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TIN TOP TRIUMPH

Lotus Cortinas take on historic touring car racing

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ON THE COVER

16 The Lotus Cortina is the car to beat in the fiercely competitive U2TC series. Andrew Charman meets two teams preparing very different examples

24 Mk2 Ford Escorts continue to win rallies outright 40 years after their debut, Jesse Crosse explains how

INDUSTRY NEWS

6 MIA reports findings on the classic motor industry; tech companies shine at Historic Motoring Awards; Jaguar launches new pre-66 race series; BRM V16 restoration update; new venues for Super Tourers; Le Mans Legend expands; Race Retro show

COMMENT

12 **Julius Thurgood** Safety equipment is one area where historic racers are allowed virtually unlimited freedom to update their cars, but it can be a difficult decision, says Julius Thurgood

14 **Mark Hales** What's the magic ingredient that gives some historic competition cars so much more performance than others? Historic racer and chassis development guru Mark Hales argues there isn't one

FEATURES

30 Porsche 911: Anthony Peacock may have found the perfect historic rally car. And it's not a Ford Escort

34 The six-wheeled March 2-4-0 may not have made it to Formula 1 in-period, but the sole surviving example is emerging as a strong contender in historic competitions, Andy Swift reports

42 Some people take up golf for retirement. John Dennis built an 8.2-litre Edwardian racing car, Chris Pickering pays him a visit

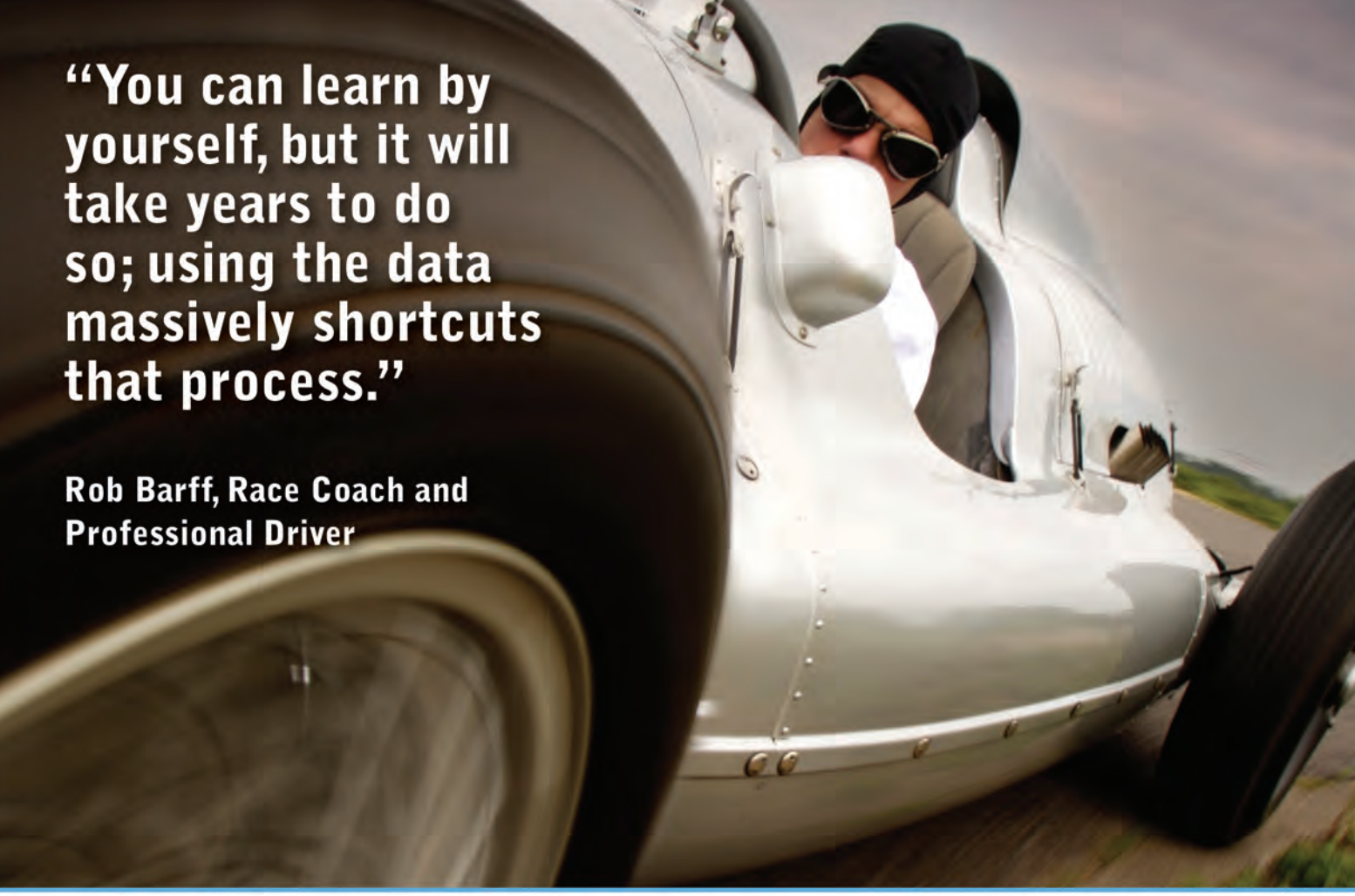
50 Coventry Climax engines powered a whole generation of racing cars, John Simister speaks to some of the leading specialists looking after these miniature powerhouses

58 Product focus on safety equipment. Advances in technology have made motorsport dramatically safer over the years, Chris Pickering looks at some of the latest developments

66 Cottage industry? Think again. How the JSW Group is bringing high-tech restoration methods to some of the most exquisite cars ever made

70 Driver coaching. How video logging is being harnessed by historic competitors

72 Product news. A look at the latest products and services in the historic motorsport sector



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EDITOR
Chris Pickering

EDITOR-IN-CHIEF
William Kimberley

CONTRIBUTORS
John Simister
Julius Thurgood
Andy Swift
Andrew Charman
Mark Hales

CONSULTANT EDITOR
Mark Skewis

ART EDITOR
Paul Bullock

WEB MANAGEMENT
Joomlaholics.com

ADMINISTRATION/ SUBSCRIPTIONS
Vikki Amour

SALES EXECUTIVES
Mike Norman
Tom Zarnecki

COMMERCIAL DIRECTOR
Maryam Lamond

PUBLISHING AND EDITORIAL DIRECTOR
Soheila Kimberley



HISTORIC RACING Technology

841 High Road, Finchley
London N12 8PT
Tel: +44 (0) 208 446 2100
Fax: +44 (0) 208 446 2191

www.racetechmag.com

Perspiration not hibernation

WINTER is upon us. Circuit racing has – in the UK at least – gone on its annual hiatus and most classics are safely tucked away in the garage awaiting the start of the new season. Most, that is, but not all.

Down in the woods it's business as usual for the rally crews. We can only assume they're made from sterner stuff, because this hardy breed seems to positively thrive on mud and snow. Historic rallying is one of the fastest growing arms of the sport and it ranges from single-day road rallies to epic marathons like the East African Safari Classic. The latter, admittedly, isn't likely to see a great deal of snow, but you can still be sure of the mud.

The machinery covers an equally broad range. In clubmans trim, a lot of road rally cars remain virtually as they left the production line. When it comes to historic stage rallying the modifications are more significant, but generally still confined to things which were known to have been done in-period. And then you reach the open class cars. Machines such as the more heavily developed Mk2 Ford Escorts that compete – and frequently win – against modern opposition.

In this issue, our rally special looks at two very different points on the spectrum, with the ubiquitous fast Fords and the Porsche 911s. There's something of an art to preparing either, with a small army of specialists on hand to help in both cases. Costs can be significant with either, but you might be surprised to see how they compare.

Of course, the activity continues elsewhere. In racing, the off-season is traditionally the busiest time for car builds, race preparation and restoration. From those chasing an outright win at Goodwood to home enthusiasts finally beginning the project they'd always promised themselves, now is the time to get working.

Such was the philosophy of the stars of our cover feature on the Lotus Cortina. Faced with a day job in the British Touring Car Championship it's perhaps no surprise that Team Dynamics saw stripping and rebuilding their recently acquired U2TC Cortina as a chance to wind down.

All in all, it's a busy time for the industry. Throw in a couple of major tradeshows and the winter break starts to look increasingly frenetic. Whatever your plans for 2015, we'd like to wish you a safe, happy and, above all, exciting New Year. HRT

Chris Pickering
Editor



NEWS

Historic industry under the spotlight

By **Chris Pickering**

A NEW report from the Motorsport Industry Association (MIA) has underlined the growing importance and relevance of historic racing in the wider motorsport business community.

In a recent survey conducted by the MIA, it was found that 80 per cent of the high tech motorsport companies sampled were also involved in supplying products or services to the historic community. Despite this, the report also concluded that many traditional historic specialists focused exclusively on this aspect of motorsport, using hands-on skilled labour to a greater degree than in 'modern' motorsport activity.

"It is this skill base that could well be said to set the two industries apart - one relying on substantial investment in R&D and new technologies and highly skilled engineers using modern techniques, and the other maintaining traditional links to the craft and skills required to maintain cars over a longer period," commented MIA chief executive, Chris Aylett.

Perhaps surprisingly, it was also found that the majority of those companies focused their historic activities on the domestic market. "It seems that there is a business opportunity for many of these companies to export their capability to growing international market places," Aylett noted.

