandro Agag, Extreme E Founder and CEO, and Mohammed Ben Sulayem, President of the FIA, have signed a Memorandum of Understanding


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# Electric hypercar World Cup unveiled

**THE** concept of a World Cup of motorsport has been revived in the guise of the Elite World Cup for hypercars.

A motorsport 'world cup', under the auspices of A1GP, ran from 2005-2009. Earlier this year Origin Sports Group revealed that it was seeking £80 million with a view to a brand relaunch.

Unveiled in Johannesburg, the Elite World Cup for hypercars deliberately steers clear from single-seaters – avoiding direct comparisons with A1GP and Formula E – in its attempts to harness the momentum of the EV movement. It is a direction which resonates with its Chinese investors.

Tellingly, though, it has been co-founded by three key players in the A1 Grand Prix World Cup of Motorsport: Liu Yu and Tokyo Sexwale, the former seat holders of the national A1GP teams from China and South Africa respectively, have joined forces with the championship's former general manager, Stephen Watson.

The intention is for the inaugural Elite World Cup to begin with a winter-season campaign in 2024/25. The choice of car, as suggested by the launch vehicle, is likely to be the 2,000 bhp Lotus Evija.

The series will use a franchise model similar to that seen in A1GP.

In some respects, the ambition of the series to attract drivers from different motorsport disciplines has an IROC (International Race of Champions) feel to it.

Watson explained that the event is called 'Elite' for a reason. "We will engage and invite experienced international racing car drivers that have competed across F1, IndyCar, NASCAR, WRC and the likes," he said. "We want the drivers and teams who have established themselves and represented their countries in various prestigious motorsport championships around the world."

"The Elite World Cup is not just a racing competition. It is a testament to the power of collaboration, innovation and sustainability," Sexwale claimed.

Each national team will require a minimum of two drivers, with races being run in a relay format, the second car taking the place of its team-mate when it pits. With multiple pit stops potentially on the agenda, fast-charging of the batteries is likely to become a feature.

Speaking at the unveiling of the Lotus Evija, at the foot of the emblematic Nelson Mandela statue, Sexwale said that the former South African president recognised that sport has the power to unite nations, driving patriotism and its positive influence for change.

"Launching the Elite World Cup, on Nelson Mandela Square at the foot of Madiba's statue on the eve of the BRICS Summit, is the start of a new and exciting era," he added.

"We have run Team China in many prestigious racing championships since we first started racing internationally in 2004," added Yu. "The automotive landscape has evolved significantly, and as the electric car industry is growing rapidly in China, we're excited and proud to be at the forefront of this Elite revolution in sports."

On the night the founders received a special message from Emerson Fittipaldi, two times F1 World Champion and Indy 500 winner. Fittipaldi, who had been attending a motorsport gathering hosted by Lotus as part of the Monterey car week in Los Angeles, sent a video note saying:" What an exciting time, the beginning, the foundation of the Elite World Cup, with these modern full electric cars, this is the future. What an idea to have the GT World Cup for country racing against country. I hope I will have the Brazilian team, for sure I am going to have the Brazilian team!" RT

**ABOVE** The Lotus Evija on display was a limited-edition Emerson Fittipaldi, one of only eight in the world

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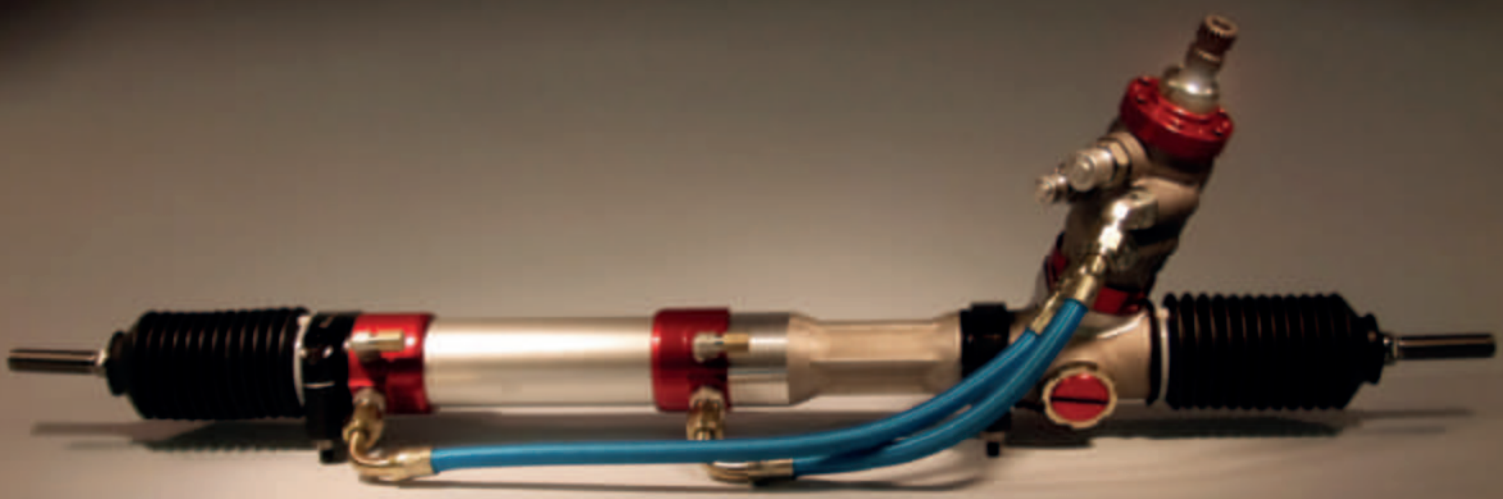

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Pirelli

# F1 risks BoP "catastrophe"

**MERCEDES** boss Toto Wolff has warned that the sport risks "catastrophe" if Formula 1 resorts to a balance of performance system in order to equalise the power disparity between manufacturers' engines.

His comments were the opening shots in a debate sparked by a meeting of the F1 Commission, which has tasked F1's Power Unit Advisory Committee to evaluate measures to help out Alpine supplier Renault.

The Commission remarked that after analysis of PU data throughout the first half of the season, the gap between Renault and its rivals, Honda, Mercedes and Ferrari, was 'notable'. The French powerplant could be as much as 30 hp down on the best of the opposition, with no prospect of closing the gap because of F1's engine freeze.

Wolff has made it clear that any actions taken to peg bag the performance of the top teams would "bankrupt" F1's meritocracy.

"Entertainment follows sport, and why the sport is so credible is because you have just got to work hard to be successful," Wolff explained.

"If you're falling back as an engine supplier, and your engine isn't as performant as others, that's obviously everybody's problem. But at the same time, with a frozen engine, we don't want to lose out on giving someone opportunities.

**ABOVE** Do moves to equalize performance threaten F1's credibility?

"But it needs to be done in a meritocratic way. And, for that, we have a rule in the 2026 power unit regulations that if one power unit will drop out of 3% below the top power unit, then the teams would sit down in good faith and debate what could be done.

"And once we have a common understanding of what the lack of performance is, we need to discuss how much more dyno hours and [development] jokers can be given. And that is something that we are to debate.

"But touching any kind of fuel flow, or BoP, is a catastrophe and bankruptcy declaration for F1. It should never even be talked about."

Alpine's hierarchy paid the price for its poor F1 performance before the summer break, with successive management reshuffles. It freely admits that it is behind rivals in the power stakes, and points out that the equalisation push is important because of the limitations imposed by the cost cap. RT

# Ban on tyre blankets delayed

**THE** FIA has decided to postpone the introduction of a tyre blanket ban for dry tyres in 2024. Instead, it will continue this discussion and further testing into 2025.

Drivers have complained that the lack of grip from unheated tyres when they come out of the pits could be a safety factor.

World champion Max Verstappen recently weighed into the debate, noting: "People probably don't know how difficult it is to drive a car with 1,000 horsepower out of the pits already, and especially when the track is also a bit slippery. It is not necessary."

Seven-time World Champion Lewis Hamilton has also been vociferous on the subject.

The FIA wants to implement the ban on the grounds of environmental and cost saving objectives. The 2023 Pirelli tyre testing campaign has focused almost entirely on this objective, with expanded test days dedicated to no-blankets testing.

Pirelli reported on the outcome of this test campaign to the F1 Commission, which insists the results of the testing undertaken so far show that the change can be implemented to the requested target specifications for 2024. However, it has been decided to "postpone" the blanket ban. RT

# "Sustainability is not just what comes out of a tailpipe"


**ABOVE** The latest forum recognized the WRC's role in driving research and innovation

**ALAIN MATHUREN**, Communications Director for Fuels Europe, has highlighted one of the elephants in the motorsport room, emphasising: "Sustainability is not just what comes out of a tailpipe."

Speaking at the World Rally Championship's latest sustainability forum, at Secto Rally Finland, Mathuren addressed the multifaceted nature of sustainability. Stressing the need for informed choices, he said: "Sustainability is from the building of the vehicle, from the production of the energy, until the use and the recycling of it. We have the solutions, but we need to be very well informed, and the science is critical in this journey. It's not only the tailpipe that counts."

The collaborative event, jointly orchestrated by WRC Promoter, AKK, Secto Automotive, and Nordic Business Forum, ignited dynamic conversations on the convergence of sustainable mobility and the future of motorsports.

A video message from FIA President Mohammed Ben Sulayem reaffirmed the governing body's commitment to sustainability. Ben Sulayem articulated the FIA's ambitious objectives: attaining the highest tier of environmental accreditation for all FIA championships by 2025 and powering championships with 100 per cent sustainable energy by 2026.

Ben Sulayem also highlighted the WRC's pioneering role in sustainability, noting its 2016 achievement as the first FIA championship to mandate event organisers' top-level FIA environmental accreditation and its leadership in adopting 100 per cent fossil-free fuels.

Santiago Pena Gomez, Sustainability Manager at WRC Promoter, highlighted motorsports' far-reaching implications beyond competition. He believes that embracing sustainable practices is pivotal for the sport's longevity, stating, "Altogether, if we look at this and we commit and act in the right way, this can help us to futureproof our sport which is what we definitely need. WRC has offered a platform, not only for testing, but for scaling up these [sustainable] solutions."

The forum also featured a roundtable panel where industry experts exchanged insights and perspectives.

Marc de Jong, Head of Business Development at WRC Promoter, emphasised the competitive spirit of engineers and their quest for efficiency, highlighting how these principles drive innovation both on and off the stages.

## "Dislike for waste"

"We recognise that sustainability is one of the biggest issues that faces us all, and as a sport we want to be part of the solution," he explained. "If there is one thing I have learned from my years in this sport, it's that the engineers are very competitive, and they have got a real dislike for waste. They like to get the best out of a unit of energy: They don't like drag, they don't like friction. These are the kinds of efficient technologies that help us go further in real life and might help us go faster in a forest here in Finland."

Toyota is the standout performer of the WRC's latest generation of rally cars and Shigeru Hayakawa, Vice Chairman of the Board of Directors at Toyota Motor Corporation, was a keynote speaker. He underscored motorsports' vital role in addressing global challenges.

Hayakawa's vision resonated powerfully as he expressed Toyota's commitment to combat climate change and promote freedom of mobility. He emphasised: "Toyota is committed to achieving carbon neutrality by 2050. It should come as no surprise that Toyota is taking advantage of the motorsports arena to develop hydrogen-engined vehicles which will be powered by the combustion of hydrogen itself. Motorsport is driving innovation which, in this case, is driving forward the development of the hydrogen engine."

- The International Automobile Federation (FIA) has launched the next World Rally Championship tyre tender for 2025. The next contract will cover a three-year period from 2025 to 2027.

  Pirelli is currently the official tyre supplier for the series, having won the most recent tyre tender to take over from long-time supplier Michelin. RT

# Formula E sets new indoors speed record

**A MODIFIED** Formula E electric race car, the GENBETA, has smashed the indoor land speed world record by more than 50 km/h. It reached a top speed of more than 218 km/h inside a building at ExCeL London at the track that hosted the London E-Prix season finale double-header.

The official GUINNESS WORLD RECORDS title was achieved by NEOM McLaren driver Jake Hughes, competing with Mahindra Racing's Lucas di Grassi.

The pair went head-to-head in the 'Duels' format used in qualifying for Formula E races to see who could set the fastest speed indoors, on just 346 metres of straight racetrack, using the same GENBETA car.

Neither driver had ever been behind the wheel of the GENBETA before. But both beat the previous world record of 165.2 km/h (102.65 mph) set in February 2021 on all three of their practice runs before their official world record efforts.

The GENBETA car featured a range of modifications to effectively 'unlock' the specifications of the GEN3 race car. The changes included: enhanced battery power output of 400 kW, up from 350 kW in the GEN3; a softer race tyre compound from Hankook; and optimised aerodynamics.

Alessandra Ciliberti, Formula E Technical Manager, FIA, said: "The GENBETA is the first time that four-wheel drive has been activated in a single-seater race car for both acceleration and braking regeneration. This was achieved by turning on the front powertrain kit to achieve greater traction during acceleration. The GENBETA showcases what will be possible for Formula E racing in the near future."

Jeff Dodds, CEO, Formula E, said: "Huge congratulations to Jake and big thanks to Lucas for competing together to smash a world record and showcase the incredible potential of EVs. Everyone involved in the GENBETA project is driven by the same goal of pioneering innovation and development in EV technology and bringing that game-changing tech to the cars we drive on city streets to create a cleaner, electric future." RT

**BELOW** Jake Hughes beat the old record by more than 50 km/h (33 mph)


# MAHLE Motorsport introduces new pistons

**MAHLE** Motorsport has released a POWERPAK Piston Kit for Porsche 964/993 enthusiasts who seek maximum displacement from their engines.

The set features high-quality OEM MAHLE Nikasil-coated cylinders available in slip-in or machine-in and is specifically designed for engines with an 80.4 mm stroke and 127 mm rod length. This takes the original OEM 3.6L to a remarkable 3.9L.

Engineered to exacting tolerances, the pistons are forged from 4032 alloy and deliver a 11.4:1 compression ratio with 1 mm deck clearance (10.9 with 1.4 mm clearance).

The POWERPAK kit comes complete with nitrided steel 1.2 mm top ring, 1.2 mm Napier second ring, and 3 mm oil ring set, precision CNC machined pin bores, and a heavy-duty wrist pin and locks. The pistons are dual-coated with phosphate and MAHLE's GRAFAL skirt coating and feature slipper-style skirts for maximum strength.

MAHLE Motorsport North America was established in 2000 and has positioned itself as a leading supplier of forged pistons and rings in motorsport.

The MAHLE Group's motorsport technology ranges from Formula 1 to winning championships in the three top levels of NASCAR. From those achievements it has created its shelf stock POWERPAK piston set programme. The forged piston sets are designed for those looking to get the best performance out of a Small Block Chevy, LS, Big Block Ford or diesel, as well as several other engine groups. RT

**BELOW** The latest POWERPAK set is for the Porsche 964/993 Stroker 3.6L to 3.9L engines

# DCE Inc expands Mooresville operation

**DCE** Inc, a leading provider of wiring harnesses and electric power steering systems, has announced that it is more than doubling its production space in Mooresville, North Carolina.

David Cunliffe, CEO, said, "We are excited to announce that, due to our continued growth over the last few years, we are moving into larger premises just down the street from our existing building here in Mooresville. The new facility will allow us to add additional build benches for the harness work as well as expanding our electric power steering range."

Production Manager, Matt Eisbrener, added: "We can't wait to get into the new building, with all of the harness production runs we are doing at present for various championships, we really are running out of space! This is going to allow us to massively increase our capacity."

Tom White, the Engineering Manager, confirmed: "The bigger building will enable a larger design area, with improved engineering tools. Our intention is to improve the efficiency of engineering and production, as well as further product development – the new building will be a huge help in fulfilling this."

DCE Inc has been based in Mooresville since 2012 when it initially opened to service the NASCAR supply chain. Cunliffe added, "When we initially set up for NASCAR, we had no idea that we would end up providing products for most of the leading motorsport championships in the US!

"In addition to this, the demand for our electric power steering products is rapidly increasing. We started out supplying the motorsport and hot-rod markets but with the rapid expansion of the electric vehicles and autonomous platforms, we now find our products on everything from the electric 1,000 bhp Nitro Rallycross Group E race cars, to marine vessels and even last-mile delivery robots carrying Pizza!" RT

**BELOW** DCE Inc has more than doubled its production space


# AMD to develop radar absorbing materials for NASA

**FORMULA 1** supplier Advanced Material Development (AMD) has signed a further contract with NASA's Jet Propulsion Laboratory (JPL).

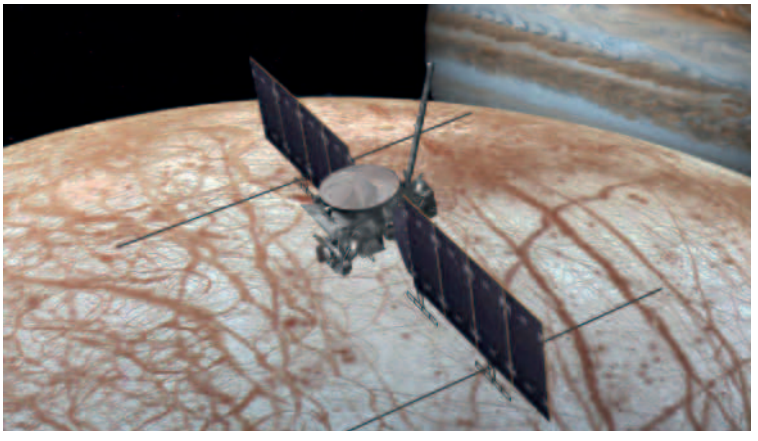
The company's radar absorbing technology is now being incorporated into foam panels and will be used by JPL during the system level electromagnetic compatibility test for the Europa Clipper spacecraft later this year.

The Europa Clipper spacecraft will perform dozens of close flybys of Jupiter's moon Europa, gathering detailed measurements from multiple instruments, including the radar instrument, to investigate whether the moon could have conditions suitable for life. Europa Clipper's primary objective is to determine whether there are places below Europa's surface that could support life.

Commenting on the collaboration, AMD's Chief Commercial Officer, Richard Lee, said, "AMD sees this as major verification of the effectiveness of our solutions in the area of radar absorbance and reflection."

AMD has carved a niche in Formula 1, where cars are an exceptionally harsh and noisy environment, with many sources of electromagnetic interference (EMI) present. These can decrease sensor accuracy and skew transmission and receipt of readings. AMD's solution is a graphene-based coating, an ultra-lightweight, ultra-thin EMI attenuating solution that can apply across numerous substrate materials and survive in the challenging conditions. RT

**BELOW** AMD is the latest F1 supplier to venture into space



# ‘LOST’ LOTUS TO BE REIMAGINED AS A TRACK CAR

Can-Am-inspired Type 66 targets modern GT3 performance. By **Mark Skewis**

**LOTUS** has brought history back to life with the world premiere of the Type 66 – and confirmed the spectacular track-only car will go into production.

The project was unveiled at ‘The Quail, A Motorsport Gathering’ as part of Monterey Car Week in California, USA. It brings to life a ‘lost Lotus’ drawing board programme from the brand’s world-renowned motorsport heritage, combining it with today’s state-of-the-art racing technology and components.

With his eyes on the high-profile and commercially lucrative Can-Am Series, Lotus founder Colin Chapman tasked Team Lotus draughtsman Geoff Ferris to launch the Type 66 project to evaluate how Lotus design principles could be applied to the category. Chapman’s primary focus on Formula 1 meant the innovative project never went beyond technical drawings and scale models.

Now, in Lotus’ 75th anniversary year, Lotus has fulfilled the original vision 53 years after the designer first put pen to paper.

Only 10 examples of this ‘rediscovered and reimagined’ Lotus V8 will be built. It’s a total selected to commemorate the number of races the Type 66 would have competed in during the 1970 season.

The car made its public debut in a heritage-inspired livery – reflecting the red, white and gold colours Lotus raced in during the early Seventies – and which could have adorned the Type 66, alongside the all-conquering Lotus Type 72 F1 car.

The Type 66 is one of the most exclusive projects Lotus has ever undertaken and each example will cost in excess of £1 million.

Simon Lane, Executive Director, Lotus Advanced Performance, said: “The Type 66 perfectly blends the past and present. It takes drivers back in time, to the iconic design, sound and pure theatre of motorsport more than 50 years ago, with added 21st century performance and safety. This is a truly unique project and in our 75th anniversary year it’s the perfect gift from Lotus, to fans worldwide and to a handful of customers.”

He continued: “While the visual expression is strikingly similar to what could have been – including the period-correct white, red and gold graphics – the technology and mechanical underpinnings of the Lotus Type 66 represent the very best in today’s advanced racing performance.”

Crucial to the development of the Type 66 programme has been Clive Chapman, Managing Director of Classic Team Lotus and son of Colin Chapman. It was documents held by Clive which allowed the Lotus Design team to bring the car to life.

## Innovative features

He commented: “The car would have shared many innovative features with our most successful F1 chassis, the Lotus Type 72, which was developed during the same era. These include side-mounted radiators which helped reduce front drag, increase front downforce and channel airflow through and over the car. The rear of the car incorporates a distinctive tail section, resembling the Le Mans endurance cars of the period. These features would have boosted its downforce considerably, compared to rivals, aiding high-speed stability and ultimately its lap times. It would have been


**BELOW** The limited-edition performance car has been rediscovered and reimagined from the company’s archives

**ABOVE** Only 10 cars will be built, each costing in excess of £1 million

spectacular, as is the actual Type 66 we see today."

Lotus F1 legend Emerson Fittipaldi would most likely have driven the Type 66 if it had been built. The Brazilian was guest of honour on the Lotus stand at The Quail and helped to unveil the car.

