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Summer 2015 Issue 5 UK £6.99 USA $12.00 www.racetechmag.com

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Volume 2 Issue 5
Published July 2015
The next issue will be published in October 2015
ISSN 2055-5938

SUBSCRIPTIONS
Subscriptions from Racecar Graphic Ltd
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Fax +44 (0)20 8446 2191

Historic Racing Technology is published quarterly by Racecar Graphic Ltd.

Cover images: Jeff Bloxham

Design & Production:
Maluma Design Associates

Printed by Warners Midlands plc

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A new face but with some history

A new face but hopefully not a new name to some of you who also read *Race Tech* magazine as I have taken on the editorship of this magazine from Chris Pickering who has so successfully created what has become an important addition to many people's reading habits. I might have been the so-called editor-in-chief but I would be making false claims if I said that I played even a bit-part role in what he has achieved in the four issues since launching the magazine last summer. He has set the bar very high indeed. I am pleased to say, though, that while he has left us to go freelance he will still be gracing these pages with his well crafted articles.

Anyway, enough about us and down to business!

Historic racing....how things have changed since I used to race in VSCC events back in the late '60s and early '70s. Back then it was a question of getting your provisional licence, sticking a black cross on a yellow patch, buy the required helmet and off you go. Goggles were a handy piece of kit but fireproof overalls, gloves and everything else required to go racing nowadays was simply not on the menu. For me it was a tee-shirt, jeans and no shoes in the idiotic and stupid belief that it gave me more "feel" for a car. Hmmm!

However, I am not for one minute saying that those days were better. I'm a great believer in looking forward. I was lucky enough to spend four years at *Motor Sport* magazine when Jenks was still writing the Formula 1 race reports and I remember him telling me to only look forward, think of the future and only regard history as providing some sort of signpost and learn from it both the things that have gone right and have gone wrong. This is advice I have taken to heart.

Another piece of advice I had even earlier in my career was when working for my uncle Lawrie Dalton, the renowned Rolls-Royce author and expert, at his publishing company Dalton Watson, which was never throw away a photograph. He would tell me that a black and white picture of a car as it left the factory or coachbuilder was far more valuable than a more modern colour one. The reason behind this is that the original would be just that whereas with a modern one you just couldn't tell what had been changed over the years, especially when it comes down to the detail. What has struck me when writing the articles in this issue on the March-BMW 782 and the Blue Bird Sunbeam was just how true this is to this day where the restorers in both cases would scour period publications and documents looking for original pictures. So even in this digital age when we all take pictures by the score, that advice still stands good to me.

In the 10 years I have been editing *Race Tech*, I have been lucky enough to meet a good many people in that particular branch of motorsport who have become good friends over time and this is something I hope and expect to achieve now that I am back in the historic car world. I am looking forward to hearing from you any interesting stories you may have and also meeting you. What I have quickly realised is that the historic racing scene is alive and buzzing and it feels especially good to be part of it again. HRT

William Kimberley
Editor

NEWS

Lottery funding boosts Silverstone Heritage Live

William Kimberley

SILVERSTONE circuit is at the starting point of creating the Silverstone Heritage Live, not a museum full of old cars looking back at the past, but a cultural attraction that it is hoped will attract more than 400,000 visitors a year, not all of whom will be motorsport fans.

Having won backing from the Heritage Lottery Development Funding to the tune of £9.1m, the task facing the British Racing Drivers Club is to match that funding by mid 2016 to ensure the project comes to life. A former World War 2 airplane hangar, a landmark at the circuit, will be the home for the new centre that will bring Silverstone's history to life and feature the BRDC Archive, a heritage trail and live interactive experiences within a Heritage 'hub' located at the entrance to the circuit. It will house the BRDC's extensive and unique archive collection; recording oral histories from former competitors such as Sir Jackie Stewart, Sir Stirling Moss and Lady Christabel Watson. There will also be a series of displays following the outline of the circuit that will use the latest technology to explain the history of British motor racing and the part that Silverstone and the BRDC have played.

At the time of the funding announcement in May, 2013, Sir Jackie Stewart said: "I am very pleased to hear that such an important initiative is underway. Silverstone holds a unique place in the history of motorsport; having hosted the first ever World Championship Grand Prix in 1950. Silverstone holds special memories for me as I am proud to have won the British Grand Prix in 1969 and 1971. This grant from the Heritage Lottery Fund is hugely important as a first step in helping the British Racing Drivers' Club and Silverstone to ensure

ABOVE & BELOW Early design plans for the Silverstone Heritage Live

ABOVE Where it all began, the very first FIA World Championship F1 race that took place at Silverstone in 1950

ABOVE Silverstone holds special memories for Jackie Stewart who will be actively supporting Silverstone Heritage Live

that the heritage of the site and that of British motorsport can reach a far wider audience than before and cements its importance for future generations."

While it is located within the circuit, though, it is not all about motorsport, but will reflect some of the area's history. For example, the Abbey and Luffield corners were named after the Benedictine Luffield Priory, the date of its foundation dating back to 1133 with gifts of land for the support of the monastery being confirmed by King Henry I. However, it had a chequered history, Archbishop Peckham finding the conduct of the prior, William de Esteneston, on a visit to the priory in 1280 so bad that he absolved him from office. The priory then got closed down by King Henry V1 in 1493. Telling stories like this will be part of the Heritage's mission.

At the other end of the scale, it will also highlight some of the activities that have taken place at the circuit, including motor racing history quietly being made in 2013. On the same day that 17 million people in Britain were tuning in to watch Andy Murray break the country's 77 year wait for a men's champion at Wimbledon in 2013, an electric single-seater car was competing in the incredibly popular Formula Student event for university teams, and by winning it became the first one to beat a petrol-powered car in any accredited motorsport competition anywhere.

As the Heritage Project Director, Sally Reynolds is responsible for bringing it all together and to organise the necessary fundraising having worked on it for a number of years before it was publicly announced during the British Grand Prix at Silverstone.

"It's going to be much more than just another museum and will reflect local history going back centuries to Saxon times," says Reynolds, "but then coming up to more modern times, it was where more than 4,000 aircrew were trained in the Second World War. So aside from its motor racing heritage, it has a very significant history. Then moving into modern times, it hosted the very first FIA World Championship Formula One race in 1950.

"Our two ambitions are for it to be a celebration of Silverstone and the UK's role in world motorsport and also wanting the technical heritage to enthuse future engineers. This means that we will not just be talking about the great moments and the history of some of the cars but also about technological developments and all the innovations that have come out of motor racing and gone into mainstream engineering.

"Another thing we want to do is tell the story of everyone involved whether they be the marshalls, the medics, the fire officers and so on, so what it won't be is a car museum. It will have cars but its emphasis will be on telling the story of British motor racing."

The emphasis now turns to fundraising through corporate, charitable and individual donations and sponsorship to ensure the targeted £18.2m is reached by this time next year. HRT

ABOVE Lady Christabel Watson (centre) will provide a recorded account of her memories of Silverstone

ABOVE With 40 cars entered at the time of going to press, the FIA Masters Formula One race at Silverstone Classic could be the world's largest Formula 1 race

World-beating F1 entry for Silverstone Classic

WITH the Silverstone Classic, which is celebrating its quarter centenary this year, being a highlight of the year for many historic racers, the FIA Masters Historic Formula One Championship is gearing up for one of the biggest races to date with an unprecedented 40 cars confirmed for the two spectacular showdowns on Saturday and Sunday afternoons in what could prove to be the world's biggest Formula 1 race. Furthermore, as part of the event's Silver Jubilee celebrations, and for one year only, both stand-out races have been symbolically extended to 25 minutes.

The line-up includes no fewer than eight Williams from the early '80s, six Tyrrells, four Marches, trios of Lotuses and Shadows plus pairs of Brabhams, Ensigns, Fittipaldis and Hesketh. Other renowned constructors on the grid include McLaren, Surtees, Penske as well as a 1981 Ligier JS/17 with its wonderful V12 Matra engine.

"The Silverstone Classic is always a highlight of the Masters Historic Racing calendar, and the strength of the entries through all the races we are managing demonstrates how popular the event is with our drivers," said Masters Historic Racing event manager Rachel Bailey. "We hope to be presenting our biggest-ever grid in the FIA Masters Historic Formula One Championship, with an unprecedented entry of over 40 cars, a line-up with which we are absolutely delighted and one which should provide many memorable sights and sounds!"

Established in 2004 by Ron Maydon with its FIA accredited Masters Historic Formula One Series that caters for 3.0-litre engined Formula One cars from 1966 through to 1985, Masters is now the leading organiser and promoter of historic motor racing. Based in the UK and North America with a dedicated team, Masters aims to provide customers with great racing at superb circuits with a wonderful atmosphere. Other series promoted by it include the Gentlemen Drivers mini-endurance races for pre-1966 GT cars, Masters 70s Celebration, Masters pre-66 Touring Cars and Masters USA and the FIA accredited Masters Historic Sports Cars.

Key to its ethos is to provide as much track time as possible for drivers and so most categories will race twice or have a longer pit stop race. With a weekend full of action, Masters competitors can race many different cars across the timetable and then enjoy the excellent hospitality and camaraderie off-track.

With action in the UK, Spain, Italy, Germany, Belgium, Holland and France, plus five North American events, it visits some superb circuits.

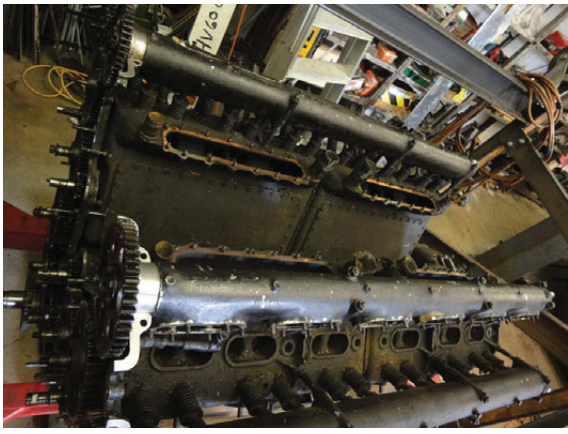
"We are competing with sports like polo and yachting when it comes to attracting the type of person who joins our series," said Bailey. "It means that while they like racing their cars, it's also a lifestyle event for them and their family, and as a consequence, some circuits like Monza, which is close to those lovely shops in Milan, are more popular than others. That's not to say that the racing isn't taken seriously, because it is, but it's just one element in what we provide."

Another element that the Masters organisation sets out to provide is networking opportunities, the hospitality unit that all the drivers and their family and friends have access to being key to this. "We want our members to be as comfortable as possible when racing and at the circuit, which is why we go to great lengths to ensure that we provide a level of service that meets their expectations. So even if the weather is inhospitable, they know that they have somewhere dry and warm to go to with plenty of good food and drink." HRT

NEWS

1,000 hp engines set for restoration

William Kimberley



ABOVE After a year of gently easing it up, the 22.5 litre V12 Matabele engine that powered Segrave's land speed record Sunbeam is ready to be stripped down and rebuilt

HAVING finally restored the Blue Bird Sunbeam, attention at the National Motor Museum in Beaulieu is now being directed at the two 22.5 litre V12 Matabele aero engines that powered Henry Segrave to a speed in excess of 200 mph, the first person to do so.

The concept for the car came from Louis Coatalen, Sunbeam's chief engineer, with detailed design work by Captain Jack Irving. Power was from two 22.5 Litre V12 Matabele aero engines, previously used in a powerboat, each delivering 435 bhp. These were positioned in line, with the driver's cockpit in between. Transmission was via a three-speed gearbox, driveshaft and chains. Actual power output was around 900 hp but the 1,000 hp title probably appealed to Sunbeam's directors.

"The idea is to get one engine running as well, ideally both, but one would be better than none," said Ian "Stan" Stanfield, senior engineer at the National Motor Museum. "However, one handicap is that we are doing so with the same amount of budget we had when doing the Blue Bird Sunbeam, ie almost nothing.

"The biggest problem with this engine and why I took it apart in the first place is that it's been sat still for too long and has corroded from the inside and has seized up. We've been nibbling at this for around a year, dosing it in oils and gently tapping things to make it move but before taking it all apart, which was the easy bit."

After inspecting it, the next stage is to change those parts, such as the bearings, that need renewing. The state of the pistons will not be known until the blocks are removed. "It depends how corroded it is in there," said Stanfield. "The only possible major expense is the liners and pistons. The bearings are readily available, the magnetos will need rebuilding and the carburettors will need stripping and cleaning but they aren't huge jobs." HRT

See TLC brings Hero back to life on page 40

BRM Preservation Appeal reaches target

ABOVE The iconic 1950 BRM V16 1.5 litre Type 15 Grand Prix car is now undergoing vital restoration work following the success in reaching the target funding figure of £50,000

THE National Motor Museum Trust's BRM Preservation Appeal, set up to fund vital restoration work on the iconic 1950 BRM V16 1.5 litre Type 15 Grand Prix car, of which only five examples were built, has successfully achieved its target of £50,000.

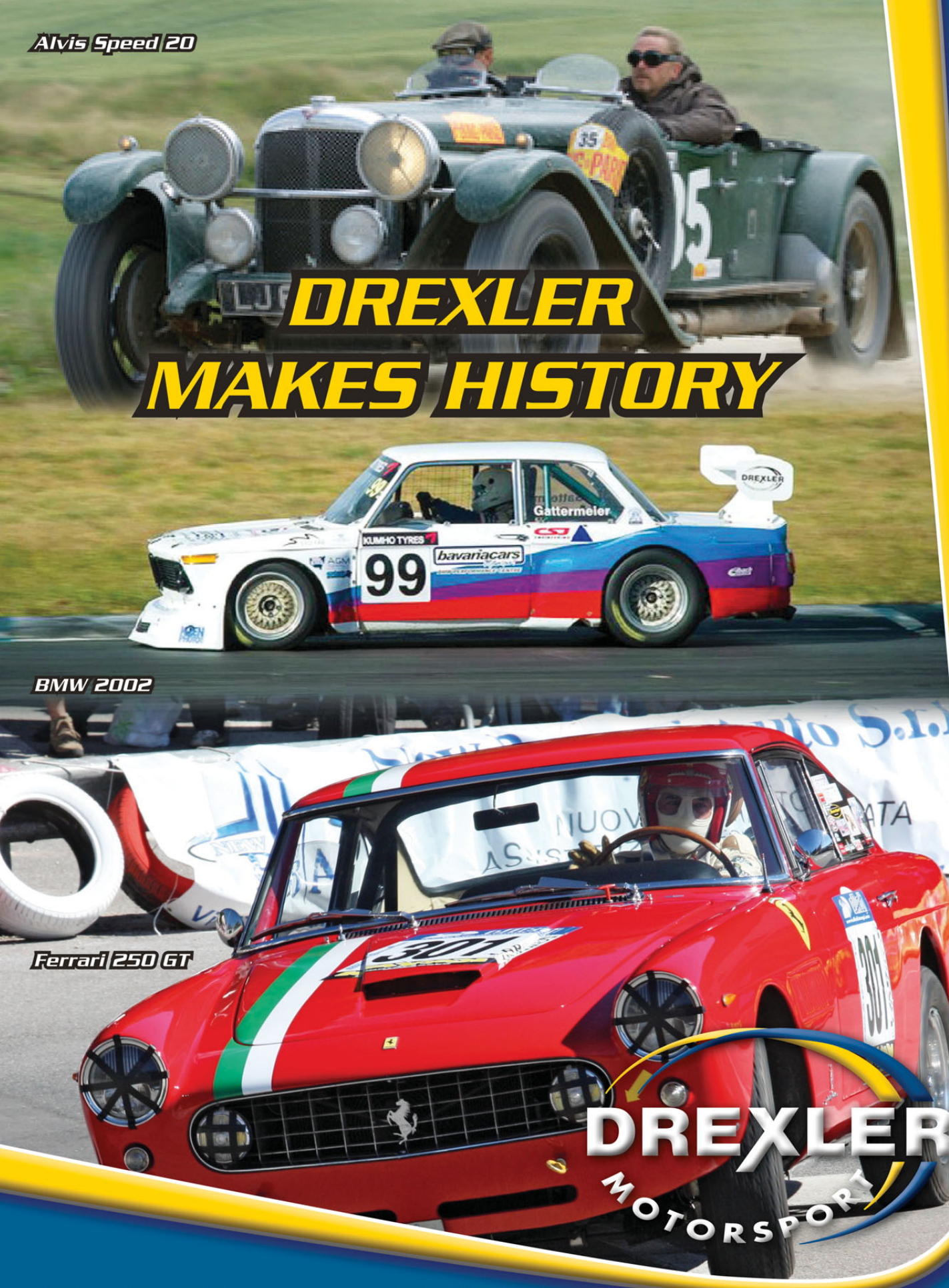
The Trust's ambition to set in motion the raising of funds for long needed work to the 1950 racing car received a boost when it was nominated as the 2014 Goodwood Revival Beneficiary Charity. The assistance of the Goodwood Revival, generous donations and fundraising activities have now brought the total of the BRM Preservation Appeal to just over £50,000. Due to its complex design, though, more may be needed, depending upon what is uncovered when work begins.

The BRM, which was built with racing chassis number one, was famously driven by racing aces Reg Parnell and Juan Manuel Fangio. Skilled restoration is required in order to keep it in fully functioning condition, including a rebuild of its supercharged 1.5-litre V16 engine.

"Thanks to the amazing achievement of raising the funds for the work to commence on the rebuild of this iconic motor car, we have been able to send the car to the BRM specialist, Hall & Hall," said Doug Hill, the National Motor Museum's manager and chief engineer. "On initial strip down of the engine we are very pleased with the good state we have found the major components to be in. We managed to identify a loose bearing carrier in the slave/output shaft. A significant amount of corrosion was discovered in the water system, but nothing serious.

"While carrying out the stripdown, we found evidence to confirm that this is the original engine, making it the first ever V16 BRM engine – racing chassis number one. Prior to the strip out we had identified an issue with the exhaust valve seals and this has now been rectified.

"So work is well underway. We hope to have the car running at the Goodwood Revival meeting in September. We will then look to see what funds remain to undertake work on the suspension and brakes." HRT



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NEWS

Springing into action

IN the face of badly made, incorrect alternatives, British Motor Heritage (BMH) is optimising its five year partnership with GB Springs to guarantee the supply of quality, original specification leaf springs for British classics of the MGB/Midget era.

"It is clear that the classic spares industry is beset with poorly produced replacement parts, many of which are safety critical items," said John Yea, the company's managing director. "The manufacture of leaf springs has recently suffered from overseas suppliers simply being asked to replicate original British items. The resultant products may fit, but that is where their suitability for purpose frequently ends. The examples we have tested had completely different spring rates, hardly surprising when leaves of equal thickness had been used in place of ones that were deliberately of varying dimension, and distorted alarmingly when subjected to load on a test rig.

"GB Springs has the technical expertise to specify our springs correctly and ensure the production items fully adhere to that specification. Our joint commitment to supporting the market has even led to us having imperial spring steel rolled in the UK, shipped abroad for the manufacture of springs, and the finished products then returned to the UK. This was necessary for the MG TC, TD and TF, for which no equivalent metric spring steel is available. This has required a significant commitment in terms of both expertise and working capital."

Most British classic cars of the '60s and '70s rely upon the tried and tested leaf spring for their rear suspension. Its success in period resulted from its relatively low cost and simple adjustability to differing vehicle configurations. For example, the MGB has different specifications for the Roadster and GT and for both chrome and rubber bumper variants. They were derived by the models' original engineers and then validated through extensive testing in all conditions.

The increasing weight and sophistication of modern cars has meant the once thriving domestic leaf spring manufacturing base is long gone. A further complication is the move to metric sizing for volume production, which has given rise to the considerable engineering challenge of matching modern materials and dimensions with period springs specified in imperial ones.

"From here on we will use the British Motor Heritage label on all our springs," said Yea. "This is the customer assurance that the product is as close to the original manufacturer's specification as possible, and that the quality of the spring has been validated and therefore justifiably carries the original part number. Without this sign of authenticity, it is really a case of buyer beware." HRT

Drexler makes history

ABOVE The bespoke limited slip differential now available from Drexler Motorsport

BAVARIAN company Drexler Motorsport has produced a bespoke limited slip differential for historic cars. Well known in both modern and classic racing circles for its innovative drivetrain technology, particularly limited slip differentials that have seen success in very many areas of motorsport around the world, it has responded to the concerns of some historic racers that off-the-shelf items are not up to the job.

"In most cases, ready-made limited slip differentials do not properly fit historic cars," said company founder Herbert Drexler. "Further assembly of the differential in these cars is a bit tricky because of their special characteristics and can only be undertaken with the required deal of sensitivity.

"However, we do not want to forget where we originally came from which is why Drexler Motorsport is offering a selected range of limited slip differentials for historic racing. We also want to provide the proven technology of the Drexler limited slip differentials to these customers as well."

Besides the superior quality of all Drexler limited slip differentials, they are relatively small and light with a fast lock-up response time. It has recently developed an adjustable limited slip differential which features an adaptation mechanism for pre-load adjustment. With the help of a long socket wrench the pre-load of the differential can be easily and quickly adjusted over a wide range to allow for more precise vehicle setup. HRT

Keeping to the party line

Mark Hales nears the limits of the racetrack and his patience

IT'S so very easy to turn a column like this into a quarterly rant. An opportunity to cloak the author's most recent grievance under the guise of discussion, easier still because unlike anything on the internet or social media, any response will be a long time coming. On the other hand, it remains the job of the press and its commentators to inform the wider world of matters which they might otherwise overlook. Balance then, is what's needed, so here goes...

I'm happy to say I've done more motor racing than I expected this year and that has ensured that I've encountered a recent piece of MSA rulemaking which warrants more scrutiny, namely the revised definition of track limits. The problem which confronts any racer is that using a different part of the track will make for a different circuit. It stands to reason that flattening the radius of a corner by making a wider entry – or exit – or moving the apex further in by driving over rather than past it, will make the bend less sharp and allow you to go faster. Why wouldn't you?

Circuit owners and operators have spent lots of effort trying to maintain the shape of some corners – but not all of them – by devising ever fiercer deterrents, like the Vallelunga saw-tooth kerb in its various dimensions, and more recently the FIA sausage that the Formula 1 cars treat with disdain, but which can flip over an errant Caterham.

Engineers of modern cars have meanwhile spent time and sponsors' money ensuring that their cars can ignore the larger of these deterrents without penalty. However, even if part of that is simply logical use of modern material technology and computer science, it wasn't anything which preoccupied the designers of cars which are now historic – not least because the deterrents weren't there. Now they are and if your old motor will ride the kerbs without launching one end or the other, or more likely breaking the transmission, it too will be quicker round the lap.

The ability of modern cars to ignore those definitions has certainly brought more of an official focus to the regulation, but as far as I was concerned, it was already absolutely clear – as long as some part of the car remained in contact with the track, then you were not liable to a penalty. The track was defined by a white painted line and anyone who has driven at Spa – or most of the European tracks – will picture the image of a Renault Clio in three positions relative to it: "OK"; "OK"; and "NOT OK".

You could in theory have half of one front tyre on the white line while the other three and a half were occupied with a glorious drift. The crucial point, though, was that it effectively gave you the width of the car to make a slight error, which being human, we will all be likely to do. However, this year the MSA has tightened the regulation and the track limit is defined by either the white line, or the edge of the kerb, neither of which can be breached. If a wheel strays over either, you will be automatically liable for a penalty.

That seems clear enough – and indeed would be if it was always the case. At a recent Donington briefing, the clerk of the course was obliged to tell us that the FIA championship races would be run to the "old" set of rules, whereas those under MSA jurisdiction would run to the new ones.

As a guest driver, I had to go and check which applied to my race. However, there were many there who would use the same car on the same circuit for two different races, but to two different sets of rules. That may be clear too, but it makes no sense whatsoever. From a purely personal point of view, it meant the mid-corner oversteer I encountered at Redgate probably had as much to do with a recent habit, which is attempting to stay right of the kerb, than any need to change the front springs. Balance of opinion? Depends on the time of day... HRT

ABOVE Whether the white line or the edge of the kerb defines the track limits, consistency is needed

NOT FADE AWAY

The 1978 Formula 2 March prompted a revival in fortunes for the embattled racing car constructor, the BMW-powered example proving to be the class of the field. **William Kimberley** looks at one that has just been restored for the BMW Museum in Munich

IT was not meant to be. As Mike Lawrence puts it in his superb book *March – the Rise and Fall of a Motor Racing Legend* first published in 1989, March was fading away in 1977. In Formula 3 it was coming under pressure from Chevron and Ralt and new constructor Argo while in Formula 2 there were only eight customer cars compared to the 19 the the year before; while Gilles Villeneuve and Bobby Rahal were mopping up Formula Atlantic in North America in their Marches, most of the company's attentions were focused on its Formula 1 activities.

