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Winning Partnerships



March, 2021

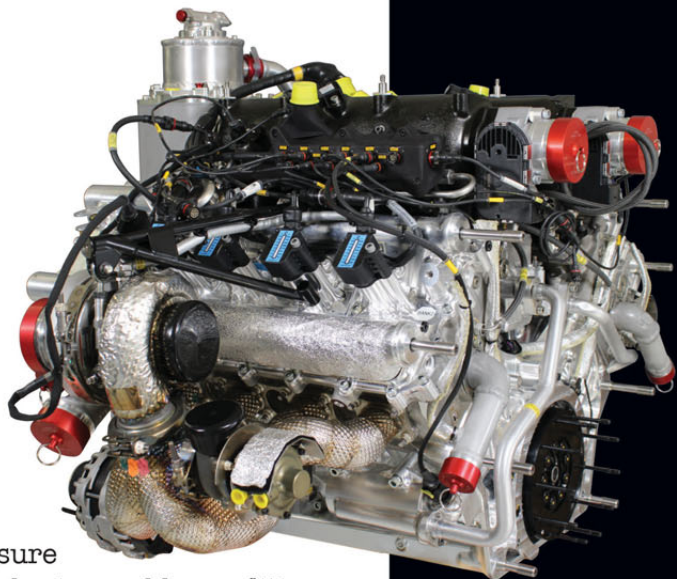
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A MAGNIFICENT MAN

NO WORDS can convey adequately the sadness with which we report the passing of RACE TECH's editor, William Kimberley, after a long battle with illness.

A multiple award-winning technical journalist, William was the orchestrator behind the much-loved series of Kimberley's Grand Prix Team Guides and original *The Ford That Beat Ferrari* book. A former custodian of MOTOR SPORT magazine and editor of the respected *Automotive Engineer*, he has been the beating heart of this magazine since 2006.

He came to regard many of you who will be reading this not as acquaintances or clients, but as friends. William looked forward to catching up with you, be it in the paddocks, pit lanes or as he paced the aisles of the trade shows around the world. He always valued your feedback and the warmth with which you greeted him and Soheila, his wife, business partner and the rock upon whom he relied.

RACE TECH will continue, as was his fervent wish. But under the circumstances we are sure you will understand why this year's RACE TECH World Motorsport Symposium cannot go ahead.

Those of you who enjoyed the WMS, who some referred to as "the Davos of Motorsport", will know that William was a key part of the team that made the event the success it was. It will return, indeed it must, for the Symposium is one of those rare arenas in which trackside rivals can come together, out of the limelight, to achieve shared goals.

Racing will always be gladiatorial – it is part of the appeal – but it is clear that we are stronger as an industry when we stand shoulder-to-shoulder, as in the sport's impressive reaction to the global pandemic, than when we waste our energy bickering with one another. Rarely has the sport – like the planet itself – faced challenges of the magnitude it does now, with no one clear technical pathway forward. But the common thread of previous World Motorsport Symposiums, and hopefully those to come, is that motorsport must become part of the solution, rather than part of the problem.

That's a sentiment of which William would have approved... **RT**



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Mark Skewis

CONSULTANT EDITOR



WILLIAM KIMBERLEY

1950-2021

A tribute to a magnificent man whose work helped shape the industry

RECALL the familiar glint in William's eyes as he recounted the tale behind the publications that first catapulted his fledgling publishing company into the limelight.

The Grand Prix Team Guides of the early eighties were extremely popular, but money was tight. So he queried the figure when informed that one client had just ordered 3,000 copies.

"No, not 3,000," came the response. "THIRTY thousand!"

Bingo. The Kimberley publishing empire had 'arrived'!

To put that escapade into context, these were Quixotic, romantic days for motorsport. On-track and off, brave risk-takers were pursuing success. In that respect, William was a product of his era. He chased his dreams. He even married one of them! Soheila, his wife and business partner, was his rock for nearly 50 years.

The next standout publication was *The Ford That Beat Ferrari*, published in 1985. It documented the racing history of every Ford GT40 chassis between 1964 and 1971. Designed by William himself in Quark Express, it marked a quantum leap forward for the company. Years later, over a coffee, he revealed that the print bill, which had to be paid in 30 days, was higher than the new mortgage which the Kimberleys had 20 years to pay!

Crucially, the tale of the GT40's Le Mans success had two 'domestic' markets – the US and the UK – so the arithmetic worked.



"What he did for the Engineering world is something I will forever be in awe of"

The book embodied many of the lessons William had learned during his 'apprenticeship' in the seventies at Dalton Watson under his uncle, Lawrence Dalton, who wrote many fine books on Rolls-Royce and Bentley – always close to William's heart! One of the things he drummed into his young charge was that the changing configurations of the cars over time mean that an original picture, often in black and white, can actually be far more valuable

than a modern one in colour.

"He told me never to throw away a photograph," William recalled. "It was a lesson that has come in handy many times, albeit it hasn't done much for the space in my garage or loft!"

If *The Ford That Beat Ferrari* was in some ways a nod to the past, it was also a bold move that had a profound influence on William's future career path. It resulted in him being head-hunted by Teesdale Publishing, in the late eighties, for a role as one of the custodians of its famous MOTOR SPORT magazine. The sport's original 'bible', it had been a ground-

breaker in its time and remained revered by some, respected by all.

The MOTOR SPORT role helped earn William his next post, Editor of the much-respected *Automotive Engineer*, a monthly magazine published by the Institution of Mechanical Engineers in the UK for the automotive industry with an international readership.

It took nearly a decade for his wife, Soheila, to entice him back into the family business. When he arrived at RACE TECH, in 2006, his teamwork, easy-going manner and sense of mischief were a breath of fresh air.

We used to pledge solemnly to the Publishing Director that we were off to resolve weighty editorial issues, then zoom across the road to annex a corner of a coffee shop. There we would ►

babble football anecdotes and 'Game of Thrones' before finally trailing back to the office in the late afternoon, like guilty school truants.

On one such expedition, as I limped along with yet another running injury, I discovered that William had once successfully completed the London Marathon. Though a super-keen squash player, he was not a natural runner. Yes, he raised money for charity, but his main motive was to challenge himself.

He suggested that for my next race it would help to get a tee-shirt printed with my name on it. "Then when spectators see you coming, invariably hobbling, and sweating profusely, they will call out your name to cheer you on," he advised.

"Did it work?" I asked.

"Yes, it did. I was amazed," came the reply.

"All these people I had never met were suddenly shouting, 'Come on William!'"

A short pause, another sip of coffee, and a sheepish grin. "Should have put my name down as 'Handsome', shouldn't I!"



RIGHT An invite to St James's Palace while publishing The Kimberley's Grand Prix Guides. Tough life at times...

LEFT & BELOW

"Never throw away a picture" he was told as an aspiring journalist. The lesson came in handy when it came to illustrating the Ford v Ferrari war at Le Mans



It was typical of the self-deprecating humour that never lurked far below the surface and which we will miss so much.

As with the marathon, William was never one to blow his own trumpet. He didn't need to. Others did it for him: a prominent member of the Guild of Motoring Writers, he was a recipient of the Jet Media Excellence Award for technical writing (1996), the Special Delphi award for Technical Publishing (1999) and won the Market Engineering Award for automotive technology journalism in 2014.

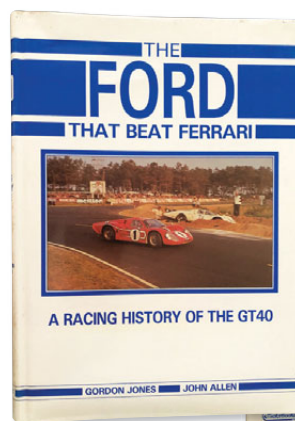
The judging panel for the latter award was looking for the ability to write articles which are valued by specialists in the subject, yet also interesting

and easily accessible to non-experts. Those were the very values he always instilled in anyone who worked alongside him.

Another of his accomplishments was the leading role he played in establishing the RACE TECH World Motorsport Symposium. First run in 2005, it quickly grew in stature and significance to the point that some now refer to it as "The Davos of Motorsport". It offers a safe zone where trackside rivals can come together as respected friends to discuss the challenges that face them all.

Chris Aylett, Chief Executive Officer of the Motorsport Industry Association, led the tributes that have poured in from the industry. ►

RIGHT The publication of the original *The Ford That Beat Ferrari* book played a pivotal role in William's career



ABOVE & BELOW
RACE TECH's
World Motorsport
Symposium, of
which William was a
lynchpin, has helped
shape the industry
as it adapts to many
new challenges

"All engaged in the business of motorsport have sadly lost a very special gentleman," he said. "Our friend William was simply the most passionate enthusiast for all forms of automotive technology and engineering, particularly when it involved motorsport, that I have ever met. As I reflect on the many years of friendship we enjoyed, our meetings always involved heated, but enjoyable, discussions on future technologies and their effect on our sport and industry."

Laughter

"In 1998, the MIA and the UK government took a large group of UK companies to the Yokohama Motor Show. William and I, joined by my friend Charles, decided to visit a new 'video games' centre and found a very realistic Le Mans game 'on screen', far ahead of anything in the UK at that time. We took it in turns to race one another, very competitively, into the small hours when, only exhaustion from laughter and the battle, brought this to an end. As we wandered the world of endless exhibitions and shows in many countries over many years, William was always



excellent company; intelligent, well-informed and sharp-witted too.

"His editorial and writing skills were exceptional. For so long, his motorsport insight and knowledge, has kept his readers enthralled and informed – from historic through endurance to F1. His mind was so active and his opinions were impeccable.

"We all admire the close family, that meant so much to him, which he and Soheila kept together with good humour and friendship. The next Kimberley generation are a real credit to William and Soheila. Indeed, they are the very best, enduring testimonial William could ever have wished for.

"Rest in peace, my friend."



ABOVE A trip to Le Mans in his beloved Bentley was one of William's annual highlights. Ever game for a laugh, he is captured here singing for a German pop video – we kid you not! – at an event organised by The Guild of Motoring Writers

BELOW Getting to see one of the most iconic film cars ever, the 1968 Ford Mustang driven by his hero, Steve McQueen, in the film *Bullitt*, was one of William's best perks in a job that he loved. Found in a barn, the car was restored and displayed on the National Mall in Washington DC, attracting around half a million people



"What he did for the Engineering world through his work at the IMechE and beyond is something I will forever be in awe of," said Giles Dawson, Managing Director of ATL. "He was the reason I threw ATL's support behind Formula Student in my early years at ATL; many words he said to me through our discussions over the years still ring in my ears. Respect is something that is earned and I do not know a single person in the industry who did not hold William in the highest regard. I just wish that he could join us in a couple of weeks for our next conversation about next generation fuels."

Ulrich Baretzky, former Audi engine supremo and co-chairman of the Symposium, said: "With the death of William, a very important and independent voice of motorsport has fallen silent.

"This voice has never been loud or

angry but strong in a very gentle and sympathetic way. The combination of his very profound technical knowledge and his skills as journalist and editor have been unique. Motorsport and its technology have not only been his passion – it has been his vocation.

"I have enjoyed many conversations with him as well as his wise comments on page 3 of the RACE TECH magazine. I am very sorry to miss all that now, but I will maintain the memory of William."

"William was the father figure of the World Motorsport Symposium," agreed former F1 aerodynamicist and fellow WMS co-chairman John Iley. "Enthusiastic and incredibly knowledgeable, he was one of the true gentlemen of our industry," he added.

"William was such a great man in every single respect, and I feel privileged to have counted him as a dear friend," added Pat Symonds, Chief Technical Officer, Formula 1. "Our whole motorsport community will miss him greatly."

"I can honestly say I know of no one else in our industry at all like him," commented Alistair Fergusson, Group Managing Director, Alcon. "He was so interesting in what he said, interested to hear what others thought and did, gentle – though


"His editorial and writing skills were exceptional"

loving a debate (!) – thoroughly decent, and a tireless supporter of those involved in the motorsport and automotive engineering world that he loved.

"His legacy is doubtless far greater than the magazines and the symposia for which he and Soheila are rightly feted, it's just that I am not sure that I saw the half of what he so modestly and unassumingly achieved. He will be much missed in our world."

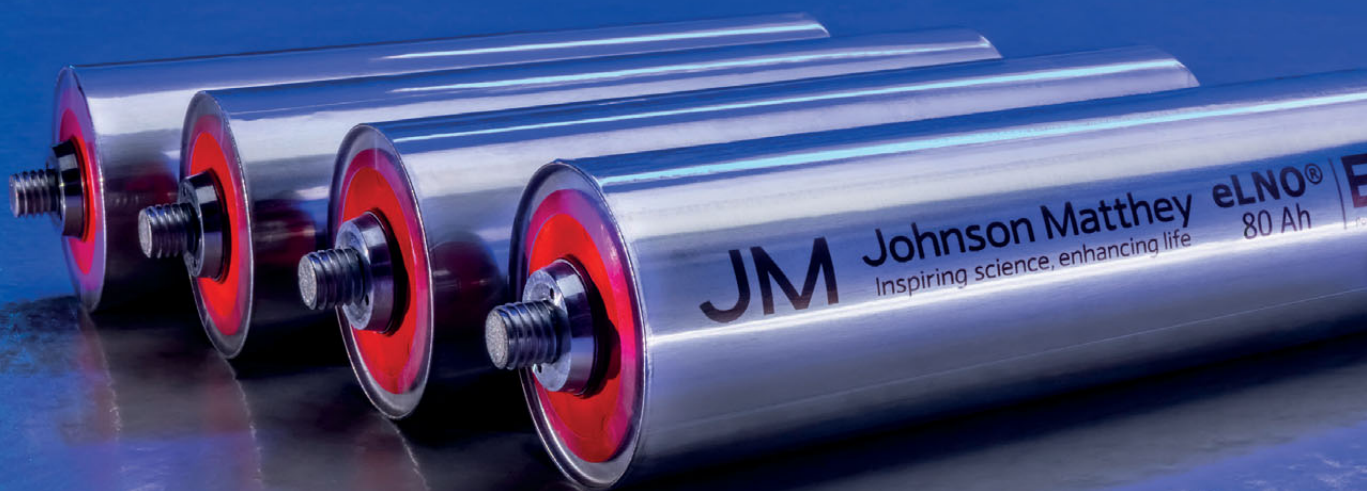
These are typical of the beautiful and heartfelt messages, from friends and even rivals, which have overwhelmed the family. Many of them are too personal to share and there is neither time nor space to do justice to them. Suffice to say, the Kimberleys are feeling the love right now and appreciate the support so many people have offered.

A common thread running throughout everyone's messages is that William was a gentleman, whose professional exploits helped shape the industry that he loved.

Equally invaluable, for me personally, was his ability to play practical jokes, tell football anecdotes and play Fantasy F1. Yet none of those attributes, impressive though they were, trumped his priceless natural ability to make everyone around him feel better about themselves. 

By Mark Skewis

Innovative nickel-rich battery material technology makes debut at COP26



THE first full-size lithium-ion battery cells featuring Johnson Matthey's advanced eLNO cathode technology have been showcased at the COP26 climate change summit.

They were installed in a unique high-performance two-seater racecar. The prototype is the result of a partnership between Johnson Matthey, a global leader in sustainable technologies, and Envision Virgin Racing, the carbon neutral Formula E team. It was designed and manufactured by Delta Cosworth at Silverstone, the home of motorsport in the UK.

eLNO is a family of nickel-rich cathode materials that safely enables batteries to perform better and charge more quickly while retaining exceptional battery lifetime.

Greater energy density

A customisable family of nickel-rich cathode materials, eLNO will meet specific battery performance requirements for individual electric vehicle platforms. eLNO is claimed to enable batteries around 20 percent greater energy density compared to today's typical NMC cathode material technology. It is ideal for use in cells powering a range of electric vehicles, particularly those with fast charging, high performance and long-range requirements, such as larger premium passenger cars and premium SUVs.

Johnson Matthey scientists have enhanced the chemistry of the cathode material using a proprietary stabiliser package and surface modification, engineering the cathode

material down to the atomic level. This enables the use of high nickel contents for increased driving range, as well as a reduction in the level of cobalt present, to sustain cycle life and stability.

Already in pilot production and being trialled by customers, eLNO will be supplied to customers in Europe from two new production facilities. The first facility in Poland is under construction and will be completed in 2022, for commercial production in 2024. A second eLNO plant is also planned in Finland. These facilities will operate sustainably as part of Johnson Matthey's commitment to overcoming climate change, circular manufacturing, and the responsible sourcing of materials.



The battery cells were developed and produced by EAS Batteries. The German specialist battery manufacturer is the first in Europe to produce large battery cells for an automotive application that feature nickel-rich eLNO cathode chemistry. The cylindrical 602030-format cells were manufactured using an almost dry coating process – which has a far lower carbon footprint than typical wet coating – with a non-toxic solvent, and less solvent waste than typical cell production processes.

“Our eLNO technology will provide a step-change in battery energy density for electric vehicles going on sale in just a few years’ time. It therefore supports the industry’s commitment to fighting climate change,” said Christian Günther, Battery Materials Sector Chief Executive, Johnson Matthey. “We are proud to have worked with Envision Virgin Racing to present eLNO in the exciting race car at the world’s biggest climate change event. It represents an important step towards high volume production of the technology in Europe within the next few years.”

The car

The racecar, designed and engineered in partnership with the Envision Virgin Racing team, is believed to be the world’s first two-seater electric racer. It will showcase production-representative eLNO technology in a challenging application, proving that Johnson Matthey’s advanced cathode material technology is ready to be integrated into batteries powering the forthcoming generation of EVs.

The car features a dedicated two-seater carbon-fibre monocoque platform that is designed and engineered to accommodate the driver and an additional passenger in tandem formation.


“As the very first public application of our eLNO technology, the two-seater race car will provide a stunning next step in bringing our ground-breaking technology to market,” said Günther. “Not only will the racer generate valuable test data, but we look forward to giving passengers the opportunity to experience the visceral thrill of a high-performance electric race car.”

“We are excited to unveil the world’s first electric

“eLNO technology will provide a step-change in battery energy density”

two-seater formula race car, the result of a very productive partnership with Johnson Matthey. Delivered in under six months, it is a fantastic achievement by all those involved,” said Sylvain Filippi, Managing Director & Chief Technology Officer at Envision Virgin Racing Formula E Team.

“The two-seater formula race car has been specifically designed to test and push the battery performance to its extreme. This battery technology is unlike anything else we’ve seen before, and we wanted to create a prototype car that would really put it through its paces and showcase its huge potential.”

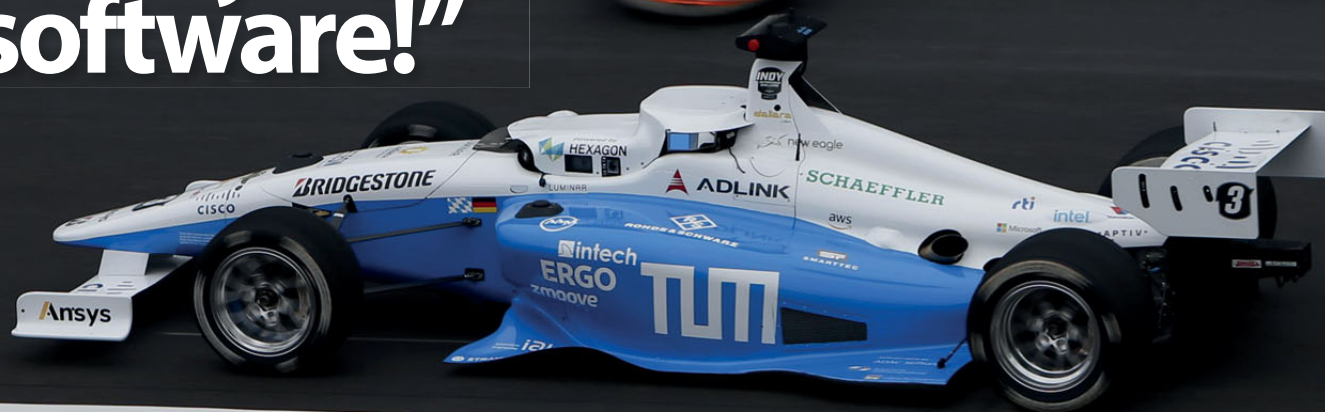
The cylindrical 602030 cells in the battery pack achieve 200 Wh/kg cell energy density for a total 47 kWh capacity, and an electrical output of 585 volts. This is delivered to the car’s electric drivetrain to produce 250 kW of power at the wheels. The racer’s targeted maximum speed is 240 km/h. 