The Lotus Type 66 has benefitted from more than half a century of technical progress since it was imagined to optimise its design, engineering and manufacture. Using state-of-the-art computer software, the team led by Russell Carr, Design Director, Lotus, digitised a series of 1/4 and 1/10th scale drawings supplied by Clive Chapman and created 3D renders to provide an entirely new perspective of the vehicle. The original sketches were true to Colin Chapman's early designs, featuring a cockpit enclosure that would reduce drag and improve airflow to the rear wing.

In order to conform to modern safety standards and to ensure 21st century driver confidence, the original designs were delicately reinterpreted. New features to the vehicle include a modernised driver compartment, inboard fuel cell, sequential transmission and anti-stall system. Everything is contained in a full carbon fibre bodyshell.


**BELOW** A V8 pushrod engine is at the heart of the car

The front wing was designed to channel air from the front of the car, through and underneath the rear wing, generating more downforce than the vehicle's total weight at full speed. This sense of porosity, where air travels through a vehicle, rather than around it, remains a signature element of Lotus vehicle design today and is seen on the Emira sports car, Eletre SUV and Evija hypercar.

Carr said: "We are incredibly proud to have completed such a unique project, and one that Colin Chapman was personally involved in. There is a real delicacy in remastering the past. This is not a re-edition or a restomod, but a completely new breed of Lotus – a commitment that our past glories will continue to be reflected in our future."

Optimised aerodynamics has been part of the Lotus DNA for all of its 75 years, and the Type 66 is no exception. More than 1,000 hours of Computational Fluid Dynamics (CFD) work has gone into the programme, resulting in downforce in excess of 800 kg at 150 mph. That's far more than the original underbody design would have been able to manage, enhancing both driver safety and vehicle performance for quicker lap times.

> ***"The iconic design, sound and pure theatre of motorsport more than 50 years ago, with added 21st century performance and safety"***

Advanced 'driver-in-the-loop' technology has been used to test how the vehicle would perform on racetracks around the globe, such as Laguna Seca, Silverstone, Fuji and Spa. Thanks to modern-day engineering and ingenuity, the Type 66 now matches the dynamic performance and lap times of a modern GT3 race car. On some circuits, such as Laguna Seca, simulator work suggests it could actually be quicker.

At the heart of the Type 66 is a period-representative V8 pushrod engine. It's mid-mounted for optimised handling, tuned by Lotus to produce more than 830 bhp at 8,800 rpm. Bespoke modern-day components include a forged crank, rod and pistons, which generate torque of more than 746 Nm at 7,400 rpm. The iconic Can-Am-inspired air intake 'trumpets' take centre stage at the top of the engine.

To ensure drivers can unlock maximum performance when on track, the Type 66 features modern comforts such as an EPASS motorsport power steering column, a sequential racing gearbox with reverse, a race ABS braking system, an anti-stall multi-plate clutch and a fixed rollover bar.

# RACE TECH

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"Racing is the fast track to the adoption of advanced technologies on the road but the path from race to road is only open if knowledge is shared"

**PAT SYMONDS**, Chief Technical Officer, F1

"This was my first time attending the World Motorsport Symposium and it was an overwhelmingly positive experience. The quality of people, content and discussions were at the highest levels but the camaraderie amongst those in attendance really stood out. I plan to mark it on my calendar now for 2023 and bring several people from NASCAR to attend. Can't wait"

**ERIC JACUZZI**, Managing Director, Aerodynamics/ Vehicle Performance, R&D Center, NASCAR

"After the sad years of COVID, it was a pleasure to meet the motorsport community again. We share the same passion and are all aware that motorsport has to evolve to green technologies, as we are doing in the ACO with the hydrogen project. These technologies were at the core of all the discussions I had"

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# THE 'PELOTON' PHENOMENON

Florian Modlinger, Porsche's director of factory motorsport for Formula E, talks **Chris Pickering** through the team's most successful season – and the racing trend sparked by the Gen3 era

**I**T was a sign of things to come when Jake Dennis swept through from second on the grid to take the first victory of Formula E's new Gen3 era at the start of this year. No less than seven different drivers would reach the top step of the podium during Season 9 – a marked contrast to the drab predictability of Formula 1 this year – but it was Dennis who went on to clinch the overall crown.

It was the Avalanche Andretti driver's first world championship title, and also the first in Formula E for Porsche, which supplies the team's 99X racecars, along with its own works effort.

This sort of partnership is now standard practice in Formula E. Nissan has partnered with McLaren, Jaguar with Envision Racing and Mahindra with Cupra. For Porsche and Andretti, it means a full technical partnership, with essentially all the hardware and software beyond the Formula E spec elements coming from Weissach and shared between the two teams.

The payback for this approach is data. As Florian Modlinger, Porsche's director of factory motorsport for Formula E, points out, "four sets of data are better than two".

It's not as simple as building a second pair of cars and then wheeling them out the door. Porsche has run a factory team in Formula E since Season 6 (2019-2020) but in order to supply a customer team it needed to expand its operation. Two trackside engineers were assigned to Andretti full-time, along with additional personnel working with the software back at base.

"Right from the beginning, we decided to work on a basis of completely open cooperation," explains Modlinger. "We work transparently, sharing setups and development ideas, which then go back


Photos: Porsche

**BELOW** After its most successful season to date, Porsche has announced a two-year extension to its Formula E commitment. It will also help shape the fourth-generation car that will build on the success of the Gen3

to the development teams at Weissach. This means Andretti can clearly see our data and we can see their data. And that's a benefit for both parties."

Formula E teams are comparatively limited on the amount of data that they can actually harvest from the cars. There simply aren't as many sensors as you'd find on a Formula 1 or LMH car. But the data that comes off the car is hugely important. It allows the drivers to identify where – and more importantly, why – they are gaining and losing time compared to each other. There's also the crucial topic of energy management.

"Data is in everything that we do," comments Modlinger. Such is the volume of information the engineers are handling that they've started looking to artificial intelligence as a means of analysing it: "It's early days, but we're starting to think about how AI could be used. We already have some small projects in that area, and it will increase next season for sure, because the amount of data that we collect is huge."

Gen3 has been a learning curve for all the manufacturers, he admits. Porsche originally joined Formula E partway through the Gen2 era, but the new generation marked a clean sheet design for everyone concerned.

"When you see how complex the challenge was to develop this car, I think the season went really well, from a technical point of view," he says. "The complexity with these Gen3 cars is huge. The effort put in by all the manufacturers has also been huge."

Porsche's powertrain was running on the test rig well before the common parts were finally released to the teams in May 2022. By that point the decision had already been made to push back the start of Season 9 from December of that year to January 2023 to give the teams enough time to prepare. Nonetheless, the schedule remained tight.

"We should have already been testing by the time that the common parts arrived, so it was really a big effort to get everything ready. We hoped that the technical issues with the RESS [Rechargeable Energy Storage System] would have already been sorted by the time it was handed over to the manufacturers, but that wasn't the case. With such a tight timescale, we wanted to be focusing on our own car and not addressing issues with the common parts," notes Modlinger.

> ***"It's like the Tour de France – you need to really think about when you go into the lead"***

The biggest technical challenge, he says, was the new braking concept. Previously, Formula E cars had up to 250 kW of regenerative braking on the rear, plus conventional brakes on both axles. For Gen3, the ▶


hydraulic brakes have been removed completely on the rear, where there is now 350 kW of regenerative braking through the manufacturer-designed powertrain. The new front powertrain, meanwhile, features spec hardware that can provide up to 250 kW of regenerative braking, but this has to be blended with both the hydraulic brakes on the front and the additional regen on the rear.

"In my opinion, the biggest challenge facing the engineers so far in Gen3 has been the complexity of the braking system," comments Modlinger. "You have two big challenges. Firstly, you have to get as much performance as possible out of the individual elements within the braking system, but you also need to do that in a way that gives the driver the confidence to brake late into the corner. They need to be able to anticipate how the car will behave."

All the teams are given a specification document from the FIA that defines the limits within which the front powertrain may be used. Beyond that, the control software and calibration are entirely left to the teams (or, in this case, the manufacturer, with Porsche and Andretti sharing their resources). This not only gives them the freedom to set the balance between the front regen, rear regen and hydraulic brakes, but also to control how that is applied throughout the braking phase. For instance, the bias could start towards the front as the brake pedal is initially applied and then shift rearwards as the pressure is released.

## Learning curve

Another challenge for Season 9 was the arrival of a new tyre supplier, with Hankook taking over from Michelin. Inevitably, a new tyre design will bring different characteristics that the engineers and drivers will need to analyse and learn to optimise.

"These [brake and tyre] changes were the main challenges at the start – not just in testing, but also in the early races. The package was far from fully optimised for every manufacturer and every team, I think," comments Modlinger. "The whole process was learning race-by-race, session-by-session, analysing new areas of potential and improving the car. We were learning throughout the whole season."

The ultimate aim of the team, Modlinger points out, is to optimise the car as a complete package. That includes working with different ambient conditions and on different track layouts. This was neatly illustrated earlier this year during Formula E's first visit to Portland, where there was an appreciable difference between the top speeds of the cars, arising from the use of different motor and transmission concepts.

Portland was also one of the tracks that highlighted the 'peloton' phenomenon that's been a major feature of the Gen3 races so far. With energy efficiency at such a premium, it's often beneficial for the drivers to drop back in the pack and take a tow from the cars in front rather than race for the lead.

The reaction to these "cycling races", as Modlinger

**ABOVE** The 'peloton phenomenon' saw drivers focus heavily on slipstreaming

**RIGHT** At its best on quick tracks, the car's braking struggles saw it hampered in cooler conditions and on tight layouts

terms them, has been mixed. Some have argued that they devalue the on-track action until the final, decisive moves at the end of the race, and that they place energy efficiency above performance. Others will point out that slipstreaming has always played a key strategic role in series like NASCAR and IndyCar, and that it's helping to stimulate overtaking in Formula E.

The Portland race, for instance, featured an outstanding 403 overtaking manoeuvres over the course of 32 laps, with all 19 finishers crossing the line on the lead lap and the top 10 separated by just 4.3 seconds. In contrast, the Formula 1 Spanish Grand Prix held a fortnight earlier saw a 24-second gap between first and second, with the 10th place finisher well over a minute behind.

For the teams, these races require a fundamentally different approach to the less energy-intensive circuits, Modlinger explains: "There are now two types of races, depending on the characteristics of the track. You have more traditional races, and then you have these cycling-style races. It's like the Tour de France – you need to really think about when you go into the lead, how many laps you lead, and whether you pull the field or not. That's a strategic decision, but it also relates back to your ▶

**RIGHT** The squad experienced both delight (above) and despair (below) during the opening season of the Gen3 era, with punctures and collisions hampering its title quest



powertrain and which type of race it suits best."

The split between regular races and 'peloton' races is largely decided by the circuit layout and the energy allocation set by the FIA before each race. During Season 9, this ranged between 27 kWh and 41 kWh. Portland, for instance, had a relatively generous allocation of 38 kWh, but it was using a very fast layout that effectively followed the conventional IndyCar circuit, rather than the tight and twisty street circuits that dominate much of the Formula E calendar.

"The more energy saving [mandated by the FIA] and the quicker the track – with longer straights and higher speeds – the more we tend to head towards this strategic 'cycling' race. Portland was a really good example, having not only the fastest speeds, but also the widest track, so the drivers were going into the corners

**LEFT** Jake Dennis, who races for the Porsche customer team Avalanche Andretti, was crowned world champion after an outstanding season

**RIGHT** Florian Modlinger, Porsche's director of factory motorsport for Formula E

**LEFT** The Porsche 99X Electric was a strong package, though rivals' tribulations probably gave a false picture of its early supremacy

five or six cars wide. That looks spectacular, but it also makes for a really challenging strategic race," notes Modlinger.

## Untapped potential

Season 9 has been a learning experience for all the Formula E manufacturers, with different car and driver combinations excelling at different tracks. With a season now under their belts, all the teams should be better equipped to exploit the capabilities of their Gen3 cars next year, but it's likely that we'll still see a fair amount of variation across the field.

"You need to look at compromises in the rear kinematics and the suspension pick up points, so you design around a point that represents the average across the season," comments Modlinger. "I think that the manufacturers all have different approaches with different strengths and weaknesses. I doubt that you can fully optimise all packages to peak performance on each track, especially with the differential and the rear kinematics."

He's upfront about the 99X's own strengths and weaknesses: "Our strengths over the season were clearly in hot conditions [and] on tracks where you have medium to high-speed corners. We struggled clearly at the beginning on tracks where we had only stop and go with low-speed rotation, because our braking performance was not the best. There we worked hard and made significant steps for braking performance. Still, I would say that we can improve clearly in qualifying and colder conditions and low-speed rotation."

This surefooted balance in high-speed corners is partly down to the 99X's kinematics and its differential behaviour. For instance, how the differential reacts if the driver lifts off in the middle of a corner.

"I think one very good example was Cape Town where we told António [Félix da Costa] that we had secured P2, and he should only make a move on the lead if it's a safe move and he feels confident to do it. And then he attacks him in one of the highest speed corners, because he felt confident and, for him, it was not a risky move," recalls Modlinger.

In addition to the technical highs and lows, there's also the performance of the team to consider. One moment, in particular, stands out here, Modlinger explains, at the inaugural Hyderabad ePrix. A huge crash for Pascal Wehrlein in FP1, initially thought to have been caused by a mechanical issue, led Porsche to sideline its cars for the remainder of the session while the data was examined. Wehrlein's car also had to be rebuilt before the following day's qualifying session, but the Porsche works cars went on to finish third and fourth.

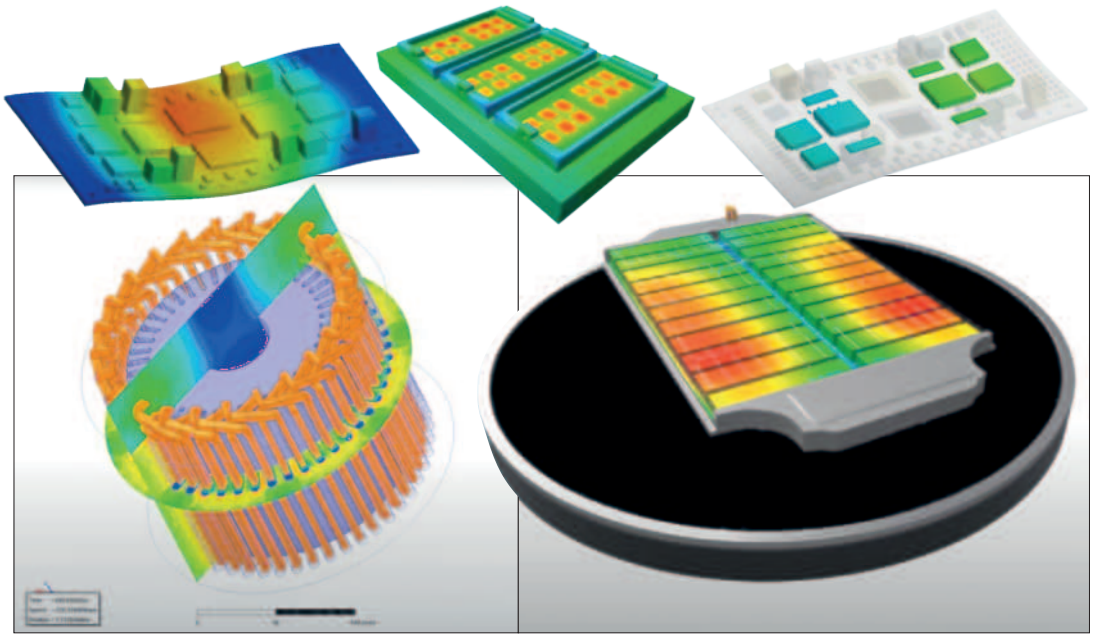
"The guys worked through the whole night to repair the car. I was really happy to see the spirit, the mindset of the team, the attitude. And then finishing with both drivers after such an incident and after such a night was a high for me," he recalls.

## Future plans

Season 9 saw the introduction of cost caps for both the manufacturers' development budgets and the teams' trackside operations. Modlinger believes this will help to keep the series financially sustainable. He also believes Formula E is in good shape from a technological perspective, demonstrating an impressive pace of evolution over its first nine seasons.

"Back in Gen1, they had two cars per race. By Gen2 it was one car. Now, in Gen3, which is the fastest, the lightest and the most powerful car that we've seen in Formula E. And, for me, the most impressive thing is the charging. Not only can the car ▶

> *"You design around a point that represents the average across the season"*



**LEFT** The squad has used ANSYS simulation software to optimise the elements of the electric powertrain throughout its Formula E programme

recharge at 600 kW during braking, but it has also been designed to recharge at 600 kW on a boost charge [in the pits] which is around twice as fast as the fastest road car systems. We produce more than 40 per cent of the energy that we use during the race through regenerative braking."

Having used a shortened layout in the past, Formula E now shares the track layout with Formula 1 when it visits Monaco. "If you look at how much energy [the other series] uses for one lap, compared to how much energy we use, you will be surprised just how efficient our cars are," he says.

It's not yet clear when and how this fast-charging capability could be expanded to become part of the racing spectacle. Plans for a 30-second 'Attack Charge' pit stop to be introduced during Season 9 were abandoned, but the topic is still very much on the agenda.

"There's an ongoing collaboration between all the teams, the FIA and FEO to look at both the technical validation and the sporting impact of fast-charging. In my opinion, from the validation work and the discussions that have taken place, it's not far away."

The next major shake-up for the series could come in Season 11. Later this year – ahead of Season 10 – the manufacturers


**ABOVE** The team's excellent reaction to adversity in Hyderabad was one of the season highlights

will be invited to test the use of the front powertrain for propulsion (as well as energy recovery) in a private test with Spark Racing Technology. If all goes well, the plan is then to roll this feature out for Season 11, although there's no word yet on what format this might take or how it will fit into the sporting regulations.

Beyond that, Modlinger hints that the next topic could be some degree of freedom in the battery and the supporting infrastructure, although that's unlikely to come before the start of Gen4 at the earliest.

For the time being, there are other things to consider. Formula E's homologation process means that the teams aren't allowed to make any hardware changes to the cars ahead of Season 10, although they are allowed to analyse setup options within the scope of the current design. The key engineering battleground, however, will be software.

Once again it will come down to the manufacturers' ability to gather and analyse data, to spot any potential inefficiencies and to exploit the existing hardware as cleverly as possible. The Gen3 era may now be established, but you can be sure there's plenty of excitement left to come. RT


**RIGHT** Ultimately, the team's poor qualifying performance was decisive. London typified that trend, with António Felix da Costa driving a sensational race from 17th on the grid to P2

**LEFT** The Portland race featured 403 overtaking manoeuvres over the course of 32 laps

# THE A-Z OF A NEW TRANS-AM

**Skitter Yaeger** reveals the key engineering calls involved in the design and build of a new racecar that is making waves in Trans-Am, home to the ultimate American road racing machines

**TA1** is the top class in the Trans-Am series, sanctioned by the SCCA. These are 900+ hp (670+ kW) tube frame silhouettes that weigh 2780 lbs (1261 kg) with the driver and an empty fuel tank. They race on the fastest American road courses and rovals. With only a single element rear wing, production car rear diffusers, and a 50 lb (23 kg) penalty for using a front diffuser, there is still enough downforce to take a typical 1.4G slick up to 2G in high-speed cornering and braking.

The previous generation Ave-Riley TA1, as prepared by Burtin Racing, was and is a really, really good racecar that makes full and consistent use of all four enormous Pirelli slicks (320/66 R18 front, 350/72 R18 rear). Don't think that carburettors and live axles mean crude or slow. These cars accelerate out of corners at 0.8G while still cornering at 1G lateral.

Claudio Burtin, Burtin Racing's team owner and driver, had a lifelong dream to run his own ultimate racing car in a top class.

For the new Burtin BR1 chassis, we had the same goals as any other racecar:

- Don't mess it up
- Reduce and centralize mass
- Increase torsional stiffness
- Reduce local compliance
- Decrease setup and manufacturing time
- Increase setup and manufacturing legibility

The build was led by Damon Lockhart, brilliant fabricator/crew chief for Burtin Racing.

"Having never built a clean-sheet car before, not just an update or restoration, it was a little daunting, but I embraced it," says Lockhart. "When I was a kid, I always said I wanted to build a car, never actually realizing that it could be a possibility, or what it even entailed.

"There is an endless list of unanswered questions: 'Where is this going to go? How will this fit? Will there be any interference? Will this break, is it strong enough, is it safe enough?' I just kept three things in mind for every problem: low, central, and easy access."

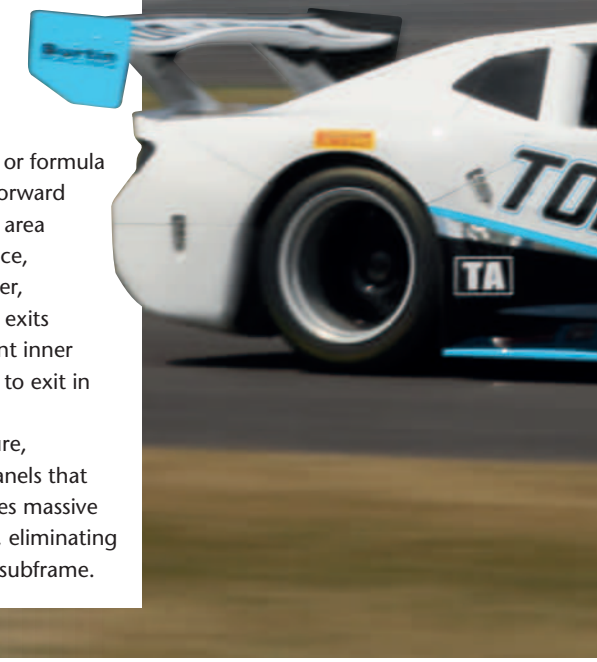
## Front Clip

In a way familiar to many prototype or formula designs, all bodywork and ducting forward of the front axle detaches. This is an area of significant aerodynamic importance, controlled by size limits on the splitter, radiator exits, and diveplanes. Hood exits were added for the radiator. The front inner fenders and door channels direct air to exit in front of the rear tyre.

