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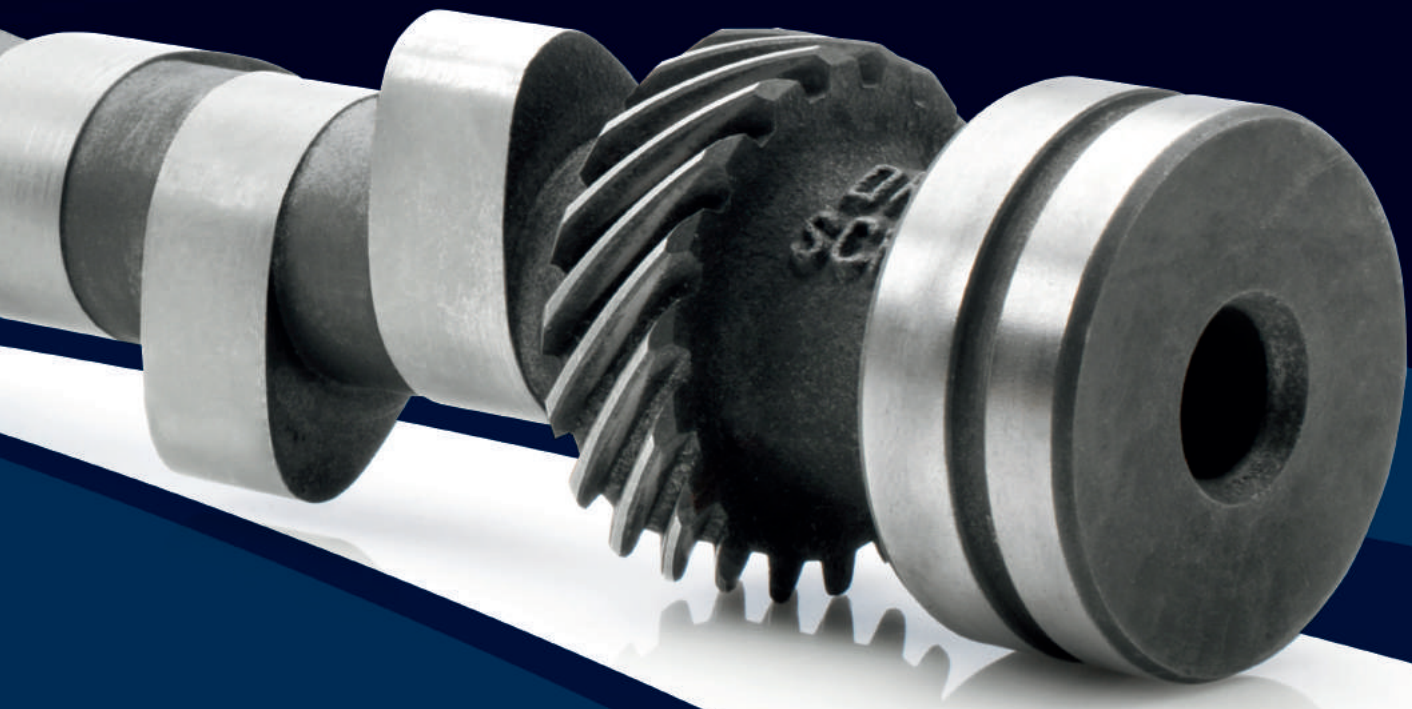

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Lotus 19 'Monte Carlo'

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LIVING IN A BUBBLE?

AS we were going to press I received the latest Vintage Sports-Car Club newsletter, always an enjoyable read, but was slightly disheartened to read that it was struggling to get enough entries to sustain the five race meetings it holds every year. On the other hand, it reported that its speed and hill climb events were increasing in popularity with nearly 450 competitors entering eight different speed events last year. The newsletter also said that trials continue to be massively popular with almost every event last year oversubscribed.

I am not sure what this really means as there is no question that interest in historic racing is at an all-time high, but when it comes to circuit racing, I think it tends to be focused on cars from the '60s, '70s and '80s and maybe even the '90s now creeping in. Perhaps it is an age thing. Those who were active vintage racers in the past are possibly hanging up their helmets for one reason or another and their places are not being fully taken up by a younger generation who prefer to compete in post-war cars.

There are also the cars to consider. When I was competing in VSCC events in the early '70s, they were already pretty old, but now they are positively ancient. I actually stopped racing for a couple of reasons – one was I got married and had a young family to feed, but secondly, I thought my 1938 car was getting too much abuse from me on the race track. What did it for me was when one of the half shafts let go which meant that for the first time ever I had to be towed back home and then the car was off the road for around six months while a replacement half shaft was sourced. Admittedly then there wasn't quite the industry we now have, but it taught me a lesson and that was my car was then 40 years old and it wasn't getting any younger. It is now coming up to its 80th birthday.

Modern motorsport is facing a bit of a crisis as it has an ageing demographic, not just in Britain, but worldwide. Last year for our sister publication *Race Tech* I wrote that I had attended the British Grand Prix at Silverstone and observed that most of the fans who were lucky enough to get inside the circuit – not the sacrosanct Formula 1 paddock where the unwashed are positively unwelcomed – were middle-aged males while two weeks later, attending Silverstone Classic, there were as many youngsters and families as there were middle-aged men, which was extremely heartwarming. It showed me that for all the glitz and glamour of Formula 1 it was historic racing that attracts the fans. Admittedly gate prices have something to do with that, as well as the fact that there is plenty of track action and you can get very close to the cars in the paddock, unlike a typical grand prix I might add, but it did show the rude health that historic racing is in.

As you will see in our News pages, there are more and more events being created, the latest being a series in Germany for former DTM and STW-Cup cars from the 1980s and 1990s, reviving what the organisers describe as the 'Golden Era' of Germany's leading Touring Car championships. Zolder in The Netherlands and Jarama in Spain are two new destinations on the Masters Historic Racing calendar for this year while Group C cars will not only be racing at Le Mans in three races over 24 hours at the Classic event in July but also playing a headline role in a new European historic tour this year being organised by French-based Peter Auto.

Historic racing is on a roll and it is growing, not just in terms of entrants and spectators, but also in its global reach. The question that needs to be asked, though, is whether there are any lessons to be learnt from the VSCC or are we living in a bubble? HRT

William Kimberley
Editor

NEWS

German Touring Cars get own historic series

ENTHUSIASTS of German Touring Car racing are following the lead of the UK's highly successful Historic Super Touring Series with a new category for DTM and STW-Cup cars from the 1980s and 1990s.

Reviving what the organisers describe as the 'Golden Era' of Germany's leading Touring Car championships, the new initially three-meeting series aims to put back on the track the cars from the Deutsche Tourenwagen Meisterschaft (DTM) between 1984 and 1999, and those of the STW-Cup that in the mid-1990s ran to 2-litre Super Touring regulations and enjoyed a brief period as a direct rival to the DTM.

The series will be split into three classes catering for former DTM/STW and DTC cars, both original and replicas, and a balance of performance system is planned to equalise the classes.

Class 1 will be for Group A DTM/STW cars of up to 2.5 litres from 1984-99, Class 2 for cars over the same period with engines of over 2.5 litres, and class 3 for DTC, effectively Group N cars of up to 2.5 litres raced between 1984 and 1994.

Classic Touring Cars and cars conforming to the FIA's Appendix K with Historic Technical Passports will be permitted to compete, while class 1 will also accept Group H former DTM/STW cars, with aerodynamics, engine and gearbox according to Group A but with upgrades such as carbon fibre doors and the engine enhancements carried out from 1988.

Class 2 will accept Group H cars in similar format to Class 1, with the six-cylinder engine modifications that offer better reliability for a performance penalty.

The class structure raises the prospect of cars such as the BMW M3 E30 and 635i, Fiat 850, Ford Sierra and Mustang, Mercedes 190 E, Opel GSI and Astra and the Rover Vitesse doing battle again.

Organisers hope to appeal to both professional racers and 'gentleman drivers' and are particularly aiming to attract former DTM/STW competitors – to the extent of billing most of the major German Touring Car names for the period on the series website.

Each race will be of 40 minutes with a mandatory pit stop between 15 and 30 minutes, with driver changes permitted but not refuelling or tyre changes. Three meetings have been scheduled for the first season, at the Nürburgring Historic Trophy on 18-19 June, the Histo Cup at the Red Bull Ring on 2-4 September, and at the Salzburgring Histo Cup on 23-25 September.

• The HSCC Super Touring Series will visit the challenging Scottish circuit of Knockhill for the first time in 2016, the meeting on 11/12 September being the finale of the series' five-weekend calendar. The cars will battle for the David Leslie trophy, named in honour of the Scottish Super Touring driver, at the track which enjoyed its biggest-ever crowds at BTCC meetings during the late 1990s Super Touring era. HRT

BMW Heritage

ABOVE Seen here in 1989, BMW and Mercedes-Benz were deadly rivals in the DTM, as they are today

Silverstone Classic

ABOVE The evocative cars in the FIA Masters Historic F1 Championship will race at new venues in 2016

New European venues for Masters in 2016

ZOLDER and Jarama are two new destinations on the Masters Historic Racing calendar for 2016. The Belgian and Spanish tracks will bookend the season of eight European events, with the FIA Masters Historic F1 and Historic Sports Car championships headlining the meetings.

The season begins at Zolder on 9/10 April at a new Masters Festival, followed by a three-strong UK tour beginning with the traditional Brands Hatch Masters Festival on 28/29 May. Donington Park is next up on 2/3 July, both it and the Brands Hatch meeting featuring three-hour races for Pre-66 Touring Cars alongside the usual Masters series, and then the series moves to the Silverstone Classic on 29-31 July.

The widely renowned Oldtimer Grand Prix at the Nürburgring, Germany follows on 12-14 August, then the series provides four categories at the Zandvoort Historic GP in the Netherlands on 2-4 September. The Masters will star at the Spa Six Hours meeting on 16/17 September before concluding its season at the new Espiritu de Jarama event on 15/16 October.

Meanwhile competitors in the Masters Pre-66 cars series will be offered autumn opportunities to compete in the US, endurance races for the cars scheduled for the Historic Sports Racing events at Daytona on 10-13 November and Sebring on 1-4 December. HRT

One-class Metros in bid to curb costs

COMPETITORS in the MG Car Club's MG Metro Cup are set to be racing for a single set of podium places in 2016 following a decision to merge the current classes and ban performance upgrades.

The change has been made in a bid to keep costs down – some drivers have been spending several thousand pounds on such upgrades as cylinder head modifications and limited-slip differentials.

Now, however, all types of car, whether A-Series or K-Series powered, naturally-aspirated or turbo, will race together with organisers using a weight and ride-height system to equalise performance, reviewing it after three rounds of the 2016 series. HRT

NEWS

GROUP C HEADING BACK TO LE MANS

SPORTS cars from the iconic Group C period of the 1980s will again feature at Le Mans in 2016, but not as a support category to the Le Mans 24 Hours. Instead the cars will form a major part of the eighth Le Mans Classic event on 8-10 July, taking part in three races over 24 hours.

Group C races will also play a headline role in a new European historic tour in 2016 being organised by French-based Peter Auto. Races will take place at Jarama, Spain on 1-3 April, 13-15 May at Spa in Belgium, 3-5 June at Dijon in France, 1-2 October at the fellow French circuit of Paul Ricard and concluding at Imola, Italy on 21-23 October. The Group C cars will also be again racing at Britain's Silverstone Classic meeting in July. HRT

ABOVE Group C cars are set to star at the Le Mans Classic in July

A-Series race debut could lead to new series

A FIELD of 22 BMC A-Series powered cars contested a trial challenge race at Silverstone on 7 November, and the successful event is likely to lead to more in 2016.

The event was organised by Julius Thurgood and his Historic Racing Drivers Club, and evolved from a race specifically for A30/A35 cars held at Mallory Park on 26 September. All pre-1966 A-Series engined machines were encouraged to enter the Silverstone event, and while Minis unsurprisingly predominated, a variety of cars took part, including Austin A35s, A40s, MG Midgets and more bespoke models such as a Lenham Le Mans Sprite. The Austin Healey Sebring Sprite of Will Corry proved victorious over the 16 laps, Corry racing for the first time at Donington.

The HRDC is now looking to run the A-Series Challenge alongside its existing championships next season. It believes the series will appeal to those owners of such cars who would rather race against similar machines than in a class alongside much larger and faster cars. HRT

Goodwood Festival marks US anniversaries

THERE will be a Stateside slant to the Goodwood Festival of Speed in 2016.

Alongside the central theme of 'Full Throttle – The Endless Pursuit of Power', the event, on 23-26 June, will celebrate two US motorsport staples. Sections of the Festival line-up will mark the 100th running of the Indianapolis 500 and the 50th anniversary of the first Can-Am sports car race – a milestone also being marked by the Silverstone Classic in July.

The Festival will also pay tribute to James Hunt on the 40th anniversary of his Formula 1 World Championship win in 1976. Goodwood has also announced that the Revival meeting on 9-11 September will celebrate the life of three-time F1 World Champion Sir Jack Brabham, 50 years after he became the first and so far only person to win the title in a car bearing his own name. HRT

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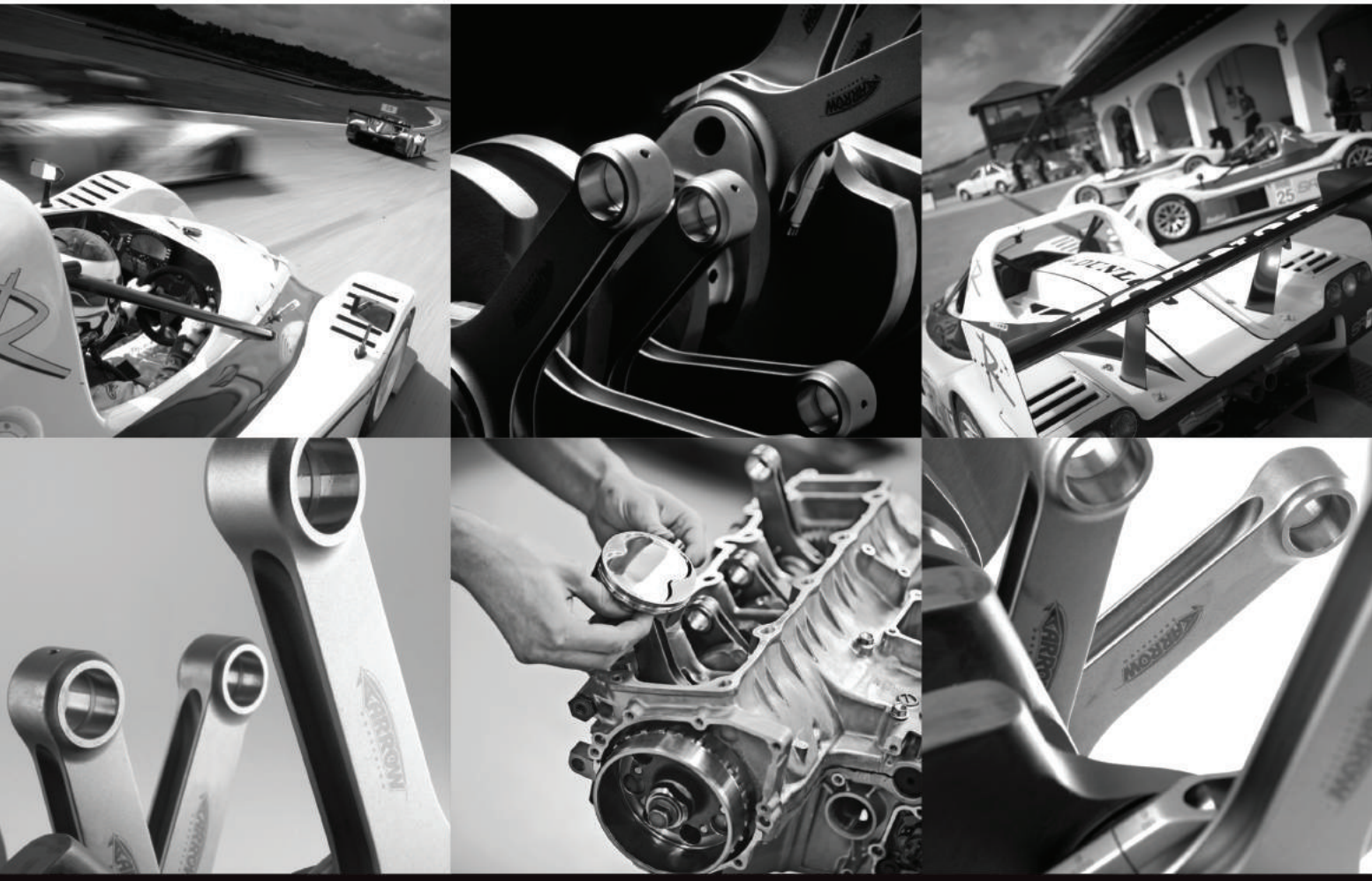

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NEWS

The RAC Rally of the Tests returns

NOVEMBER 2016 sees the return of one of the most iconic and famous rallies in the world, The RAC Rally of the Tests.

The event was first staged in 1932 and enjoyed huge success up until 1939. Returning after the war in 1951, it went from strength to strength and became the keystone of modern stage rallying as we know it today. From its inception in the 1930s, huge crowds have flocked to witness the spectacle of competitors battling against some of the most challenging routes and conditions in motorsport. The event was pivotal in bringing rallying to mainstream media and launched many household names throughout its history.

With the resurgence of interest in classic motoring, a three-way partnership has been forged to allow the RAC Rally of the Tests to return. The revival of this most famous of sporting occasions further strengthens the relationship between HERO Events and the Royal Automobile Club, a partnership that led to the Royal Automobile Club 1000 Mile Trial being awarded Rally of the Year at the International Historic Motoring Awards and nominated again in 2016.

The 2016 RAC Rally will form part of the HERO Cup for Drivers, held in association with EFG International and Zenith Watches, Official Timekeeper of the HERO Cup.

The format of the event will retain maps for navigation and will, where possible, utilise tests and sections that were used in the heyday of the RAC Rally of the Tests. To add to the already authentic feel, public-facing venues will be used with easy access that will allow spectators to support and see these amazing vehicles.

"The Royal Automobile Club is delighted that one of the greatest, most loved, names in the history of motorsport has been restored to its place on the international calendar," said the Royal Automobile Club's chairman, Tom Purves. "The RAC Rally of the Tests was always a challenge for man and machine, but also a great spectacle which delighted spectators up and down the country. We look forward to supporting the RAC and HERO in this exciting venture." HRT

ABOVE 2015 Rally of the Tests winners Howard Warren and Iain Tullie in their Porsche 356

IN BRIEF

THE second running of the Historic Sportscar Racing Classic 24 Hours at Daytona International Raceway on 14/15 November attracted a 174-car entry from across the globe and a host of famed endurance racing names including multiple Le Mans and Daytona 24-hour winners Derek Bell and Brian Redman. The meeting was based around six period-correct groups, each competing in four races rotating through 24 hours on the 3.56-mile Daytona course.

OWNERS of 1600 cc Formula Three cars from the early 1970s are being sought by the Historic Sports Car Club (HSCC) in an effort to bolster fields in its Classic Formula Three Championship. Currently fields in the series are dominated by later 2-litre machines and the club would like to see at least six to 10 of the 1600 cc cars that were built by the likes of Lotus, March and GRD.

THE HSCC is also hoping to attract more MGBs to its 70s Road Sports Championship by adding a new class, 1600 to 1800 cc, specifically suited to them. A new single up to 1600 cc class has also been added, no longer differentiating between steel and glassfibre-bodied cars.

AND in a third move the HSCC's Classic Racing Car category is to be expanded in a bid to boost grids. Formula 2, F3 and Atlantic cars built before 1972, and running slick tyres and wings, will be permitted to race alongside the category's traditional 1960s single-seaters. HRT

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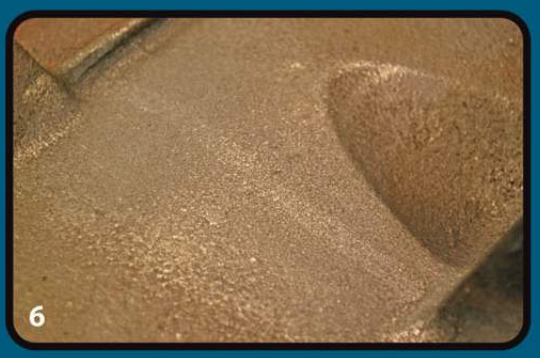

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Rising from the ashes

Had it not been for a set of circumstances that would have stopped most people in their tracks, Tolman Motorsport would never have come into being, and perhaps neither would have the Lotus 19 it has so lovingly created, as **William Kimberley** reports

CHRIS Tolman is a resolute character, someone who has bounced back from the precipice of disaster to create what is becoming a major player in motorsport engineering and yet the business is not even 10 years old, Tolman Motorsport celebrating only its seventh anniversary in 2015. During this time the business has doubled in size every year.