The importance of reverse engineering capabilities was also highlighted. "Modern measuring and modelling techniques mean that cars that were difficult to restore are now becoming less so," commented Aylett. "How this affects the essential argument of originality is going to be a big question in the future; it's one of the most difficult problems to resolve for owners, operators and legislators.

"How can this particular sector authenticate every vehicle as being historic and how important is it in fact, that this authenticity is retained? The FIA moves have allowed replication, and by doing so, they have spawned a whole opportunity of producing excellent copies of the original car, some of which have not necessarily passed through the FIA certification process.

"In developing markets throughout the world, will they really go to the trouble of going through the paperwork trail of FIA certification, or will they simply produce excellent replicas which they then put on to overseas markets? Does this activity breach any copyright, or design issues, or is it simply going to become a matter of free trade?"

Following the release of the report, the MIA is understood to be setting up a new committee to represent the interests of its members within the historic motorsport industry. HRT



ABOVE MIA chief executive Chris Aylett

Icons celebrated at Race Retro

RACE RETRO returns to Stoneleigh Park on Friday 20th to Sunday 22nd February. This year the historic motorsport show pays special tribute to three famous icons who have had a significant impact on motorsport.

Chevron is celebrated in the marque's 50th anniversary year, alongside motorcycle legend Mike Hailwood and rally star Richard Burns. A collection of Burns' cars will be displayed in the Rally Hall, while various bikes campaigned by Hailwood will be on display in Hall 3.

As well as the celebrations inside the four halls, the fourth hosting the autojumble and the Parc Ferme exhibit, the grounds of Stoneleigh Park will be transformed into a live rally stage, with the fearsome Group B cars taking to the track. To book tickets and for the latest updates visit www.raceretro.com HRT

Jaguar launches one-make historic series

By **Andrew Charman**

JAGUAR has launched a new historic race series for pre-1966 examples of the marque's cars.

The 2015 Jaguar Heritage Challenge has evolved from the Jaguar E-type Challenge that ran for a number of racing seasons and proved highly popular. The new series will be run by the Historic Sports Car Club (HSCC), which also administered the E-type challenge. Models eligible to race in will include the XK series, C and D-types, Mk 1, Mk 2, and pre-1966 E-types.



Five races are planned for the inaugural 2015 season, four at major UK venues and one at a European circuit. Dates, classes and race venues are currently being finalised.

According to Jaguar Land Rover heritage business director, Derek Weale (pictured), the new series is further evidence of the expanding presence the marque has established in historic competition in recent times, notably at the Mille Miglia and Goodwood Revival: "A single-marque race series will be an exciting addition to our plans for next year, and I look forward to meeting privateer teams that want to race Jaguar heritage sports and saloon cars in 2015." HRT

Strong response to BRM V16 restoration

By **Andrew Charman**

EFFORTS by the National Motor Museum Trust to raise £50,000 in order to restore the museum's BRM V16 Type 15 have benefited from the Trust being named the official 2014 Goodwood Revival Beneficiary Charity.

The Formula 1 car, which dates from 1950 and was acquired by the museum in 1983, is one of only five examples built of the earliest design produced by British Racing Motors, known to the motorsport world as BRM. Drivers who campaigned it included Reg Parnell and five-time F1 World Champion Juan Manuel Fangio.

The museum intends to restore the car to running condition including a rebuild of its supercharged 1.5-litre V16 engine. The BRM ran demonstration laps at the Goodwood Revival meeting in September, while the NMMT stand included a display of BRM V16 engine parts.

Prior to the Goodwood involvement the appeal had already passed £34,600 but NMMT chief engineer Douglas Hill admits the funding needed could exceed £50,000.

"Thanks to the donations we have received so far, the engine can be removed and tested on a dynamometer to see how much power it is still producing, before the unit is disassembled and inspected," he said. "However, we still don't know what will be uncovered during the strip-down so we are uncertain how much time and money will ultimately be required.

"After the engine is rebuilt and refitted, the sophisticated oleo-hydraulic suspension needs to be completely refurbished, as it is in poor condition, while the brakes need to be rebuilt. Finally, if funds allow, the car will be repainted."

Donations to the appeal can be made at www.nationalmotormuseum.org.uk/BRM_appeal HRT



ABOVE The museum's BRM V16 ran demonstration laps at the Goodwood Revival in September



New venue for Super Tourers in 2015

By **Andrew Charman**

THE Super Touring Championship has dropped a meeting for its third season in 2015, but will again feature as a support event to the current British Touring Car Championship.

The modern and historic touring car series last shared the bill at Oulton Park in May last year, when the historic cars proved highly popular with the BTCC spectators. In the 2015 season, however, the Super Tourers will not visit Oulton Park, instead supporting the BTCC at Rockingham on 5th-6th September. This is new ground for the historic series, as the combined oval and road circuit was not built until after the Super Touring era of the BTCC that ran from 1991 to 2000.

The now four-round series retains its traditional role at the Silverstone Classic meeting in July - it was a race created at the 2012 Classic meeting that led to the formation of the Super Touring championship.

Also new to the calendar is Donington Park, while the high-speed Hampshire circuit of Thruxton, which staged the series opener in 2014, has like Oulton Park been dropped. The Brands Hatch round moves from the Historic Superprix meeting in July to the Masters Historic Festival in May. HRT

Cornish venue for rallysprint revival

THE growing number of motorsport festivals staged at traditionally non-competition venues will gain another member in 2015 with the Pentillie Festival of Motorsport on 26th July.

The event, at Pentillie Castle & Estate, in St Mellion, Cornwall, follows on from the Festival of Speed held at the venue in 2012, which itself recalled the original rallysprint events. These were created in the Esgair Dafydd Welsh forest complex in the late 1970s and grew to become highly popular events with TV coverage.

Organisers GoMotosport promise a full day's action on the mixed-surface track featuring both current-day rally cars and a wide selection of classic vehicles.

More details can be obtained at www.pentilliefestivalofmotorsport.co.uk HRT

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Tech companies shine in historic awards

EMERGING technology in the competition arena made its presence felt at the International Historic Motoring Awards, held at St Pancras, London on 20th November.

While the Specialist of the Year Award was taken by HK Engineering of Germany, renowned across the world for its expertise in restoring Mercedes-Benz 300SLs to concours condition, Dorset-based 3D Engineers was shortlisted for its reverse engineering services.

Motorsport winners on the night included the Race Series of the Year prize going to the Stirling Moss Trophy run by Motor Racing Legends for pre-1961 sports cars. The Rally of the Year award was taken by the Royal Automobile Club 1000-Mile Trial, while the Le Mans Classic, which attracted some 110,000 spectators in 2014, was named motorsport event of the year.

The Shelby Cobra Daytona Coupe CSX2287 - the prototype model, which broke 23 records at Bonneville Salt Flats in 1965 and in 2014 became the first car to be accepted into The National Historic Registry of the United States - was named Car of the Year. Now part of the collection of the Simeone Foundation Automotive Museum in Philadelphia, USA, the Cobra triumphed in the one award decided by members of the public, with votes coming in from right across the globe.

A lifetime achievement award was presented to Willy Cave, who started as a works rally navigator in 1954, in an MG Magnette for the BMC Rally team, and is still competing today, well into his 80s. Former Jaguar test driver and race driver Norman Dewis, aged 94, was also honoured with the Personal Achievement award, for his very active role in this year's celebrations of the 60th anniversary of the D-type Jaguar.

The Mercedes-Benz Classic organisation was named Industry Supporter of The Year for its extensive international activities in 2014 marking 120 years of motorsport. HRT



ABOVE The Stirling Moss Trophy was one of the winners at the Historic Motoring Awards

Historic skills given training boost

THE International Guild of Specialist Engineers (TIGOSE) has announced changes to its apprenticeship programme. As part of a new partnership with Nottingham-based Emtec Colleges Ltd, the scheme has now expanded to include modules on paint, panel work, trim, customer service, parts and machine shop engineering.

The partnership was agreed in November and the first apprentices started their programme on 8th December. Its stated aim is to maintain expertise and development in what TIGOSE describes as 'one of the fastest-growing industries of all time'. HRT



BELOW Apprentices Jake McEwan and David Brown (in green) with guest Fuzz Townshend, Guild founder Michael Scott and Jon Rawson from Emtec Colleges



ABOVE The Ford GT40 is likely to be a star of the 2015 Le Mans Legend race

Le Mans Legend to expand

THE annual Le Mans Legend race will extend its entry criteria for 2015 in the expectation of producing a full 61-car grid. Eligible years now span from 1949 up to and including 1968, the extension bringing in several iconic cars including the legendary Ford GT40.

The Porsche 908 and 910 and the Alfa Romeo T33/2 will also now compete among the sports and GT cars from the 1950s and 1960s that have traditionally filled the Legend grid.

According to Motor Racing Legends chairman Duncan Wiltshire, the new criteria will allow spectators to see cars from 20 years of Le Mans history all racing at the same time: "We recognise the traditionally broad spread of performances between the fastest and the slowest cars, so we will limit entries from the earlier cars to those we believe capable of lapping Le Mans in a reasonable time. The result should be stunning – from the earliest cars such as C-type Jaguars and Allard J2s up to the newest additions to the grid such as the GT40s."