Instead of a secondary steel structure, Lockhart created cockpit closeout panels that also support the bodywork. This saves massive weight, and repairs are panel swaps, eliminating cutting and welding on a damaged subframe.

**RIGHT** Exterior bodywork is provided by approved suppliers. Mounting to a bespoke chassis is each team's responsibility

**RIGHT** (A) The steering rack and crossmember

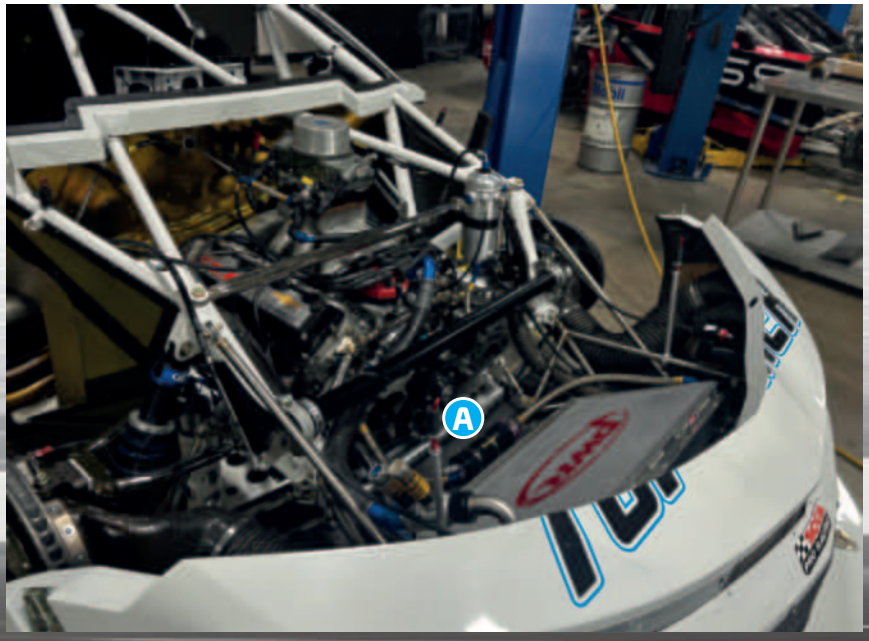



## Steering Rack

It may look like a lot of space, with the first spark plug lined up with the front axle, but the steering rack was one of the toughest components to package. Bump steer was a problem that had been greatly improved, but not completely resolved with the previous car. Too many things are competing for the same space. Changing the engine envelope is expensive and has performance risks. And there are high forces coming in from the lower wishbones that need to be carried across the chassis.

If this program had F1 budgets, the steering rack would be fully stressed. And so would the dry sump and bellhousing, instead of the gaping hole from the front crossmember to the transmission mounts in the firewall. We considered stressing the existing rack housing, but decided not to risk binding.

Clamped by the same bolts as the steering rack, a machined aluminium crossmember carries the lower wishbone loads in cornering, instead of a chassis tube. We were able to move it forward to clear the front belt drives and make engine removal easier. ▶





**LEFT** The new Burtin BR1 showed competitive pace in its debut at Indianapolis Motor Speedway, but the outing was cut short by a flat tyre

## Front Suspension

The previous generation front suspension had no bad tendencies. Data from the new tyres was limited. The initial thought was to preserve existing kinematics and build in significant, easy, repeatable adjustments.

- Caster: The aluminium wishbone pickups are asymmetric. Flipping the upper wishbone mounts relative to the lower wishbone mounts offers three caster angles before adjusting rod ends.
- Camber: Shims are bolted in or out between the outboard wishbone pickup and the legs.
- Toe: Traditional left- and right-threaded steering links.
- Anti-dive, anti-lift, roll centres: Titanium top hats in each wishbone pickup give two options per infinitely machinable pair design.
- Bump steer: Like the wishbones, the steering rack has different mounts available to stay parallel, aided by outboard standoffs.
- Ride height: Lockhart added the quick, flippable hats at the top of the spring+damper. I am 100% stealing that for future cars.

Geometry changes can now be made in a quarter of the time they could before. There were hints that slightly more camber gain and slightly lower roll centres would suit the driver, race engineer and tyre personalities. Those adjustments are now proved out.

## Engine

From ECR Engines, this is a 358 cubic inch (5.9L) naturally aspirated V8. There is a single four-barrel carburettor. There are two valves per cylinder, pushrod-operated. The compression ratio is unlimited, and there is 112 octane fuel. The block is iron, with manufacturer or homologated aftermarket aluminium heads.

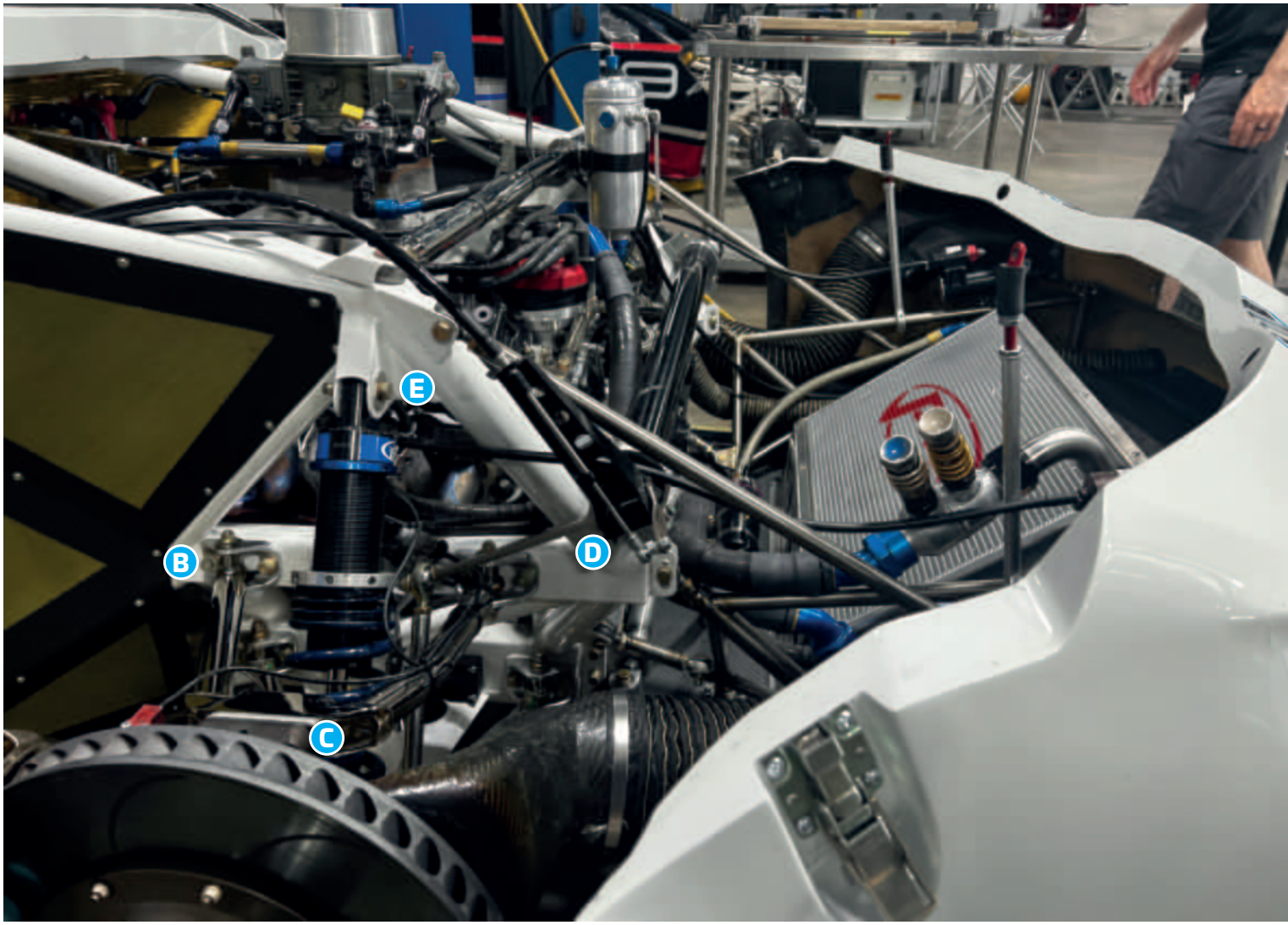
How efficient is the combustion?

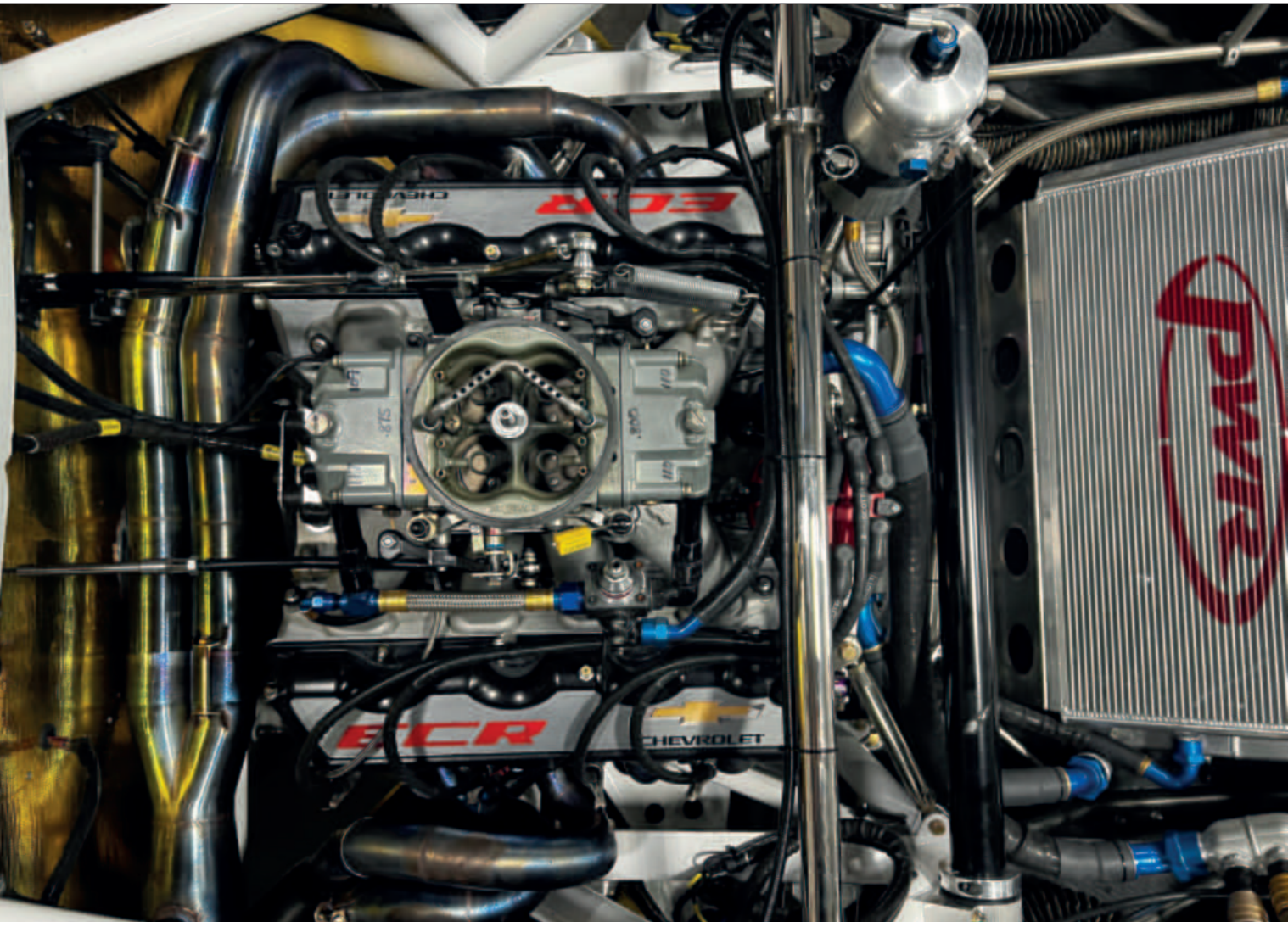
Assume 240 lb (108 kg) of fuel, 40 laps at Road Atlanta, 80s pace.

**108 kg * 12.9 kWh/kg gasoline = 1,393 kWh**
**670 kW * 80% throttle * 40 laps * 80 s/lap / 3600 s/h = 476 kWh**
**476 kWh / 1,393 kWh = 34% efficiency.**

**RIGHT** Lots of room for very long primary and secondary headers. The driver's side crossover overlaps the bellhousing

**BELOW** (B) Reversible wishbone pickup, with flippable top hats, (C) camber shim, (D) anti-roll bar with driver-adjustable blade end, (E) slotted ride height hats






Impressive, especially without fuel injection. Efficiency is power.

Traction control is illegal, and its use will result in all of the following: the confiscation of the car; a two-year ban; a $250,000 fine.

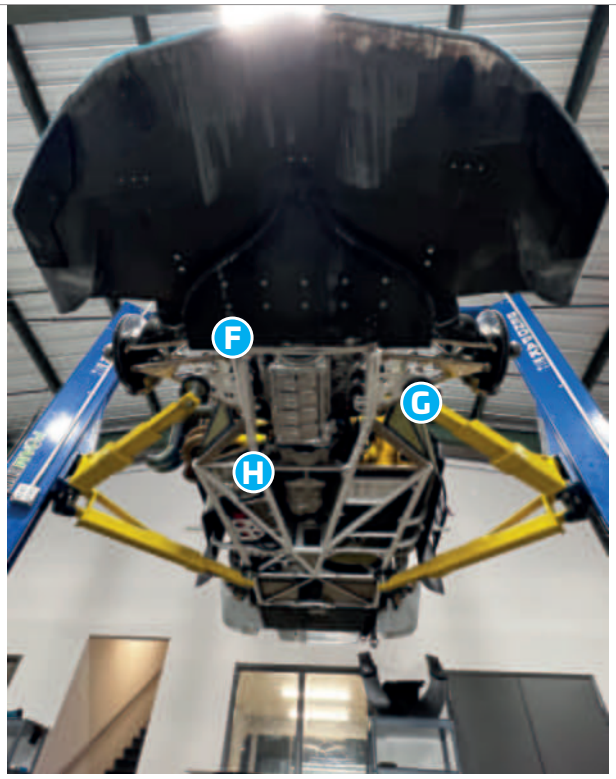
My preferred strategy uses first gear for the first traction-limited 100 mph (161 km/h). That might sound high; it's equivalent to second gear on my old 73 hp (54 kW) Insight. The other four gears are for reaching 200 mph (322 km/h). Legacy rules allow a mass reduction of 25 lb (11 kg) for 4-speed transmissions. Given the high speeds and linear power of naturally aspirated engines, the mass would have to be even lower to tempt me.

## Chassis Design

Burtin Racing was given an amazing opportunity to partner with CP-Tech, which also manufactures F1 Halos. We were given access to its proprietary CPDUR1000 tubing, which has much higher material properties than 4130, and with the correct filler rod, can be welded without affecting those properties. This allows the strategic use of incredibly light tubing. This also means strength is maintained through repairs and modifications.

As always, we started by locating as many components in CAD as possible. We selected three sizes of tubing to use for the entire chassis, emphasizing stiffness::mass ratio in all areas. Tubes were placed in all rules locations, and we tried to let the rest design itself. Across dozens of torsional ▶

**BELOW** Looking back after finalizing the design, of course I only see the little things I want to improve




**LEFT** (F) steering rack crossmember, (G) front air jacks, (H) transmission crossmember. Not installed: driveshaft

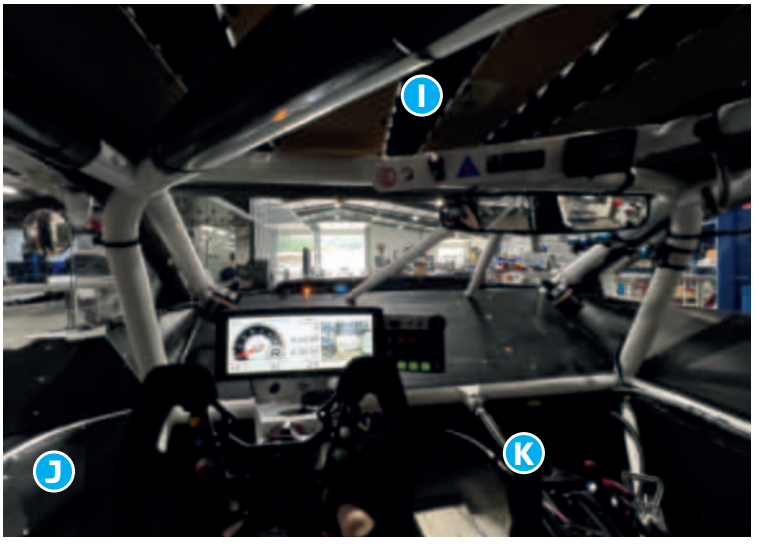
**BELOW** If they exist at all, doors are cut by the teams from standard bodywork. These were extended down to the height of the chassis door bars

simulations, the chassis reached diminishing returns and a good balance of mass, stiffness and simplicity at a calculated 26,000 ft-lbs/deg (35,000 Nm/deg).

Another high design priority was fast installation and removal of the transmission and driveline. This large keep-out zone in the floor had a strong influence on the chassis geometry. As with the steering rack, removable machined crossmembers replace chassis tubes. The transmission assembly itself is used for vertical stiffness.

The crew can now choose to independently remove the engine and transmission with all crossmembers remaining in place. Or open the entire area and pull the assembly out in one piece. Or anything in between, depending on how the race weekend goes.

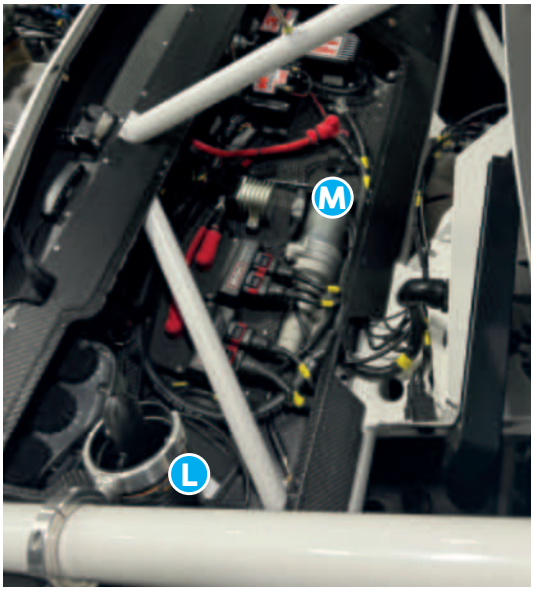
According to Lockhart, "The initial stages of the build were made much easier by CP-Tech and their incredibly accurate bending, cope design, and laser cutting. Almost zero gaps anywhere. Welding on the CPDUR1000 is much like 4130 Chromoly, just a different filler rod. In contrast, because of the extreme toughness, it felt like I went through hundreds of drill bits and taps."




**ABOVE** (I) Roof louvres, (J) entry ramp, (K) sequential shift lever

## Cockpit

There were many requests for changes between the firewalls, starting with more space for big and tall drivers. A lot of work went into smoothing out the entry and egress area. A-pillar visibility was maximized by aligning sightlines with the bodywork, 8" (200 mm) wider than the previous generation. Tubes were also located in the windscreen area to tie the front shock and anti-roll pickups to the roof. I was not allowed to consider X-shaped tubing behind the windscreen. ▶




**RIGHT** Dashboard electronics: (L) defog with air conditioning, (M) programmable electric power steering

## Rear Suspension, Decoupled 3-Link

With a solid rear axle, negative camber and toe are permanently set when the mounts for the hub carriers are welded on. This dates back to the "Grey Ghost" 1964 Pontiac Tempest built for the 1971 Trans-Am season. Solid axle camber only changes due to axle roll from differential tyre deflection or kerbs. Axle splines into the hubs are a wear item, and the limiting factor on angularity.

Only ratcheting (Detroit Locker) or helical (Torson, Quaife) differentials are legal, or the differential may be replaced with a spool. There are not many differential tuning options, especially at these power levels.

The side view angle of the trailing arms is the coarse setting for anti-squat and anti-lift. Over generations of Trans-Am cars, trailing arms evolved straight out, longer and longer, to attach just below the centre of mass. The horizontal alignment places roll steer into understeer, and combined with long length, minimizes its effect, while also minimizing changes in the very high levels of anti-squat through suspension travel.

Each brake caliper has a freely rotating mount on the axle, and uses a separate link to react the braking torque. This allows the anti-lift to be fine-tuned independently of the anti-squat.

A third link at the top of the axle, near the driveshaft, reacts the acceleration torque. The third link side-view angle serves as fine-tuning for anti-squat. We had to compromise on a lower mounting location on the axle itself, rather than moving the large diameter X-brace of the main roll hoop. This increases the third link internal forces.

We also ran out of space for the ideal location to balance the pinion torque that unloads the right rear tyre under acceleration. So there is a small variation in left-right rear tyre loads caused by drive torque.

The traditional front attachment for a Trans-Am third-link uses a lead screw. Big adjustments are sometimes made between qualifying and the race due to fuel load. Lockhart conceived the experiment in this car: a motor attached to the lead screw, for on-the-fly adjustment. Binding and galling became huge design concerns with the lead screw unlocked and loaded. There are a number of bronze or aluminium bronze parts to smooth the action out.