As a young man he trained as an aircraft engineer, at the Ministry of Defence's premier test and evaluation centre DERA, Boscombe Down, working on projects including the Eurofighter Typhoon and the Empire Test Pilots Hawker Hunter. In his spare time he competed in a self-prepared Sunbeam Talbot, built a Ralt RT33 for the British Classic F3 Championship and prepared and developed a Peugeot 205 GTI for the Yokohama Stock Hatch Championship.

He professionally entered the world of motorsport in 1999 when he joined Prodrive. His involvement in the Ford Mondeo Super Touring Car programme saw him work in France to build the first of the new engines with Sodemo, the engine specialist. In 2000, the cars took an unprecedented 1-2-3 in the British Touring Car Championship.

He then joined the Mitsubishi Ralliart World Rally Team in 2001, working in sub-assembly on suspension and power steering, then moving to the test team for a couple of years before ending up in the engine shop when the decision was made to hand engine development to Ralliart rather than ship them in from Japan. It was a job he relished. Unfortunately, though, it was cut short when he was diagnosed with the dreaded C-word – cancer – a week after his 30th birthday.

There followed two years of hospital visits for things like chemotherapy, rejoining Ralliart in late 2007, just in time for the team to announce its closure. As a side issue, his wife of four months had also left him during this period.

"Not only did I get restarted as a human being but I had to reset everything else as well," he says with a wry smile. "I had a television on the floor, a knife, fork, spoon, plate, cup and bowl and my clothes in bin bags, and that was

ABOVE & LEFT The recreation of the stunning Lotus 19 Monte Carlo, commissioned by Christopher Ross, is Tolman Motorsport's highest profile project to date

it. The problem was that in applying for a job, if I was asked how many days I had had off sick over the last couple of years, then I was buggered, so I decided that the best thing I could do was to do something I'd always wanted: start my own business. I only had a smallish redundancy but I cut it in half, one being for three months wages and the other to start the business.

"I bought a few tools, did a few jobs for clients but it was a fortuitous meeting with Adam Harper – a former colleague from Mitsubishi, who had been made redundant from Prodrive and started working for me – that helped me turn a corner. This was then boosted by an investor a couple of years later who wanted to get into motorsport, which enabled us to grow the business that much more quickly. Up until that time we had just been doing prep on race and historic cars, but the investment meant that we could now enter motorsport in our own right as a team with a car, which we did with an entry in the Ginetta Challenge.

AIMING HIGH

"My aim from the start was to become the next Prodrive," admits Tolman. "Having had the training I had in the military and then at Prodrive and Ralliart, I've always had the intention to have the equipment to do any job and be able to react quickly to a problem. The business has been built up so that we can design in-house, we can fabricate in-house, we can do engines and transmissions in-house, so we have a pretty good control on most of the projects. However, our biggest asset is the people that work here."

Tolman had originally planned for his business to be 40% motor racing, 40% classic and 20% general engineering. "We specialise in the Lotus Elite but we have also been involved in diverse engineering projects such as helping the British women's bobsleigh team on a panic programme. The way things are going, though, it's now almost entirely motor racing, including historics. We are contesting the SRO British GT Championship this year with two factory-backed Ginetta G55 GT3 cars. It means that Ginetta and Tolman Motorsport can now take a driver from grassroots racing in the Protyre Motorsport Ginetta GT5 Challenge into top level GT4 and GT3 racing, something no other manufacturer is capable of."

This is not to understate the importance of the historic restoration side of the business. The company has been involved in a number of projects in its short life, perhaps the most high profile of which has been the restoration of the Lotus 19 Monte Carlo recreation. The story started in June 2012 when Tolman Motorsport was commissioned by Christopher Ross to complete the rebuild of one that had come up for sale.

"The Lotus 19 was a project put together by the late four-time British hillclimb champion Roy Lane, and the story I was told by his son was that when he was testing at Silverstone back in the day, Colin Chapman turned up with this brand new 19 which blew Roy away," says Tolman. ▶

ABOVE The entire front of the chassis was replaced and roll over protection installed

"He there and then vowed that one day he would own one."

The 19 was an extension of the Lotus 18 F1 car and was Chapman's response to the Cooper Monaco. While the Monaco tag was a tribute to Maurice Trintignant's victory in the 1958 Monaco Grand Prix in a Cooper, Monte Carlo was a meaningless name that did not really stick.

It was powered by the same 2.5-litre Coventry Climax FPF engine and Lotus' own 'queerbox' sequential 5-speed transaxle. It retained the cruciform bulkheads, suspension geometry and suspension layout but was made wider to accommodate a passenger seat. The body was composed of a quickly detachable fibre glass nose-section and one-piece engine cover and fabricated aluminium doors. The chassis was constructed from tubular steel with aluminium stressed panels. It was also one of the last to be fusion-welded. Fuel capacity was 82 litres (18 gallons in pannier tanks each side of the cockpit). Stirling Moss tested the prototype in 1960 and drove it to a win in a 56-mile race at Karlskoga in Sweden on August 7.

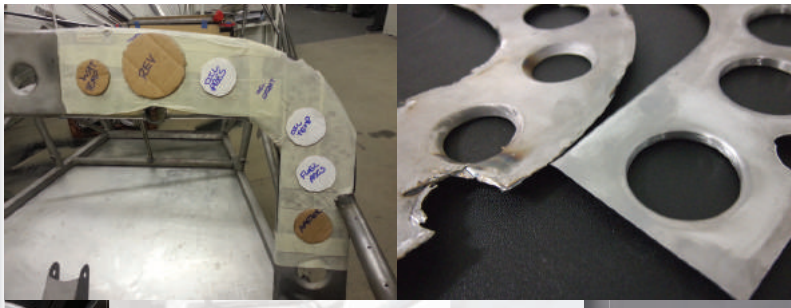
According to Anthony Pritchard in his book *The Competition Cars: Lotus*, Lotus built 12 of these cars with delivery being made in 1961. The UDT-Laystall team bought three while the rest were sold in the US. Over time, all 12 cars were either written off or damaged.

DETECTIVE WORK

The car acquired by Ross and presented to Tolman Motorsport as an accumulation of parts was actually a replica, the chassis having been built by Ken Nichols in Devon that had been acquired by Lane. While some work had been carried out in skinning the chassis and installing the V8 Buick engine, it was only to a mock-up stage. It soon became clear that a great deal of work ▶

History of chassis 19-965

THE original car that this recreation is based on, chassis 19-965, was the last Lotus 19 built, followed only by the Lotus 19B special ordered by Dan Gurney. It was delivered new without engine to John Mecom Jr. The Mecom team drivers were AJ Foyt, Walt Hansgen (below) and Augie Pabst. HRT



ABOVE & BELOW With most of the original chassis having been written off and rebuilt, the project demanded a mix of detective work and painstaking accuracy

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ABOVE To the team's knowledge, this is the first Lotus 19 recreation to have achieved a full FIA Historic Technical Passport

was needed in order to fulfil the brief which was to produce an accurate and raceworthy car, as well as proving to the FIA that the machine they had created was indeed period-correct.

The decision was made by Ross and Tolman that the recreation would be based on chassis 19-965, the last one made that was delivered to John Mecom Racing in Texas. "It had to be a recreation of a car that raced internationally," says Tolman. "However, it wasn't intended for championship racing, but primarily for shorter events and circuits. So finding an example that would fit the V8 spec wasn't going to be easy and without the FIA stamp, the finished machine would be little more than an expensive kit car.

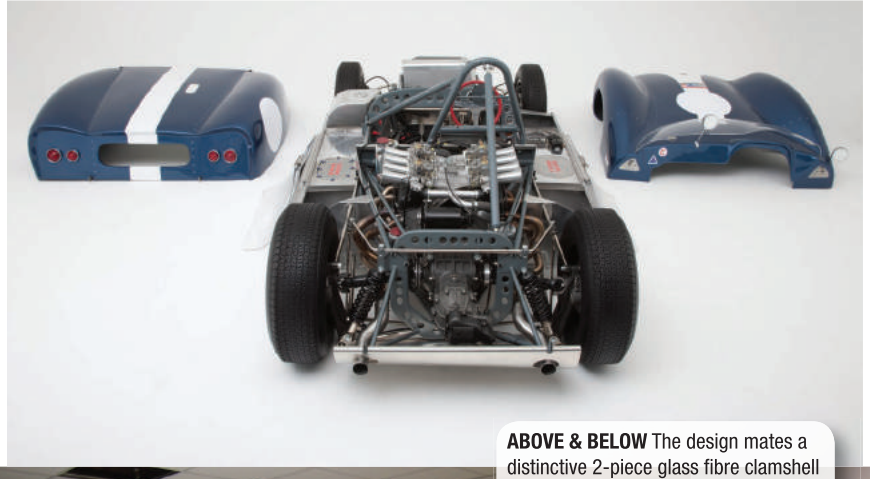
"Our job was then to rebuild it but nothing really fitted with many aspects of the chassis just not accurate enough to make a genuine reproduction."

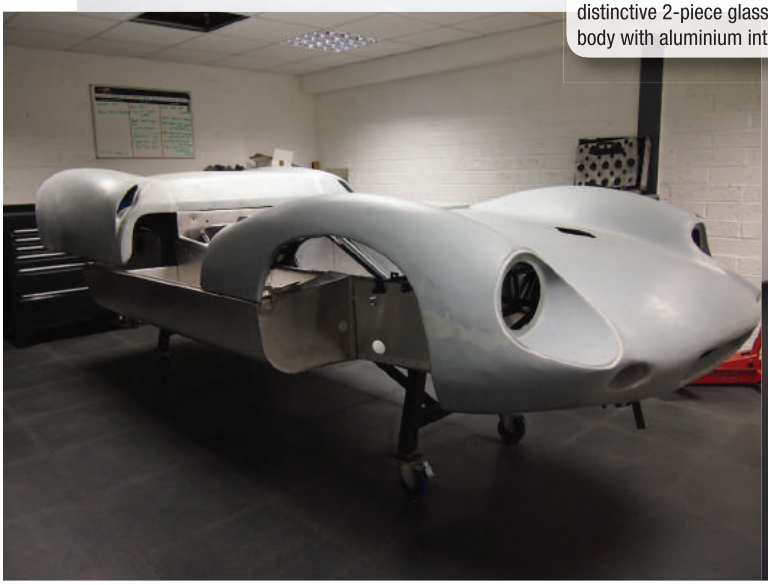
What helped in this process was being able to look at an existing original car. "We could only find a total of six that still existed, but every one of them had been crashed at some stage in its life, meaning that there wasn't an original as it left Lotus," he recounts. "The best one we did eventually find lived in Denmark, the only one with an HTP passport."

This was the Rosebud Team car that had been fitted with a Ferrari V12 3-litre engine for Innes Ireland to drive at Pacific Raceway near Seattle on 27 September, 1963. In fact, he had a bad crash in it that put him out of racing for the rest of the season while the car itself was a write-off. Over time the car was fully restored but with a 2.0-litre Coventry Climax engine.

"The owner was very gracious in allowing us to go there to measure and photograph his car, where we instantly discovered that our sidepods were two and a half inches too tall!" he laughs. "We consequently cut them off, put correctly sized ones on and the body fitted.

"After around a three-month period of investigation, we stripped the chassis, ▶





ABOVE & BELOW The design mates a distinctive 2-piece glass fibre clamshell body with aluminium internal structure

which I'm glad we did as the welding wasn't great, and then measured it with a FaroArm so we could create a 3D model. We also managed to acquire some chassis drawings thanks to Peter Denty, the Historic Lotus Register registrar for the Lotus 30 and 40, and realised that the front end was also completely incorrect. We had to do a lot of development, going back and forth to the original drawings.

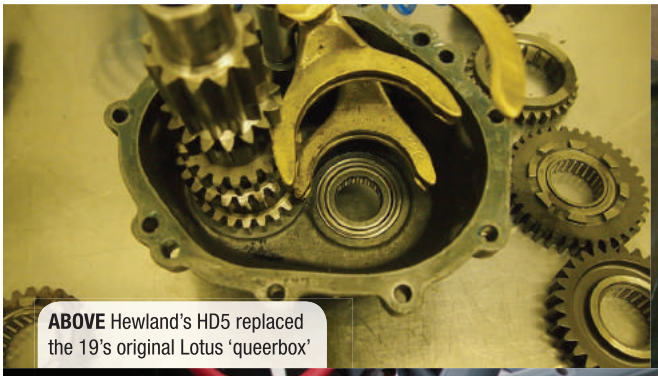
"We modelled all the suspension points and found around 14 degrees of castor, so it was completely wrong. This resulted in our making a flat bed table onto which we bolted the chassis, did all the work in CAD to get the jig work done, then chopped the chassis off, put the jig on the side with all the correct points and joined everything together. We then made the front end as it should be with the right bump steer. All the engine and transmission mounts were subsequently modified, the entire front of the chassis was replaced and new body parts also had to be made – new doors being rolled using the original techniques.

"Knowing that Chapman was an aircraft guy, we also questioned why the floor was just a piece of skin. We decided to use proper aircraft aluminium that we could bond and rivet so that it was much stiffer, especially in a crash.

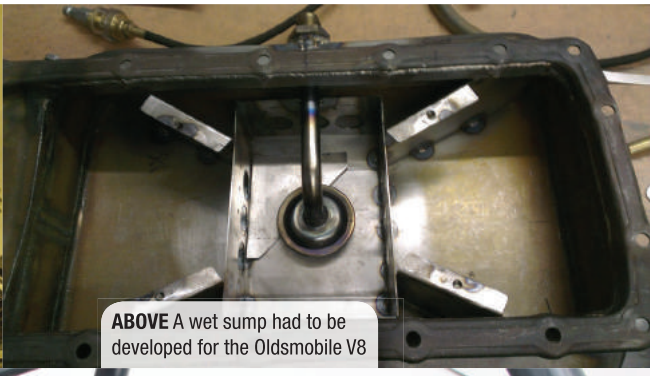
"We also thought we must have a T45 roll hoop combining fore and aft location correctly stressed; it wasn't an afterthought. In fact, when we consulted the MSA for the papers, they advised us to do more with the cage than we initially thought we'd be able to, the advantage to this being that it made the chassis stiffer.

"We also realised that we had to run a different engine to the Buick if we were going to homologate the car. It took a great deal of research but we were very fortuitous in what we found. One picture came with the car, on the back of which was written: '64 Brands (Hatch), Walt Hansgen."

Digging deeper, Tolman discovered that it was the Guards Trophy meeting, even finding an original programme for ▶



ABOVE Hewland's HD5 replaced the 19's original Lotus 'queerbox'



ABOVE A wet sump had to be developed for the Oldsmobile V8

ABOVE Research revealed that the Oldsmobile V8 would be required for homologation, rather than the Buick with which the car was acquired

Jeff Bloxham

ABOVE Dovetailing aesthetics with authenticity, the Lotus 19 Monte Carlo takes to the track

it which showed that the car belonged to the US Mecon Racing Team and that it was powered by a 4.2-litre Oldsmobile. "That was our green light and we then just had to prove what it was," says Tolman. "We knew that it was chassis number 965 and found a picture of the car with the Oldsmobile engine with four Weber carburettors. It also showed us that it had extra bracing going back to the gearbox, showing a specific mounting. We could also see that it was fitted with a Hewland HD5 box which meant that we could then go ahead and build it.

"While the heads of the Buick engine we had were identical to those of the Olsdmobile, the block was different but we managed to source that through JE Developments while we replaced the Holley carburettors with the Webers. This was all actually pretty simple."

STUMBLING BLOCKS

One of the stumbling blocks was that in order to get the necessary FIA accreditation it would need a wet sump, as at that time dry sump V8s were very rare in the US. "A picture showed that the Buick had a dry sump and we started to plumb the car accordingly but were then told that American engines in general had wet sumps at that time so we had to develop a wet sump system ourselves for the Oldsmobile!" says Tolman. "It was all a bit of a headache, but we got it done in the end."

All of the fluid lines, wiring harness and the bodywork could then be finalised and many of the smaller components such as the tanks, gear linkage and roll bars all had to be manufactured. Over 80% of the entire build was manufactured in-house although items like the AP Racing triple plate clutch were easy to source from the suppliers.

Once complete, everything was stripped down to component form and the process of painting and plating carried out. The transmission was overhauled, a fresh engine built and tested on the dyno prior to installation and a custom racing fuel cell from Aero Tec Laboratories (ATL) installed. A bespoke exhaust system that was both accurate for the papers but could also be quickly adapted to meet the current noise regulations needed a lot of lateral thinking.

"To help get us underway, John Eales of JE Developments lent us a dummy block with heads on and we had the gearbox with the correct mountings so that we could do all of the work on the car and do a complete dry build and fabricate everything," says Tolman. "Peter Denty was also very helpful as he had restored the first Lotus 19 with a V8. He sent me a picture of the engine he had installed, together with another that came from the mechanic who had installed it in the Sixties in the States, so again we had evidence of how it was mounted and copied it.

"One of the things I wanted to do during the research of the car was to put bigger callipers on the front. However, the MSA was adamant that unless I could prove that that car on that day had bigger callipers, then it would not accept them. We built the car, showed it at the Autosport show in 2014 and it just so happened that John Wood, a friend of Christopher's and former MIRA CEO and technical director at the RAC, came onto the stand and was excited because he hadn't seen it since it raced at Brands.

"He then went on to say that he had

Technical specifications

Engine
- Aluminium 4200 cc Oldsmobile V8 developing 300 bhp and 519 lb ft maximum torque
- Quad 45 mm Weber carburettors, 100 mm trumpets with custom-made air filters
- Lightweight flywheel with AP Racing multi-plate clutch
- Modified rocker covers fitted with twin Monza caps and bespoke breather system

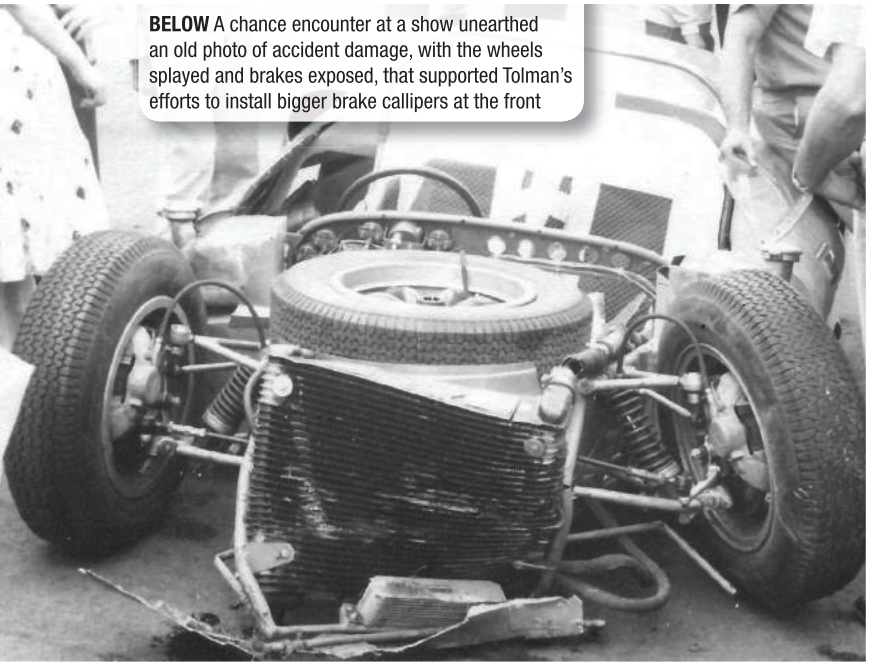
Chassis
- Tubular steel fusion-welded chassis with stressed aluminium skin
- 2-piece glass fibre clamshell body with aluminium internal structure
- Handmade aluminium doors

Transmission
- Hewland HD5 transaxle with cam & pawl LSD
- Fixed length driveshafts

Braking system
- Stainless steel brake lines and fittings
- Twin master cylinders with adjustable bias
- Fabric covered flexible braided hoses
- Front: Girling AR calliper 10.6" disc
- Rear: Girling AR calliper 9.5" disc

Fuel system
- Holley fuel pump
- Holley adjustable fuel pressure regulator
- New FIA-standard FT3-1999 custom fuel cell manufactured by Aero Tec Laboratories. Fitted within left-hand sill.

"The car crashed, exposing the brakes, and a member of the public took a picture that he was still able to find 60 years later – it was unbelievable!"



BELOW A chance encounter at a show unearthed an old photo of accident damage, with the wheels splayed and brakes exposed, that supported Tolman's efforts to install bigger brake callipers at the front

even taken some pictures. Amazingly, included in them was a close up of the car after its accident which with the splayed wheels and bent suspension clearly showed that it had bigger, non-standard callipers. It fact it's so extraordinary that you almost can't believe it: that the car should crash; that the front was damaged, showing the brakes; that a member of the public took a picture; that he was at the Autosport show 60 years later when he car was first being shown – and that he still had the picture which he could lay his hands on and could give us! You just couldn't write it!

"Not only that, when we started to drive the car we were having cooling problems with the 19 radiator we were using. When we further studied the picture, we realised that it wasn't a 19, but a larger one that had been lent back in the frame. We thought we'd also do that and solve all our problems! The end result was that we got the go-ahead to put the bigger callipers from BG Developments on as well as a proper radiator and suddenly the car worked."