Race organisers are still keen to hear of potential entries for the race – details can be found at www.motoracinglegends.com HRT

IN BRIEF

THE Sportscar Vintage Racing Association (SVRA) has gained a new sponsor for its Brickyard Vintage Racing Invitational at Indianapolis Motor Speedway on 11th-14th July 2015 in the form of electronics manufacturer Bosch Motorsport. The event is expected to attract more than 500 historic race cars competing on both the road course and 2.5-mile oval. According to Bosch engineering director Jim Emerson the sponsorship is highly appropriate with so many of the entrants using the firm's products.

RESURFACING of Watkins Glen circuit in New York State late in 2014, following the track's headline NASCAR race meeting, will result in the SVRA US Vintage Grand Prix moving from its traditional September weekend to be held on 23rd-25th July. The programme will also see the 28 year old event, for 2014 only, being run on the track's shorter configuration, the same as used by NASCAR.

BRIAN Lister, founder of Lister Cars, passed away on 14th December, aged 88. He will be remembered for the sports racing cars and single seaters that bore his name in the 1950s and '60s. Later in life he acted as a consultant for the company's historic racing programme. He also continued to indulge his lifelong passion for jazz, performing regularly as a drummer until 1990.

GOODWOOD has also confirmed at least 15 Group C cars will race at the Members Meeting. Entries will include XJR-9, XJR-11 and XJR-12 Jaguars, two Lancia LC2s, examples of the Porsche 956 and 962 and the works Aston Martin AMR1.

THE international Group C schedule for 2015 will run over six meetings across Europe, at Barcelona, Spa, Monza, Zandvoort, Paul Ricard and a UK round at the Silverstone Classic in July.

THE Historic Formula Two Association has been formed to promote cars of the one-litre F2 era between 1964 to 1966. The Association hopes eventually to stage dedicated races for surviving examples of these cars. Details are at http://onelitref2.org

THE 750 Motor Club will include Historic V8 Drivers' Association championships in its meetings next season. Rounds of the Bernie's V8 Series for 1950s-1990s sports and saloons will be staged, which organisers say will lead tor educed costs for competitors. HRT



Safety first?

How do you reconcile modern safety standards with period authenticity? **Julius Thurgood** looks at some difficult choices

As one of the organising team for the three meetings that are held at Goodwood, I am often asked to comment on the aesthetics of a competition car being lobbied for selection. Determining accurate period detail on a historic racing car is a relatively straightforward exercise. Archive material is usually accessible for any generic period and, if the car in question has scant reference material to endorse its application, there is a proven critical path of determining comparable period reference to the detail which is presented on the candidate's vehicle. Should a car fall short, but is inherently close to being acceptable, it's easy enough to change minor details; 1970s-style wing mirrors swapped for correct items on a '50s car, for example, bumpers reinstated, door cards and interior trim restored, non-period decals removed and so on.

But what happens about safety equipment? I recently watched an enthralling documentary on Jim Clark entitled The Quiet Champion. Seeing Clark three-wheeling his Lotus Cortina was awe-inspiring – a master class. Winding that section of film back several times I was made painfully aware that no roll cage was fitted to Clark's car. Historical fact. But here is the dilemma: would it be right to let a similar period competition car race today without a cage?

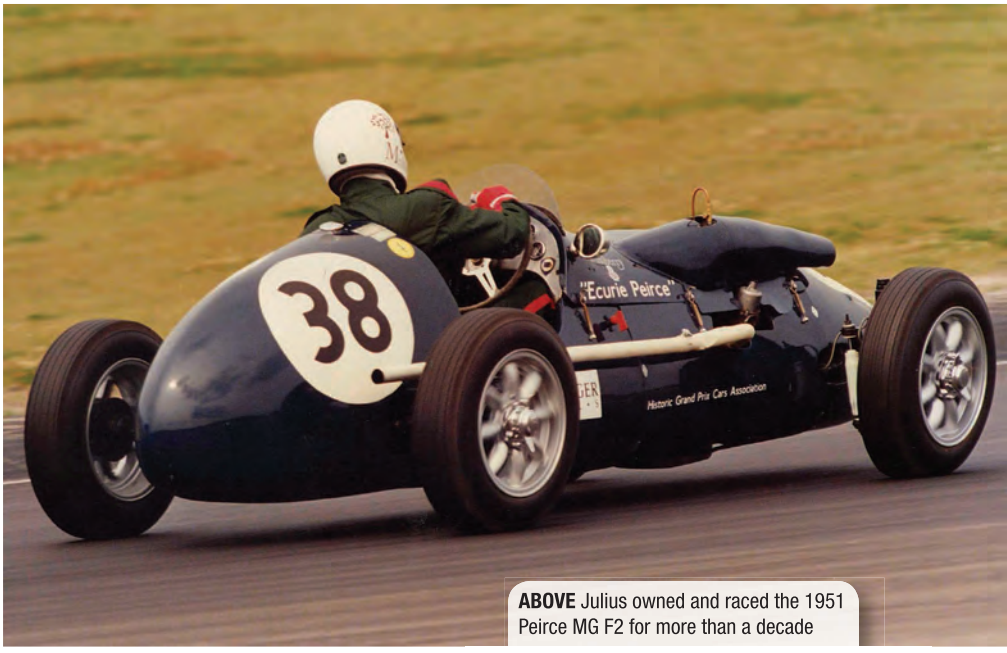
The answer surely has to be 'no'. With a saloon car, or any car with a roof, the exercise of fitting a roll cage is relatively straightforward and – given the time to think it through – fitment can be relatively unobtrusive. As no one in their right mind would race a historic saloon car with an original low-back seat and no harness these days it follows, in addition to a roll over protection system (ROPS), that a proper race seat and harness plus all the auxiliary safety equipment is fitted as a matter of course – with no exceptions.

I adopted this ethos when I was developing the HRDC Academy car (a concept for an entry-level, one-make, historic race series based on the Austin A35). By approaching the task from a safety first, cost secondary, perspective I was sure to get the best possible protection for the drivers. To counteract the cost, I simply cut out any 'middleman' in the supply chain. The safety equipment for these cars is sold direct by the manufacturer to the drivers/constructors and the development fees were funded independently.

Of course, a dilemma still remains. What do you do when it comes to a Cooper Bristol single-seater or a pre-war Bugatti Type 35? Safety aside, the aesthetic challenges are an anathema to many. For years I drove a 1951 F2 car in the HGPCA series. A true period survivor, the car was never, ever, fitted with any safety equipment other than a cut-out switch and a fire extinguisher.

I was very aware of my mortality when driving that historic racer, especially so when I was clipped by a Maserati 250F running through the high speed Tarzan corner at Zandvoort. But it was a personal judgement decision to race that car and I am glad that I did – and survived to tell the tale. However, recent tragic events with similar cars that provide no real driver protection has polarised opinion.

Much as I eschew non-original equipment on historic cars, I am beginning to think that it's time for some serious safety R&D to be applied in this area. Jim Clark's death stands testament to that. Owners of period jewels who do not want to fit non-period safety equipment to their car may inevitably find that the decision to continue to race them as they were in-period or face consigning their famous steeds to being paddock porn has been taken for them, while those with conforming safety-equipped replicas continue to provide the real action in relative safety. HRT



ABOVE Julius owned and raced the 1951 Peirce MG F2 for more than a decade

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The magic ingredient

Can modern technology alone help historic racers to emulate the likes of Jim Clark? **Mark Hales** isn't convinced

IT'S an old chestnut I know, but there's a general acceptance that historic cars now are faster than historic cars then. The FIA certainly thinks so, and has recently appointed a new man to try and slow them down, or failing that, to apply the rules with yet more vigour. That's a whole separate topic which we will doubtless revisit, but I say a general acceptance because I'm not sure it's true in every case. But when they are faster and still meet the rules, the more interesting question is why. What have teams and owners done to make them so when the people who designed and built them 50 years ago passed up a similar opportunity?

It's a big topic but the first thing is, it depends a great deal on which car we're looking at. I certainly don't believe the single seaters are all faster than they were. If we take Goodwood, which apart from a smoother surface and some different kerbs, hasn't changed in layout, the race record for the last Formula One race held there in 1965 says Jim Clark and Jackie Stewart both recorded a 1:20.4 lap - and this with 1.5-litre cars which probably had about 220 bhp at their disposal. Even the good guys today are four or five seconds shy of that.

The Jim Clark factor is an uncomfortable realisation for some of us, so saloon cars are a much easier case to consider, mainly because there wasn't the envelope for Clark and Co to demonstrate their genius, but also because at the top level there was a requirement to conform to a specification which had been agreed with the rulemakers. We are talking now mainly about the period pre-1965 - which is the cut off for the FIA's Period F. A Period F saloon, though, has a fantastically well defined specification. Track width, wheelbase, gear ratios, carburettor sizes, exhaust manifold dimensions had all been laid down in forensic detail by Ford Motor Company or BMC or whoever. Even minute detail like the area of the pads and size of the pistons in the calipers was specified and it is that document with which cars today must also comply.



ABOVE Historic racers have yet to match Clark's 1965 lap record at Goodwood

The Lotus Cortina is a good case in point, and it's the focus of particular attention from the FIA, probably because there are so many of them. The race for under 2-litre touring cars at the 2013 Silverstone Classic, featured 51 cars, of which 24 were Lotus Cortinas; one of them, driven by yours truly, exhibited oversteer so instant and so acute that it was easy to identify the problem. Fixing it, though, has proved rather more labour and time intensive.