## Fuel Cell

The most ambitious and difficult target was containing all the fuel between the axles. There were times we felt the jaws of defeat: can't get there from here. 240 lbs (108 kg) of fuel, moved about 25" (635 mm) forward is only a 2% shift in centre of mass. But it is much safer inside the big chassis tubes: there is only a 2% balance change from full to empty instead of 4%, and the polar moment of the fuel is halved.

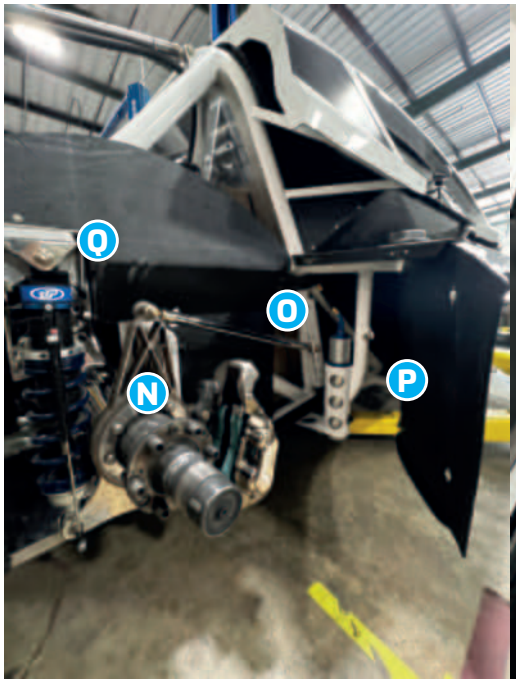
This was not without performance risk, especially with little data about the change from 16" to 18" tyres. While the 16" tyre responded well to forward ballast testing, an increase in rear tyre load sensitivity could have left the car unable to achieve maximum rear grip. A relative increase in the front load sensitivity could have left the car with incurable understeer. We calculated the necessary ballast to match the previous generation corner weights, and were able to save mass elsewhere to stay at the rules minimum.

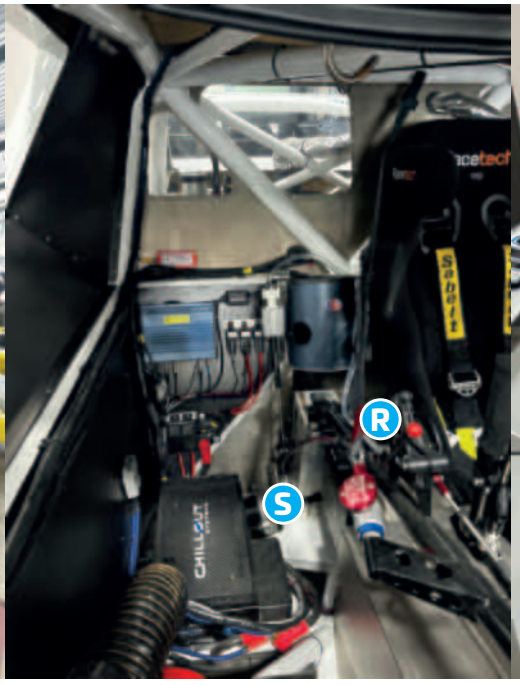
Another concern was the car rotating too fast for gentleman drivers. ▶

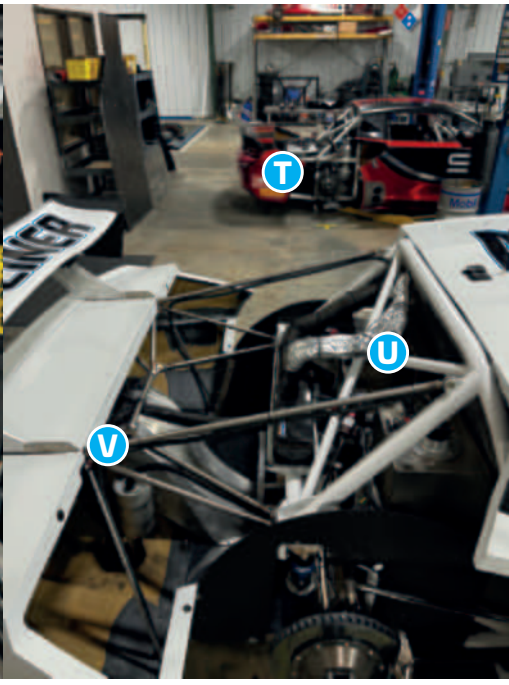
**BELOW LEFT** (N) Freely rotating caliper mount, (O) anti-lift options, (P) trailing arm options, (Q) ride height shims

**BELOW CENTRE** Rear firewall, (R) front and rear anti-roll blade adjustment levers, (S) power adjustable third-link mount

**BELOW** (T) Previous generation fuel cell location, (U) Burtin BR1 split cell locations. The bulk and structure of the car now ends at the rear axle. We did leave the gearbox and differential cooler (V) in its previous-generation position



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## Rear Suspension, Lateral and Roll Centre

The trailing arms, third link, and caliper links carry the longitudinal forces on the solid axle. A separate system is needed to carry the lateral forces.

"Everyone knows solid axle suspensions are bad!" If you leave the roll centre at axle height (most stock production), and lower the centre of mass to the axle height (starting guess for a good racecar), there is absolutely zero roll control from the springs, dampers or anti-roll bar. The result is predictably awful.

Drag racers use anti-squat over 100%. Acceleration forces physically lift the centre of mass and increase rear load transfer. Plus the momentary increase from accelerating the mass upward. The previous generation Trans-Am car used ~30% anti-squat at ride height to fractionally reduce the squat, and keep the centre of mass, rear load transfer, and rear traction fractionally higher. Higher anti-squat was theoretically beneficial, but caused unacceptable wheel hop under acceleration and braking.

> *"We were interested in a Mumford both for extremely low and tuneable roll centres, and to get the rear axle out of the airflow"*

Roll centre height can be thought of as the geometric anti-roll percentage in exactly the same way. For the same springs and bar, a higher roll centre keeps the centre of mass fractionally higher ("jacking forces") for faster (less movement) and fractionally higher load transfer. A roll centre with 100% anti-roll leaves no control for springs, dampers, or anti-roll bars. A roll centre below ground will use the lateral forces to pull the centre of mass lower ("jacking down").

We targeted a very low roll centre for two reasons. First, indirectly reducing wheel hop under combined cornering and braking or acceleration. A higher roll couple increases the percentage of lateral forces controlled by the dampers. Second, making a slower transient response possible at the rear axle, compensating for the lower polar moment.

From a roll centre perspective, and many others, double wishbone suspensions are brilliant. The roll centres move down in bump, softening the response when highly loaded. When decomposing the reaction forces for outside and inside tyres in roll, the reaction height and geometric anti-roll percentage is reduced for the outside tyre. As far as solid axle suspensions:

### Panhard bars are brilliant

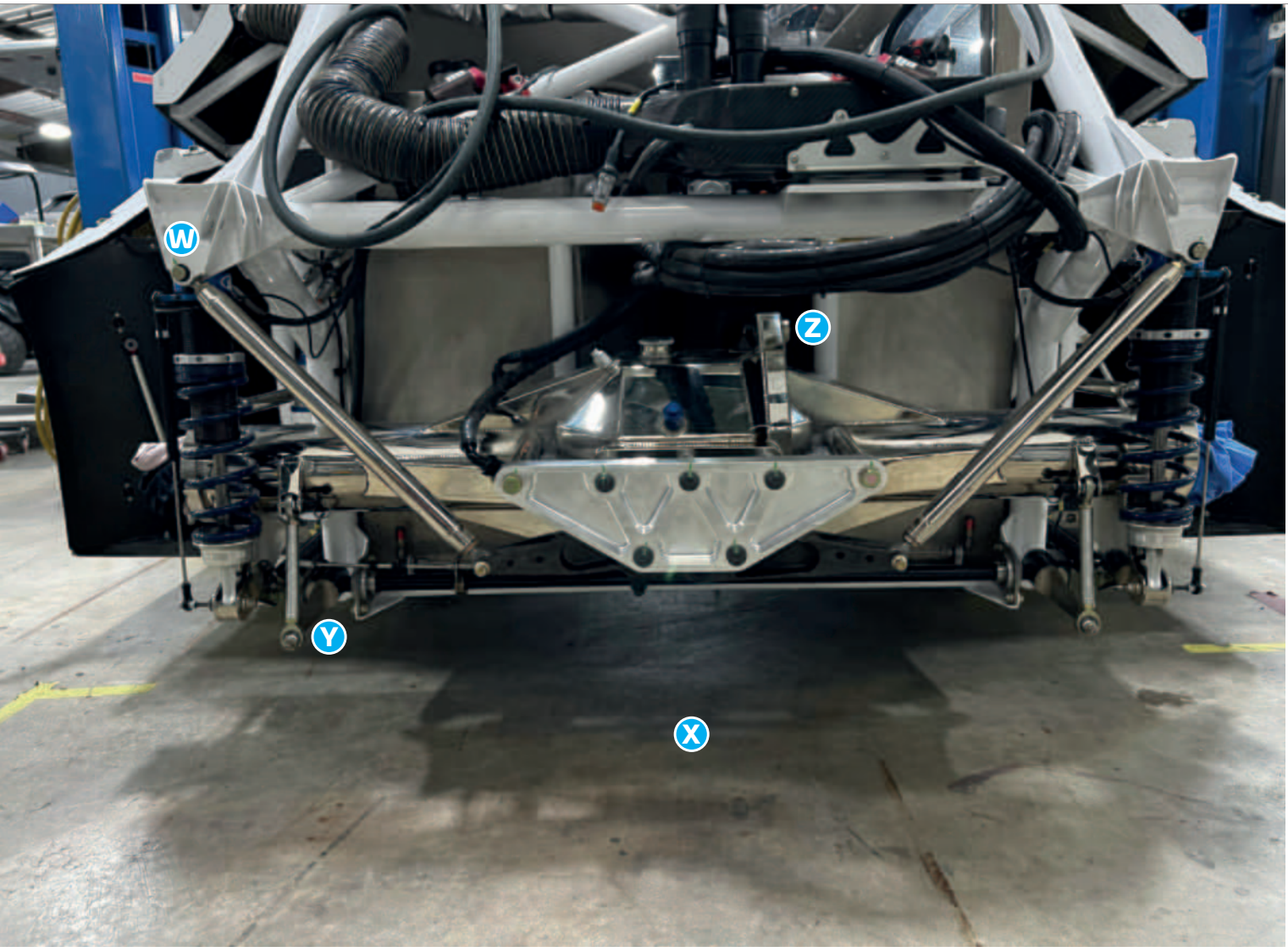
- Make it as long and level and low as possible across the bottom of the chassis
  - Level and low for the roll centre at centreline
  - Long and level for minimal lateral movement
- Roll centre barely moves from the bottom of the chassis
  - Angled gives increasingly bad lateral movement
  - Angled gives increasingly different left and right responses
- Many great solid axle racecars use Panhard bars

### Watt's linkages are brilliant and foolproof

- Rotate the pivot below the axle
  - Ground-clearance roll centre even lower than a Panhard
  - Mounted on the axle, the roll centre never moves, aside from axle roll
  - The centre link needs enough length to account for travel
- Zero lateral movement (within design limits)
- This was the previous generation setup

**RIGHT** (W) The Mumford linkage connects to the chassis near the rear spring-damper mounts. (X) The roll centre is at the intersection of the two chassis links. (Y) Driver-adjustable anti-roll bar blade. (Z) Third link attachment, axle side

**BELOW** The Mumford linkage on the BR1 offers even more possibilities than a double wishbone




## Wait, what is a Mumford link?

- Arthur Mallock's archives are by far the best resource
  - Invented for solid axle cars with underbody aerodynamics
- Overall, it's just a modified Watt's linkage
  - Two lateral links, one lever arm, one bell crank, one connecting link
  - Pivots could be mounted on the chassis or the axle
- Just like a Panhard and a Watt's, the axle can move freely in bump and roll
  - Only lateral motion is constrained
- The roll centre is at the intersection of the lateral link centrelines
- The Mumford link on the Burtin BR1 looks like this (left):

We were interested in a Mumford both for extremely low and tuneable roll centres, and to get the rear axle out of the airflow. In theory, we could have matched the roll centre motion to the front suspension. I'm of the opinion that front and rear suspensions should be very similar on balanced cars. But the Mumford linkage offers even more possibilities than a double wishbone. As a baseline, we were able to match the Watt's linkage roll centre and restrict the movement to only 0.12" (3 mm) through the entire range of rear suspension travel.

Like a double wishbone suspension, the roll centre starts moving significantly in extreme bump or droop. A car becomes less consistent and harder to tune the faster a roll centre moves. Worse yet, the Mumford roll centre rises in both bump and droop outside the local plateau. We bias the setup for the roll centre to rise more in droop, when the forces are smaller.

There is also a smaller window of travel before the axle starts moving side to side. So the linkage must be adjusted in parallel with rear ride height.

We had some mass available at the rear of the car. And we needed it, because the internal forces are crazy on the Daytona banking. Just like a Panhard or a Watt's linkage, the entire roll couple is carried through the Mumford. Any offset from the attachment to the axle has leverage trying to rip off the mount. So there is a substantial backing brace to give the axle its own leverage. The lever arm and bell crank put three times the combined rear tyre cornering force on their respective pivots.

So far every driver, pro and amateur, prefers the car at the lowest possible roll centres.

When we were testing the car and starting to go fast, there was a moment when the crew was gathered around the back, looking through the window at the rear axle. The test plan was going well; everybody was happy. Someone remarked that it was the first Mumford link they'd ever seen in person.

Yeah, me too.

**Skitter Yaeger** is a simulation and design engineer. He works with Leap Racing, an engineering consulting company in Atlanta, GA, and is a technical editor for DesignJudges.com.

# TYRRELL'S BIGGEST FAN

In this extract from his new book, **Richard Jenkins** explains that when Ken Tyrrell abandoned his six-wheeler for a 'conventional' car, he got more than he bargained for: F1's first 'fan car', plus innovative features such as active camber control and data acquisition


Motorsport Images/LAT

**Extract** from:
*Tyrrell – The story of the Tyrrell Racing Organisation.* Written by Richard Jenkins. Evro Publishing. Foreword by Sir Jackie Stewart OBE. UK price: £90.00, hardback


**MAURICE** Phillippe's first Tyrrell car, the 008, had met most objectives wanted of it. Certainly, simplicity and a much more conventional approach were uppermost in Ken Tyrrell's mind at the start of the year, as Maurice Hamilton's biography confirms: "I discussed 1978 at great length with Maurice Phillippe. He thought the six-wheeler was too complicated to get the front suspension geometry correct.

"He also felt that by having an unusual car, we might not know where we stand in terms of gaining an advantage. But Maurice also wanted to design a car that was simple for the mechanics to service; he wanted a straightforward design."

At first Phillippe had had other ideas. This was the beginning of the ground-effect era, as pioneered by the Lotus 78 during the 1977 season. As ever in motor racing, other Formula 1 designers – including Phillippe – observed Colin Chapman's aerodynamic breakthrough and contemplated how to go one better. Phillippe's solution was that he wanted Tyrrell's next design to be as radical as the P34: the 008 was going to be Formula 1's first 'fan car'.

In the quoted passage that follows, the author has combined the memories of various people involved in the design and development of the Tyrrell 'fan car'. Those who provided their recollections of this intriguing 'might-have-been' were designers John Gentry, Graham Heard, Gene Varnier and Brian Lisles, data analyst Karl Kempf, and mechanics Jonathan Greaves, Ian Hunter, Bob Skene and Clive Walton.

"Outwardly, the car looked conventional, certainly compared to the P34, of course, but it was to have a large fan fitted to the front of the crankshaft that would suck air through the water radiator and oil coolers underneath the back end of the chassis. This would not only cool the engine but would also suck the car down to the ground. In essence, it was a different type of ground effect.

"A test rig was set up in the race shop and various fans were tried, all of which were run by a large electric motor. We went through a lot of designs, as the size of the fan was restricted and we had to make its vanes ourselves. Some fans we tried sounded like ▶

Motorsport Images/David Phipps

**FAR LEFT** Patrick Depailler finally won a Grand Prix in 1978, in Monaco after a well-judged race in his Tyrrell 008

**LEFT** The Tyrrell 008, which only raced for one season, was a simple, robust car. Note how the oil coolers and water radiators, one of each on either side of the car, are mounted one above the other and aligned with the airflow

air-raid sirens, but eventually an optimum arrangement was fitted to an experimental 008. This was taken to a winter test at Paul Ricard, where other teams present took great interest in the new car but failed to notice that it had no visible radiators.

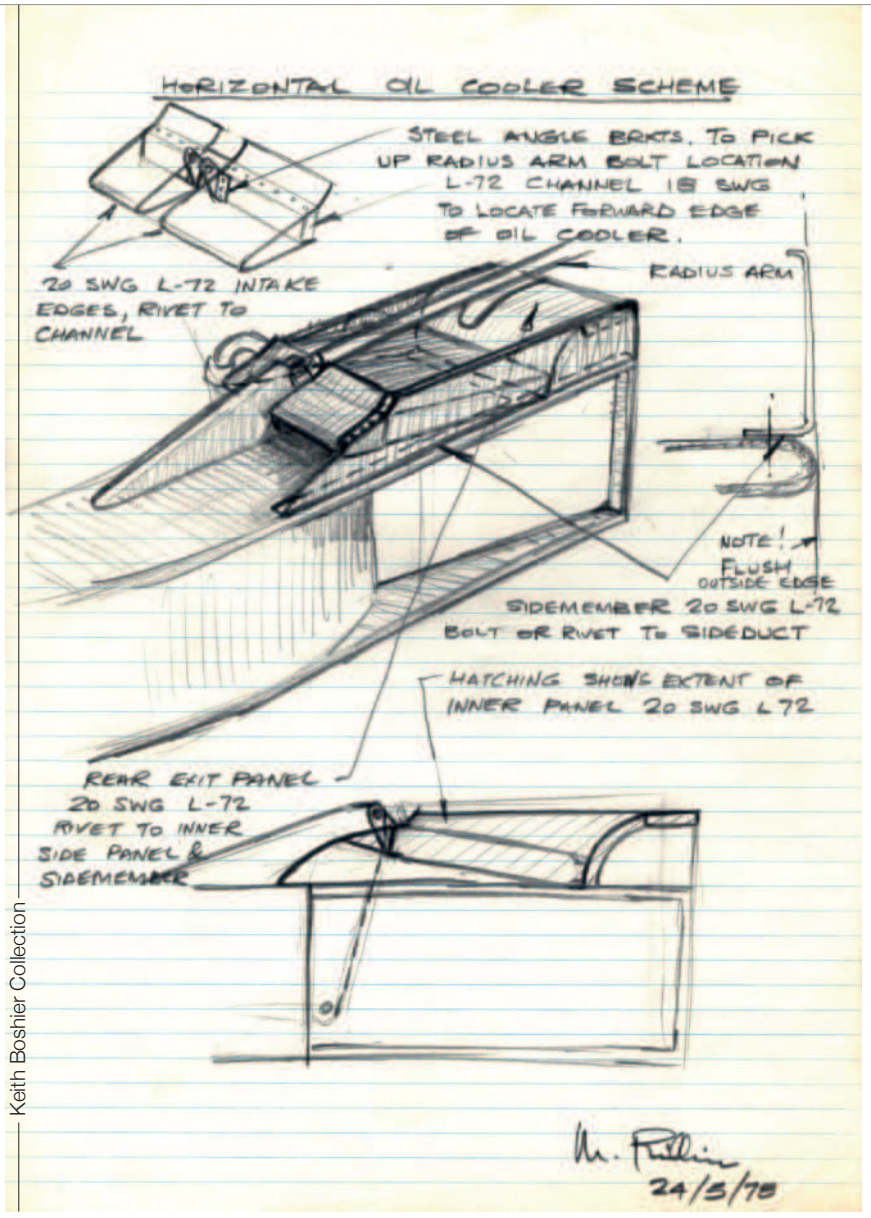
"The weather was cold, but this didn't stop the car turning into something akin to a steam car. It kept giving trouble every time the engine reached 10,500 rpm. No matter what we did, it just kept overheating, so the next day a more conventional set-up was adopted. We pretty much gave up after that test.

"As the 1978 racing season was rapidly approaching, it was decided to temporarily shelve the fan development and quickly move the water radiator and oil coolers to the rearward sides on the chassis and bodywork. By the time we had time to revisit the idea, Brabham had beaten us to it…"

## Coincidence or copy?

On the début of Brabham's 'fan car', the Gordon Murray-designed BT46B, in the 1978 Swedish Grand Prix, Niki Lauda took a dominant win – after which team owner Bernie Ecclestone decided to withdraw it.