The wheels were recreated but Tolman found it very difficult to get any information on the originals. "We got a set with the car and made everything work with what we had," he reports. "They were the right width but we knew absolutely nothing about things like offset and things like that. We then got another set of wheels that had been given to the client, but the offsets were completely different which meant that we didn't have to run spacers at the back of the car. Looking at them in period they look at lot bigger than what we've got."

Neat touches included the LED rear brake lights which are also the rear indicators, and the oil warning light. "While the owner was going to use one that had come off an old Land Rover, we had an old oil gauge in stock," he says. "We replaced all the internals with ultra bright LEDs, inserted an orange filter and glass on top so that it looks like an old oil gauge but if the oil level gets too low, it becomes bright orange.

"We used an aircraft specification wiring loom following major discussions on what it should look like, as we did with the switch panel and the Lucas fuse box, which looks period. Internally, though, it is totally modern as the owner was meticulous about every single detail and didn't want anything that looked out of period. However, what we did want to do was to protect the car, so right from the outset we knew we wanted to data log it, but it had to be discrete and hidden.

"It's part of our philosophy anyway that when modernising a car, we try to do so as unobtrusively as possible. Our theory is that if we are to make a modification to these cars, it has to be unseen and that it can be taken off without damaging the car and the original put back on. It also has to look right." HRT

No Stone Left Unturned

The ERA has a special place in British motorsport history, one that actively continues to this day thanks to the passion and knowledge of the restoration experts as **Andy Swift** recounts

IT seems hard to believe given the UK's position of pre-eminence in global race car technology today, but during the 1930s the country was a bit-player. Grand Prix racing was the preserve of the French, German and Italian grandees: Bugatti; Mercedes-Benz; Alfa-Romeo; Maserati; et al.

In 1933, an ambitious company was launched by old Oundelian driver Raymond Mays, benefactor Humphrey Cook and designer Peter Berthon. English Racing Automobiles (known universally by its acronym ERA) set its sights on the voiturette category for cars up to 1500 cc featuring forced induction.

Based in Bourne, Lincolnshire, ERA became a mainstay of *monoposto* racing through the mid to late 1930s and well into the post-war years as grand prix racing found its feet again after six years in suspended animation. In total, 17 of the traditional, 'perpendicular' ERAs were produced in period, with a further two E-Types: low-line cars clearly inspired by the Mercedes-Benz W125 and W154 grand prix weapons.

Of those 17 cars, all bar one remains in existence, with another built up around spare parts and taking the number AJM1, in deference to its creator, Anthony J Merrick. These cars are among the most sought-after racers of the pre-war era and many became instant mainstays in VSCC (Vintage Sports Car Club) – and similar – competition immediately upon ceasing their contemporary careers. It might prove difficult to confirm but it's a fair bet that the most frequently exercised of the ERAs are among the most active

competition cars in circuit racing history, enjoying near-constant starts over an 80-year period.

Today, owning an ERA provides an entry ticket to events from the prestigious Monaco Historique and Goodwood Revival down to club-level hillclimbs and sprints – a situation entirely reflective of the cars' period competition lives when Shelsley Walsh was considered almost as important as Donington Park.

Few engineers currently prepare the cars for racing but among their number is James Baxter, proprietor of Tip Top Engineering, a small firm specialising in pre-war road and race cars. In recent years he has spent countless hours teasing performance and underlining the safety of ERA chassis R4A, R4D and AJM1.

Baxter's lifelong obsession with old cars was perhaps inevitable. While the young Baxter was still an infant, his father used the family's maternity money to purchase an Austin Seven. This set the tone for a childhood spectating on VSCC events at Oulton Park, leading eventually to competing aboard first Chryslers and later Frazer Nashes of varying potency.

It was through Frazer Nash ownership that Baxter sharpened his driving skills through the cars' unique, forgiving handling and sharp steering. Equally, it honed the engineering skills he had developed through a mechanical engineering apprenticeship and degree working for Holset Turbos, a division of Cummins. That rigorous, analytical, first-principles style of mechanical engineering is the foundation of all the work Baxter has applied to the ERAs. ▶

ABOVE Mark Gillies in ERA R3A at Goodwood with seven more ERAs in his wake

Photo: Andy Swift

Photo: Andy Swift

ABOVE James Baxter holds every pre-war record on the UK hills. He is pictured here in R4A at Prescott

A CONTINUOUS HISTORY

When discussing racing cars of this vintage, the obvious elephant in the room is originality and Baxter is typically forthright about this: "It's perhaps ironic but today the ERA containing the most original parts is probably AJM1! R4D has received at least one new chassis and perhaps none of them, save maybe Romulus – the famous ex-Bira car – has its original engine block." He continues: "The cars' identity is in their continuity, not the components themselves."

The ERAs employed a Riley-derived straight-six engine of varying capacities – from 1,100 cc up to 2,000 cc – often interchangeable within the same chassis. For a period, Baxter was a part-carer of R4A, a car which ran with 1,100 cc, 1,500 cc and 2,000 cc engines during its contemporary career. That makes the monitoring of conformance with any specific rules set rather difficult; there is definitely no 'absolute' specification for any of the cars. The active cars carry a Historic Technical Passport and are, naturally, scrutineered on an event-by-event basis but the competitors very much police one another. As Baxter asserts, "If somebody turned up with a much larger supercharger, one of us would notice!"

> "21st-century analytics applied to 1930s racing cars"

After one season competing in R4A with friend and owner Nick Topliss, Baxter initiated a full rebuild. He found the engine internals to be in generally good condition but all six pistons were cracked so they were replaced with a new set from Cosworth, which had been bought with the car. The shells for the big end bearings were renewed but otherwise, everything from the 37 head studs to the Hyatt roller bearing crank was found to be eminently serviceable. When reassembling the motor, Baxter reset the timing for inlet and exhaust cams by 10 degs in opposite directions, immediately liberating 30 bhp at 4,000 rpm. The timing he employed apparently works well on every engine in his experience and was an easy win in terms of chasing performance.

ERAs have always run on methanol fuel which has several benefits but can also be catastrophic for delicate race engines. In period, it is believed a mix of 80 per cent methanol, 10 per cent petrol and 10 per cent benzene was employed. Methanol is a constituent of modern biodiesel and therefore fairly easy to obtain and today Baxter uses it neat in pre-war racers. He buys it directly from chemical companies for about £1 per litre, though necessarily in reasonably large quantities. While that sounds inexpensive, due to its low calorific value, about 2.2 times as much methanol is required for combustion relative to petrol. That calorific value also contributes to rather alarming fuel consumption of just two to three miles per gallon.

Baxter insists that there is sufficient scope for an entire article on methanol alone but highlights the key benefits and issues in handling and using it. Methanol will never detonate, meaning no danger of knock and the ability for engines to run extremely high compression ratios – of particular benefit for forced-induction

motors like the supercharged ERAs' which run at a compression ratio of 7:1, with the superchargers generating 16–17 psi. It also has a very low latent heat of vapourisation, allowing the cars to run very cool. It does, though, mean that they can take a long time to warm up and use huge amounts of fuel in so doing.

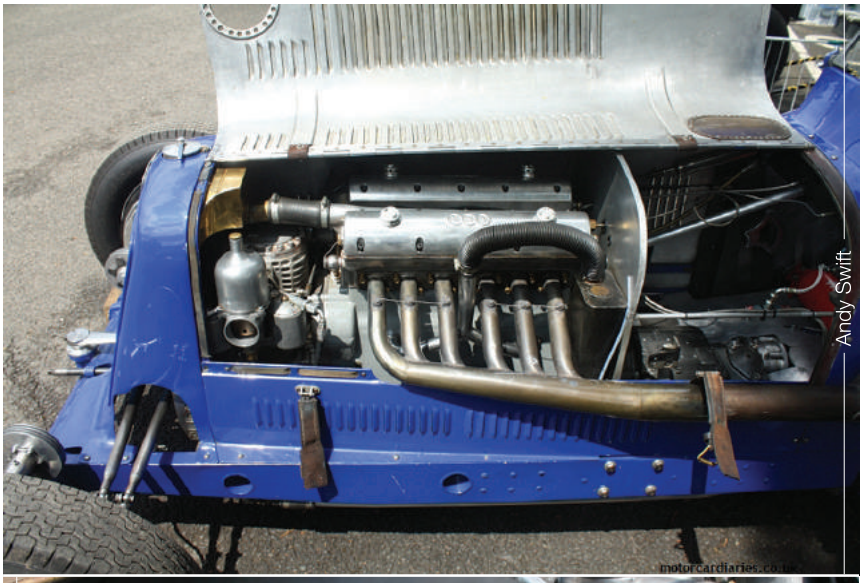
The major downside of working with methanol is the effect it has on aluminium and magnesium components. It will strip the protective oxide layer from aluminium surfaces, which causes them to oxidise more aggressively. This process becomes self-perpetuating and leads to the engine internals degrading and becoming caked in a nasty emulsion which is extremely difficult – or even impossible – to remove.

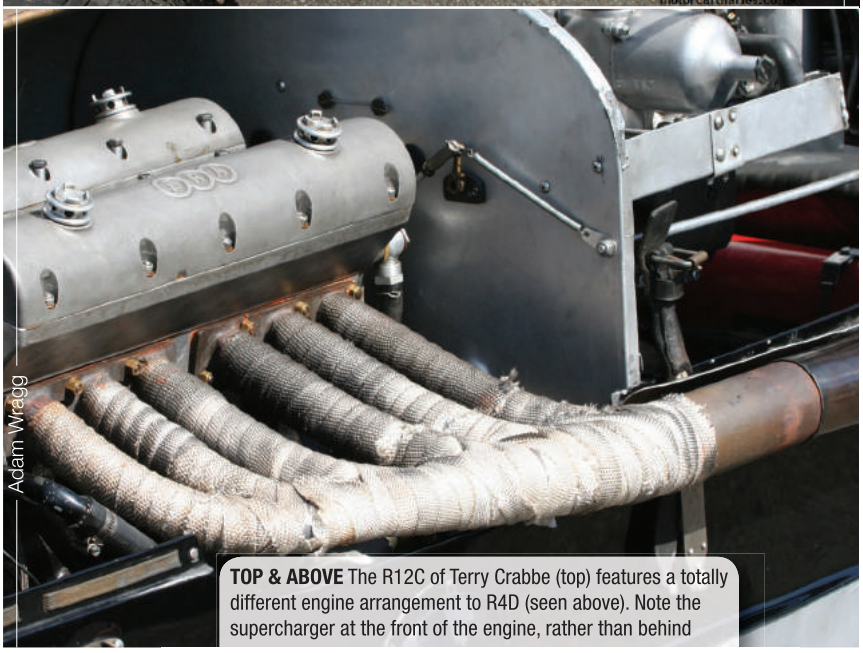
Baxter laments the effects on R4D's magnesium inlet manifold which had suffered with this problem over time. The trick, he claims, is to drain the engine internals once the car has returned from a competitive event; this includes the supercharger, which features its own drain point. He also remarks with a knowing grin that it's imperative to close the valve again once the supercharger is drained. The same applies to the cooling system – it's vital that the engine is wintered properly, with the water jacket drained to protect the block and head.

Baxter now includes an additive called Blue Alky in his methanol, procured through Summit Racing, a specialist supplier to the drag racing industry. It leaves an oily residue on aluminium and magnesium parts, offering protection from the effects of the methanol. It has the added, and significant, benefit of giving the methanol a visible flame.

The employment of methanol as fuel has also affected the lubricants used, not only in the ERA community, but also the wider vintage racing world. Vegetable oil is used rather than mineral oil as it is more tolerant of mixing with methanol and gives the cars that distinctive 'boot polish' smell. Vegetable oil has the added benefit of a higher film strength relative to a mineral oil equivalent.

Known generically as Castrol R – a fortuitous piece of castor oil-based lubricants branding for Castrol – Baxter uses Millers Oils' vegetable oil and





TOP & ABOVE The R12C of Terry Crabbe (top) features a totally different engine arrangement to R4D (seen above). Note the supercharger at the front of the engine, rather than behind

enthuses about their services: "They will now analyse a sample of your used oil. They can check for traces of metals and signs of excessive heat." Here are 21st-century analytics applied to 1930s racing cars.

CLOSE-KNIT COMMUNITY

The ERA community is small but close-knit and members support one another in their efforts to keep these precious cars running. Virtually all the cars are now understood to be competing with reproduction engines as a result of the corrosive effects of methanol fuel. The current owner of R4D, Brian Fidler, has supplied new blocks and heads, while long-time owner of R12C, Terry Crabbe, has produced a batch of diff casings.

These large, cast parts require significant tooling but Baxter has a fine local supply chain which helps with more incidental parts. When stripping R4D, he found the head studs were substandard and the threads were inconsistent. He produced a simple set of engineering drawings which enabled a local firm to produce a replacement batch. He had these produced from aircraft-grade steel, with rolled rather than die-cut threads by Dobson & Beaumont of Bolton.

He gives the example of a bronze bush which was produced on a modern CNC machine by another local firm for a few pounds. This replaced a tired bush in the steering box of R4D and cured unwanted play in the steering. Knowing another local firm which specialises in spinning metals, Calder Metal Spinning of Brighouse, he had a batch of brake back plates produced which he was able to share with other owners.

The procurement of parts is greatly aided ▶

by the archive of original drawings which is retained by David Morris, owner of R11B, the famous ERA known as 'Humphrey'. Morris possesses approximately 2,400 original works drawings. Every ERA is unique so working to the correct drawings is imperative as iterative changes were undertaken throughout the company's period competition history. Baxter strikes a mischievous note of cynicism: "99 per cent of parts are bespoke – it's almost as if Raymond Mays wanted customers to go back to him for parts!"

Baxter uses various methods for procuring parts for the ERAs, as well as other pre-war cars in his care. Where appropriate, he will produce his own dimensioned sketch designs, or send copies of the originals from the drawing archives if they're available. Alternatively, he will simply supply the original piece. When doing so, he will also provide any interactive parts where tolerance is critical to ensure maximum accuracy.

NO SHORTCUTS WHEN FIRING UP

The paddock of any VSCC meeting will inevitably feature a small pack of ERAs with their rear wheels jacked up in the air, protected by clothes horses while the engines warm through. This distinctive automotive pose is the result of a tortuous-sounding starting and warm-up procedure.

As a result of having no flywheel and hence no ring gear, the ERAs were never fitted with on-board starters and, in period, starting handles were used to turn over the engines. Today, to alleviate the risk of dangerous kickback from manually cranking the engine, three methods are employed: lift the rear wheels and coordinate two mechanics to push them; tow start behind another vehicle; electric starter in the nose. The push is extremely difficult from cold but does offer the opportunity to check for oil leaks as the car is static. The tow method can be difficult in a busy paddock and doesn't permit the opportunity to continually check for any fluid leaks.

Baxter favours the external starter option and has recently fabricated a quick-release starter dog for R4D to link the drivetrain to an outboard, electric starter. It prevents the need for the car to carry around a long starter bar, saving weight, while allowing the engine to start with the oil already up to pressure. One ERA – R7B – has been fitted with a ring gear inside the bell housing and carries an onboard starter, though Baxter feels the benefit is not worth the added weight and complexity.

Baxter offers a step-by-step guide to actually starting an ERA: "First add hot water, pull the plugs out and drain the methanol from the carbs. Next, turn the engine over to get oil pressure, add the warm-up plugs, fill the carbs with methanol and turn the fuel back off. Squirt petrol into the carbs, start the engine, turn the fuel on and warm to about 70°F. Finally, swap plugs, run again." Simple!

With the engine finally started, the car is warmed in that classic, bottom-up ERA pose, rear wheels spinning freely. This is the result of a number of factors, mostly relating to the cars' pre-selector gearbox. The gearbox is perhaps the most perplexing aspect of an ERA judged by today's engineering conventions; in fact it took Baxter three months of careful studying to fully learn.


James Baxter

ABOVE All 37 head studs for R4D

THE PRE-SELECTOR GEARBOX

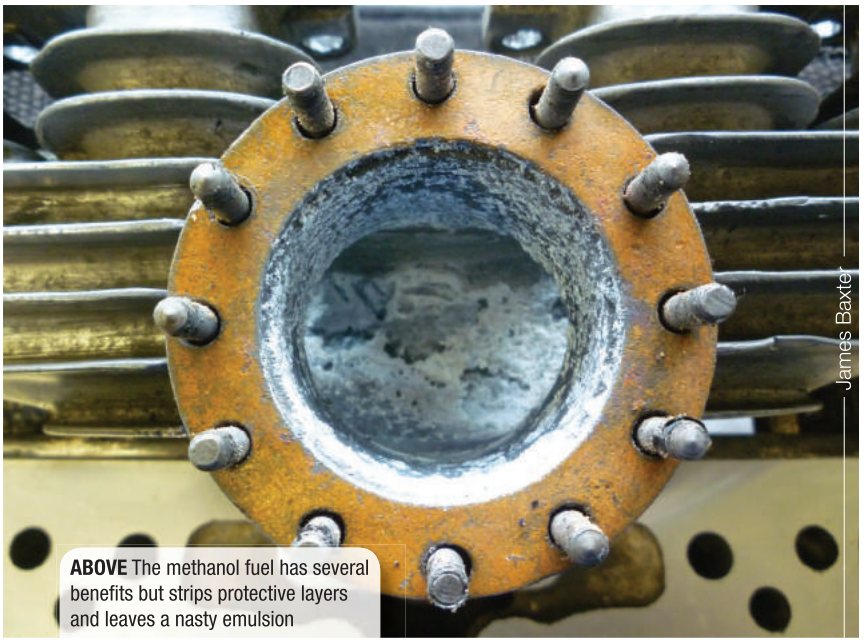
The Wilson pre-selector gearbox works on the principle of brake bands applied to a series of epicyclic gear trains – one for all intermediate ratios – each comprising a sun, a group of planet gears and an annulus. At any one time, one of the gears ▶

will be static, with the other two spinning at considerable speed. For a gear to be engaged, the annulus must be static while the sun and planet gears rotate. Fourth gear is a straight-through 1:1 ratio, doing away for the need for an additional epicyclic gear train.

Quite apart from the sheer weight of the rotating masses and the complicated mass of cams, toggles, switches and levers, the major downfall for the Wilson pre-selector 'box is the friction from so many gears and the drag from bands grabbing neighbouring drums. It's an arrangement which rewards patient attention to detail during preparation.

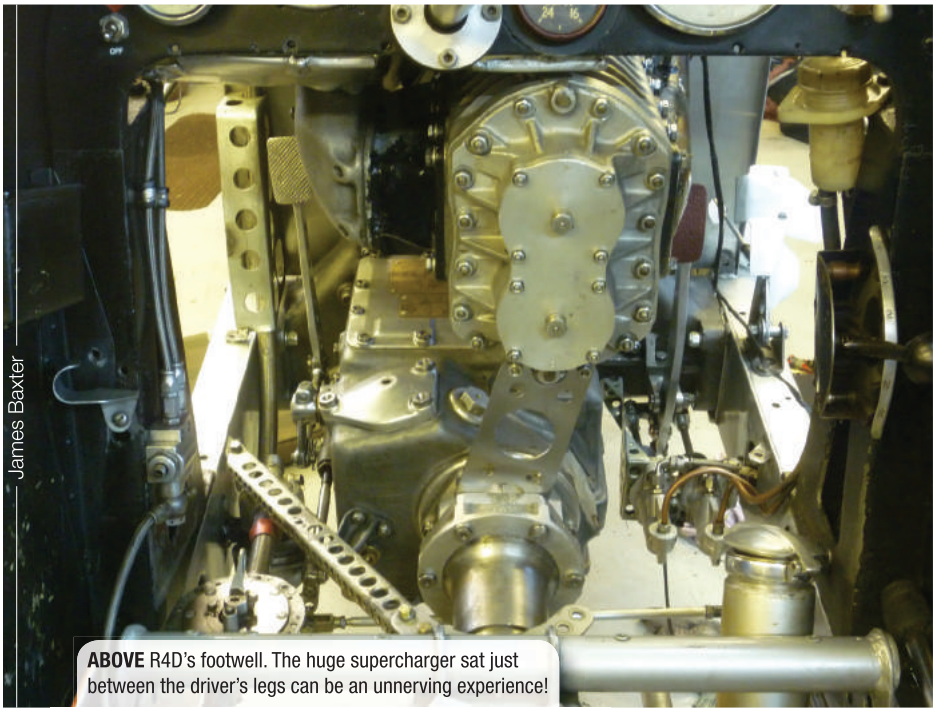
The pre-selector mechanism does away with a clutch, though the driver's left foot operates the actuator in a similar manner to a conventional clutch pedal. The key benefit foreseen with the pre-selector 'box during the 1930s was the ability for the driver to pre-select his next ratio well in advance, enabling him – or indeed her – to change gear with both hands on the wheel.