ABOVE & RIGHT

Cells with eLNO cathodes have been installed in the world’s first electric two-seater racecar



"Ladies and gentlemen, start your software!"



TUM Autonomous Motorsport, from the Technische Universität München (TUM), won the Indy Autonomous Challenge Powered by Cisco (IAC), the first autonomous racecar competition at the Indianapolis Motor Speedway (IMS). TUM competed in a field of nine teams from 21 universities to win the \$1 million grand prize.

Indiana Governor Eric J. Holcomb officially started the competition with the call, "Ladies and gentlemen start your software and crank your engines."

The Rules of the IAC required each team to compete

In addition, the competition serves as a platform for students to excel in Science, Technology, Engineering and Maths (STEM) and inspire the next generation of innovators.

The hope is that automotive, engineering, tech and many more industries are going to see tangible results from the nine-car autonomous competition.

"We're going to see leapfrog improvements in sensor fusion, in low-latency decision making, that are all key to the commercialisation of autonomous vehicles, which we know is critical for society from

ABOVE & BELOW

LEFT The ground-breaking IAC, won by TUM Autonomous Motorsports (top), could contribute to moving the Autonomous dial



in a fastest lap competition that included an obstacle avoidance component. The winning team recorded the fastest two-lap average speed of 135.944 mph on the famed IMS Oval.

Organised by Energy Systems Network and the Indianapolis Motor Speedway, the primary goal of the IAC was to advance technology that can speed the commercialisation of fully autonomous vehicles and deployments of advanced driver-assistance systems (ADAS). Examples of ADAS features in passenger cars include adaptive cruise control, anti-lock brakes, traction control and lane departure warning.

an efficiency standpoint and from an environmental standpoint," said Paul Mitchell, president and CEO of event co-organiser Energy Systems Network.

"And particularly from the standpoint of saving lives, because these advances, ADAS systems, are really critical to reducing driver fatalities."

"We think the Indianapolis Motor Speedway is a pretty special place, and I think for any race fan on the planet it's a special place, but the activities here under the Indy Autonomous Challenge are truly incredible," said Mark Miles, president and CEO of Penske Entertainment Corp. "This is on a whole new

“This is on a whole new order of magnitude. The degree of difficulty here is extraordinary”

order of magnitude. The degree of difficulty here is extraordinary.”

While nine cars were entered in the competition, which was reminiscent of Indianapolis 500 qualifying, not all teams were able to make runs due to the challenging nature of the event.

Meanwhile, EuroRacing, a team made up of students from Italy, Switzerland and Poland, recorded the fastest one-lap speed in autonomous oval racing competition, 139.009 mph.

Times matched fifties Indy

The single-car runs produced average speeds that were not seen in Indianapolis 500 qualifying until the 1950s. In 1951, Duke Nalon won the pole for the Indianapolis 500 with a four-lap average speed of 136.498 mph. In 1950, Walt Faulkner won the pole with an average speed of 134.343 mph, slower than the two-lap average speed produced by TUM Autonomous Motorsports.

“Participating in the Indy Autonomous Challenge allowed our team to advance autonomous driving technology and being able to take first place after two years of hard work acknowledges that we had an outstanding team,” said Alex Wischniewski, team leader of TUM Autonomous Motorsport. “Our next goal is to win a high-speed autonomous head-to-head race.”

The prize money won by TUM Autonomous Motorsport will go to the Technical University of Munich to support its efforts to further autonomous technology research and development.

It was a record-breaking and monumental weekend in Indianapolis, and one that Miles believes will take time for society to understand and appreciate what exactly was learned, innovated and applied. “Like all innovation, I don’t think we know what this is going to mean,” Miles said. “Time will tell.” **RT**

“They didn’t know it was impossible”

THE prospect of a full field of autonomous-enabled cars racing wheel-to-wheel, with their software making split-second decisions to overtake and to avoid each other, did not materialise as planned.

Then again, when autonomous vehicle experts from around the world met at Indianapolis before the 2019 Indy 500 to hatch the plan for this event, nobody could have seen COVID-19 coming.

The global pandemic wreaked havoc on the competition, making teamwork in close quarters virtually impossible for long periods of time. Teams communicated via online video platforms to discuss and begin building the sophisticated coding and algorithms that would eventually compete at Indianapolis.

Such was the impact of the disruption that the very format of the event had to be changed, with the ‘race’ morphing into something more reminiscent of Indy 500 qualifying.

“There’s a long history of prize competitions setting goals that are meant to be impossible, just to see how close one might get to that goal,” explained Paul Mitchell, the president and CEO of Energy Systems Network. “Yes, it would be exciting to see even two cars on-track at the same time, and we have had them doing overtaking in practice, but we weren’t at a point where it was consistent enough to feel like the level of performance was on-par with what we wanted to showcase at an event like this.”

So, given the upheaval, what was the verdict on the event from those on the scene?

“Four months ago, robot cars could hardly maintain speeds of 30 mph while circling Lucas Oil Raceway – even with a chase car able to take some control of the racecar,” reported Nathan Brown of the *Indianapolis Star*. “Teams struggled to have one car stop in the proper spot in the pits and allow the next car to exit the pits in under 15 minutes.

“What had been billed in its introduction two years ago as a traditional race with a packed track, with cars hitting speeds nearing 200 mph over 20 laps to decide a winner, was seriously in danger of being a complete flop.

“[The] competition, which was reformatted into a challenge somewhat mirroring Day 1 of Indianapolis 500 qualifying, didn’t meet those original lofty standards, including four notable crashes out of the 11 total runs. But those involved came away largely satisfied in the level of technology that was put on display and what it may signal over the next decade of traditional road car development.

“All the technology in these cars was already available,” said Andrea Pontremoli, the CEO of Dallara. “Maybe the difference is the fact that we now, because of this, have the algorithms to use that technology in an innovative way. Competition like this can enable a lot of people to think in a different way – even myself.

“Companies themselves would have said earlier that this was impossible, but the students didn’t know it was impossible, and they did it.” **RT**



LEFT It was a race against time to get the technology working



FIA/WRC

AI camera heralds breakthrough in rally safety

THE inclusion of a footnote in the release accompanying the FIA World Motor Sport Council hints at an exciting breakthrough in attempts to improve safety in the World Rally Championship.

Starting from 2022, the FIA Artificial Intelligence Safety Camera (AISC) will become mandatory in all Rally1 cars. Although more testing is required before the governing body communicates officially on the subject, the introduction of the camera represents a landmark moment in a project that began almost three years ago.

This forward-facing in-car camera will continually scan the special stage and its direct surroundings, identifying the shapes and analysing the position of spectators in the environment, hence helping to supplement the work undertaken by the FIA Safety Delegate to address unsafe situations. The crew-facing High-Speed Camera (HSC) currently in use in all Priority 1 cars will no longer be mandatory but only recommended.

Rally fans have always been renowned for their fanaticism – even before social media created pressure for increasingly daring photographs. Back in the Group B era, mechanics would tell of having to regularly remove severed fingers from the ducting at the end of the stage after reckless fans had insisted on reaching out and touching the cars as they passed in full flight. That was in the mid-1980s; the current generation of cars are quicker still.

Pre-COVID restrictions, more than four million spectators attended Rally events, which take place on stages that can stretch across more than 25 kilometres. This can make it difficult for race organisers to monitor

ABOVE The WRC is harnessing the latest technology to deal with 'rogue' spectators, like those captured here on an in-car camera

an entire stage, which are often on relatively narrow dirt and gravel roads that cut through diverse terrain, further hampering efforts of drivers and spotters to watch for fans who may be in harm's way.


The FIA began exploring high-tech solutions to the problem early in 2019. It initially joined forces with global technology group Siemens to improve the detection of spectators in dangerous locations. The plan, unveiled at the Geneva International Motor Show, was for the FIA to leverage Siemens' expertise in chip-to-city engineering in real-world autonomous and connected vehicle applications. However, collaboration between the two parties is thought to have ended more than a year ago.

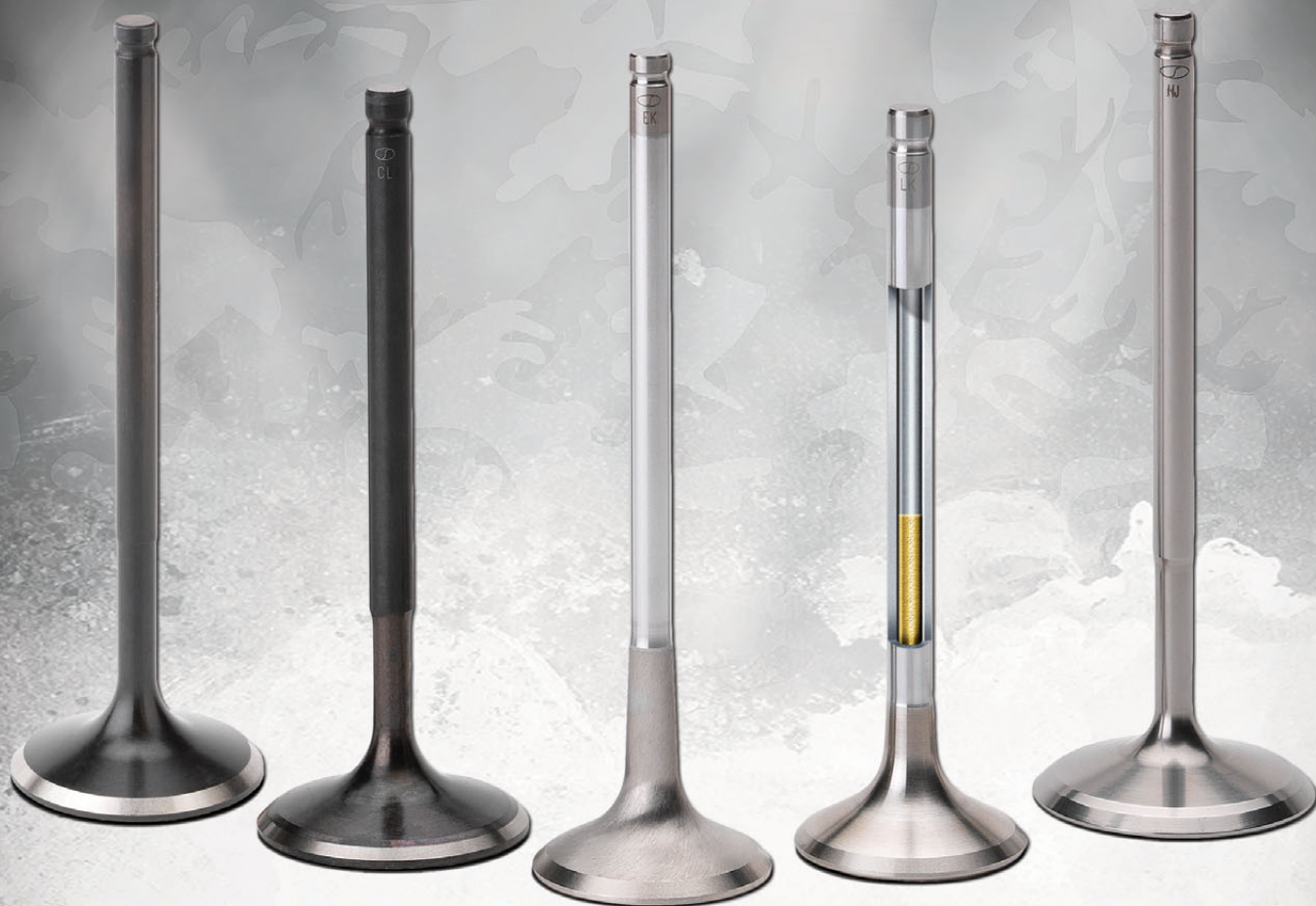
Spectator 'heat map'

Initial steps in solving the crowd problem involved creating an advanced 2D and 3D simulation using vehicle and trackside arrayed sensor-based systems deployed on stages. The intention was to build a 'heat map' of spectator movement, utilising AI technology to predict behaviour, much as a road car's autonomous technology might predict a pedestrian about to step off the pavement in front of it.

Although much of the tech involved would likely be road-to-track, the hope is that some expertise will also flow in the opposite direction.

FIA President Jean Todt, a World Rally Championship Constructors' Champion as a co-driver with Talbot Sunbeam in 1981, has been an advocate of the project from the outset. "The FIA leads the agenda to connect motorsport and urban mobility in order to inspire change and create a transformative impact on people's lives," he said.

"A project that involves R&D with the highest level of motorsport and urban transportation technologies will enable us to make racing safer and significantly influence the development of transportation in smart cities." 



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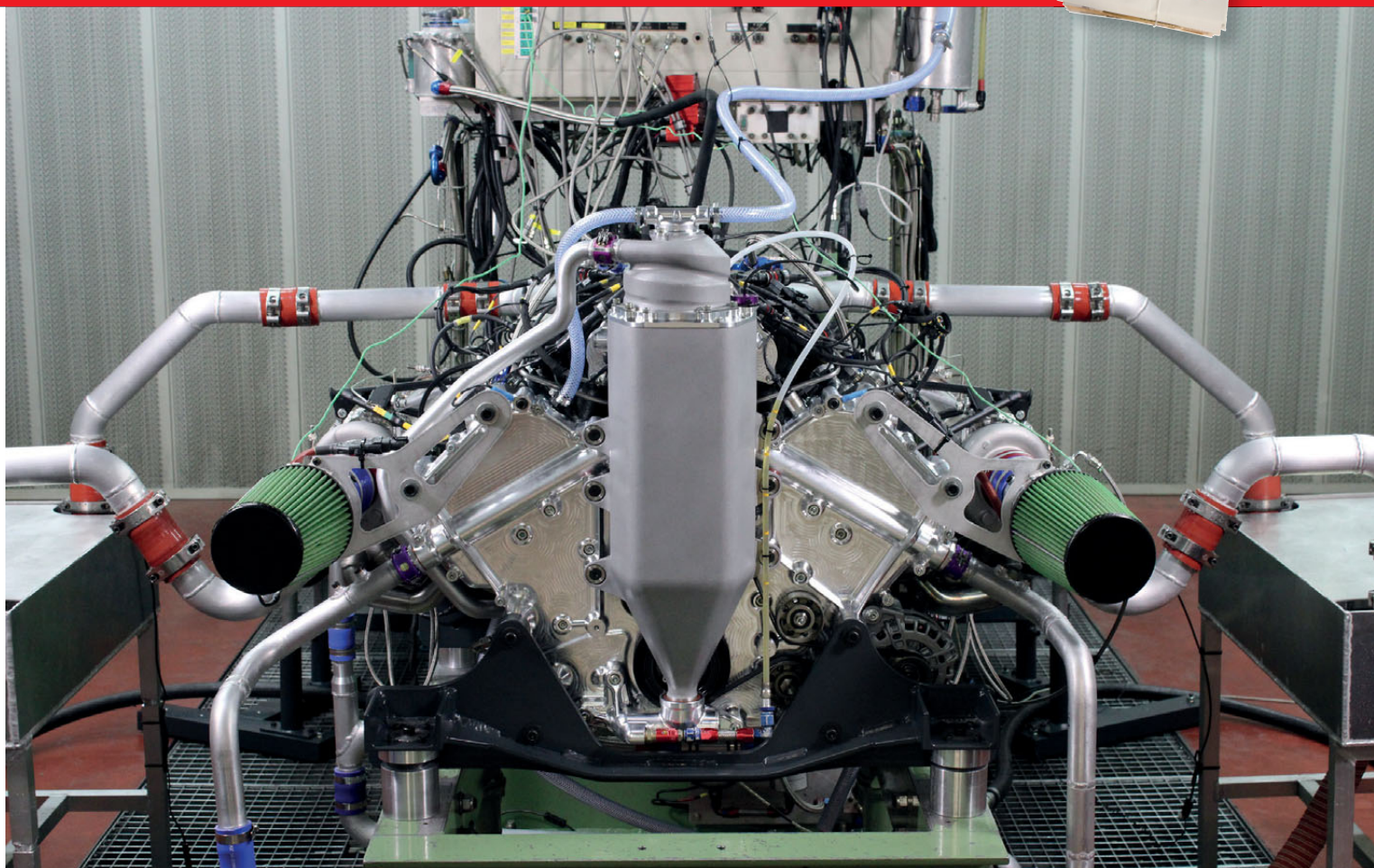
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Pipo Moteurs to produce hydrogen turbo engine for Dakar Rally

FRENCH engine specialist Pipo Moteurs is to produce a hydrogen-powered ICE engine for the 2023 Dakar Rally.

The company forged its reputation producing successful ICE engines for manufacturers in the World Rally Championship and World Rallycross. It currently supplies twin-turbo V8s for the Glickenhaus SCG007 Le Mans Hypercars in the World Endurance Championship.

It has already been working on the use of synthetic and biofuels in ICEs and its general manager, Frédéric Barozier, believes that hydrogen combustion is the way of the future for motorsport, rather than the fuel cell.

"The hydrogen engine is the third generation of engine after gasoline and diesel in the last century," he told the recent Hydrogen Symposium in Le Mans. "The usual parts are present but everything is different: the size of the turbos, the geometry of the cams, the volumetric ratios etc."

New generation


Pipo's vision is for the new generation of internal combustion engines based on classical principles. As with classic ICE engines, the hydrogen will be sprayed towards the combustion chamber through dedicated injectors, forming the mixture with the air that will

start the combustion through a specific spark plug.

According to the French engineers, the result will be a turbo engine capable of having the same performance as a classic ICE with the same range but with zero emissions and a sound similar to that of a "normal" turbocharged engine.

The intention is to have the engine running on the dyno before the end of the year, with testing commencing in 2022 prior to a debut at the Dakar in the T1U (Ultimate) class in 2023.

The Dakar Rally is currently the subject of an energy revolution, with the organisers planning to abandon fossil-derived fuel by 2030 in favour of ICE hydrogen engines, hybrid cars powered by e-fuels, electric, and hydrogen-powered fuel cells.

The growing momentum behind hydrogen was illustrated elsewhere by the news that AVL and SuperTurbo Technologies will collaborate on a project to investigate the emission reduction possibilities of the hydrogen internal combustion engine (H2ICE). Focusing specifically on commercial vehicle applications, they will explore the benefits of applying an innovative mechanically driven turbocharger drive unit to a 13-litre engine with H2 combustion. 

ABOVE The plan is for the hydrogen-powered unit to replace the conventional ICEs on Pipo's dyno before the end of the year

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Bosch seeks race-to-road innovation with Formula E

FORMULA E and Bosch have agreed a new, multi-year partnership to continue showcasing the German manufacturer's sustainable mobility solutions.

Having worked closely with Formula E since first announcing their partnership in Season 4, Bosch has committed to sharing its expertise as an Official Partner of the ABB FIA Formula E World Championship through Season 10. With Formula E entering the Gen3 era from Season 9, Bosch will work with the series as its more powerful and lighter cars race on city streets around the world.

Bosch's industry-leading software and hardware promotes innovation in all forms of e-mobility, in particular through a tailor-made vehicle management system as demonstrated in its relationship with DRAGON / PENSKE AUTOSPORT. The combined focus on technology and delivering sustainable mobility

makes the partnership between Formula E and Bosch the kind of authentic, integrated collaboration the championship prides itself on.

Jamie Reigle, Chief Executive Officer, Formula E, said: "Each of our partners has a true, integrated alignment to our common mission and Bosch's leading role in accelerating the global electromobility agenda makes them the perfect partner for the ABB FIA Formula E World Championship. Bosch has committed to advancing electromobility through integrated technology and marketing initiatives and we are delighted they will continue to showcase their innovations in cities around the world in partnership with Formula E."

Dr Markus Heyn, Member of Bosch's Board of Management, said: "Electromobility is establishing itself as a core area of business for Bosch. Electric cars with our components can by now be found on roads around the world. By continuing in our role as official sponsor of Formula E and supplier of tried-and-tested motor racing technology to the first purely electric racing series, we're demonstrating that we're the number-one partner for electric driving." **RT**

ABOVE Bosch and DRAGON/PENSKE AUTOSPORT have a technical partnership

UK to host Extreme E finale

EXTREME E, the electric off-road racing series, has confirmed that its Season 1 finale, 'the Jurassic X Prix', will take place in Bovington, in the UK's South Coast county of Dorset, in December.

Alejandro Agag, Extreme E Founder and CEO, said: "This move is a poignant shift in our mission to race in remote, far-away places to highlight the effects of climate change, as more increasingly, the issues we talk about are literally happening in our backyards so it felt like the right time to bring the spotlight home, and help the army reduce its own carbon footprint.