So the prospects for 1978 did not look that great although there was a glimmer of hope when Italian driver Bruno Giacomelli won the final F2 race at Donington Park late in 1977, driving the 1978 prototype works chassis which featured substantial changes from the previous models. The monocoque was completely new, claimed to be far stronger, safer and easier to build, while the car's entire weight distribution had been revised, the driver sitting further forward and the water radiator moved back to the front after four years of hanging onto the side. The whole package was clothed in a wide, all-enveloping body. By this time the 4-cylinder BMW M12 had almost become obsolete, so designer Paul Rosche had worked on modifying its camshaft configuration in order to extract more power.

As it turned out, 1978 was an extraordinary year for the March-BMW partnership that was celebrating its sixth straight year. In a formula that was admired for its close and competitive

All photos: Michael Donne Photography

Jeff Bloxham

ABOVE The car that revived March has now itself been given a new lease of life, speeding up the Goodwood hill

“An extraordinary year for the March-BMW partnership”

racing, the March-BMW 782 was the most successful chassis in Formula 2 that year. Two thousand miles of pre-race testing had put Giacomelli streets ahead of the opposition by the time of the first race at the Easter Thruxton meeting so that it simply became a case of just how many races it would take him to win the title. In the event, he won eight races from 10 finishes, took eight pole positions and six fastest laps. He always qualified in the first four throughout the year and only retired once through a mechanical failure, at Nürburgring while leading. It was BMW’s fourth championship win in six seasons.

It is no wonder that this is a part of BMW’s motorsport history that it wants to celebrate. The March-BMW 782 that sped up the Goodwood hillclimb during the recent Festival of Speed had just undergone an extensive restoration by specialists Cars International for the Munich manufacturer, the car going straight to its museum after the event.

It was a mammoth project to undertake because as Cars International director Tim Preston puts it, neither he nor any of his colleagues in the business, including partner Paul Osborn, had been involved in restoring a March of any kind before. However, they had been entrusted with the project through Preston’s contacts. He had started his motorsport career in the design office at Williams Grand Prix Engineering, as it then was, in 1989 until the end of ’97, joining Sauber F1 for a couple of years as head of track engineering, before returning to Williams for the 2000 season where he headed up test and development, remaining there until 2004. Taking a year out, he began to work with Paul Osborn, who owned Cars International, and together they formed Cars International Service Ltd a year later. He continues to be involved in current ▶

> **“As we dug into it and looked at period photographs, while also getting a bit of history from BMW, it was clear that there were many things wrong with it”**

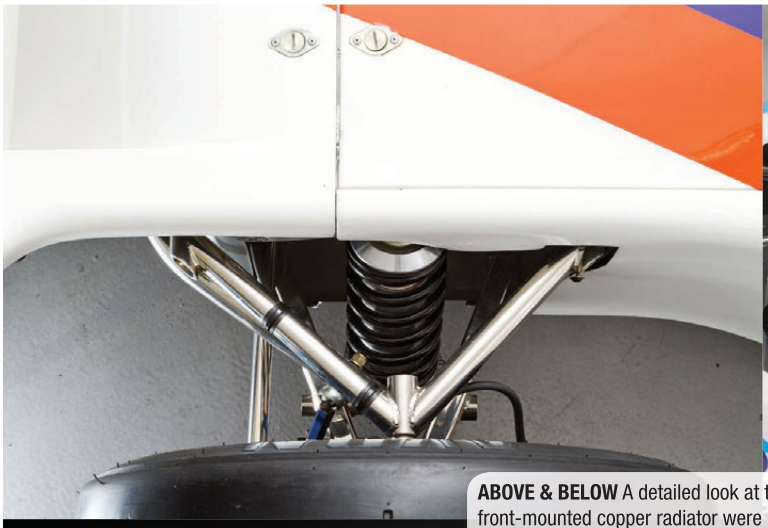
high level motorsport, having a senior performance engineering role in the Mercedes DTM programme, but it was former BMW colleagues that led to the initial contact.

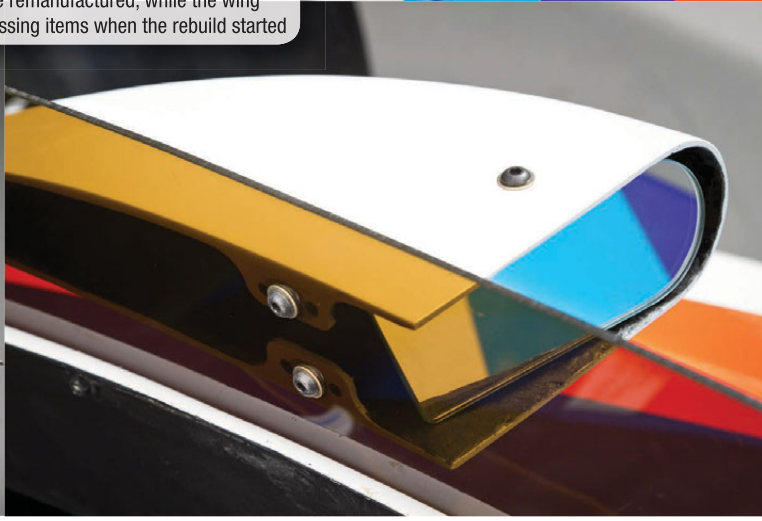
A NEW CHALLENGE

“We are experienced in rebuilding a variety of Formula 1 cars, including the Manor F1 demonstration car, the Williams F1 Heritage collection, and many different types of GTs, but the March-BMW 782 is the first period formula car that the company has done,” says Preston. “We went to great lengths to make it as authentic as possible, although to be honest it’s probably better than it ever was when leaving March. We very much take the approach with all our cars that if our customer wants to go racing, go and buy something cheap with ready supplies, but treat what we do like a Swiss watch.”

The car had not always belonged to the museum but BMW had decided that it needed an example and so had bought a rolling chassis that was in private hands. “We are no March experts by any means but as we dug into it and looked at period photographs while also getting a bit of history from BMW, it was clear that there were many things wrong with it,” he says. “While the chassis and bodywork themselves were basically fine – BMW had painted it but taken care not to have it look absolutely flawless and brand new and had applied a few star cracks – things like the oil tank, the cooling system and the electrical installation were totally incorrect.”

Through Andy Gilberg, who owns Marchives (see sidebar) and bought the engineering assets of March in the late ‘90s, many of the original drawings were relatively easily acquired, which helped considerably. “This turned out to be pretty interesting because back in the day, although it was a customer car with a Hart engine option also, true to form many of the original drawings weren’t necessarily updated so we had this myriad of drawings we thought were representative,” observes Preston. “It meant we had to trawl through them to identify the different parts and those that we were missing, gradually piecing it together a bit like a jigsaw puzzle. We ▶





ABOVE & BELOW A detailed look at the 782. Mounting frames for the front-mounted copper radiator were remanufactured, while the wing mirrors (below) were among the missing items when the rebuild started

BACK TO THE FUTURE?

Environmentalism in motorsport - a quest for the impossible?

Society may demand 'green' motorsport while industry benefits from the development that takes place, but what about the fans who are voting with their feet and fingers on TV remote controls and being turned off at virtually all levels? So should motorsport go BACK TO THE FUTURE to the time when men were men and cars were cars?

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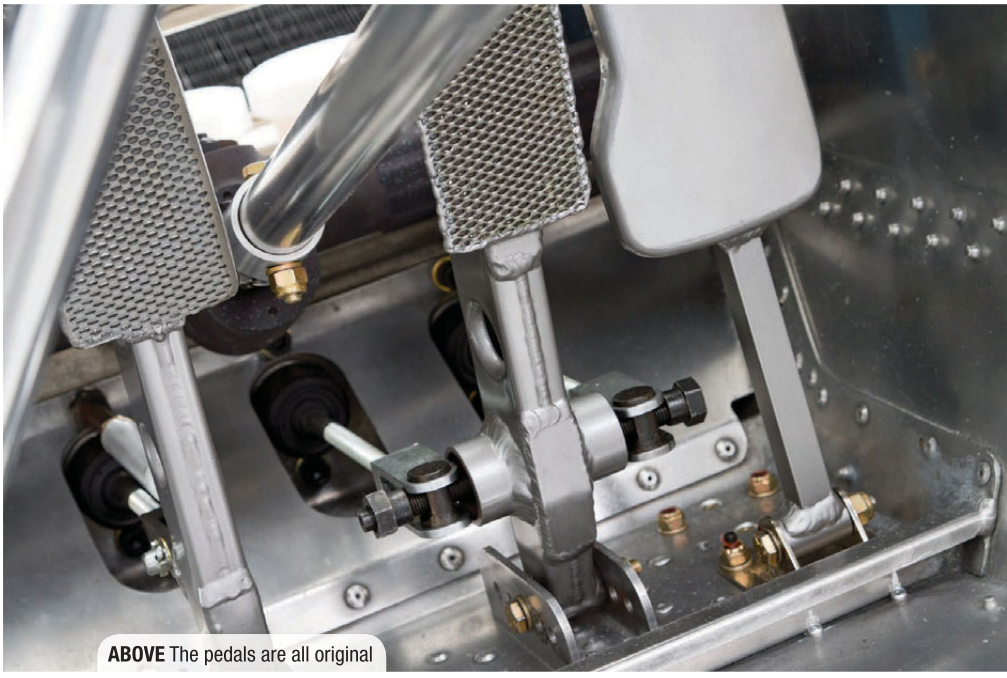
also looked at several 782s in the UK that were owned by various people.

"However, many of those being raced now aren't very original. For example, they feature different rear brake installations and different callipers, but because ours was going to be a museum car, it had to be historically accurate. For example, the driveshafts on the original car were Hardy Spicer's that were used on the Land Rover of the time and now not available, so it meant we had to spend a great deal of time remanufacturing them. The inboard, non-floating discs, the inner and outer universal joints and driveshafts are period correct unlike ▶



ABOVE The pedals are all original

Mesmerised with March

MARCHIVES (www.marchives.com) was established about 15 years ago by Andy Gilberg in the US to assist March owners in restoring and maintaining their cars, to memorialise the March story and pay tribute to the hundreds of talented workers and engineers who passed through its doors.

Gilberg is a mechanical engineer by trade, having graduated in 1970, coincidentally the year of March's formation. "I spent part of that summer between college and graduate school in England, working as a draughtsman in the drawing room of BRM just to see what the top level of the sport was like," he says. "I worked under Tony Southgate and Alec Stokes. Tony was a brilliant designer at the top of his game and was also very generous with his time and advice to me. Alec was the gearbox designer who was also very welcoming to me. I was paid the princely sum of 25 pounds per week.

"I spent my weekends attending races throughout England and, on one occasion, saw Jackie Stewart and Chris Amon drive the March 701s at a non-championship race that took place at Brands Hatch. From that moment on, I was mesmerised with March. It was the vestigial wing-shaped fuel tanks, not to mention the DFVs' beautiful song, that did it.

"While I was at BRM, I was briefly assigned to go to a storage building across town and work on drawing a snowmobile (this is the truth!) as BRM was considering branching out into this area of consumer products. In this building, there were stored a number of older race cars and engines, some of which were uncompleted projects. Among the unfinished cars was a tub on a surface plate that had an unusual upside-down wing profile. I later learned that it would have been the first ground effects F1 car. It was conceived by Peter Wright and Tony Rudd and was never finished because they left (or were sent away from) BRM to be replaced by Tony Southgate.

"I also connected the inverted wing concept on the March 701 and that BRM chassis in my mind and began to wonder if the idea had any merit. Of course, the world found out about a decade later that it did indeed have merit. If only March had added the endplates...

"Throughout my 20s I longed for the finances to afford a Formula Atlantic March but it never happened. Finally, I gave up on racing because it became apparent I would never be able to afford to advance. I quit racing completely for 20 years and played with restoration of Lotus street cars and muscle cars and built my business. Then, I discovered vintage and historic racing.

"Around this time, I met and later hired an ex-March employee, Jeremy Buckingham, to assist me in my engineering business. He also helped me run and maintain my vintage F2 Royale race car. One day, in 1998, I came across an advert in the back of *Racer* magazine for 'March drawing sets'. I showed it to Jeremy and he said one can't sell drawing sets because many March drawings were carried over year-to-year and, except for the 1970 cars, there would be no complete sets.

"To make a very long story short, I called the owner of the drawings and explained this to him. Many months later he was convinced and we made a deal for the entire March drawing collection. These were essentially the drawings for customer cars only that were built at the Murdock Road plant. It consisted of about 33,000 drawings, over 99% drawn by hand.

"These drawings have been a college education in race car design for me and they also represent the absolute pinnacle of hand-drawn industrial art. They have been an inspiration for me, both as an engineer and an over-the-top race fan. Since beginning this fantasy, I have acquired a March Indycar, a March Formula 1 car, a March F5000 car and, nearest and dearest to my heart, the very first March, the 693. At Indianapolis in mid-June, I became perhaps the oldest Indy rookie in the world by driving my 87C on the oval at the SVRA event. I think I would have qualified in 1960 or so..." HRT

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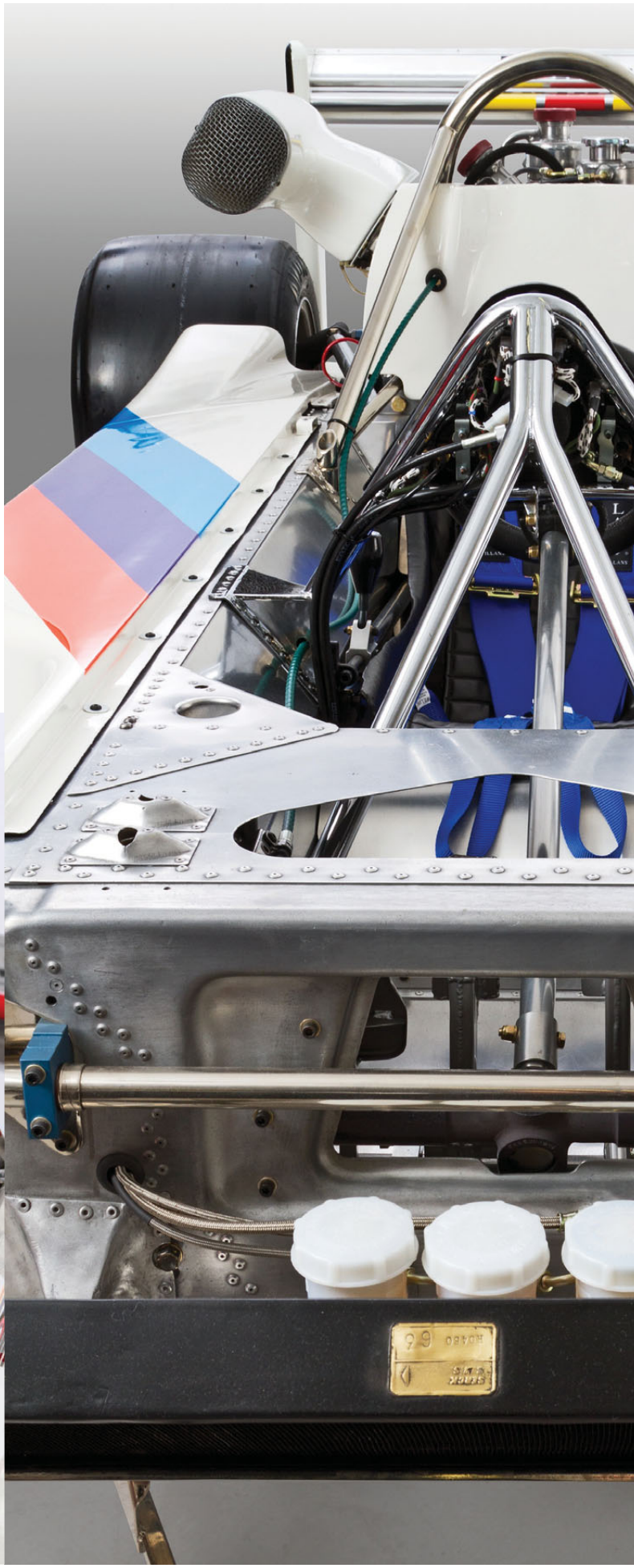
many other updated 782s. In fact, it was generally a question of buying old stock parts that we could find and making new parts ourselves or from trusted suppliers. For example, the car did have its original exhaust but we commissioned RS Fabrications to supply a 105 Db silencer."

All-new suspension, which was nickel rather than chrome plated, and the chassis frames were remanufactured from the original chassis drawings. "We tend not to make the suspension in-house now," says Preston. "We have the equipment and have done so in the past, but it's really not cost-effective for a small business like ours. However, we usually do Formula 1 gearboxes in-house as we are geared up for that, but having refurbished this one we also sent it to an historic Hewland specialist to provide the gears. The original Koni dampers have all been serviced."

The steering rack is a replacement one from Titan Motorsport, the original Jack Knight being very badly worn. The chassis cross-member is the original but had obviously been involved in an accident and repaired. "It was a high-pressure die tooled bit in its day," says Preston, "and the one on this car is generally pretty good, which is just as well as it can't be readily replaced today because nobody's doing work like that as the tools for it would cost thousands of pounds.

ABOVE The original air filter was repaired and fitted with gauze



ABOVE The restored car will now reside in Munich

> **“The copper radiator at the front makes me laugh: so many historic racers have replaced it with an aluminium one and then wondered why the weight distribution is wrong”**

ARTISTIC LICENCE

“We also had some replica wheels made, although they aren’t absolutely correct as the original fronts were single rather the three-piece,” says Preston. “Other missing items included the wing mirrors, which nobody seems to use now so we had to pattern and tool them to remake them from the original. For bits like this we had artistic licence to piece together from the parts list but between the three full-time employees here we do have a great deal of experience and are usually able to arrive at a satisfactory in-period solution.

“The wiring is also pretty period correct and has been done in-house, one of our guys having an artistic bent for it. While we tried to keep to the original way of wiring, we updated it by using a fabric covered wire that’s more in period than just a normal cable.”

In the cockpit, the dash panel is original but while the original Smiths gauges couldn’t be found, the gauge layout is retained. The original 2-bottle extinguisher has also been replaced by a modern single-bottle extinguisher from Lifeline that is more efficient and easier to package and service. The Willans seatbelts are a bit wider than the original to accommodate a HANS device. The pedals, though, are all original.

The engine itself, which is absolutely original even with the original trumpet intakes, arrived from Munich in a crate along with a fuel pump, says Preston. “However, we had to devise part of the throttle cable attachment that was missing because even at BMW it wasn’t particularly well documented, so we studied pictures of the time and also used our own engineering experience to arrive at a conclusion. This also applied to the pedal stops that were not inconsequential in terms of overstroking master cylinders or the throttle cable where there were just no details. We also managed to find an original air filter that we repaired and had fitted with gauze on the front. It was things like this, the tricky little ones, that were difficult to detail.”

The oil and header tank are both new. “The car was supplied to us with what we believe to be a March Formula 3 tank, which is slightly different, but we managed to find the original drawings for that to manufacture the tank,” he says. “In the original car there were a couple of horrible Jubilee clips holding the fuel filler, which we didn’t really believe until we saw original photos, so we’ve taken a bit of licence with some of the oil crossovers just to tidy that up. The hoses are all silicone but black to look period correct.

“The car also featured a copper radiator at the front which makes me laugh as so many historic racers have replaced it with an aluminium one and then wonder why the weight distribution is wrong. We’ve tested and kept the original. The mounting frames have been remanufactured to the original drawings.”

Prior to ascending the hill at Goodwood, the car was given a shakedown test in the pouring rain at Silverstone in early June. “We learnt that the brakes worked if it went in a straight line and that it’s got all the gears, but that was about it,” says Preston. “When we set it up, we went through our normal procedures to get all the suspension links the same length and set the ride height.”

The car has now been transported to its resting place in Munich where it will reside, reminding visitors of a part of motorsport history that is often overlooked. HRT

All photos: Andy Swift

ABOVE The C11 raised the bar in sportscar racing in period. The technology still impresses today

Still potent, still fast – and still racing

The Audis or Toyotas weren't the fastest cars down the Mulsanne Straight at a recent Le Mans 24 Hours, but a car a quarter of a century older as **Andy Swift** recounts

DURING the 2011 Group C Racing qualifying session at Spa, Bob Berridge planted his 21-year-old Sauber C11 on pole in a time of 2:05.295s – good enough to have put him fourth overall on the grid for the contemporary 1000 km race for the Intercontinental Le Mans Cup, which had taken place three weeks earlier. This provides a vivid illustration of the incredible potency of the fastest Group C cars: these are historic racing cars which can still stand toe-to-toe with today's sports prototypes.

Berridge is co-proprietor, with Gareth Evans, of Chamberlain Synergy. The team raced for several seasons through the last decade in contemporary sportscar racing, first with a brace of TVR T440Rs before moving into LMP2 with Lola. It enjoyed significant success with Evans securing the LMP2 Le Mans Series title in 2005, prefacing a move to LMP1.

Today the team is one of the leading lights in the burgeoning Group C movement, home to the world's fastest historic racing cars. The squad's stable currently includes a Jaguar XJR-9, Lancia LC2, Nissan R93CK, Toyota CV92 and 86C, and Sauber C11 chassis C11-89-00. As if that wasn't enough, it has only recently sold the sole active Jaguar XJR-14 'atmo' car. It's a truly sensational selection of iconic sports racers, prepared by a small crew of three full-time staff members and a further six part-timers.

Berridge is unequivocal, however, about his favourite and conversation naturally gravitates towards one special car. "You can quote me on this – it is an absolute privilege to drive the C11. It's far superior to anything else I've ever driven. It's not just any one thing either, everything is fantastic: the handling, the engine, the gearbox, the downforce, the torque..."

The C11 was a landmark in Mercedes-Benz history and heralded a return to motor racing as a works squad for the first time since 1955, when it withdrew in the aftermath of the Le Mans disaster. Having supported Sauber's efforts to take victory at Le Mans in 1989, the works stepped up to put its name, resources and expertise into the C11. The phenomenal engineering might of Mercedes which led it to such success pre-war and during the early-mid 1950s made itself immediately evident in the C11.

"The lads absolutely love working on the car; it's a total peach," explains Berridge. "When we bought it, we decided to strip it down to find out what single aspect made it so special. It turned out that it wasn't just one thing; it was 50 things which added up to an amazing cumulative effect. A proper factory race car is profoundly different to a customer car, even when compared to a really good customer car like the Lola-built Nissan R93CK."

This extreme level of detail and

commitment to perfection is evident across the entire machine. The front and rear anti-roll bars, the suspension geometry, the quality of the bodywork, the wing profiles, the pushrod suspension and the underbody are all optimised to an extent that was way beyond the means of even the best customer teams – and Berridge includes the likes of Lola among them. For the C11, advanced pushrod suspension replaced the earlier C9's conventional rocker arrangement, with Mercedes' own gearbox replacing the proprietary unit previously bought in from Hewland, creating a fully-integrated and exceptionally stiff rear end.

SPECIAL PEDIGREE

Every single aspect of the C11 has been designed and executed with a view to how every element will integrate. As Berridge puts it: "There are no parts-bin specials anywhere on the car. Everything is bespoke and has been designed for perfect integration."

He cites as an example the titanium rising rate springs that the car employs. "I cannot even imagine how we would replace them – or how much they must've cost to create." It is evident that the C11 – and other factory cars of its ilk – is a sports prototype in the purest sense with no use of proprietary or hand-me-down parts.

A car of such special pedigree might not, therefore, be an obvious choice for the historic racer. When describing the season-long running and preparation of these mighty racecars, Berridge actually makes the process sound fairly simple. Each car will receive a full rebuild during the off-season, with Chamberlain Synergy doing all the mechanical work and Xtec Engineering in Walsall completing all engine work. From there, the small team at Chamberlain Synergy is capable of completing all the day-to-day race operations itself, with three mechanics tending to a two-car team over a race weekend.