At this point, it would have been easy to suppose that those in similar cars up at the sharp end had found some magic ingredient which may or may not be legal but I don't think it's that either. It's the amount of time spent arranging a simple set of parameters so that they are all in harmony. It's the time spent on the dyno with jets and trumpets and cam profiles. It's measuring the rate of a leaf spring and then carefully reducing its thickness with an angle grinder. It's which ramps you put in the differential and how much preload you set. It's the exact angle of rake, the precise length of bump stop in the dampers and so on. It takes a huge amount of time and everything has to be right. Any one of them out, and the balance of the car shifts.

So it's effort and time, both in the workshop and testing at the track, rather than something outside the regulations, and that will be a hard thing to regulate if the FIA just looks at the lap times. And you can argue that it shouldn't be regulated. If the car conforms to the regulations and someone spends a lot of time optimising it, that's what racing has always been about. It's not so much the technology that has changed, it's the amount of effort time and money spent on Old Motors. HRT

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Lotus position

Ford Lotus Cortinas dominate the success story that is the Under 2-litre Touring Car Championship. **Andrew Charman** and **Chris Pickering** talk to two very different teams

THE Under 2-litre Touring Car category, U2TC to those who compete in it, is among the most hotly contested in the entire historic arena, in both numbers and the quality of the machinery and personnel involved.

Now going into its eighth season, the series races as part of major meetings at classic venues, the 2014 calendar including two visits to Spa and a starring role in one of the UK's biggest annual historic meetings, the Silverstone Classic.

U2TC is very strictly regulated. Touring Cars of less than 2-litre capacity homologated before 1st January 1966 are eligible, and must conform to the 2014 Appendix K requirements of the FIA, with all cars requiring a valid Historic Technical Passport (HTP).

Subject to the discretion of the organisers, Alfa Romeo Giulia Sprint GT



Jakob Ebrey/Silverstone Classic

cars or other models from a similar period and performance may be included. The cars are expected to be raced in period specification, with virtually no modern updates apart from the obvious safety requirements.

There are four classes, simply divided by power: A is up to 1000 cc, B to 1300 cc, C to 1600 cc and D to 2000 cc. While class A is dominated by Minis, class D by the BMW 1800 Ti, by far the most numerous class is C, split 60/40 between the iconic Ford Lotus Cortina and those Alfa Giulias.

At the 2014 Silverstone Classic meeting the U2TC entry stretched close to 60 cars and class C provided more than half of the grids. In this feature we look at two of the Cortinas entered, which arrived on the grid in very different ways.

A BUSMAN'S HOLIDAY

Team Dynamics has contended for overall honours in Britain's biggest motorsport series, the British Touring Car Championship, for much of the last decade, and soaked up all the pressure that comes with running a works team for car manufacturer Honda. So how does the team relax? Simple, go historic racing...

Speaking to HRT at the team's compact workshops in Pershore, Worcestershire, Team Dynamics technical director Barry Plowman admits that the programme that put 2012 BTCC Champion Gordon Shedden on pole position for the Silverstone Classic U2TC race started simply as a means of finding something fun to do. "Not that the BTCC isn't enjoyable," he stresses, "but there's a lot of pressure to perform. We wanted to do this purely for fun, so it wouldn't matter if we got a result, just for the pure enjoyment of going and competing."

First priority was to find a car with a good engine, which Plowman considered would be 80 per cent of the battle won. The perfect solution appeared in the shape of a Cortina previously raced by Neil Brown, as in Neil Brown Race Engineering that has been preparing the Dynamics BTCC engines for many years.

> **"The A-frame rear suspension setup is a bone of contention, with many arguing that the leaf spring arrangement is far more effective"**

According to Plowman, the car was in a condition that many drivers would have been happy to race it in, but Dynamics applied its BTCC standards to a complete stripdown and rebuild, having first done an initial test with it. He admits that probably the biggest issue at the test was the drivers, Matt Neal and Gordon 'Flash' Shedden, with four BTCC titles between them. "They took time getting their heads round it, how bad the brakes were, how little grip you get out of the tyres. It was very alien to what they were used to."

In fact he adds that the only team members not on a voyage of discovery were himself and race engineer Eddie Hinckley. "Live axle cars and cars with front struts the way they are on the Cortina, were about in Eddie's and my early days, when I was working with Mk1 Escorts, Mk2 Cortinas.

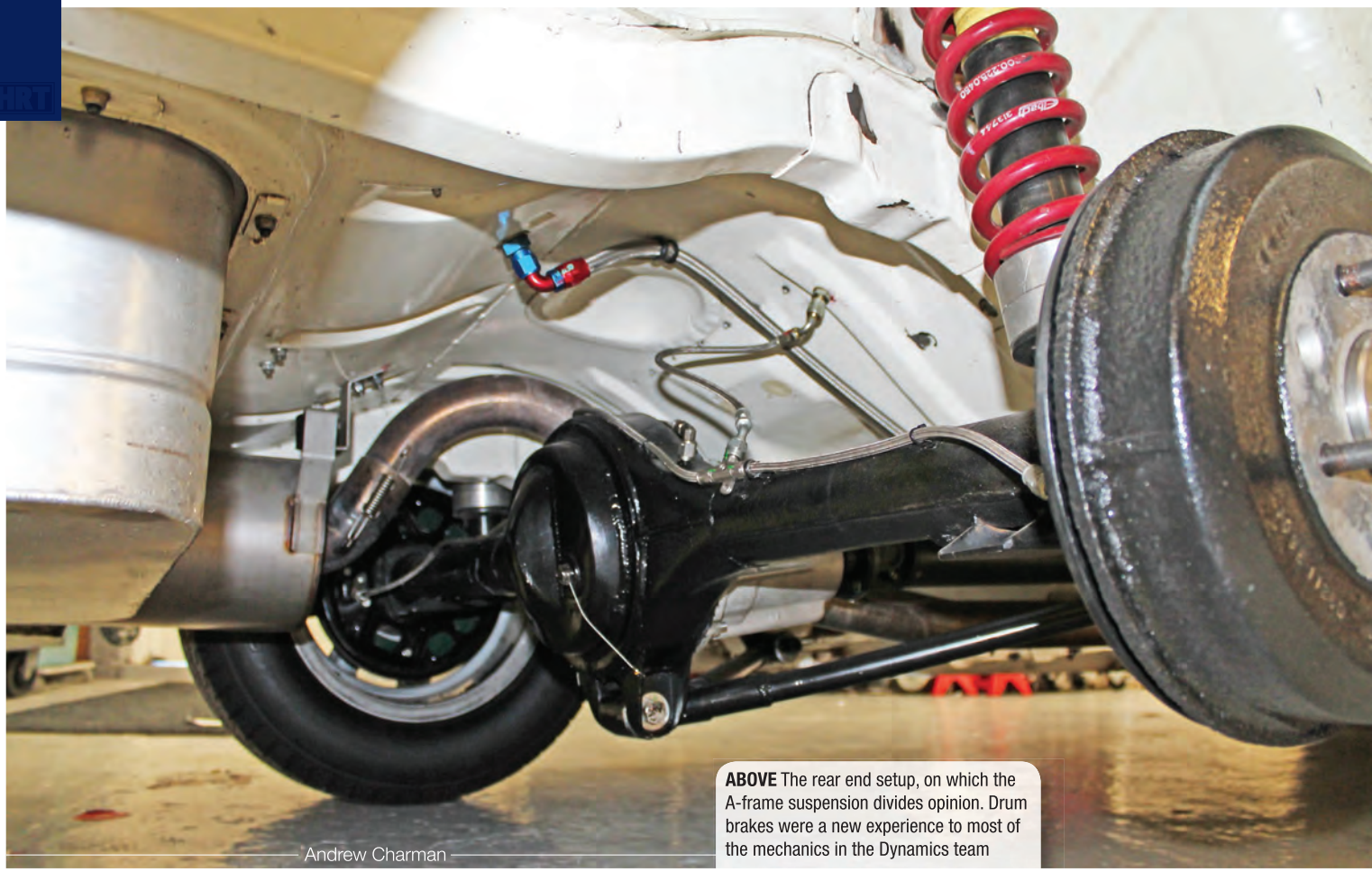
"It was not totally alien to us, so some education of the rest of the team was necessary. They had never seen such things as drum rear brakes, but that was part of the appeal of it."

Following the test the car was completely stripped and rebuilt. "We went through everything," says Plowman. "We put new bushes in to ensure everything was moving up and down correctly, had the dampers rebuilt, rebuilt the diffs, put new halfshafts in it."

As supplied the car was fitted with the A-frame rear suspension setup. This is a bone of contention in U2TC with many, including 1965 Cortina racer Sir John Whitmore, arguing that the alternative leaf spring arrangement is far more effective. Plowman does not concur, however. "We looked at the car's A-frame and found that a lot of ▶



ABOVE Dynamic performance: Gordon Shedden hustles the Team Dynamics Cortina through a corner during the 2014 Silverstone Classic U2TC race, the first outing for the team's "busman's holiday"



Andrew Charman

ABOVE The rear end setup, on which the A-frame suspension divides opinion. Drum brakes were a new experience to most of the mechanics in the Dynamics team

brackets on it were out of line and bent, so we corrected them all. The A-frame is fine when it has all brand-new bushes, it's clean and it moves freely, but the minute it gets a knock and gets out of line it becomes a problem because it doesn't go up and down correctly – that doesn't happen with the leaf spring."