"The world needs to move forward when it comes to the combustion engine and many other practices, and what better way to symbolise that than with a Jurassic themed X Prix. Unless we push forward with climate and sustainability action, certain species risk becoming extinct, and

that is something we simply cannot ignore any longer."

Bovington is a well-known British Army military base and sits just off the Jurassic Coastline. Extreme E is working closely with the British Ministry of Defence and Army which has recently revealed its climate change and sustainability strategy. The strategy combines the mitigation of



ABOVE The first Extreme E season will culminate on the Dorset coast

environmental impact whilst maintaining military output. It aims to do this by reducing emissions and scaling up the transition to renewables, thus contributing to the UK's aim to be net zero by 2050. Efforts have started already with the Army piloting electric armoured vehicles and carbon efficient accommodation.

Hugh Chambers, CEO of Motorsport UK, the national governing body for motorsport, commented: "This event comes at an important time for Motorsport UK, as we announce our own Sustainability Strategy and seek to address the many issues that have been looming large for a number of years and that recent challenges have brought into even sharper focus, environmental concerns and Equality, Diversity and Inclusion chief among them. Extreme E has been conceived to promote those issues and the very different world we face going forward. We look forward to seeing the first Extreme E champion crowned on UK soil in December." **RT**

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ABOVE The Bronco DR features the first application of Multimatic's Positional Selective Damping technology

Multimatic launches next-gen tech on new Ford Bronco DR off-road racer

FORD'S new Bronco DR, billed as the ultimate production desert racing vehicle, relies on several innovative solutions from Multimatic – including the largest and toughest evolution of its proprietary spool valve dampers to date.

A long-term partner of Ford Performance, having worked on the Ford GT, Mk II track car and every iteration of competition Mustangs, Multimatic was tasked with the development, build, and distribution of the Ford Bronco DR.

Its long-travel suspension is designed around bespoke Multimatic Positional Selective DSSV Dampers, specifically engineered, calibrated, and scaled for the torturous impacts and loads of long-distance, high-speed desert racing. This brings together an 80 mm diameter main-body tube, a pair of high-capacity finned fluid returns located at the valve exits to maximize cooling, and five spool valves per damper selectively creating a range of positional damping control.

The rear dampers feature 22 mm shafts and 70 mm pistons in a

package over 1,000 mm in length with a stroke of 425 mm. The front dampers include the same size shafts and pistons in a more compact 842 mm package with a stroke of 260 mm. Running in parallel, primary monotube DSSV dampers on the rear and coil-overs on the front operate through two spool valves each, for a total of seven per corner, controlling suspension motion.

Developed exclusively for the Bronco DR, the Multimatic spool-valve dampers provide three distinct damping levels, or zones, in bump and two in the rebound stroke. The boundaries between each zone are precisely defined and the stroke position at which the different damping forces engage is unrestricted and selectable.

Multimatic performed extensive analytical simulations in the engineering and optimization of the Bronco DR's SCORE-compliant roll cage and highly modified chassis-frame structure. The final design retains the production Bronco's Multimatic-manufactured, blow-form-hardened Boron Steel ACCRA roof rails. **RT**

Prodrive Hunter first to run on sustainable fuel

BAHRAIN Raid Xtreme (BRX) will be the first major motorsport team to compete with a new generation of advanced sustainable fuels in the FIA World Cup for Cross Country Rallies, when it takes on the Abu Dhabi Desert Challenge later this year, followed by the Hail rally and then Dakar in 2022.

Prodrive has developed a new sustainable fuel over the past eight months in conjunction with Coryton Advanced Fuels. Called Prodrive ECOpower, it meets the latest FIA regulations and has been specifically developed to demonstrate the environmental benefits of the latest sustainable fuel technology.

The main components are generation 2 biofuel manufactured from agricultural waste and efuels created from carbon capture. As a result, the fuel offers an 80% reduction in greenhouse gas emissions compared to equivalent petrol.

The new Prodrive Hunter T1+ has already begun an extensive test programme running on the new fuel.

BRX team director, David Richards, said: "I am a great advocate of motorsport taking the lead in developing, proving and promoting new technologies that can help address climate change. The Dakar and the FIA World Cup for Cross Country Rallies are the perfect environment to showcase the benefits of the next generation of sustainable fuels and demonstrate that they can be used in road vehicles to reduce the use of fossil fuels, while still offering the same performance and range."

While Prodrive ECOpower has been developed for motorsport use, such sustainable fuel can be used as a direct replacement for unleaded petrol and the company is planning to run a near-identical fuel in a number of its road vehicles to further prove out the technology.

Coryton CEO, Andrew Willson, said: "Coryton has a long history in blending bespoke fuels for the motorsport industry, and to further support our customers' evolving needs, we've recently launched Sustain, our new sustainable fuels offering. We knew that partnering with Prodrive would be an ideal way to test our capability in some of the world's most challenging racing environments, alongside some of the finest engineering expertise in the industry." **RT**

**PRODRIVE
ECOPOWER**
See page 34



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ABOVE The cars will be eligible for key historic events and series

Three continuation Rouse Sierra RS500s to be built

TOURING car preparation specialist CNC Motorsport AWS will build three Andy Rouse Engineering specification Ford Sierra RS500 Group A race cars in collaboration with the four-time British champion.

Each will be constructed from an original Ford Sierra bodyshell to an exacting design set by the 60-time British Touring Car Championship (BTCC) race winner. Just as it was in period, the first chassis, set to be completed by early 2022, will be built from a brand new '909' Motorsport shell, which has been unused and carefully stored since the

1980s. Cars will come with HTP papers, fuel cell and roll cage certificates and will be ready to race.

Rouse retired from professional motorsport in 1995 and this is the first project he has been involved with since the SCV8 concept in 2003.

CNC Motorsport AWS, founded by Alan Strachan, is a renowned restorer and builder of historic Touring Cars from the 1970s to 2000s. Strachan worked for Rouse in period, building and running cars in the BTCC between 1989 and 1992 – the height of the RS500's dominance in

Touring Cars – and from 1993 to 1996.

Each car will use a freshly-built 575 bhp Cosworth YB unit with input from original ARE engine builder Vic Drake, who in period produced over 100 RS500 engines. The continuation cars will feature a Getrag five-speed gearbox, Proflex Advanced Technology fuel system and later 9" viscous differential. Other features include the correct gauges, metal brake master cylinder reservoir and specific ARE build plate. Each car will be supplied in plain white with options for painted liveries. **RT**

Hino tests hybrid Dakar truck

THE truck that Hino Motors Ltd will be entering as HINO TEAM SUGAWARA in January's Dakar Rally is now complete.

Based on the truck with bonnet-type cab that competed in the 2020 race, the new vehicle has shed more weight, and runs on Hino's first racing hybrid system and high horsepower engine.

"We worked on the truck with bonnet-type cab from top to bottom to improve its acceleration performance," said Mitsuru Enomoto, Project Chief Engineer. "With an engine that produces 800 ps thanks to its newly-developed, high-efficiency turbo, and a battery (capacitor) that can be expected to generate instantaneous motor output, we now have an engine plus hybrid combination that delivers a total of over 1,000 ps."

"We fine-tuned the settings for the hybrid, automatic transmission and suspension systems during our test runs in October," reported Teruhito Sugawara, Team Director and driver. "We also improved the truck's acceleration performance

dramatically, and its speed is very encouraging. I'm looking forward to see how well we compete against our heavy-duty rivals."

In addition, the truck features new technologies including a racing AT that shifts instantly, and an ultra-lightweight rear body that makes heavy use of high-strength aluminium and GFRP. **RT**

BELOW HINO TEAM SUGAWARA will be fielding a truck equipped with a racing hybrid system





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William's contribution to the world of Engineering is immeasurable and he will be greatly missed professionally and personally by all who had the good fortune to know him.



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DTM Electric Design Model unveiled

A DTM Electric series for 2023 moved a step closer last month when a 1,000 hp design model was showcased at the Norisring.

The car is a 1:1 model of the prototype for the race series that is currently being developed and shows what the DTM Electric cars will look like. Participants will have the opportunity to adapt the chassis with their own specific design characteristics.

The DTM Electric Design Model is the next big step after the presentation of the DTM Electric Demo Car at Hockenheim in November 2020 that demonstrated the technical basis of the futuristic race series. Over 1,000 horsepower and top speeds of well over 300 km/h are envisaged.

Benedikt Böhme, managing director, ITR, said: "The next step will be to combine the performance as we know it from the Demo Car with the looks of the Design Model."

"Unveiling the next development level of DTM Electric is an important milestone for us as a pioneer in e-mobility," said Matthias Zink, CEO Automotive Technologies, Schaeffler. "The technology and the looks of the car is getting already very close to what could be racing from 2023 onwards."

Fred Türk, (Vice President of MAHLE Motorsport, said: "It is important for us to be involved in DTM Electric from the very beginning, as a development partner and as a supplier. With its competence, MAHLE can help to realise the complex vehicle technology for this race series. Moreover, from the demanding

competition environment in racing, we can draw relevant conclusions for serial use and reach solutions for electro mobility even more rapidly."

The future DTM Electric cars will have single-wheel electric drives from Schaeffler, featuring an infinitely variable torque distribution. The Space Drive steering system that is already successfully used in DTM will be installed. Innovative thermal management solutions by MAHLE will ensure the complex cooling of the drive components in competition.

DTM boss Gerhard Berger said: "Development for DTM Electric is in full swing. The looks of the car express our vision of a fully electrified high-performance race series: futuristic, aerodynamically efficient, innovative and sporty to the core." **RT**



BELOW ITR, Schaeffler and MAHLE unveiled the car at Norisring

Chevrolet produces "king" crate engine

CHEVROLET Performance has introduced the ZZ632/1000 crate engine – the largest and most powerful crate engine in the brand's history.

The naturally aspirated 632-cubic-inch V8 produces 1,004 horsepower and 876 lb-ft of torque.

"This is the biggest, baddest crate engine we've ever built," said Russ O'Blenes, GM director of the Performance and Racing Propulsion Team. "The ZZ632 sits at the top of our unparalleled crate engine line-up as the king of performance. It delivers incredible power, and it does it on pump gas."

The Big Block V8 reaches peak power at 6,600 rpm and revs to a recommended maximum of 7,000 rpm. Fuel is delivered by eight port injectors with the engine breathing through CNC-machined high-flow aluminium cylinder heads featuring symmetrical ports.

While Big Blocks have traditionally been designed with variations in port shape

from cylinder to cylinder, all eight intake ports of the ZZ632 have the same length, volume and layout. Similarly, all of the ZZ632's exhaust ports are identical. This symmetry ensures individual cylinders all produce similar power.

These RS-X Symmetrical Port cylinder heads are named for powertrain engineer Ron

Sperry, who designed them as one of his final accomplishments in more than 50 years working on General Motors performance and racing engines. Sperry also introduced symmetrical ports to Chevy's iconic Small Block V8 with the Gen III LS1 engine that debuted in the 1997 Chevrolet Corvette.

The ZZ632's iron block shares a mould with Chevrolet Performance's ZZ572 crate engines, but the castings are machined to accommodate the massive 632-cubic-inch displacement. The bore grows by 0.040 inch compared to the 572-cubic-inch V8s, with most of the displacement gain coming from a stroke that's 0.375 inch longer. To provide clearance for that long stroke, engineers modified both the block and the connecting rods.

Four-bolt main caps and a forged rotating assembly ensure strength and durability. During development, a single engine endured more than 200 simulated drag strip passes on a dynamometer. **RT**



ABOVE The ZZ632/1000 is the most powerful crate engine in the brand's history

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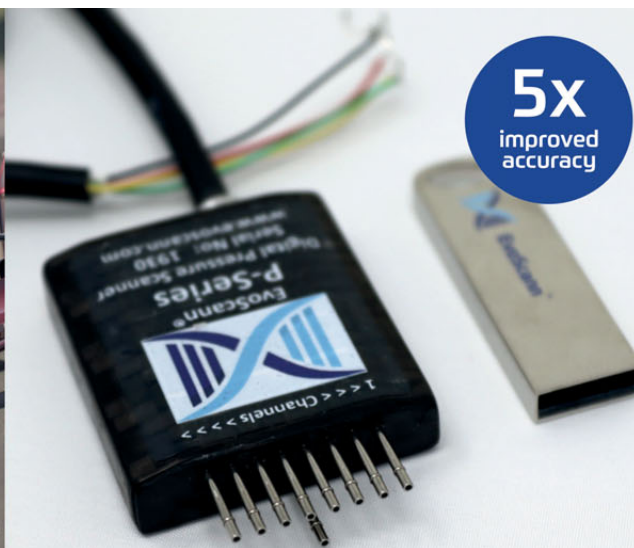
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With the world's most guilt-laden frequent fliers gathered for the climate change conference, *Chris Ellis* asks...

WHAT DOES COP26 MEAN FOR MOTORSPORT?

AS the Climate Summit concludes, how much does motorsport *really* care about the vast amount of natural wind power emanating from Glasgow?

The answer is that it *should* care. The fallout from the conference could have a direct impact on the efforts of every motorsport championship and race team to strive for sustainability.

A few years ago, that objective tended to be mentioned, if we are honest, only as an act of lip-service. It was a kind of 'if we say the words you want us to say, will you please leave us to go and play in peace?' gesture to maintain political correctness. But no more. Now it's for real.

Of all the stories produced at this year's Le Mans 24 Hours, for instance, sustainability was

the dominant theme. Its importance was further underlined last month when Williams Racing became the latest Formula 1 team to be awarded the highest level of the Fédération Internationale de l'Automobile's Environmental Accreditation Programme, following an audit of its Environmental Management System. It's no longer just a team's performance on the racetrack alone that defines its success, popularity – or marketability.

For COP26 to be a success, the government needs the public to buy into its "green revolution". Motorsport's huge audience figures suggest it has the credentials to be an ideal platform from which to shape public opinion.

Jost Capito, CEO, Williams Racing, acknowledged: "Formula 1 has the power to inspire millions of

ABOVE & RIGHT

Transporting the cars, equipment and personnel is perhaps the hardest part of the sustainability puzzle to solve



“Projects that should help F1 reach its sustainability targets more rapidly than promised”



Red Bull

people across the globe and has been at the forefront of an incredible amount of advanced technologies. We, as an industry, have the power to use our sport as a platform and catalyst for good, helping to tackle the challenges we face as a planet.”

One of the ‘solutions’ motorsport is already helping investigate is the use of hydrogen and that featured strongly in the UK Prime Minister’s preamble to the Glasgow showpiece.

Betting on hydrogen

“I think hydrogen is part of the solution,” Boris Johnson told the recent Global Investment Summit, “because ▶

I saw a JCB digger recently that ran on hydrogen and to drive a digger or a truck or to hurl a *massive* passenger plane down a runway, you need what Jeremy Clarkson used to call grunt. And hydrogen provides that grunt."

Note the inclusion of 'massive' (my italics), which would have been absent six months ago. Basically, it's there because the DLR (the German Aerospace Centre) says it should be. In the latest

“We, as an industry, have the power to use our sport as a platform and catalyst for good”

Clean Sky traffic forecast the share of total annual passenger miles in aircraft with more than 200 seats is predicted to grow globally to over 87%. Which puts the climate benefits of fixing smaller aircraft into perspective, hence the need for 'massive' in the PM's scenario.

Ever optimistic, I have taken the inclusion of 'massive' in the Prime Minister's GIS speech to be a signal that we can expect a detailed explanation of how large hydrogen-powered airliners could be in service by 2030 at COP26.

By the time you read this, the world's largest collection of frequent flyers will have gathered together in Glasgow, feeling particularly guilty because they know exactly how much damage

RIGHT The Envision Virgin Racing Formula E squad teamed up with COP26 to encourage global action against climate change. Yet the switch to EVs is not the only solution



Audi AG

the flights they need to make are causing to the climate. So I'm predicting the British government will announce at the conference two new projects that should help to reduce aviation's impact on the environment much faster than currently forecast.

These projects are relevant to motorsport because they should help Formula 1 to reach its sustainability targets more rapidly than promised. For your entertainment, I'm sticking my neck out here because I'm writing this before COP, and you will be reading this after Boris's conference speech, so please check to see if my predictions are accurate before believing them!

'The science bit'

The carbon footprint of the cars is a very small percentage of Formula 1's carbon footprint as a sport (0.7%) but it is important that the most visual part of our sport is sustainable and can have real world ►

BELOW Hydrogen technology, an inevitable focus of COP26, is already being pioneered in motorsport with the ACO's Mission H24 project



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benefits. Therefore F1 is rightly targeting a next generation engine that combines hybrid technology with sustainable fuels.

The reality, of course, is that flying the cars, personnel and equipment all over the world for a record-breaking 23-race calendar is the hardest part to fix. That's why motorsport's movers and shakers should listen very carefully to COP26's discussion of the future direction of aviation. Help is on its way...

Clean Sky 2

In May 2021 Clean Sky 2 published its Technology Evaluator assessment. One of its key conclusions was that: "The main focus on decarbonising aviation should be on short-range aircraft flying distances of less than 4,000 km, however with much

larger passenger capacity, well over 300, even over 400 passengers in the cabin. This type of aircraft does not exist today."

However, the report seemed to ignore the fact that the ideal type of aircraft almost exists today if liquid hydrogen is the preferred fuel.

The chart in the web link opposite summarises the DLR's results, with the scope of '<4,000 km' overlaid. Note that the chart shows the percentages of CO₂ produced if all flights still used kerosene. The bottom line is that almost 60% of the CO₂ produced by aviation will be removed if the '<4,000 km' type of large airliner is powered by hydrogen.

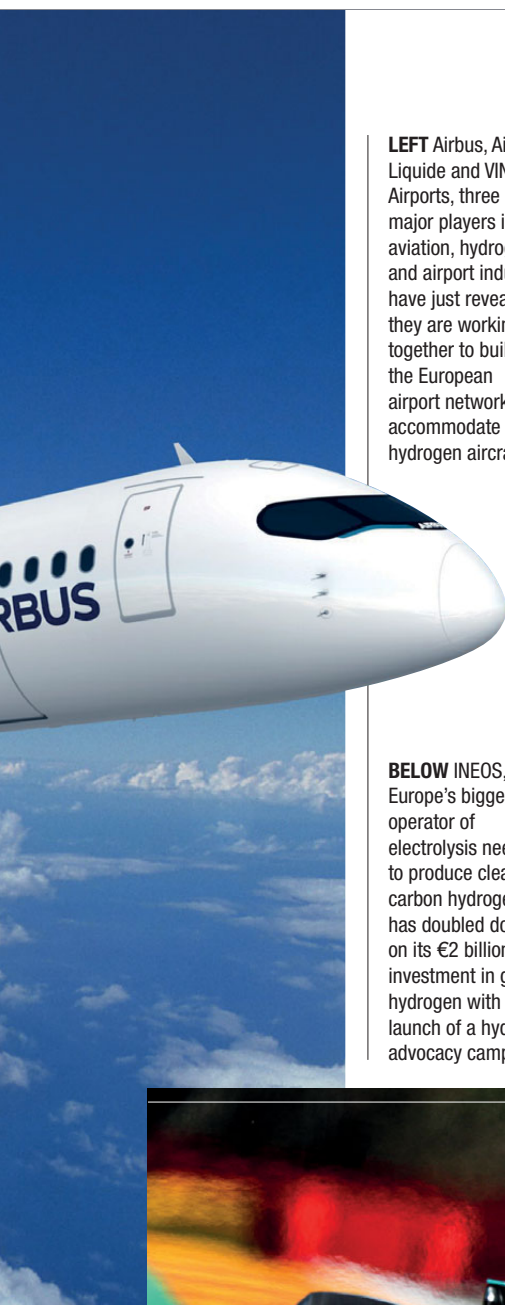
The current Airbus A350-900ULR provides the ideal starting point for the development of an 'A350-H' to meet the

'<4,000 km' requirement. The key reason is that its fuel tanks have already proved to be big enough to provide a range of over 16,000 km when its engines are running on kerosene or SAFs (sustainable aviation fuels). The tanks are in the A350's wings, and could be replaced by new insulated tanks designed to contain enough liquid hydrogen to fuel flights of up to 4,000 km.

A year ago, Airbus announced its aim to have the first hydrogen-powered 200-seat airliners in service by 2035, which will address less than 12% of aviation's CO₂ problem. It now seems possible that Airbus could begin to address an additional 50+% of the problem, five years earlier.

Airbus has been told! And so has Rolls-Royce...