> **"We decided to strip the C11 down to find out what single aspect made it so special. It turned out that it wasn't just one thing; it was 50"**

Running a C1 car such as a TWR Jaguar, Porsche 956 or Mercedes for a full season, including a comprehensive rebuild, costs in the region of £100,000; a C2 car half that. When compared to a British GT campaign – now something north of £350,000 – and recognising that these cars are mostly appreciating in value, it starts to sound like a bargain.

Generally speaking, spare parts have not been a massive issue for the team. All the cars, including the C11, have arrived with a fairly comprehensive spares package from the works. From there, many incidental parts can be fabricated from the local supply chain and Berridge is effusive in his praise of the many small, independent firms operating in the M40 corridor.

These 'artisans', as he describes them, are capable of producing an incredible array of parts – and just about anything the team might require. "There are too many to mention – and I wouldn't like to leave anybody out – but we use five or six of these wonderful, small firms. They are fantastic and all have experience in producing parts for F1, LMP and so on." Even at 25 years old, a Group C ▶

BELOW The Lola-built Nissan R93CK

ABOVE The ability to machine one-off parts with CNC technology has helped keep rare cars like Lancia's LC2 running

car is still so modern and so potent that Chamberlain Synergy is turning to today's Formula 1 supply chain for solutions.

An off-season rebuild will typically comprise the strip, inspection and (where necessary) renewal of all moving parts. These will include the engine, gearbox, driveshafts, brakes and uprights. Xtec completes a total engine stripdown annually, crack testing everything and lifing certain parts such as valves and valve springs. Consumables such as crankshaft bearings and timing chains are renewed as a matter of course.

Xtec itself employs a select group of skilled local firms to create specialist replacement parts where originals are no longer available. The firm tends to employ a sampling process for procuring replacement parts. Using a subcontractor such as Capricorn or Omega, Xtec will send existing parts for inspection and assessment. From there, the subcontractor will produce its own manufacturing drawings for approval and subsequent production.

Paul Knapton of Xtec doesn't cite great strides in metallurgy during the last 25 years for any increase in performance and generally parts are built as close to original specification as possible. If there is an opportunity to improve performance without compromising legality or reliability, naturally this is investigated.

MODERN METHODS

One aspect he identifies as having made a major difference in the manufacture of spare parts for these very rare cars is the current proliferation of CNC machines. Previously a bespoke casting might have been required, involving a sizeable tooling commitment. Today, though, parts such as oil pump housings can be machined from single billets – and done so as one-off parts – on a CNC machine. This is vastly more cost efficient than casting and enables unusual pieces to be made as and when required. Unlike, say, the Jaguar XK engine, there are not scores of people looking for minor engine components for the Lancia LC2.

These cars were designed with the punishing 24-hour races at Le Mans and Daytona in mind. This focus on endurance means they are operating well within their design parameters during the typical Group C season today. As Berridge points out, his 12-hour historic racing season is only half a Le Mans distance.

On top of the reduced mileage, the cars are not generally running to the same extreme levels of performance they would have done during their period racing careers. In spite of rumours around the paddock of inflated boost levels employed by some teams, Chamberlain Synergy is running its cars in a very conservative state of tune. Berridge asserts: "We are running absolutely to the cars' contemporary homologation. We won't crank up the boost as we generally only have one engine per car and that is much too precious to lose."

While success on track is Chamberlain Synergy's raison d'être, this is not a 'win at all costs' ethos and there remains a healthy degree of respect towards these important racing cars. In spite of that 'conservative' tune, the monster Nissan R93CK and Mercedes are still producing upwards of 800 bhp.

This sentiment is echoed by Knapton. "We are still going for maximum performance, of course, but we are cautious," he says. "It's worth remembering that Group C was a fuel formula in period, though, and we are not limited in our fuel usage today. That means our performance level is probably somewhere between a contemporary race and qualifying level."

To offer some further perspective on the level of performance of a Group C weapon, Chamberlain Synergy ran a Sauber-Mercedes C9 during the 2012 season, with team co-owner Gareth Evans hitting 352 km/h down the Mulsanne Straight during the Le Mans support race. That's 220 mph in old ▶

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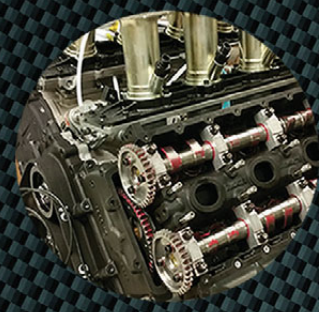
Peugeot 905 V10 Sports Car
Porsche 935 & 962 Group C
Nissan V6 & V8 Group C
Aston Martin V8
Hart V10 F1



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money, making Evans the fastest driver during the entire Le Mans weekend – a useful chunk ahead of even the contemporary works LMP1 efforts from Audi and Toyota.

This phenomenal performance makes the prospect of any potential issue with the cars quite a frightening one. As proven during Group C's 1980s and 1990s heyday, there is no such thing as a small accident at 220 mph. The TWR Jaguar team introduced full carbon fibre monocoques to the movement during the mid-1980s and they were *de rigueur* by the time the R93CK and C11 appeared.

In historic racing circles, however, carbon fibre is an extremely new technology, with Group C – an historic category effectively since 1999 – leading the way in racing cars of this construction. During the off-season, all carbon parts are crack-tested for integrity but the long-term fears for the material which some have voiced are yet to be realised.

A KNOWN TECHNOLOGY

Having run contemporary sports prototypes, though, any long-term deterioration of carbon fibre parts is quickly dismissed by Berridge. "Carbon fibre's a known technology now – really, it's old hat!" he insists. "There's so much expertise in the material that there are scores of composites engineers we can call upon if we need to. I'd compare it to aluminium. In the early days of aluminium monocoques, very few people knew how to work on them but soon it became the norm. Today, there are far fewer people who know how to work on structural aluminium than structural carbon."

That experience of running contemporary sports prototypes extends to track set-up work as well. "We've developed three basic set-ups that we call short track, long track and Le Mans," he explains. "Short track we would use for Silverstone, Spa-Francorchamps and Barcelona; long track for Monza and Paul Ricard. Le Mans is so unusual that it requires its own set-up."

For the most part, set-up data is derived from the team's experience during the European Le Mans Series campaigns.

BELOW Aero was, and remains, king in Group C racing

> **"The ability to manipulate aerodynamics is one of the key differentiators between running a Group C car and almost anything else in the historic racing movement"**

The differences between the individual set-ups relate primarily to aerodynamic settings and gear ratios as these are the areas where the team has identified the greatest benefits.

The focus on – and, crucially, the ability to manipulate – the cars' aerodynamics is one of the key differentiators between running a Group C car and almost anything else in the historic racing movement. It's certainly a factor in illustrating how contemporary sports prototype experience helps enormously in realising the cars' full potential.

The major works teams spent a huge amount of time working on engine mapping and fuel injection during these cars' period competition careers, with Porsche and Mercedes entering into collaboration with Bosch to provide electronics. Running cars with the original ECUs is possible today, though there are perhaps simpler and more modern approaches. Issues with hardware and software aren't uncommon, though Xtec still prepares engines governed by their original software.

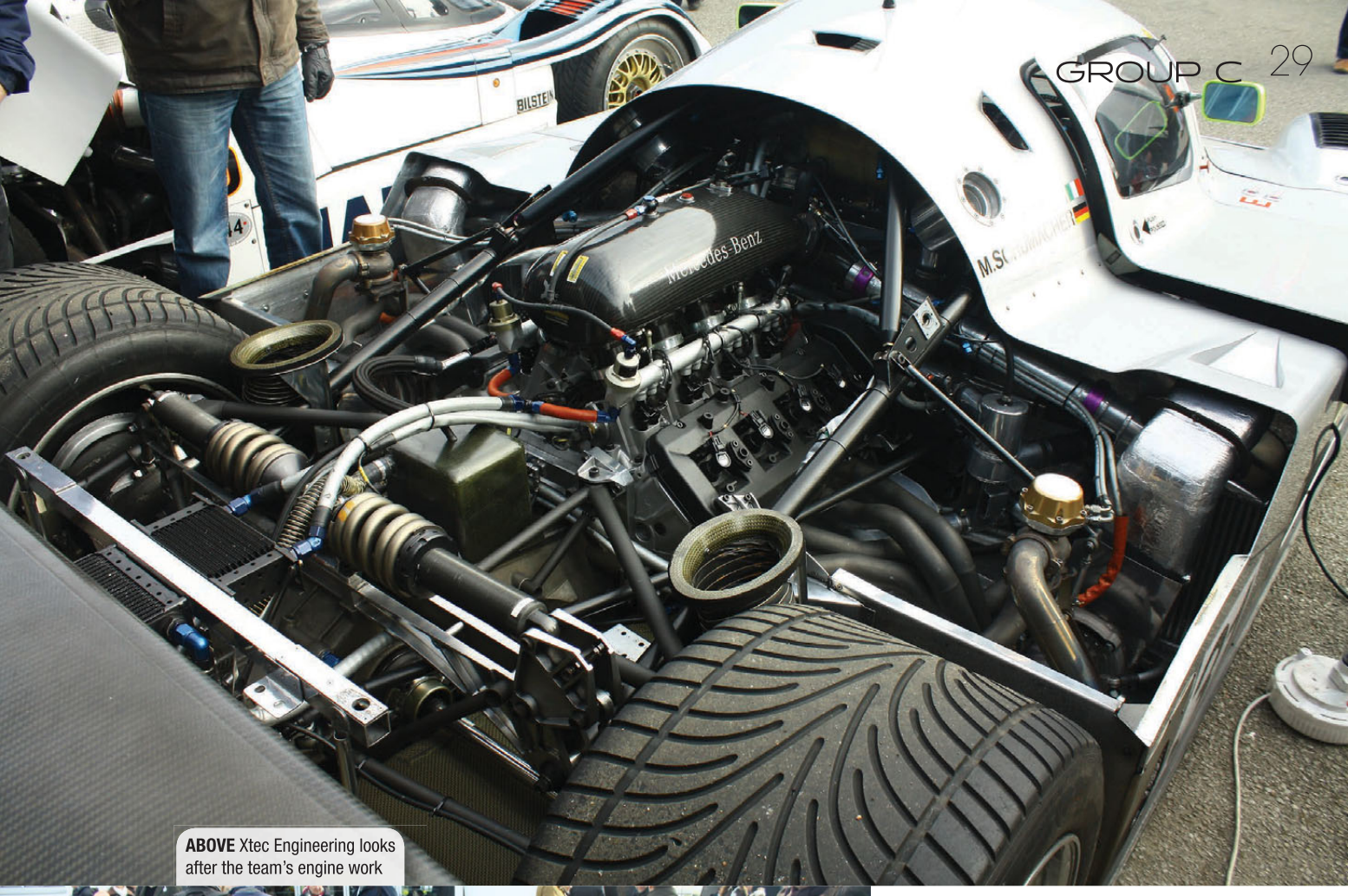
Today MoTeC offers a 'plug-and-play' solution for most Group C cars which requires custom mapping, but which allows teams to operate the maps from a modern laptop at the racetrack. Knapton says this solution works well but is at pains to point out the work that went into the original ECUs: "Porsche and Mercedes poured a massive amount of resource into their projects with Bosch and those original maps were extremely well optimised at the time. Don't forget this was a fuel formula so efficient mapping was absolutely crucial." A salient lesson, perhaps, not to throw the baby out with the bath water.

Xtec, though, is happy to cater to its customers' needs and will even produce a replica Bosch-style housing for a modern MoTeC ECU to maintain that essential '80s aesthetic. Chamberlain Synergy, along with many of the other Group C teams, uses Dave Roe at EPS Motorsport for its mapping and he is always on hand to provide track support. Generally speaking, the MoTeC system is the easiest solution from an operational perspective, but it's not the only one.

Group C Racing, the current historic category, is supported by Avon as a single tyre supplier. Each car is permitted two sets of slick tyres per weekend and this, according to Berridge, is plenty. "Avon has produced a very good tyre and does a great job for us. There are a couple of different sizes available, which seem to suit everyone, and it's produced a good, durable, predictable tyre."

The perfect solution, then, for amateur drivers while permitting a level playing field for the teams.

Aside from occasional professional interlopers like Al Buncombe and Andy Meyrick, the majority of Group C drivers are amateurs. This has guided teams in



ABOVE Xtec Engineering looks after the team's engine work

ABOVE The C11's advanced pushrod suspension, allied to Mercedes' own gearbox, gave the C11 a fully-integrated and exceptionally stiff rear end

terms of how to approach car set-up, as Berridge explains. "The most important aspect in finding time is the driver. There's no point playing about with castor or camber unnecessarily as there are far bigger chunks of time available simply with seat time." He elaborates, "If you think of it, there's no wonder Lewis Hamilton can do the things he can do with a car: he gets almost seven hours of seat time per race weekend. At best we might get two hours over a whole race weekend – and there are only five or six meetings per season."

This really helps illustrate the team's approach – a well-balanced, reliable and consistent car which permits the amateur driver plenty of seat time will reap rewards. There is no benefit in spending half of a precious session in the garage poring over data, making quarter-degree tweaks to suspension geometry. Equally, as Berridge alludes to, chasing the last few horsepower and compromising reliability will be of proportionally little benefit.

This approach is reflected in data acquisition as well. The team will use sensors for basic parameters such as rpm, wheel speed, throttle position and brake pressure. Any more data would be impossible to make use of over a race weekend, especially when the driver alone can find four to five seconds between sessions, purely from familiarity.

In spite of all the otherworldly technology, the advanced materials and incredible attention to detail, the success of any Group C team depends upon making the hostile environment of a 220 mph Le Mans weapon approachable and accessible to its pilot. This is as true today as it was during the category's glory days. Furthermore, nowhere else in the historic racing sphere is there greater symbiosis visible between the contemporary and the classic. Here is an historic movement featuring cars so advanced that it has to feed off the knowledge and expertise of those running at the highest level in F1 and sports car racing – and Chamberlain Synergy is winning with the most advanced cars of the lot. HRT

The Racing Engine for the Masses

Chris Pickering investigates an engine that from its first inception was born to be a hardy annual and which to this day bears this out

YOU could argue that the Lotus twin cam was a racing engine for the masses. Colin Chapman was a big fan of Coventry Climax, but when it came to designing the Elan, these highly strung all-aluminium engines were simply deemed too costly. Instead, he began looking for a mass produced unit that could be used as the basis for the new design.

The first engine that caught his eye was the 1.00-litre Ford 105E used in the Anglia. With its non-siamesed intake ports and rev-friendly oversquare bore/stroke ratio it seemed like a good candidate.

Ex ERA, BRM and Coventry Climax designer Harry Mundy was brought in to design a double overhead cam eight valve cylinder head. In order to simplify production, the original pushrod engine's camshaft was retained (complete) in the block to drive the new valvegear via chain.

He opted for a hemispherical combustion chamber design with the valves angled at 27 degrees – a concept that had been in use in racing engines for decades, but still a real rarity in road cars. Canting them over allows the use of larger valves within the same bore diameter, as well as giving a straighter flow path in and out of the engine, both of which provide benefits at high rpm, but make it harder to achieve the required intake flow speeds at low revs.

By the time Lotus was ready to proceed, Ford had released a 1,339 cc variant known as the 109E, which was used for much of the development. Before long, though, this too was superseded by the 1,498 cc 116E engine, which used five main bearings on the crankshaft and a slightly taller block. It was this unit, with its 80.96 mm (3.187 inch) bore and 72.75 mm (2.864 inch) stroke that went on to underpin the first Lotus twin cams.

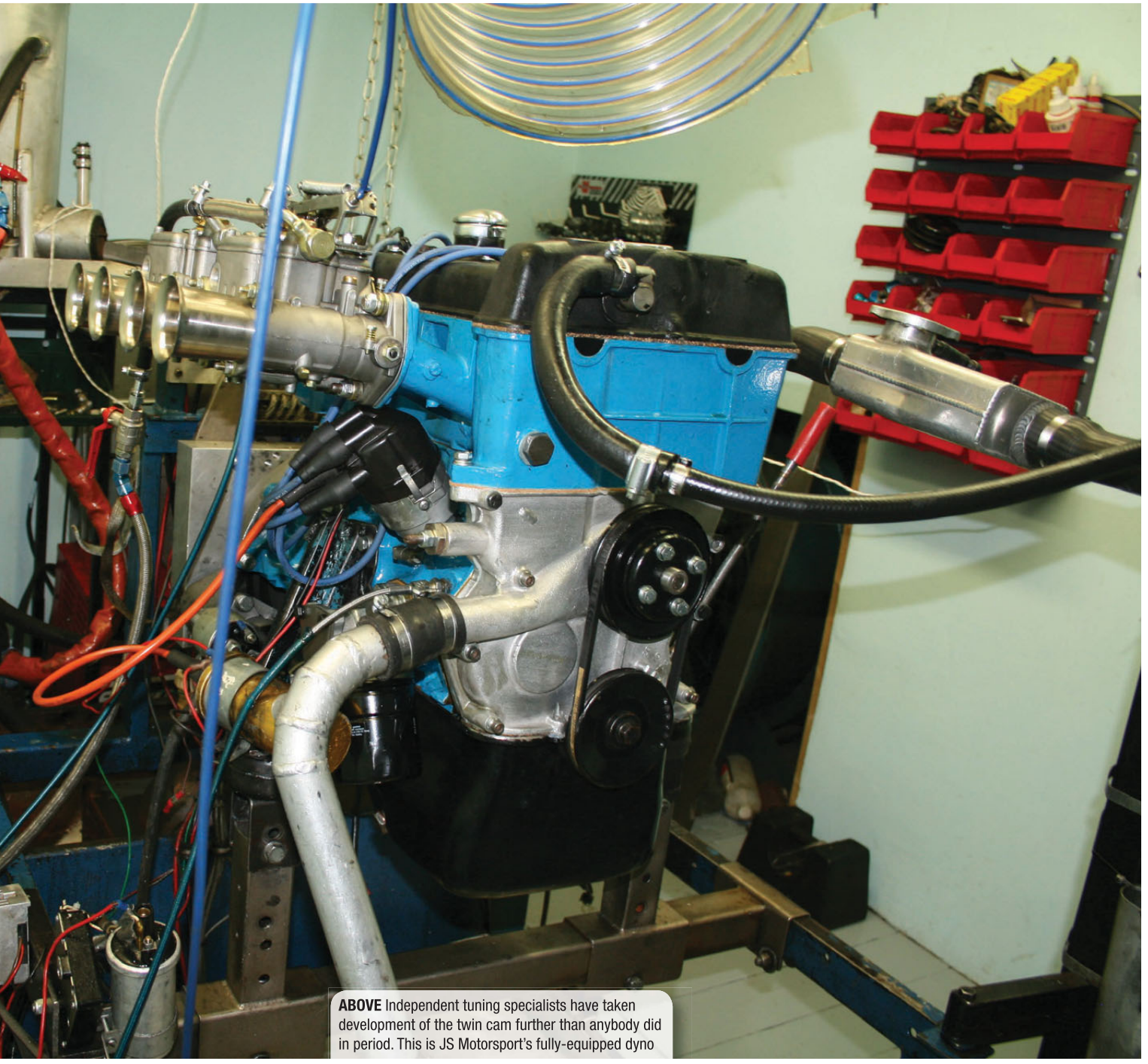
Around 50 engines were produced initially, going into the Elan 1500 road car and a variety of racing cars. This included the original factory prototype of the Lotus 23 that streaked away from the Aston Martins and Ferraris on its competition debut at the Nürburgring in 1962, despite conceding several hundred horsepower!

Soon Lotus moved to a larger 82.55 mm (3.25 inch) bore, which upped the capacity to 1,558 cc and allowed the engine to sit right at the top end of the 1600 class with the permitted 1 mm overbore. It is this engine with its round main bearing caps and four-bolt flywheel fixing that accounts for most of the Mk1 twin cams in existence.

In 1967, a Mk2 variant of the engine was introduced with a thicker purpose-cast cylinder block and a six-bolt crankshaft. Initially these retained the round main bearing caps, although they later moved to sturdier square bearing caps. They also benefited from new lip-seals on the crank, sleeved cam follower bores and better oil returns to the block.

In total, over 55,000 examples of the various twin cam engines went on to be produced – no doubt much to the dismay of Mundy, who had been offered either a £1 royalty for each engine sold or a £1,000 flat fee for his work and opted to take the latter. He was by no means the only famous name onboard, either. Mike Costin and Keith Duckworth were both heavily involved in the initial development, as was Harry Weslake.

Soon after, Cosworth – headed up



ABOVE Independent tuning specialists have taken development of the twin cam further than anybody did in period. This is JS Motorsport's fully-equipped dyno

by Costin and Duckworth – went on to produce a succession of twin cam-based race engines for Team Lotus and others. In Mk 16 form a twin cam-derived engine even found its way to Formula 1 in the back of a Cooper T71/73 entered by Bob Gerrard in the 1964 British Grand Prix. Later, the Type 47 racing variant of the Lotus Europa used a Cosworth Mk 13 engine fitted with Tecalemit-Jackson mechanical fuel injection in place of the normal twin carburettors.

Ford's association with the twin cam was to prove a lengthy one. After the Mk1 Lotus Cortina came the Mk2 (for a time marketed as the Cortina twin cam). It was sold alongside the Ford Escort twin cam, which was a force to be reckoned with in both rallying and saloon car racing until 1970. Lotus, meanwhile, continued using the engine until Elan production stopped in 1974, by which point it had also seen service in the Lotus Seven and the Caterham Super Seven.

However, that was just the beginning of the story. Since then a whole band of independent tuning companies have embraced the twin cam – in some cases taking it further than anybody did in-period.

CRAIG BECK

The twin cam was somewhat ahead of its time. Thanks to the five bearing crank and lightweight double overhead cam valvetrain it could rev comparatively high straight out the box. Blueprinted examples of the Sprint engine, with its enlarged 1.562 inch inlet and 1.365 inch exhaust valves, can reliably meet – and sometimes exceed – the original claim of 126 bhp, but to go much beyond that requires the use of stronger internals.

"You can get up to 190 bhp from the cylinder head and the block if the castings are okay, but you need to fit a ▶

ABOVE & BELOW The twin cam-engined Lotus Cortinas and Escorts remain a force to be reckoned with on the racetrack and rally stage

steel crank and rods," comments Craig Beck, owner of Craig Beck Racing."Then a lot of the work comes in on the cylinder head, fitting bigger valves and different cams."

Beck is one of the younger twin cam specialists out there, but don't let that fool you. He's been working on these engines since his teens when he apprenticed with renowned twin cam builder George Wadsworth at Racing Fabrications. Now the Lotus engine accounts for some 85 per cent of his business.

He has recently developed a new crankshaft in EN40 steel that matches the Mk2 six-bolt single counterweight design and commissioned a set of bespoke connecting rods. Under the Appendix K rules, twin cams have to use I-beam rods, but Beck runs longer ones with shorter pistons to reduce the reciprocating mass and help the engine rev more freely.

Once the belt and braces job of fitting lighter, stronger internals has been carried out, the real key to extracting power from the twin cam lies with the valves and camshafts.

"The FIA engines run a Sprint-type valve so they fit in the standard head quite easily and the best ones can produce up to 180 bhp," says Beck. "You can go to the next valve size (1.625 inch inlet and 1.4 inch exhaust) on the standard seats, but the ultra-big valves (1.7 inch inlet and 1.440 inch exhaust) used in some single-seaters and sports racing cars require different seats."

To accommodate the ultra-big valves the seats need to be removed and the area of the combustion chamber where they sit needs to be machined quite extensively. The aluminium cylinder head is then baked in an industrial oven to over 200°C for several hours while the steel seats are frozen with liquid nitrogen. The seats are made a few thou oversize, so they are an interference fit even before the head cools and shrinks around the valve.

Generally, though, Beck says he prefers to work on the cam profile and stick with the standard valve seats.

Using the 1.625 inch inlet valves and a very high lift cam he has managed to coax 191 bhp at 8,250 rpm out of the 1600 engine in a Lotus 23B. "There was no power to speak of under 6,000 rpm, but as soon as you got to 6,500 rpm it took off and revved right the way to 9,000 rpm, where it was still making 180 bhp," he comments.