In practice, the pre-selector gearbox impacts significantly on the warm-up procedure. Neutral actually engages both first and reverse gears slightly, with a baulking mechanism preventing them becoming fully engaged. This makes the brake bands drag, causing more wear than if the car was in gear. Furthermore, in neutral, the annulus – third gear – is spinning backwards at three times engine speed, with the neighbouring drum running forwards at engine speed. That means the neighbouring drums are rotating at an opposing rate of four times the engine speed, causing considerable wear on internal bronze bushes.


James Baxter

ABOVE The methanol fuel has several benefits but strips protective layers and leaves a nasty emulsion

Exacerbating the gearbox's peculiarities is its lubrication system. The 'box features two oil pumps, one of which operates on the output shaft. Running the engine in gear therefore means the gearbox oil warms up more quickly and the 'box is lubricated more thoroughly. The solution to these various problems is to start the car with the rear wheels on a quick-lift and warm the engine with top gear engaged and the engine revving freely.


James Baxter

ABOVE R4D's footwell. The huge supercharger sat just between the driver's legs can be an unnerving experience!

A CAUSE FOR CONFUSION

If the gearbox seems idiosyncratic by today's standards then so, too, is the suspension set-up, particularly of the later C-Type and one-off D-Type, R4D. The A- and B-Type ERAs employed a beam axle front end with radius arms featuring milled hollows for lightness mounted on semi-elliptical leaf springs. The bottom arms were found to be inadequate over time and most have since been augmented with a second set of radius rods.

The later cars, however, followed an independent, torsion beam front suspension system of the type pioneered by Porsche. It was this suspension system which caused Baxter considerable confusion when he first worked on R4D: "Seen from above, the wheelbase was clearly different one side to the other. I thought the chassis must have been twisted so I decided to mark the hard points and geometry out on the garage floor using a plumb line and chalk." What he found was that the alignment was correct but that the front wheels did not sit on the same lateral plane as one another; rather they were subtly staggered. ▶

New from the publishers of RACE TECH

I am pleased to introduce an exciting new title 'Track Car Performance' which I am sure will be of great interest to you.

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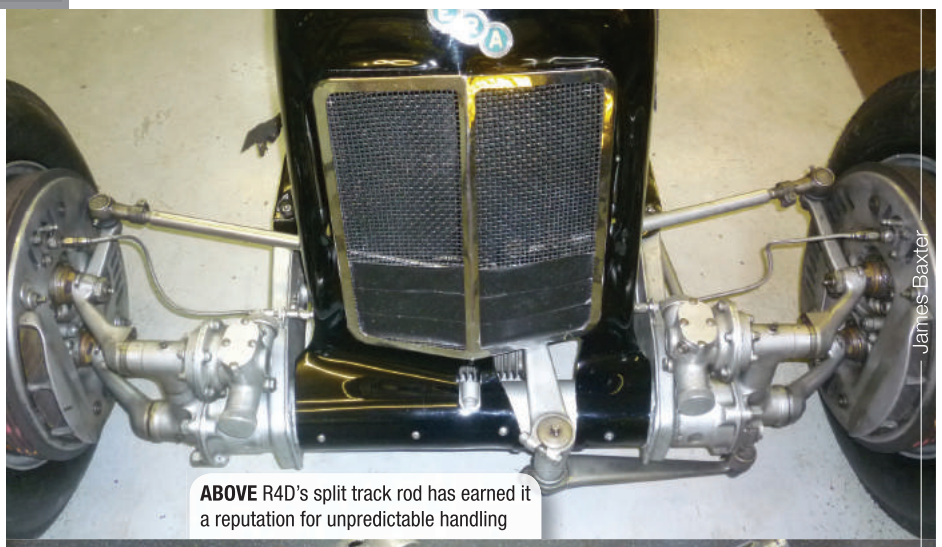
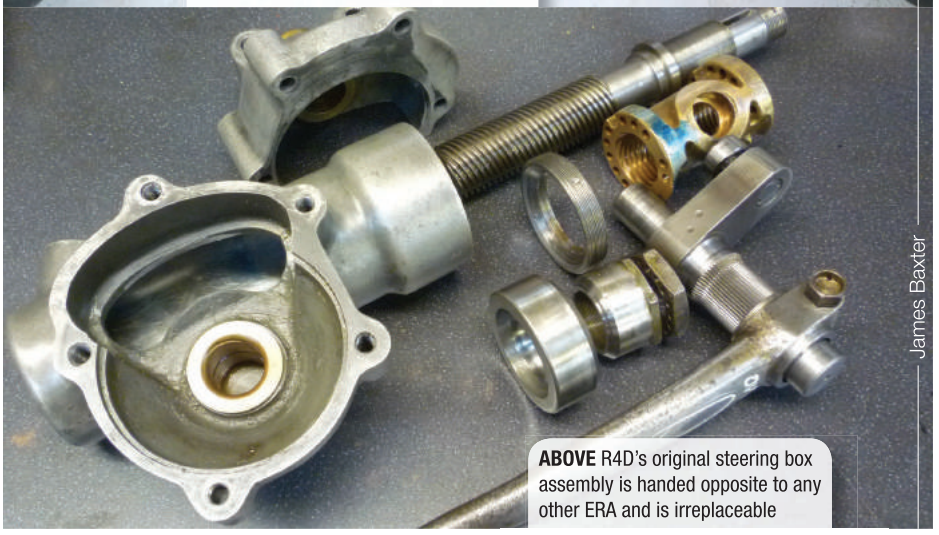

James Baxter

ABOVE R4D's split track rod has earned it a reputation for unpredictable handling


James Baxter

ABOVE R4D's original steering box assembly is handed opposite to any other ERA and is irreplaceable

This is the result of the two torsion beams running one behind the other in a shared lateral cross-member, within which they cannot both occupy the same space. Each one is mounted solidly at one end of the cross-member and to the trailing arm at the other, permitting torsion along its length. In spite of this apparently awkward arrangement, Baxter was able to get the corner weights to within 5 kilograms across the front axle.

While the torsion beam arrangement doesn't seem to affect the handling of R4D too badly, it is, though, compromised by its steering arrangement. The steering box is unique, being effectively left-hand drive, where all the other cars are right-hand drive. This casting is one of the few components left on the car which can be definitively traced back to the 1930s.

The steering box is offset, with unequal-length stub arms right to left, the result being that different lock is applied to each wheel. In fact there is as much as 30 mm difference in track rod length on full lock. Because the steering box is offset, that change in track rod length is different on right-hand lock than it is to the left. It is perhaps unsurprising, therefore, that R4D has gained a reputation for somewhat unpredictable handling characteristics.

The roll centre for R4D is actually somewhere below the ground, making nuanced ride height adjustment slightly moot. Adjustment is carried out by turning the splines on the torsion bar against fixed teeth. Baxter laughs when confirming that there is little benefit to be derived from altering the toeing when the fundamental track rod length issue remains. The solution, as employed by Terry Crabbe in ERA R12C, is a full-width track rod. It's clear Baxter is champing at the bit to install a similar device in R4D.

The rear suspension arrangement remained common across all the A- to D-Type ERAs, with cord-bound semi-elliptic leaf springs on both sides. The cords are prone to hold water and the leafs of R4D had developed some surface rust over time. When restoring the car, Baxter stripped the springs, cleaned the surfaces with a wire brush and polished before VSCC member Rob Pike instated new cording.

There is little adjustability in the rear suspension arrangement but Baxter did discover that rotating the rear spring shackles through 180 degrees dropped the ride height by about 2.5". He claims much of the benefit of this kind of move is doubtless psychological but it's a sign of how thorough and detailed engineering implemented across an entire car can bring wholesale, cumulative benefit.

In period the ERAs raced on every conceivable kind of circuit, from the banked Brooklands Outer Circuit, where an average of over 120 mph was possible, to the dusty tracks of Bathurst in Australia. Concurrently, the cars raced in hillclimb events and these were equally varied, from the fiendishly narrow and quintessentially English Shelsley Walsh to the majesty of Grossglockner in Austria.

VARIETY IS THE SPICE

Today, that variety is reflected in the cars' historic racing careers. In a typical season, a well-used example will compete in sprints, hillclimbs and race events. It is the challenge of the hills which really excites Baxter and he holds every pre-war record on the UK hills. As always, there's a balance to be struck in preparing the cars for these disparate disciplines. Baxter has fitted R4A with what he terms a sprint 'box. This is a gearbox which employs the works' suggestion for A-Type gearing but which is no longer so fashionable. A 3:1 first gear gives tremendous acceleration off the line compared to the more conventional 2:1 of the competition. This gearbox seems equally at home on the race tracks and helped propel Nick Topliss into the lead at the start of the Goodwood Trophy earlier this year.

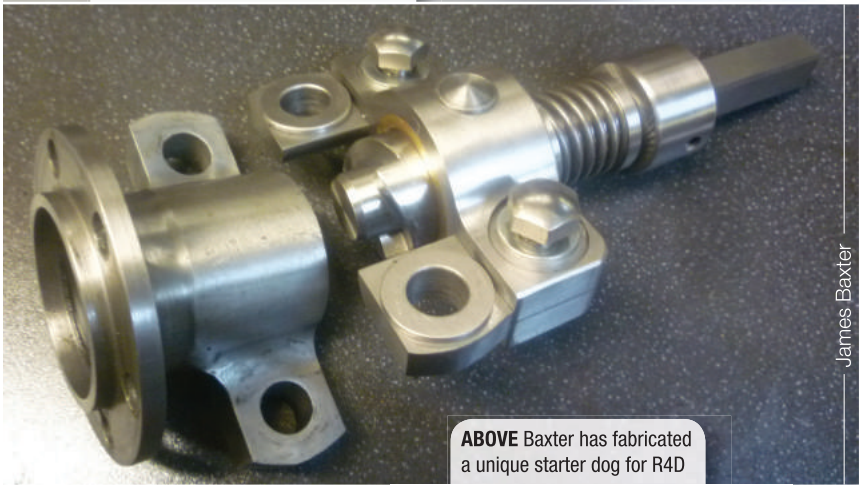
In the period, the ERAs became synonymous with the use of twin rear wheels for hillclimbing, as did Auto Union with its V16 monsters. This modification is

ABOVE Baxter at the revived Chateau Impney hillclimb last summer, from which he emerged as class winner, and fastest pre-war racing car, in R4D

Andy Swift

James Baxter

ABOVE The distinctive warm-up procedure, demonstrated here on R4A



James Baxter

ABOVE Baxter has fabricated a unique starter dog for R4D

possible today, though only Terry Crabbe is believed to possess the requisite parts. The twin rear wheels are of 19" diameter, rather than the 16" of conventional ERA wheels. This necessitates different tyres, as well as special wheel rims and new hubs. It's a heavy combination but one Baxter would simply love to try: "ERAs generally oversteer so we'll do whatever we can to help the rear tyres; we've even fitted a handbrake to the front for bigger burn-outs on hillclimbs."

It's clear that no stone will be left unturned in James Baxter's quest to squeeze more speed from any ERA in his charge. This work is evolutionary, rather than revolutionary – Baxter is simply applying best practice to ensure every tolerance is perfect, every moving part is properly lubricated and every material is being allowed to perform as it should. Iterative improvements based on sound, thorough and well-executed engineering – just as the works did when developing from the A-Type of 1933 to the last knockings with R4D. With the cars cared for like this, it should ensure another three generations are able to savour the wonderful sound, sight and smell of an upright English Racing Automobile in full flight. HRT

POWERFULLY UNCOMPLICATED

Robust, solid and straightforward, the BMC C-Series found under the bonnet of some Austin Healeys has been developed to give a performance its original designers could only dream about, as **Chris Pickering** recounts

THERE'S a persistent myth about the Austin Healey 3000 engine. Pub bores across the land will tell you that the BMC C-Series straight six was originally designed for use in a truck. While that's not strictly true – unless you count the Austin Westminster – it's not hard to see how the reputation came about.

This is a robust, uncomplicated engine. It uses a pushrod valvetrain with a single camshaft housed in the cylinder block and two valves per cylinder. In production trim, both the cylinder head and the block were made from cast-iron, while the crankshaft is a simple five-bearing affair, only designed to rev to about 6,000 rpm. Early 2.6-litre versions in the Austin Healey 100-6 even came with a four-port siamesed cylinder head, complete with a disastrously inefficient integral intake manifold.

On paper, it doesn't sound like the most promising basis for a competition car, but its torquey delivery and barrel-chested soundtrack has won the Big Healey engine legions of admirers over the years.

Austin Healey made three main variants of the 3000, and these days the Mk1 and Mk2 cars are most sought after for racing. While the Mk3 may be the quickest and the most powerful 3000 in production trim, it uses a heavier rear axle, along with a stepped chassis at the back, which limits how far the ride height can be dropped for circuit use. Conversely, the extra ground clearance and increased suspension travel make it the most popular choice for rallying.

Austin Healey used a variety of camshafts and carburettor configurations, resulting in power outputs ranging from 117 bhp in the 3000

JME Healeys

ABOVE A wide variety of different carburettor setups have been used, but the so-called tri-carb configuration offers the best performance

ABOVE The Austin Healey 3000 is now more popular than ever as a circuit racer

Andy Swift

Mk1 (and the six-port variant of the 100-6) through to 148 bhp in the road-going Mk3. Under the bonnet, however, the engines are fundamentally the same.

RECIPROCATING ASSEMBLY

In-period, even the works cars ran a relatively mild state of tune, which included standard con rods, a small increase in compression ratio and what would these days be considered a fast road cam. As such they were good for around 200 bhp, but the best FIA-legal historic engines are now comfortably over 280 bhp. So what's the key to getting the best out of them?

The answer lies partly with the use of modern materials. Design modifications tend to be quite conservative – modern Healey pistons for instance, look much the same as their 1960s counterparts – but contemporary materials lead to a virtuous circle within the engine.

High-strength steel con rods, forged pistons and modern ring technology allow the engine to withstand higher combustion pressures. At the same time, these parts are significantly lighter than those used in-period, which reduces the loads on the reciprocating assembly. This, combined with modern crankshaft design using lighter, stronger steel, helps the engine to rev a lot more freely.

Renowned Austin Healey racer John Chatham has first-hand experience of the benefits this can bring. As a driver, his racing career spanned nearly four decades and included factory drives with BMC on events like the Targa Florio. Half a century on he's still one of the top race preparation specialists for the marque.

"The works engines used a forged steel crank and we had them revving to 7,000 rpm in the Sixties, but the standard engine tries to blow itself apart at about 6,400 rpm," he recalls. "Nowadays, our competition engine will rev to 8,000 rpm without breaking – we don't use all of that because there's no point, but it will safely go there."

There are a handful of dedicated parts suppliers that make this sort of performance possible. The largest is AH Spares, which manufactures and supplies a range of fast-road and competition parts under its AH Performance sub-brand, including all the reciprocating assembly components.

Made from gas-nitrided EN40B steel and cross-drilled, the AH Performance competition cranks are significantly lighter than the stock items. Although the fundamental geometry such as the stroke is unchanged they feature a modern streamlined web design that helps to reduce windage and oil drag. They are supplied in either 8 or 12-bolt configurations to suit the company's lightweight flywheels.

The steel H-beam rods that make up the next part of the assembly are shot peened, with EN24V big end bolts. They use slightly larger big end bearings than the original Austin Healey design, providing greater strength.

Omega Pistons also serves the Austin Healey race market, as the company's general manager, Andy Baker explains: "We do a lot of forged pistons for the Big Healeys, but it's one of the few applications where there's still a demand for cast pistons."

Omega's cast piston is very close to the original design, he explains. It features a slight dish but there are no valve pockets or indentations. The forged piston, on the other hand, is a completely flat top design, which raises the compression ratio slightly, but it's still about as simple ▶

as a racing piston gets.

"There's nothing particularly clever about the design," comments Baker. "If you look at a race piston for something like a Jaguar XK you're permanently fighting detonation, but we never have any problems with the Austin Healeys. It's one of those engines that just works."

CYLINDER BLOCK

The relative abundance of Austin Healey engines means that original blocks still tend to be used for race engines. Generally speaking, these castings – the youngest of which is nearly half a century old – are still up to the job, but it pays to prepare them carefully.

"It's a good strong engine; it's very rare that you see anything go bang in a big way, but if you take an old BMC block or head you can see the porosities in it," comments Chris Everard, managing director of JME Healeys, an independent specialist based in the old Healey factory at Warwick.

"You notice casting issues in other areas too. Some engines have got a lot of slag inside the cooling galleries, which affects the flow of water. As a result you get some engines that run considerably cooler than others, due to the individual casting."

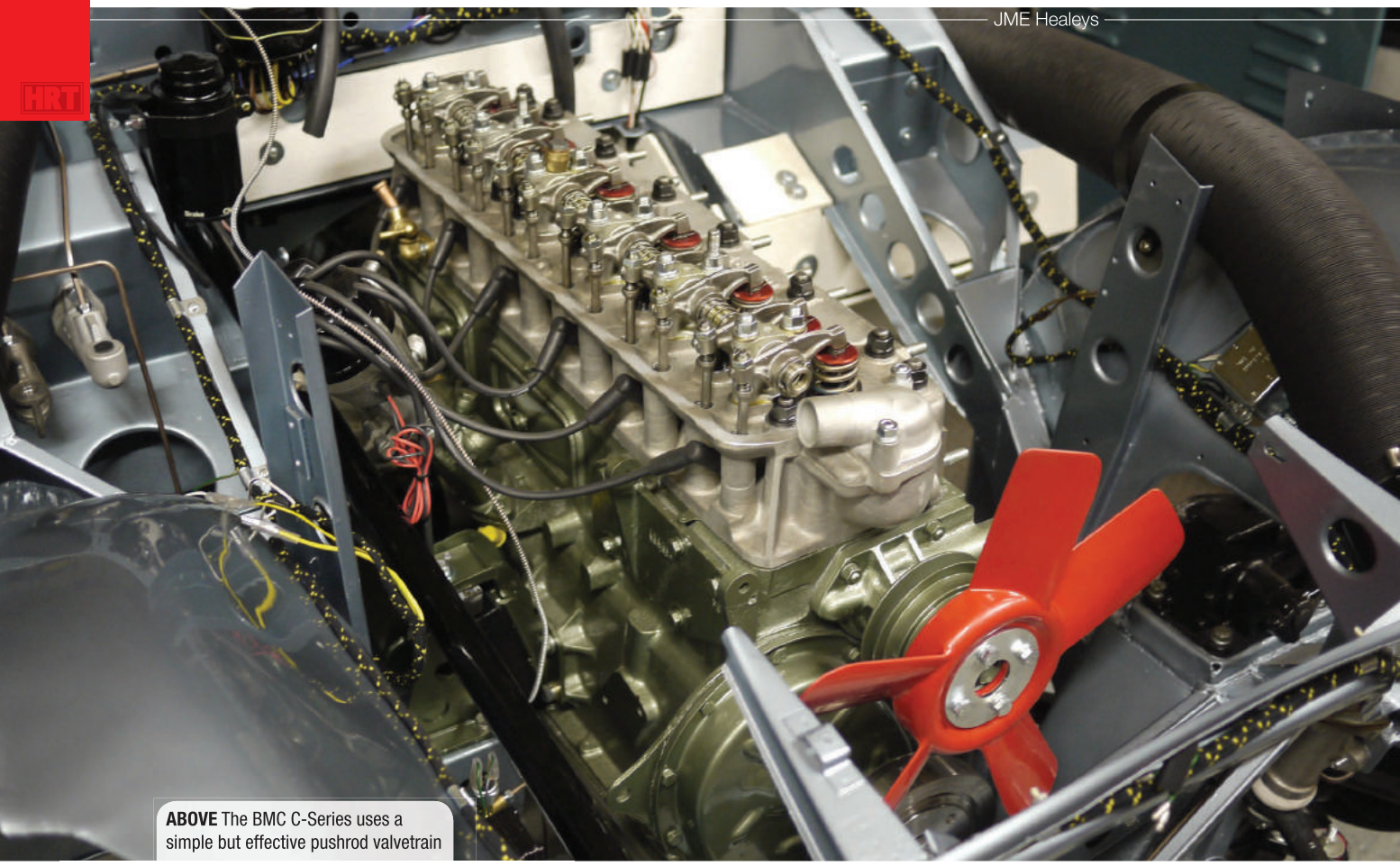
By default, JME acid dips the blocks it works with to remove sediment, but access can make it tricky to take the concept any further. The area around the water pump isn't too bad, but around cylinders five and six the cooling channels are virtually impossible to reach.

However, once up to speed, cooling doesn't tend to be a problem. "You very rarely see an engine overheat once you've got decent airflow through the radiator," says Everard. "The only potential problem comes when you're stationary – there's no real cowling between the radiator core and the fan, so it doesn't draw very effectively. A lot of people add electric cooling fans for when you're in the paddock or maybe on the warm up lap, but once you're racing you don't need them."

In-period the Austin Healey 3000 was only ever homologated with the standard cast-iron block, which means that teams hoping to compete under ▶

John Chatham

ABOVE, BELOW & BOTTOM John Chatham's re-engineered "3000S" model, which features an all-aluminium engine based on the ill-fated 1967 RAC Rally spec



JME Healeys

ABOVE The BMC C-Series uses a simple but effective pushrod valvetrain

the FIA's Appendix K historic regulations have to follow suit. However, that's not quite the full story.