The first of the two possible COP26



LEFT Airbus, Air Liquide and VINCI Airports, three major players in the aviation, hydrogen and airport industries, have just revealed they are working together to build the European airport network to accommodate future hydrogen aircraft

BELOW INEOS, Europe's biggest operator of electrolysis needed to produce clean, low carbon hydrogen, has doubled down on its €2 billion investment in green hydrogen with the launch of a hydrogen advocacy campaign

projects should enable Airbus, Rolls-Royce and others to develop a new version of the Airbus A350-900, the A350-H, which will be powered by gas turbine engines running on liquid hydrogen, and have a maximum range of at least 4,000 km.

For more details, search: www.h2-view.com/open-access/large-hydrogen-powered-airliners-could-be-in-service-by-2030/.


The second project the UK government may fund (with the Gates Foundation?) would set up an enhanced version of the existing NATS air traffic control system in the Shanwick Oceanic Control Area, to the west of the UK. This will have two new features – the ability to forecast where persistent contrails could form, and then the ability to predict the optimal change in flight path (usually just a minor change in flight level) needed to avoid the supersaturated air. This project should be under the control of the UK's Aerospace Technology Institute, supported by Cranfield University, NATS and Satavia, among others.

Currently it is believed that the total impact of aviation on global warming may be more than double that of just the CO₂ output, with the rest mainly due to

the blanketing effect overnight of artificial cloud formations formed by aircraft emissions (see: <https://www.bbc.co.uk/news/business-58769351>). The Shanwick project will investigate this in detail, and include the first A350-H prototypes as soon as they are available. It could start using an RAF A330 MRTT with one of its Trent engines modified to burn hydrogen.

F1 needs net-zero flying

Once the NATS upgrades have been proved safe and effective they will probably be made available globally. It seems this could have a large and very rapid beneficial effect, because it should reduce substantially the climate impact of almost all existing airliners and freighters, whether their engines are running on kerosene or sustainable aviation fuels. Perhaps as early as 2025? This contrasts with an optimistic forecast of only 20% of jet fuel being SAFs by 2030, and 50% being hydrogen by 2040.

Bottom line: motorsport, and F1 in particular, needs net-zero flying more than almost any other business to minimize its climate impact; hopefully it will now be happening fast, if the PM makes the appropriate commitments at COP26. 

Mercedes-AMG F1



PRODRIVE CHAMPIONS NEXT GENERATION OF SUSTAINABLE FUELS

Generation 2 biofuel manufactured from agricultural waste and efuels created from carbon capture offer Prodrive's Dakar challenger an 80% reduction in greenhouse gas emissions. **Chris Pickering** investigates

As we look to the future of transport, it's increasingly clear that there won't be one universal energy solution. Battery electric vehicles may be tipped to become the dominant technology in light-duty passenger cars, but that doesn't mean they'll suit every vehicle on the road. And it certainly doesn't mean they'll suit every vehicle in motorsport.

The question of how to decarbonise is a particularly challenging one for endurance competitions, as Prodrive's chief engineer for engines, Arthur Shaw, points out: "You have to start by looking at what the car is going to be used for. Most of our projects are based around endurance competitions, such as Le Mans or the Dakar Rally, where battery electric powertrains simply aren't a viable option for the distances involved at sustained high power level at the moment. It was clear that if we wanted to move away from fossil fuels, we'd need to find a different way to do it."

Around the time that the Prodrive BRX Hunter made its Dakar debut in January, the rally organisers announced an ambitious plan to move all professional entries across to low-carbon powertrains by 2026. Starting from 2022, the regulations will be thrown wide open in an attempt to encourage alternative technologies.

For the Prodrive engineers, this

provided the flexibility they needed to pursue more sustainable options for their rally raid programme. A number of different possibilities are being considered for the long term, but for 2022 the company has partnered with Coryton Advanced Fuels to develop a low-carbon 'drop-in fuel' for the tried and tested Ford EcoBoost V6 in the Hunter T1+. This offers a dramatic reduction in Green House Gas emissions, while still providing the required energy density for long-distance off-road events.

"What we've found in Coryton is a genuine technical partner that can provide the right expertise to support our testing rather than simply a fuel supplier," comments Shaw. "Likewise, we can provide real-world engineering testing across a wide range of conditions."

Work on the bespoke fuel, known as Prodrive ECOpower, began earlier this year. It's primarily comprised of second-generation biofuel produced by the catalytic transformation of bioethanol derived from agricultural waste. The remainder includes a mixture of ethanol and methanol efuels, created using carbon dioxide captured directly from the atmosphere. Raw biofuel tends to have quite a low octane number, so these alcohols are added to get the blend up to the 102 RON limit set by the FIA.

The processes used to create efuel ►

BELOW Coryton has recently launched Sustain, a new sustainable fuels offering



can be tailored to just about any fuel specification, and Shaw sees the potential for this technology to be employed more extensively in the future: "During our initial research on this project, it became clear that efuels technology is coming on at quite a pace, but the industry is not in a position yet to produce it in large quantities. We think it's going to be two-to-three years before genuine efuels are commercially available at a sensible price. It's exciting to be using a small amount of efuel at the moment, and we expect that to be available in quantity before too long."

Development of the fuel was guided by the specifications laid down in the FIA's Appendix J regulations. These have been expanded with the addition of article 9.3.1, which covers sustainable fuels and allows a little bit more freedom than the definitions used for standard unleaded race fuel. The key performance



“ *We wanted to show that there are genuine drop-in viable alternatives to fossil fuels available now”*



LEFT & BELOW The new Prodrive Hunter T1+ has begun an extensive test programme running on the new fuel

parameters, such as research octane number (RON), motor octane number (MON) and density remain the same to ensure parity with traditional fuels, but other aspects have been relaxed slightly to accommodate the new chemistries.

"The regulations are still more restrictive than we would have liked, but there are good reasons for that," comments Shaw. "For instance, the methanol content is capped at three per cent. Ideally, we would have liked to have gone to five per cent, because methanol is a good way to achieve the octane rating that we need. However, the FIA had found that higher concentrations led to possible re-lighting of fires once they'd been extinguished, so there's a safety concern associated with that. So we were happy to keep to the three per cent limit."

Drop-in fuel

Top of the list of requirements drawn up by Prodrive was that the fuel had to be a drop-in substitute for normal gasoline, with no hardware modifications required. To a certain extent, the fuel's suitability for a particular engine can be inferred from its specification, but the engineers in Banbury still needed to embark on a comprehensive programme of physical testing.

"There are three main things that you're looking at when contemplating a change to the way you run an engine. First is reliability, second is engine performance and third is any risk of knock-on effects in the vehicle," comments Shaw.

In terms of reliability, the main concerns were the risk of pre-ignition and detonation, which were ►



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monitored using in-cylinder pressure measurements. Secondary factors included chemical corrosion from the ethanol and methanol content of the fuel.

Meanwhile, oil dilution was monitored to ensure there would be no long-term durability impacts. The performance target was to equal the capabilities of the FIA's 102 RON reference fuel. This was analysed by monitoring the indicated mean effective pressure (IMEP), brake specific fuel consumption (BSFC) and combustion quality and of course engine power across a range of fuel temperatures and ambient conditions.

In total, seven batches of fuel were tested in the engine, Shaw explains: "For most of the testing, we ran two batches at a time. We'd report back on how the engine behaved, what we liked and what we didn't like. That typically included comments on things like BSFC and density, pre-ignition and knock behaviour etc. After that, we'd get another two batches of fuel with some of the characteristics altered to home in on the properties we were looking for."

Although essentially a drop-in fuel, the new blend's behaviour isn't identical to conventional gasoline. Alcohol fuels such as bioethanol run at far richer air-to-fuel ratios than conventional gasoline – around 6.5:1 instead of 14.7:1. The small quantities used in the ECOpower fuel have a limited effect, reducing the stoichiometric ratio to just under 14:1. The target lambda value is understood to be the same but the fuel flow rates have been increased by a few per cent higher to account for the reduced stoichiometric ratio, while the fuel mass on the start line will now be slightly different.

"A decade ago we ran a car for Lord Drayson in GT3



ABOVE Bahrain Raid Xtreme (BRX) will be the first major motorsport team to compete with a new generation of advanced sustainable fuels in the FIA World Cup for Cross Country Rallies

that used E75 [a 75 per cent bioethanol blend]. That required a significant number of changes, including a new fuel tank, new hoses and new injectors and engine cal," notes Shaw. "This time around, we wanted a genuine drop-in replacement to show that there are genuine drop-in viable alternatives to fossil fuels available now."

Future plans

The distinction between fossil fuels and their more sustainable substitutes is a crucial one. Prodrive has calculated that running the Hunter T1+ on the ►

BELOW The T1+ (right) has been redesigned to incorporate the latest rules while eradicating its predecessor's shortcomings



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new fuel blend will slash its greenhouse gas emissions by 80 per cent. Factor in the energy consumed during the manufacturing process and it's almost certainly a greener option overall than building and running an electric powertrain for the relatively short lifespan of a competition car. So could this be accepted as part of the FIA and the ASO's long-term plan to move towards low-carbon technology for the Dakar?

"Sustainable fuels are very definitely part of the FIA and the ASO's road map," comments Shaw. "The forthcoming T1U

class will be performance balanced with the T1+ class that we'll be racing in next year and it will allow different technologies, such as all-electric cars, hydrogen fuel cells and range extenders. A T1+ car running on biofuel wouldn't necessarily meet those regulations at the moment, but something like a plug-in hybrid running on biofuel certainly would."

The plan is for the T1U class to be introduced in 2023 (a separate T1E category will allow range-extended electric cars to compete in 2022). Initially, T1U will run alongside the current T1+ class, with

“A dramatic reduction in Green House Gas emissions, while still providing the required energy density for long-distance off-road events”



performance balancing measures to equate the two. However, the mandatory shift for professional drivers over to T1U in 2026 means that the current T1+ cars could have a relatively short shelf-life.

"We've got a roadmap in our mind, and we're looking at a couple of technologies that would allow us to go into T1U with the Hunter," comments Shaw. "One possibility is a parallel hybrid, which is something that the packaging space of the car was designed to accept. It would allow us to demonstrate hybrid technologies to maximise efficiency and it could be combined with fossil-free fuels to get a very low overall carbon footprint. But we're also looking at a couple of other areas that would be a bit more radical."




ABOVE & RIGHT A fifth place finish and retirement on last year's Dakar Rally leaves a sense of unfinished business for the team



There's no word yet on what these radical solutions may be. However, Prodrive is known to have looked at the idea of a compact four-cylinder powerplant in its original concept studies for the Hunter, which may also point towards a range extender or a series hybrid.

"We're quite close to a decision on what route we go down," says Shaw. "One of the things that's holding us back is that the sporting regulations for T1U have yet to be finalised. For instance, does the vehicle have to be capable of travelling on electricity alone, and if so, how far? We're working closely with the FIA on that and we're doing work in the background to look at the various options."

For now, the focus is firmly on the recently-revised T1+ version of the Hunter and its new sustainable fuel, he explains: "The sustainable fuel world is developing at a very rapid rate. Some of the components that we've got in the fuel now weren't available when we began the project less than a year ago. The fuel has now been dyno tested by the FIA and homologated, so although we'll still be feeding observations back to Coryton, the challenge has shifted more towards logistics – getting sufficient quantities of the fuel, and getting that shipped out to the Middle East. After Dakar, we expect the technical conversation to ramp up again as we look to homologate a new blend."

Quite where that conversation will lead remains to be seen. What's clear for the Dakar is that it's unlikely to follow the default route of a battery electric powertrain. With concepts including range-extenders, hydrogen combustion, plug-in hybrids and fuel cells, it's certainly set to be an interesting time for the world's most gruelling endurance event. 

LEFT Prodrive ECOpower under development in the Hunter engine on Prodrive's dyno



THE CHAMPIONS' SECRET WEAPONS

With fluids accounting for a substantial percentage of the overall power gain in a Formula 1 engine, the pursuit of improvement, however marginal, can make all the difference.

Chris Pickering talks to the PETRONAS trackside fluid engineers

FUELS and lubricants can play a significant – and sometimes controversial – role in the performance of a Formula 1 engine. They also offer a unique insight into the health and durability of these highly-stressed machines.

The job of monitoring these fluids falls to specialist engineers who travel with the F1 circus, providing on-site analysis and diagnostic services to the teams. In the case of the Mercedes-AMG PETRONAS Formula One Team, and those using customer engines from Mercedes-AMG, that service

LEFT 214 fuel and oil samples are checked at each grand prix



ABOVE The effort invested in every iteration of each potential blend is demonstrated by approximately 2,600 litres being required to validate a new engine fuel or an oil candidate's performance

“You do have some scary moments but it’s all about keeping your inner cool: panic just brings a lot more issues”

is provided by Stephanie Travers and En De Liow. The two PETRONAS trackside fluid engineers (or PTFEs for short) are on hand throughout the race weekend and during the lead up, clocking a total of around 214 fuel and oil samples at each event.

“We arrive the Monday before the race and get ready to go in for Tuesday morning,” explains Travers. “The first job is to test all our equipment and ensure nothing has been damaged in transit – that’s especially important for the flyaway rounds when everything goes by air freight.” ►

Once the portable laboratory is up and running, samples are taken from each drum of the PETRONAS Primax fuel at the circuit to ensure that they match the homologated formulation that's been submitted to the FIA. These checks are repeated once the teams have filled the refuelling rigs on Wednesday to ensure there's no contamination.

"The tolerances these days are so small that it's vital to check," comments Liow. "The cars and the equipment travel

through all sorts of conditions. If it's really dusty or really wet it's possible to get contamination. Similarly, the teams use solvents to clean the fuel cells and it's possible for small quantities of those to remain if they're not flushed completely. We try to be gatekeepers at each stage to catch anything like that before it becomes an issue."

Thursday sees the cars fired up for the first time, prior to the first track running on Friday. Once again, the PTFEs

are called in after the fire-up and the flushing procedures to collect samples of engine oil, gearbox oil and fuel. The results of this analysis are compared to pre-determined limits set by each outfit based on historical data. If anything unusual is flagged up, it gets posted to a secure network that's visible to the team, the Mercedes powertrain engineers in Brixworth and the PETRONAS laboratories in Turin and Malaysia.

"Formula 1 is all about teamwork. If

BELOW The two PETRONAS trackside fluid engineers, Stephanie Travers and En De Liow, head for debrief with world champion Lewis Hamilton





we find something we immediately contact the relevant departments, whether it's the engine department or gearbox to discuss the relevant course of action," comments Travers. "At that point, the mechanics are turning around for the next session and the race engineers are reviewing the data; there are so many things for them to look at, it's always good for us to just go over our results

Mobile laboratory

The equipment used to analyse the samples constitutes a full-scale mobile laboratory. A spectrometer measures the concentration of metallic materials in the oil samples by burning a two-millilitre sample and using a high-speed camera to detect the frequencies of light given off in the flame. This indicates the presence of

ABOVE The evolution of fluid technology in F1 is relentless. Over the past decade, PETRONAS has on average sent a new fuel or oil candidate to Mercedes-AMG High Performance Powertrains every 6-7 weeks

“If anything unusual is flagged up, it gets posted to a secure network that's visible to the team, the engineers in Brixworth and laboratories in Turin and Malaysia”

and start that dialogue with them. And then it's a team effort to decide what the next point of action is – whether the issue is something that we really want to act upon, or something that we want to see how it plays out in the next session. That will all be discussed as a collective team.”

It can be frenetic at times, but the key is maintaining your inner calm she says: “You do have some scary moments at times but it's all about keeping your inner cool and just being calm because panic just brings a lot more issues. En de and I work really well together, so we're there to support each other and react to any situations that arise.”

wear metals, which can be traced to particular components based on their chemical composition.

Elsewhere in the lab, a viscometer is used to measure the viscosity of the oil before the car goes out and track how much it changes during the session. The other major piece of equipment is a gas chromatograph, which is used to analyse the chemical fingerprint of the fuel. This is the most time-consuming element of the process, taking 30 minutes to complete each set of samples, while the viscometer takes around four minutes and the spectrometer just 30 seconds.

Conditions inside the engine are so harsh that ►



the oil oxidises far quicker than it would in a road car, meaning that there's a measurable amount of degradation even in a very short session. Historical data helps to build up a picture of what the oil should look like at each stage of the engine's life. If an unexpected spike in wear metals appears or anything else seems untoward, the PTFEs consult with the team to check if they've noticed anything in the telemetry. Borescope inspections can also be carried out to assist with the diagnosis.

"The life of an engine is dictated by thousands of different parameters," comments Liow. "The health of the oil is one of the few key indicators that can help us predict things. It's not an absolute science, but a picture built up on past experience. PETRONAS and Mercedes have been partners for more than a decade now. And all that valuable historic data can at least paint a picture of what the

typical lifespan of an engine should be. That's as close to a crystal ball as we can get."

Although there are just two PETRONAS engineers at the track, they're backed up by a team at the company's research and technology centre in Turin. "Aside from the routine checks, we do get the teams coming to us with specific requests," comments Liow. "We've had instances of so-called mystery fluids, where there's a leak coming from somewhere and the team has asked us to identify exactly what it is. The great thing is that we can always send the samples back for further analysis if there are any questions we can't answer at the track."

With the calendar now beginning in early March for testing and stretching through to mid-December for the final round, much of the PTFEs' time is spent at the track. But they also play an active role in planning and reviewing activities for

ABOVE De Liow (here in action at the Emilia Romagna GP) and Travers are key links in a chain involving thousands of people

RIGHT Stephanie Travers (seen here with Valtteri Bottas in testing) was the successful candidate from PETRONAS' inaugural global talent search in 2018, beating 7,000 rival applicants

the season as well.

"We try to be as involved as we can on the technical side – not just with the fluid development at PETRONAS but with the teams," says Travers. "For instance, coming into this season we worked with the gearbox team, to look at how we analyse and plot the data that we collect from the gearbox oil to better predict the lifetime of the hardware. We identified some potential updates, so we tried to bring those in during the off-season. We've applied those this year, and that's something we're pretty proud of bringing to the team."

Changes

Since 2020, the teams have been required to homologate a single fuel blend at the start of the season. This has simplified things and reduced operating

costs somewhat compared to the old system where up to five different blends were allowed.

"COVID has placed extra stress on the teams, so there's been an effort to keep the areas of development, and the expenditure, in check," comments Liow. "In the past, you could introduce

“As close to a crystal ball as we can get”

mid-season upgrades, but it's now just one spec of fuel and one spec of oil, so you've got to get it right."

Behind the scenes, a huge research and development effort is ploughed into getting each of those blends correct. Thousands of people are involved in the

chain, which stretches well beyond the trackside engineers themselves.

The company has also invested heavily in facilities, with recent upgrades to the mobile laboratory. With McLaren's decision to switch to Mercedes power units for 2021, the PTFEs are now supporting four different teams, which has led to additional equipment to cope with the number of samples being processed.

In other respects, the daily trackside routine for the PTFEs has stayed much the same since they joined the sport. For Travers, that moment came in 2019 when she first joined the team for pre-season testing in Barcelona, while Liow followed in 2020. Both are still brimming with enthusiasm when we catch up for this interview on the Wednesday before the Turkish Grand Prix, so what have been their favourite moments? ►



"For me, being part of a championship-winning effort in Formula 1 wasn't something I'd dared to imagine – let alone in my first year. So that was special and just being around people with great energy and immense passion for the sport is tremendous," comments Liow.

Travers points to that first experience of testing in Barcelona: "I'd always dreamt of being in the sport, so to be there and to be welcomed by everyone with such open arms is such a great feeling. And that's really a testament to the team. They help you progress, and really thrive within the environment. So the drivers, Toto [Wolff], the

“With just one spec of fuel and oil, you’ve got to get it right”

mechanics, engineers, everyone is just one big happy family.”

Another key moment for Travers, and for the sport as a whole, took place when she became the first black woman to stand on the Formula 1 podium, accepting the constructors' trophy on behalf of Mercedes and PETRONAS at the 2020

BELOW McLaren's decision to switch to Mercedes power units – which earned the squad its first one-two finish in 220 GPs – means the PTFEs are now supporting four different teams





ABOVE & BELOW The equipment used to analyse the samples constitutes a full-scale mobile laboratory


Styrian Grand Prix. “That was a really momentous occasion for myself and for my family, and an historical moment in the sport as well. It’s something that I’ll definitely treasure for the rest of my life,” she recalls.

More changes lie ahead for next season. The power unit regulations remain the same, but

radical revisions to the chassis and aero regulations will have a significant knock-on impact on the duty cycle. More to the point, the fuel itself is changing, with the mandatory 5.75 per cent bio content for this year increasing to 10 per cent.

Aggressive changes

“There’s a lot changing, and I think it’s going to be exciting,” comments Travers. “Our team are doing a lot of research and trying to create fluids that can give us similar success to that we’ve had so far. And that’s all being done hand-in-hand with Mercedes.”