By his own admission this is not a profile he would want to use in an Elan, let alone a 750 kg Cortina, but for a sub-500 kg racing car it makes sense. "With the heavier cars – particularly the Cortinas – it's worth sacrificing four or five bhp at the top end to get a better spread of torque."

The more extreme cams come with their own challenges, he explains. ▶

BELOW FIA-spec connecting rods ready to go into a JS Motorsport twin cam

"We're talking about nearly half an inch of lift, so the valves get very, very close to the piston. We have to machine the valve pockets so they're both deeper and wider – around 1.5 to 2 mm has to be built in for valve float and the diameter of the pocket is also slightly oversize to account for the valve flexing laterally. Once the engine is ready, we do a trial assembly, set the timing and turn it over with Plasticine in the valve pockets to check the clearance."

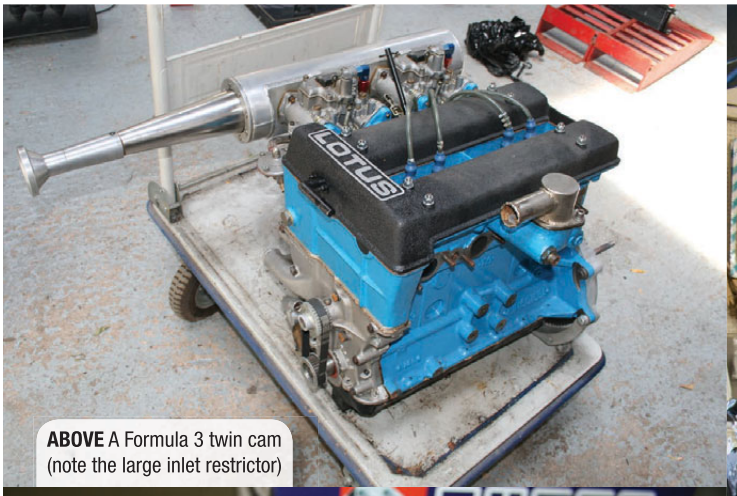
JOHN SMIRTHWAITE

JS Motorsport, based in deepest rural Warwickshire in the UK, is another notable twin cam specialist. Owner John Smirthwaite has been working on these engines for decades and points out that the engine needs to be tailored to the customer as well as the application.

"If you've got a club racer turning up with a Transit and trailer they're best off with a torquey engine that's maybe 10 bhp down at the top end but perhaps 30 bhp up at 4,000 rpm," he comments. "They can run a longer final drive so they're not stressing the gearbox and axle as much, which all helps the package last longer. The gearboxes are the weak link on these cars – one of the top teams we've dealt with was reportedly pulling 8,700 rpm in top gear down the back straight at Monza and if you're doing that for an hour at a time it's not going to last forever."

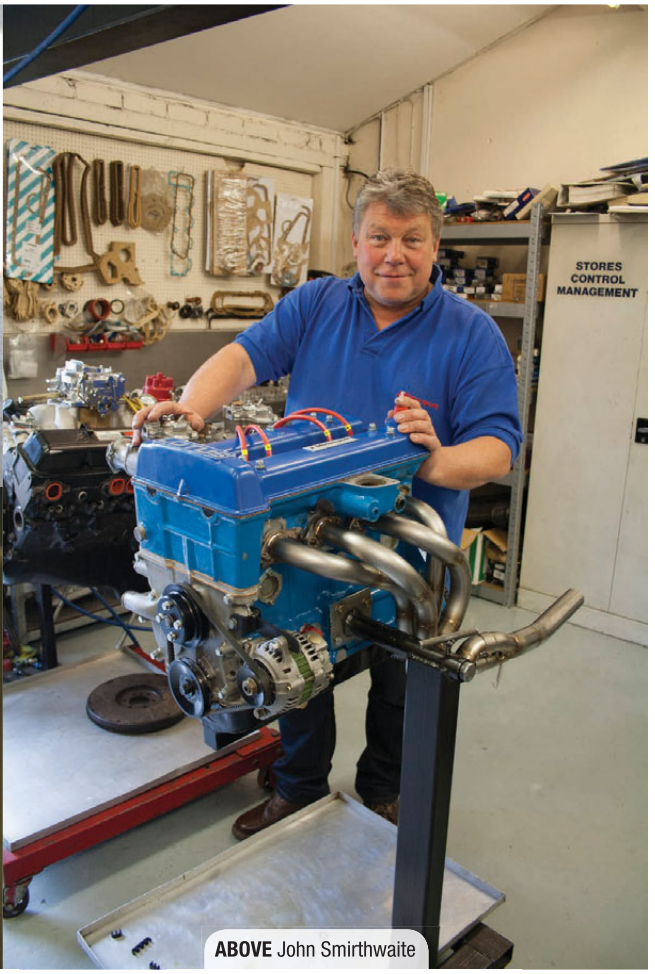
It's a question of balancing outright power against longevity and drivability. Physical changes between the two specs include things like cam profiles, compression ratios and changes to the gas flow. JS Motorsport carries out its porting by hand with a series of 'go' and 'no-go' blanks that are fed into the ports to ascertain whether they're the right size or shape. "We've had CNC ported heads in here and they've not shown any advantages. In fact sometimes they've been worse," says Smirthwaite.

Valve seat cutting is handled in-house



ABOVE A Formula 3 twin cam (note the large inlet restrictor)

ABOVE Smirthwaite's pistons are machined to a bespoke spec



ABOVE John Smirthwaite

at JS Motorsport using a MIRA valve seat cutter to cut the seats and blend the throats. “We try and get the valves as far away from the surface as we can to prevent any shrouding and we get them as close as we dare to the piston. We also run the pistons out the block to maximise squish,” says Smirthwaite. “The ultra-big valves only really work right at the top of the rev range, so you end up having to cut the valves back in the chamber to get the clearance on overlap which results in very little benefit overall. All you really gain is about 10 hours’ machining!”

Most twin cam specialists prefer to use new head and block castings for their race engines and Smirthwaite is no exception. “The original 701M ‘L’ block with square caps was pretty bullet proof really, but they’re all 50 years old now so they’re losing their integrity. We use new castings for virtually all of the frontline FIA teams. I think it gives you more rigidity, so the bore and piston sealing is better.”

Even with the new castings, each one is ceramic sealed and pressure tested. Quite a lot of metal is removed as the porting is carried out, with particular attention paid to maintaining gas velocity in the inlet ports. The pistons, similarly, are supplied by Omega to a standard pattern before they’re re-machined on-site to a bespoke spec, featuring a very flat crown to minimise the length of the flame path.

A rather more prosaic mod comes in the form of the cluster-type water pumps that JS Motorsport often employs. Fuelled by Chapman’s weight saving obsession ▶

The stuff of legends

WHEN it comes to finding parts for the twin cam engine, or any other classic Ford engine for that matter, one of the first places to check out is Burton Power. It has been in business for over 50 years and holds thousands of parts in stock.

“It’s the stuff legends are made of,” says managing director Steve Burton. “The Lotus twin cam was the engine of the Sixties, especially in cars such as the Ford Mk1 Cortina and Anglia, which was the first road-type car, albeit in prototype form, to carry the motor. Images of Jim Clark belting round a race track cocking a front wheel go hand in hand with this unit.

“There are basically two Ford–derived ‘Twinks’, the Mk1 introduced in the Mk1 Cortina in 1963, and the Mk2, which was fitted in the Mk2 Cortina Lotus from March 1967. This version was also fitted to the 1968 Escort twin cam.

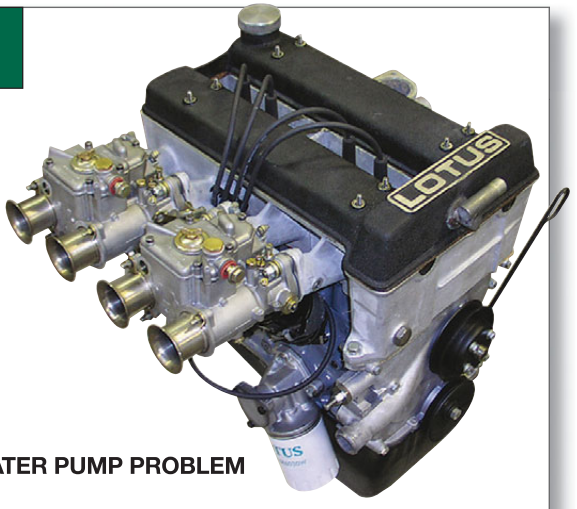
“This is actually the better engine since it has a purpose-cast Lotus block – identified with a large ‘L’ on the side, but usually hidden under an engine mount – as opposed to a mere graded Cortina 1500 block. As such, the engine was based on a Ford Pre-Crossflow with a Harry Mundy-designed, twin cam alloy head, with chain drive and eight valves. Blocks were bored to 82.55 mm from the Pre-Crossflow’s standard 80.96 mm – hence the Mk2 having a thicker casting to carry the increased capacity more reliably that allowed 1558 cc.

“These engines also had square mains caps – the same as 711M Crossflows, proper oil seals as opposed to the Mk1’s rope-type, plus, stronger 125E rods. The Mk2 engine also had sleeved tappet bores, better oil returns to the block, plus a 6-bolt flywheel fixing in the crank, which supersedes the earlier 4-bolt type.

“In addition, you will also find a ‘Twink’ in Lotus Elans and later Europas and it was also a standard fitment in some Caterham Super 7s. Naturally, there were several versions of these too.

“The Special Equipment (S/E) with 115 bhp was fitted to S2-S4s, whilst the Elan Sprint received bigger valves – and has Big Valve on the rocker cover, higher compression, better cams and exhaust, resulting in 126 bhp.

There is also a Stromberg-carburettored engine, although most had a Weber DCOE type manifold cast into the head, which interchanges with the similar and occasionally fitted, Dellorto side draught.”



THE WATER PUMP PROBLEM

“’Twinks’ do have a reputation for water pump failure but this is mostly due to the engine being left standing for long periods – the pump goes dry and rips the seal when it’s turned over. We have re-designed this area to incorporate a modular-type water pump so that it’s easier to remove and replace. See our advertisement in this issue. We also offer the water pump housing in two heights to suit standard or Crossflow-based engines.

“The latter is also a popular route for building a ‘Twink’ since L-blocks are becoming scarce. In addition, the Crossflow block can be increased up to 1700cc obviously giving a performance increase too. We also stock the special spacing components required for this conversion.”

TUNING THE ‘TWINK’

“More power is reasonably straightforward with the engine responding well to head porting, cam change and 45 DCOEs. A usable 140+ bhp can be achieved with the right cams and in full race trim this engine can produce 185 bhp + but these are all steel screamers on 48 DCOE carbs.

“Due to the age of most head castings, we would recommend getting the head checked over first. Then we can advise on how suitable it is for further improvements to be made.

“We keep a whole range of replacement and performance parts for this engine in stock, including forged pistons, steel cranks/rods, steel flywheels, camshafts, large valves, steel tappets and even brand new cylinder heads.” HRT

the original twin cam had its water pump integrated into the front cover of the engine, but this made changing the pump mammoth task that included removing the sump and the cylinder head. You can now buy a removable pump capsule that fixes into a modified front cover with just three bolts, slashing the time taken to change the pump from five hours to around 15 minutes.

"These days, if the pump fails in the middle of the Spa Six Hours you can have the car back on track in 20 minutes," says Smirthwaite.

DAVID GATHERCOLE

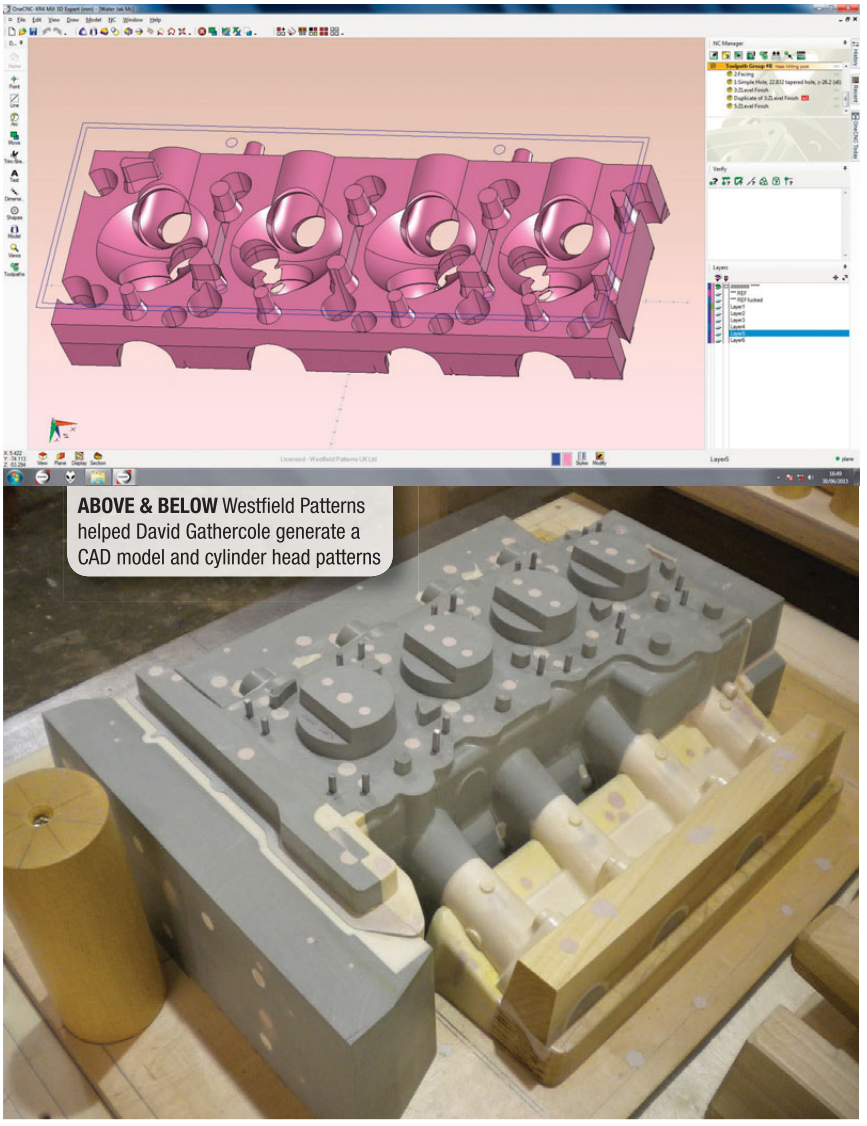
Aged 17 David Gathercole was presented with a dilemma: buy a car or convert his father's hillclimb and sprint Elan back to road use. Not surprisingly, he chose the latter option and nearly four decades later he owns a race preparation business specialising in the twin cam and its Cosworth cousins.

One of the most notable points is that Gathercole produces his own engine blocks and cylinder heads, albeit outsourced to a local foundry. The cylinder blocks are based around the much-prized 'L' block, but they use a slightly stronger grade of iron and a slightly greater wall thickness. The cylinder heads, meanwhile, are modelled on the Mk1 engine.

"Most of the reproduction cylinder heads on the market are based on the Mk2, but people are becoming more particular about the cars and the engines looking period-correct, which is why we've gone down the route of producing a copy of the Mk1 head," he explains.

An original cylinder was reverse engineered with the help of a co-ordinate measuring machine (CMM) by Westfield Patterns in Peterborough to build up a comprehensive 3D CAD model. This was used to generate a 3D model of the pattern work which was then CNC cut.

Gathercole also produces a 2.0-litre aluminium block for non-FIA engines. This is the same height as the 1558 cast-iron block and outwardly the two are very similar, even using the same moulds. Inside, however, it's a wet liner engine with 90.4 mm bores and weight is some 20 kg down on the cast-iron block.



ABOVE & BELOW Westfield Patterns helped David Gathercole generate a CAD model and cylinder head patterns

As with the original twin cam, Gathercole's cast-iron blocks run without liners. However, where cast-iron piston rings would have been used in-period, he says that chrome-plated piston rings work well with modern lubricants, dramatically reducing engine wear. Similarly, while the Mk1 heads historically had problems with wear on the un-sleeved cam follower bores, this too appears to have been solved with the use of modern lubricants.

"Engine oils are now so much better than they were in the Sixties," he says. "The tolerances back then had to be big because of poor quality oils, but if the engine is built to the sort of tolerances that modern oils allow now, it's very reliable."

The standard engine doesn't use stem seals on the valve guides. This tends to result in oil consumption, which has led to some engines being fitted with aftermarket seals, but this is only really an issue for road car engines that go for comparatively long distances between rebuilds. Gathercole also recommends the use of phosphor bronze guides, which resist wear far better than the cast-iron originals.

"By 30,000 miles the valve guides were pretty much worn out on most original engines," he comments. "These days the rebuild life for a road engine is around twice that."

One part of the rebuild procedure that's dreaded by many engine builders is tackling the rope seals used on the early engines. It's a fiddly job and the rope seals are prone to weeping oil, so they are often swapped for modern lip seals, but Gathercole isn't convinced.

"There's a bit of trickery involved in getting them to seal, but I actually believe rope seals produce less friction than a lip seal," he says. "They've only recently allowed lip seals on Appendix K engines, but we've found the rope seals to be just as reliable once you get used to using them." ▶

ABOVE Wilcox got to know the twin cam intimately during a golden era of rallying

JOHN WILCOX

John Wilcox has perhaps had an unusual route into engine building. He left school to pursue a professional football career, signing for Coventry City, but was soon forced to retire due to injury. After a stint as a trackside mechanic he went to work for Roger Clark, building some of his international rally cars and even the odd racing powerboat. At times he was also Pat Moss's mechanic and an accomplished rally co-driver in his own right.

It was during his time with Roger Clark that Wilcox really got to know the Lotus twin cam. He was involved with the works Mk1 and Mk2 Lotus Cortinas, then later the Escort twin cam. Since then he has been responsible for some of the most extreme variants of the twin cam.

"Over the years we had to keep moving up," he says. "We used 1600 thick-wall iron blocks with a bigger stroke to get the engines up to 1900-and-a-bit cc. Then it was the aluminium blocks in 2 and 2.2 litres and we slowly moved on, doing headwork with big valves."

When it comes to twin cams, however, bigger is not necessarily better. "As the engines get bigger everybody assumes you get a lot more power, but you don't. You get a slight increase in power with colossal torque, but the engines don't rev. You can build a 1600 revving to 8,500 rpm and producing 180 bhp, then when you make the engine bigger, you get maybe 190 bhp but it's at 6,500 rpm."

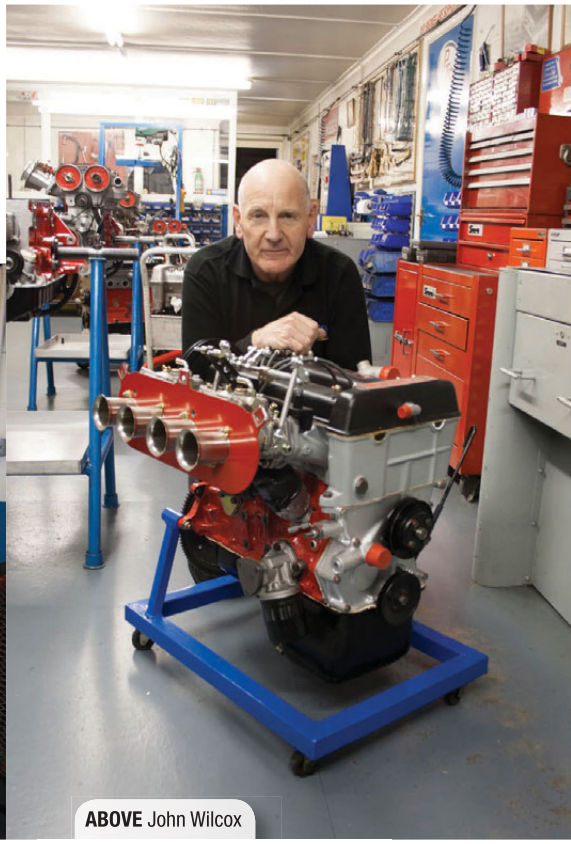
Again, the problem was the risk of the valves clashing. To get around this, Wilcox did a huge amount of work on their position, even making a set of dummy valve inserts that could be slid in and out of the head to check for clearance while the engine was turned over by hand. Eventually, by recessing the valves deep into the head and developing a special cam profile he succeeded, squeezing more than 220 bhp out of a 2.2-litre aluminium block engine.

Other projects he's worked on include fitting fuel injection and converting carburettor-fed engines to work on electronic ignition.

"It's only a question of adding a few sensors," he says. "We did an engine for a Lotus Europa with electronic ignition. Because it was running 50s there was no carburettor spindle to attach a throttle position sensor to, so we used a vacuum sensor on the intake instead. It was very discrete, so at first glance you'd never know it had a management system."

Ironically, there's now a move towards more traditional specifications, certainly as far as the competition market is concerned. However, while the things might be getting more conservative on-paper, the reality is that the twin cam builders are just as clever as ever. HRT

ABOVE The dyno room at John Wilcox Competition Engines



ABOVE John Wilcox

TLC BRINGS HERO BACK TO LIFE

The mount that once, as a five-year-old car, carried Malcolm Campbell to a new land speed record, has just re-emerged from a 10-year loving rebuild. **William Kimberley** investigates

Jeff Bloxham

> **“Campbell discovered at first hand the car’s nasty handling trait of yawing to the right”**

SUNBEAM is one of the many car companies that have sadly become extinct over time and yet it could have been so different. While WO Bentley was launching his first car in 1919, the car company from Wolverhampton was well into its stride having already established nearly two decades of building and also racing them, chief designer Louis Coatalen coining the famous phrase that “racing improved the breed”. Part of this racing philosophy was making Land Speed Record cars.

While the Great War of 1914-18 put a temporary stop to this, the company instead going into aircraft engine production as well as building lorries, motorbikes and ambulances, once hostilities ended, it was back to the production of cars. However, the post-war economy had drastically changed everything.

Within a couple of years, Sunbeam had merged with French car manufacturer Automobiles Darracq – which had already acquired the London-based company Clement-Talbot – leading to the creation of Sunbeam-Talbot-Darracq or STD Motors. Through all this, though, the racing ethos was maintained, the company becoming a dominant player in Land Speed Records, Grand Prix and Voiturette racing, both in Britain and abroad in the next decade.

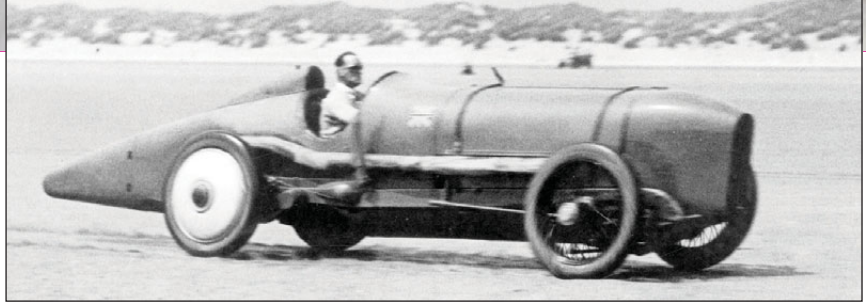
ABOVE The modified 18.3-litre Sunbeam V12 Manitou aero engine

One of the first cars to be built was a Brooklands special with a purpose-built V12 18.3-litre engine that was a hybrid of the Sunbeam Manitou and Arab aero engines. It is this car, the 350hp, that is the subject of this story.

However, the omens for any future it might have were not good as its outings were plagued with bad luck in the early days. The damage sustained due to a crash following a burst tyre during practice in the 1920 Whitsun Brooklands meeting, its first race, stopped it from racing; later in the year a stalled engine led to it being withdrawn from its next event. It finally did prove itself a few months later when René Thomas succeeded in taking the course record at the Gaillon Hill Climb in France with a 108 mph (173.8 km/h)

ABOVE Back in action: the Sunbeam 350hp at Goodwood

BELOW The original Blue Bird mounting a record attempt on Pendine Sands



run on the 1 kilometre hill.

While Kenelm Lee Guinness was perhaps one of the few drivers able to get the best from the car, even he suffered from its gremlins. The first time he drove it the following year in the Lightning Short Handicap, at the Brooklands Easter meeting, he lost second gear. However, this setback didn't prevent him from finishing second in the Long Handicap event later the same day. At the Autumn meeting he again finished second in the Long Handicap race, achieving speeds of 140 mph (225.31 km/h).