So, was the Brabham BT46B a coincidence or a copy? Well, in late 1977, David Cox, an innovative design engineer, was interviewed for a job at Tyrrell. While there, as he explained in an article for *Autosport* in February




Keith Boshier Collection

**ABOVE** During the 1978 season, Maurice Phillippe adopted this arrangement that placed each oil cooler almost horizontally on the sidepod. The drawing is dated 24th May and the revised layout was in use at the Spanish Grand Prix 10 days later


Pete Austin

**LEFT** Didier Pironi, seen at the British Grand Prix at Brands Hatch, made it an all-French driver line-up for Tyrrell in 1978. With five points-scoring finishes, he supported well enough to be retained for a second season

**RIGHT** It's tense for Tyrrell personnel at the trackside as Patrick Depailler leads the Monaco Grand Prix. Steve Leyshon displays the key information – in the lead by 18 seconds – while those behind include Norah Tyrrell (keeping the lap chart) and designer Gene Varnier (arms folded)

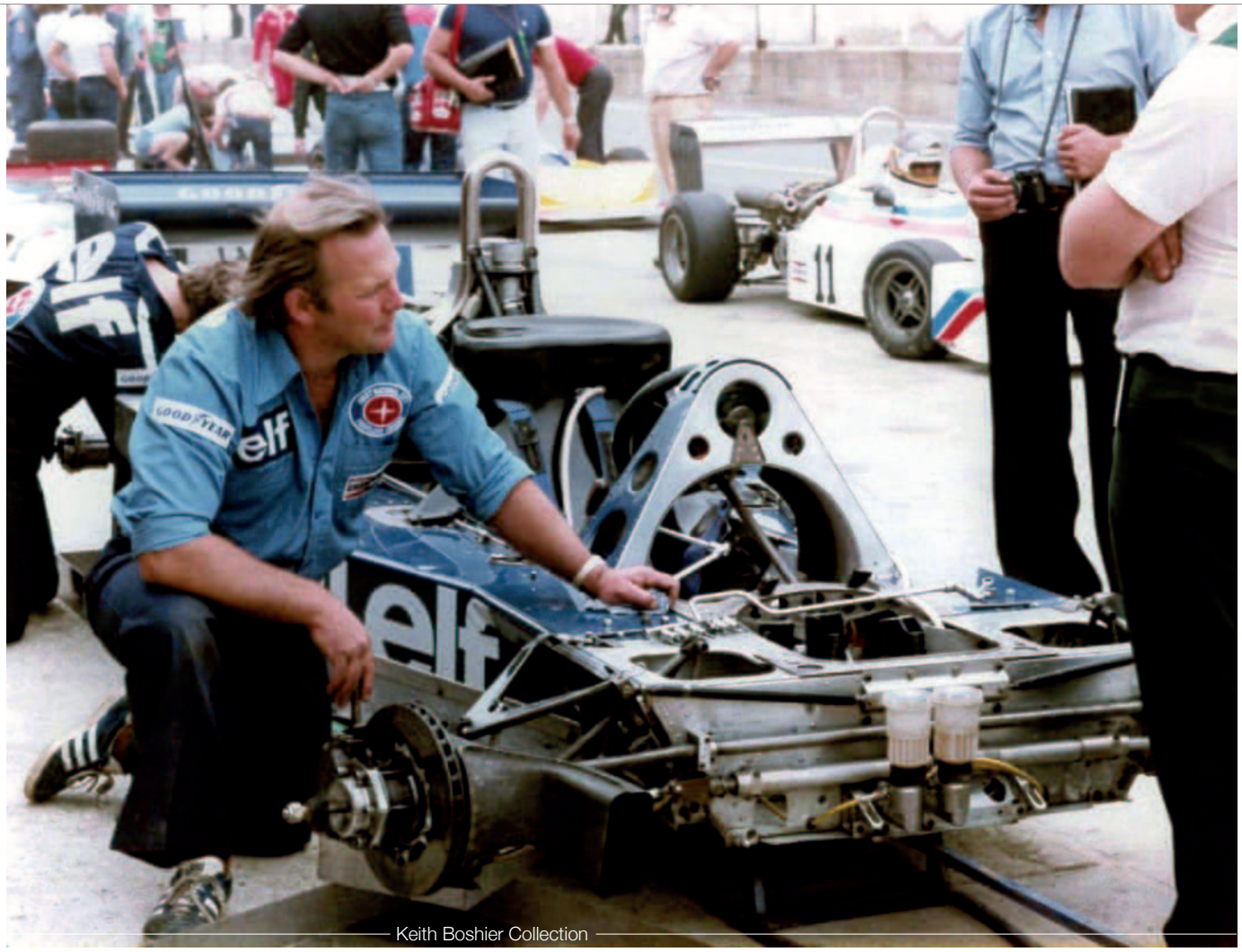
Motorsport Images/David Phipps


**BELOW** Pictured at the British Grand Prix, Patrick Depailler finished fifth in the 1978 World Championship thanks to seven points-scoring finishes, including a win and two second places

1979, he saw a sketch of a fan layout on Phillippe's drawing board but promised that he wouldn't tell anyone about it. Soon afterwards he did some work as a consultant with Brabham's Gordon Murray, working on what was proving to be a troublesome cooling system using surface-mounted radiators. Cox claimed that some judicious prompting on his part led Murray to mention the idea of a 'fan car', allowing Cox to consider that he hadn't broken his promise to Phillippe. It should be added that neither Phillippe nor Murray could claim credit for the notion of a 'fan car' because it had first emerged eight years earlier in the form of Jim Hall's Can-Am Chaparral 2J and both designers would have been well aware of this forebear.

Another intriguing technical novelty thought up by Phillippe and refined with much input from Kempf was 'active camber' for the front suspension: "Literally, with a twist of a knob on the unit, you could turn the car from oversteer to understeer, or understeer to oversteer. ▶

Alan Radley




Keith Boshier Collection

It was the first active-suspension unit of its kind in Formula 1. Instead of the usual procedures of adjusting the wings, anti-roll bar, springs and so on, you could alter the car's handling just by using this camber control.

"The system worked with a pendulum that moved the top suspension links in unison. In effect, it was almost like a cannonball with this mechanism attached to it. When the car went round a corner, the pendulum would swing and change the wheel camber.

"Maurice prototyped the concept on his Cortina Mk3 using a pendulum-controlled spool valve. It provided acceptable response time for a road car but we deemed it too slow for a racing application. So we tried to apply technology to the installation, using Moog valves and hydraulic rams. By this time we had the race cars instrumented in any case with microprocessors to record suspension behaviour – steering angle, lateral G, rotational mobility and so forth – so we already had the data we needed.

"However, we couldn't make the room at the bottom of the car to make it work with the ground-effect and the lower wishbones. The top wishbones basically controlled how much the wheels go up and down and the lower wishbones basically took all the weight load/suction. So, when you were trying to keep the bottom of the car controlled, it was harder as two of the props had rockers on the top.

> *"Literally, with a twist of a knob on the unit, you could turn the car from oversteer to understeer, or understeer to oversteer. It was the first active-suspension unit of its kind in Formula 1"*

"It was very promising indeed. We built a 008 with the system and it held corners like a motorcycle. It reduced the lap time at Silverstone by something like one and a half seconds. But when the Lotus 79 ground-effect car came along [in May 1978 at the Belgian Grand Prix], we knew there was too much to catch up by pursuing this idea and we shelved it."

**ABOVE** John Dabbs works on the front end of one of the Tyrrell 008s at Brands Hatch while competitors in the Formula 3 support race get ready for a practice session, with Geoff Brabham, son of three-time World Champion Jack, prominent in his Ralt RT1

**RIGHT** Track limits? What track limits! Didier Pironi gives it everything in his pursuit of Emerson Fittipaldi and the soon-to-retire Jean-Pierre Jabouille in the early stages of the 1978 German Grand Prix at Hockenheim

Keith Boshier Collection

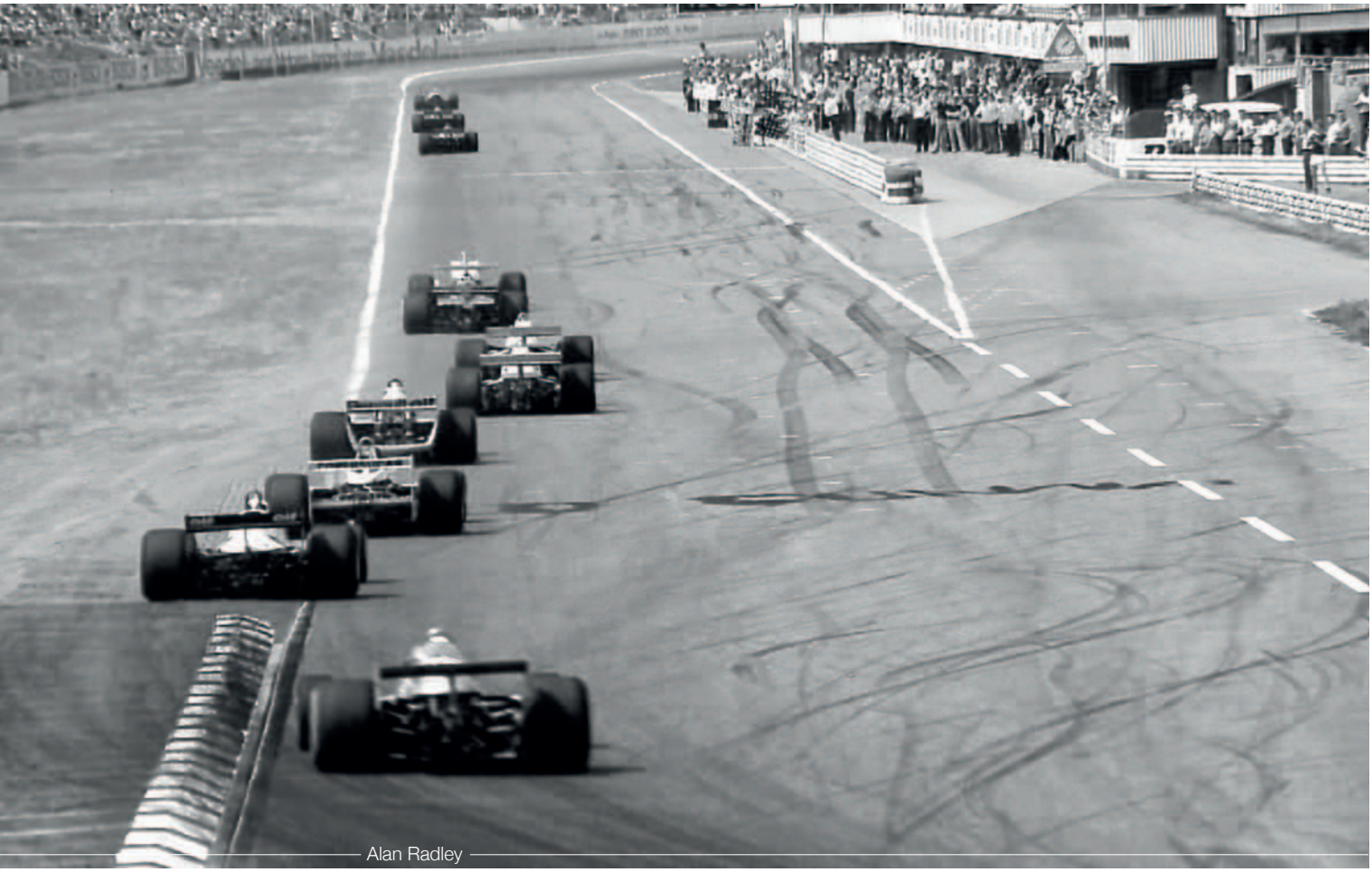
## Black arts pioneer

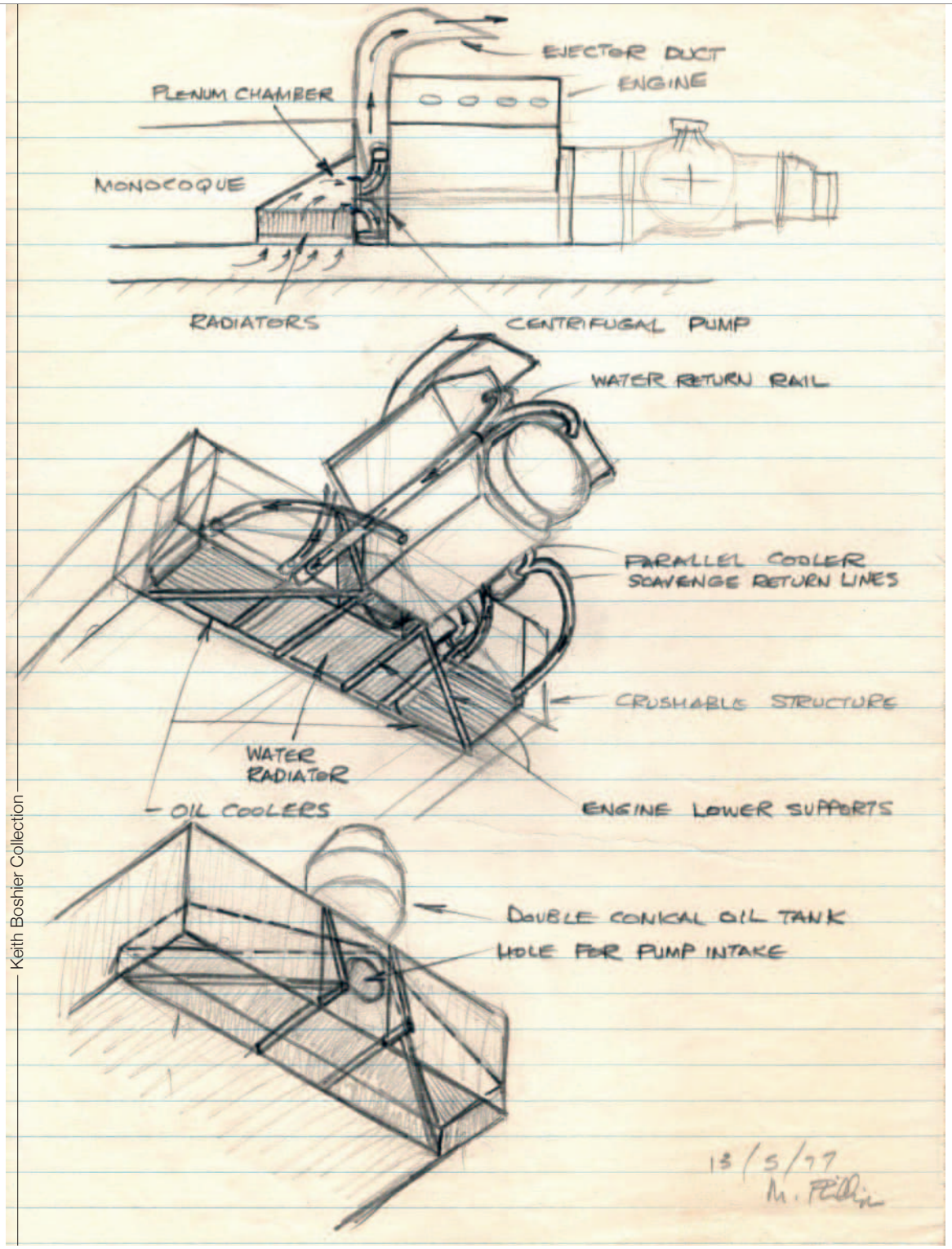
Tyrrell became a pioneer in the black arts of telemetry and data acquisition during the 1977 season. To do this, Ken acquired the services of a young American, Karl Kempf, who explained the background to the author: "When I was working on my PhD thesis at Stanford, I did a related four-month internship with Goodyear in Ohio. I was in the high-performance tyre group, which is basically aeroplane tyres and racing tyres. Later, when I was back at Stanford finishing my PhD, I decided to go up to the Canadian Grand Prix and bought a $20 infield ticket.

"I was just walking around near the pits and bumped into a guy I'd known during my internship, Dennis Chrobak, who was now working in the international racing division at Goodyear. He said, 'I've got an idea, why don't you come and do all the crazy stuff we talked about over lunches?' I took about two nanoseconds to think this might be a good idea and went to chat with him in the Goodyear trailer. He said, 'If you take a job with us, you'll be splitting your time between our two main contracted teams, which are Tyrrell and Ferrari.'

"The Tyrrell facilities were different from Ferrari, sure. But I was steeped in motorsport history so I was more than happy to go to Tyrrell, to meet Ken Tyrrell, and holy smoke, then bump into Jackie Stewart, who would come to tests and visit. Obviously, the Ferrari facilities meant you could drive ▶

**ABOVE** Jackie Stewart drove a 008 for a filming session during the build-up to the British Grand Prix at Brands Hatch. While a couple of technicians adjust the camera, Tyrrell men Richard Gear (left) and Roger Finnis look on


Alan Radley




Keith Boshier Collection

around Fiorano [Ferrari's own test track], which was great, but I was a happy camper.

"Ultimately, both teams had the same problems. When I got to Tyrrell, the main problem was lack of data. All they had to go by was lap times and driver feedback. Ferrari had a bit more, but fundamentally it was the same.

"The first year's priority was to get a measurement package, a kind of box that lived on the car. One of the main problems was where you put this electronics package, because real estate on a Formula 1 car is pretty limited.

"Goodyear wanted me to do a particular set of mathematical tasks, but this isn't what Mauro Forghieri [of Ferrari] or Derek Gardner wanted me to do. The job for me at Tyrrell was 'here's the chassis' and the tyre company would say 'here's the properties of the tyres', and my job was to link it all up, take the maximum advantage of the tyre and search for solutions. So, we needed data from the car, to discover things like pitch/roll bounce, acceleration, throttle position and so on, to build a good enough model of the car.

"There were never any restrictions at Tyrrell

**RIGHT** Goodyear boffin Karl Kempf (right), pictured with Derek Gardner, was assigned to the Tyrrell team in 1977 with a pioneering brief to use datalogging equipment to analyse the P34's on-track performance

**RIGHT** Karl Kempf's recording equipment used conventional compact cassette tapes and was housed in the P34's right-hand sidepod

**LEFT** These three Maurice Phillippe sketches for Tyrrell's still-born 'fan car' show his scheme for the underside, with a large central water radiator and two oil coolers positioned horizontally behind the monocoque and adjoining a crankshaft-driven fan – labelled 'centrifugal pump' on the top drawing – that sucked air from beneath the car to enhance ground-effect downforce. The date is 13th May 1977, long before Brabham's famous 'fan car' came into being

**RIGHT** This drawing by Maurice Phillippe, dated two months after the previous one, shows his specification for the fan itself

when it came to spending money to get data. We had access to a Renault Le Mans car and put the instrument package on that. Sitting alongside Patrick [Depailler] going around Paul Ricard at 200 mph was an excellent learning curve. We dialled in aerodynamic understeer for a few laps, then aerodynamic oversteer for a few laps, then suspension understeer and oversteer.

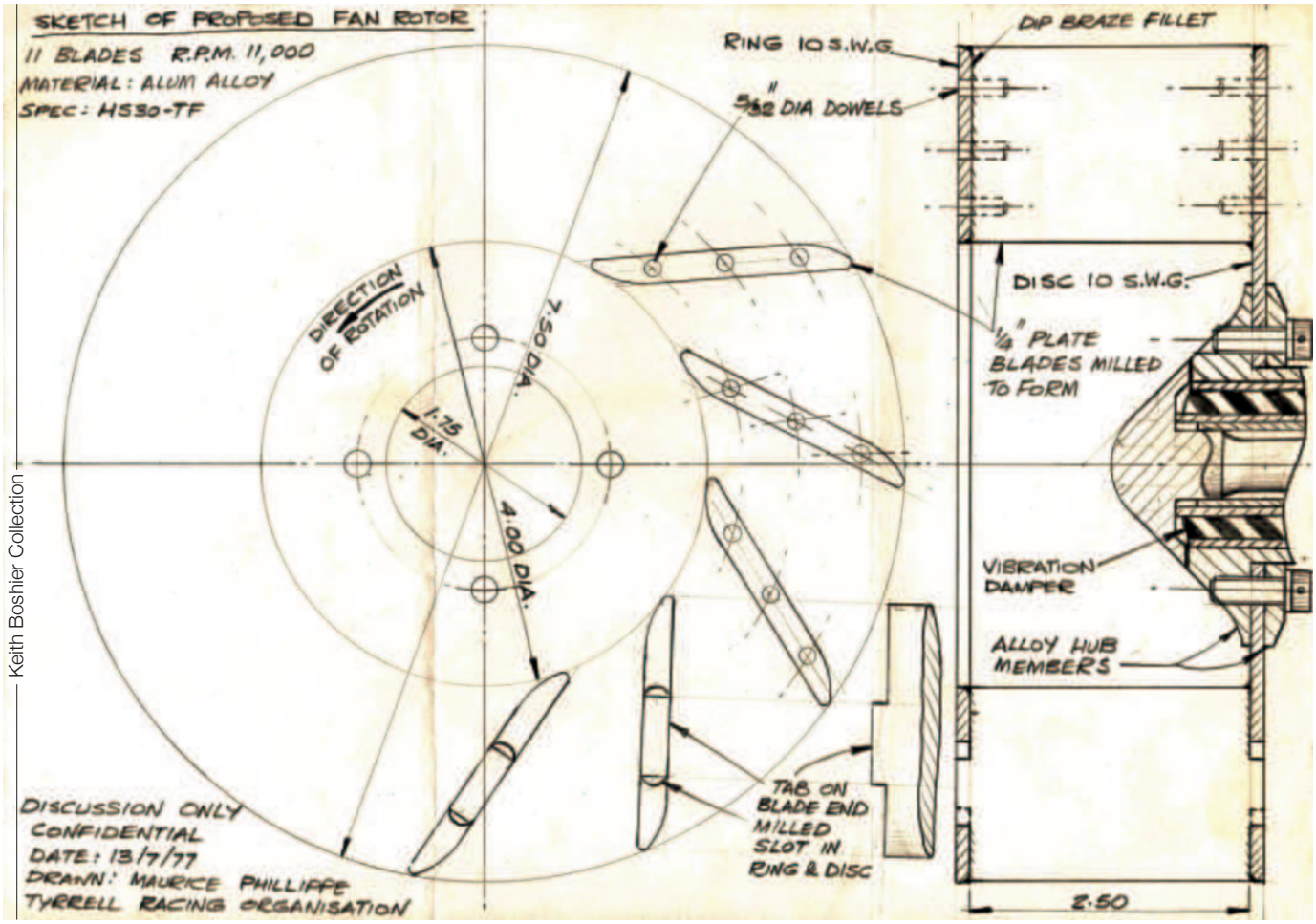
## Innovative features

"We obtained all sorts of data at Tyrrell and I could tell them so much. I remember one day after practice Ken said to Patrick, 'So, you're flat through here?', and Patrick said, 'Oh yes'. I got the throttle data and said, 'Well, almost but not quite!' Although you had the data, you'd still talk to the driver about where he had the power and where he needed to turn in and so on, but now we could go way deeper and understand, for example, why the car didn't turn in at one corner but did so everywhere else. Patrick was interested in seeing the data and we developed a very nice working relationship."