Beyond that, even more aggressive changes are on the cards. The details of the next big rule change – expected in 2025 – have yet to be finalised, but they’re tipped to include a massive increase in the electrical capability of the system, along with fully sustainable fuel. This, of course, will be a core challenge for the fuel and lubricant developers back in the R&D centres, not to mention those working trackside. Whatever the future holds, it’s clear that the PTFEs will have a pivotal role to play. 



DRIVING IN THE DIGITAL DOMAIN

Computers have evolved into incredibly sophisticated simulation machines, but there's still no substitute for the human brain. **Chris Pickering** investigates

WE live in an increasingly digital world. Cars begin as CAD models; engines fire up in 1D simulations long before they reach the dyno; and aero packages are just as likely to be honed in CFD as the wind tunnel. But there's a limit to how effective the digital world can be on its own. Just ask Ansible Motion technical director, Kia Cammaerts.

Before founding the Norfolk-based simulator manufacturer, the ex-F1 and IndyCar engineer had worked on offline simulations for lap time prediction. Initially, each new refinement to the mathematical model brought its predicted performance a step closer to the real car. Beyond a certain point, however, improving the numerical side of the simulation no longer seemed to yield the improvements that were expected.

Something was missing, and Cammaerts soon realised what it was: even with highly skilled professional drivers, there were

“Innovations to break down the last remaining barriers between simulation and reality”

ABOVE Ansible Motion was a pioneer in the development of helmet loading to carefully apply sustained forces to the driver's head in lateral and longitudinal axes

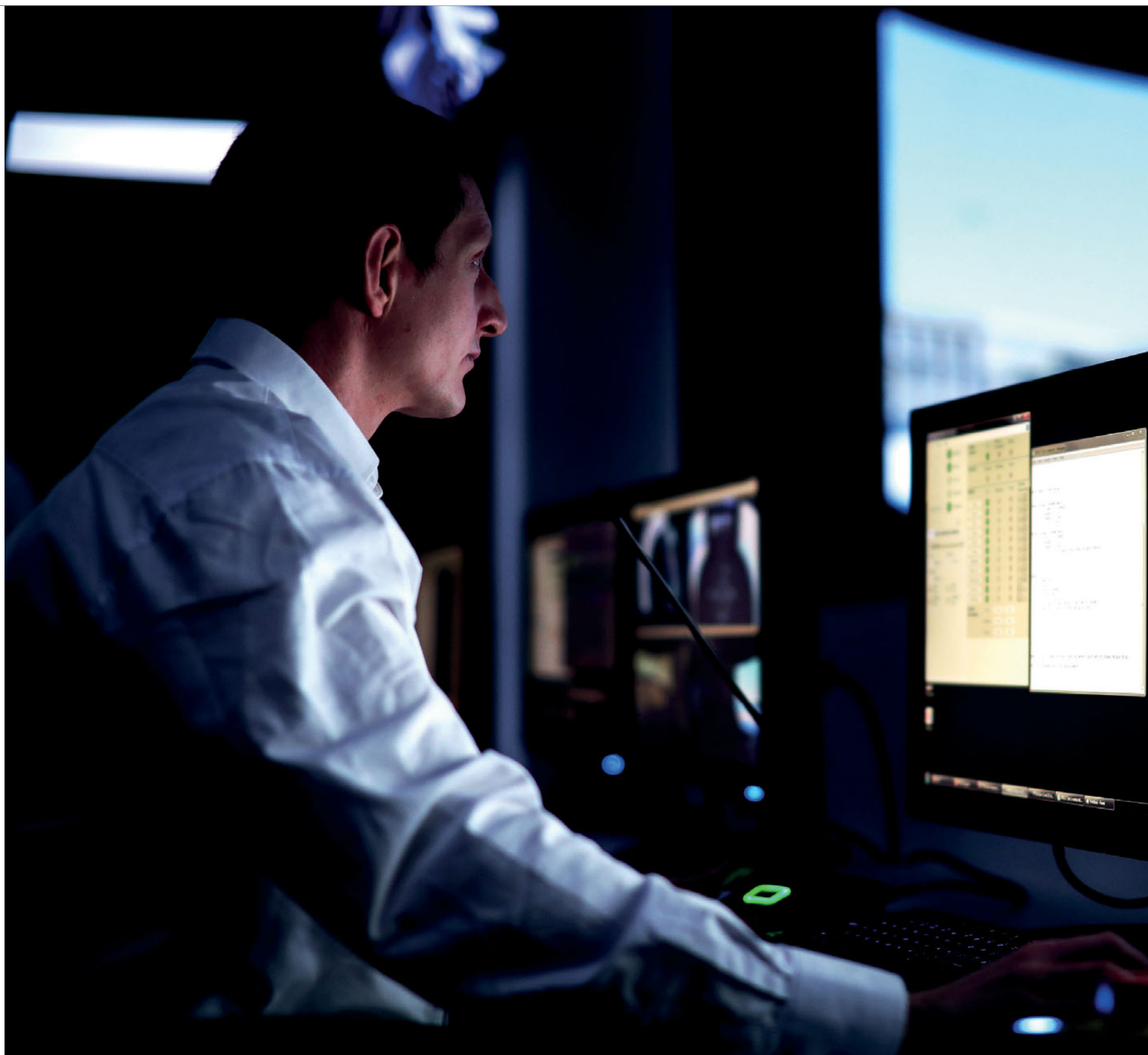
differences in driving style from one individual to another, and little nuances that gave them the confidence to push harder when they felt more comfortable with the car. A theoretically beneficial setup change, for instance, wouldn't help if it made the car too twitchy for the driver to exploit on anything other than a perfect lap. It became clear that the best way to improve the accuracy of the simulation would be to introduce a human driver into the loop to capture authentic control inputs and responses.

Fast-forward to the present day, and driver in the loop (DiL) simulation is an established part of motorsport, covering not just driver training and circuit familiarisation, but fundamental engineering decisions on setup and vehicle design. It's a discipline that's rapidly evolving as simulator hardware improves,

processing power grows and the reliance on digital engineering increases.

“We're seeing a big increase in the use of DiL simulation, which I think is partly driven by growing expertise in the industry,” comments Cammaerts, founder of Ansible Motion. “There are a lot more engineers out there now who've devoted time to understanding vehicle modelling, and in some cases they've practically grown up with it.”

The same applies to the drivers. The age of the current Formula 1 grid averages out at 27. That means the vast majority of them are younger than the original Sony PlayStation, which also turns 27 this year. By the time the likes of Lando Norris and Mick Schumacher were starting school, the Gran Turismo franchise was already into its fourth instalment. ►



Work and play

Professional-quality simulators are a world away from arcade gaming, but these formative years spent on the PlayStation or Xbox mean that the current generation of drivers are very much at home in the virtual world.

"Simulators have come on a lot in recent years. One of the drivers in a NASCAR team that we supply commented that if the car started to slide in the static simulator they used to use it would take the whole width of the track to correct the slide; with a dynamic simulator using a 100 Hz control system the same correction took half the track – and with our 1,000



Pirelli

“The change in noise as the powertrain went into regen was a cue that was missing from the existing model, so we added an additional audio model”

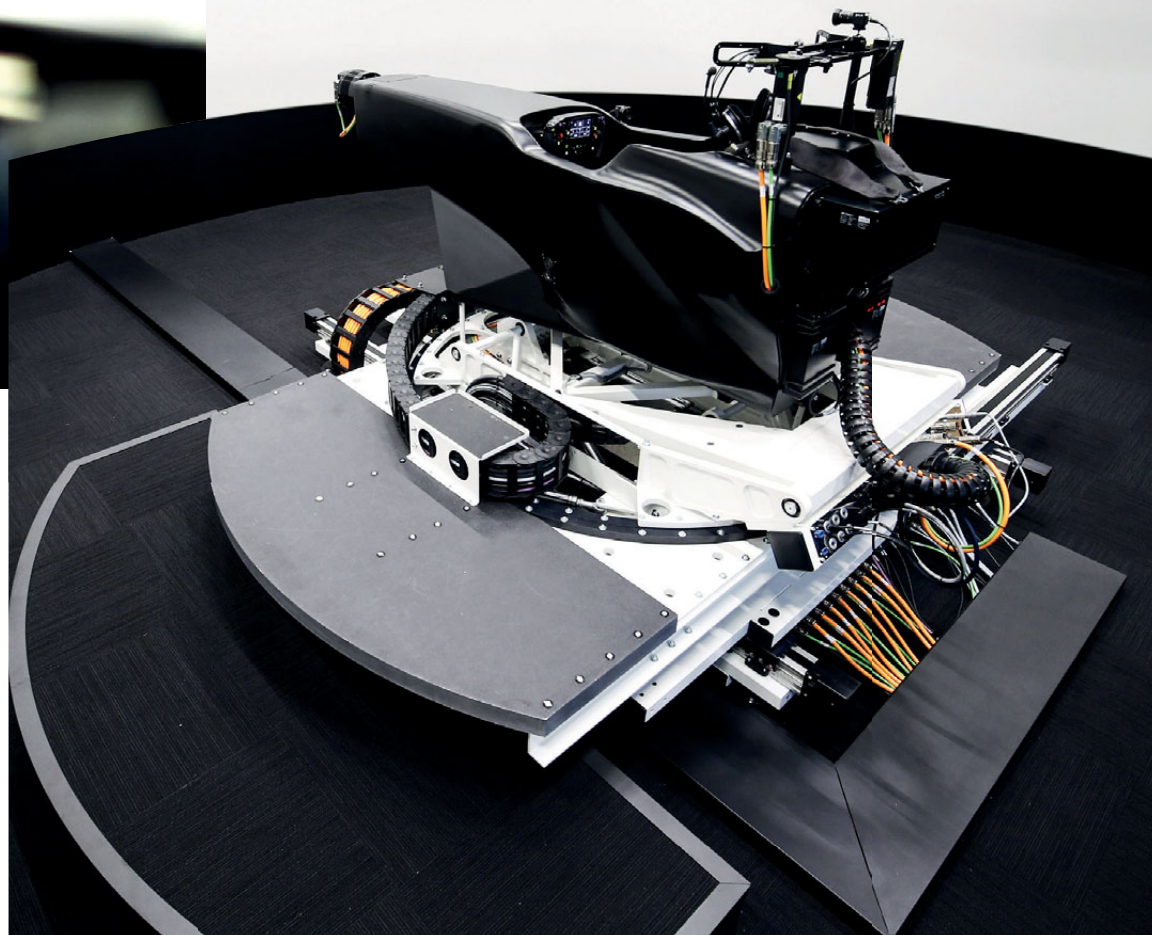
LEFT Just as past generations would benefit from immersing themselves in data after a session, rather than heading straight for the restaurant, the analytical approach to simulation is offering teams and drivers a competitive edge

Hz control system it was possible within half a car's width,” comments Cammaerts.

“Improvements in the hardware and software are constantly bringing the simulator experience closer to the real world, but there are still some drivers who get more out of it than others.”

He likens it to Michael Schumacher's famously analytical approach: “Schumacher would spend hours in the evening going over the data with his engineers at a time when a lot of drivers didn't really see that as their job. He's said to have gained a lot of benefit from that, and the top teams' investment in data solutions as a result is well documented. I think being able to use a simulator effectively can give teams a similar edge – whether the race drivers are logging a lot of time in the simulator themselves or whether it helps them to engage with their colleagues who are.” ►

BELOW The motion platforms always amaze the uninitiated, but it is the exact approach to the tuning of the control system that is the biggest performance differentiator



LEFT The latest generation of F1 drivers have grown up in the digital age, enabling them to extract ever more from simulation

A modern-day example of this analytical approach came to light after this year's British Grand Prix at Silverstone. Lewis Hamilton took advantage of the circuit's proximity to the Mercedes F1 HQ in Brackley to nip back for additional simulator practice before the qualifying session. He attributed his pole position for the sprint race partly to this time in the simulator, which led to grumblings from some of the other teams, unable to do the same.

Changes

For most of the top-tier teams, simulators have now become an everyday element of car and driver development. But arguably their greatest engineering benefit comes when change is imposed on the teams. Simulator development was a key battleground in the early days of Formula E, for instance, as the teams scrambled to master their energy management strategies in the new series, and again as brake-by-wire systems were introduced for Gen2. Similar challenges present themselves in new formulas such as LMH and LMDh, as well as the forthcoming FIA Electric GT Championship and the eTouring Car World Cup.

"Any major rule changes tend to drive big changes in in the vehicle, and therefore a strong demand for simulation," comments Cammaerts. "That's particularly noticeable where

we've got series with hybrid or fully-electric powertrains. The nature of those powertrain changes fundamentally affects the way the racecar and the strategy can be optimised for racing. That means there's a lot to learn in a short time, and simulation is ideal for that."

These emerging forms of racing have also led to new challenges for the simulator manufacturers. Ansible Motion has worked with a number of customers to develop new audio simulations that replicate the sounds associated with electric and hybrid powertrains, such as the subtle changes in noise during regenerative braking.

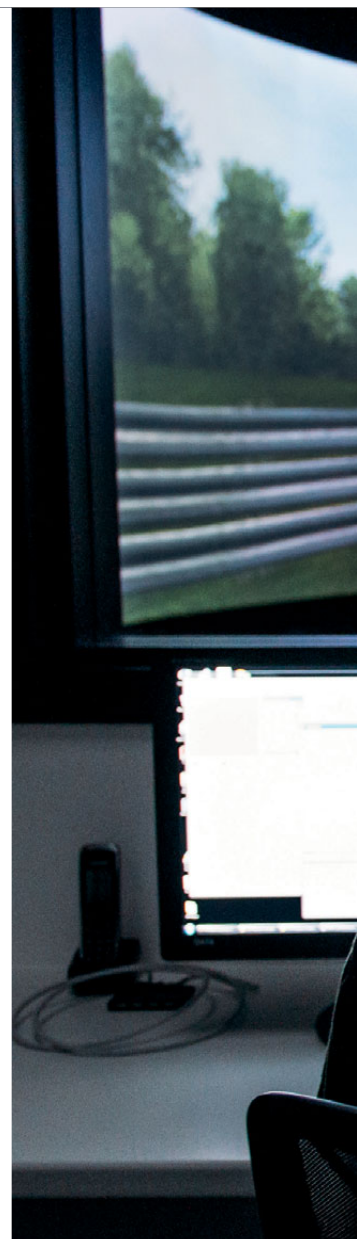
"That came as a result of a request from a driver," notes Cammaerts. "The change in noise as the powertrain went into regen was a cue that was missing from the existing model, so we added an additional audio model that filtered and manipulated recordings of the real hybrid system."

There's also a trend towards more complex hardware, both on and off the simulator. At least one team is understood

“The simulator's control system provides a motion cue that tricks the driver's brain”

RIGHT Ansible Motion provides driving simulator solutions for professional motorsports organisations around the world, from teams competing in NASCAR and sports-prototypes, to F1 and IndyCar

BELOW Simulators are invaluable when teams need to master energy management strategies, as they will in new series like Electric GT



FIA



to have run a whole car on a test bench hooked up to the simulator – complete with a working brake system to capture accurate thermal effects.

Some of the biggest gains are to be found in motion cueing. For motorsport applications, it simply isn't possible to deliver sustained forces of the magnitude required using the motion platform alone; the area required to do so would be vast. Instead, the simulator's control system provides a motion cue that tricks the driver's brain into responding in a similar manner. It's a subtle distinction, but a very important one that allows simulators to coax authentic driver responses in a controlled, repeatable environment.

This concept of acceleration-onset cueing is central to all dynamic simulators, but the exact approach to the tuning of the control system is one of the major features



ABOVE Former F1 and IndyCar engineer Kia Cammaerts had the vision to found Ansible Motion

that distinguishes them. What's more, simulator manufacturers have developed additional cueing devices to mimic the sustained forces. Seatbelt loading is relatively common in high-g motorsport simulations, but Ansible Motion has gone a step further, pioneering the use of helmet loading to carefully apply sustained forces to the driver's head in the lateral and longitudinal axes.

Innovations such as these are helping to break down the last remaining barriers between simulation and reality. They're creating ever more powerful tools for assessing performance and durability, even at the very earliest stages of a vehicle's development. And the key to all of this is the simple realisation that the most critical part of the simulation is not the hardware or the software, but the driver sat behind the controls. **RT**

A FAREWELL TO TRUCK ARMS

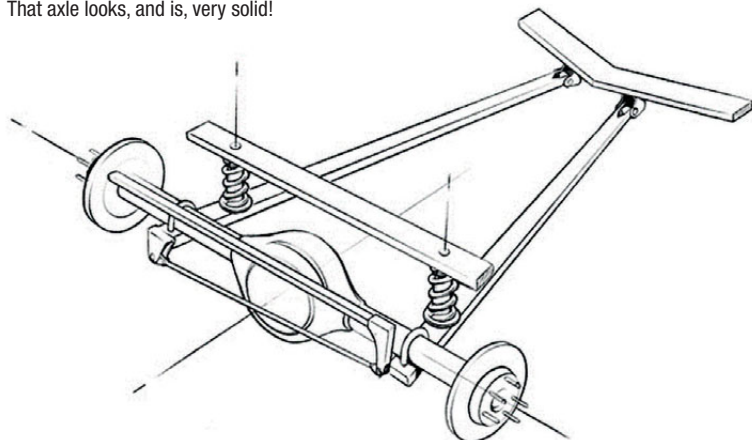
Dr Oliver Watkins, former Head of Simulation Development at McLaren Racing, bids goodbye to NASCAR's trailing arm suspension – by simulating its use on a Formula 1 car!

ON November 7th 2021, NASCAR will race its Generation 6 car for the last time, and in so doing say goodbye to one of the most unusual suspension geometries in modern motorsport.

Here at Canopy Simulations, we have mixed feelings about this: coming from the steady and straightforward world of Formula 1, almost everything about the truck-arm rear suspension seems crazy; on the other hand, it definitely has character.

“Almost everything about the truck-arm rear suspension seems crazy”

BELOW The layout of the truck-arm (or trailing arm) suspension. That axle looks, and is, very solid!



So what is NASCAR doing now, and what is it going to be doing in 2022?

The Gen-6 rear suspension uses a solid axle, which rigidly connects the rear wheels together. The solid axle is then mounted on a frame which connects to the chassis via a gimbal joint some distance in front of the wheels. The whole frame can then roll, pitch and yaw relative to the chassis. The aim of the suspension is to control these three degrees of freedom of movement, so we need three further connections between the chassis and the suspension frame. These come in the form of two spring/damper suspension struts, and finally the “Panhard Arm” (or track bar, or track rod).

Having been brought up on a diet of independent suspensions, this looks pretty unusual, to say the least. We wouldn't claim to be experts in exploiting this type ▶



RIGHT NASCAR's idiosyncratic trailing arm suspension geometry races for the last time this month



Getty Images/NASCAR

of suspension, but that won't stop us playing our favourite game at this point: asking what would happen if an F1 car had this sort of suspension.

We've set up a car with:

- A truck arm suspension where 200 kg of the 700 kg vehicle mass is in the suspension assembly.
- Spring rates matched to our baseline F1 car, so that the ride height vs speed characteristics match.

Absurd

We can then give it a lap of Barcelona and see how it performs against a conventional suspension (Figure 1). This is completely absurd: this type of geometry is usually heavily optimized to run on an oval

leads down a deep rabbit hole of asymmetric setup. Inflation pressures, spring stiffnesses and shims, suspension tweaks and even tyre compounds vary between left and right. This is what racing in a Formula series is all about: taking a set of tightly constrained technical regs and working your way through them to maximise performance.

We've long speculated that F1 is a racket run by engineers for the benefit of engineers. Every few years everyone starts to get a bit bored, at which point there's a big rules rewrite and everyone has something fun to get their teeth into again. And this, it seems, is what's happening in NASCAR: out with the truck arm and in with a conventional suspension.

We're sad to see the disappearance

“Introducing a little bit of asymmetry leads down a deep rabbit hole of asymmetric setup”

track and make turning left as painless as possible. In fact, one of the neat characteristics of the Panhard Arm is that if you lengthen it, it pushes the whole rear suspension assembly sideways, thus causing the car to turn left if without steering.

Therefore, to go in a straight line the driver must turn to the right, effectively causing the car to crab along the straights. However, when the infamous left turns arrive, the bodywork and front wheels can all be aligned with the oncoming air flow, and around the car will go. This offers significant aero benefits.