The 3000's last major international outing was due to be the 1967 RAC Rally, for which the factory pulled out all the stops. This included the development of a prototype aluminium engine block, which resulted in a dramatic weight saving. A handful of these blocks were produced, but an outbreak of foot and mouth disease meant the rally was cancelled and the 3000 never saw action again with the works.

At least one of the aluminium blocks was later used in private hands by John Chatham, who has since developed his own version in conjunction with BAW Engineering. "It's a direct copy of the works development aluminium block with some minor strengthening modifications," he explains. "It's around 50 per cent lighter, which leads to tangible benefits in terms of handling, acceleration and braking. It also means the steering is much lighter – even with a high ratio steering box."

Chatham supplies the aluminium blocks for non-FIA race engines and fast road cars, including his own re-engineered 3000S model, which also features lightweight aluminium bodywork and a straight cut 'Tulip' gearbox with a competition overdrive, effectively resulting in a six-speed transmission.

TOP END

While aluminium blocks might be outlawed, alloy heads were used on the works competition cars from 1961, and as such they're considered a must-have for serious racers today. AH Performance produces a range of fast road and race heads, supplied ported, polished and ready to fit.

Externally, these are identical to standard cast-iron items, but they offer several key advantages. First and foremost, they shave the best part of 20 kg (35 lb) from the top of the engine, which has a marked effect on the handling. Aluminium also has much better thermal conductivity than cast-iron, which improves heat transfer. ▶

ABOVE Many of the road-going cars use twin carbs

JME Healeys

Finally, the standard heads are prone to cracking between the valve seats, but the aluminium heads don't seem to suffer the same issues.

Porting is a major factor, with heads opened up around the inlet valves to improve flow. Most engine builders do not tend to deviate that far from the standard valve sizes, though, explains AH Performance's Gary Pinks: "The standard valves are already quite large, so people tend to concentrate more on the ports and the cam profile."

AH supplies a range of bespoke cam profiles for fast road, race and rally use, alongside a replica of the factory camshaft from the 3000 Mk3 (also used in some of the earlier competition cars).

"We used a lot of computer simulation to optimise the new camshafts," Pinks explains. "The competition profiles are completely new, so these really are the most modern high tech cams available today. They offer vastly improved volumetric filling efficiency, which ultimately means more power."

Ironically, although Austin Healey 3000 pistons do not require recesses for valve clearance, the bores do. "If you're going to run a full race camshaft you need a pocketed block, because the valves are angled outwards and the lift and duration are such that they would strike the side of the bore otherwise," Pinks explains.

Take a closer look at the sort of cam profiles used on these engines and you can see why the pockets become a necessity. Fellow camshaft supplier Piper Cams uses 528 thou of lift and 328 degrees' duration on its full race cam, compared to 360 thou lift and 270 degrees' duration on the standard road cam.

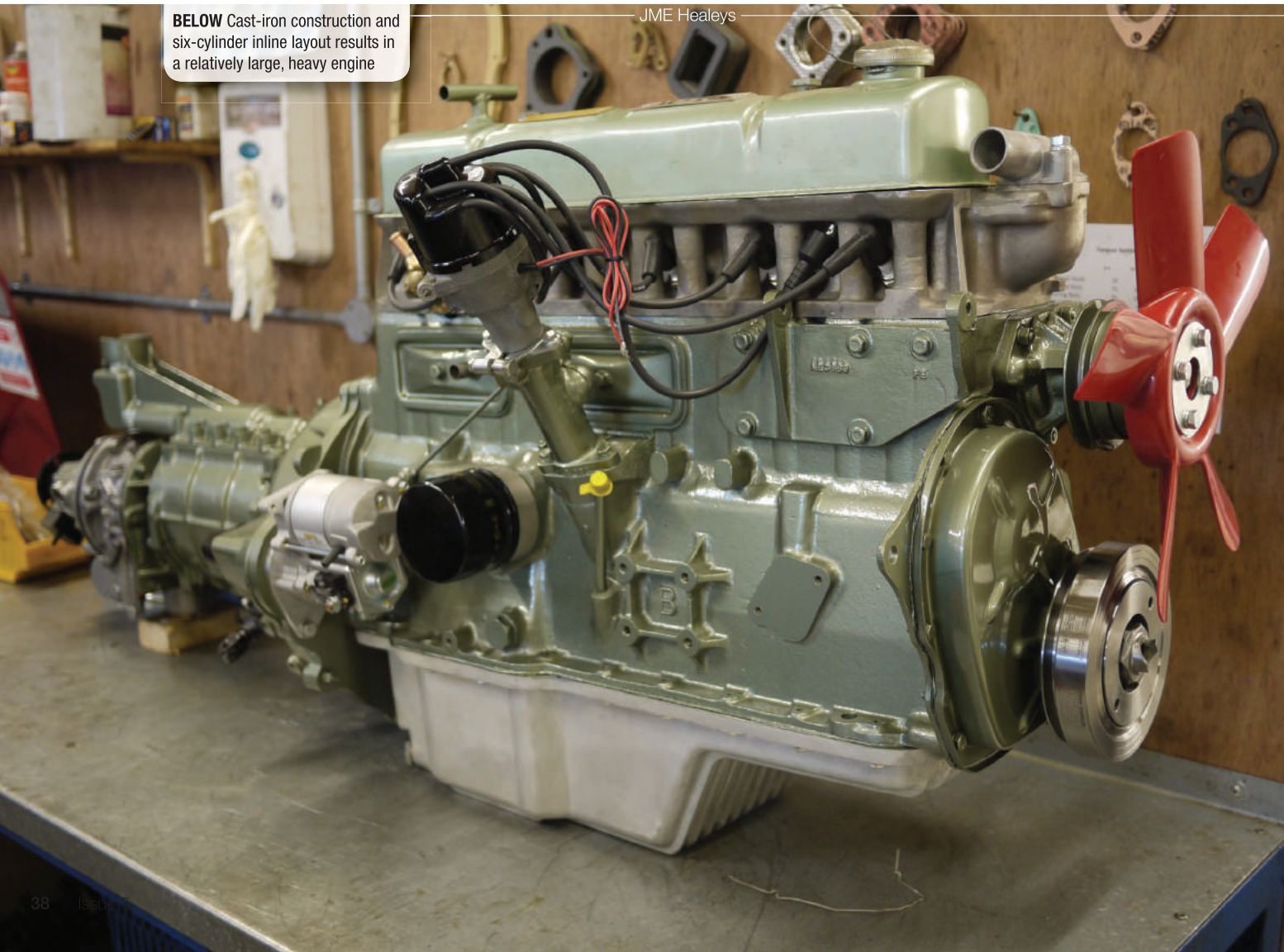
Material choice comes down to budget, explains Piper Cams technical director John Crabb: "Billet cams cost more than forged steel, but they can be gun drilled to reduce weight. Options include superfinishing and diamond like carbon (DLC) coated steel followers."

For high lift cams, solid steel rocker pedestals are often used in place of the standard aluminium items. This mod dates right back to the original works cars and it not only improves the strength of the pedestal, but helps to locate the rocker shaft more effectively, preventing fretting and improving valve control at high rpm.

ANCILLARIES

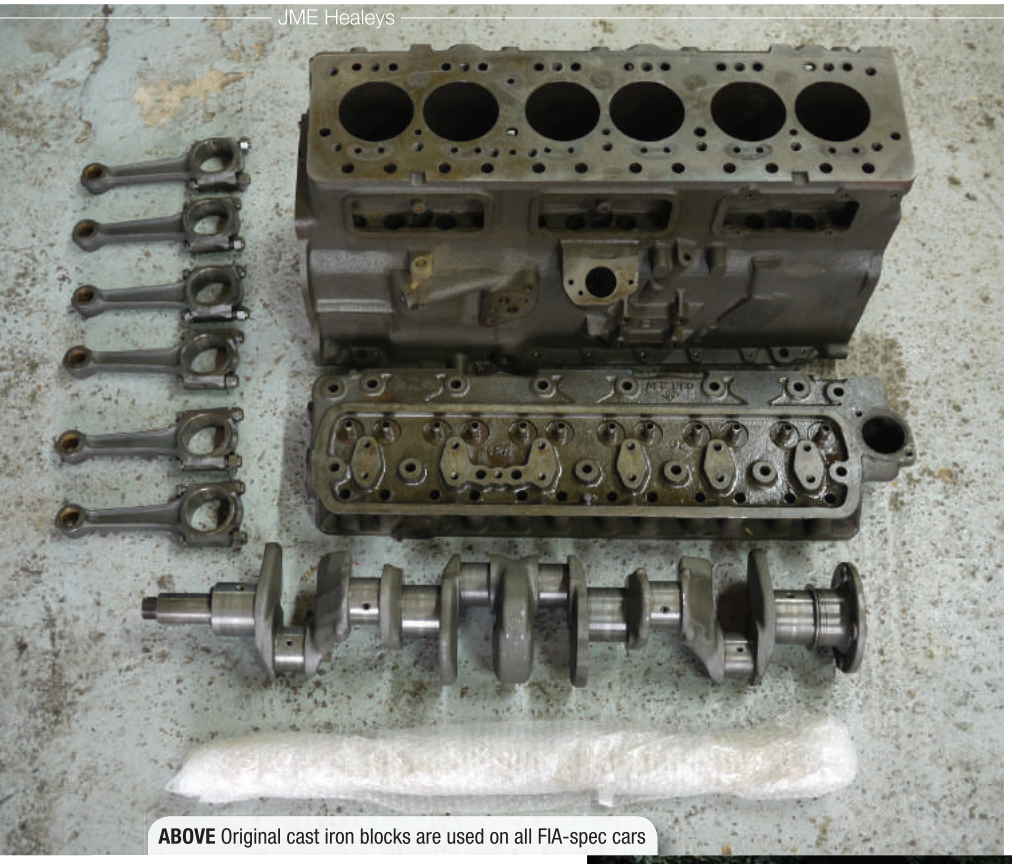
Lubrication is generally not a problem on the 3000 engine, although it does tend to lose a bit of oil pressure over time as the big ends and the main shell bearings wear. On road car engines, it's quite common to counteract this with a high capacity oil pump, which extends the rebuild life of the engine, but it's not recommended for competition use.

"Even on a race engine you don't need more than 45 or 50 psi and the standard



JME Healeys

BELOW Cast-iron construction and six-cylinder inline layout results in a relatively large, heavy engine



ABOVE Original cast iron blocks are used on all FIA-spec cars

oil pump is very good," comments Everard. "The sump is quite large – it holds about 8.5 litres – but the oil pump can shift all of that within a couple of rotations. Using a high capacity oil pump on a high revving race engine just risks shredding the drive gear and if that goes you'll know about it!"

Under FIA Appendix K all Austin Healey 3000 engines must run a wet sump, so decent baffling is essential. An aluminium sump is also a popular addition, which offers reduced weight, improved strength and better cooling.

Of course, those aren't the only points to consider. Higher compression, made possible by modern internals, means that race engines now have to be fitted with high torque starter motors. Outside of Appendix K, it's also common to fit an alternator in place of the original dynamo.

Firms such as Mallory Ignition can provide an electronic ignition conversion where permitted. For those limited to a period distributor the works-type Lucas unit with its preset timing curves offers more advance than the standard unit.

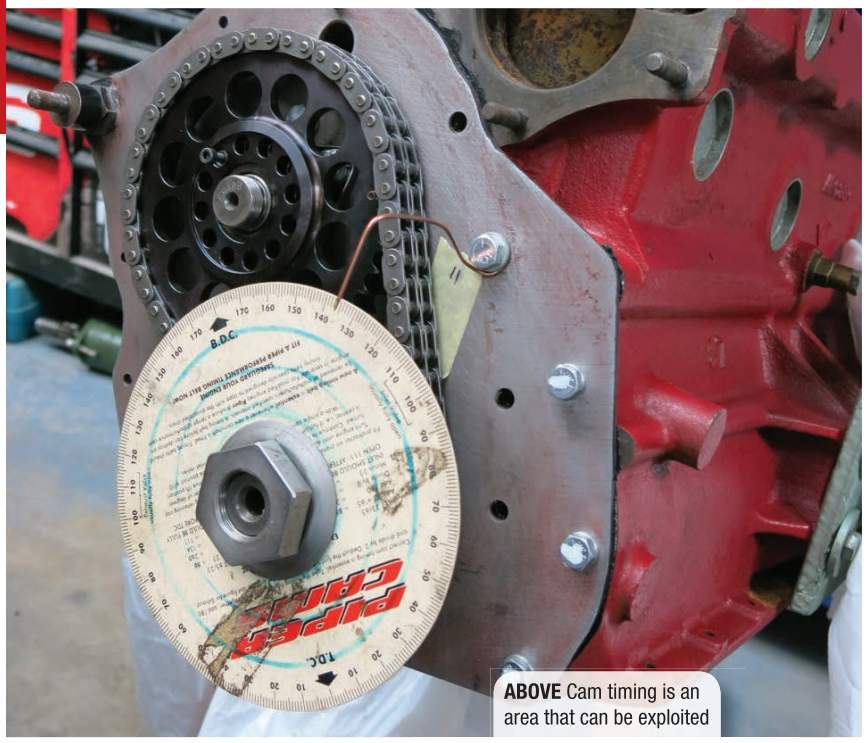
FUELLING AND IGNITION

Quite a variety of different carburettor setups were used in period, which means there's a plethora of potential options for a modern historic racing engine, but in reality everybody uses Webers. As Everard explains: "A set of triple Weber 45 DCOEs is the setup you need to go racing, even on the 100-Six. It's bolt-on horsepower. That said, the Webers are actually quite poor at low speeds. Triple SUs make the car a lot more tractable across the rev range, but they haven't quite got the same oomph at the top end."

Just as in the Sixties, race and rally engines tend to be quite similar under the skin. The main difference is the choice of carburettors and camshaft.

"The secret to the Healey engine is getting everything to work together," Everard concludes. "It's all about understanding the right compression ratio for the engine; getting the valve timing, ignition and fuelling right. They're time-consuming engines to set up and it's important to have the right equipment." HRT

ABOVE The Austin Healey 3000's greatest successes in-period came in rallying and it continues to be a popular historic rally car



ABOVE Cam timing is an area that can be exploited

PLAYING THE ODDS

Bill Rawles offers tips on engine preparation for Healeys

THE name Rawles is synonymous with Big Healeys. Accomplished Healey racer Bill Rawles also restores and prepares them under the banner of Bill Rawles Classic Cars.

Like the other engine builders we've spoken to he is quick to emphasise the importance of a good quality crankshaft. "A steel crank is a must to make the engine hold together," he notes.

The Big Healey engine is limited by the same torsional balancing issues as any other straight six. Theoretically, it has perfect first and second order balance, but this oft-quoted property of the straight six layout assumes an infinitely rigid crankshaft. In reality, anything up to a couple of degrees of flex can occur, at which point the firing of cylinders slips out of phase and the engine becomes dangerously unbalanced.

There are various ways to tackle this. A stronger crankshaft, lighter reciprocating components and a torsional damper integrated into the crank pulley all help.

"We've found it's essential to run a proper damper on the front of the engine like an ATI Super Damper," comments Rawles. "Without that, the harmonics in the crankshaft limit the engine speed you can reach."

His approach is pragmatic and like others he believes that attempting to over-engineer this fundamentally simple unit can backfire: "I think these engines reached their extreme back in the Nineties when people were breaking things regularly in search of an extra one or two horsepower. Since then everyone has pulled back a bit."

One example he gives is the compression. Rawles reckons the optimum compression ratio on high quality pump fuel is around 11.5:1 for racing. Some engine builders go higher, but that runs the risk of detonation unless you're using specially formulated race fuel, which is banned in a lot of historic events. This comparatively conservative compression ratio improves reliability and also causes the engine to run a little cooler.

GAS FLOW

It's a similar situation with gas flow, he explains: "Over the years people have taken more and more out of the heads, but it doesn't really work. The trick is to keep them quite small so you increase the gas velocity going into the engine. We used to flow bench our own heads, but with modern CNC machining the off-the-shelf competition heads are now so good that we don't need to.

"You can get big valves too – about 1.5 mm larger than standard – but you see no difference at all. We use proper racing valves with a wasted and fluted design, but size-wise they're completely standard. The danger of using big valves is that they get so close to each other they split across the seats."

One area that has benefitted from recent work is cam design, he explains: "We're running a new cam from Sideways Engineering in Sweden at the moment and the car has suddenly jumped to the front. It's an interesting configuration – it's got a bit more lift than the usual Healey cams and it's got a lot of duration, but the timing is quite retarded. The power curve is smoother now and it pulls right the way from about 3,500 rpm."

However, while there are still gains to be made in performance, the Big Healey's greatest strength remains its longevity.

"Where the Healey comes into its own is endurance racing," he says. "At events like the Spa Six Hours they just keep going."

It's a comment born out of personal experience. Two years ago at the Spa Six Hours, the Rawles car finished 17th overall, beating 91 other competitors, including E-Types, Cobras and GT40s. While the more exotic cars may have the edge on pace, the 3000 has the staying power required to claim some serious scalps in long distance events. Just as it was in the Sixties. HRT

Masters HISTORIC RACING

2016 EVENT CALENDAR

APRIL	09 – 10	Zolder, Belgium	Masters Festival
MAY	28 – 29	Brands Hatch GP, UK	Masters Historic Festival
JULY	02 – 03	Donington Park GP, UK	Masters Festival
	29 – 31	Silverstone GP, UK	Silverstone Classic
AUGUST	12 – 14	Nürburgring, Germany	Oldtimer Grand Prix
SEPTEMBER	02 – 04	Zandvoort, Holland	Historic Grand Prix
	16 – 18	Spa-Francorchamps, Belgium	Spa Six Hours
OCTOBER	15 – 16	Jarama, Spain	Espiritu de Jarama

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NOVEMBER	10 – 13	Daytona International Speedway, USA	Daytona Historics
DECEMBER	01 – 04	Sebring International Speedway, USA	Sebring Historics

Correct at time of going to press. Dates and venues may be subject to change.

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PREVENTION BETTER THAN CURE

Why a crankshaft vibration damper is a crucial ally in the quest for performance

BORN as a local transmission shop, ATI Performance Products forged its reputation as a leading manufacturer of transmission and driveline components on the dragstrip in the US. Over the past 55 years it has earned a reputation for its cutting edge technology, attention to detail, and rigorous testing under race conditions. One of its principal products is the crankshaft vibration damper, the Super Damper.

"I've been around dampers for a long time and have travelled to numerous engine shops around the country to physically test crankshaft twist over the past 16 years," says JC Beattie Jr, of the Baltimore-based company. "Throughout this time, I have collected considerable data that allows me to determine 'how much damper' a certain engine needs. When given the crank weight, peak normal operating rpm, horsepower, rotating system materials, rules about the damper specifications (if racing), and the application of the engine – road racing, oval or drag – I can make a very good prediction of the amount of inertia weight and the type of device that the engine will need.

"What would happen to an engine without harmonic balancer or an engine running more rpm and horsepower with the wrong damper?" he asks rhetorically. "Depending on the application, bearings would fail, then the timing chain or belt. Then there would be wet sump oil pump problems and finally crank breakage from too much torsional twist.

"This is what I measure when I'm damper testing. It is this action that breaks parts and robs you of horsepower when there's nothing to counteract and eliminate the twist. In this system, the worst torsional vibrations, or twist, will always occur at the farthest point from the greatest load, or the heaviest mass. A torsional twist is defined as a twist without a bend. If you get too much of this twist, you will have a bend and this will cause engine and/or crank failures. Think about twisting a piece of rope over and over: you can make one or two revolutions and nothing happens; after that it starts to get a wave in it, and then as you twist more, the rope will pull your hands closer together.

"Once torsional vibrations get to the front of the engine, something there needs to counteract that motion. This is where the damper comes into play. The damper's job is to absorb and counteract as much of the twist as possible. With the right damper on the engine, the majority of the twist can be eliminated. However, with the wrong damper, virtually all of the twist can remain. A damper's job is to rebound the recoil of a spring. In this case, the spring is the crankshaft twisting and when it tries to rebound past that natural state is when the damper needs to stop it."

The ATI Super Damper serpentine harmonic balancers contain grooves for serpentine belts machined into the outer damper shell. The dampers come standard with six outer grooves for standard OEM drive systems. Specifically designed for high-performance engines, they are tuned to eliminate the harmful crankshaft harmonics that cause parasitic horsepower loss. These balancers are tunable in the field, re-buildable, and extremely efficient at all rpm.