Another major issue with these cars are oil leaks, something Dynamics was determined to rule completely out: "Cars in this series will go out and do four or five laps, during which they get oil all over the rear tyres and the dynamics of the car change accordingly. So once you cure those problems, you work the car less, so you then have brakes that will stay in for a few laps longer, and it is a big help."

The standard Mk1 Cortina gearbox used is a prime leak suspect, from the gearchange turret, and this was cured with new seals and gaskets. "There were a few oil leaks out of the rear diff housing, and we spent hours chasing pin holes round and welding them up," he says. "All the stuff is old – only me and Eddie in this building are older than that car; all the youngsters we have working here weren't born when that car was racing."

With the car complete, the next step was more testing – without the banks of laptops to pore over and detailed setup programmes that the team is used to on a BTCC race weekend. "A lot of our testing consisted of trying small adjustments on dampers, toes and such like, seeing if what other people were telling us was correct," says Plowman.

He admits that the advice sought from others in the series produced confusing results. With such aspects as tyres, for example, there were mixed messages coming back on whether to run them new, or scrubbed and such like. The team tried the options and found no difference between them.

"We watched what other cars were doing – but they are all so vastly different. Some are nose down, others nose up, some flat, even among the front-runners," he adds, demonstrating another example of how different period touring car racing was to today, when competing cars are virtually identical in their setup. "In those days you simply drove the car in the way it suited you."

The team did discover how big a difference in performance tyre pressures could make, explains Plowman: "These tyres are totally unlike what we are used to: they run at much higher pressure, and you have a wider tyre on the rear than on the front, so there's no rotating of wheels on the grid like we do today. It was all a bit strange."

While Plowman admits to putting a VBOX data logger with a camera in the car during the test, which produced useful information, driver feedback also assumed greater importance in making the car go more quickly. This was a challenge with two drivers who were still learning what the car would, or more pertinently wouldn't, do: "For a time Flash was still expecting too much of it, expecting it to handle more like a modern car. We were educating him to the fact that it didn't have the stopping power or grip he wanted. Though he drove it very well to be fair."

This was demonstrated firmly when the team debuted at the Silverstone Classic and, to raised eyebrows among rivals, Shedden put the car on pole position for the U2TC race. He also qualified third of 50 cars for the Transatlantic Touring Car Trophy, surrounded by hordes of 4.7-litre Ford Mustangs. "The Mustang drivers thought it was funny, but I'm not sure the other competitors in the under 2-litre ▶

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class liked it so much when he put it on pole there," Plowman confesses.

Race success did not follow, Plowman thinking that Shedden possibly underestimated the race distance, working the car too hard too early and flatting a tyre, which then damaged the radiator.

More opportunities will follow, however, as the "Team Dynamics Busman's Holiday" is set to continue, with Plowman adding that he might even get a licence and have a go himself.

He considers that the team, particularly the younger members, have learnt a lot from the experience. "The car is old and it has to be treated with the respect something of that age deserves," he says. "It's taught our mechanics that not everything in those days was as good as what they have now, with all-machined pieces that you take out of a box and virtually fit straight in. I think it increased their appreciation of what was involved in top-line motor racing of that period."

LETTS GO RACING

So what comprises a U2TC Lotus Cortina? To find out HRT spoke to Alan and Geoff Letts, who have been competing in the series virtually since its inception in a car that in its past history had been to Australia but when purchased had spent several years in a chicken shed.

The car was in good condition but very much out of date, with such undesirables as an aluminium rollcage and a road car seat, with only some extra bolsters added. So a complete rebuild was undertaken to bring the car up to U2TC specification.

Putting the car on a jig – a suitable Cortina jig having been found in a skip by the brothers' preferred local bodyshop – revealed that it had endured a hard racing life, being at one point hit from behind and one side hard enough to require the removal and welding back in of the dash.

Weight saving is a key to competitiveness in U2TC and most front-runners run at the minimum weight, but according to Alan Letts achieving this is not at all easy. "You do the obvious things then you look around for the little things – for example a battery that's of similar power but half the size of the already small one in the car.

"Drilling holes in various places, cutting out unnecessary brackets or tags, also helps. If you build the car yourself, remove anything that isn't metal, dip the shell and go from there, that's the ideal.

"If you take the doorcards out and replace with aluminium panels, take out the wiper motors, nuts, bolts, and then place them in a pile on the floor and weigh them: you might be surprised how a pile of bits adds up to a few kilos."

Other permitted weight-saving measures have included swapping several steel items for lighter magnesium replacements, notably the clutch bellhousing, the differential casing and the wheels.

The homologated engines in U2TC are typical competition units – today a ▶









CLOCKWISE FROM TOP LEFT The seat, switchbox and extinguisher are the only modern additions in the driver's compartment; the engine bay, in which oil leaks from the bellhousing are a common issue; front suspension; and the simple dash

Photos: Andrew Charman

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Andy Swift

BELOW Fowl no more: after five years the Letts brothers have turned a car found in a chicken shed into a competitive proposition



Silverstone Classic

BELOW The U2TC series always provides an enormous grid for its race at the Silverstone Classic meeting, with Lotus Cortinas dominating

well-sorted Lotus Cortina engine puts out around 180 bhp, which compares to 115 bhp in stock 1960s form.

According to Geoff Letts original engine components can be replaced with upgraded material, so long as it matches the shape and form of the original. Camshafts are free, valve sizes closely monitored and to original homologation.

The Letts engine was built by Tim Swadkin Race Engineering. Swadkin has very many years of Ford engine experience from Pinto to DFV – the writer recalls describing him as a veteran engine builder when covering the much-lamented Thundersaloon Championship, some 25 years ago...

In this case the specification is Farndon Engineering steel racing pistons and rods, an EN40 steel crankshaft by QED and the usual programme of lightening, balancing and blueprinting. An overbore is permitted, the car 1592 cc compared to the original 1552 cc.

The cylinder head casting must remain standard and the valve sizes are as originally homologated by Ford for racing in the 1960s. While the camshaft is a free item and this case made by Kent Cams, the small-sized valves limit the amount of modification possible.

Fuelling is of course by carburettors, the original road car's Weber 40 DCOEs uprated to 45s. Injection trumpet length has to be a compromise due to the car's bulging inner wings restricting the space available. "A shorter trumpet means more power, a longer more torque, and you really want torque over power but you can't have much because the inner wing is in the way," Geoff Letts says.

The regulations also demand the retention of the original condenser ignition, which Alan Letts admits can be an Achilles heel of the car.

The car is wet-sumped, though the sump has been enlarged to increase capacity, and a vital baffle added. "At Spa, hitting the brakes from 120 mph the oil would surge and easily run a bearing – it's all part of the painful steep learning curve when you are doing this yourself rather than buying a sorted car or going to a team who know it already," Alan adds.

The exhaust manifold is also homologated, the same shape and pipe size as in 1964/65 but in modern materials to prevent cracking through age. Suspension must remain period and according to Alan there is not much that can be carried out trickery-wise that would remain within the rule book. And while the series is well-policed by its scrutineer, there is also a "gentlemen's agreement" that competitors do not cheat.

However, Alan points out that a lot can be gained by going to the right company for custom-made units: "The front legs and rear shocks on the car look ordinary, but there's a lot of money in them. We have a specialist do the valving; the suspension is dyno-tested each season like most would an engine."

Geoff considers that of all the components on which modification was allowed, the hardest to manufacture was the front anti-roll bar: "We run a much fatter one and the ability to get the right material and form it into tight bends that you need to make it fit the car is quite a feat."

The rear suspension setup divides

competitors. Unlike Barry Plowman at Team Dynamics, the Letts brothers are not fans of the A-frame. They tried the car with a pair of coilovers –legal for this car because the early Cortinas, before late 1964, didn't come with leaf springs – but couldn't get it to work. Instead they converted to leaf springs because the car had a horrible tendency of unexpectedly going right up on two wheels.

Remarkably, the Cortina's first race after being rebuilt was at Daytona International Speedway in the USA, the prospect of racing at the famed track having first set the brothers searching for a suitable car. Since then they have been regular competitors in U2TC and have improved along the way.

Alan adds that remaining competitive in the U2TC is not easy: "It's one thing to have a set of homologation papers, but you are on quite a steep learning curve to get the right equipment and setup. The Cortinas are a very tricky car to drive quickly: there's a fine line between the back coming out a little bit and you being quick, and stepping over that line where the back comes way out and you are slow or, worse still, fighting to hang on to it."



Chris Pickering

ABOVE The dash display of the Letts car – nothing to distract from the driving…

Alan Letts adds that the clincher was the advice of someone who should know, Sir John Whitmore having taken a Lotus-Cortina to the 1965 European Touring Car Championship. "We were talking with him about his experience back in the day and he said don't bother with the A bracket, it's a waste of time and it never works. From the horse's mouth!"

Other suspension modifications are strictly limited. Some front-end geometry tweaks are permitted, but the manner in which the struts are bolted into the inner wing restricts the amount of camber that can be dialled in. "We can adjust castor and some camber, but only within constraints," notes Alan. "In some ways it's great because everyone's in the same boat."

The brakes remain period, but with modern competition linings. Geoff admits there are advantages to be gained in this area, to the extent that he will not reveal the manufacturer used on his car.

His brother admits that early races with the car were difficult: "It would bite you on the bottom and scare you in a heartbeat – it was just unpredictable and nothing like Alan and I had ever raced before. Before that you had a feeling of confidence and if a car wasn't good you had a feeling it wasn't gripping or handling before it happened, but this gave you no warning."