We can now have some fun changing the length of the Panhard Arm (Figure 2). As we sweep this from 50 mm longer than normal to 50 mm shorter than normal, the vehicle dynamics get very challenging. As we might expect, turning left gets a lot easier and turning right a lot harder. [1]


Asymmetric setup

This illustration probably helps to show why asymmetry in F1 has never really taken off. A few tracks offer limited potential for asymmetric setup, but balanced left/right performance usually means that any asymmetry is very limited.

In NASCAR, in fact in all oval racing series we serve, quite the reverse is true: introducing a little bit of asymmetry

of this most idiosyncratic suspension geometry, but from a commercial perspective we're quite pleased to see the new regs lining up with our core capability in which we have shown our strength in a huge variety of race series.

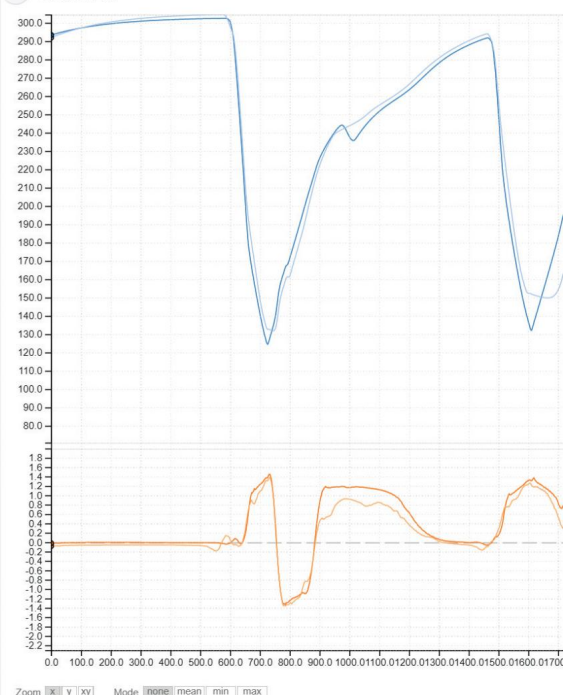
Canopy already serves customers operating in a huge variety of formulae around the world: Formula 1, Formula E, IndyCar, WEC, Formula 2, GT3, etc. If you are in a NASCAR team getting to grips with the challenges thrown up by the 2022 NASCAR regulations, and you'd like to make your life easier with the world's best motorsport simulation software, get in touch via hello@canopysimulations.com.

- Dr Oliver Watkins spent 10 years at McLaren Racing, five of those as Head of Simulation Development. He has a track record of inventing suspension components and is now a vehicle modelling and simulations expert at Canopy Simulations, which he co-founded. 

[1] Race engineers familiar with this type of suspension are probably grinding their teeth now: I'm sure that a 50 mm adjustment is probably about an order of magnitude larger than typical.

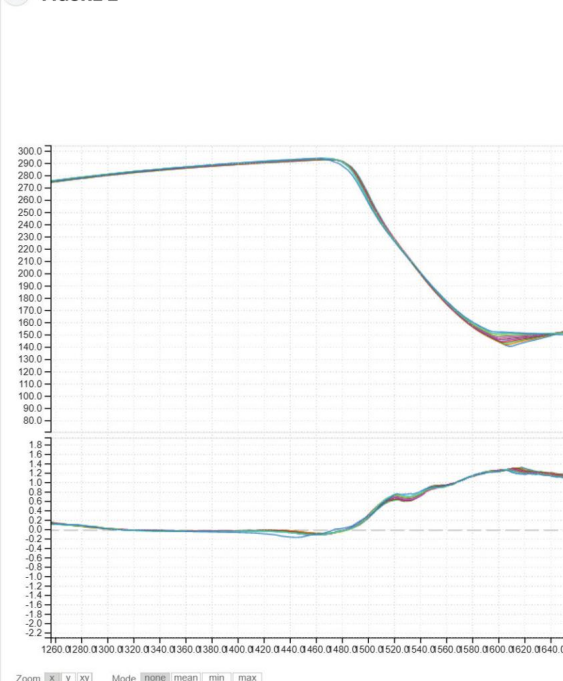
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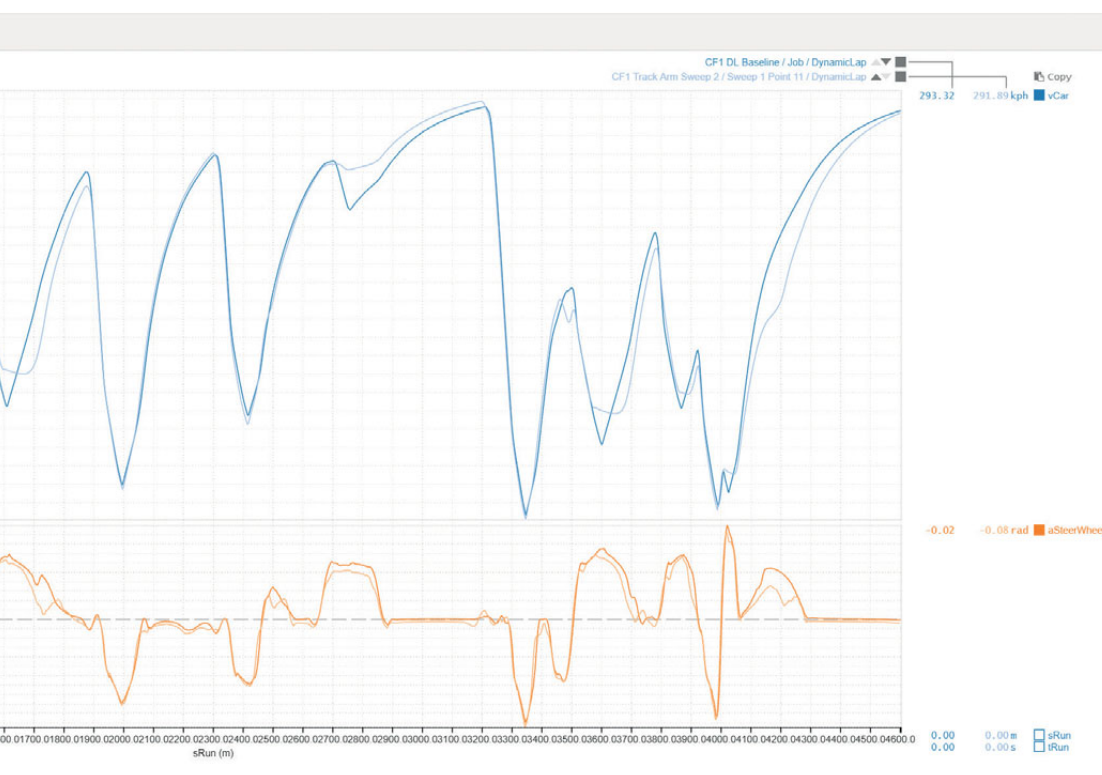
FIGURE 1



DynamicLap Default-DynamicLap-sRun

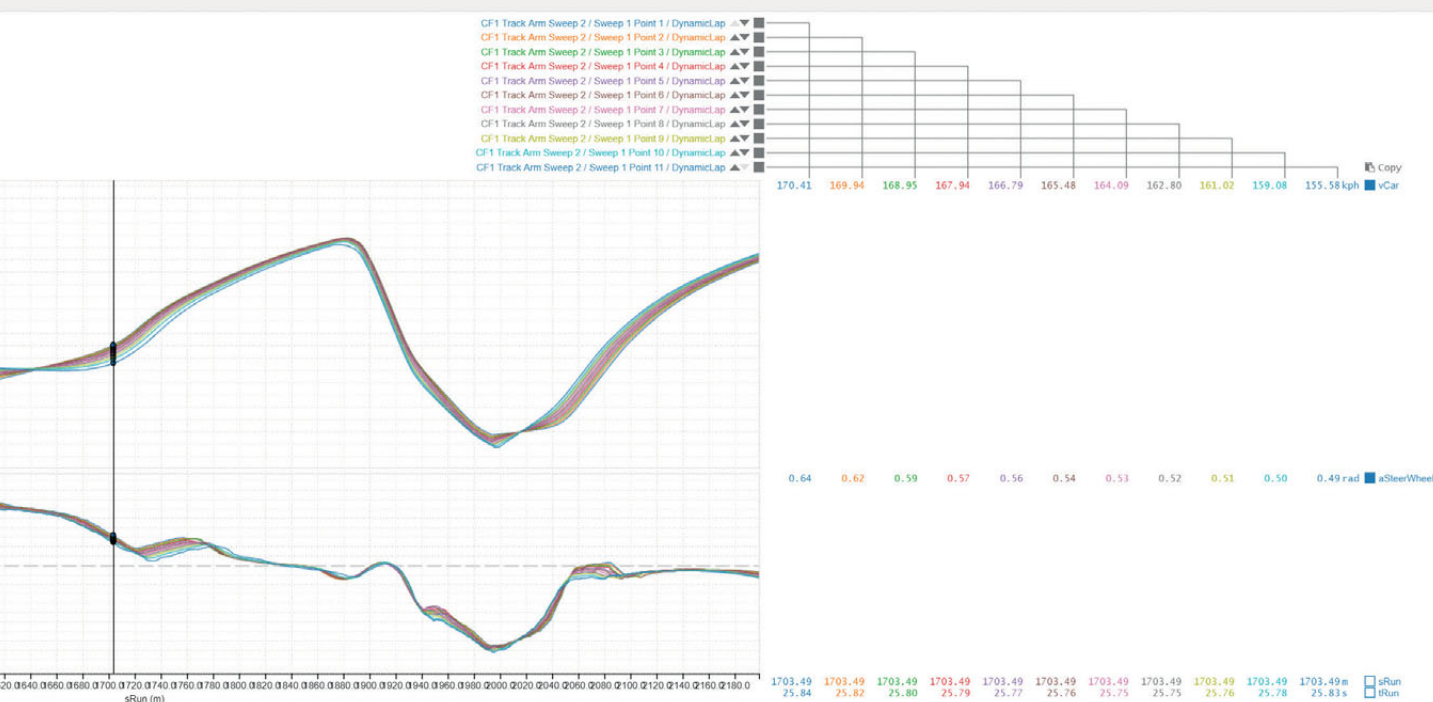
FIGURE 2





LEFT The comparison here is very interesting. Through turn 4, a medium-speed right-hander, the apex speed outperforms the F1 car but then we lose out horribly under traction. This is hardly surprising: the mechanical balance of the car has gone a long way rearward. In order to match the heavy stiffness, we've made a terrible mess of the roll stiffness – with disastrous consequences. For turn 5, however, a sharp left-hander, everything is just great: this car really wants to turn left!

BELOW More of turns 4 and 5 at Barcelona. As we change the length of the Panhard Arm, the left/right bias gets worse and worse. Let's stick to ovals...



WHISPER IT, BUT WE COULD MEET FACE-TO-FACE!

It's goodbye Zoom, hello show season. **Mark Skewis** offers a sneak preview of some of the new products developed for a resurgent motorsport market

WITH everyone finally daring to venture back into the world, eager to discover the new products that have been developed over the past two years for the challenges that lie ahead, an intriguing show season awaits.

Ahead lie PMW, SEMA, PRI and ASI. Different shows in different countries, but they are bound by one common theme: motorsport's need to rise to the challenge of sustainability and adapt to a fast-changing technical landscape.

The first of these events, Professional MotorSport World Expo, opens its doors on November 10 for three days. It will showcase the latest and best technologies for motorsport and ultra-high-performance road car applications.

BELOW Some of the race series interesting suppliers at the resumption of the trade shows hadn't even turned a wheel in anger when we all went into lockdown

First wireless load stick **Intercomp**

INTERCOMP is introducing the RFX Wireless Suspension Load Stick, the first wireless load stick in the racing industry. This effective setup tool is enhanced with RFX Wireless Weighing Technology, eliminating the cabled indicator currently utilized by most load sticks on the market.

Without a cable to mind, the Load Stick allows racers to concentrate more on obtaining the correct measurement and less on breaking an indicator cable and rendering the tool useless. Individual load sticks are also available without an indicator, allowing single- or dual-load stick systems to be expanded later.

Load sticks mounted on all four corners of a racecar help provide a picture of the vehicle's load distribution in different chassis attitudes. This allows racers to determine the exact spring rates needed to get the car into the dynamic ride heights required to carry maximum speed and momentum through a turn. The two-load stick system allows a racer to collect dynamic load data at left-side, right-side or opposing corners of the car. These can be critical measurements



that can mean the difference between a fast or slow car in dirt and paved oval racing.

Each Intercomp load stick has an industrial-strength 3,000 lb (1,300 kg) capacity load cell and can span shock mounting points 15-25.25in (381-641 mm) apart, utilizing three interchangeable bodies. Load Stick bodies are machined from tough, hex-shaped billet aluminium, making them easier to extend and retract using hand tools. High-quality spherical rod ends with ultra-low-friction PTFE inserts provide a long service life without the need to maintain the joints with grease.

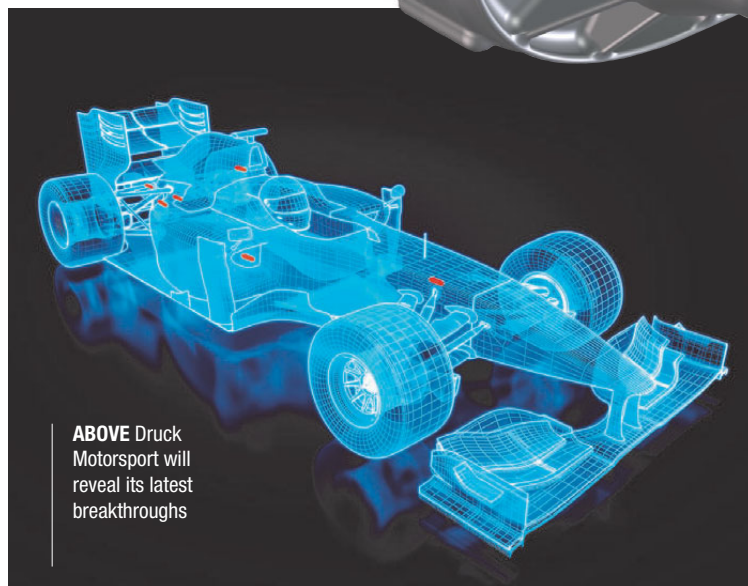
Latest sensor innovation

Druck Motorsport

DRUCK is announcing the launch of its latest innovation, the 4400T, a combined Pressure and Temperature Sensor, conceived specifically for motorsport and designed to suit all chassis and engine pressure measurement applications. The new 4400T leverages the proven design of the 4400 series pressure sensors to offer top performance in the harshest environments common in high-end motorsport.

The 4400T offers all the benefits of a small, highly accurate pressure sensor with the added benefit of a pt1000 temperature sensor. Combining pressure and temperature measurements provides race engineers with a number of key benefits. First and foremost, it is said to produce unrivalled levels of accuracy and reliability across pressure and temperature measurement. The 4400T mass is less than that of two independent sensors, and consumes less real estate, which simplifies installation. Wiring looms are also simplified, further reducing mass and complexity.

In addition, the measurement of temperature and pressure is taken in the same location, resulting in more consistent data.



ABOVE Druck Motorsport will reveal its latest breakthroughs

Test systems for next-gen powertrains

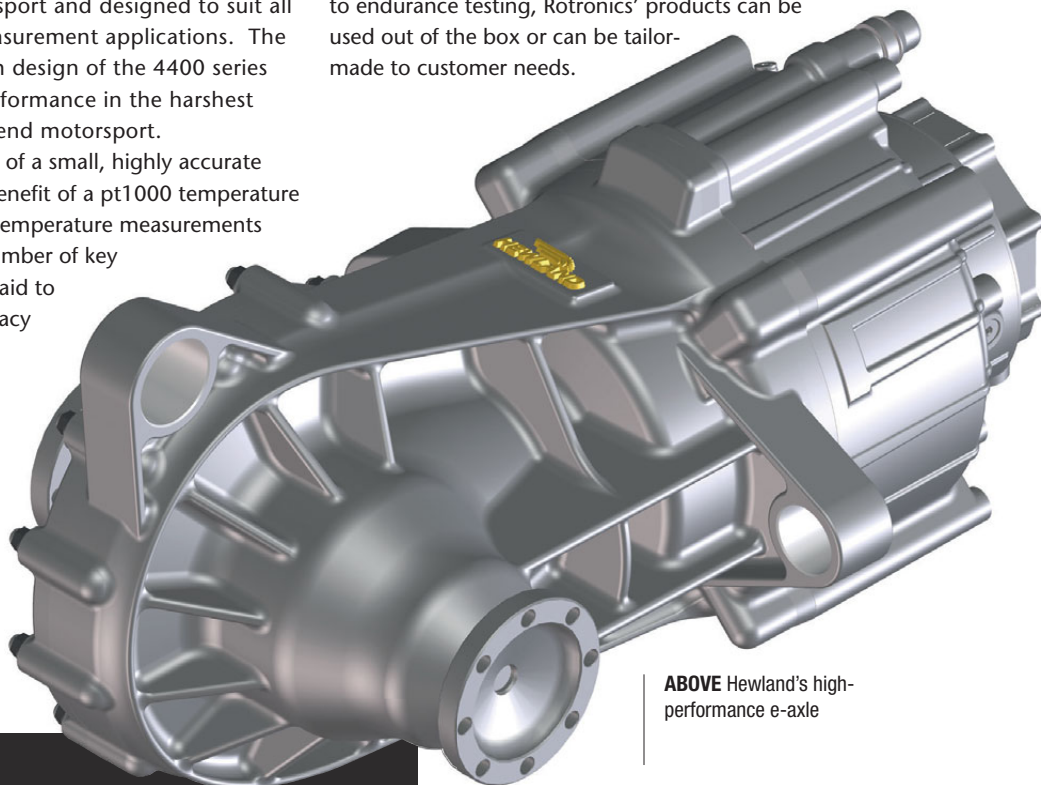
Rotronics Testing Solutions

ROTRONICS has been a key player in the vehicle, engine and component testing facilities fields since 1991, but its products are increasingly being employed to face new challenges with standard, hybrid or electrical motors.

Based in France, it designs, manufactures and delivers chassis dynos, hub dynos and engine test benches for R&D, racing, engine optimization and end of line testing.

Its products are already known for their adaptability, repeatability and performance level and customers include automotive OEMs, suppliers, racing teams and universities.

The company's Autoscan dyno is capable of reaching 400 km/h with unbowed traction due to its single roller design and has perfect synchronization at any speed. From engine optimization to endurance testing, Rotronics' products can be used out of the box or can be tailor-made to customer needs.



ABOVE Hewland's high-performance e-axle

New high-performance e-axle

Hewland

HEWLAND, in partnership with Integral Powertrain, is announcing the release of a brand-new, high-performance e-axle.

The HEA-200 incorporates the very latest IPT motor, the CTSM242, with leading power and torque density producing up to 400 kW and 520 Nm. The motor integrates seamlessly within a compact aluminium or magnesium casing, housing a two-stage epicyclic reduction ratio gearbox and differential. This unique configuration allows the motor to spin up to 15,000 rpm, maximizing the performance and efficiency, delivering up to 4,500 Nm at the wheels.

Utilising state-of-the-art gear design and ►

manufacturing technology, along with the latest oil analysis and casing optimization software suites, the e-axle boasts an unrivalled performance versus weight while maintaining optimal NVH. A range of ratio options up to 10:1 and various differentials provide the flexibility that makes this e-axle suitable for a range of applications.

Hewland, part of the Hero Motors Group, can supply the integrated e-axle, and others, as a one-off or in mass volume series production.

Switch to fuel tanks

Continental Fuel Storage Systems GmbH

CONTINENTAL Tires Germany has changed its name to Continental Fuel Storage Systems GmbH.

The company is emerging from the turbulent economic period by displaying its latest range of high-performance racing fuel tanks. All variants meet and exceed the FIA FT3.0 and FT3.5 standards, being crash resistant, explosion suppressant and thermally stable between -50°C and +90°C. The lightweight, flexible, robust fuel tanks are available in custom shapes and sizes and come with the appropriate connection components and tank inserts.

Continental Fuel Storage Systems can make its fuel tanks as one-offs or put them into series production.

All-in-one GNSS datalogger and lap timing display

Racelogic

VBOX Mini LapTimer is a GNSS datalogger and lap timing display in one. Its miniature design means that it is ideal for applications where there is limited space to mount lap timing devices, such as in a single-seater racecar.

Mini LapTimer provides instant feedback on the screen and via the bright LEDs, indicating where time is being lost and where time can be gained around a circuit. By using position rather than distance, the predictive lap time remains accurate, even if the driver takes a different line each lap. It provides drivers with accurate, real-time lap comparison, and it works at any track. You don't need any external beacons, and there is no setting up required.