"When you are looking at crankshaft dampers, you have to know they are not all the same," says Beattie. "There are a few different designs that all claim to do the job, but for the most part, they are all just an OEM-style damper with a rubber strip or silicone fluid in them. If you are turning OEM rpm, and making OEM horsepower, then an OEM-style damper will work for you. If you are not, then you better be looking for a performance damper, such as the ATI Super Damper, or you will be replacing broken parts sooner than you need to." HRT

ABOVE A cutaway of ATI Performance Products' Super Damper

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A STEEP LEARNING CURVE

A year out of university in industrial placement can often be a waste of time for the student, but not so for two from Oxford Brookes University who found themselves fully immersed in a full-on race car build and development project, as **William Kimberley** discovers

ASK most people of a certain age and the venerable Austin A40 Farina was a car that their granny or great aunt pottered around town in. It was solid and reliable and actually pretty advanced in its styling, with a legitimate claim to be the world's first hatchback. What is forgotten, though, if it were ever known outside motor racing circles, was that it enabled George 'Doc' Shepherd to claim the British Saloon Car Championship in 1960 in the Don Moore Racing team car. He was also runner-up the year before. In other words, it's a model with some racing pedigree.

Fast-forward 55 years and it has become a mainstay in historic racing. Its relatively simple mechanics mean that it is the vehicle of choice for the racer with a limited budget, while also opening the way to a great deal of fun on the race track.

One of the leading lights in preparing and running these cars in the Historic Racing Drivers Club is the Jordan Racing Team, but there are also a number of other squads who try their hand with them as they represent so much fun. One such is the British Motor Heritage (BMH) team.

"It was back in 2006 through a contact we had with Ding Boston, the Oxford Universities Motorsport Foundation's (OUMF) coordinator and driving force, when we took on a student from Oxford Brookes doing a motorsport degree who spent a year with us building up an FIA-compliant racing MGB, the first car we had built," says BMH owner and managing director John Yea. "Using a Heritage shell, it was really quite a straightforward project other than the fact that truthfully we knew nothing about what was required to build a race car. We relied upon a great deal of support from Doug Smith at MG Motorsport and ended up with a car that is still racing today.

"Then in a moment of madness a few years later I thought an Austin A40 would be a good idea and consequently bought one off eBay. Although 54 years-old, it still looked half decent and it came with an MoT so it was legally roadworthy although it was always my intention to turn it into a race car. As far as British Motor Heritage is concerned, the A40 is probably not the best choice (unlike the MGB) as it's a bit peripheral in terms of what we do.

"If you look at the popularity of the HRDC series, there's a lot of nostalgia associated with the car and they are simple. It's not true to say they're cheap as they are clearly racing Midgets underneath, all with very highly stressed A-series engines, and we've probably spent more money on this car than we've ever spent on the MGB. However, another attraction was the David and Goliath appeal where the smaller car clearly doesn't have the straight-line performance, but it does have the handling."

STUDENTS TO THE RESCUE

It was the arrival of Jimmy Allen and Dominic Norman from Oxford Brookes University in July 2014 for their year out in industry that kick-started the project to life. An important element in this was Dave Savidge, their mentor at BMH, because while they were full of enthusiasm they lacked a broad range of experience.

"What was very critical from their viewpoint, though, was that the project cut the mustard with the college as it needed to tick a number of boxes in terms of what they would have to do," says Yea. "However, to be honest, we kind of threw them into the deep end on the basis that we were aware of the race series and had seen it, but hadn't done anything there, so they were given the task from the outset of researching the cars while at the same time stripping down the one we had here. That's what got it underway. The intention was to have a competitive car in a particular class and that's probably what we've got. From that viewpoint, it's been a great and successful project."

> **"My first few laps were horrifying and all I could think was, 'What have I done?' But now it's a proper little race car"**

The starting point was setting out a timescale and assessing how long each part would take, the target being the ▶

ABOVE Industry gurus willingly shared their knowledge with the students on the A40 programme

first race of the season in 2015. The seven-month project turned out to be slightly ambitious!

"What really helped us was the advice and guidance we received from some of the gurus in the industry, who volunteered to share their knowledge with the boys as their status allowed them to visit others who would not ordinarily welcome someone who is building a rival race car," says Yea. "It was invaluable and demonstrated a great willingness of members of our industry to assist technical education without the expectation of anything in return."

One of the first tasks was to complete a 'bill of material' with outline costings and a detailed weight-saving hit list, while of a more technical nature were the proposed suspension calculations and overall project document.

On receiving the car, it was completely stripped down and the individual mechanical parts catalogued and stored. The bare bodyshell was then sent away to SPL in the West Midlands for a total acid dip. "We lost a lot of time on the shell which was worse than we expected," says Yea. "It also showed up the poor level of repair over the years."

Because it is important for both the strength of the shell and the final appearance, new front wings and floors as well as the sills were ordered from Radford Panels, which manufactures its products by hand and necessitated a three-month lead time. It then took around five weeks doing the bodywork and repairs, which took the project into the start of the year.

Prior to the shell going off to the paint shop, Allen and Norman carried out quite a bit of pre-paint preparation themselves under the guidance of Dave Cooke at Kennington Motors. However, it was not until the first week of May that the painted bodyshell was returned to BMH.

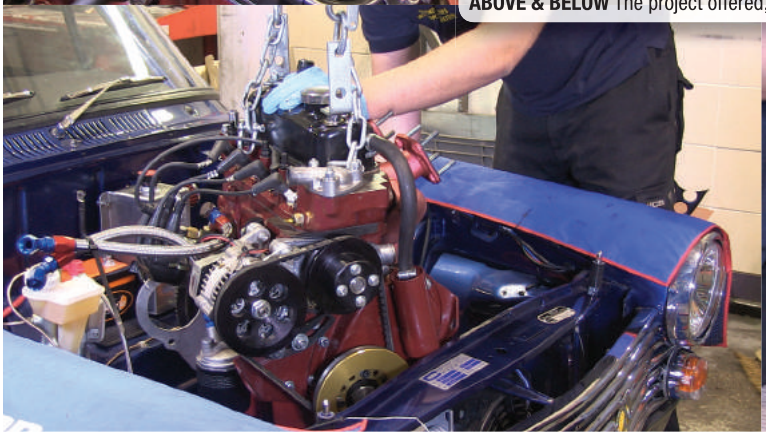
THE DRIVER AS AN AFTERTHOUGHT

One of the early tasks was deciding on the seating position. The regulations dictate that there must be a nominal passenger seat but the driver's seat location is quite open. "We started the seat placement with myself getting an early sight of the likely view once we finalised the position," says Yea. "For weight distribution, chassis 'feel' and safety, the optimum placement was as low down in the car as possible. However, I had to insist that actually being able to see where I was going was also pretty important, along with ability to place the car into corners! It's actually a very strange seating position – bizarre on the road but fine for the race track."

"We went for a 13" Moto-Lita steering wheel, John's personal preference, while with the pedals we got John into the car and built everything around him to the best of our abilities," says Allen. "We could have used a new Tilton pedal box but instead opted for a dual circuit master cylinder from a Mini which was about the right bias front to back, although we have now added a proportioning valve."

Many of the suspension components were sourced from Rae Davis Racing, an acknowledged source of excellence in preparing these cars, while Rae Davis himself is a driver of some note.

"Underneath it's all Midget with standard spec callipers and discs but everything about the suspension has been upgraded from rubber to polybushes to try and get the slop out of ▶



ABOVE & BELOW The project offered, quite literally, hands-on experience

everything," says Norman. "We calculated the spring rate we might want and verified that with all the competition and came up with twice as stiff front springs as standard that are a bit lower, while the rear ones are a completely standard spring rate. The general consensus on these cars is that because the tyres are so slippery they just oversteer everywhere. By having a softer spring on the back it kind of sits on the back allowing articulation for greater rear grip."

There is an A-frame at the back for tramp and sideways location. "We did the spring rate based on a ride frequency of 2 Hz which came out as about 650 lb springs," says Allen. "We spoke to CCK that runs 600 lb who told us to keep going as stiff as we could until it became undriveable, although the Jordan cars run 700 lb springs. We used MGB anti-roll bars, which we hold in stock, and machined their aluminium mounts. We now have three different sizes depending on the weather and track conditions.

"We originally had refurbished lever arm dampers where the valve was modified to increase the stiffness, but there is a company in the US that does adjustable ones with an exterior needle valve so that we can tweak it. It is possible to get the original Armstrong 22 adjustables, but they do go for quite a lot of money on eBay, a pair of rears costing £500, although the American ones aren't cheap."

Another expert in the field is Ralph Sanders at Pitstop, who is widely regarded as one of the leading BMC A series engine gurus. "We had a good idea of what goes into a good race engine but it was more of a question of our learning from Ralph, so he would have his ideas and we would chip in

ABOVE The students were advised to go as stiff as possible on the springs, until the car was undriveable. The early laps indicated that the goal had been achieved!

ABOVE The preparation of the shell, which was acid dipped, involved a lot of time

with our thoughts," says Norman. "What we have in effect is a Mini Miglia race engine. The only regulation is that the capacity had to be under 1300 cc and it has to be an original block and the head made of the same material as the original, but all the internals are free."

EVERY LITTLE BIT HELPS

"The main thing we learnt through all this was about the bridges and friction loss and undergrinding the crank to allow more room to reduce the friction, lighter oil and optimising every little bit," says Allen. "We also used Omega forged pistons that are just a first stage overbore to take it from 1275 cc to 1293. However, we couldn't find anyone who had a forged steel crank in stock for this engine, so we had to wait until they were back in production."

The compression on the engine is not ridiculous, nearer 11:1 compared to the 13.5:1 that some people are running. 127 bhp has been recorded on the rolling road, with 120-135 being in the ballpark. "At this stage reliability is more important that extracting the final bit of horsepower," says Allen.

Fitting the carburettors proved to be pretty challenging and annoyingly required the removal of part of the freshly painted metalwork from the bulkhead just to get them in place. Bespoke plates and bracketry were also required to achieve fitment of the throttle cable.

Motul is the team's preferred choice for lubricants based on recommendation from Doug Smith who prepares a lot of these cars. "Essentially we decided, 'Why try and be different?'" says Allen.

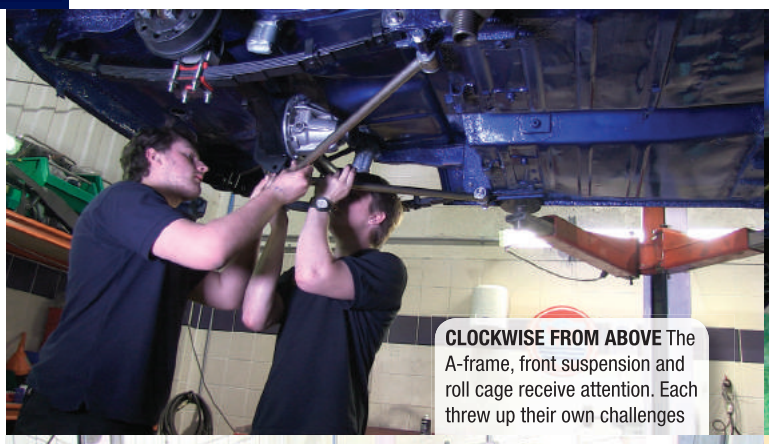
"Concept Racing designed and built us an aluminium radiator to the overall dimensions of the original A40 rad, but with an up-rated core. If it's running too cool we can always block it off. The oil cooler is mounted vertically just in front of it."

Allen and Norman opted for a Maniflow exhaust system kit that came in several bits, but it turned out to be very hard to assemble in the space available and difficult to maintain a reasonable ride height. "We struggled to get it under the noise limit and ended up replacing the rear box with a conventional racing silencer," says Norman. "We also had problems with the inlet. The length of it was ridiculously short and there were heat issues, so we had to make an elaborate heat shield along the manifold and Zircotec coat the inlet and outlet.

"We did toy with taking it to a specialist like BTB but felt that until we had really honed in on the engine spec it would be a waste of time. It was a matter of just getting us into the first few races and learning before refining it into something that we wanted."

One of the requirements of the HRDC series that the A40 races in is that the car must have the original gearbox casing although the internals are free. "We had to decide whether to go for a synchro or straight-cut dog box, deciding on the latter," says Allen. "We stripped the old box and used all the original manuals and with Dave's expertise started to put a Quaife gearset into the casing ourselves. However, we had to go through the assembly process several times just to get it all right.

"We use a Helix racing clutch, not ▶



CLOCKWISE FROM ABOVE The A-frame, front suspension and roll cage receive attention. Each threw up their own challenges

one from Formula 3 but just a normal single organic plate 7½" clutch that has a roller release bearing. There was the choice between concentric hydraulic release or just arm, but the cost difference is ridiculous between them. The concentric release has a nicer action and it will wear more evenly, but actually having a chat with Helix about them it's potentially adding in a bit of unreliability, so we've stuck with the normal slave cylinder and arm."

PROPSHAFT ISSUES

"After the first race we were also having issues with the diff as it was pulling itself apart, and it was only after casually talking about it to the guy at Bailey Morris we learnt that our prop was running over its operational speed and we needed a larger diameter one to avoid the vibration that was damaging both our diff and gearbox," says Norman. "We did think about using a carbon fibre one, but as it would have cost around £1500 it wasn't in our budget; there was also the issue of size because when we worked out what we needed, it would be of a diameter where we would struggle to fit it under the tunnel. It would have been great because our prop is around 5 kg and the carbon fibre one around half a kilo but I think it struggles with normal universal joints because of the amount of flex that's allowed. The one we saw had just two aluminium plates that only allowed three degrees of movement."

The back axle has the original casing but with the ratio changed from 4.2 to 4.5 diff. "We worked out that you might want a 4.9 diff at Mallory Park, but struggled to find one although they were originally fitted to an Austin A30 van," says Norman.

"We did have issues with the original 3J limited slip diff. We built it about 10 times, but every time there seemed to be a slight run-out on the crown wheel where it was just getting a tighter mesh at one point. When we checked, everything was fine, and after taking advice from Peter May who supplied the diff, we decided to accept the run-out. The 4.5 diff has now completed three races and we have also built a 4.9 diff using a Quaife LSD for those tighter circuits.

"We obtained hardened half shafts from Peter May as well. The thing with these cars is that we have to use the Dunlop CR65 cross-section tyres which are not particularly grippy, so I guess that takes a lot of strain off the half shafts."

Allen and Norman designed the aluminium fuel tank, getting it made by Concept Racing of Ross-on-Wye, which also did the radiator. "Having taken advice from Ralph on the fuel consumption, his prediction being just under a litre a minute, we made a fuel tank with 44-litre capacity," says Allen. "We wanted it mounted as low and as shallow as possible and we wanted an in-boot filler."

Alloy wheels are forbidden unless they were used in period. "We've got Weller wheels supplied by Rae Davis which everyone was using," says Norman, "but then there was a safety issue with them to do with the quality of the weld with a few explosive decompressions on track. However, we haven't had any issues with them and have done three races with them although we do take the tyres off to inspect the wheels and as it's the back left wheel that takes all the strain, we also rotate them around the car." ▶


ABOVE The shell was in a poor state

"We did the wiring completely from scratch," says Allen. "We worked out what the original wiring loom was doing then drew up a wiring diagram of everything we wanted to include. We used the original BMC wiring colour coding so faults could be traced back very quickly. We also made a diagram to make sure we didn't miss anything then we just did it straight into the car, effectively using that as the breadboard. There were no thoughts about using special racing connectors but using the more traditional pull-in Lucas ones as there shouldn't be too many vibrations going through the car.

"We also wanted the gauges to look period, the only nod to technology being the Stack rev counter that has half an hour of playback. Other concessions to making it more modern were a water temp warning light to make it clearer.

"On the OUMF Riley we have a Racelogic VBox with potentiometers on all the suspension and steering angle sensors and it's something that's being considered for the A40. We've got to the point with the Riley that between qualifying and the race we will sit down with the driver and see what they are doing."

A major delay in the project was the roll cage, as it was delivered much later than promised and it then became clear that fitting it to the required standard was a specialist job. The supplier, Custom Cages, could have installed it but as it was very busy in the run-up to the new season, it would have meant a delay of several weeks. However, a fortunate conversation at Race Retro in February led to their contacting Richard Townsend, an expert in the field who was keen to move into the classic racing sector.

"Richard kindly accommodated us in his busy schedule and not only made a superb job of fitting the cage, but was happy to share his knowledge with Jimmy and Dominic," says Yea. "He's also an expert at setting up the dampers on BTCC cars, so a really useful guy to know."

The overall weight of the car is still an issue. "It's currently 765 kg while we are allowed 712 kg, including five gallons of fuel onboard, so there's quite a bit to lose," says Norman. "It's now a question of optimising the car, such as replacing the heavy steel bumpers with glass fibre ones and cutting holes wherever we can. It was kind of good that the shell was dipped and in a poor state as ▶


ABOVE Allen and Norman designed an aluminium fuel tank to sit as shallow and low as possible

we could go along and take everything off, but a lot did come back with the new Radford panels."

TAKING TO THE TRACK

"Getting to the first race was a major undertaking because while it appeared that we had a lot of time there were all kinds of problems on the rolling road with things like fuel vaporisation and gearbox issues," says Yea. "Then at the first test session at Brands Hatch it was one of those moments when the car was so bad I wondered just what we were doing. While I was sitting comfortably at a hotel in Brands Hatch, mighty efforts were made by the team to create a race-ready car. Thanks to the efforts of Jimmy and Dominic, Dave Savidge and Dave Jane, along with Ralph, Darren and Liam from Pitstop, the car was finally ready for action in the early hours of Thursday morning.

"The circuit proved to be overcast with intermittent rain and my first few laps in the A40 were frankly horrifying. It felt dreadful and really slow and all I could think was, 'What have I done?' The effect was further compounded by the gearbox only selecting first and second. However, this proved to be nothing more than an idiosyncrasy of the reverse gear lockout.

"We steadily worked our way through a list of changes and by the end of the day were able to stretch the Austin's legs and, to my absolute delight, it suddenly became a proper little race car.

"In the first race at Oulton Park, a circuit I quite like although it's not my best one, we didn't qualify too badly. As I approached the grid I realised I hadn't done a practice start, nor had we practised a pit stop because during the race you've got to pit, stop the car and turn it off, get out, shut the door and then get back in again. After all that, though, we did finish the race.

"The car was much better for our second race at Mallory Park and we were more competitive, but two things happened. First, it blew out all the water and it expired, but I had already unknowingly by then been disqualified as I had loosened the safety belts in the approach to the mandatory pit stop and had been spotted doing so!

"The final race of the season was at Donington Park which I like but we had a poor pit stop which let us down, but the car was good. What's important about it is that it's really great to drive in a fun series. The car is very much where we think it ought to be but we've not really tried to make any small adjustments. We hope to have the VBox installed soon so that we can do some proper measurements.

"In summing up, we have all learnt a great deal. It has been a very good project to do while for British Motor Heritage it's good because we are being seen in areas that people don't really associate with us, as we specialise more in Minis and MGs." HRT

ABOVE There was a David vs Goliath appeal to the choice of the A40

A discipline apart

What is the FIA Appendix K, and what are the basics to understanding it? "**Woody**", our inside industry expert, explains

FIRST, the FIA Appendix K is nothing very new. It's been around historic motorsport since the late Seventies, early Eighties, when historic motorsport started taking off and when more and more cars were coming back to the tracks after a brief retirement from modern racing.

The thinking behind Appendix K was that "Historic cars may be used for competitions under a set of rules that preserve the specification of their period and prevent modifications of performance and behaviour which arise through the application of modern technology," as set out in Article 1 of the "Blue Book".

Another interesting fact, which is a testimony to the spirit of historic motorsport, is a sentence from that same article: "Historic competition is not simply another formula in which to acquire trophies, it is a discipline apart in which one of the essential ingredients is a devotion to the cars and to their history," and "Historic motorsport enables the active celebration of the history of the motor car".

Importantly, Appendix K not only applies to original cars but also to those built to precisely the same specification as those models with an international competition history complying with the international rules of the period.

The perplexing question is how should the rulebook be read by an enthusiast or someone building a car to meet the needs of its owner? It's no secret that Appendix K is not simple but as with any technical regulations, it cannot be as it tries to take every aspect into account.