In summing up the Tyrrell 008 as a whole, Brian Lisles looks back on it with pride: "It had genuine innovative features such as active camber control, fan concept and data acquisition. That's an incredible list of ideas there." RT

Motorsport Images/David Phipps


Motorsport Images/David Phipps



Keith Boshier Collection


# FROM 24 HORSEPOWER TO THE '24 WEC


Photos: Isotta Fraschini

Isotta Fraschini's first car, boasting just 24 hp, would not have appealed to the Hollywood stars who later frequented its famous limousines. But the legendary brand's new car for 2024 would certainly catch their eye. By **Gary Watkins**

**THE** name Isotta Fraschini wasn't instantly recognisable when the long latent brand announced back in October of last year an intent to join the top class of the World Endurance Championship. Only aficionados of the Targa Florio road race and Hollywood movies of a certain vintage would have been familiar with those two words. Yet the names behind a project that will put a Le Mans Hypercar on the grid at the start of 2024 are well known and of undoubted pedigree.

The project has been initiated and masterminded by Michelotto Engineering, which developed and built a line of ultra-successful racing machinery – in both the GT2/GTE and GT3 realms – stretching from the 360 Modena introduced in 2000 to the 488 replaced this season by the 296 after a seven-year life.

The partners it has assembled in the development of a car now known as the Isotta Fraschini Tipo 6 LMH Competizione are equally well known. WAE Technologies, HWA GmbH, Helix UK and Xtrac are all key suppliers in the project.

The relationship between Michelotto and Ferrari, which stretches all the way back to the late 1970s, is central to the story of the Tipo 6. The design, build and service of Ferrari's ultra-successful GT racers was masterminded from Michelotto's HQ in Padua near Venice. The factory became more involved with the 458 Italia GT and the sister GT3 car that came on stream in 2011 and then more so again with the 488 GTE/GT3 – the car was modifiable between specifications – that followed in 2016.

## Point to prove?

Design and development of the 296 GT3 was taken fully in-house at Ferrari's new Attivita Sportive GT facility opened in early 2021. The tender process for the build of the cars was then won by French motorsport powerhouse ORECA from its Signes headquarters adjacent to Circuit Paul Ricard.

Company founder Giuliano Michelotto is at pains to stress that the long relationship with Ferrari is far from over. It's just that these days, he says, "it is more on the production side than on the motorsport side". But he admits that the company had a hole to fill. The LMH ▶

**ABOVE** Isotta is targeting between 10-12,000 km of testing before its Tipo 6 LMH Competizione is homologated in November

project was conceived to plug the gap and at the same time showcase the company's technical credentials.

"We couldn't just stop and lose our technical ability while we waited for the next project," explains Michelotto. "Endurance racing is the best form of racing, so the best way to show how good you are is to build an endurance racing car. Developing an LMH shows our abilities by working on the most complicated car possible."

It has also enabled Michelotto to keep its core group of people together, says long-time technical director Luigi Dind, who has led a 25-strong team – roughly one quarter of the company's staff – on the Isotta programme. "The people are the most important part of any company," he adds.

The idea for an LMH predates the link-up with the owners of the Isotta Fraschini automotive brand, which won the Targa Florio in 1908 and built limousines favoured by Hollywood icons, Rudolf Valentino among them, before World War 2. The rules for the Hypercar division demand that participants must either be a manufacturer or have a close link with one. Michelotto couldn't join the WEC under its own flag without a concurrent road car project.

> *"Developing an LMH shows our abilities by working on the most complicated car possible"*

**LEFT** Giuliano Michelotto's ultra-successful engineers at his Padua HQ have developed the project

A relaunch of the Isotta automotive brand after an absence dating back to the early 1950s with an all-electric limousine had faltered during COVID despite the involvement of Frank Kanayet. One of the first investors in the FIA Formula E Championship and Croatian EV specialist Rimac, now partnered with Bugatti under the umbrella of the Volkswagen group, he had taken a majority share in the Milan-based marque in the late 2010s. A new group of investors was assembled after the approach from Michelotto, details


**BELOW** The Tipo 6 is scheduled to race for the first time in the 2024 season-opener in Qatar

Newspress

**ABOVE** Although now best known for its powerful racing cars and the luxury limousines built until the end of the Second World War, Fraschini's first car was a more modest machine. A small two-seater voiturette, chassis number one was powered by a single-cylinder De Dion Bouton engine

of which haven't been disclosed. Kayanet admits that he has gone from a majority to a minority shareholder.

The link-up with Isotta in late 2021 allowed Michelotto to push on with a project that had started a year before. Pertinently, it permitted it to move ahead with the partners that it had already identified. "Design is one thing, but you start spending big money when you begin to build the car," he adds.

On the partners Dindo says: "We went looking for the best. This is the first car like this for us; in the past we have always built cars based on production machinery. We needed experienced partners because we didn't have time to lose."

## Star cast

WAE Technologies, formerly Williams Advanced Engineering, has been the partner for the Tipo 6's aerodynamic development, while the spin-off of the F1 team now under separate ownership is also supplying the high-voltage battery. The motor generator unit (MGU) at the front axle is supplied by Helix UK. BrightLoop Converters is providing the DCDC high to low-voltage system.

The engine is a three-litre single turbo V6 developed by HWA GmbH. It is bespoke powerplant, running a cold vee turbo set-up, produced specifically for the Isotta, says Dindo. ▶

The electronic systems for what is a complex racing car are entirely the work of Michelotto in Padua. "All the electronics are made by us – for the engine, the hybrid system, everything," he explains.

Michelotto and Isotta had an ambitious timeline for the project. The Tipo 6 LMH project was announced with the intent to join the WEC as a full-season participant with a single car in 2023. It planned to be ready to race from round three at Spa at the end of April, the last event prior to the Le Mans 24 Hours, though it conceded from the outset that it wouldn't be testing until March.

## Hugely optimistic

Claudio Berro, who joined Isotta in September '22 as its motorsport boss with a seat on the board, admits that it was hugely optimistic. But he insists it was vital to go through the due processes with WEC organisers the FIA and the Automobile Club de l'Ouest.

"It was important for Isotta to send a message to the FIA and the ACO that we were serious," explains former Ferrari Formula 1 team manager Berro, who is probably best known for heading up Maserati's return to the racetrack with the MC12 GT1 car in the 2000s. "We had to show them our programme and go through all the procedures."

Michelotto isn't a race team and needed another partner – one to run the car. There were several potentials, including JAS Engineering, one of Honda's long-time motorsport partners across a variety of disciplines, and GT3 team Emil Frey Racing. A deal was eventually forged with a new kid on the block, Vector Sport from the UK. The team, now based near Stratford-upon-Avon, is in its second full season in the LMP2 class of the WEC after a toe in the water programme at Le Mans in 2021 under the Risi Competizione banner.

Vector founder and team principal Gary Holland worked with Giuseppe Risi when he was team manager in 2014 and '15 of Krohn Racing, which ran its IMSA United SportsCar Championship

**BELOW** The engine is a three-litre single turbo V6 developed by HWA GmbH

> *"It was important for Isotta to send a message to the FIA and the ACO that we were serious"*

programmes first with a Ferrari 458 and then a Ligier-Judd/BMW JSP2 out of Risi's Houston workshops. That meant he also knew the people at Michelotto well.

The fledgling team had made known its aspirations to join the top class of the WEC ahead of its full-season entry into the series in 2022. It stated as much and also gave a clear signal of its ambitions with its choice of drivers: the full-season pros in the car were Audi-contracted Nico Muller and four-time Champ Car title winner Sebastien Bourdais.

"I knew the guys at Michelotto and all the engineers, and have done so for a dozen years," says Holland. "So it was a fairly easy conversation with them. We always made it clear that we wanted to move onwards and upwards in the WEC. But there were really only two options to go to Hypercar: buy a Porsche [963] LMDh, because they are the only manufacturer pushing out customer cars, or join forces with someone who wanted to go the LMH route.

Bain News Service

**ABOVE** Isotta Fraschini initially carved out its reputation at the Targa Florio, Vincenzo Trucco winning the 1908 event with the marque's type I

"We preferred working with someone in LMH and actively sought that, because as a team you can have a really big involvement in the development phase. This is a real collaboration: it's not just Isotta and Michelotto handing over a car to us."

Vector describes itself as a "partner team". It is neither a factory operation in the conventional sense nor a pure customer. It clearly brings something to the table financially in what Berro calls "a good deal for them and a good deal for us".

Isotta and Vector didn't get their Hypercar entry for 2023. They were turned down by the FIA and the ACO, and not unexpectedly so – to the wider world and Isotta itself. "Disappointed but not surprised" is how Berro put it.

Had the entry been accepted, the specification of the Tipo 6 would have effectively been frozen after just a couple of months as testing: only five performance ▶

**BELOW** A scale model of a road-going Tipo 6, dubbed the Stradale, was also showcased at Monza

## The magic of Michelotto

**MICHELOTTO** is inextricably linked with Ferrari courtesy of the quartet of ultra-successful GT racers it developed and built for the Maranello marque – the 360, the 430, the 458 and the 488 – over a period of nearly a quarter of century. But its relationship with the most famous sportscar brand of them all extends back almost another 25 years.

The tie-up between them started in 1978 when Michelotto began development of a 308 GTB rally car built to Group 4 regulations with the backing and assistance of the factory. More than a dozen Group 4 and then Group B 308s rolled out of Michelotto's workshops.

Ten years later, the Padua organisation was chosen to develop the F40 for a new GT class that FISA, then the sporting arm of the FIA, announced as part of the World Sports-Prototype Championship for 1989. There were no other takers for the category, which was stillborn. That's why the F40LM would initially race only in North America in IMSA's GTO class. Jean Alesi, Jean-Pierre Jabouille and Eric van de Poele were among the drivers in two partial programmes under the banner of Ferrari France – one of the prime movers in the project – in 1989 and '90.

The F40 concept was revived and refined when GT racing in Europe filled the void left by the death of Group C. A modified F40 road car was a winner in the BPR Organisation's new non-championship series of enduros in 1994. The F40LM and then the updated F40 GT-Evoluzione developed by Michelotto were winners, too, when those races became the Global GT Endurance Series.

Yet Michelotto's history with Ferrari also encompasses prototype sportscar racing. It took over the Ferrari 333SP IMSA World Sports Car project for 1996 on the direction of Claudio Berro, whose role with Ferrari was growing beyond his F1 duties. It would oversee the build of more than half the 40-plus cars produced over the 333SP's lifetime. From next year, a Michelotto-developed machine will be racing against a Ferrari prototype, the 499P LMH. RT

**ABOVE** Michelotto was instrumental in the development of the F40 for GT racing

updates – so-called Evo jokers – are allowed during the lifespan of an LMH after its homologation ahead of its race debut. That explains why the organisers told Berro that "it would be better to do more testing on track before we homologate". It didn't change anything, he insisted at the time. The project was still full steam ahead.

The first car was completed in February and launched at the end of that month. Validation at the Sauber windtunnel, where the aerodynamic homologation for LMH and LMDh machinery competing in the WEC is undertaken, and running on AVL's all-wheel-drive dyno in Italy followed, before a roll-out of the car at Vallelunga in April.

At this stage, Isotta still had plans to race this year, albeit on a non-points, invitational basis. It was looking to take up the same option offered – though not taken – to Porsche with its 963 LMDh last year. The idea was initially to join the WEC at Monza for the first post-Le Mans round in July, symbolic because the marque is incorporated as Isotta Fraschini Milano. That was set back to the season finale in Bahrain in November, though that has been abandoned, too. It conflicted with the planned visits to Sauber and the FIA logistics and technical centre in Valleiry, in France, just across the border from the governing body's Geneva headquarters, for the final homologation of the car. The Tipo 6 is now scheduled to race for the first time in the 2024 season-opener at the Losail circuit in Qatar at the start of March.

Isotta did take the opportunity, however, to run the LMH in public at Monza. It demoed the car over the course of the WEC weekend along with a track-day version of the car, known as the Pista. It also showed a scale model of a road-going Tipo 6, dubbed

WEC

**ABOVE** The doubters were silenced when the car broke cover for early tests

**ABOVE RIGHT** Partner team Vector Sport is currently campaigning an LMP2 ORECA-Gibson in the WEC

**ABOVE LEFT** Isotta motorsport boss Claudio Berro is a former Ferrari team manager and the man who headed up Maserati's return to the racetrack with the MC12 GT1

the Stradale. There are plans to make 12, though it is looking for an order of around 10 before pushing the button on the project. These models help the marque satisfy the demand that it be a bona fide manufacturer.

The plan for the luxury EV remains current, while there has also been talk of a GT car at some point in the future. For the moment, however, Isotta's top brass is keeping its future plans close to its chest.

## Monza fire

Testing of the LMH, which was initially handled at the shakedown by Michelotto-affiliated Maurizio Mediani, continued with former Audi LMP1 driver Marco Bonanomi and Jean-Karl Vernay, Peugeot's reserve driver in the final year of the 908 turbodiesel P1 programme in 2011. More than 5,000 km had been completed prior to a planned intensive week of testing in August with two days each at Monza and Mugello. Gabriel Aubry and Ryan Cullen, two thirds of Vector's 2023 P2 line-up, were due to get their first taste of the car, but a lubricant leak during the Monza run resulted in a fire that damaged the wiring loom. A return to base was necessary.

Isotta is targeting between 10-12,000 km before homologation in November, and then more kilometres before its race debut. It insists that it can be in the fight, to be a credible player, when it goes into the rarefied environment of a class that will have representation from seven major manufacturers in 2024.

"Isotta and ourselves wouldn't be going into this if we didn't think we can be somewhere in the mix," says Holland. "The rules are pretty tight with the performance windows laid down and then you have the Balance of Performance on top of that, so you can't be a million miles away. I'm confident because Isotta and Michelotto are confident." RT


**RIGHT** The new LMH machine was run in public at Monza during the WEC weekend along with a track-day version of the car, known as the Pista

# SHOOTING AT A MOVING TARGET

With the new cars for next season's LMGT3 category still evolving, **Chris Pickering** finds out how Goodyear is approaching the development of tyres that will help define an exciting new era

**THERE** are big changes afoot in GT3. Long seen as the penultimate step on the FIA's GT racing podium, it will take over as the premier category from 2024, filling GTE's sizeable boots in the World Endurance Championship (WEC), including blue ribband events like the 24 Hours of Le Mans.

The new LMGT3 class will follow essentially the same technical regulations as before, although there are changes. Aside from the addition of Hypercar-style torque sensors, and the controversial GT3 Premium body kits, which now may not even happen, the biggest impact on the teams is likely to come from the new single-make Goodyear tyres.

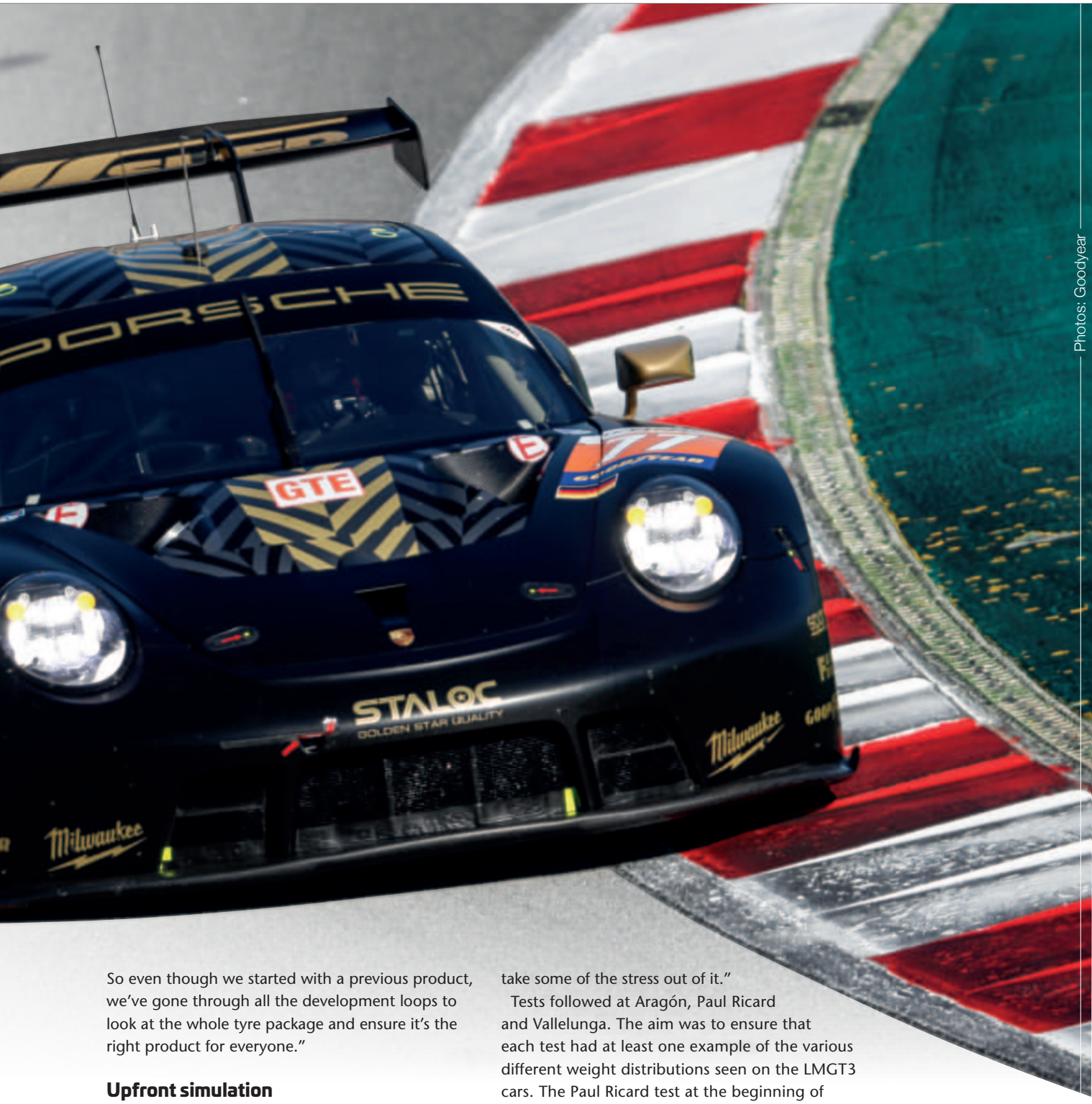
Goodyear already has a wealth of experience in sportscar racing. The American brand is the official supplier of GTE tyres to the European Le Mans Series (ELMS) as well as the official supplier to the WEC's LMP2 category. It even has an existing GT3 programme.

Perhaps the biggest surprise is that the new LMGT3 tyres owe more to Goodyear's GTE expertise than they do to the current GT3 projects. The reason for this is simple, though. Goodyear has worked in close collaboration with a handful of specific partners on its GT3 programme at the Nürburgring, whereas the diverse field of manufacturers and vehicle configurations in LMGT3 will be closer in scope to that of GTE.

"We started with the current ELMS GTE tyre, because we wanted to make sure that the balance of performance was going to work well," comments Goodyear's endurance programme manager Mike McGregor.

"Having a tyre that we've already raced with Aston Martin, Ferrari and Porsche – and knowing that each of those cars can win races on that tyre – was a good starting point for us. But actually, when we got down to it, we ended up doing a new mould cavity design, a new construction package and a new compound.

**ABOVE** The new LMGT3 tyres owe more to Goodyear's GTE expertise than to current GT3 projects




Photos: Goodyear

So even though we started with a previous product, we've gone through all the development loops to look at the whole tyre package and ensure it's the right product for everyone."

## Upfront simulation

Taking on GT3 is a big deal for Goodyear, he admits. The company wasn't chosen as the official supplier until April this year (with Pirelli, Michelin and Hankook also rumoured to have been in contention). Nonetheless, work on the tyre began last winter in anticipation, and the first tests had already taken place by the time that the decision was announced.

"We started with a lot of upfront simulation to understand the weight distributions of the various different cars, and where the different aerodynamics platforms would fit before we hit the track," recalls McGregor. "It's a big project, but that simulation work, along with our previous work in GT3, helped to take some of the stress out of it."

Tests followed at Aragón, Paul Ricard and Vallelunga. The aim was to ensure that each test had at least one example of the various different weight distributions seen on the LMGT3 cars. The Paul Ricard test at the beginning of August, for instance, had a front-engined Ford Mustang, a mid-engined Ferrari and Lamborghini, plus a rear-engined Porsche.

"We have to look at that balance across all the chassis to ensure we're not giving a performance advantage or disadvantage to one of the cars," comments McGregor. "One of the other big challenges with LMGT3 having 12 to 14 manufacturers that could possibly be on the grid, is the car setup as well. It's not just a question of bolting the right tyre on, and suddenly everything works."

While the optional Premium kits may shift the relative performance of the individual cars, they ▶


should all still sit within the current GT3 aero window. Nonetheless, the downforce levels are significantly lower than that of GTE.

The kinematics are different too, with some manufacturers pushing the suspension geometry on their GTE cars further away from the road car than they do in the more production-based GT3 class. Perhaps the ultimate example of this is Porsche, which has stuck with the classic rear-engined layout for its GT3 R racecar, while the outgoing GTE machine used a mid-engined configuration to even out weight distribution, tyre wear and aerodynamic requirements. The end result is a far greater spread of different characteristics within GT3 than has been seen in GTE in recent years.