Predictive lap timing adds another element to datalogging, as drivers have a real-time comparison of their current lap against their previously recorded best lap – so they will always be trying to beat it. It means they can judge the effectiveness of different lines and get immediate feedback on the graphical display of how much time they're losing or gaining.

Racelogic OLED Displays are a common sight in racecars around the world and are now available in a smaller form like the VBOX Mini LapTimer. The high-contrast OLED Display remains the perfect partner to a VBOX video datalogger and retains the same

features and functions as the larger variant. Suitable even in bright conditions, the display provides sharp graphics and is simple to use. It can show a wide range of parameters, including live and max speed, lap times and predictive lap timing.

Electrical motors up to 60V

XAP Technology

SINCE 1996, XAP Technology has designed, manufactured and maintained innovative products for the racing industry. Most international championships (Formula E, Formula 2, Formula 3, Rally, LMP3, etc) use at least one of its products.

This year, XAP Technology started to design and manufacture electrical motors up to 60V, allowing hybridization of existing systems. It completes the global system architecture that the company provides to customers.

It will be displaying its new-generation technologies for the 2022 Formula E and Formula 2 championships at PMW Expo 2021. The company specializes in drivers and system machine interfaces, power distribution and electrical modules, gearbox actuators, air conditioning and electrical and powertrain solutions.

XAP Technology manages 90% of its production internally for an optimal design and complete chain control. All its products pass through its own engineering department, melding the company's mechanical, electrical, electronic, electromechanical and software abilities.

RIGHT The Stilo DG WL-10 Wireless intercom is at the heart of the Venti WRC helmet

BELOW XAP's new-generation technologies will be on display



New range of turbocharger solutions

VAN DER LEE Turbo Systems

VAN DER LEE Turbo Systems offers high-end technical solutions in matching, design, development, testing and manufacturing of turbo systems for every conceivable purpose.

As a supplier for LMP1, Formula 2 and international touring car and rally class race teams, the company has in-depth knowledge of different race classes, regulations and requirements.

At the PMW Expo 2021, VAN DER LEE Turbo Systems will be presenting its latest range of high-end and cost-effective turbocharger solutions for motorsport applications. These have been designed with the latest compressor and turbine geometries, are lightweight, can handle high temperatures, and all manufacturing is supported by the automotive quality management system.

The range will support applications from 200 hp to 800 hp per turbo fit for 1.6 to 4.0-litre single and twin-turbo engines. There are turbocharger options of non- and integrated wastegate systems. Integrated wastegated systems can be fitted with pneumatic and electric actuators. There are also turbocharger options for journal bearing and ball bearing systems.

Racing coolant improves heat transfer

VP Racing Fuels

VP RACING developed Stay Frosty Race Ready as a proprietary racing coolant. Not only is it formulated for high-compression, high-heat racing engines, but the racing coolant contains a specialized blend of heat transfer agents that drastically improves the coolant's ability to transfer heat away from high-temperature cylinder heads. This both increases the density of the air/fuel mix and allows ignition timing to be safely advanced without the threat of detonation. Consequently, cars get more power and torque.

Stay Frosty Race Ready is said to reduce cylinder head temperatures by an average of 62°C compared to waterless engine coolant. It also reduces engine cylinder head temperatures by an average 43°C as compared to a conventional 50/50 mix.



The waterless engine coolant is composed of 100% glycol while Stay Frosty is a 100% water-based formula. Water transfers approximately twice the heat glycol does. The viscosity of glycol is 10 times higher than water; the viscosity of a 50/50 mix is three to six times higher than water. High coolant viscosity reduces flow rate, which further elevates temperatures unless a high-flow water pump is installed.

New temperature sensor released

Variohm EuroSensor

VARIOHM EuroSensor has several new products to present to the motorsport world.

Among them is a new temperature sensor, the ETP-MO. This sensor has been specifically designed for demanding temperature measurement tasks. The probe is designed to withstand shock and vibration due to a robust overall construction. The materials are oil and fuel resistant, for use in typical mobile applications across a wide environmental temperature range.

Other new products for motorsport and mobile vehicle applications are the R2 Rotary Position Sensor, the S-Series Magnetic Speed Sensor and the K9 Series Geartooth Sensor.

The R2 is a cost-effective device that accurately determines the absolute positions of rotating shafts, can be

configured for analogue or PWM output and is programmable for sensing angles between 0° and 360°. A non-contact device in a rugged, reinforced nylon housing, the R2 is ideally suited for demanding applications.

The S-Series is a magnetic and Hall-Effect sensor capable of reading speeds from 0-100 kHz. The K9 has high-speed operation (15 kHz) and a working temperature from -40°C to +125°C.

Wireless rally helmet

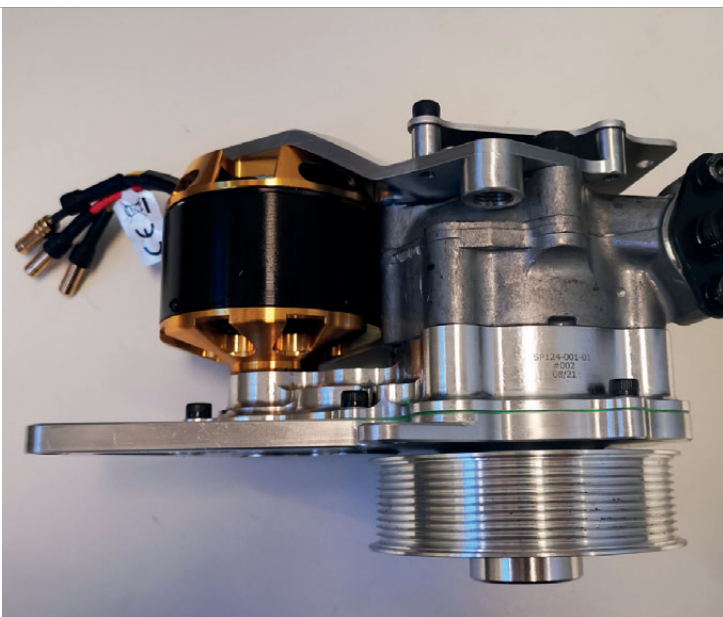
Stilo

TWENTY years after the launch of Stilo's iconic WRC helmet with its fixed microphone boom, the WRC Venti has had a design change, further improving this most popular rally helmet, with its established reputation for being safe, light and functional.

Featuring top air cooling, revised peak design, updated noise cancelling and a compact and recessed side port, the WRC Venti is designed to lead a new generation to success.

All-new carbon shells come with Puro Technology, developed for the Stilo Zero 8860 top-level helmets but now available on all helmets in the carbon line. The unique technology eliminates the need for a final, clear coat layer, saving weight.

In another development, the Venti WRC helmet has been designed around a new communication system: a professional ►



LEFT Sportech Engineering will exhibit a new compact electrohydraulic steering pump

BELOW Irmmler's toe and camber measurement system

intercom system that is completely wireless. The Stilo DG WL-10 Wireless intercom helmet key plugs directly into the comm port of the Venti helmet while the control unit is installed inside the car.

Steering systems for hybrid racing Sportech Engineering

SPORTECH Engineering, a supplier of motorsport and high-performance vehicles power steering systems, will exhibit a new compact electrohydraulic steering pump.

This innovative unit can be considered a hybrid pump as it can be driven both mechanically and by a 12V electric motor. This feature ensures power assistance of hybrid cars both when the IC engine is on (mechanical drive) and when it is off (electric drive). The four-quadrant motor can be controlled by a CAN and it drives the pump and the regeneration circuit. Thanks to the CAN communication, all internal parameters and status information can be logged and integration with the car system is complete.

This hybrid pump stands up to the power assistance requirements of the most demanding motorsport applications, such as rough gravel WRC rallies, cross country rallies, world rallycross and other extreme environments.

The system was originally designed to suit the 2022 hybrid WRC regulations, requiring the car to run both in IC and full EV mode, but its efficiency and special features (mechanical drive, electric drive, hybrid drive and regeneration mode) will be of interest across a wide range of applications from hypercars to circuit racing and rough off-road usage.

Hub stands and alignment system Irmmler

IRMLER has developed and designed the Setting One/Easy Setup toe and camber measurement system. Provisionally designed by Stefan Kissling for TCR, Irmmler has optimized the system and got it to work for old, classic touring cars and more, including Formula and GT cars.

In motorsport, the driving time is influenced in part by the talent of the driver, but also by perfect technology. The toe and camber values must be measured precisely as part of the setup adjustments. With this system, the axles can be aligned on-site: this allows you to respond to finer points such as changes in weather, the driving style of the race driver or the racetrack asphalt.

The sturdy, CNC-produced measurement system measures the toe and camber

settings of all classic touring cars, current GT vehicles and current TCR vehicles quickly and precisely without affecting the rim and wheel geometry, no matter where you are: workshop or racetrack.

New line of forged wheels Seido DE Srl/Evo Corse

EVO Corse has taken a further step forward with its line of forged wheels, designed for the most extreme competitions, with what it claims is a game-changer in the racing field.

The well-known cast products of the Italian brand now have their own forged versions in aircraft alloy, opening the doors to a new audience.

The quality, lightness and resistance that characterize all EVO Corse wheels are brought to the highest level thanks to the forging technique: 8,000-ton presses combined with the most advanced machining centres. Features include increased load index without growth in terms of weight.

The EVO Corse line of forged wheels is currently available in 18in, 19in and 20in with a wide range of widths and can be adapted to any car model.

Investments into the future Precision Technologies

PRECISION Technologies International Limited is welcoming the arrival of Langstone Engineering Limited into the Gearing Up Limited group.

Langstone Engineering Limited is based in ►



Essential BOOK for the motorsport engineer's library:

Making Sense of Squiggly Lines: £40

The Basic Analysis of Race Car Data Acquisition by **Christopher Brown**

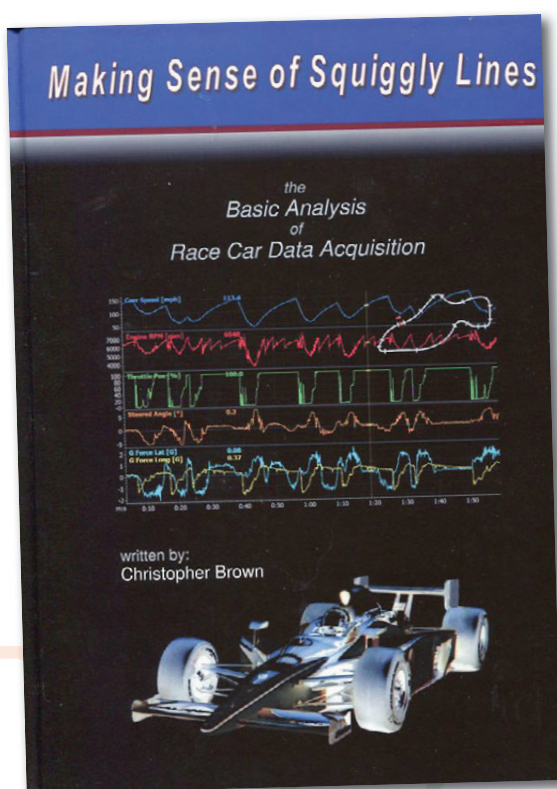


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Portsmouth, UK and has over 20 years of experience in mould tools, precision engineering and design. Specializing in five-axis machining with a team of around 45 engineers, Langstone serves customers in motorsport, aerospace and marine among other sectors.

Precision Technologies continued to invest despite the global pandemic. Having acquired the Hofler Viper 500K, the first one of its type in the UK, Precision Technologies is able to grind gears to an extremely high accuracy and produce the complex microgeometry often used in electric vehicle transmissions.

This sets Precision Technologies at the forefront of high-precision gear production. From one-off prototype gears through to low-volume production but always at a high accuracy, this adds to Precision Technologies' existing plant.

In addition, it has recently taken ownership of the latest CNC precision measuring centre: the Klingelnberg P 65.

New ECUs

DTAFast

DTAFast is announcing the release of its new T-Series ECUs (above). Building on the reliability and usability of the S-Series ECUs, the T-Series adds new features such as Bosch onboard wideband lambda control, onboard fly-by-wire and onboard knock control.

The company's highly regarded motorsport features are all available, including closed-loop flat shift, launch control, traction control, datalogging and much more.

Built from the ground up using automotive-specific microcontrollers, the new T-Series ECUs offer the highest precision control of ignition and injection, with unrivalled accuracy. Map tables can be sized from 10x10 to 30x30 and input/output assignments are fully configurable.

The T-Series ECUs are configured with new, more user-friendly software. Written from scratch, the software also comes with a responsive design that allows for better readability on high DPI displays, as well as large displays with large scaling factors.

The entire range of T-Series ECUs is highly water resistant, including the entry-level T2 and the ignition-only T2i.

DTAFast's roots are in club-level motorsport.



It will always strive to keep adding features from more advanced ECUs and making them available for customers. The company's aim is always to keep the ECUs as simple to understand and use as possible.

Web-based dynamometer software

Mustang Dynamometer

MUSTANG Dynamometer is introducing its new web-based dynamometer software to the tuning industry – the Hole Shot web interface for dynos.

Web-based user interfaces (UI) provide the user with the ability to be completely untethered to a specific device or operating system (OS). Users can log into their controller from any OS with any device and from anywhere on the premises within range of the server's wireless service.

The system supports Android, Windows, Linux and iOS. This allows the user complete freedom from wires as well as freedom from OS licenses.

Want to use an iPad? No problem. The system uses the most advanced coding techniques currently being deployed for web applications, including Angular JS. System updates are pushed to all platforms via the internet, so users always use the most up-to-date version of the platform. Mustang currently offers worldwide seven-day-a-week support via WhatsApp, remote desktop, email and phone.

3D-printed turbocharger demonstrator

GF Casting Solutions

SPEED is crucial in motorsports, not only on the racetrack, but also in product development. GF Casting Solutions offers

rapid prototyping, spare parts on demand and short lead times for 3D-printed components, plus support from the first design concept.

Additive manufacturing offers unlimited possibilities in terms of design, speed and production processes. GF Casting Solutions offers serial production of big components with complex forms and functional integration – even for motorsport solutions, thanks to printing spaces of up to 500 x 500 x 500 mm as well as certified in-house post processing.

The new 3D-printed turbocharger demonstrator is made from Inconel 718 material, with a density of 8.2g/cm³, weight of 19.5 kg and volume of 2,373.5 cm³.

The turbocharger demonstrator boasts a great freedom in design options, including a focus on part functionality: extreme shapes can be printed, such as hollow structures, unique double-wall construction designs, or very thin walls; additionally there is topological optimization and the possibility to integrate a lattice structure.

Increased thermal insulation ensures effective operation of the turbocharger and performance is further optimized with increased air flow through the cylinders' combustion chamber to augment the engine power output.

Award winner

EEC Performance Systems

EEC Performance Systems will be showcasing new products in addition to its award-winning f-POD Intelligent Race Fuel Browsers and Wi-POD Intelligent Wireless Corner Weight Scales, which are used by top-level motorsport teams worldwide.

The new products on show include E-POD Endurance Rig Scales, the E-POD Intelligent Fuel Timer and the E-POD Wireless Endurance Fuel Rig System.

EEC Performance Systems identified the need for a purpose-built fuel rig scale, designed as an alternative to the adapted parcel scales currently available from most rig manufacturers. The E-POD Endurance Rig Scale is designed to fit, without modifications, most fuel rig tanks on the market including ATL, Caseliner and Premier.

Designed with simplicity in mind, the new E-POD Intelligent Fuel Timer is easy to

operate, allowing users to read and review previous stored times. The operation of the timer is totally automatic, starting and stopping on connection and disconnection of the fuel nozzle.

The E-POD Wireless Endurance Fuel Rig System is a completely wireless endurance fuel rig monitoring and logging system. The system, with its 15in full-colour touchscreen, is designed to be mounted into the garage walling, adjacent to the fuel rig. It is completely modular, with inputs for fuel weight, fuel time and fuel and air temperature. All data is stored in the system's memory and can be viewed remotely on any PC or portable device within the same VPN.

EEC Performance Systems can adapt a team's existing rig scales to wireless so they can work with this system.

High-end rotary boom

Caseliner

CASELINER will introduce its Rotary Boom Carbon CB400. It has a double rotating arm, which is required in WEC, ELMS, and Asia LMS competitions. The telescopic arm can offer complete coverage for the fastest pit stop with a stylish, lightweight and high-tech design. The peak performance of carbon elements is combined with CNC technology of all-aluminium parts. The boom has the highest quality of machining, is lightweight and is very compact in size for easy transport.

Caseliner offers another version with a single carbon arm, the CB200. An

additional offering is the best-selling stainless-steel Rotary Boom IB100, which has an option to add another arm.

All products use high-tech rotary motion transmission. Thus these booms achieve a high-precision air transmission for use with a Paoli mechanical tightening gun.

Caseliner booms are very popular in the WEC, GT Challenge, DTM, ELMS, British GT, Australia GT and Japan GT series.

Small, light, powerful converters

BrightLoop

A COMBINATION of the most advanced technologies along with broad expertise in power electronics has allowed BrightLoop to develop the smallest, lightest and most powerful DC/DC converters on the market with 3 kW/kg power density.

The Performance DC/DC product line includes five converters (2 LV<->LV and 3 HV<->LV) ranging from 1.7 kW to 10 kW and designed for harsh environments. Leveraging GaN and SiC technologies, these converters are around half the size and weight of BrightLoop's previous generation DC/DC converters released just three years ago.

BrightLoop's DC/DC converters are used in the most high-performing hybrid and electric series, such as Formula 1, Formula E, Extreme E, etc.

A converter's function is to power the low-voltage electronics including pumps, lighting and radio. Thanks to innovative architecture, great versatility is provided, allowing easy setup of multiple

output voltage. Different voltages can be used for the loads, paving the way for advanced multi-voltage architectures such as 12V–48V.

The high number of possible outputs (up to eight) allows power distribution functions to be realised by the DC/DC converter, without the need for other equipment. It also features full reversibility, opening the possibilities for advanced functions such as active pre-charge of HV bus.


BrightLoop's converters go beyond the main function of power conversion and include extensive CAN remote monitoring and software-settable output voltage and current.

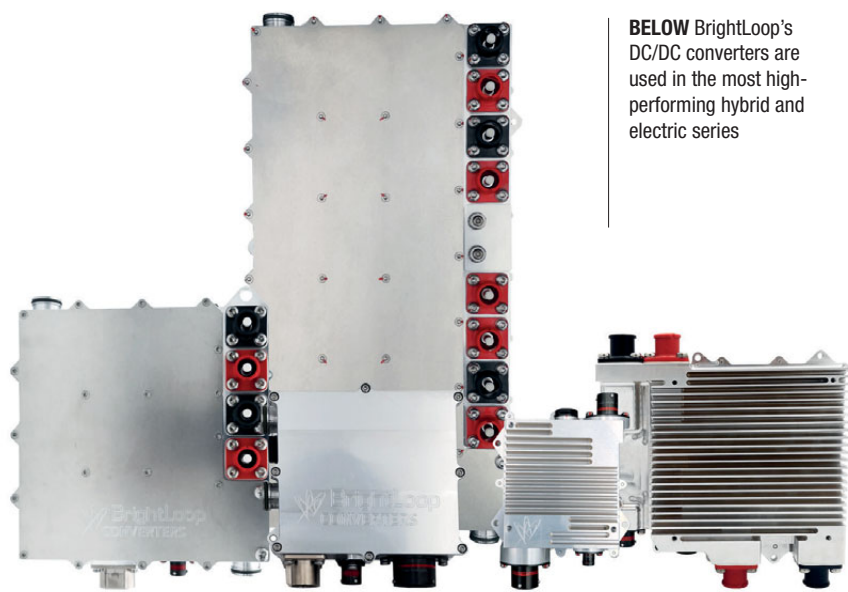
Natural fibre composites

Bcomp

IN the realm of motorsport, sustainability is all too often considered a hindrance or compromise – something that will detract from maximum possible performance or add substantial cost. Now though, sustainable lightweighting company Bcomp has developed natural fibre technologies that offer equivalent performance to carbon fibre while cutting material cost by 30% and cradle-to-gate CO2 emissions by 75%.

Bcomp's technologies – branded ampliTex and powerRibs – harness the natural mechanical properties of flax fibres, a low-maintenance and resistant crop that is indigenous to Europe. The company is turning these fibres into high-performance composites for a host of advanced applications from motorsport bodywork and seats to satellite panels for the European Space Agency. Teams in Formula 1, Formula E, Extreme E and Porsche Motorsport's GT4 programme have already adopted Bcomp composite solutions. These are also being used in the pioneering eSkootr Scooter Championship (eSC) – a race series that centres around high-performance e-mobility.