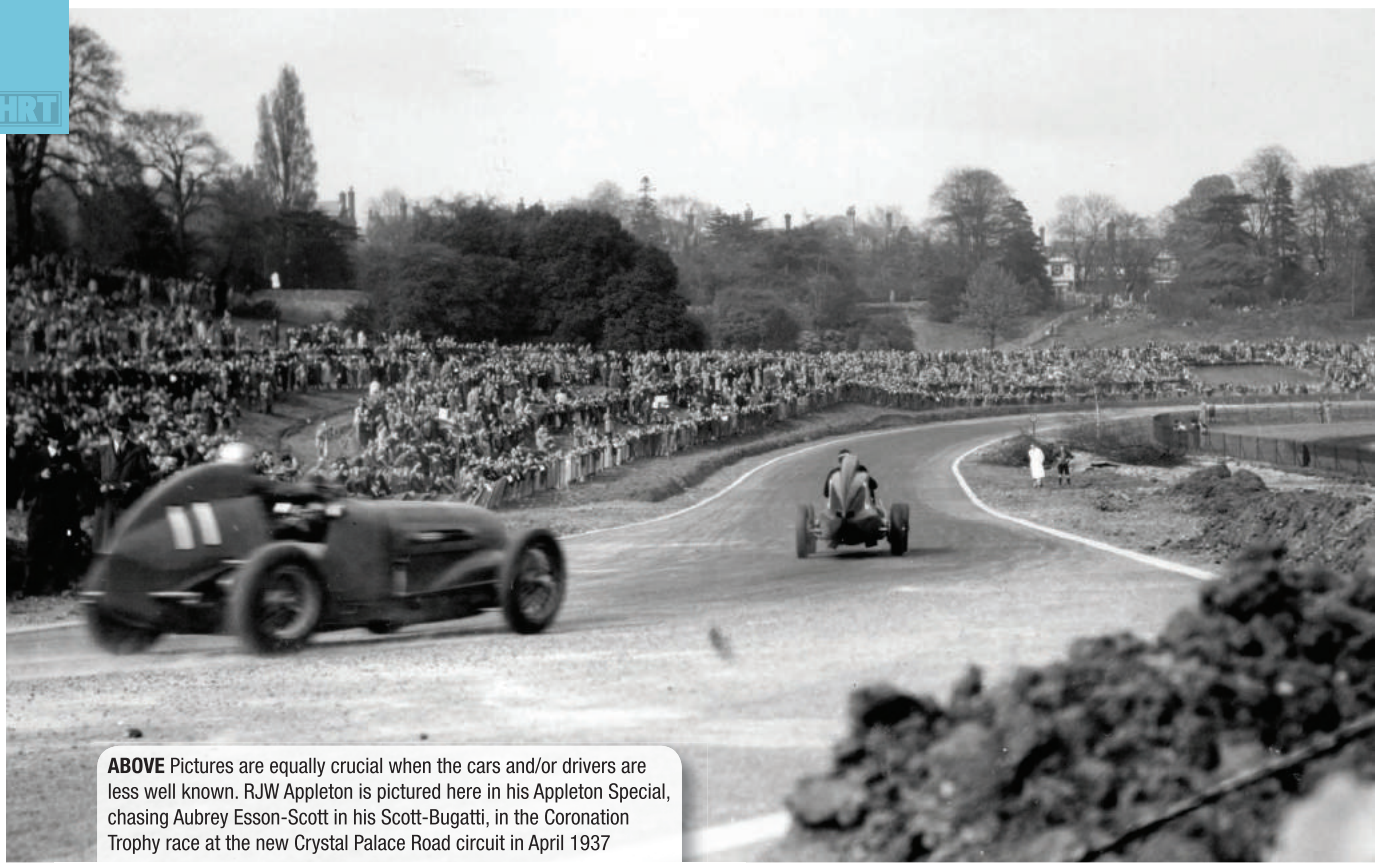
It is also intrinsically part of a network of technical regulations and is part of the International Sporting Code (ISC) that defines all international and national motorsport. Appendix K is also linked to Appendix L, which defines the basic licensing system and safety devices, and also to Appendix J which defines motorsport and all basic technical regulations for the recognised competitions and categories.

Where interpretation is needed is when the original rule book might state that "injection is free" for example, which has to be interpreted today as meaning "injection is free providing you can prove it was used in period on that car and document it".

This is where the Period FIA ▶

> **"Appendix K exists to ensure a level playing field"**

ABOVE Historic photographs play a vital role in validating a car's provenance, this one depicting "B. Bira" winning the International Trophy race at Brooklands in 1936 in his ERA



ABOVE Pictures are equally crucial when the cars and/or drivers are less well known. RJW Appleton is pictured here in his Appleton Special, chasing Aubrey Esson-Scott in his Scott-Bugatti, in the Coronation Trophy race at the new Crystal Palace Road circuit in April 1937

Homologation process comes into play. These are the forms registered in period for what were the "homologated cars" that detail the basics of any homologated vehicle, engine, transmission and bodywork of the roadgoing version. Then, of course, there are the "variant options" that were developed in period within the regulations and for competition such as the 24-valve head for the BMW 3.0 CSL that was homologated as an option by BMW to challenge the Cologne Capris in period. These are available for many cars when homologated as GT, Group 1, Group 2, Group 4, and the list goes on as categories evolved or were simply outlawed throughout the years.

Then there is the period specification which covers the details of how a specific car actually ran at a certain event in a certain year. It is not cherry picking from a list of homologated items that might have been offered over a multi-year period. It has to replicate what history was at a certain point, and that also applies to "non-homologated" cars such as Group 5, Group 6 and even wilder Group 7 although for that the reliance is often solely on period pictures along with manufacturers' documentation, where it exists, and acknowledged facts such as knowing that the Porsche 917 was never equipped with a Flat-6...

An important element in this is also personal knowledge. Such as, for instance, knowing that in 1975 a special bulletin was published by the FIA regarding Group 2 cars and outlawing a number of "variant options" on safety grounds. Another example is everything that resulted in one of motorsport's biggest volte-faces, the 1976 Appendix J, and why cars such as the Cologne Capri were outlawed and CSLs had to drop the 24-valve M49 engine as well as their 5-speed gearbox.

If you have understood all that, you now have the basics to understanding historic motorsport and the way to getting your Historic Technical Passport, that complicated set of papers that everyone talks about. However, the thing to remember about Appendix K is that it exists to ensure one particular aspect as well: a level playing field. If Appendix K did not exist or was not applied, it would turn into modern racing with cars that tend to look historic. HRT

ABOVE Registering a car can be a complex process, as Josh Sadler discovered with his 1964 Ford Falcon

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BELOW Tapping the first set of holes

A STITCH IN TIME

Chris Pickering looks at a metal stitching process for crack repairs that is popular in the historic racing world

ONE of the great dilemmas facing restoration specialists is always whether to repair or to replace. With originality so highly prized in the historic car world and the cost of fabricating new parts sometimes eye-watering, it pays to save original components wherever possible.

The industry is constantly coming up with new and inventive ways to do this, from laser welding to vacuum sealing, but there's a simple, well-established and cost-effective technique for reviving damaged castings that tends to get overlooked – metal stitching.

This is a collective term for a family of different methods, some of which have been around for the best part of a century. They all work on the principle of mechanically stitching pieces of metal together, without the use of heat or adhesives.

The most common use of metal stitching is for crack repairs, but it can also be used to patch in whole sections of a casting, for instance when a piston has made a bid for freedom out the side of the crankcase.

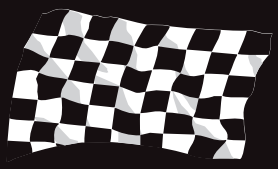
Lock-N-Stitch is perhaps the best known metal stitching system in historic car circles. The process is named after the Californian company that invented it in the early nineties, although in the UK the technique has been championed by the Jim Stokes Workshop (JSW). The Hampshire-based restoration specialist acts as a distributor for Lock-N-Stitch supplies and also offers an in-house repair service.

"Most of the work we do is on cast-iron, steel or aluminium. You can also stitch magnesium, which is very similar to aluminium in its properties," comments JSW's Bob Stokes. "We try to use Lock-N-Stitch wherever possible on cast-iron because it's so tricky to weld. You have to pre-heat the entire casting to very high temperatures, before you can even attempt it. After that you have to cool it down over a very prolonged period to stop it hardening, otherwise it becomes like glass. In fact, quite often we have to use Lock-N-Stitch to fix a part that someone else has tried to weld."

SURPRISINGLY STRAIGHTFORWARD

Done properly, it's a durable repair that should be stronger than the underlying casting. It's also relatively cheap and surprisingly straightforward. The process begins by drilling a series of holes along the line of the crack using a special jig. These holes are spot faced then tapped, ready to receive a series of stitching pins, of which Lock-N-Stitch offers two different types. The Cast Master (or C-Series) range of pins uses a barbed thread, a bit like a fishhook, which folds back on itself. This pulls the two sides of the crack together as it is tightened. The L-Series pins, on the other hand, have a countersunk head and a standard thread, which pushes ▶

ABOVE Initially a pin is inserted into every other hole



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BELOW Putting the second set of pins in. You can see the locks and the first line of pins that have been ground down

ABOVE Believe it or not there's a crack repair on this block!

outwards and relies on an interference fit to seal. These tend to be used on heavily contoured surfaces or around holes.

Both types of pin feature a wasted section just below the head, which is machined to snap off at a predetermined torque, preventing them from working their way out. A thread-sealing compound is also applied for extra strength.

Once the pins have been screwed into this first set of holes they leave a row of bolt heads proud of the surface, which have to be ground off. Next, a second series of holes is drilled in between the newly installed pins. This starts with a single drilling between the first and second pins, which acts as a locating hole for the jig. After that, a new hole is drilled on the intersection between every second pair of pins, ensuring that no pin ever has a drilling on both sides. Another set of pins is then screwed into this second row of holes and ground down. Finally, a third set of pins is inserted on the remaining intersections, leaving a series of overlapping metal blemishes on the surface, which can be painted over or distressed to disguise their presence.

It sounds like a rather protracted process, but Stokes assures us it's not: "If you've got all the right tools and you know what you're doing you can stitch a basic inch-long crack in about five minutes. The time consuming bit is usually getting the right finish afterwards. We tend to use a needle scaler, which pits the surface very slightly, leaving a similar surface finish to sandblasting. It just blends it all in."

The stitch pins should provide a pressure-tight seal. Often that's enough, but where there is a significant amount of force on the casting trying to pull the crack open a set of locking inserts can be used to provide extra strength.

The locks resemble a string of dog bones joined together. Using another jig this shape can be drilled into the casting, perpendicular to the row of pins. The locks are then driven in with a hammer and a punch, using a lubricating sealant that helps to overcome the interference fit. As with the pins, they are then ground or filed down to a flush surface.

"If there's any lateral movement on the crack you'd fit locks to give it more strength, but that's not normally required," comments Stokes.

Unlike the pins, the locks can only be used on a flat surface. They're cut from aircraft-grade 4130 steel using a punch or an electrical discharge (EDM) process. Even the smallest has an individual tensile strength of 1,050 psi. The largest – generally reserved for industrial applications like steam turbines, admittedly – is rated at over 200,000 psi.

It's a very simple process in principle and the equipment is out there for anyone to attempt their own Lock-N-Stitch repair. The skill comes in assessing the job and identifying potential challenges, Stokes explains: "Over time cast-iron can age-harden, which makes it very difficult to drill. Likewise, if the material has been chilled during casting it can be very difficult to work with."

Another thing to watch for is corrosion, he explains: "Sometimes you start drilling a part and the drill just goes through it like a wet paper bag. You need at least 3 mm of good, solid material for the smallest pin."

JSW's back catalogue is varied to say the least. Over the last 20 years the company has used Lock-N-Stitch on subjects as diverse as piano frames, windmills and the giant marine diesel engine from a container ship that had called into a nearby port for emergency repairs. The bulk of the work, however, remains historic racing.

"We had an Alfa 8C where one of the connecting rods had blown and punched out 280 degrees of the 360-degree crank case. Some of the pieces weren't salvageable so we had to fabricate new sections, but we managed to get that put back together and it's still running to this day," Stokes recalls. It's just another example of how parts that would previously have been beyond repair can now live on in the cars for which they were built. And that has to be a good thing. HRT

N.A.R.T.

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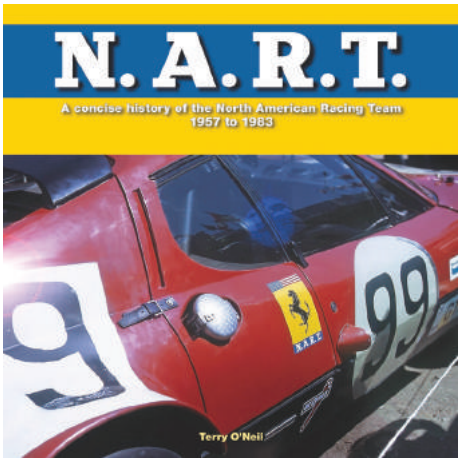


WRITTEN by Terry O'Neill, a British author with a track record of dealing with less well known motorsport topics, but also the former archivist and committee member of the Ferrari Owners Club, this book about the North American Racing Team is well overdue. As he rightly points out, NART and Luigi Chinetti, its founder, are inextricably linked so the first chapter is rightfully focused on him, who he was, where he came from and how he founded NART.

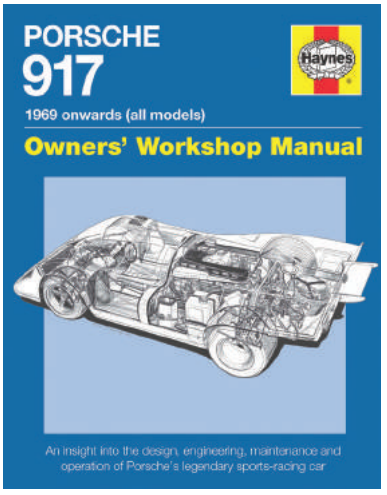
The book is full of the most nostalgic pictures of historic racing Ferraris in both colour and black and white along with some interlopers, such as the NART-entered Corvette in 1972, that also add to the story. As to be expected, there are plenty of great anecdotes that litter the book. For example, O'Neill recounts the story of when the team was based at a Volkswagen garage when competing at Le Mans. Deciding that the rear spoiler on one of its cars needed extra support, the mechanics needed some thin tubing, but had none to hand until they found a bike on the premises that had just the right diameter frame tubing for the job. They consequently cut it up and used the tubing to support the wing. Evidently the bike belonged to the garage owner's wife, who never did find out who stole it.

The book is also full of interesting asides such as when Ferrari started testing a four-cylinder 850 cc prototype engine installed in a modified chassis and body of a Fiat 1200 Pininfarina. Throughout the development Ferrari would not allow his Prancing Horse emblem to be used on the car and when produced he would not allow Ferrari dealers to market or sell the car – with the exception of Luigi Chinetti, who had the rights to sell and market it in North America.

This really is a fabulous book and while it is not cheap, it is worth every penny for the Ferrari enthusiast. HRT

Porsche 917

1969 onwards (all models) Owners' Workshop Manual
Ian Wagstaff
Published by Haynes Publishing
ISBN 978 085733 765 8
156 pages
£22.99



IN the last issue of *Historic Racing Technology* we reviewed a very splendid book on a specific Porsche 917 by Ian Wagstaff, which I highly recommended. Well here he is again, but this time covering the model in its entirety, and it's another masterpiece.

As you would expect of an author of Ian's calibre, it is well researched and well written and well illustrated. On page 5 is a full frontal action shot of one the Gulf cars at Le Mans that typifies for me why I love the car and for that matter Steve McQueen's *Le Mans* film. There is just something about the car that's perfect.

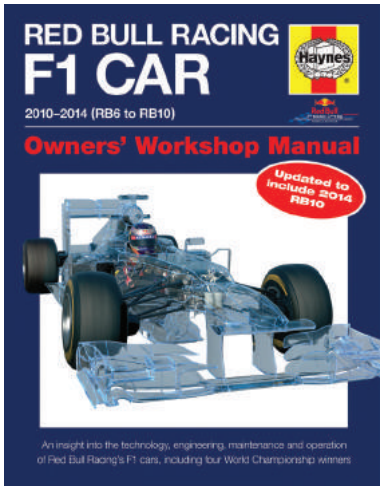
Turning to the inside, there are a number of fairly familiar pictures, including the famous one of the 25 cars that were lined up at the Zuffenhausen plant ready to be inspected by the CSI representatives, Porsche outflanking the-then governing body which thought when coming up with the quantity that it would be too much for any manufacturer to commit to producing. That was to underrate the iron will of Ferdinand Piech, Porsche's technical director and grandson of the company's founder Ferdinand Porsche.

The author delves into the history in some detail and then begins to drive down into the car itself, so things like the chassis, cockpit and, of course, the engine and transmission, are examined in great detail. There is an excellent chapter on the different drivers who handled the car, many with some great stories to tell, and another chapter on the mechanics' side of things.

There is a separate chapter on the Can-Am 917 – the 917/10 and 917/30 – with plenty of line drawings and a cutaway followed by a chapter detailing a potted history of each of the chassis. HRT

Red Bull Racing

F1 Car
2010-2014 (RB6 to RB10)
Steve Rendle
Foreword by Adrian Newey
Published by Haynes Publishing
ISBN 978 085733 801 3
204 pages
£22.99



THIS book covers the RB6, RB7, RB8 and RB9 cars that won the team the World Championship for Sebastian Vettel and well as for the team itself, and also the RB10, the one that got rather blown away by Mercedes in 2014.

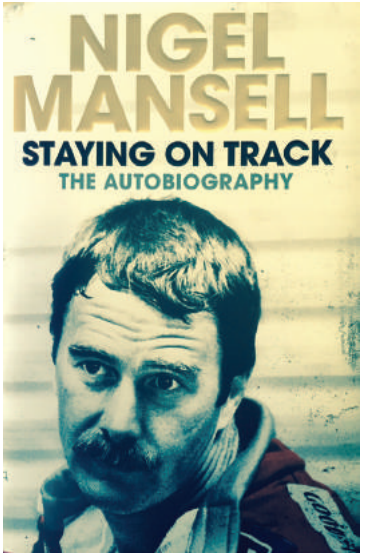
The book has been produced in full cooperation with Red Bull Racing with extensive input from the team's technical personnel and drivers which has enabled the author to really get under the skin of all these cars. For example, there is superb diagram that explains the principle behind the RB6's F-duct. In fact, the book abounds with great schematics such as a view of the front suspension showing the layout of the anti-roll bar components or another showing the typical layout of the transmission components, all clearly labelled and colour coded. Others include the V6 engine turbocharger, the energy recovery system, the electronic brake control system, chassis, suspension, steering, gearbox and the hydraulic system. There is also an easy-to-understand explanation of the Drag Reduction System and the double diffuser that was seen on the cars in 2009 and 2010.

Additional chapters provide insight into the design and development process, explaining how the wind tunnel, computational fluid dynamics, simulation and on-track testing are used to develop a winning package.

In fact, while the Red Bull cars are the focus of this book, just reading it through you will learn a great deal about how any of the current and recent past Formula 1 cars work. The level of detail is astonishing, the photographs superb and the line drawings and schematics exemplary. For anyone wanting to know more about the underlying principles of what makes a Formula 1 car tick, then this is it. HRT

Nigel Mansell

Staying on Track
The Autobiography
Published by Simon & Schuster
ISBN 978 1 4711 5022 7
370 pages
£20



NIGEL Mansell is still remembered with great affection by many and his antics on the race track missed. He always seemed to be in the thick of action wherever it happened. It has taken him some time to write it, but here is his autobiography which is a compelling read for anyone who watched him in his prime. We learn about his intense rivalries with Alain Prost, Nelson Piquet and Michael Schumacher, driving for Lotus, Williams, Ferrari and McLaren and his successful spell in IndyCars.

Perhaps one of my favourite chapters is that on the Lotus years and working with Colin Chapman. He recounts the time when he was the third driver in the team and so had a point to prove when he felt a burning sensation on his backside when he lined up on the grid for the Austrian Grand Prix. It turned out to be a fuel leak – and the remedy was a bucket of cold water being poured into the cockpit to dilute the effect. Not sure I can see that happening today. Anyway, off he set, eventually retiring on lap 40 when the engine blew. It couldn't have come quick enough for Mansell.

He recounts how driving at Ferrari was a very special experience and how he found the entire culture of the team so mesmerising. He tells how the introduction of the semi-automatic paddleshift gearbox, which at the time was revolutionary, meant almost relearning how to drive in certain circumstances.

The book continues into his post-motor racing life and comes right up to date with his current activities. He also gives his views on current cars and drivers, which are interesting.

This is a thoroughly good read and while being a fan of Nigel Mansell will be a help, the book will appeal to all students of motor racing history. HRT

ABOVE When beauty meets performance

Making the World go Round

The quest for improved performance makes wheel manufacture an area of particular interest to historic racers

TURRINO Wheels manufactures or restores any type of wire wheel for cars or aircraft, and will design new wheels to customer requirements, sometimes with just a picture to go by. The wheels are produced at its Northamptonshire workshops where all types of splined, peg drive and other wheel hubs can also be made. It is also the only company producing tubeless alloy wire wheels that incorporate the mandatory tyre bead retention hump.

However, the historic racer will probably be most interested in the light alloy rim wire wheel designs that offer additional performance benefits beyond the obvious saving of unsprung weight. Rim weight reduction will improve acceleration due to reduced rotational moment of inertia; with the product of mass x the square of the radius, the gains are greater than generally realised. The rule of thumb is that one kilo saved at the rim is equivalent to a five to 10 kg saving of total car weight. This quickly multiplies up as the larger rims may be five kilos lighter than a steel equivalent. Four wheels then translate to an equivalent 100 to 200 kg overall weight reduction to be accelerated. Making the wheels tubeless will provide further rotational weight saving with some tubes weighing over 1.5 kg.

The narrower section/larger diameter pre-war style rims are made by rolling and welding 6000 series alloy extrusions. They are made slightly undersize and then hydraulically stretched up to the exact rim circumference. Interestingly, the earliest of these rims as made by Borrani in Italy were held together by riveted plates rather than welding. This method can still be duplicated where originality is important.