## Blind testing

The test programme followed a set process, with a number of defined development loops. The first of these focused on the tyre construction and the mould cavity. Various different designs were tested based on the simulation work that had taken place over the winter. Once these had given the engineers confirmation that they were on the right track, the next step was to introduce compound choices to look at how that would affect grip, warm-up characteristics and durability.

**ABOVE** Goodyear's ability to develop unique tyre solutions was demonstrated most recently, and impressively, with NASCAR's Garage 56 project

Each of these tests has featured a mixture of Pro and Am drivers, all of whom would test the different options 'blind' to avoid any preconceptions, with a rating sheet that includes understeer, oversteer, mid-corner, grip, braking, traction and overall performance. Data was also taken from the cars for the engineers to analyse and relate back to the drivers' feedback.

A lot of it comes back to analysing how the tyre is working across a broad range of different chassis setups, McGregor points out: "It's about understanding why we're getting certain handling characteristics from a car with one weight distribution versus another, and then looking at how we can refine that further in the next development phase of the package. On top of that, at Aragón, we had both

> *"We've had up to five stints in LMP2, which is theoretically more than the driver can physically do in the car"*

day and night testing, which gives you a lot of data points to understand how all of that is coming together."

As well as past GT3 and GT experience, Goodyear has also leaned on expertise from its LMP2 programme to a certain extent.

"In days of old there were huge differences between GT3 and LMP2. There was a lot more body roll and a lot less aero load on the GT3 cars, with a very different centre of gravity height and weight distribution," comments McGregor. "The product that we've ended up with is not derived at all from our LMP2 product, but there's some good learnings. A modern GT3 car is much more like a prototype now than it was previously, but it's still a production-derived design as opposed to an out and out racecar."

## Start your engines

The standard of the drivers in GT3 is high, and set to get even more impressive as it becomes the premier category of GT racing. Along with world-class Pros there are some extremely capable Am drivers. ▶


**ABOVE** Mike McGregor is Goodyear's endurance programme manager


**ABOVE & BELOW LEFT** With the manufacturers' new GT3 cars, like the Corvette Z06 GT3.R and Ferrari 296 GT3, still evolving, Goodyear has been aiming at a moving target

The new LMGT3 tyre has to be designed to suit the full range of different backgrounds.

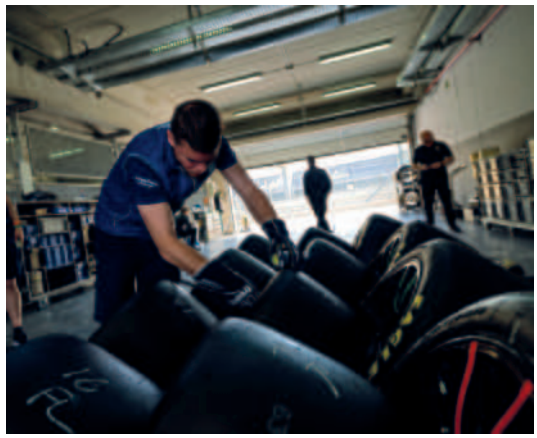
"You have to look at all of the handling characteristics of a tyre. Particularly for Am drivers, you can't have a tyre that's too sharp, too snappy or unpredictable. You've got to make something that's a very good all-round product, and I think that's probably the key area where we can lean on our experience from LMP2.

## Outlawed

"Even at the start of this year, when tyre blankets were first outlawed, the feedback was, there's no difficulty, the tyre warm-up has been great and the drivers have the confidence to be able to push early on the tyres. And whether that's the top-level drivers, people like António Félix da Costa, who's now moved from LMP2 to Hypercar, or François Perrodo, who's been one of the key gentleman drivers, the drivability is there for both levels of driver to ensure they can get the most out of the product."

One of the biggest changes is likely to be stint lengths, McGregor believes: "We've seen GT3 races like the Spa 24 Hours, where people are still single-stinting all the way through the race, whereas we're looking at double stints or triple stints at Le Mans already in the first season with the new tyre next year. The biggest target for us is to have a tyre that delivers the performance for longer."

**RIGHT** The development programme has a mountain of work to get through



**BELOW** The company's LMP2 supply deal has already demonstrated that, properly conceived, a single tyre specification can race well across the wide variety of tracks on the WEC calendar

This concept of sustained performance over a long distance lies at the very core of endurance racing, and it's also key to what Goodyear is looking to get out of motorsport, according to McGregor: "One of the reasons we go racing is to push those boundaries. No one wants a tyre that goes quickly for a couple of ▶

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laps and then drops off or is difficult to drive. It's about consistency and pace. We've had up to five stints in LMP2, which is theoretically more than the driver can physically do in the car. Our aim is to push those same boundaries in GT3."

There's a sustainability aspect to extending the usable life of the tyre too. Alongside this, Goodyear has been looking into the use of sustainable materials. Earlier this year it presented a technology demonstrator with 90 per cent sustainable content for the passenger car market, with plans to offer a 70 per cent sustainable market to consumers. It's unlikely that LMGT3 tyres will achieve those sorts of levels, but McGregor confirms that sustainable materials will play a role.

"We still haven't finalised what the percentage of sustainable material will be within the tyre, but that is something we're looking at," he comments. "Alongside that, we're trying to limit the number of different specifications that we're freighting around the world. Obviously, a lot of categories, they're still using two or three specifications, whereas we've already proven the point in LMP2 that a single spec, if done right, can race at every circuit around the world. Just from a logistics point, transporting a third of the number of tyres would make a big difference."

Development is still ongoing and the number of tyre compounds for LMGT3 has yet to be confirmed, but this appears to hint strongly at the company's intentions.

## New challenges

Although the core ingredients that make up next year's LMGT3 battle in the WEC will be familiar from either GTE or the existing GT3 format, there's still bound to be a shake-up – especially when the new tyres are added into the mix. The ability to react to these changes could prove a crucial deciding factor.

"To start with, I think part of the performance will come down to how well people can get their heads around setting up the car for the new tyre package," says McGregor. "There are going to be new challenges. Qatar, for instance, has been fully resurfaced, so it's going to be an unknown for everybody. But I think the teams that can tune the car in faster to get the most out of longevity and performance are the ones that are really going to see the biggest benefits."

Goodyear plans to host an open test event for the manufacturers at the end of this year's ELMS season. Far from marking the end of the development, that will be where much of the work starts, McGregor points out.

"After that we'll be working with all the teams to refine the product as much as possible to the setup of the cars and the different driving styles to ensure they get as much out of it as possible. Even though we go through this huge development process, it doesn't stop there. It just keeps going."

And in a very literal sense, it will keep going after that too. Next season marks the start of a three-year contract, which will see Goodyear supplying the WEC's LMGT3 class until at least the end of the 2025 season. By that point, GT3 should be very much established at the top of the GT racing ladder, and its position as the perennial bridesmaid firmly consigned to the history books.


**ABOVE** Goodyear recently showcased a 90% sustainable-material demonstration tyre that includes 17 featured ingredients across 12 different components. The sustainability message is still an important one for the new LMGT3 tyre


**BELOW** Data is king as the new project unfolds

**BELOW** The new tyres must perform well across a wide range of machinery and in the hands of drivers of different skill levels

*"We have to ensure we're not giving a performance advantage or disadvantage to one of the cars"*

# A NEW GENERATION OF GT4 RACING?

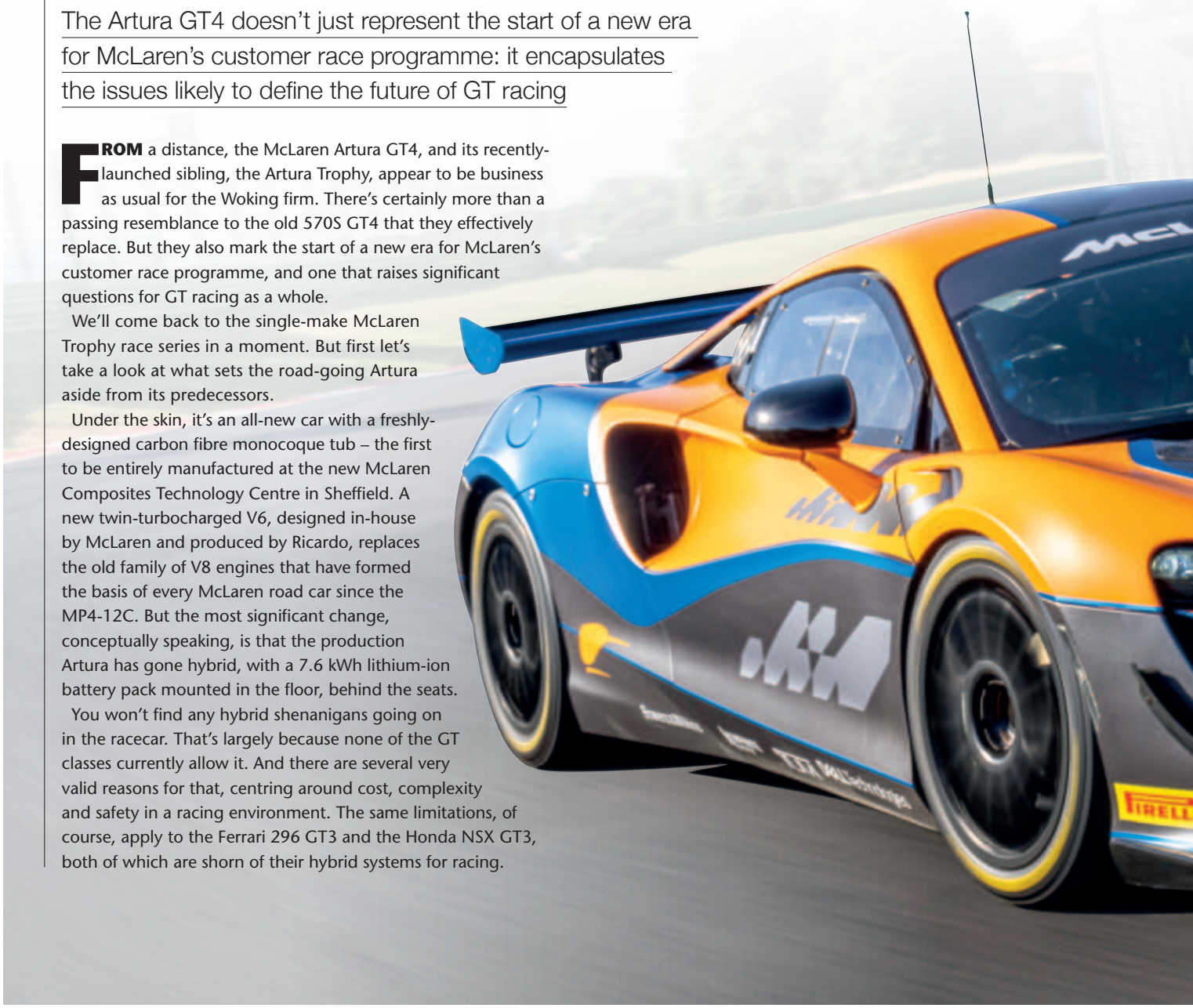
The Artura GT4 doesn't just represent the start of a new era for McLaren's customer race programme: it encapsulates the issues likely to define the future of GT racing

**FROM** a distance, the McLaren Artura GT4, and its recently-launched sibling, the Artura Trophy, appear to be business as usual for the Woking firm. There's certainly more than a passing resemblance to the old 570S GT4 that they effectively replace. But they also mark the start of a new era for McLaren's customer race programme, and one that raises significant questions for GT racing as a whole.

We'll come back to the single-make McLaren Trophy race series in a moment. But first let's take a look at what sets the road-going Artura aside from its predecessors.

Under the skin, it's an all-new car with a freshly-designed carbon fibre monocoque tub – the first to be entirely manufactured at the new McLaren Composites Technology Centre in Sheffield. A new twin-turbocharged V6, designed in-house by McLaren and produced by Ricardo, replaces the old family of V8 engines that have formed the basis of every McLaren road car since the MP4-12C. But the most significant change, conceptually speaking, is that the production Artura has gone hybrid, with a 7.6 kWh lithium-ion battery pack mounted in the floor, behind the seats.

You won't find any hybrid shenanigans going on in the racecar. That's largely because none of the GT classes currently allow it. And there are several very valid reasons for that, centring around cost, complexity and safety in a racing environment. The same limitations, of course, apply to the Ferrari 296 GT3 and the Honda NSX GT3, both of which are shorn of their hybrid systems for racing.



Collectively, though, they mark a sea change in supercar thinking. McLaren and Ferrari have both been dabbling in hybrid hypercars for a decade or so in low volumes at the very top of their ranges. But cars like the Artura and the 296 GTB represent this technology taking over the supercar heartland. They're the core offerings from their respective manufacturers, and they help to define the very class of vehicle that modern GT racing is based around.

It's perhaps something of a moot point. Once the hybrid system is taken out of the equation, the task of integrating and calibrating the various powertrain components is little changed from any other GT racing project. In some respects, it's actually simplified by freeing up the space that's occupied by the hybrid components on the road car. But, conceptually, it does mark a greater divergence between the racecars and their road-going counterparts.

Is this something that the GT classes will eventually have to adapt to accommodate? "A lot of the concern about electrified powertrains in motorsport currently revolves around safety," comments Malcolm Gerrish, chief engineer of McLaren Motorsport. "My personal opinion is that we can't shy away from hybrid technology. It's something that will come [to customer racing] at some point in the future, but from our visibility of the GT regulations, there's nothing on the horizon at the moment."

## Safety focus

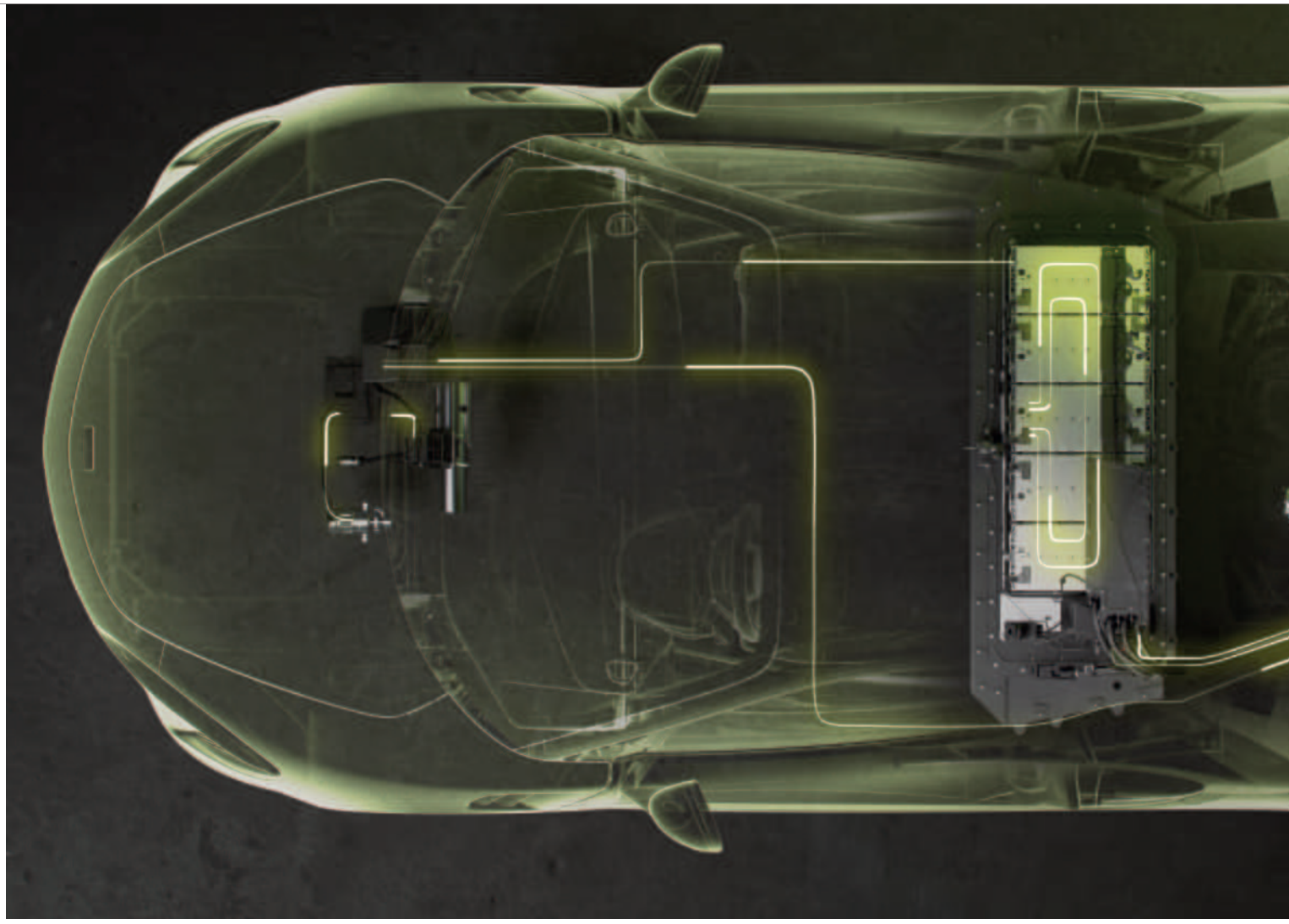
Work on the Artura GT4 began around two years before the launch of the road car. "There's always a bit of balance to strike with a GT racer, because if you start too early, then the road car derivative is not mature enough, which can lead to problems, particularly in a category like GT4, which is still heavily road car based. So we found quite a nice, happy medium with this project," notes Gerrish.

In all levels of GT racing, the cars have to strike a balance between the needs of amateur drivers and professionals, but the GT4 class is particularly focused on the 'Am' side of the equation. Generally, it's the amateur driver that's the owner of the car, so the first priority is to ensure that they enjoy the experience, explains Gerrish.

"The production Artura already gave us a very strong platform in terms of kinematics. Where the racecar differs is that it's got quite a lot of additional ▶


LAT Images

**BELOW** With hybrids increasingly populating the supercar heartland, the Artura GT4 could portend a seismic shift in GT racing



aero," he points out. "The key thing there – particularly for gentleman drivers – is to ensure that it's got a stable aero balance, especially in dirty air. The last thing we want is for the aero balance to suddenly shift. We want to produce a car that will be engaging to drive."

Safety is clearly a priority for any driver, but it's a particularly strong selling point to Am drivers who may need to be back in the boardroom on Monday morning. One of the strengths of the old 570S GT4 was its immensely strong carbon fibre MonoCell construction. The Artura builds on this with a new monocoque, featuring a new resin system and a new structural core material.

A highly-automated process combines 500 individual pieces of carbon fibre into 72 pre-forms, making up 11 sub-assemblies. These are fed into a single giant tool and subjected to an RTM-style process that draws resin through the material before it's cured. Aluminium subframes – lighter and stiffer than those on the previous chassis – hold the powertrain and suspension, as well as providing a deformable crash structure at the front.

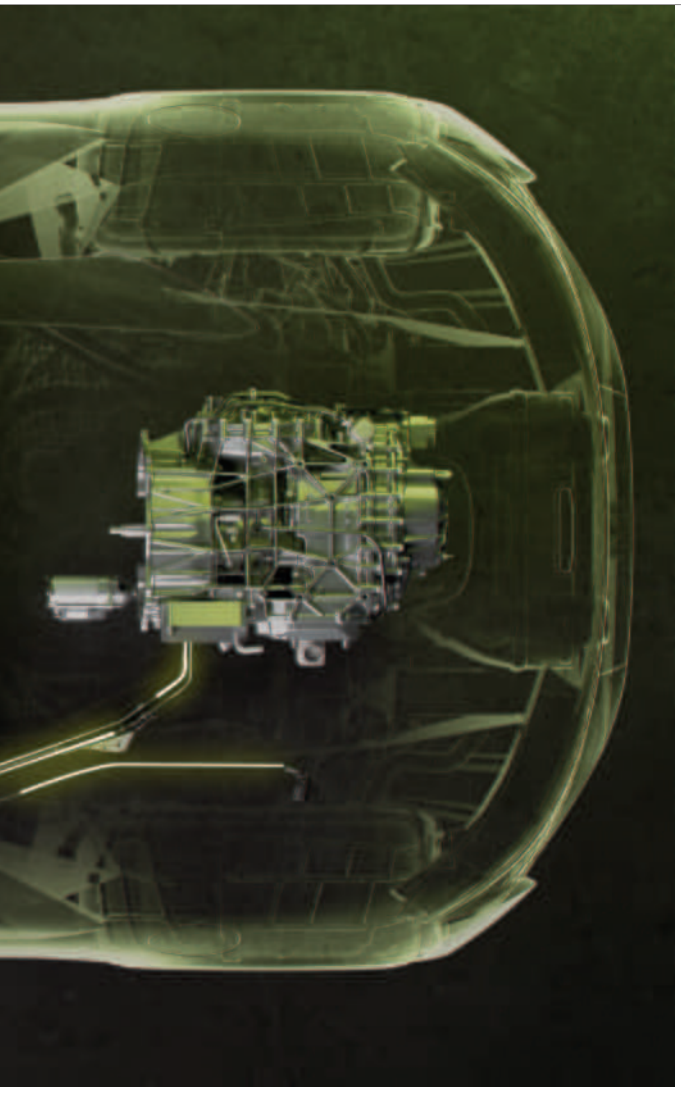
Inside, the FIA-spec roll cage has been sculpted to allow drivers of all shapes and sizes to get in and out of the car with ease. Likewise, the cabin has been sized for a 97.5th percentile driver (6ft 4) to stretch out with ease and comes with a fixed FIA 8862-spec seat placed as far back as possible, with a sliding pedal box and an adjustable steering column.

> *"We can't shy away from hybrid technology"*

Another benefit of the road car's construction is that the rear upper bodywork is a single-piece clamshell design. For the GT4, the hidden fixings of the production model were swapped with external quick release fittings, which allow the whole rear end to be accessed in around 30 seconds for fault finding or repairs.