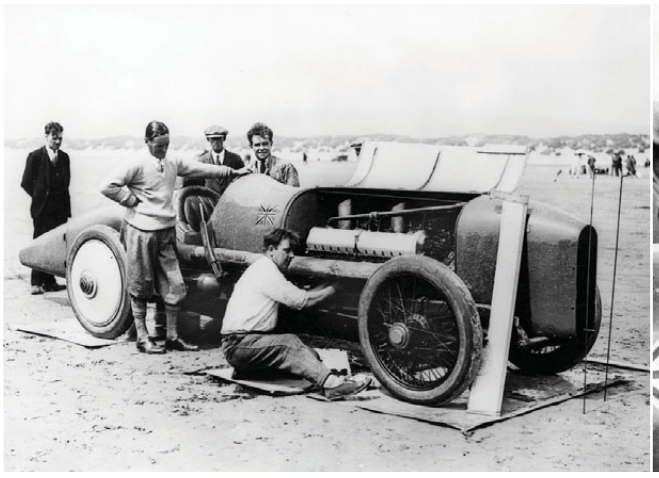
1922 was the year that the Blue Bird Sunbeam finally started to make its mark, Guinness bringing it to Brooklands on 17 May with the sole intention of breaking a few records, which he achieved. Among those that he took were the Brooklands lap record at 121.54 mph (195.59 km/h), then the flying-start land speed records over a half-mile, kilometre, mile and two miles, the fastest one being 136.05 mph (218.95 km/h) for the half-mile. It turned out that these were the last land speed records to be set on a racetrack rather than a beach or salt flat.

THE MALCOLM CAMPBELL ERA

The car was then acquired by Malcolm Campbell in 1923. He saw in it the opportunity of achieving his long-desired ambition of being the first man to reach 150 mph (241.4 km/h). After repainting it in his familiar blue colour scheme from the original green, he took it to Denmark in June where the Danish Automobile Club was holding its International Speed Trials on the beach at Fanoe Island. However, he was thwarted in setting a new speed record, not due to the car letting him down but by the timing apparatus. He had achieved a mean speed of 137.72 mph (221.63 km/h) for each way of the 1 kilometre course, which included a speed of 146.4 mph (235.6 km/h) in one direction, but it was not recognised by the Commission Sportive as the new record because it did not approve of the timing equipment.

During his runs, though, Campbell discovered at first hand the car's nasty handling trait of yawing to the right that required considerable effort to keep it going straight ahead. So on returning back to England, the car was sent to aircraft manufacturer Boulton & Paul's wind tunnel in Norwich to try to see what could be done to overcome this. The result was that the car was adorned with a narrow radiator cowl, a long tapered tail and a driver headrest, while discs were fitted to the rear wire wheels to improve airflow.

Thus equipped, the following year the ▶



car was taken to the Saltburn Speed Trials in England but despite recording speeds of 142.2 mph (228.8 km/h) and 143.39 mph (230.76 km/h) over the six runs of the two-mile strip, the Commission Sportive was again unable to approve the figures. It maintained that the Yorkshire Automobile Club timekeepers had used hand-held stopwatches rather than the electrical timing equipment required by the official rules.

Campbell then took the car back to the International Speed Trials at Fanoe in June. He ensured that the timing equipment, this time supplied by the RAC complete with an official timekeeper from Brooklands, was approved by the Commission Sportive.

On the first run the car went well, but skidded with both rear tyres coming off. Fortunately Campbell managed to stop safely before ploughing into the crowd, which he had already complained was too close to the track anyway. On the second run, though, disaster did strike when the offside front tyre came off, bounding into the crowd and hitting a young boy who subsequently died from his injuries. The meeting was immediately abandoned.

Never one to give up, Campbell then took the car to Pendine in South Wales three months later in September. There he did finally set a new world record, averaging a mean speed of 146.16 mph (235.22 km/h) over the kilometre. Intent on attaining even greater speeds, but unsure that the car could achieve that magic 150 mph, he put it up for sale with a price tag of £1,500 and made plans to build a new record-breaking car. However, he subsequently changed his mind: perhaps he could reach that elusive speed with the car?

Sporting newly-designed Dunlop racing tyres on well-base rims, the big Sunbeam ran again at Pendine under more favourable conditions on 21 July 1925. There it averaged 150.87 mph (242.80 km/h) for the kilometre and 150.76 mph (242.62 km/h) for the mile. The fastest kilometre was run at 151.48 mph (243.78 km/h) and the fastest mile at 152.83 mph (245.95 km/h), the highest speed officially recorded to that date.

At last he had achieved his ambition to be the first man to exceed 150 mph and the five-year-old Sunbeam had finally shown what it could do. The car was subsequently sold to Ralph Aspden that year. Billy Cotton, the well known band leader and ERA driver, achieved a speed of 121.50 mph (195.53 km/h) at Southport Speed Trials 11 years later, earning a '100 Gold Badge', proving that the car was still able to put in competitive performances.

DECLINE AND REBIRTH

During the Second World War, though, this historic car went into severe decline. It was more or less left to rot until it was rescued by Harold Pratley in 1944. He subsequently loaned it to Rootes Ltd, the successors to the Sunbeam Company, where it underwent a cosmetic restoration for promotional purposes. In 1958 it passed into the care of the-then Montagu Motor Museum where it was brought back to working order and driven by Lord Montagu in various events although it proved to be challenging to keep going with parts often breaking. There were the occasional forays on the circuit, but they always proved to be disastrous. The car remained a museum exhibit, albeit a prized one, for very many years.

While Malcolm Campbell had a burning passion to be the first man to exceed 150 mph, in senior engineer Ian "Stan" Stanfield, with 38 years experience at the National Motor Museum, as it has since become, it had an employee who ▶

ABOVE & BELOW Ian "Stan" Stanfield has breathed fresh life into a machine catapulted to fame by Malcolm Campbell

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had the determination and passion to bring this car back to life. That was easier said than done, as there was simply little or no funding.

"It has been a very painful and frustrating experience," says Stanfield, "because having no funds to rebuild the car, we have had to beg, borrow and steal everything. Where we have been extremely fortunate, though, is in having people like Terry Formhalls of Formhalls, who managed to do the white metalling for nothing for us, while Nick Hood of casting repairs company SureLock did the cold metal stitching on the crankcase. Arrow Precision made a new set of rods based on a patterned king slave rod we sent them, at a very reduced price, while G&S Valves did the valves for nothing for us. The Sunbeam Talbot Register also contributed to various bits and pieces with time and a bit of financing for valve springs and things like that. This is why the rebuild's taken 10 years."

As described in Anthony Heal's seminal book *The Sunbeam Racing Cars 1910-1930*, published by Haynes in 1989, the 12-cylinder engine was not a Sunbeam aero-engine but one that had been specially designed and made for the car. As quoted in the book, Coatalen had written in the *Brooklands Year Book* for 1924 that 'the engine specially built for this car was based, so far as its design was concerned, on the very latest development of the Sunbeam Manitou aviation engine. To adapt it for racing car work several modifications were made.'

THE 18.3-LITRE V12

The aluminium cylinder blocks were cast in groups of three, set in two banks of six, at an included valve angle of 60 degrees. Steel liners and aluminium pistons, with three compression and one scraper ring, were provided. Unlike the 1913 Mohawk engine, in which the big-end rods of each pair of connecting rods worked side by side on the crank-pin, articulated rods were used, which resulted in a worthwhile reduction in the length of the crankshaft; it also meant that the stroke of one bank of cylinders was longer than the other. Officially the dimensions were recorded as 120 mm x 135 mm, but Coatalen wrote: 'The bore is 120 mm and the mean stroke is 138.5 mm and the total cylinder capacity is 18.322 cc.'

The crankshaft, camshafts and connecting rods were all machined from solid billets of nickel-chrome steel. A train of spur gears at the front of the engine drove a camshaft on each bank of cylinders to operate one inlet and two exhaust valves in each cylinder. The latter was actuated by two rockers as on the Sunbeam Arab aero-engine.

Two twin-choke Claude-Hobson HC7 carburettors were mounted between the cylinder blocks and two 12-cylinder BTH magnetos fired two spark plugs in each

Jeff Bloxham

BELOW One of the most significant Land Speed Record contenders, the Sunbeam held the record on three occasions

cylinder. The crankshaft, which was drilled for pressure lubrication, was carried on seven white metal-lined bearings. Dry sump lubrication was effected by three gravity-type oil pumps with an oil tank in the tail of the car.

The engine, multiplate clutch and separate four-speed gearbox were carried in the U-shape subframe which was mounted at three points on the main chassis frame as on the 1914 Grand Prix cars. A clutch stop was fitted to the clutch shaft and a large ribbed transmission brake behind the gearbox was operated by a long external hand lever. The universally-joined propeller shaft drove the bevel rear axle with a ratio of 1.5: 1.

No differential was fitted. The torque and thrust were taken by the underslung half-elliptic rear springs, which were mounted on outrigger brackets further apart than the front springs. Two André Hartford friction shock absorbers were fitted to the front and rear axles.

"The reason the engine had died in the first place after the war was that it used Castrol R, which is a wonderful oil but needs to be replaced after every run and the engine stripped and cleaned," says Stanfield. "However, modern oils are a bit more forgiving as they're not the vegetable-based type, so they don't solidify. We are still running on Castrol but a straight Castrol 30 and either Castrol or Penrite in the gearbox and an equivalent to 250 gear oil in the rear axle.

"You do need to be careful with some of the historic oils, though, ▶

"It has an Albion truck gearbox which is rated at 35 hp, while we're putting 350 hp through it"

White metal specialists

IT'S Boxing Day in 2007 and Terry Formhalls of Formhalls Vintage & Racing is hard at work in his workshop. The job in question is renovating the mains and big ends of a very special engine, the record-breaking Blue Bird Sunbeam, which is still some way away from being run.

"This was at a time when it was just my brother and I working from my home workshop and we had to earn a living," he recalls, "so a project for the National Motor Museum, which we did for love, was done in our spare time.

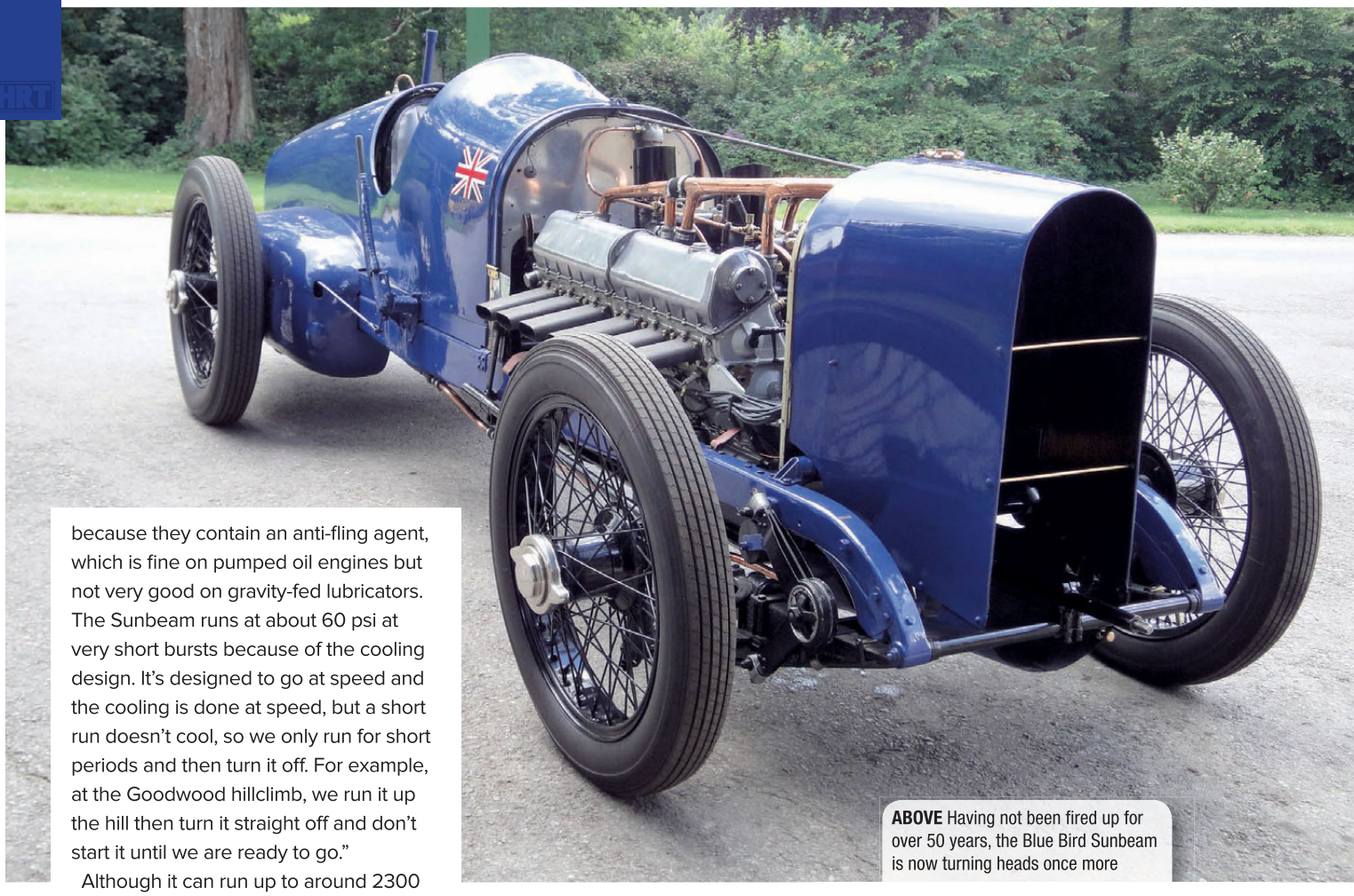
"We did the mains and big ends and had to straighten out the crankshaft as it was quite a bit bent, probably due to the stresses caused by a broken conrod. Fortunately, though, it wasn't cracked and so survived the straightening. The last few thou runout was then ground true.

"On the mains we had to run out the old while metal and then recast the original shell backs. They were then roughed down close to the butt faces. The casting goes over the faces, which we then reduced back down again afterwards. We then rough bored the bearings in the lathe to leave around 100 thou for line boring. The oil grooves were also done at this stage. The mains bearings were then nipped in. This is a long and careful process which involves making sure that the faces of the bearing halves stand slightly proud, a couple of thou per side so that when it's all clamped down, the bearings are an interference fit in the housing.

"The next stage is the line boring machine with the front and back housings clocked off so that we can put a straight line through the crankcases.

"The new conrods where designed to allow the big ends to be metalled direct. They were then bored on our rod boring machines to get the right clearance, which from memory was two and a half thou on the Sunbeam. It's then all bolted in and fingers crossed it still turns.

"Obviously, the Sunbeam is a very important, priceless engine and we were very careful with it as there would be no question of finding another one! However, the process used and care required is very much the same as on any other engine." HRT



ABOVE Having not been fired up for over 50 years, the Blue Bird Sunbeam is now turning heads once more

because they contain an anti-fling agent, which is fine on pumped oil engines but not very good on gravity-fed lubricators. The Sunbeam runs at about 60 psi at very short bursts because of the cooling design. It's designed to go at speed and the cooling is done at speed, but a short run doesn't cool, so we only run for short periods and then turn it off. For example, at the Goodwood hillclimb, we run it up the hill then turn it straight off and don't start it until we are ready to go."

Although it can run up to around 2300 rpm, Stanfield says that nowadays they don't like to run it at more than 1500 rpm. "Between 800 and 1500 rpm you literally rest your foot on the throttle pedal and that doubles the rpm," he says. "It's very delicate and easy to over-rev, which is something we don't want to do."

Items that proved difficult to replace in the rebuild were things like the pistons, in the end being sourced by Venolia in the US. "Being a unique engine, we couldn't get anyone to make pistons at a reasonable price in England," comments Stanfield. "In fact, there's nothing on this car that isn't bespoke – the springs, the axles, the chassis, the engine and gearbox are all unique. That meant we had to do a lot of research as there isn't much out there, so the starting point was stripping the damaged engine and sourcing all the parts.

"Last year we finally managed to get it all back together having stripped the chassis and the axles and everything else, which all needed cleaning and rebuilding. For example, the oil in the axle was solid and had to be chiselled out. It's not an original gearbox. That had disappeared over time so it has an Albion truck gearbox which is rated at 35 hp, while we're putting 350 hp through it. What we want to do is build one with the right transmission brake so the braking system works properly.

"On the original, the footbrake was on the transmission brake on the gearbox while the handbrake was on the rear wheels, so it's been re-engineered at some point, probably in the '50s when the gearbox broke. That meant that the footbrake was running on the rear wheels, which is interesting coming down Goodwood hill because the more you push the brakes, the more the axle twists and the more the brakes come off: you get to a point where the brake pedal hits the flywheel and won't go any further."

The car features a Ferodo-type lining on the rear shoes but originally they were metal to metal except for the handbrake. "We're slowing it down now on those wheels," Stanfield says, "but we've still got the original steel linings so when we get to building the original gearbox, we will put the transmission brake back into it."

The wheels have been rebuilt with new hubs but the actual hubs on the car are original. "The rest of the car is as was although the tail is new because the original was all battered," says Stanfield. "When we first had the car it was displayed in the 350hp Sunbeam format and the tail is the oil tank and fuel tank but it was then skinned over with a streamlined body by Campbell."

While most of the instrument gauges have disappeared over time, the rev counter is original. "Last year at the autojumble here at Beaulieu I managed to find a couple of Sunbeam pressure and temperature gauges which are in period and have Sunbeam written on the cases," he says. "The only modern gauge is that for the fuel pressure and the temperature gauge is of the World War II era."

The steering box is original, with the magnetos working quite well. Still original on the car are Claudel-Hobson HC7 carburettors, as are the water and oil pumps, radiator, flywheel and clutch. The chassis is original, as is most of the body.

"It's never going to be run at speed or land speed records but we want it to be as right as can be, and that takes money," admits Stanfield. "With the right funding and the right will it can be done. Now that it's up and running again, that's what we intend to do." HRT

A new life in the digital domain

William Kimberley meets a man who is relishing his second career

SCANNING is one of those fairly modern technologies increasingly finding a place in historic racing.

For those who don't know it and are put off by the terminology, it is the simple act of scanning a car, or a part of it, and digitally storing it for future reference. Some, like the National Motor Museum, have had their land speed record cars all scanned as a reference point should anything happen; others have their cars scanned to see if they can be improved once the digital components are fed into a computer and analysed. As such it is a handy tool for product development, numerical simulation such as FEA and CFD, advanced surfacing and reverse engineering.

For Stuart Brown, owner of 3D Engineers, it has been a question of being in the right place at the right time, making up for an earlier career when he was in the right career at the wrong time.

"I was in the insurance game before the days of the Internet, working for a broker, but then along came Direct Line and all the other online brokers and that was the end of the line in that profession for me," he says. After a few years of sabbatical while he gathered his thoughts, he decided there may be opportunities in scanning cars and planes and anything else that came along.

Not doing things by half, he read up and researched the technology and also took an engineering degree so he was fully equipped to enter the market. It was a brave move considering that even today it's still not on everyone's bucket list of things they need to do, but he believed that once people could see what he offered, they would want it – and that is the way it has turned out.

Over the last few years his services have been increasingly in demand. For example, he was commissioned by the Bugatti Trust to scan every part of a Type 35 – all 2,800 parts. He flew to the US four times last year to scan customers' cars, and recently shot off to Italy at the drop of a hat to scan a priceless Mercedes-Benz. He also scanned all four of the National Motor Museum's land speed record cars.

"I love what I do," he says, "because I meet such interesting people and see such fabulous cars. I'm not sure I would have had such a good time had I remained in the insurance business." HRT

SOMETHING OUT OF NOTHING

Chris Pickering looks into a revolutionary welding process that makes the impossible possible

WOULDN'T it be great if you could summon something out of nothing? Surfaces worn away over the years magically reinstated, areas ravaged by corrosion miraculously restored and holes plugged – all without having to replace the component itself.

It sounds fanciful, but that's not so far from the truth when it comes to laser welding. We first heard about this technique being used to rebuild material on historic cars during a visit to the Jim Stokes Workshops Ltd (JSWL) last year. At the time, owner Jim Stokes gave the example of a gearbox shaft that had run a bearing; using laser welding it was possible to build up the surface again and then grind it down to a completely seamless repair.

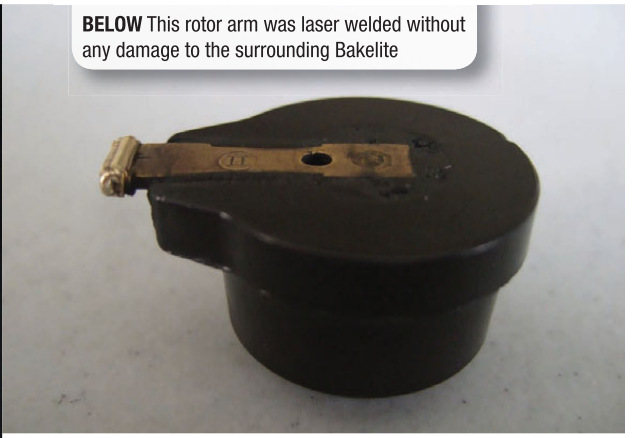
However, that's only the tip of the iceberg – piston crowns damaged by detonation, scoring on cylinder heads, cracks and corrosion damage, even clean breaks where lugs or fittings have detached completely. There isn't much you can't fill, plug or re-attach with laser welding.

Of course, welding parts is nothing new, but this revolutionary technique eliminates some of the traditional drawbacks and opens up a whole new range of options. To find out more we've returned to JSWL.

"The beauty of this approach is that it allows you to recover parts that might not otherwise have been salvageable," explains Stokes. "We recently had a cutter break during the repair on a competition steering box. It's quite a complex part so you really don't want to scrap it and start again. Instead, we had a bit of laser welding done to build up the material again. Once it has been re-machined you won't even know it's there, but the best thing is that it doesn't add temperature into the job."

That last part is key. This particular method is known as pulsed laser welding, and it works by firing a stream of laser pulses at the part you wish to weld and then feeding in new material in the form of a wire. At that precise point the surface of the metal

ABOVE Laser welding was used to repair the cylinder heads on this Ferrari 156 F1 Sharknose recreation built by JSWL



BELOW This rotor arm was laser welded without any damage to the surrounding Bakelite

Another major advantage is access. Due to the nature of the equipment you can reach places that would be utterly impossible with a TIG gun, such as the inside diameter of deep, narrow holes.

EMP

To get a better idea of what is involved we head over to JSWL's welding contractor, EMP. Originally known as Emsworth Mould Polishers, this family-run business first began using laser welding on the tool pieces for injection moulding.

"We'd already done bits of polishing for Jim [Stokes]," explains EMP director, Alan Barker. "When we got the first laser he came straight over to have a look and started asking us questions about how it could be applied to automotive applications."