He appreciates that the car's specification has to be treated with respect. "You are putting 180 horsepower through a leaf spring rear end that is pretty basic and like it was back in the day.

"Today a well-sorted Lotus Cortina engine puts out around 180 bhp, which compares to 115 bhp in stock 1960s form"

"It's a pair of radius rods, a pair of leaf springs and the only controlling factor is the shock absorbers. You do what you can with them – it isn't sophisticated with lots of areas for adjustment.

"It is a car that has a tendency very much to oversteer and we kept on adjusting the front end. In a lot of racecars you want to dial out understeer; in this one we're trying to put it in to take oversteer away from the rear."

As a result the front end has been stiffened to the point where understeer was appearing, in turn producing more grip on the rear end. However the Cortina still remains very tricky to set up and drive consistently as quickly as the front runners: "You can have a perfect setup at one circuit, go to the next round a month later and it won't handle nearly as well, when you've changed nothing.

"The difference between quick and not-so-quick cars is a package. Setup is key. With a professionally-built engine producing circa 180 horsepower you are competitive, then it's setup, weight and the guy behind the wheel. You can be a great driver in another type of series but come into this and struggle in the Cortina."

Having been in the series five years, the Letts brothers feel that they have completed the steepest part of the learning curve, admitting: "It's a top 10 car but we still need to sort the handling and the reliability, then it can be a fifth, sixth place car come race end. We are going in the right direction.

"Overall when it's going well the whole package, series, car racing is just the best. We go to some of the best circuits in Europe and have great close non-contact racing with similar cars. When it's going well it is a joy and a buzz." HRT



Andrew Manston / M and H Rally Photography

ABOVE The Escort adopts its typical cornering attitude

The greatest rally car of all time?

Nearly half a century after its debut the Ford Escort is still proving hard to beat in tarmac rallying, says **Jesse Crosse**

Arguably the greatest rally car of all time. That's quite a claim, but consider this. The Ford Escort Mk1 and Mk2 started winning rallies in 1968 with the introduction of the Escort Twin Cam. Escorts took eight consecutive wins on the RAC Rally from 1972 to 1979. In the 13 years from 1968 to 1981, they took over 140 victories in international rallies and hundreds more throughout the world at national and club level during the same period. In just six years from 1975 to 1981, the Mk2 Escort won no less than 20 WRC events outright.

46 years on, Mk2 Escorts are still winning rallies outright today, often against far more modern equipment including WRC cars. The rear wheel-drive Escorts are still the 'must-have' car for many drivers. Although not an entry-level car in terms of cost, the Escort can still be relatively affordable even in a high specification. The performance of Escorts built for non-historic tarmac rallying has risen considerably. At the end of its evolution as an international contender in the early 1980s, power output from the 2.0-litre BDG engines didn't rise beyond 270 bhp. Today, equipped with specialist engines of up to 2.5 litres, cars are producing in excess of 320 bhp.

In historic rallying, the cars' specifications must conform closely to the original homologation details, but for non-historic events, anything goes within the overall technical regulations. As a result, the 'modern' Escort has been developed with a variety of engine choices available, larger wheels with bigger brakes to match and a variety of transmissions from straight cut H-patterns to 6-speed sequentials, the latter with the option of a flat shift.

Coil-over dampers often replace the original leaf springs on the rear suspension and the availability of high-end, three-way adjustable



damping systems takes suspension setup to a level early Escort campaigners could only have dreamed of. Electric power steering is a common fitment in the modern Group 4 Escort and a major benefit to those competing on tarmac events using the latest moulded slick rally tyre technology.

Some purists dislike the idea of modern equipment on an historic car, but it should be applauded. The Escort remains an ideal combination of size, low weight, poise and most important of all, it's easy to drive. With crucial upgrades to performance, drivability, grip, traction and braking it's still hard to beat as an overall package, especially in tarmac trim.

Modern Mk2s are based on Group 4 specification for which the Escort was homologated late on in its career for the 1978 season. Today's cars are structurally identical, only some of the key details have moved on.

ENGINES

The MSA technical regulations restrict engine size for stage rallying (with a dispensation for the Metro 6R4 and 16-valve V8 engines) to 3.0 litres. Specialist competition engines are allowed outside the historic regs of four cylinders and up to 2.5 litres. Although many Ford engines are still used in Escorts from 8-valve Kent engines to 16-valve Ford Cosworth BDGs, naturally aspirated YBs and Duratecs, non-Ford 'hybrids' abound. A high proportion of Mk2 Escorts in open class stage rallying run either Vauxhall 2-litre, 2.4-litre or 2.5-litre engines (all based on the 1998 cc C20XE engine) or the bespoke, all alloy, 2.5-litre Series One or Series Two Millington Diamond. All of these engine options offer robustness and high specific power.

The Vauxhall C20XE engine was designed by Dr Fritz Indra at Opel in 1987, Cosworth playing a big part ▶



BELOW Vauxhall engines are a common transplant. This 2-litre C20XE unit produces over 290 bhp

in designing the cylinder head and supplying the earlier head castings. These are identified by a 'Coscast' logo and are sought after for competition use due to their superior material, casting quality and suitability for extreme porting compared to later GM-cast heads.

Today, the XE is well supported with dry sump systems, steel crankshafts and rods and forged pistons. Omega Pistons manufactures a low-friction 'slipper' piston with a super-short skirt, a single compression ring and one oil control ring. Equipped with a CNC-ported cylinder with 35 mm inlet valves, race cams, steel crank and rods, dry sump and Jenvey taper throttle bodies, a 2-litre XE can produce well in excess of 280 bhp for race and rally use. Popular ECUs commonly used on these engines include DTA, Omex, MBE and Life Racing.

The Millington Diamond is perhaps the most desired of all the 'modern' Escort powerplants. Developed by Roy Millington, the Millington Series 1 started life as a Ford Cosworth YB-based engine with bespoke aluminium block and modified production head. It was produced in both 2-litre and 2.5-litre form. Today, the 2.5-litre Millington Diamond Series 2 has a block and head entirely designed and produced by Millington Racing Engines. The engine produces a quoted 325 bhp and 245 lb ft torque and has a rev limit of 9,000 rpm. Not surprisingly, the engines are supplied with an in-car switchable wet map for the DTA S60 Pro ECU. Weighing just 83 kg, the Diamond Series 2 therefore produces an impressive 3.9 bhp/kg.

Historic Escorts

IT WILL come as no surprise that historic spec Mk1 and Mk2 Escorts are subject to much greater restriction than their non-historic counterparts and essentially they must conform to the original homologated specification. Under the MSA regulations, this means historic Mk1 and Mk2 Escorts fall into Historic Categories 2, 3 or 4 covering the homologation period from 1st January 1968 to 31st January 1985. Cars must be issued with an Historic Rally Vehicle Identity Form by the MSA and although period modifications are allowed, the owner must be able to prove their validity if necessary.

That said, the basic shells are the same as the non-historic cars with the exception that fully welded roll cages are not allowed. The same five link fully floating Atlas axles are permitted (as they were homologated) but brakes must be historic legal, so while AP Monte Carlo closed back front calipers are historic legal, Pro 5000s would not be.

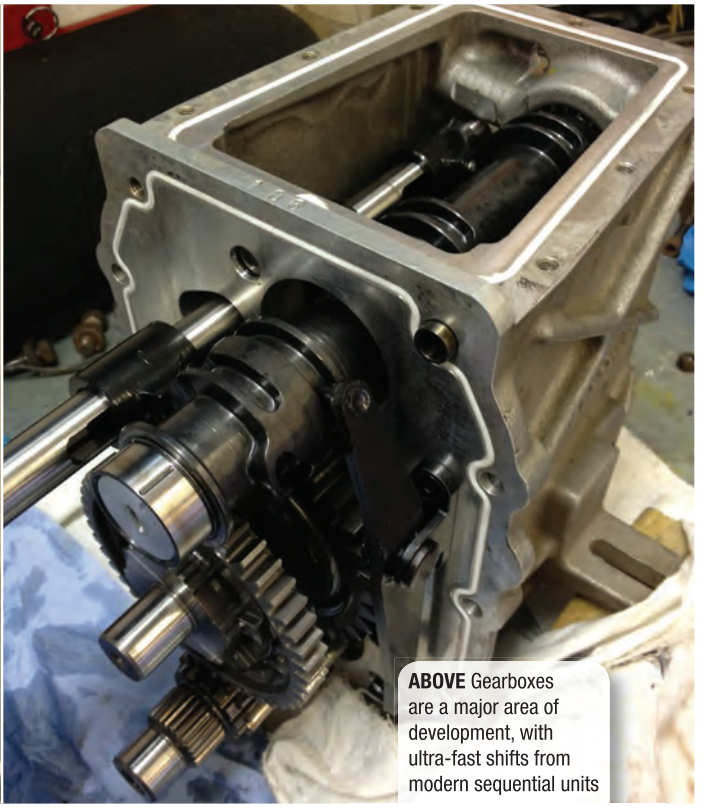
The biggest difference with an historic Escort is, perhaps, the powertrain, which must conform to the original homologation papers. For the Escort, this means only homologated Ford engines may be used and for high-end cars, the 2-litre Ford Cosworth BDG combined with a ZF 5-speed gearbox is the only option. All-alloy 2-litre BDG engines are still manufactured new by a number of specialists such as John Wilcox Competition Engines or Sherwood Engines. HRT

TRANSMISSIONS

Within the limits of the overall MSA technical regulations transmissions are free for non-historic rallies. The most common choice of manual gearbox for the Escort is the Sierra-derived Ford Type 9, 5-speed transmission and Quaife produces a wide range of Type 9 replacement parts and gearboxes ▶



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BELOW Jesse Crosse in action in the 'Yellow Peril'

Andrew Marston / M and H Rally Photography

including straight-cut dog engagement and with a variety of ratios available. The classic ZF 5-speed as used in original works cars is an option too, although mainly used in historic specification cars. Elite Racing Transmissions produces a brand new replacement for the ZF with the option of either dog or synchromesh engagement. For high output engines, AP Racing paddle clutches with cerametallic friction surfaces are still a benchmark and extremely robust.