Similarly, McLaren's production cars have always been praised for their visibility, which takes a lot of the stress out of driving these machines on the road. The motorsport engineers were keen to ensure this was carried over to the racecar, with several different iterations of the front roll cage hoop explored to ensure that the tubing remained hidden within the A-pillar and didn't compromise the driver's field of view.

Sustainability is very much on the agenda with GT4. Under the current regulations, any newly-homologated car must use natural fibres (rather than carbon) for additional aerodynamic devices, such as wings and splitters. As well as reducing the environmental impact of the parts, it's also said to offer a safety benefit. Unlike carbon fibre, these materials don't produce sharp splinters or debris when they crack, so the



**LEFT** The road car is designed with a 7.6 kWh lithium-ion battery pack mounted in the floor, behind the seats. The hybrid system is removed for racing, but for how long?

risk of tyre deflation is reduced.

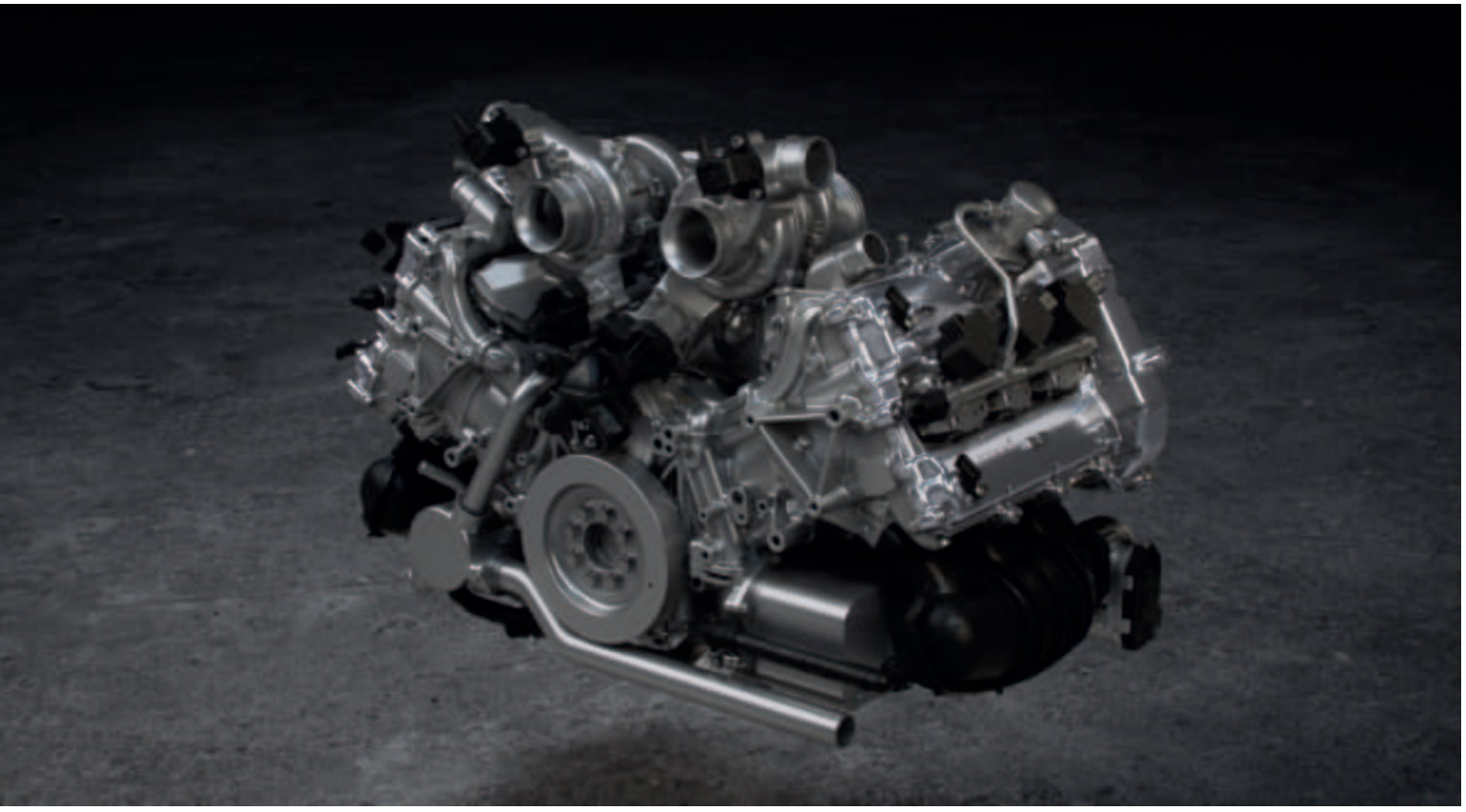
Looking ahead, that's just one of the sustainability aspects being considered at McLaren, Gerrish explains. "We are thinking more and more about end of life of the car and how we make the right choices in some of the materials that we are using," he notes.

## Evolution

The guiding principle behind the Artura GT4 was to build on the strengths of the 570S GT4 and address its weaknesses. Ironically, both of these were influenced by the fact it was a comparatively early generation of GT4 car. As such, it was heavily production based. Gerrish likens it to driving a road car fitted with slicks and wings, and says that's one of the reasons the 570S GT4 was so confidence-inspiring for Am drivers.

On the downside, the road car electrical architecture used on the 570S GT4 came to be recognised as its principal weakness as the class evolved. Using the standard production ECU meant it wasn't possible to control the performance of the car through its powertrain configuration – the only real option was to add ballast, which stresses the brakes and the tyres.

"The very first thing you always want to do when you're designing a racecar is take as much weight out as possible, so it's painful to see it being added back in," comments Gerrish. "That was no fault of the car. It was just designed a long time ago, for a different market. GT4 racing has evolved massively in that time." ▶



**BELOW** A new twin-turbocharged V6, produced by Ricardo, forms the basis of the package, replacing the old family of V8 engines

The motorsport-specific Bosch ECU used on the Artura GT4 has brought things bang up to date, allowing the car's power output to be adjusted electronically (alongside adjustments to the weight and aero characteristics). It's part of a bespoke electrical architecture, which also includes a power distribution module, a modular wiring harness and a single-seater-style steering wheel that puts all of the controls at the driver's fingertips.

## Traction control

While its predecessor essentially used the road car's driver aids, the Artura GT4 uses Bosch's motorsport traction control and ABS systems, calibrated by McLaren. It also features a mechanical limited slip differential (mirroring the road-going Artura, which is the first McLaren to feature an e-diff in place of an open differential).

"The combination of an open diff and road car ESC in the 570S GT4 made it very easy to drive, but it meant that when the drivers started to push, they could spin the inside wheel and slow down. Now, the motorsport traction control gives them the support and the confidence that they need, while the limited slip differential allows the drivers who can really lean on the car to get more out of it," says Gerrish.

Without a limited slip differential, McLaren's road cars had previously relied on torque vectoring applied by the brakes. Ostensibly done to save weight, it enabled the vehicle's software to load the differential by applying the brake to the inside rear wheel, essentially mimicking a limited slip diff.

This was inspired by the company's Brake Steer technology in Formula 1, which used an additional brake pedal to load one rear wheel (either left or right depending on the more problematic corners on the track). Doing so allowed the car to be set up with more stable, conservative handling characteristics, while still enabling the driver to trim out any understeer with the additional pedal. It was used to great effect on the MP4/12 driven by Mika Häkkinen and David Coulthard in 1997, with benefits of nearly half a second per lap in testing. Rivals were less impressed, and while the system was deemed legal for that season, it was subsequently outlawed in 1998.

This isn't McLaren's first GT racer to use a limited slip differential. The current 720S GT3, for instance, has one. Nonetheless, careful attention was paid to the setup to ensure that

**LEFT** The car features a 720SGT3-style steering wheel

strong traction on corner exit was combined with a willingness to rotate on corner entry.

"During development we narrowed it down to two different ramp angle options for both the coasts and drive ramps. We then put both of those through rigorous back-to-back with two cars set up identically," says Gerrish. "There is a trade-off. Under certain circumstances, you can get a bit more push-on understeer or lack of rotation with a limited slip diff. Working with our factory drivers, we dialled the chassis setup into the best option for drivability for both Pro and Am drivers."

## Supercar start

While mid-engined supercars are a defining part of GT racing, they're only one element of a diverse line-up. The GT4 category, in particular, has a bewildering array of options from front-engined grand tourers like the Aston Martin Vantage through to muscle cars like the Chevrolet Camaro. Although subject to performance balancing, each type of car retains its own particular quirks, due to differing mass, weight distribution, tyre usage and aero characteristics.

Naturally, every manufacturer has its own opinion on this, and it's not always a given that a faster road car will produce a better racecar. So where does Gerrish see the supercar manufacturers fitting into this equation?

"We're very lucky to start with an amazing product. Taking a very advanced supercar and turning it into a racecar certainly does make things easier in some respects. The weight distribution and the kinematics, for instance, give us a really good starting point," he says.

"I don't envy the people at SRO, IMSA and all the other series organisers who have to balance these different cars. It's an immensely difficult job, with different inherent characteristics to all the cars, but they do it very, very well. The cars all have different strengths, and that's what makes racing interesting."

A key part of the challenge when it comes to engineering a car to run in a performance-balanced Pro-Am series is consistency, he points out. Pro drivers are able to react to changes from one corner to the next. For less experienced Am drivers, consistent behaviour is key to maximising the performance they can get out of the car. It's also one of the factors that differentiates race pace over a 50-minute event from single-lap pace. McLaren's aim, Gerrish explains, is to get a car that feels as strong at the end of the stint, as it does at the beginning.

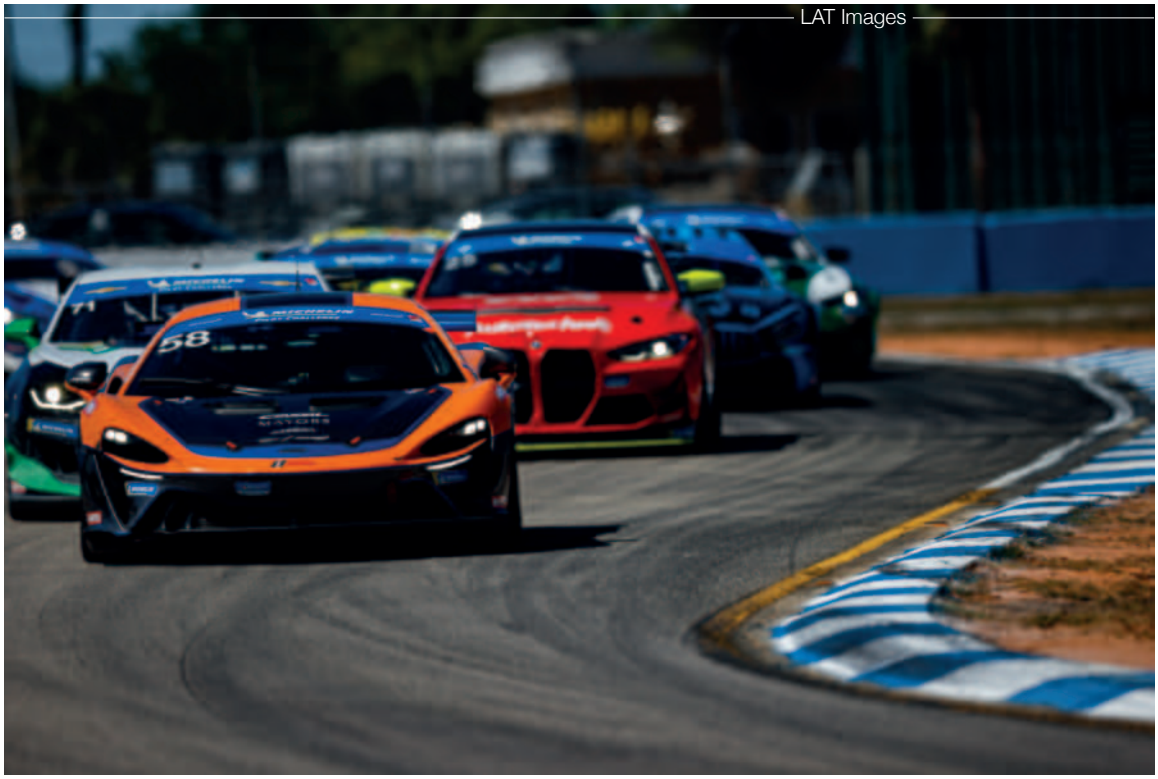
> *"Sustainability is very much on the agenda with GT4"*

There was a good example of this in the development of the Artura GT4, he recalls: "We've got quite a light, mid-engined car, so you would expect it to be kind to the tyres on the front axle. Because of the constraints of the hardware, we couldn't fit as wide a front tyre as we wanted to, but we were able to increase the front wheel width compared to the 570S GT4. That on its own gave us more contact patch, which has given us more mechanical grip on the front, ▶

**BELOW RIGHT** The Artura GT4 is finding a niche on both sides of the Atlantic

**BELOW LEFT** The rear wing is mounted away from the rear deck to aid accessibility

LAT Images



**LEFT** The new Artura Trophy, seen here at the Goodwood Festival of Speed, has an aggressive aero package and can be easily converted back to GT4 spec

**LEFT** Single-make series like the McLaren Trophy are a vital part of the GT racing ecosystem

**RIGHT** The Artura is based on a carbon fibre monocoque with deformable aluminium crash structure and subframes to hold the powertrain and suspension

but also less degradation as the tyre isn't working as hard."

There are also areas of the car that aren't explicitly covered by the BoP regulations. Notably, the brakes are an area where performance can be optimised by managing temperatures and preventing excessive pad degradation. The road car's carbon ceramic setup isn't allowed in GT4, so McLaren had to source iron discs. Careful attention was paid to both the choice of the hardware and the aerodynamic design of the brake ducting.

## Less is more

While stripping out the hybrid hardware was a relatively routine process in most respects, it did create some challenges. Chief among these was the gearbox. The key obstacle to taking the eight-speed unit from the production Artura was that it has no reverse gear – the car relies on its electric motor when it needs to go backwards. Instead, the Graziano seven-speed dual clutch unit fitted to the 570S GT4 was pressed into action. This is effectively an amalgamation of bits from the 570S and 765LT road cars, with the addition of a mechanical limited slip diff. A special bellhousing was designed to allow the Artura's engine to remain in its stock position, while a set of bespoke brackets mean that the gearbox also fixes to the standard mountings.

The mechanical limited slip differential that's been adopted for the Artura GT4 was already an option for the Graziano gearbox, so this proved to be an easy swap. A shorter final drive ratio was also fitted to adapt the ratios to the characteristics of the Artura's V6 powerplant.

> *"GT4 racing has evolved massively"*

Another point to consider was the electrical system. The hybrid road car has no alternator, and it uses a high voltage air conditioning compressor. To overcome this in the racecar, a short driveshaft now leads off the nose of the crankshaft, going into a void that would normally be occupied by the road car's battery and fuel tank, to a mechanism with an alternator and an HVAC compressor. The motorsport fuel tank sits above and around this assembly, which is encased in a carbon Kevlar shroud.

"Basic things like making sure you've got an alternator on there to charge the battery can become deceptively challenging," comments Gerrish. "Our philosophy was to tackle the biggest potential challenges, and those with the longest lead times, first. In the end, it worked extremely well. When the car first ran it was just a powertrain mule with no aero, because we knew that we had to prove out the gearbox and the ancillary drive system, but we had very, very few teething problems."

Despite the differences to the technology and the duty cycles, the McLaren Motorsport engineers were still able to use the engine calibration from the road car as the basis for their powertrain development. Under the performance balancing regulations for GT4, the racecar actually produces less power than the internal combustion portion of the road car powertrain. There are no changes to the hardware on the engine itself, and the

process of re-calibrating the engine took around five weeks on the dyno.

One of the compelling features of the Artura road car is the way it uses the electrical assistance to fill in any gaps in the torque curve and banish the turbo lag that was quite noticeable on its predecessors.

"The V6 is a fantastic asset for us," comments Gerrish. "It's lighter and more fuel efficient than the previous V8, and the transient response of this engine is better, even without the hybrid assistance. It's a direct injection engine [unlike the port injection system on the 570S] and the turbos are very well optimised."

## Trophy series

GT4 is a globally-recognised category that allows the Artura to compete in scores of national and regional championships around the world, not to mention blue ribband events like the Nürburgring 24 Hours. Since 2018, McLaren has also hosted its own one-make series. Originally conceived in 2018 as the Pure McLaren GT Series, it has been relaunched for 2023 as the McLaren Trophy.

While its predecessor used standard GT4 cars, the new Trophy format is closer in performance to GT3. Freed from the constraints of GT4's performance balancing, the Artura Trophy gets a revised ECU calibration that takes the power output up to 585 hp, along with a high downforce aero kit consisting of a new front splitter and rear wing. A similar kit is available for the 570S GT4, which is also eligible for the series.

These simple but significant changes are said to add up to a big difference, with the cars as much as four seconds per lap quicker than a standard GT4 machine.

The Artura Trophy package is sold as an upgrade to the GT4 machine. It's fully reversible, meaning that the same car could be used for GT4 events one weekend and the McLaren Trophy the next, but the Trophy specification has been part of the plan from the start, explains Gerrish.

"We were already thinking about future-proofing the car for the Trophy when we were designing the GT4," he explains. "Speaking personally, I can't stand waste. Inefficiency is a terrible thing, and we were determined not to have to go back and redo anything. So, for example, when we were developing the brakes, we made sure that we were running at the highest duty cycle physically possible, so we knew that they'd be up to the job with the extra power of the Trophy car.

## Quick switch

"The key philosophy was to be able to switch between GT4 and Trophy specifications with the minimum amount of time and parts. The flipside, admittedly, was ensuring that we didn't massively over-engineer the GT4 car for a percentage that would turn into Trophy cars, but I think we got the balance spot-on. I'm very proud of the base car that we've engineered to see that it can go so quickly with just a few straightforward changes."

For some drivers, single-make series like the McLaren Trophy are the first step on a ladder that could lead to Le Mans or Daytona. They're a vital part of the GT racing ecosystem, and a profitable enterprise for the manufacturers.

Whatever the future brings in terms of technology, you can be sure that this concept will endure. RT

Alpine

# BoP IN F1? PLEASE, NO!

Alpine's struggles in F1, allied to the rules freeze, force **Sergio Rinland** to confront one of his worst nightmares

**IN THE** wake of an unnecessarily controversial Le Mans 24 Hours, the motorsport world was left talking about Balance of Performance rather than an epic race.

We ourselves criticized the application of Balance of Performance to LMH but, at the same time, praised the Equivalence of Technology between LMH and LMDh: two different concepts altogether. EoT is about equalizing the performance of two different sets of rules, such as LMH and LMDh, so both formulas can have, in theory, a chance of winning, making it possible to have a healthy grid in all WEC races.

Conversely, BoP is nothing less than rule manipulation to equalize the performance of two or more cars running under the *same* regulations but with different outcomes for their efforts. Such is life if you believe in meritocracy, which is the DNA of motorsport.

Once the rule-makers start tampering with the regulations through BoP, it opens a can of worms. You are damned if you do, as at Le Mans when they handicapped Toyota and Ferrari were happy; and you are damned if you don't, as at Monza where Ferrari thought the rule-makers were 'unfair' with them this time.

BoP may work in series where drivers compete with cars that are slightly tuned production models, not manufactured with racing in mind. But it has no place in professional motorsport, where people build specially designed cars under a set of rules.

We used to design cars to follow a set of rules, some with better results than others through different skills and/or resources. Then we went racing and tried to improve the package, day-in and day-out. We persevered, without thinking 'life is unfair'; we just got on with it and tried to do a better job next time round. Or, if some of us were fortunate enough, we went and worked for a team with better resources to give us a better chance. And that was the nature of the beast.

These days, as in LMH for example, everybody is given the same freedom, limiting the outcome of the biggest performance differentiators: power and aero performance. That is already a great equalizer, leaving freedom of second-order performance differentiators. Under these rules, if a team does not come up to scratch it is because it did not do as good a job as its rivals. So… back to the drawing board!

I heard, to my horror, that Alpine's struggles have raised the spectre of BoP in F1! All because in the last 10 years, we had Mercedes winning seven championships in a row and now everybody is afraid that Red Bull will do the same until the next rule change. Did anyone stop for a second to ask why this is happening now?

In the old days, if a team won two championships in a row it was an extraordinary event. When the rules changed in 2014, the chassis and aerodynamics had been in constant evolution for about 30 years, well understood and honed by nearly everybody. The rule change was all about Power Units, and Mercedes had the upper hand because their engineers understood the new rules better than anyone else until Honda caught up.

It took this long to beat Mercedes because development was so limited by the rules (through the 'tokens' method) that teams could not throw away what they had and start again from scratch.

Then the rules changed again…

This time, the Power Unit was frozen and the new rules were all about aerodynamics. This time round, Red Bull aerodynamicists (with a certain Adrian Newey in charge) understood the new rules better than anyone else. Engines continue to evolve at a slower pace – yes, the deficit of Alpine's Renault PU has been noted, but this is nine years after those engines were first introduced! – so now it is all about aero.

Here again, because of the tough restrictions on development through the budget cap, the wind tunnel/CFD use and the tight aero regulations, teams are finding it extremely difficult to improve their design.

In the past, we had our own limitations so it was up to us. Now, the rule-makers are setting the limitations, so even if someone comes up with 'the' solution mid-season, the engineers cannot test in the wind tunnel or spend more money manufacturing new bodywork: they are stuck.

Hence, instead of penalizing the team who did better than others to 'equalize' performance in the name of 'the spectacle', please look at why this is happening. Mend the rules and limitations so that everybody has a chance to improve a bit faster than in three or four years' time.

**ABOVE** Alpine's struggles have prompted a sinister BoP debate

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