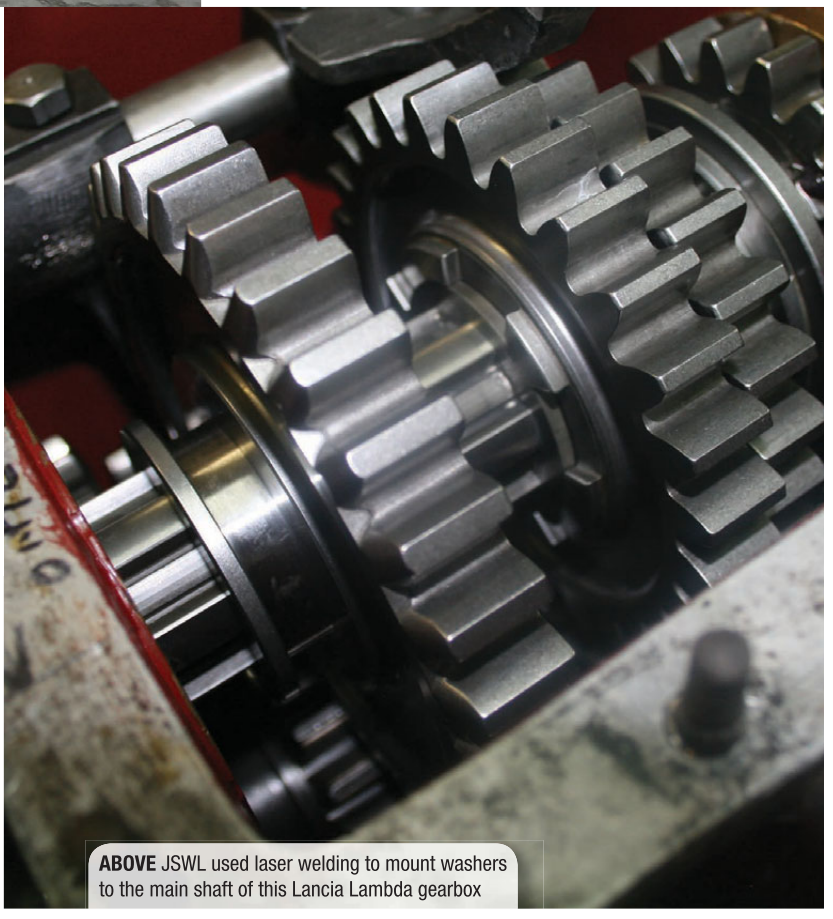
Since then laser welding has come on in leaps ▶

gets extremely hot (somewhere in the region of 3,000°C), but each pulse of the laser is applied to such a small area over such a short space of time that the total amount of heat energy is negligible – something I will later discover for myself in a very hands-on demonstration.

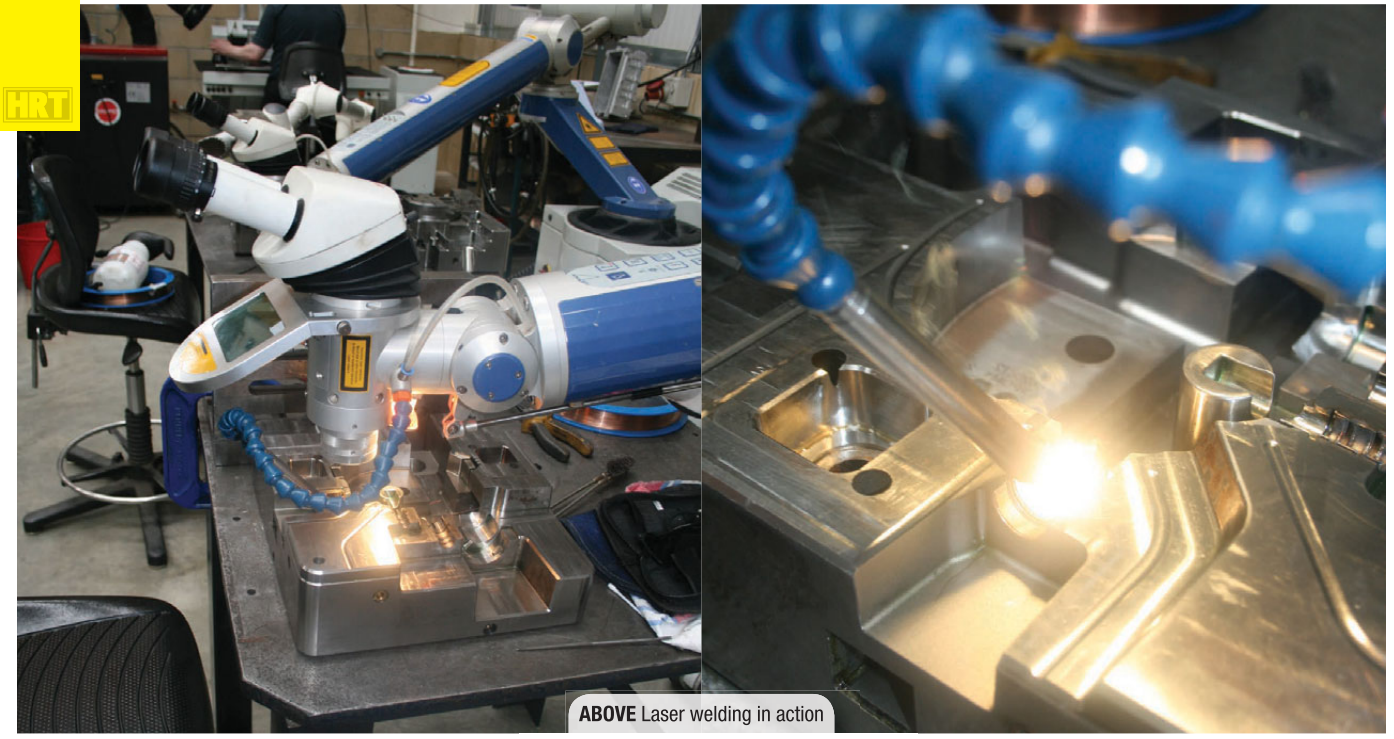
"Heat distortion is virtually zero," explains JSWL workshop manager Tim Sanders. Unlike TIG welding, the parts never have to be heated to prevent distortion and it opens up repairs you simply wouldn't be able to do with conventional methods.

"One of the strangest things we've done with laser welding was a rotor arm," Sanders continues. "The original was completely unobtainable so we had the brass electrode welded back into the centre of the arm. The joint had to be able to conduct and we couldn't get the surrounding Bakelite hot so there wasn't really anything else we could use."

Because the process puts so little heat into the part it also means the heat treatment is unaffected. Using the right wire, it's possible to put down material with a hardness of up to 66 Rockwell – comparable to top-end tool steel – so there's no need to re-apply the heat treatment. Conversely, there's nothing to stop you matching the hardness of the underlying part and then heat treating the whole thing once the welding has been carried out.



ABOVE JSWL used laser welding to mount washers to the main shaft of this Lancia Lambda gearbox



ABOVE Laser welding in action

and bounds. EMP has been using the technique for around 15 years now and Barker says that previously uneconomical repairs have now become viable. "A job that would have taken us six hours to complete on our first laser would be under an hour now," he comments.

Just about any ferrous or non-ferrous metal can be laser welded. Cast-iron, tool steel, aluminium, Inconel, brass, copper, titanium and bronze are all possible. With specialist equipment, some firms can even weld glass and plastics.

"Half the time we don't know exactly what the material is, but it's not a big issue. We know what tends to work with each family of materials," says Barker. "Generally we keep them fairly similar to the base material, but you can do some really wacky stuff – I worked on a Formula 1 engine where we welded copper to aluminium. The important thing is to find a bridging material that will weld to both; because laser welding is so localised you never really get all three metals mixing."

Recently JSWL and EMP have been working together to develop techniques for welding magnesium, which is notoriously tricky with conventional methods. With a laser it is still one of the more difficult mediums to tackle, but the reduced heat soak makes things considerably easier.

At first glance, the laser welding stations in EMP's workshop resemble a brace of robot arms. Each has a base unit that supports the rig and controls its movement, while the 'arm' itself contains the laser. The beam is reflected down a series of mirrors and focused through a lens at the end to fire downwards onto the workpiece, while separate flexible hose pumps inert argon gas onto the joint. Above, connected to the end of the arm, sits what looks like a microscope. This acts like a gunsight allowing the operator to target the weld with pinpoint precision.

The basic act of operating the machine is actually remarkably straightforward and almost clinical in its approach. Once everything is lined up in the crosshairs, a foot pedal is used to fire the laser and the wire can either be fed in by hand or dispensed by a machine. Meanwhile a small joystick is used to move the gun over the part. Outwardly, things couldn't be simpler.

The skill lies not in manual dexterity but in knowing what wire to use and how to configure the laser. There's a faintly bewildering array of settings, including voltage, beam diameter, focal length, pulse duration and frequency. Just to make things more confusing, the various parameters all interact and the same results can often be achieved through different means. For example, increasing the frequency or the duration of each individual pulse can have much the same outcome as upping the voltage. Similarly, if you reduce the beam diameter it focuses the energy onto a small area and the laser effectively becomes more intense.

"After a while you get a feel for it," explains Barker. "I can tell if the settings are right by looking under the scope and listening to the sound. You get to know what works well for a particular material and wire thickness."

Providing there's enough room to insert the wire – possibly from a different route – you can weld anything within line of sight. That includes the bottom of deep, narrow drillings such as bolt holes or water channels. Of course, there are often alternatives, such as opening out the hole and fitting a sleeve or filling it completely and re-cutting the bore, but it's amazing what you can achieve with welding alone.

Incredibly, it's even possible to weld round corners under certain circumstances. Using diamond-polished copper plates you can bounce the laser beam through different angles, like light travelling through a periscope. That way, as long you can bend the wire to follow an equally circuitous route (or feed it in from an alternative angle), it becomes feasible to weld seemingly impossible jobs.

We don't witness anything quite that complicated, but in order to demonstrate the technique, Barker grabs a piece of scrap metal and sits down at one of the welding stations. A line of tiny spots promptly makes its way across the surface as each pulse hits home. The instant his foot comes off the pedal he ▶

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hands me the steel block and encourages me to run my finger over the weld. I can't deny I'm a little hesitant at first, but sure enough, the weld is close to room temperature a matter of seconds after we saw it being formed.

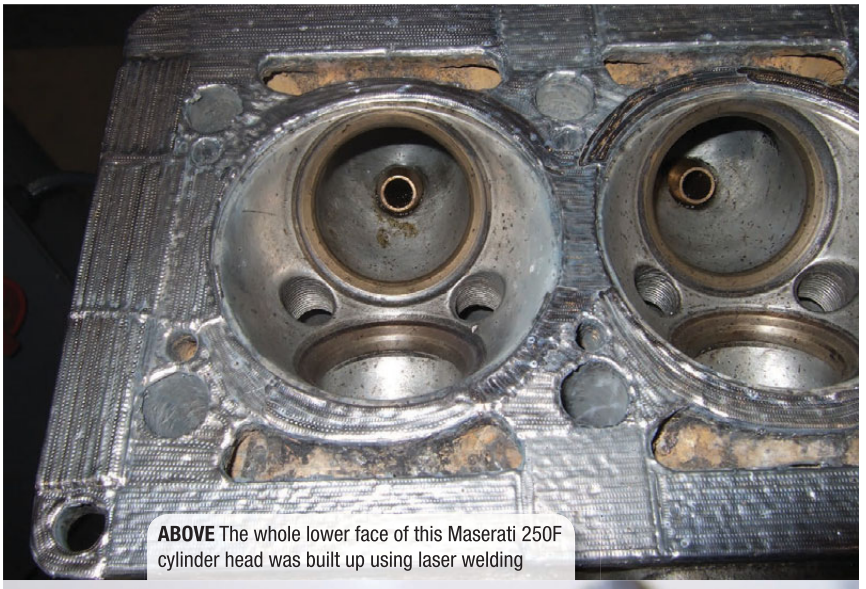
For the more intricate jobs, EMP tends to operate the lasers manually, but the technique does lend itself quite nicely to CNC control, at least for simple operations like rotating cylindrical parts or building up square pads.

"We did a Maserati 250F cylinder head. The whole of the lower face of the cylinder head needed building up to a depth of several millimetres and there was a sealing groove running right the way round the opposing face on the cylinder block that needed filling," Barker recalls. "The underside of the head was a very large area with relatively simple geometry, so it was definitely worth CNC programming."

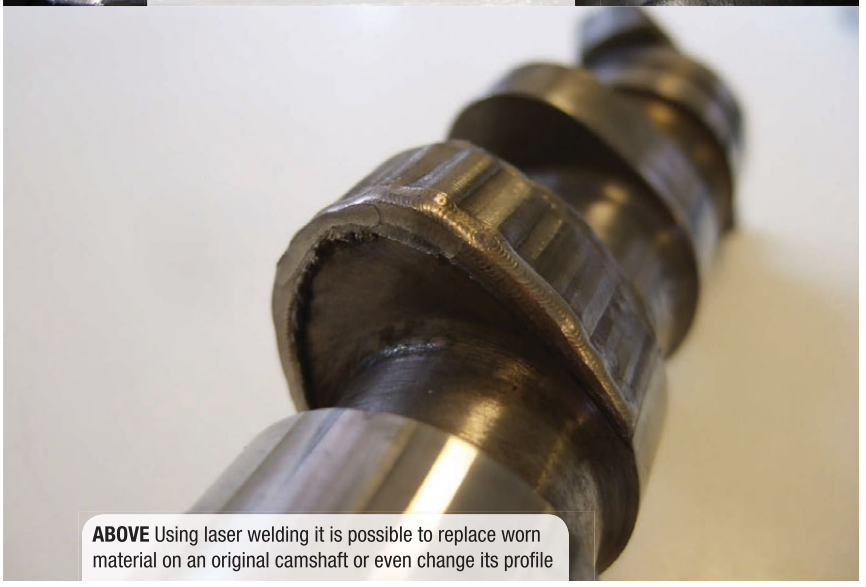
However, even with the use of automation it wasn't going to be a cheap operation. "When the owner came in I warned him the cost might be prohibitive, but he said 'try me'.

"The base material was so poor we had to run the laser over the surface to re-melt it before we could go back and put the new weld down. Some areas that looked quite good just collapsed into voids when we began welding."

The final bill ran into the thousands, but it was still around a tenth of the cost of a new one-off cylinder head – and more importantly, it allowed the owner to retain the original casting with virtually no trace of the work that had been carried out.



ABOVE The whole lower face of this Maserati 250F cylinder head was built up using laser welding



ABOVE Using laser welding it is possible to replace worn material on an original camshaft or even change its profile

MYRIAD APPLICATIONS

At times, laser welding can even be used like a coating. For example, applying a layer of ultra-hard D2 tool steel onto the edge of a mild steel part. It's also compatible with anodised materials and most traditional surface treatments.

"We've used it to build up material on camshafts quite a bit over the years," explains Barker. "Generally these are case hardened and we can go straight on with a hard material to match the original surface. In one instance we've even been asked to build up the surface so the cam can be re-ground to a new profile."

The process also works well with other treatments. On older cylinder head castings where porosity can be an issue, JSWL often combines laser welding and ceramic sealing. Likewise, on occasions where TIG welding is more cost-effective for the bulk of the job, a laser can be used to touch up any blow holes.

It is not just for substantial chunks, either. Thanks to its low heat distortion, laser welding works beautifully on thin-wall fabricated parts. A couple of the examples EMP has tackled include vintage mudguards and a set of F1 intake trumpets that came to the workshop in a variety of pieces. In all these cases the new material can then be ground, machined, milled or polished just like any other metal.

As Sanders points out, "laser welding is a fix-all solution." So where's the catch? Predictably, it's cost, but not to the extent you might imagine. In some instances, the upfront cost can actually be lower than TIG welding. Other times the welding itself can be as much as 10 times more, but that's often cancelled out by the fact that you don't have to spend additional money preventing or correcting distortion. Then, of course, there are the times when traditional methods simply wouldn't be possible.

"Some of the most challenging examples are cylinder head cracks," says Sanders. "An original cylinder head is such a valuable component and you're talking tens of thousands if you have to re-cast the whole thing. Even something small like a damaged tooth on a crown wheel and pinion set could be upwards of £2,000 to replace, but a laser repair might only cost £100."

So it's not quite something from nothing, but in the context of the value of, say, an original Maserati 250F cylinder head or a Bugatti Brescia gearbox it's really not that far off.

Seven decades and still going

It may be the world's longest-surviving constructor of racing cars for customers, but Crosslé's not just in the heritage game. **William Kimberley** reports

WHAT do Derek Daly, Eddie Irvine, Eddie Jordan, Nigel Mansell, John Watson and Chip Ganassi all have in common? Without the last name, it would have been Formula 1, but including Chip, the answer is Crosslé, whose cars they all drove at some point, usually at the start of their career.

This racing car manufacturer has provided the springboard for many more drivers than those just mentioned, producing cars that have competed over the years in Formula Junior, Formula Ford, Formula 3, Formula 2, Formula Atlantic, Super Vee and even Formula 5000, let alone a number of sports racing cars and a trials model. Unlike many iconic constructors, however, this is not only a name from the past but a living, ongoing business.

Still located in the same discrete premises on the outskirts of Belfast in Northern Ireland from which it has operated continuously for the last 55 years, Crosslé continues in the business of building competition cars, although the last single-seater to leave its premises as a new car was the 72F in 1989. Since then the company has produced the 80T trials cars and the 9S sports racing car.

While the company has remained in one place, its ownership has changed. In 1997, founders John and Rosemary Crosslé sold the business to Arnie Black, who then successfully navigated it during a critical 'boom and bust' 15-year period.

> **"I didn't take the company over as a heritage project or simply to revel in the past, but to drive it forward"**

Black made it a priority to continue production of the pretty 9S, a car that first appeared in 1966 at a time when Abarth, Brabham, Chevron, Elva, Lola and Lotus were all bringing out sports racing cars. This particular Crosslé was reborn, revised and updated from the original drawings 20 years later. Known currently as the 9S Zetec it continues in production to this day, together with the original 9S HTP (Historic Technical Passport).

Resuming 9S production followed the FIA's decision to permit original manufacturers of racing cars to produce continuation models to comply with its then-new HTP regulations. Subsequent rule changes meant that HTPs could be obtained for replica cars from sources unrelated to the original constructor, provided each car complied with period specification of the particular model it represented. The 9S HTP is consequently built to the rules of the 1966 European International 2.0 Litre Group Six Championship, updated only to comply with current safety requirements. With the 2.0-litre BMW or 1600 Lotus-Ford twin cam, it is eligible to race in a growing number of prestigious events including the FIA Masters Historic Sports Car Championship, Classic Endurance Racing, V de V Endurance Series and the HSCC Martini Trophy.

In the meantime, the company again changed hands when global businessman, racer and Crosslé collector Paul McMorran, who worked as an engineering undergraduate in the famous Harland & Wolff shipyard, acquired it in November 2012.

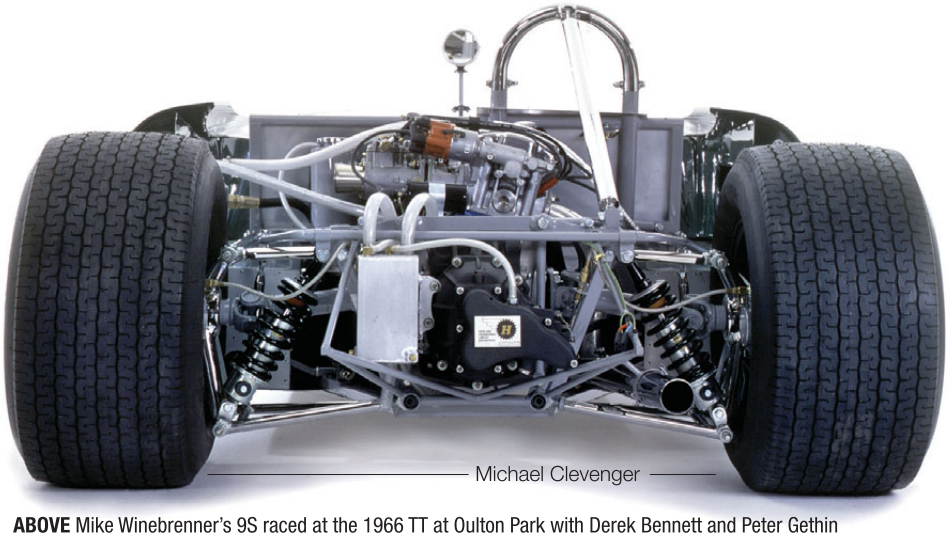
Gilles Bouvier

NOT LOCKED IN THE PAST

"Some people think of us as a company focused on the past. Obviously our historical achievements are something we're very proud of and want to continue the association with," says McMorran. "We aren't a museum or a historic racing club, but the world's longest-surviving constructor of customer racing cars. I didn't take the company over as a heritage project or simply to revel in the past, but to drive it forward and keep the company growing because that's the only way to succeed. So I have been thinking very carefully ▶

ABOVE John Crosslé with his all-new 60F in 1985 — Esler Crawford

ABOVE Crosslé owner Paul McMorran, a well-known competitor in historic racing across Europe, in his 22/26F Formula Atlantic at Dijon


Michael Clevenger

ABOVE Mike Winebrenner's 9S raced at the 1966 TT at Oulton Park with Derek Bennett and Peter Gethin

about which aspects of the business need to be conserved and nourished, which parts need to be eventually wound down, and what needs to be developed and built up, or even introduced from scratch.

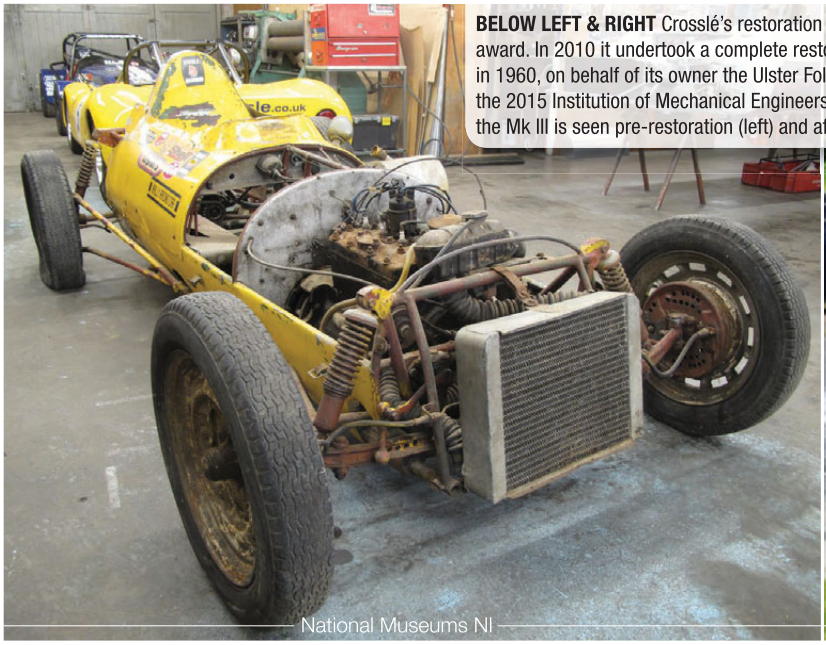
"One of the strengths of Crosslé is that while it was a small company based in Northern Ireland, the majority of its products back in the day were exported, mostly to the US. The situation in Northern Ireland through the 1970s and '80s was difficult and potential customers in England – the obvious target market for most of our production – had a huge choice of alternatives on their doorstep. To travel to Northern Ireland at the time was not an obvious thing to do. As a result Crosslé never really cracked this market to the extent that it might have done, had circumstances been different.

"On the other hand, whether they were buying a car from Northern Ireland or from England, it was pretty much the same thing for customers based in the US and for that reason Crosslé had a good market there. Our cars were also competitive, strong, user-friendly and easy to repair and service and so were very successful in the States. As a result, Crosslé became a stronger and better-known brand in the US than in England or Europe. For example, around two thirds of the Formula Fords built between 1973 and 1983, around 700 of them, were sent to the US. Skip Barber's racing school bought scores of cars that ended up in the hands of private owners, where they continue to be raced to this day. Formula Ford is still very popular there."

An interesting observation that McMorran makes is that historic racing in the US is quite different to anything happening in the UK or Europe. "Racers in Europe compete in historic racing at the level that their budget will permit, aspiring ultimately to prestigious events like Goodwood or Monaco. However, it seems different in the US, a huge country with perhaps less of a hierarchy. American historic racers tend to be more laid back about results, with some clubs and circuits offering a comfortable clubhouse and social events as part of a 'country club' experience, rather than pure racing.

"Our agent in California continues to look after the cars and supply spare parts, and we're working with a new partner on the East Coast to develop our presence there. We also have Esprit Compétition in the south of France and useful contacts in other countries.