Alongside low weight, emissions and cost, Bcomp's technologies offer additional advantages over traditional motorsport composites, like 250% better vibration damping and, importantly, improved crash behaviour. Unlike carbon fibre, which fractures and splinters on failure, Bcomp's composites remain in one piece and have a ductile failure mode. 



BELOW BrightLoop's DC/DC converters are used in the most high-performing hybrid and electric series

TAKING THE LEAD IN THE RACE FOR SUSTAINABILITY

Retrac Group, an established F1 composites supplier, launched its own sustainable bio-composite materials range at the Advanced Engineering Show. **Mark Skewis** investigates

MOTORSPORT stands at a crossroads with the world's drive towards sustainability. Is it going to be part of the problem, or part of the solution?

It is, of course, uniquely placed among all sports to be a part of the solution. Unlike any other, it can be a powerful vehicle for the sustainability message.

And motorsport's unique entwinement with the automotive industry means that their adoption of sustainably-sourced composite materials could go hand-in-hand. Motorsport may have gone through its own "light-weighting revolution" more than 60 years ago, but by championing bio-composites now it can play a vital role in encouraging the hot-housed development of materials for mass adoption across all future transport solutions.

Innovation will come through regulation and investment from the top down, but it can also come from the bottom up.

Extensive R&D programme

An example within the UK's motorsport supply-chain industry is Retrac Group, whose Retrac Composites division has been an established supplier to F1 teams for nearly 25 years. Also a supplier into the automotive and aerospace sectors, it has fielded such an acceleration in sustainable composites enquiries it launched its own sustainable bio-composite range at this year's Advanced Engineering Show at NEC Birmingham early in November.

The new Retrac Future range features five sustainable or recycled composite material options and has been

ABOVE Retrac has produced a demonstrator bonnet panel for a race-bred GT3 supercar to showcase its new Future range

“Unique bio-composites solutions developed through in-depth experimentation with bio-resins”

developed to offer customers access to enhanced sustainability with high performance. The product of an extensive R&D programme, Retrac Future showcases an array of recycled carbon fibre and natural-fibre products suitable for multiple applications.

The environmental credentials of these composite materials is enhanced further by Retrac Future also utilising the most sustainably-sourced epoxy resin systems available alongside an energy-efficient production process featuring bespoke compression moulding techniques. This three-layered approach puts Retrac Future at the cutting-edge of reducing the carbon footprint of high-end composite solutions.

“The world is on the cusp of a light-weighting revolution, and Retrac Group is positioning itself at the forefront of knowledge and technique to maximise successful applications of natural fibres and recycled composites,” says Retrac Group CEO, Dan Walmsley.

“The menu of material options in the Retrac Future range serves to demonstrate to customers the breadth of what is possible with our various techniques using sustainable and recycled materials,” he adds. “We always offer our customers bespoke solutions to specific problems, but we have invested in R&D to develop manufacturing capability using numerous interesting materials that give our customers a great platform to specify their requirements in sustainable composites.”

High-profile case studies for natural-fibre applications in motorsport have centred around leading flax natural fibre specialist Bcomp. The Swiss-based company is the mandated supplier of fibres for the SRO’s new GT4 sportscar rulebook which requires consumable front and rear body structures to be made from flax-fibre by all car manufacturers. It also created F1’s first bio-composite seat with McLaren Racing, and has fielded enquiries from Formula E teams which are reacting to the FIA’s regulatory incentive for them to adopt sustainable composites for non-structural components.

Retrac Group has recently forged alliances in the supply chain with Bcomp and Composites Evolution, the UK-based prepreg manufacturer and supplier, which earlier this year launched the Evopreg ampliTex prepreg range. The latter combines its high-performance Evopreg epoxy resin systems with Bcomp’s award-winning ▶





ampliTex range of flax reinforcements.

Using Evopreg ampliTex alongside Bcomp's powerRibs reinforcement system, Retrac is supplying GT4 parts to its OEM customers, but has also produced a demonstrator bonnet panel for a race-bred GT3 supercar. This was the centrepiece of its display at the NEC, showcasing the Retrac Future range and its expertise in the field of manufacturing bio-composites.

This material combination forms one of the five examples put forward in the Retrac Future range to demonstrate the possibilities for sustainable composites. Alongside this is a flax material utilised with an epoxy resin system which features a market-leading level of sustainably-sourced ingredients, while another option is a recycled carbon fibre material. Additionally, Retrac has developed two thermoplastic materials from woven carbon and woven glass respectively, which can both be manufactured in the compression moulding press system.

Compression moulding

Retrac's compression moulding press system is the third pillar of its Retrac Future offering. A 60-tonne electric servo press has been used for product development, and is a bespoke construction to Retrac's specification. The servo-driven design allows precise control of platen position and load at every part of the pressing cycle, critical for repeatable, high-quality manufacturing of composite parts. This press system not only allows for high-volume productionisation of composite components, it can also be used more energy-efficiently than a traditional autoclave.


"Over the past 18 months we have developed a deep understanding of the processing requirements and properties of bio-composites combined with the complementary role of bio-resins and a variety of manufacturing processes," says Alan Purves, Head of R&D at Retrac Composites.

"Sustainability is fast becoming a vital factor

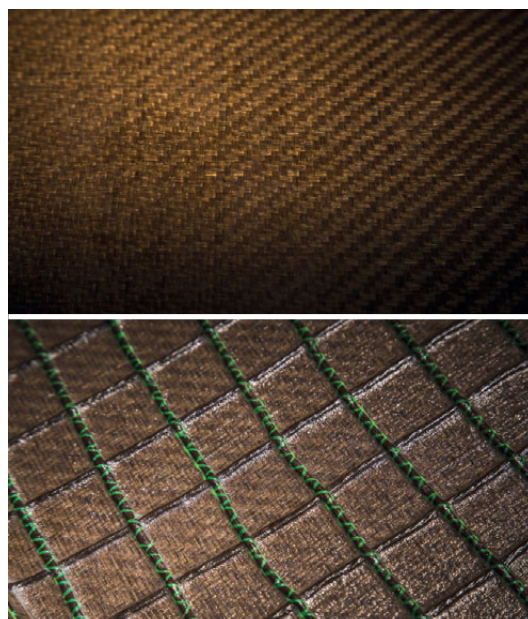
ABOVE The 60-tonne electric servo press can be used more energy-efficiently than a traditional autoclave

across many industries as manufacturers and engineers seek out alternative solutions in response to government legislation and increasing global pressure – motorsports, high-performance automotive and Electrical Vehicle applications are no exception," he adds. "We have developed some unique bio-composites solutions through in-depth experimentation with bio-resins to provide exceptional performance for component applications.

"The Retrac Future range demonstrates to customers what is possible and how we can best meet their requirements as we move towards a mass-market adoption of sustainable composite materials and their lightweighting potential."

For motorsport to grasp its opportunity to be an indispensable part in the drive for sustainability, and to co-exist with the automotive industry's own adoption of new low-energy solutions, it may well rely on the small innovators as well as the large regulators. 

RIGHT A detailed look at Bcomp's flax fibre (above) and award-winning powerRibs natural fibre reinforcement system (below), which is used in conjunction with Evopreg ampliTex



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No time, no money, no staff – and a best result of tenth place. Find out why **Sergio Rinland** rates this car as one of his most accomplished F1 designs

THE 2021 Belgian Grand Prix at Spa was Formula 1's shortest ever race. With the results declared after just one lap behind the Safety Car, it will go down in history for most people as a 'non-event'. But not for me.

This was the 100th Belgian GP and for the occasion the organisers sourced several classic items of F1 machinery, as well as some of their glorious in-period drivers. One of those cars was the 1992 Fondmetal GR02, together with the man who drove that car for the last time at Monza 1992, local hero Eric van de Poele. He was kind enough to invite me to the event to be reunited, 29 years on, with the car that I had designed.

Even though the Fondmetal GR02 was not a successful car by F1 standards, for me it was one of my most accomplished designs.

At the end of 1991, the Brabham-Yamaha team had been disbanded. Yamaha kept the Chessington Brabham facilities, putting Herbie Blash in charge of

BELOW Sergio Rinland and Eric van de Poele reunited at Spa

the newly-formed company, Activa Technologies. The Brabham team, owned by the Middlebridge Group, moved to Milton Keynes. John Macdonald presided over the last few months of the Brabham-Yamaha concern. They kept some of the Brabham employees to produce an updated version of the BT60 with a Judd V10 engine, in place of the Yamaha V12, which ended up behind the Jordan for the 1992 season.

I did not move to Milton Keynes, but decided instead to set up my own consultancy company, Astauto Ltd, in Tolworth, just round the corner from the old Brabham factory. Come December 1991, Macdonald – with whom I had stayed friends since he gave me my first F1 opportunity at RAM in 1983 – put me in touch with Gabriele Rumi, the Italian industrialist who owned the Fondmetal F1 team. Rumi was looking for someone to design and build his 1992 car after falling out with Fomet, Robin Herd's design company in Bicester.

December 1991 was very late in the day to be starting an F1 project for 1992!

Too difficult? No such thing!

But that, for a young and ambitious designer, was not an insurmountable challenge. In two weeks (with Christmas in between!) I gathered together most of my old Brabham design team: the genial aerodynamicist Hans Fouche, Martin O'Connor, Chris Arnold and Chris Radage, plus my PA, Debbie Sidwell, and the purchasing and production managers, Chris Leslie and Tim Cox. We also engaged one of the model makers, Chas Phillips, some of the fabricators and mechanics, Tommy Ross, Dean Legg and Andy Routledge, and also one of the Brabham van drivers, Pete Rollins, to do the runs between all the suppliers spread across the UK.

At a distance – remember there were no e-mails in those days! – we also had the participation of the young aerodynamicist Mariano Alperin, who at the ▶



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time was employed by Fondmetal.

That was the entire team. A bit of a contrast to the 400+ design outfits we are used to in Formula 1 today!

Within those two weeks, with the help of Tim Cox and Chris Leslie, we found an office in Tolworth, bought the necessary furniture, drawing boards, computers and four CATIA stations. By January 1st, we were up and running.

Rumi did a deal with Cosworth for the leasing of the Ford HB engines used by Jordan in 1991, so for the first two weeks of January we concentrated on updating the Fomet chassis to use the HB engine to start the season. Once that was done, we went headfirst into the design and build of the Fondmetal GR02. By the middle of May, only four months later (!), we were testing the first car at Fiorano, courtesy of Ferrari. Its first race was at the Canadian GP on June 14.

“December 1991 was very late in the day to be starting an F1 project for 1992!”

In those four months we worked, as a union leader in Argentina once famously put it, “24 hours a day and the night as well”, seven days a week. We produced two wind tunnel models to test at the old Brabham wind tunnels, now owned by Yamaha. That was a huge benefit, since together with Hans Fouché we had developed the Brabham BT60 there and started the research of what would have been the BT61, before the team went north. Hence, we hit the ground running: we knew what we wanted to do on the aerodynamic front.

Mechanically, we decided to keep the car simpler



than the BT60. We discarded the monoshock idea, considering that for a small team such as Fondmetal, the simpler, the better. The gearbox was also simpler than on the Brabham: a normal two-shaft transverse with Xtrac internals, which we shared with Team Lotus.

The chassis and bodywork followed the same philosophy that we had utilised at Brabham for the BT60 – monocoque in one piece, with separate roll hoops and lid/floor to close it. The seat was one structure together with the tank bulkhead and joined at the dash bulkhead: compact, light and stiff.

A first for F1


Apart from designing and building the car in only four months – all done by outsourcing every component, sent in boxes to Italy and assembled at the Fondmetal premises in Bergamo – what still

today gives me a sense of pride is the aerodynamics design of that car. The front wing was in 3D with very curvy endplates and a good airflow treatment around the front wheels. It also featured side channels to create side vortices to help the underfloor flow. A first in F1, it has become normal practice today, even in sports cars! The radiators were tricky. They had a step to allow for those side channels, which ran the risk of cracking, but they did not.

The Ford Cosworth HB was one of the best engines I had the good fortune to design a car around. Once we were given the data and drawings, we no longer wondered why the Jordan had been such a good car in 1991!

As it transpired, the Fondmetal team did not have the financial resources promised, so we only did seven races with the GR02, Monza being the last. Hampered by a limited amount of spares, we had only one test prior to the British GP.

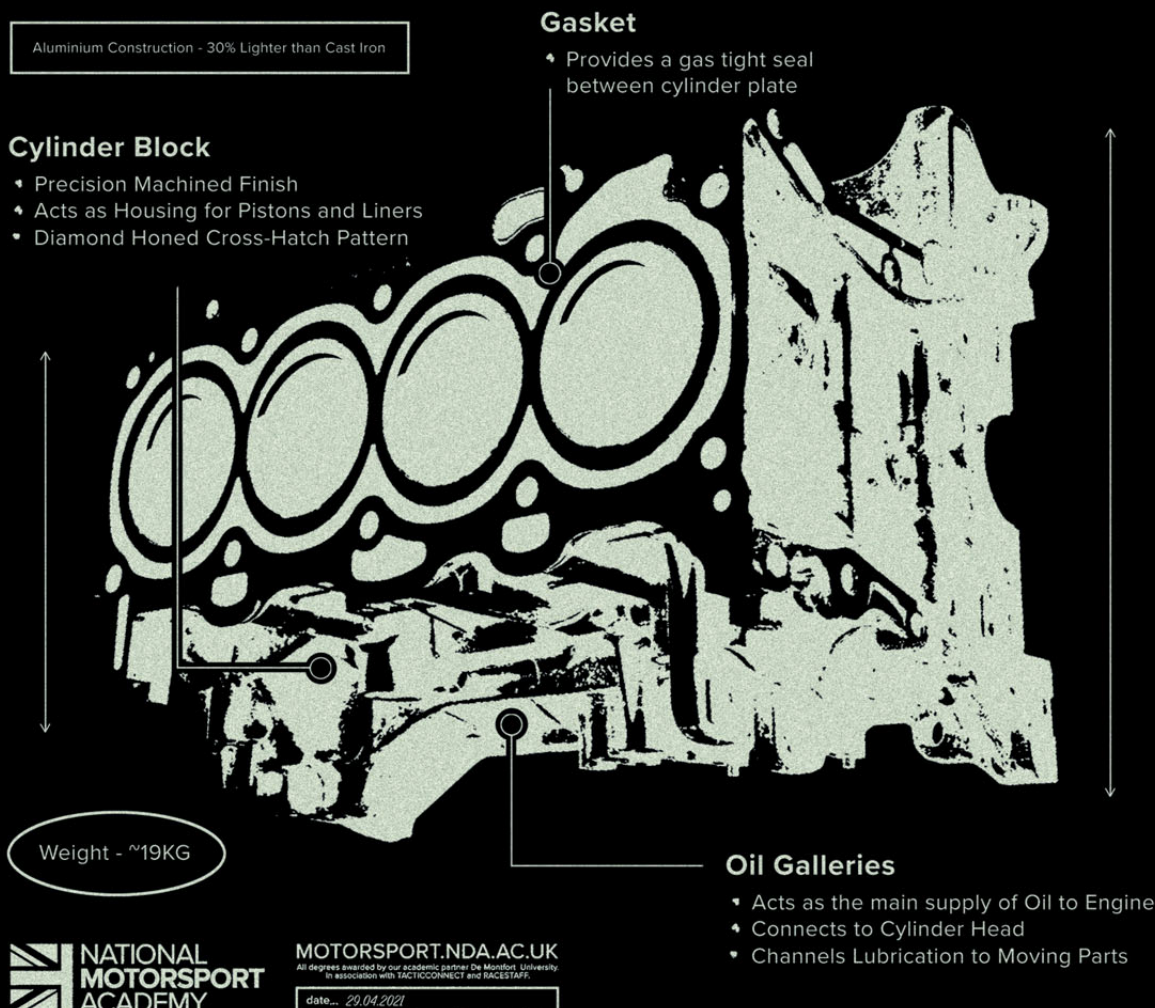
In my memory, however, I treasure two of the best compliments any designer could have. The first was from the drivers, Gabriele Tarquini and Eric van de Poele, who still today tell me that the GR02 was one of the best racing cars they ever drove.

The other was paid by a certain Patrick Head on the Belgian GP grid in 1992. He wandered down to where our car lined up and told me, “This is the only car on the grid I can learn something from.” That year Williams won 10 of the 16 races, scooping the Constructors’ and Drivers’ World Championship titles with Nigel Mansell. *That* was a compliment! I need no more. 

ABOVE Fully restored to its former glory, the Fondmetal GR02 takes to the track again at Spa, the scene of its best result



LEFT The aero design set the template for future F1 cars



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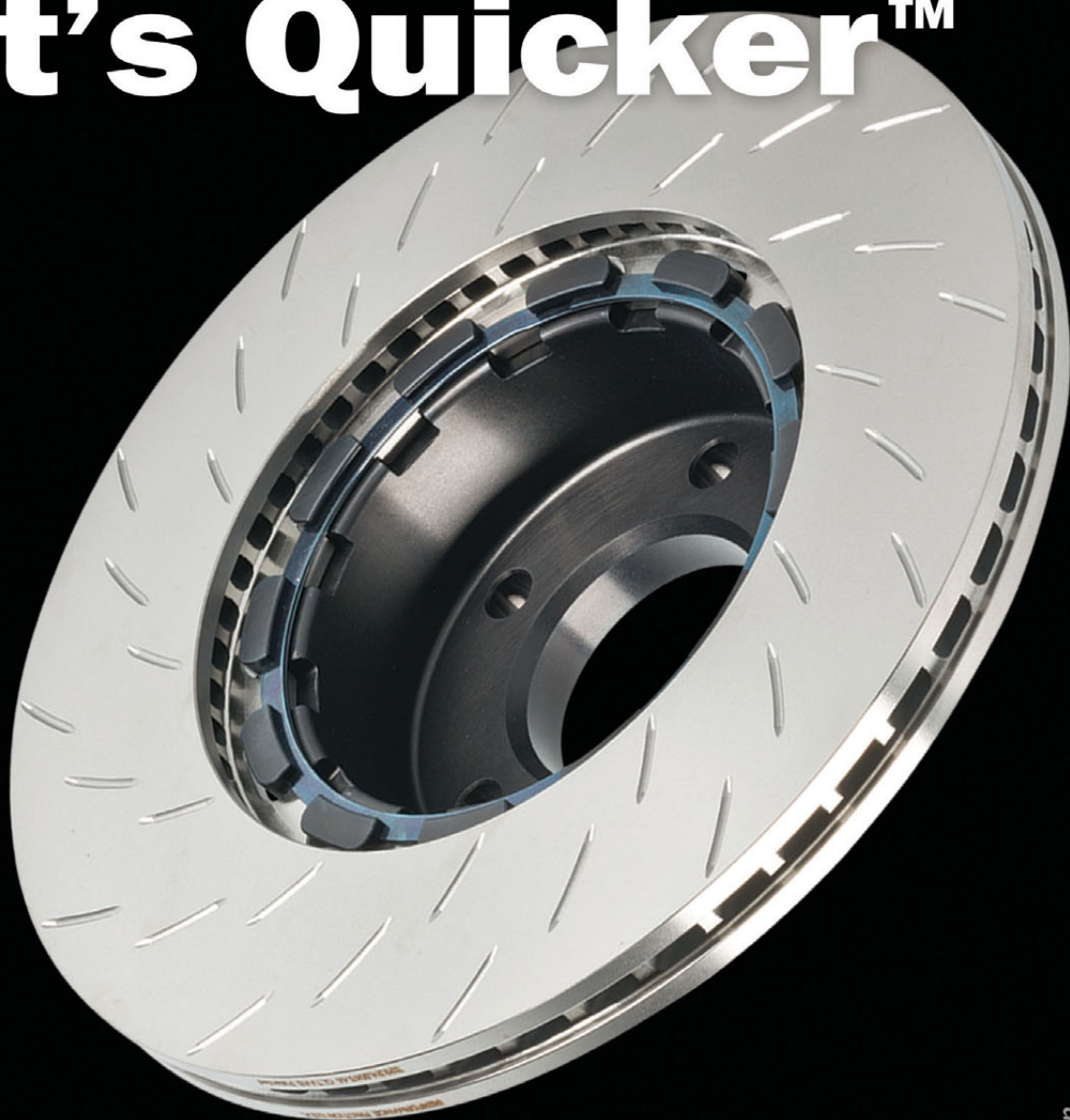
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