The 14 to 16-inch Turrino rims for the classic post-war cars were originally made from 5000 series flat plate, spun first to a saucepan shape, the bottom cut out, and then spun again to final rim profile. However, a more recent development has been the use of thick wall tube – also 5000 series – which allows for thicker rims to be spun than by the flat plate method. These are then machined in the lathe allowing more or less material, as required, for strength and lightness. This also offers the opportunity to replicate old rim profiles no longer available elsewhere. In the Fifties and Sixties some rims were produced without spoke 'dimples' and this can easily be copied now by allowing extra material.

Turrino has also patented a modular alloy wire wheel design which allows the use of stock 'split rims' to provide tubeless wheels without the use of sealant. Single car sets can be produced without the need for expensive rim tooling and in diameters up to 22-inch and widths up to 14-inch. HRT

ABOVE & BELOW
New carbon discs and brake kits have been released

A TRANSFORMING PROCESS

The next-generation of carbon-ceramic technology has arrived

RACING Beat Europe has announced a new range of direct bolt-on carbon-ceramic (CCM) discs and brake kits, which are available for most Ferrari models. It is also offering Ferrari steel big disc conversion kits that are a cost-effective option if replacing standard carbon-ceramic discs for road or race applications.

Racing Beat Europe also offers the widest range available for steel to carbon discs and carbon to steel upgrades, not only for Ferraris, but also for Porsches, McLarens, Mercedes and Aston Martins, plus a carbon-ceramic brake upgrade for the Nissan GT-R R35.

Manufactured by Racing Brake in California, these discs are produced using Surface Transforms' unique patented next-generation carbon-ceramic technology, an advanced carbon fibre reinforced ceramic (CFRC) transforming carbon-carbon into carbon-silicon carbide (CSiC) ceramic. While carbon-ceramic discs on production road cars conventionally use discontinuous – chopped – carbon fibre, Surface Transforms creates a 3D multi-directional matrix from multiple layers of carbon fibre cloth weaved together to form the base carbon material, otherwise known as pre-form. The carbon pre-forms are then heated to a temperature of 1,000-3,000°C in a furnace filled with a gas mixture that does not contain oxygen, the lack of which prevents the carbon from burning in the very high temperatures.

As the pre-forms are heated, they begin to lose their non-carbon atoms, plus a few carbon atoms as well, in the form of various gases. These include water vapour, ammonia, carbon monoxide, carbon dioxide, hydrogen, nitrogen, and others. As the non-carbon atoms are expelled, the remaining carbon atoms form tightly bonded carbon crystals that are aligned more or less parallel to the long axis of the fibres.

Surface Transforms has developed its own process based on what it calls the Chemical Vapour Infiltration Surface Transforms (CVIST) method of ceramic matrix composites fabrication. This is a process in which reactant gases diffuse into the porous pre-form and form a deposition that fills the space between the fibres, forming composite material in which matrix is the deposited material and dispersed phase is the fibres of the pre-form.

Following the chemical vapour infiltration process, the parts are placed in a furnace and taken through a further cycle at very high temperatures. At this stage, the parts are solid blanks of close to the finished dimensions but not yet as hard as the final part. Most of the machining of the component features is done at this stage, as machining after the next stage is expensive and time-consuming due to the high hardness of the material.

A Surface Transforms process of melt infiltration deposits the silicon carbide into the carbon pre-form to produce the final composite material. A final machining process is needed to achieve the specific tolerances required for brake components. An anti-oxidant coating is added to increase the life of the part, followed by a CMM inspection along with DTV – disc thickness variation – measurements performed to ensure all parts meet the required strict tolerances.

The end result is a stronger and more durable product with three times the heat conductivity of standard production components. This keeps the brake system temperature down and the performance consistent while there are also weight savings of up to 70% compared to iron brakes – typically 20 kg of unsprung weight. HRT

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Quick Release system and compact pyrometer

B-G Racing has been busy in the last few months with new products. They include the Quick Release system which allows for quick and easy removal of the steering wheel from the column, making it much easier to get in and out of any racecar. A master spline positioned dead centre allows the use of the steering wheel as a reference point, ensuring perfect realignment every time.

Finished in elegant black anodising and bright yellow powder coating, this racing quick release system fully conforms to the latest FIA technical specifications. It is manufactured from high quality aircraft grade aluminium with a hard anodised inner splined hub for durability. The 20 mm steel splined shaft is available in a choice of 5/8", ¾", and 1" diameters that will require welding to the steering column.

B-G Racing has also released a compact pyrometer that is easy to use for both left- or right-handed users. The pyrometer records three temperatures per tyre and stores up to 10 sets of memory at any time. It also has the ability to calculate the average tyre temperatures for each side of the vehicle, the cross corners and the axles.

An auto lock recording feature is incorporated which means once the highest temperature is seen, it is automatically recorded and the user can move to the next location on the tyre. All four brake temperatures can be recorded and stored in the 10 sets of memory, but the brake temperature function requires an additional probe.

ABOVE The B-G Quick Release system allows for quick and easy removal of the steering wheel from the column

Contactless electronic distributor

MINI Spares is now offering a contactless electronic distributor to replace the points-type distributor used on Pre A plus cars – negative Earth Only. This distributor replaces 41824A and 41418 distributors as well as any 998/1098 cc distributor up to the changeover to the A plus type.

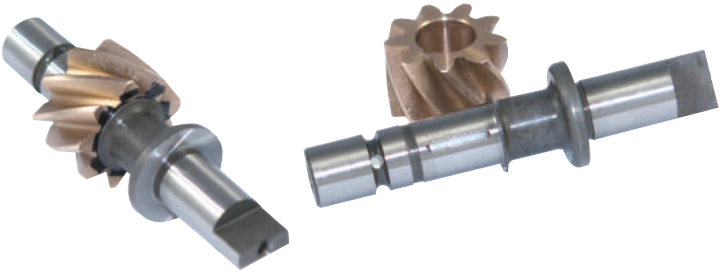
The 45D Electronic Distributor is supplied set up for any 998/1098/1275 cc engine, although they will work fine on any other year 998/1098 cc Mini and will even work on the Allegro and Maxi 1500/1750 cc made from 1974 to 1977.

MGB oil pump drive

THE oil pump drive on the MGB can be a source of problems, particularly on highly-tuned race engines that are running aftermarket cams. The tolerances on the original one-piece drive varied considerably which means that the drive that an aftermarket cam was designed to match might not be the same as the drive in another MGB engine. This mismatch causes excessive wear on both the drive gear and the gear on the cam and this can quickly reduce an expensive race camshaft to scrap. In certain cases this has even happened on the dyno before the new engine was even fitted in to the car!

Now Cambridge Motorsport Parts has come up with a solution. Its new drive is made in two pieces – a brand new hardened steel shaft with a bronze gear locked onto it. The softer bronze gear will wear to the shape of the cam gear without causing damage to the cam shaft. In the event of excessive wear the bronze gear can be removed and replaced, leaving the more expensive camshaft intact.

The hardened steel shaft retails at £59.80 plus VAT and the replaceable bronze gear retails at just £49.50 plus VAT, which is far cheaper than replacing a race camshaft!



Kent Cams for Ford BDA engine

JUST when you thought that virtually every modification to the Ford Cosworth BDA race engine possible had been done, Kent Cams has come up with not one, but two new profiles.

Coming up with an improved modification for this well tried engine was not easy and it involved some engineering trickery as well as radical thinking. Most performance camshafts involve increasing the lift by making the lobes bigger, but there comes a point when the lobes would be too big to go through the bearing housings and the camshaft would not be able to be installed. Kent has taken a new approach to the design of the lobe profile and has managed to extract more power from the engine by increasing lobe area and lift whilst reducing peak cam stress.

The new Kent Cams for the BDA are available as BDA 279 and BDA 267 profiles and prices start at £512.00 per pair plus VAT.

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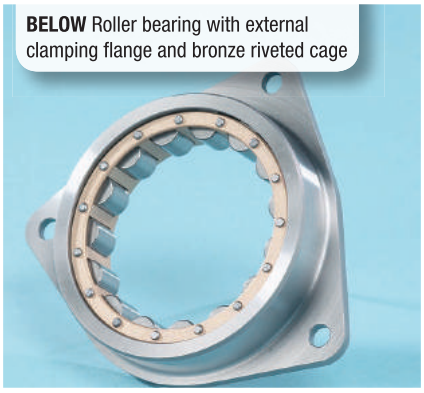
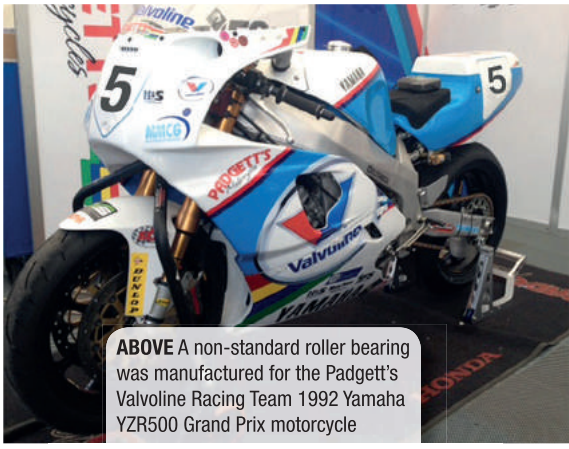
Bespoke bearings service

HB Bearings motorsport division, the leading UK manufacturer of precision bespoke bearings for motorsport, is now offering a low-volume, high quality, special bearing manufacturing service to keep historic machines racing. For example, it recently manufactured a non-standard roller bearing used in a 1992 Yamaha YZR500 Grand Prix motorcycle gearbox for Padgett's Motorcycles of Batley. The bearing was reverse engineered from the old sample as this was the only information available, but achievable due to HB's 42 years of technical expertise in bearing manufacture.



BELOW Roller bearing with external clamping flange and bronze riveted cage

The motorbike was then raced at the 2015 Isle of Man Classic in June by the Padgett's Valvoline Racing Team, ridden by popular TT rider Bruce Anstey who came second overall in the Formula One TT race. He also set a new lap record for a two-stroke machine with an average speed of 126.261 mph.



ABOVE A non-standard roller bearing was manufactured for the Padgett's Valvoline Racing Team 1992 Yamaha YZR500 Grand Prix motorcycle

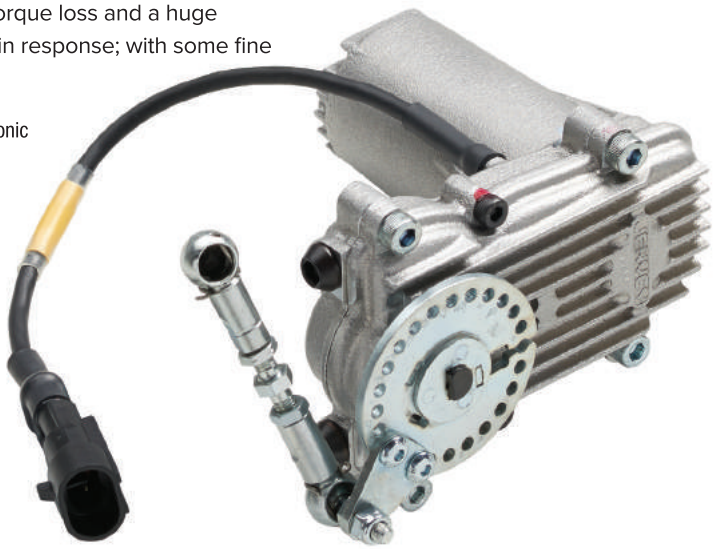
Downdraft throttle body kit

JENVEY Dynamics has launched its new downdraft throttle body kit for the Chevrolet LS3 V8 engine to meet high demand from the US and within Europe. The LS3 is a popular engine choice for high-end sports car builders for road and race, and the new kit provides a high-quality downdraft alternative to the crossover option already available from Jenvey.

"The modular design and light weight of the LS3 downdraft kit is perfect for highly configurable, bespoke vehicle builds where space may be at a premium or customers require a choice of engine bay aesthetics," says Jenvey Dynamics managing director Mike Jenvey. "Recent testing of the LS3 downdraft kit on an LS376/525 engine showed a 40 bhp gain with no torque loss and a huge improvement in response; with some fine tuning the engine gave 585 bhp on the full race kit."

The base Chevrolet LS3 ITB downdraft kit includes eight SFD 52 mm parallel bore throttle bodies, a pair of lightweight manifolds with fuel rails to suit the standard injectors, short billet air horns and an optional, easy-to-fit idle air system. The full race kit includes larger SFD 58 mm taper throttle bodies and 60 mm-long carbon air horns.

The throttle bodies are positioned as close together as possible for optimum packaging and designed for the best possible port alignment and minimum flow disruption. Injector positions are machined into the manifold for good emissions control using a billet fuel rail or with optional injectors in the throttle bodies with a large bore steel rail for improved performance. Manifolds are also machined to take an all-metal push fit vacuum rail system.



RIGHT The ETA2 Motorsport electronic throttle actuator

The system is available with a progressive mechanical linkage or as an electronically actuated kit. The Jenvey electronic throttle actuator is the first of its type for aftermarket individual throttle body (ITB) kits, and complements the modular design of the new CKCT04 Chevrolet LS3 downdraft ITBs to help solve packaging problems, provide gains in driveability and optimise performance. It is also compatible with launch control, anti-lag, switchable pedal maps, controllable push-to-pass strategy, pit lane speed control, traction control and variable bank-to-bank control.

All Jenvey Dynamics products undergo CAE stress analysis of manifolds to verify OE-quality of components, all of which are CAD developed, prototyped, tested and produced in-house in the UK. Over 25 years of experience enables the company to reduce weight by optimising design and production processes. Aircraft-grade aluminium is used to ensure durability.

The new CKCT04 Chevrolet LS3 downdraft SFD and SFD taper kits add to Jenvey's extensive range of induction components, including kits for engines by Cosworth, Porsche and BMW. The first batches are now available at the price of £2220. The price as a package to include the ETA2 electronic throttle actuator is £2693.

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ABOVE '9 VPD' will be going under the hammer

A VERY SPECIAL JAGUAR

William Kimberley reports on one of the most historically significant E-Types to come to market in recent years

OVERSEEN by Jaguar's engineering director Bill Heynes and supplied to favoured teams on Lofty England's say so, the seven right-hand drive Roadsters built to Project ZP 537/24 specification were the very first E-Type competition cars. Upgraded by the Competition Department at Browns Lane, the septet had particular attention paid to their running gear: increased compression ratio, gas flowed cylinder head, lightened flywheel, competition clutch springs and close-ratio gearbox etc.

One of two cars earmarked for John Coombs – the other five being distributed among Tommy Sopwith, Peter Berry and Sir Gawaine Baillie – chassis 850007 was completed on 29th March 1961 but not officially road registered as '9 VPD' for another four months (21st July 1961). Typically used as the Coombs team's paddock car whilst its sister machine '4 WPD' (chassis 850006 which became the first 'Lightweight') performed most of the racing duties, '9 VPD' took to the track for the Scott Brown Trophy on 23rd July 1961.

Albert Powell had been due to drive one of Peter Berry's 'Project ZP 537/24' E-Types (chassis 850010, '3 BXV') at the event but suffered a driveshaft failure during practice. His entry was thus in doubt until Coombs sportingly offered '9 VPD' as a stand-in. Sadly, a broken fanbelt denied Powell the chance to take the chequered flag on a day when four of the other 'Project ZP 537/24' Roadsters were competing (chassis 850005 and 850006 taking first and second places respectively). Little more is known about chassis 850007's period competition history but it certainly led a quieter life than '4 WPD'.

Sold off into private hands, '9 VPD' had not moved under its own power for 15 years or so by the time that the current owner acquired it in July 2002. Conscious of the Jaguar's historical significance, he entrusted it to marque specialist Beacon Hill Garage with instructions that they preserve as many original components as possible. Thus although chassis 850007 was restored as an FIA-compliant racer, numerous 'surplus' parts were preserved for posterity. They included the original 'outside lock' bonnet, boot lid, doors, cylinder head, crankshaft, conrods, seats, close-ratio gearbox, and hood frame.

The original tub (body number R1017) was salvaged and restored in steel, whilst the exterior panels were replaced with 'Lightweight' specification aluminium equivalents. Repainted in its initial opalescent dark blue livery, the re-born '9 VPD' returned to the track for the July 2005 Silverstone Classic Festival. Finishing fourth at the 2006 Le Mans Classic behind two Ford GT40s and a Cobra, the E-Type won its class during the Spa 6-hour race that same year with Richard Attwood joining Steve Markey and Radical ace Austin Kinsella behind the wheel.

First Jaguar home during the Legends race which preceded the 2007 Le Mans 24 hours and paid tribute to the 50th anniversary of the Coventry marque's famous 1957 victory, '9 VPD' made its Goodwood Revival debut that season too with Rauno Aaltonen co-driving alongside Steve Markey. A regular at the Goodwood Revival, Le Mans Classic and Spa since then, chassis 850007 has also been helmed by the likes of Emanuele Pirro, Marc Gene and Tony Jardine.

Among the most historically significant E-Types to come to market in recent years, '9 VPD' will be going under the hammer courtesy of H&H Classics at the Imperial War Museum, Duxford on Wednesday April 20th 2016. HRT

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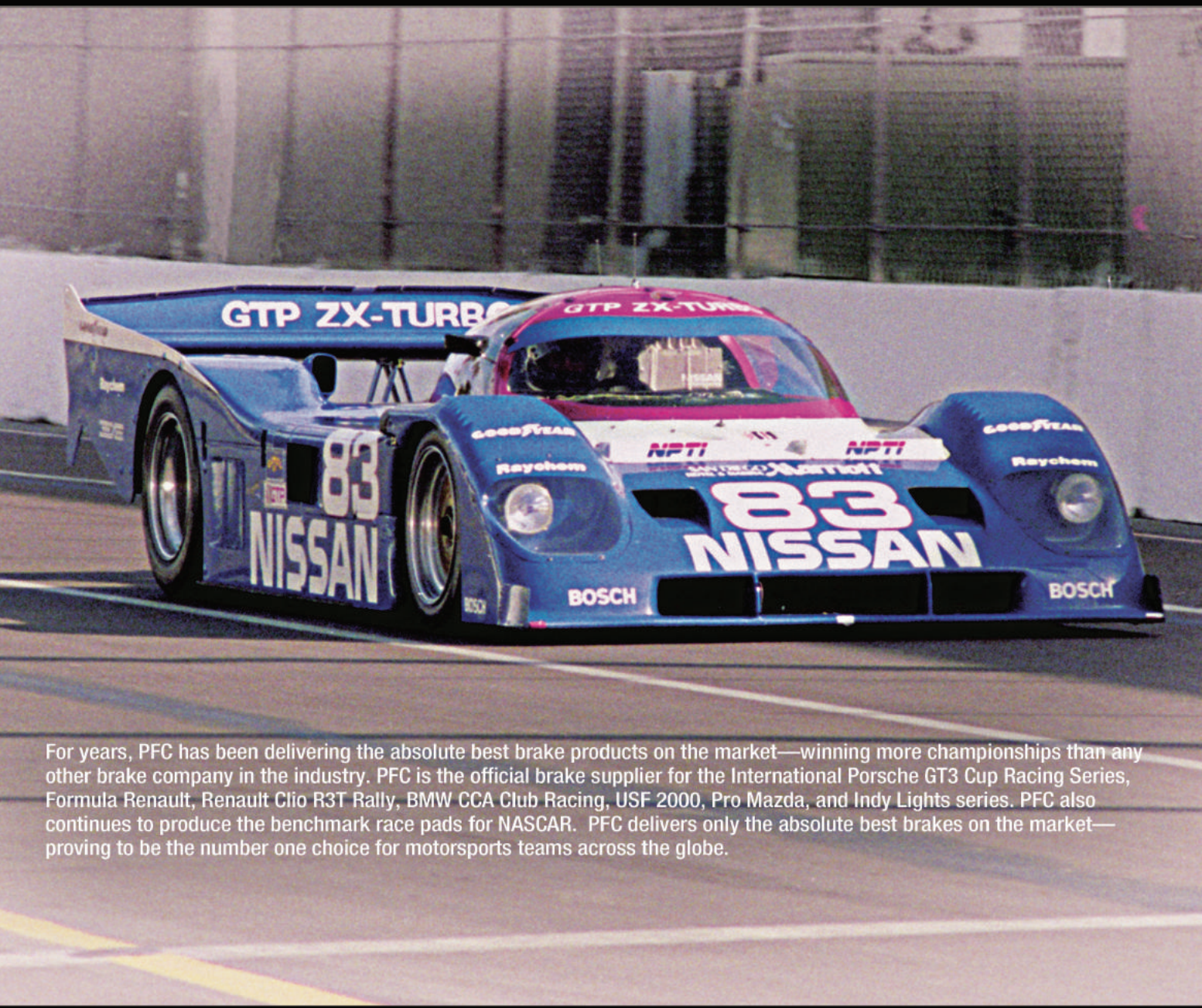

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