"I want to see us grow and create new overseas opportunities. There are traditional markets like the US and some parts of Europe where I think we have potential. However, I think the Crosslé brand remains underdeveloped compared to some, and leaders like Classic Team Lotus show what can be achieved. Our profile reflects the personality of our founder, an extremely modest over-achiever but under-presenter of himself and the company. While John's cars spoke for themselves in the past, I think nowadays we have to more actively promote our products and the company." ▶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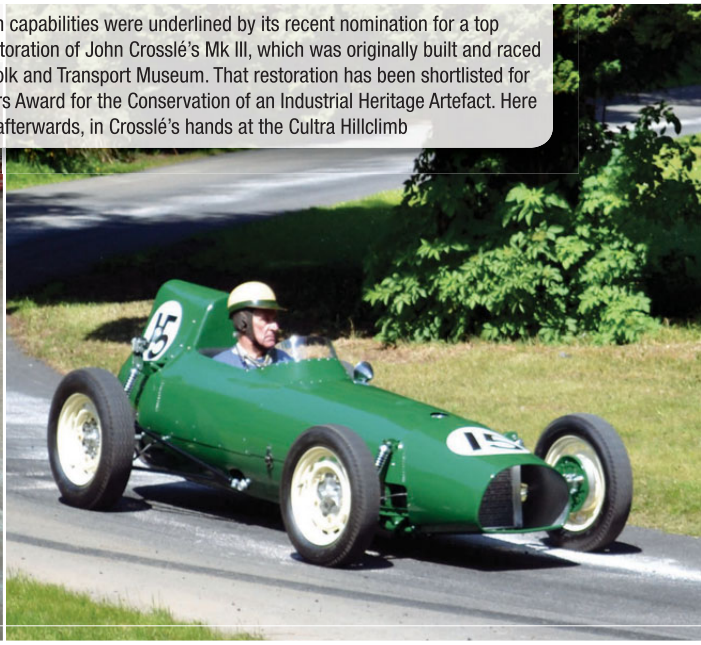


BELOW LEFT & RIGHT Crosslé's restoration capabilities were underlined by its recent nomination for a top award. In 2010 it undertook a complete restoration of John Crosslé's Mk III, which was originally built and raced in 1960, on behalf of its owner the Ulster Folk and Transport Museum. That restoration has been shortlisted for the 2015 Institution of Mechanical Engineers Award for the Conservation of an Industrial Heritage Artefact. Here the Mk III is seen pre-restoration (left) and afterwards, in Crosslé's hands at the Cultra Hillclimb

The Crosslé 9S reborn

MCGP

Crosslé 9S Zetec

Chassis	Tubular steel spaceframe with integrated ROPS structure in T45/4130 and hardened aluminium floor
Front suspension	Unequal length wishbone, adjustable anti-roll bar
Rear suspension	Lower wishbone and transverse link. Upper and lower trailing links. Adjustable anti-roll bar
Brakes	Wilwood callipers all-round, mounted outboard front and rear, with cockpit-adjustable brake bias
Steering	Rack and pinion
Engine	Dunnell-tuned Ford Zetec 2.0-litre twin cam with Weber carburettors, producing 220 bhp (and typically allowing 2-3 seasons between rebuild)
Transmission	Hewland Mk9 5-speed gearbox with LSD and series 5 gears
Bodywork	Lightweight, self-coloured fibreglass body in six sections

Tom Maxwell

Crosslé 9S HTP

Chassis	Tubular steel spaceframe following original 1966 design, modified only to incorporate FIA roll structure and other safety requirements
Front suspension	Unequal length wishbone with silentblock bushes incorporating adjustable coil spring damper units and spring platforms
Rear suspension	Lower wishbone with silentblock bushes and trailing link with adjustable coil spring damper units and spring platforms
Brakes	Solid disc front and rear with Girling AR3 callipers using cockpit-adjustable brake bias
Steering	Rack and pinion
Engine	BMW M10 2.0-litre developing 215 bhp or Lotus-Ford twin cam developing 180 bhp
Transmission	Hewland FT200 5-speed gearbox with LSD or Hewland Mk5 5-speed box
Bodywork	Lightweight self-coloured fibreglass in four sections. Aluminium alloy sidepods riveted over spaceframe and containing fuel tanks

'NOT YET' TO NEW SINGLE-SEATERS

McMorran says that he is sometimes asked whether he will return the company to making single-seaters again, but resists the idea for now. "The last new single-seater we built was the Formula Ford 72F in 1989 – there hasn't been one since – and I am very conscious of that. While nothing is ruled in or out, there has to be a sound commercial basis for any new project. The market that supported the dramatic expansion in Formula Ford in the '70s and '80s no longer exists, and I'm reluctant to dive into something like that just for the excitement of it. We have enough excitement anyway, investing for the future while still balancing accounts at the end of the month!

"The cars that we do build are competitive and rewarding to drive, but they are also things of beauty that are constructed in a way that we are very proud of. There are modern competitors like Radical that have a terrific product and have done fabulously well, but theirs is very different from the one we are selling. People buy a Radical to race and to win and to move onto something more exciting. People buy a Crosslé 9S because it's lovely to look at as well as drive, it's beautifully made, and they'll want to keep it for decades. It's not a stepping stone to something else."

An important revenue stream for the company is the repair of Crosslés and similar racing cars of other marques, as well as restoration and preparation of historically significant competition cars. Recent examples include pre-war racing machinery from Aston Martin and MG and the 4WD 500 cc McCandless Formula 3 car that will feature at Goodwood in 2015, through Brabham, Lotus and Chevron to modern machinery.

"One thing that has become apparent in recent decades is that historic racing is a growth industry. Although Crosslé may no longer be at the cutting edge of club racing as we were until the late '80s, we are now very much at the centre of historic racing in those areas in which we are involved," says McMorran. "I would say we are exceptional in the service we can provide to owners

of cars that are eligible for historic racing. Quite often we are contacted by customers near the end of their tether, trying to find some obscure part or specific skill after scouring the usual outlets, without thinking of contacting us. We often have this on the shelf, or can deliver it quickly and at a competitive price compared to their previous experience. This is a niche for us that's not fully exploited.

"We hold a large stock of spare parts for most Crosslés, and can usually send these worldwide within 24 hours. We also have a unique set of original jigs, moulds and drawings back to some of the earliest cars. For example, only three 15F Formula 5000 cars were built, but original drawings and jigs helped us provide parts for the two cars racing this year at Monterey.

"I'd like to see more of the old cars restored and in use, and also make historic racing simpler and more accessible to a wider group. Historic motorsport can still be affordable, Formula Ford being an example of that. We also support customer cars at circuits and occasionally rent cars of our own. I'm constantly looking for new opportunities to grow the business in ways that are consistent with our focus on constructing and restoring competition cars. In every case there has to be a compelling commercial argument for doing it.

"Looking ahead five years, I want to grow the Crosslé business in order to provide the level of service that I believe customers will expect. This means investing and doing new things, which are only possible if we're generating cash and getting the basics right. So we have to tread carefully. Ultimately, I would like to be in a position to introduce new products and new cars, and to grow our activity internationally. In the meantime, keeping in touch with customers means that I still have to occasionally get behind the wheel of a historic Crosslé or two of my own." HRT

Martyn Goddard

ABOVE A loft with a difference! An overhead crane and hinged opening in the floor allow Crosslé to store chassis, spare parts and complete cars upstairs at its purpose-built Rory's Wood base. The Lotus 22 and Brabham BT28 seen here in red (as well as the Crosslé 7S in blue) are customer cars, typical of the kind it maintains in addition to its main activity of building and maintaining cars of its own manufacture

Why a lined bearing has torque

Regarded by many in the motorsport industry as the guru on all rod end matters, **John McCrory** of Aurora Bearings explains the principle behind the self-lubricating PTFE lined bearing

SELF lubricating rod ends and spherical bearings first appeared on race cars in the early 1960s. Their zero clearance fit and maintenance free nature have resulted in the type becoming universal in most forms of motorsport. However, the preload fit can be an impediment to smooth repeatable linkage movement, but hopefully this will help explain why a lined bearing has torque and how it may be managed.

The torque fit of a lined bearing basically results from two things – the thickness of the liner being greater than the radial clearance that exists between the race ID and ball OD ie the compression of the liner, and the co-efficient of friction at the ball/liner interface. While the liner thickness and compression are a result of manufacturing, and generally not user-controlled, the co-efficient of friction can be user-managed.

People often refer to self-lubricating PTFE lined bearings as "Teflon coated". The liner is not a coating as one would find on cookware but rather a PTFE component for lubricity, combined with a carrier, typically a fabric, which gives it load bearing strength.

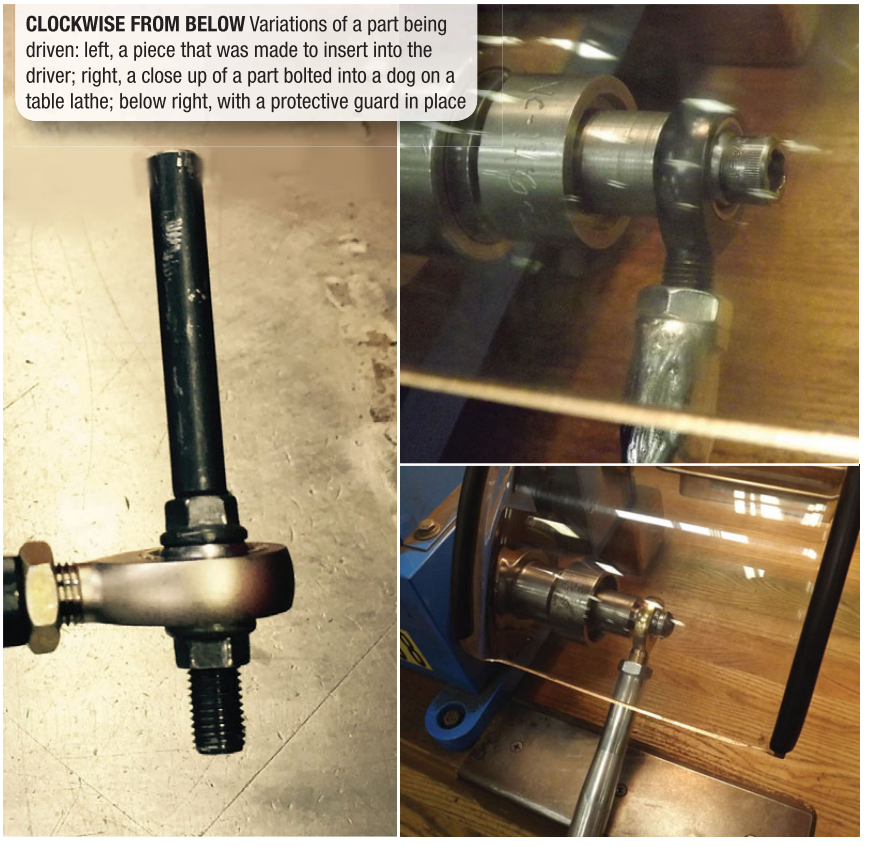
At this point, we will break for some legalese. PTFE is the commonly used abbreviation for PolyTetraFluoroEthylene, a synthetic fluoropolymer of tetrafluoroetheylene. This was discovered by DuPont in 1938 which aggressively and proudly protected their trademark for PTFE, Teflon®. Basically, it should be understood that despite the vernacular use of "teflon", Teflon® is PTFE, but not all PTFE is Teflon®. Use of the Teflon® brand requires express permission and license from Dupont.

PTFE itself is a poor bearing – its compressive strength is only on the order of 10-15,000 psi, but it is an excellent lubricant. However, combined with a fabric , the resulting liner system can have a compressive strength of 50,000 psi or more.

When a bearing is brand new, the liner is in its thickest state, and the co-efficient of friction is highest as no PTFE transfer has occurred; the liner surface upon which the ball rides is not homogenous PTFE, but rather portions of it suspended in a resin, or interwoven with the carrier fabric.

However, as the surface of the ball picks up PTFE from the liner under pressure and movement, it is transferred back to what were initially non-PTFE liner surfaces. This continues where sufficient PTFE becomes burnished onto the ball surface as well as across the liner to the point where no more is transferred as the co-efficient of friction between ball and liner is low enough.

This transfer rate is governed by variables such as load, amount and speed of movement. In instances where ▶



CLOCKWISE FROM BELOW Variations of a part being driven: left, a piece that was made to insert into the driver; right, a close up of a part bolted into a dog on a table lathe; below right, with a protective guard in place

ABOVE Three different components being driven in three different ways. The cutaway (bottom right) is a cross-section of an insert for a rod end bearing showing the outer raceway and the inner ball, with the dark line between the two being the PTFE liner

there are many rod ends in a group or system, such as on the suspension of a race car, this PTFE transfer or "bedding in" can occur at different rates in different locations. However, it is commonly seen as desirable to have all bearings in their optimum state so their torque and resistance to movement are consistent, leading to the action of the suspension, steering, and related control systems being consistent.

In applications where it is desired that all bearings in the system are at their optimum friction level as soon as possible and all at the same time, operations are carried out to "bed in" parts prior to actual use. As a generalisation, a method is found to drive or rotate the ball at a constant speed. For instance, a rod end is fixed in a mating part such as a tube and a bolt is located in the bore of the ball and held in place by a nut. The bolt is then driven, for example by a lathe, at a relatively low constant speed, something less than 100 rpm. Technically, most manufacturers recommend a maximum surface speed for the ball of less than 20 feet/minute, but with no loads 100 rpm is a broad, consistent and safe speed. In addition, the part may also be oscillated.

At a certain point, a full PTFE transfer will be achieved and the torque felt on the mating part will have decreased to a lower, consistent value as compared to the initial condition. If the part gets noticeably hot or begins to smoke, the process must be interrupted until the part cools to ambient temperature. No supplemental lubricant should be used as these are definitely not recommended, either in this process or with PTFE liners in general.

In all cases, not just with the running-in process, lubricants present a unique problem when used with a lined bearing. The introduction of supplemental lubricants such as oil or grease or of moisture/corrosion inhibitors can in fact have a detrimental effect on the performance of PTFE liners.

The transfer of PTFE from the liner to the ball and back is the basis of the self-lubricating nature of a lined bearing. When a lubricant is introduced, the lubricant film that develops between the ball and liner acts as a barrier that impedes the burnishing action. The movement between the two surfaces can remove the exposed PTFE from the liner face, but the material will not adhere to or burnish on to the ball surface. Eventually, the wear surface of the liner may have all the exposed PTFE material removed at which point the coefficient of friction between the uncoated ball and the wear face of the liner will drastically increase.

In the normal cycle of PTFE transfer, as it is no longer exposed above the liner surface, localised portions of the liner are removed to expose additional PTFE and continue the self-lubricating transfer cycle. In the case of a lined bearing that has been lubricated, little or no PTFE is exposed above the liner face, not just locally but around the entire ball surface, and degradation of the wear face to expose sufficient PTFE cannot occur fast enough. When this occurs, a used bearing will actually become or be tighter than when new. "Running-in" will jump start and accelerate the PTFE transfer process, ideally recreating a PTFE on PTFE interface.

Whether it is to establish the optimum friction level on new, unused bearings, or recreate a PTFE on a wear surface after it has been compromised, running-in is an effective and established procedure and can be a benefit when done correctly. HRT

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GIVING SHELTER

From emergencies around the world, to military deployments in theatres such as Afghanistan, the inflatable shelter from Aireshelta is a required piece of kit. Its popularity is also growing in motorsport, as **William Kimberley** finds out

AIRESHELTA has been recognised as the leading inflatable shelter manufacturer for over 26 years, its core business being the supply of rapid deployable shelters to the emergency services. As such, it can boast that every Blue Light service in the UK, Isle of Man and the Channel Islands has owned and regularly used one of its products.

The design and product teams are used to meeting any task, creating cutting edge shelters that provide practical solutions for a number of challenges, regardless of size or environment. Often its shelters have had to undergo rigorous testing to ensure that they can survive in rugged climatic and operational conditions, such as Afghanistan, where shelters were used by the armed forces to support maintenance and logistics operations.

Listening to the requirements of the modern emergency services that carry ever more equipment, gone are the old, heavyweight products, replaced by a new breed of lightweight and compact sealed beam ones.

Sealed beam construction gives shelters from Aireshelta much greater strength in all weathers than flimsier shelter systems, and wide standing pads and water-filled side skirts provide strong anchoring. Once assembled, sealed beams give shelters the robustness required to withstand bad weather.

As the name suggests, they do not rely on a constant running inflation fan but a small compact inflation blower which is provided to give an inflation time of under two minutes. As one customer recently remarked: “It takes our kettle longer to boil than it does to inflate the Aireshelta.”

The company is very proud to be the chosen supplier to Marshalls of Cambridge for the manufacture and supply of the specialised Airesheltas used by the Ministry of Defence for the repair and service of military vehicles in current war zones. It is also the chosen supplier to the Nationwide Crash Repair Centres for the purpose-built and designed Inflatable capsules seen on many driveways for the repair of scratched or damaged vehicles.

It is the current managing director’s absolute passion for motorsport that led to the “excuse” of being able to extend the Aireshelta product range into the motorsport market. As such, Aireshelta is a regular exhibitor at the Autosport International show, Race Retro and Goodwood.

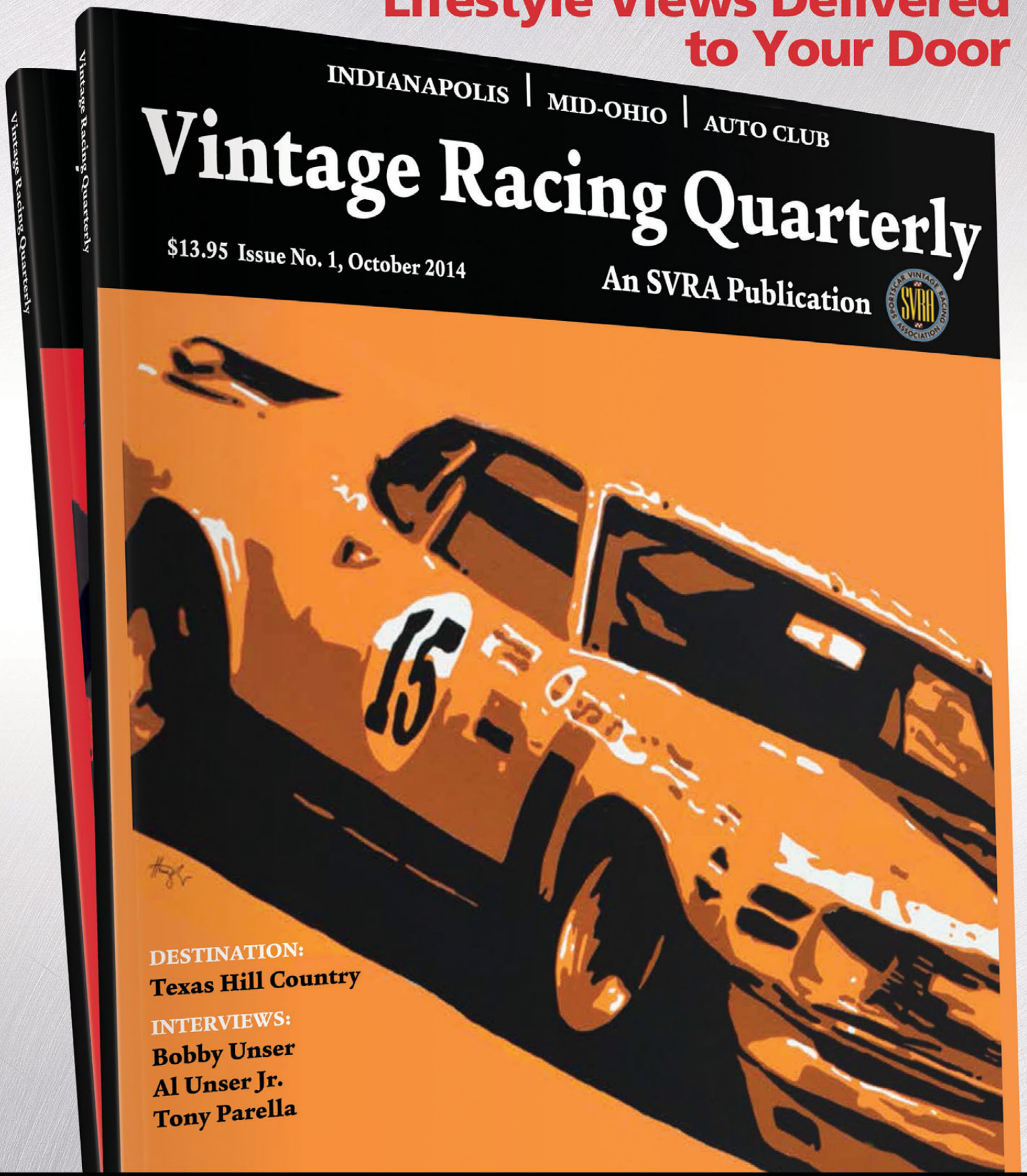
Over the last eight years, the company has seen a year on year growth in the number of Airesheltas, providing shelters to professional and amateur motorsport for many years, from individual teams competing in all classes, up to Formula 1 and the forthcoming – and very large-scale – Bloodhound SSC (Super Sonic Car) attempt to establish a new land speed record of 1,000 mph.

A certain amount of trust in the product had to be gained due to the fact that everyone only had the choice of the Ezzy-Up type frame shelters. Not that there is anything wrong with frame shelters if the requirement is only for a low-priced temporary shelter that is infrequently used. However, an Aireshelta makes more of an impact in the paddock, claims the company.

The standard sizes are 3 x 3 Paddock Pod and the 3.6 x 5 AirePod, which is ideal for kart or motorcycle racers, but it is the 4.5 x 5 CarPod, which is aimed at the individual driver running his own car, that has been designed to accommodate a standard size car and allow both doors to be opened when parked inside. The shelters can also be designed to allow equipment containers and portable workshops to be integrated through the sidewalls. HRT

ABOVE Aireshelta is making inroads into the motorsport market

North American Vintage Racing and Lifestyle Views Delivered to Your Door



Vintage Racing Quarterly celebrates the SVRA lifestyle at its best. ***VRQ*** offers quality photography and editorial about the cars, events and lifestyle of SVRA members and the sport of vintage racing in the US. It also delivers a unique look at the broad activities and interest of vintage racers: travel, new car reviews, racing legends interviews, history and racing destinations and more.

1 year (4 issues): US $44; Int'l $70
2 years (8 issues): US $76; Int'l $125

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First Principles

The Official Biography of Keith Duckworth OBE
Norman Burr
Published by Veloce
ISBN 978-1-845845-28-5
352 pages (hardback)
£35.00

THIS is a book that is long overdue. Anyone worth their salt knows that Keith Duckworth has to be one of the motorsport engineering stars of the 20th century, the list of engines to his credit long and extensive, the DFV being the one that perhaps most readily trips off the tongue.

Author Norman Burr is a technical journalist who trained as an engineer at Rolls-Royce Aero Engines and so knows what he is writing about, his attention to detail about Duckworth and his work breathtaking. The book is full of quotes and nuggets of information that are fascinating and memorable.

The book covers Duckworth's entire life with interviews from various family members as well as many people who worked for Cosworth. According to the author, the company was a breath of fresh air where everyone was encouraged to have their say and argue their case when typically in the 1960s and '70s, British engineering companies were very traditional, rather stuffy and out of touch.

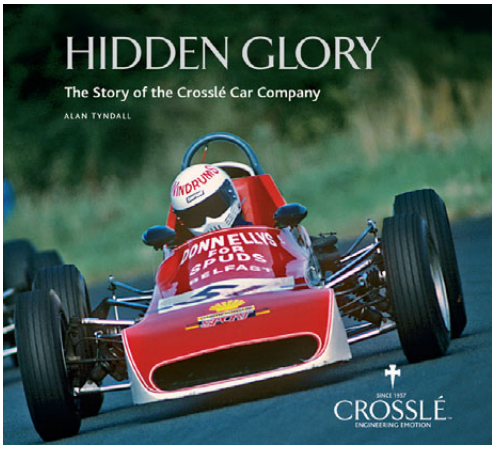
According to a quote in the book, part of the company's success was reversing the Peter Principle, which states that managers rise to their level of incompetence. Instead, a Duckworthism, as the book terms it is: "I think we (Cosworth) always managed to under-employ people. We achieved higher standards than the others – it came from not promoting people to the level at which they're making a lot of mistakes. It's the reverse of the Peter Principle."

Interestingly, bearing in mind today's political infighting in Formula 1, in Duckworth's ideal world, everyone in motorsport would behave reasonably and logically and there would be no need for politics and backbiting and the best drivers and equipment would naturally rise to the top. Nothing, it seems, changes.