The preferred transmission choice, budget permitting, is a 6-speed sequential dog-engagement motorsport gearbox and a number are available which will fit into the space occupied by a Type 9, with the appropriate mountings added to the bodyshell and modifications to the transmission tunnel. Tractive RD906, Sadev SCL82-17, Drenth DG400, Quaife G60, Saenz TT3 and Elite IL300 gearboxes are all used in Escorts.

Flat shift (or 'shift-cut') is a common option, a switch either integral with or mounted on the gearbox sending a signal to the engine ECU when pressure is applied to the gearlever. To change gear using a dog-engagement gearbox (whether it is an H-pattern manual or sequential) drive torque must be taken out completely to enable the dogs on the driven gear to separate and re-engage with the gear being selected. The driver can do this manually with a quick lift but with a sequential gearbox it's more effective and easier on the components to enable shift-cut in the ECU.

The Drenth, for example, has a robust plunger-type switch acting directly onto the selector mechanism which can be shimmed to adjust free movement before being closed. Some manufacturers offer gear levers incorporating strain gauges to do the same job as a switch. A DTA ECU, for example, incorporates a wide range of shift-cut settings including ignition dead cut for a specific period which can be individually set for each gear. An alternative option is to retard the ignition rather than perform a dead cut although this is less popular. Ignition can also be retarded following a dead-cut event to reinstate the torque more gradually. Shift cut can also be configured to activate only above a certain percentage of throttle opening so the car can be driven gently to and from stages without its intervention.

This is essentially still a mechanical system completely under control of the driver, unlike road cars where a request from the driver to shift is analysed by the on-board ECUs which decide which action to take. As a result it's about as fast as it can be, taking under 100 ms to go from initial pressure on the gear lever back to full power in the next ratio. Some drivers also opt for pneumatic actuated paddleshift systems controlling both up and down shifts.

BODY AND CHASSIS

Group 4 bodyshells remain much as they always have with seam welds along the joints, gusseting, plating, substantial strengthening of the chassis rails and



BELOW Sequential gearshift, hydraulic handbrake ... and room for a navigator

The 'Yellow Peril'

JESSE Crosse has campaigned his own Escort, affectionately referred to as the Yellow Peril, since 2012. It's based on a 1978 Mk2 Escort, now fitted with 2-litre Vauxhall engine good for over 290 bhp.

Bodyshell:	Full Gp 4 with part welded, part bolted cage. Roof vent, polycarbonate side and rear windows, heated screen, fully seam welded, gusseted and plated. Lifeline Zero 2000 plumbed in and handheld extinguishers
Engine:	JRE Vauxhall C20XE 2-litre rated at 291bhp. Coscast big valve head, Pace dry sump lubrication, Jenvey taper throttle bodies, Omega slipper pistons, Saenz steel con rods and steel crank. Simpson stainless exhaust manifold
Transmission:	Drenth DG400 6-speed sequential motorsport gearbox
Front axle:	Bilstein Gp 4 coilover MacPherson struts with adjustable spring seats. Tension strut location and anti-roll bar
Rear axle:	Fully floating Ford Atlas with Gripper 5.3:1 CWP with LSD
Brakes:	AP Racing Pro 5000+ 4-piston front with 304 mm ventilated discs. Ferodo DS 3000 pads. AP Racing Gp 4 2-piston rear with ventilated discs
Steering:	Electrically assisted, heavy duty 2.2-turn Gp 4 steering rack
Wheels and tyres:	15x8 Revolution Gp 4 alloy wheels with Kumho C03 moulded slicks

skidding of underbodies with steel plate. Roll cages for non-historic cars can be fully welded into the car whereas historics are bolt-in. Polycarbonate windows are allowed in non-historic too, but laminated glass must be retained for the front screen. These are often heated in the Escort, with heaters removed and ventilator modern roof vents added for cooling and demisting. A full Group 4 shell will usually have an exhaust tunnel allowing the exhaust pipe to be partially set up into the shell.

Over 40 years on, the favoured rear axle setup is still the works-type Ford Atlas. The Atlas is located by four trailing links longitudinally and laterally either by a Panhard Rod or Watts Linkage on non-historic cars. Most serious tarmac cars use coilover dampers in place of leaf springs at the rear. At the front, Group 4-style MacPerson struts still prevail, located longitudinally either by tension struts or, more usually for tarmac rallying, compression struts.

On non-historics, front struts will usually be of the coil-over variety again with adjustable spring seats. Damping, however, has moved on. Although budget often dictates sticking with Bilstein struts and rear dampers, Reiger, Proflex and AVO offer three-way adjustable damping front and rear at a price. Many drivers opt for 15-inch wheels on non-historic tarmac cars. While increasing unsprung weight, these also provide a larger contact patch because of the increased rolling circumference. Since the MSA restricted the width of wheel and tyre assemblies to nine inches in non-historic rallying for the 2012 season onwards, this has become more significant.

The larger wheels provide setup challenges, however, particularly when it comes to maintaining a low enough ride height, but they also allow the fitting of much larger front brakes, such as AP Racing's Pro 5000+ range. The Pro 5000+ is an open back, radial mount design and its use goes hand-in-hand with larger diameter discs, typically increasing from 260 mm with 13-inch wheels to 304 mm depending on original fitment. Most serious Gp 4 tarmac Escorts are equipped with power steering thanks to systems developed for the job around the Vauxhall Corsa B system. Using a wheel sensor, these allow button-press adjustment of steering weight, while a toggle switch can determine if this should be fixed or speed proportional.

So motorsport's love affair with the Mk2 Escort is far from over and the pace of development continues at full throttle. Although the cost of donor three-door shells on which to base a new Gp 4 Escort is rising, there's still a plentiful supply and the demand shows no sign of abating. HRT



ABOVE The 1978 donor shell has been built to Gp 4 spec

No good for rallying? Think again!

Anthony Peacock shoots down the myth that Porsches are too temperamental for the rough stuff

FORD Mk2 Escorts are as synonymous with rallying as pre-dawn starts and bacon rolls, but the Porsche 911 has always been a breed apart. Perhaps that's because of its traditionally elite image or maybe because of its unusual rear-wheel drive, rear-engined layout: normally the preserve of racing cars.

The theory goes that such a car would be unsuitable for rallying, not having anything approaching optimal 50-50 weight distribution that forms a Holy Grail for most car designers.

But the urban legend that a Porsche 911 is somehow as temperamental as a starving shark is entirely without foundation. It probably stems from the fact that pinstriped bankers at the height of the financial boom in the 1980s – who had never previously experienced anything more powerful than the Metropolitan Line to Aldgate – occasionally parked their Guards Red 911s in a hedge in Surrey, invariably as a result of user error.

On the contrary, the weight distribution and layout of the 911 actually flatters most rally drivers, because of the better traction



> "Put someone in a 911 and a Mkl Escort. I bet they would be quicker in the Escort after a day. But after a week, they're always going to be quicker in the Porsche"





ABOVE & LEFT
Tuthill Porsches are still performing with distinction, whether the terrain be snow, tarmac or the mud and sand of the East African Safari Classic

Photos: Tuthill Porsche

that the engine over the rear wheels provides. Then there is the increased pendulum effect when it comes to the essential art of hand-braking the car around corners (which is far easier in a 911 than any other historic car).

One man who knows this well is Richard Tuthill, boss of the eponymous Porsche preparation firm in Oxfordshire. “Driving a historic 911 makes you appreciate just how far ahead of its time the car was originally,” he explains. “You’ve got power, independent rear suspension, and perfect traction: what more do you need? You have to invest a bit of time and thought however; if you put someone in a 911 and a MkI Ford Escort for example, I bet they would be quicker in the Escort after a day. But after a week, once they get it, they’re always going to be quicker in the Porsche, even if the power is the same.”

There are only two reasons why a driver would ever get into trouble driving a historic 911: too much steering and/or too much throttle. This is the bit that takes time to master. It’s a delicate balance between aggression, the stab of throttle required to initiate a slide, and the finesse required to hold it thereafter.

Once you master the theory, though – thanks to a few simple tricks such as keeping your hands fixed on the steering wheel (to avoid too much wheel-twirling and therefore disorientation about the straight-ahead position) – it actually becomes easy: armfuls of useless understeer are gradually dialled out and an elusive rhythm is achieved. In terms of driver satisfaction, it doesn’t get much better.

This is why a Porsche 911 is always going to be an interesting alternative to many of the more conventional historic rally cars out there. Preparation of a historic Porsche happens in much the same way as any other rally car, although because it was designed as a performance vehicle from the outset, less strengthening is needed. A variety of engines are available, starting with early 2.0-litre units, which continued to be sold in the United States right up to the 1970s, with the most common variant being the 3.2.