As good as this book is and should be read by everyone interested in motorsport history and in an engineering genius, it is unlikely that Duckworth himself would have read it. According to the author, he quotes him as saying that "…..I decided to stop reading books, which only tend to mislead me. I decided that it was always better to work things out from first principles." HRT

Hidden Glory

The Story of the Crosslé Car Company
Alan Tyndall
Published by Booklink
ISBN 978-1-906886-59-2
224 pages (hardback)
£60.00



AS reported in this issue of the magazine, the Crosslé Car Company is Britain's longest surviving manufacturer of customer racing cars and this book commemorates this gem of a company.

With a foreword by John Watson, the book chronicles the journey this company has been on since John Crosslé set up shop on his father's County Down farm in Northern Ireland 60 years ago, initially welding up people's rusty old cars, rebuilding tractor and car engines and undertaking anything that came his way.

However, it was not long before he started to build his own cars, the Crosslé Mk 1 being cobbled together in March 1957, but at its first outing it was disappointing. However, niggling misfiring problems were soon ironed out, leading to a memorable day a year later on 18 March at Newtownards Airfield circuit when he won his first race in his own creation. It was the launch pad of a company that continues to fly today.

This beautifully presented book, which is extremely well illustrated with hundred of pictures never seen before, really does justice to this company, while the text is full of anecdotes and interesting facts.

A chapter is devoted to the US as it was such an important market for Crosslé, America proving to be more of a home market that England and that is thanks to Bruce Klussman, an American who ran an ice cream and dairy business in Pennsylvania who unexpectedly turned up at the factory in 1965 and ordered a 6F. He then returned a year later to help build a 12F which he took to victory at Watkins Glen on 15 October that year to claim Crosslé's first win in the US. It was one that opened the floodgates.

This book deserves to be on the shelves of everyone who is remotely interested in motorsport history and is a tremendous tribute to John Crosslé, the man who started it all. HRT

Unfair tax or a necessary evil?

Historic Technical Passports may not be universally popular but they are essential if there is to be any sort of cohesion in historic motor racing – as **William Kimberley** discovers when talking to historic racer Josh Sadler

TO many, Josh Sadler is Mr Porsche, his Autofarm business being a Mecca for Porsche owners and enthusiasts over the years.

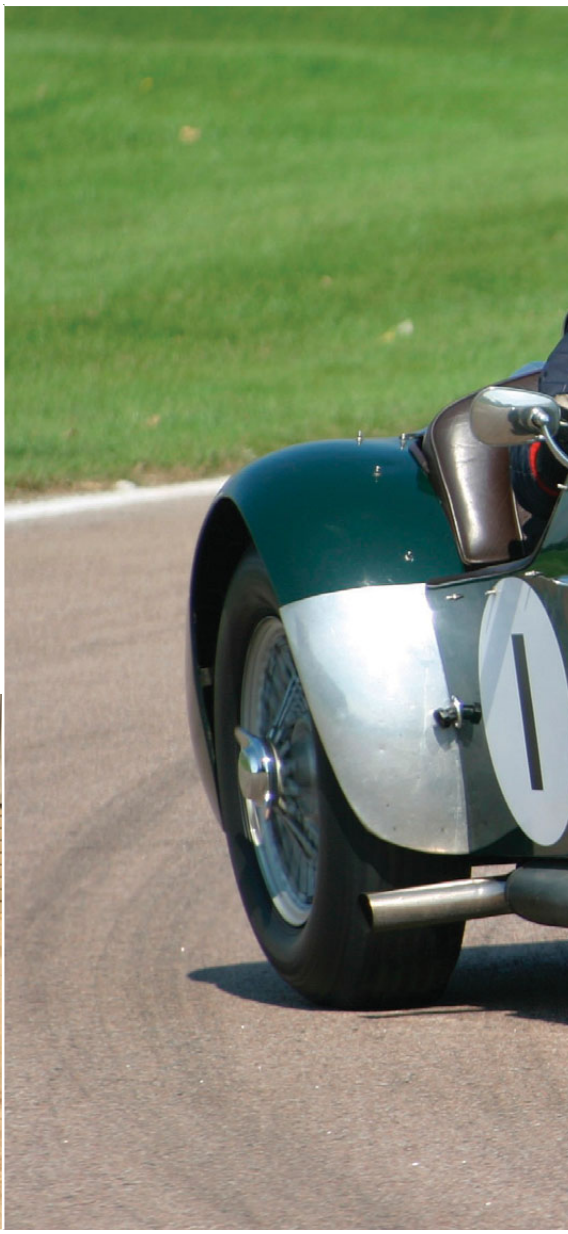
Aside from running his business – which he sold in January this year to long-time employees Mikey Wastie and Steve Wood, but with which he is still actively involved – he has long been an avid historic racer and so has very firm views on the issue of Historic Technical Passports (HTPs). While there are those who think they are essential, the general feeling is that they are an intrusive nuisance and little more than a way for the FIA to claim a pretty hefty amount of money from anyone wanting to go historic racing.

"There is no doubt that a framework is needed because without it this form of racing would be open to abuse of all kinds," he says. "In fact, it already is but it could be far worse without HTPs.

"It's human nature to be competitive, so a framework is necessary. It's either that or it's pointless racing as you wouldn't know who or what you are racing. So it is essential that it's steadily tightened up over time, but there is an associated cost and associated political hassle."

The purpose of the HTP, which was introduced in 2004 to replace the earlier FIA Historic Vehicle Identity Forms that became invalid at the end of 2006, is to allow a car to take part in international competitions. An HTP says nothing about the authenticity, provenance and origins of a car but is concerned only that its specification is that of the particular model it purports to be. The whole purpose is to try to ensure

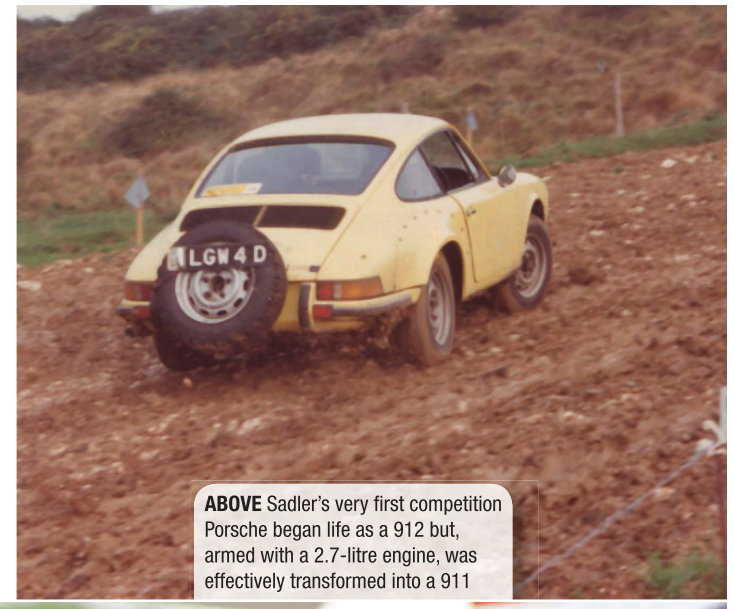
ABOVE Registering the 1964 Ford Falcon has proved a complex process



that cars accord with the authentic specification and can therefore compete with one another fairly. The prime criteria to be granted an HTP are that the car represents a provable specification and type that competed internationally in period.

What has drawn criticism is their cost, which is in the region of £1,000, plus the fact that it is not for life but valid for just 10 years – albeit this is an improvement on the five years that was in place until the beginning of this year. The FIA, and every country's motoring association that administers the process, argue that the funds are helping build up a global database of every historic racing car. But those who have to pay it, many of whom are occasional weekend racers, see it as a very unfair tax.

While Sadler doesn't rail against the cost, it has caused him to stop the process of trying to register his 1964 Ford Falcon. "I've been trying to renew the papers on the car but it's come to a temporary halt as my wallet needs replenishing," he says with a shrug of the shoulders. ▶



ABOVE Sadler's very first competition Porsche began life as a 912 but, armed with a 2.7-litre engine, was effectively transformed into a 911

ABOVE Sadler's Allard J2X, seen here at Goodwood, illustrates the woollier scenario of a period when homologation didn't exist as we know it today

ABOVE As provenance has become increasingly important to investors, Autofarm's expertise and history has helped customers seek correct specification cars

"When I bought it, the papers were due to expire at the end of 2014. It was FIA Technical Delegate Mike Garton who advised me that even with 18 months to go before they expired, I would need all that time to go through the process. He was absolutely right. Because the Ford Falcons are so competitive and because their original homologation was in hindsight a little tongue in cheek, you cannot build one down to the homologated weight.

TECHNICAL EVOLUTION

"The FIA is continually trying to make it a more thorough process to try and control the technical evolution of what is supposed to be original period motorcars. Like any other form of motorsport, it's a constant challenge between the regulation writers and the competitors. The only difference is that you have time on your side with the historics.

"However, the problem with HTPs is that you can build a new car and providing you build it correctly, you'll get an HTP. Especially on the Continent, trying to police it and checking a car out is such a challenge for those who do it."

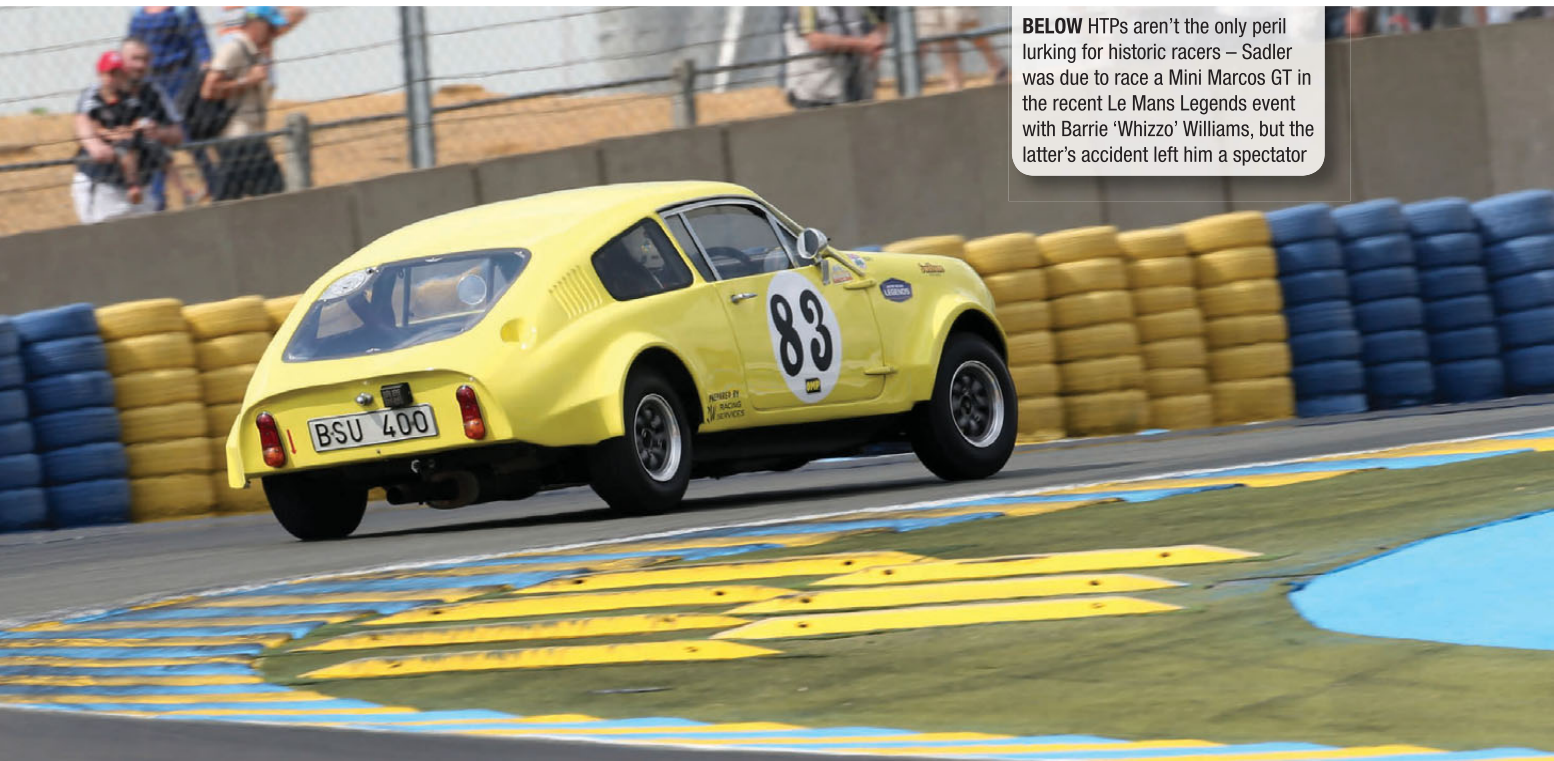
He then gives an example of some of the problems involved when trying to register a car that is out of the norm. "My 911 is an old factory prototype with a slightly odd chassis number, so initially it got thrown out as it was thought that it didn't exist," he explains. "It took some time to go back through the Porsche records to prove that it did actually exist.

"When you go back to the time when Porsche was still a very small company with a motorsport department on the side, it was always trying out different things with every permutation of bore and stroke you can think of in the early '70s. However, when it comes down to actual homologation, there's a much more defined situation. I applied for the 1970/71 period and I know perfectly well that 2.5-litre engines were being run and there's also the 915 gearbox that appeared in production in late '71, but I can't have that gearbox in my car because it wasn't homologated until 1st January, 1972! I can also only have 2.3 litres because in that period that was what was officially homologated."

> **"HTPs will prove their worth in the future, it's just that the modern day competitor is paying for it now"**

Go back to even earlier cars and it becomes far more difficult to determine just what should be homologated, Sadler giving the example of his 1952 Allard J2X. "I got some papers years ago for this car and it's a much woollier scenario because there wasn't homologation as such, so it was a case of proving what was used in international competition in period. You've then got to define in period but there is a little bit more flexibility."

As Sadler says, "For all the criticism of the value and cost of HTPs, there's no doubt that they will prove their worth in the future, it's just that the modern day competitor is paying for it now." HRT



BELOW HTPs aren't the only peril lurking for historic racers – Sadler was due to race a Mini Marcos GT in the recent Le Mans Legends event with Barrie 'Whizzo' Williams, but the latter's accident left him a spectator

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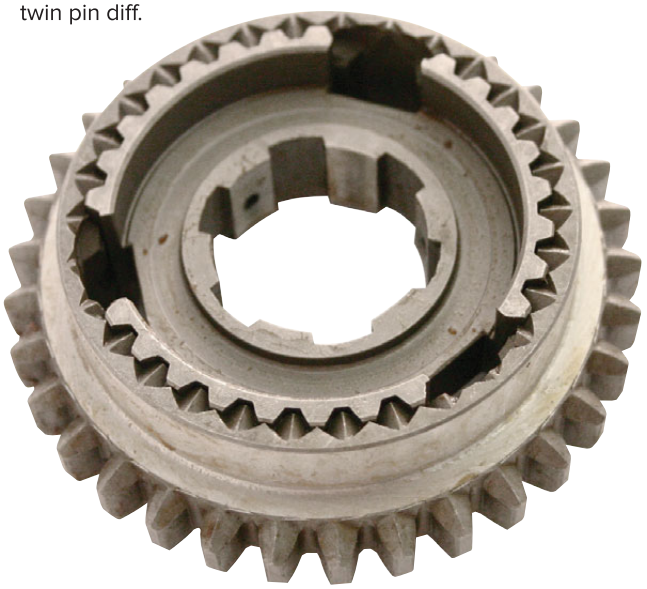
Hub assemblies and helical gear kits for classic Minis

MINI SPARES has announced that the 1st and 2nd synchro hub assembly for classic Minis with the 'B' Type 3 Syncro is available again. It claims that it is superior to the outer track from the Sprite (22G1119, part of 22G1118), which was not reliable enough as it would allow balls and springs to fly out from the synchro hub when there was undue wear in any of the parts of the gearbox.

Mini Spares has also just released its own new profile helical cut gears for the 4-synchromesh gearbox. The gears have been cut to Clubman ratios and are stronger and quieter than the originals. The teeth are a different shape and angle and have a wider profile – of at least 2-4mm more – than any of the original helical gears made for the Mini.

For the final stage of development, Mini Spares enlisted the services of Bill Richards to test the gears in his racing Mini equipped with a 160 hp, 8 port head engine and Mini Spares twin pin diff.



ABOVE The 1st and 2nd synchro hub assembly for classic Minis

BELOW New profile helical cut gears for the classic Mini 4-synchromesh gearbox

Ignition cable for BD Series applications

BURTON POWER has just added a BD Series application to its range of Burton PowerLeads. Burton PowerLeads are manufactured using a premium 8mm ignition cable that is ideal for all high-performance applications. The ferromagnetic core uses a Kevlar and fibreglass base. A ferromagnetic compound is extruded onto this which is tightly wound with a stainless steel resistance wire bound with a conductive lacquer. This design ensures maximum spark quality with virtually zero voltage loss while suppressing 99.9% of all electromagnetic interference. The cable has a resistance of 5.6Kohm/metre (nom) and a temperature rating from -40°C to +220°C. However, they only suit engines using the later type Lucas 43/45D4 distributor, not the 23/25D4 type.

Applications include the Ford Escort Mk1 RS1600 1970-1974, Ford Escort Mk2 RS1800 1975-1977, BDA 1.6 road engine, BDB/BDC 1.7 rally/race engine, BDD 1.6 race Atlantic engine, BDE 1.8 race engine, BDG 2.0 race engine, BDH 1.3 race engine, BDJ 1.1 race engine, BDP 2.0 race engine, BDR 1.6/1.7 Caterham Super Seven engine, BDT 1.8 RS200 engine and the BDX 2.0+ race engine.

Steering wheel spacers

B-G RACING has produced some steering wheel spacers made from aluminium billet for the classic car market. There is the fixed 60mm steering wheel spacer and the adjustable version that offers adjustment to bring the steering wheel between 45mm to 70mm closer to the driver. Both spacers have a multi-pattern PCD that allows steering wheels with either 6 x 70mm or 6 x 74mm bolt patterns to be fitted.

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Heat Shroud

DESIGN Engineering Inc. (DEI), specialists in heat and sound control, now offers a new convenient way to protect fuel lines, wires, cables and hoses from excessive direct or radiant heat. Its Heat Shroud is made with a high-temperature resistant glass fibre fabric bonded to aluminised material that reflects 90% of radiant heat and direct heat up to 500° F (260° C).

A hook and loop 'Velcro' style closure makes the shroud simple and easy to install. This time-saving convenience makes it possible to get a secure thermal protection barrier with less chance of damaging or misconnecting wiring while working quickly. This is especially important for clubman or professional motorsports.

DEI's Heat Shroud is extremely pliable and fireproof and fits inside-diameters ranging from ½" to 2½" (1.27cm-6.35cm). In addition to its heat reflecting properties, it also provides additional protection against oil, dirt and abrasion and can be trimmed to length. Being fireproof and heat resistant, it can also be used to provide temporary protection for wiring whilst welding is being carried out nearby and can then be quickly removed by peeling the hook and loop closure apart. It is available in 3 foot (91.44cm) lengths with adjustable diameters.

Liquid crystal display electric water pump

AUSTRALIAN automotive cooling technologies manufacturer Davies, Craig has announced the arrival of the updated liquid crystal display (LCD) electric water pump (EWP)/fan digital controller that offers drivers a broader menu of engine cooling management functions at a glance. It becomes the engine's new and contemporary 'thermostat' with nine targeted temperature settings that can be programmed at the push of a button. It manages the operation of the EWP or billeted electric water pump by varying the pump's speed and subsequent coolant flow in response to engine coolant temperature as well as managing the thermal control of the electric Davies, Craig Thermatic fan. In combination with it, the temperature of the engine's cooling system can be more specifically controlled.

Compatible for 12v and 24v electrical systems, the EWP/fan digital controller will operate the EWP even after ignition/engine shutdown, circulating coolant and rapidly dissipating heat more efficiently to avoid heat-soak. If the engine temperature cools below the targeted/set temperature, the EWP/fan digital controller will step back from full system voltage back to 12 or 6 volt operation and revert to pulse width modulation mode when highway cruising.

The LCD EWP/fan digital controller weighs only 90 grams (3.2oz) and can be easily and conveniently mounted anywhere in the driving compartment.

Shaft end kit for early production Weber DCOE carbs

WEBCON has introduced a throttle shaft end service kit for the early production Weber DCOE carburettors. Supplied with the correct leather washers, cups, springs, tabs and nuts, part number FK0004 is essential for anyone refurbishing these early carburettors. Each kit contains sufficient parts to service one carburettor. They are available directly from Webcon and from appointed Webcon dealers around the world.

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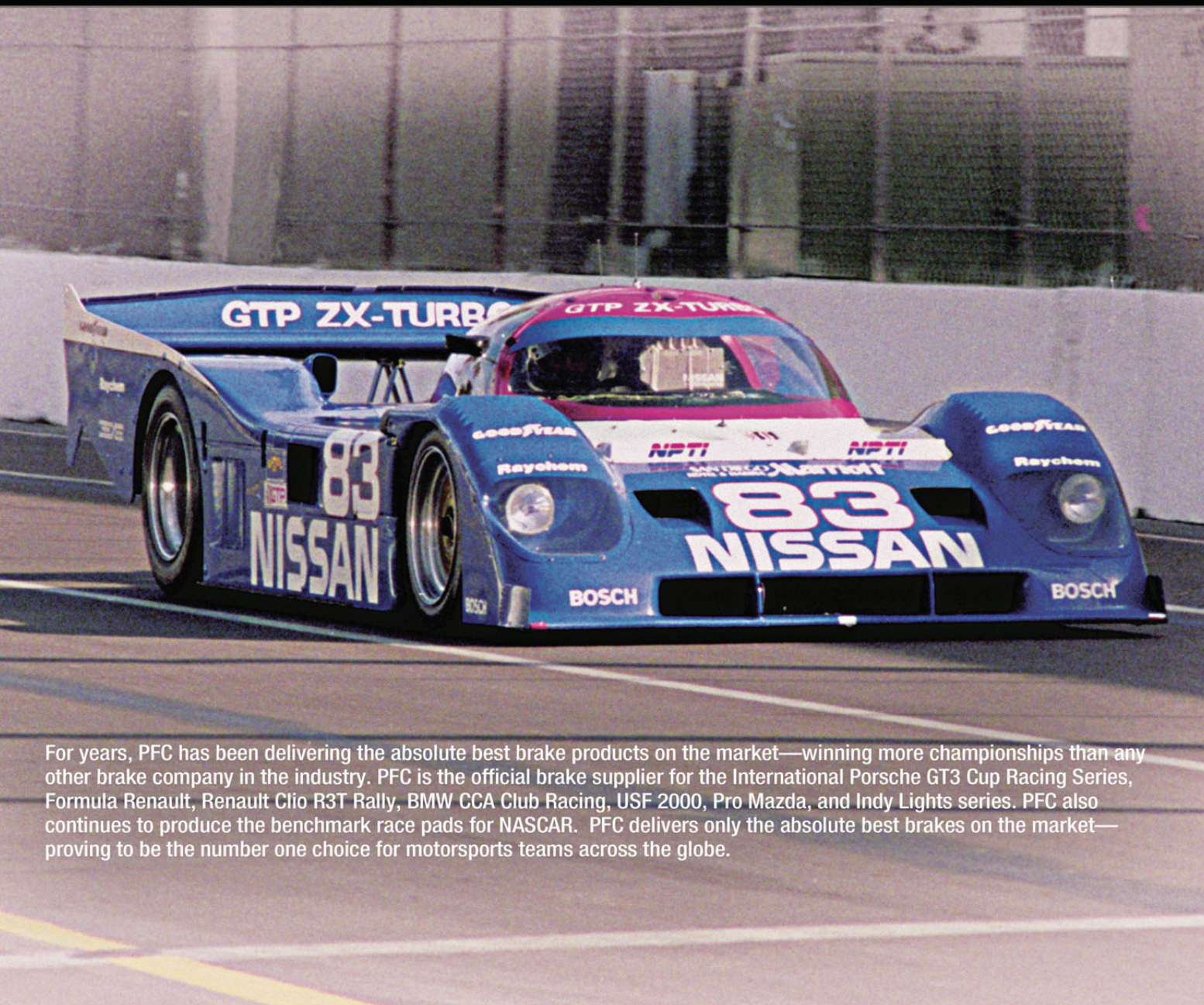

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