But unlike many of the extensively re-engineered Ford Escorts that are out there (Colin McRae owned an example that he described as “basically a WRC car with an old Mk2 bodyshell”), FIA regulations place strict restrictions on what can and cannot be done to a historic Porsche, ensuring originality and fairness in competition. Ironically, this often makes owning a historic Porsche rally car a considerably more financially practical prospect than an Escort of similar vintage.

One of the biggest areas of freedom worked on by Porsche preparation experts is suspension and damping, which is what makes the real difference between a good historic Porsche and a merely average one, as traction and grip are such key issues. How to get the power down – with all that weight over the rear wheels – while ensuring a decent turn-in from the unloaded front, will always be at the heart of extracting the maximum performance from a Porsche. As a result, there are a number of dampers that have been specifically created for the car, using the latest technology. Engines, by contrast, are largely untouched, having been developed in-period specifically for performance.

Even pre-911, when Porsche was essentially a cottage industry based out of a barn in Gmund, Austria, the original 356 was designed for rallying rather than racing. For Ferry Porsche, the company’s founder, it was simply the only way to showcase his firm’s products in a real-world, post-war environment. As a result, historic rallies such as the Tour Britannia and Carrera Panamericana are frequently bolstered by a healthy contingent of Porsche 356s as well.

But it was the iconic 911 that brought Porsche to prominence as a factory rally team, winning on a variety of surfaces including snow, ice, gravel and asphalt. One of the car’s biggest exponents was the inaugural world rally champion: the late Bjorn Waldegard, who passed away earlier this year, but ▶

who actually sealed his famous 1979 title in a Mk2 Ford Escort.

"People say to me you must like driving the Ford Escort and of course I do," said Waldegard, after winning the 2012 East African Safari Classic in a 911. "But then I also drove a Porsche throughout my career, which was always a truly special car."

That Safari rally was Waldegard's last international success. His very first one was also in a Porsche, on the 1968 Swedish Rally. Waldegard went on to win in Monte Carlo with a 911 as well, cementing the car's almost unbeatable reputation in slippery conditions: the legacy of that rear-wheel drive, rear engine layout. Those attributes still hold true today.

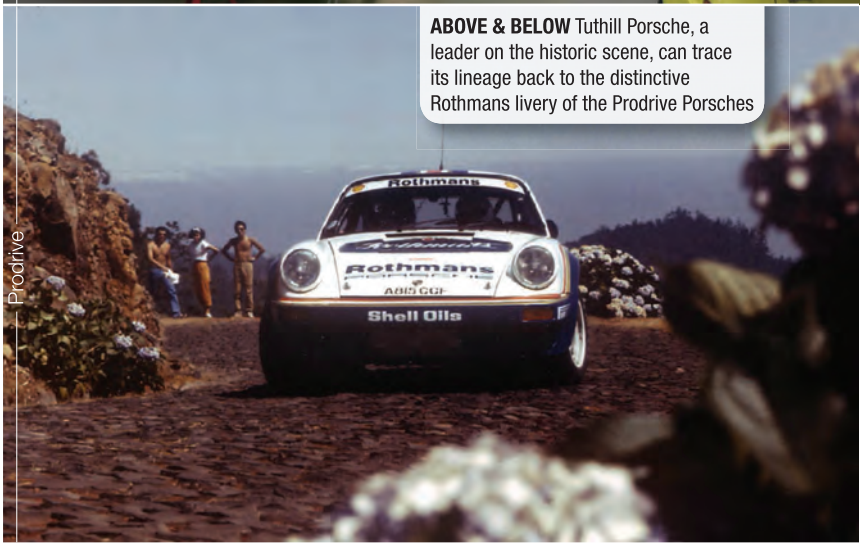
PERFECT FOR TRICKY CONDITIONS

Another exponent of Porsche power was Frenchman Jean-Pierre Nicolas, who also drove an Almeras Porsche 911 to victory on the 1978 Monte Carlo Rally: an event so snowy that many of the roads that year were impassable. "It was a special moment," remembers Nicolas. "I'll always have a huge affection for Porsches.
For historic rallying now, they are really perfect: especially in tricky conditions. And even though they have this reputation for being difficult, it is a very friendly car to drive: really no problems at all, even for an amateur driver. It is one of the best choices for a historic rally car."

He's right. A lot has been said and written – with varying degrees of truth – about the tail-happy behaviour of early 911s, but how many of us can say that we have taken the proper time to fully understand the physics at work?
And to completely comprehend the dynamics of a historic 911, you have to understand about left foot braking: an essential technique for getting the best out of these cars.

Waldegard, the master, explained it once in his own inimitable way: "Before a cat jumps onto a wall, it crouches over its front feet, then launches itself," he said. "If you brake, the front of a car is pushed down into the ice, gravel or tarmac, which means you've got steering. You have also made its rear go light. With a 911, you have to upset its balance otherwise it won't turn in. Its steering wheel is only to initiate a turn, to show the car the way, and maybe to sort out your lack of control of the throttle on the exit, to fix things. Drive it properly and it's all done on the brakes and throttle."


Tuthill Porsche



Prodrive

ABOVE & BELOW Tuthill Porsche, a leader on the historic scene, can trace its lineage back to the distinctive Rothmans livery of the Prodrive Porsches

And here we were thinking that cars not needing steering wheels was just a dream of the future. Porsche got there years ago.

The truth is that the German firm could have dominated rallying right up into the 1980s but Porsche began to question the expense of fielding factory teams on events it had already won, particularly in light of a general lack of promotion and competition. Success, as a result, became sporadic thereafter, and the last factory finish for a Porsche came on the 1986 Acropolis Rally, courtesy of Saeed Al Hajri. Again, not territory you would automatically associate with a 911.

The car was run by Prodrive, in its distinctive Rothmans livery, and it's from there that Tuthill Porsche – one of the leaders on the current Porsche historic scene – can trace its lineage; not to mention the secret of its success.
"For us, it all started when Prodrive's David Richards wanted to pitch the idea of a Porsche team to Rothmans," concludes Richard Tuthill. "He bought my father's left-hand drive SC RS on the understanding that we would be allowed to do the paintwork on his cars. We did all the Rothmans Porsches, BMW M3s and MG Metro 6R4s.

"We did all the bodywork, too: the 911s, 959s, M3s and Prodrive Subarus. We repaired every single crash Colin McRae had in a Legacy or Impreza. We were busy boys. We ran a nightshift to keep him going. That's the secret of our success today: our cars' longevity. We produce the best bodyshells in the world because dad learned it all from the works team."

And that's probably how you build a successful historic Porsche these days. By finding things out the hard and sleepless way. HRT

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THE SIX-WHEELED WONDER

Plagued with problems when it first appeared, the March 2-4-0 has now emerged as a successful Historic Formula 1 car, **Andy Swift** reports


Andy Swift

ABOVE A historic oddity brought to life: the March 2-4-0 has shown its true colours after a restoration project that revealed the merits of the original concept

"**IT'S** a spontaneous car!" proclaims Tony 'Taff' Smith as he looks across his workshop at the March's alien form. Surveying the car's ludicrous proportions, six wheels, and mismatched livery - and considering its suitably unorthodox birth - it's impossible to argue.

The 2-4-0 was the unlikely result of two usually divergent forces in motor racing: the commercial and the technical. Both of these appear to have been inspired by Derek Gardner's wonderfully madcap, and ultimately fairly successful six-wheeled grand prix car, the Tyrrell P34 – though naturally for rather different reasons.

Since its inception, March had existed in a rather hand-to-mouth fashion and by the mid-1970s its F1 programme was struggling. During the run-up to Christmas in 1976, Max Mosley had noticed the remarkable sales success of P34 models and felt there was considerable marketing potential in something similar for March. At the same time, design boss Robin Herd felt that the six-wheeled grand prix car concept might be optimised by employing four driving wheels at the rear and two at the front. Its name aping railway locomotive parlance, the March 2-4-0 promised to be the panacea for both engineer and marketeer.

The 2-4-0 was revealed to a surprised, and rather sceptical, press late in 1976, with the March hierarchy boasting that the car was the result of considerable wind tunnel testing and a very serious effort. Sadly for a fundamentally sound concept, quite the opposite was true and the 2-4-0 was the result of one employee, Wayne Eckersley, and a budget of next to nothing. That a subsequent short test programme proved unsuccessful was perhaps unsurprising and the project was quietly mothballed, allowing March to focus on its customer race programmes. During that time, however, March did produce a second – apparently superior – back end which was considerably stiffer than the original unit and known informally as the Mk II. The Mk I drivetrain was employed in a show car which now resides in the famous Louwman Museum in Holland.

Recognising the potential in its unusual layout, hillclimber Roy Lane purchased the Mk II March drivetrain and the works mated it to Lane's 771 grand prix chassis. Lane enjoyed a reasonably successful 1979 British Hillclimb season, including a couple of run-off victories. The car's traction was notable but so too were lubrication issues within the drivetrain. Lane decided to focus on a conventional four-wheeled March and the 2-4-0 was mothballed once again. Passing through a variety of owners, the next time the 2-4-0 saw action would be 2012.

In researching the car, one aspect which sets the 2-4-0 apart is that its history and provenance lies specifically in its embossed drivetrain and not in its chassis, like so many race cars. In fact, Smith believes the drivetrain has been mated to anything up to four different aluminium monocoques during



“The drivetrain has been mated to anything up to four different aluminium monocoques during its lifetime”

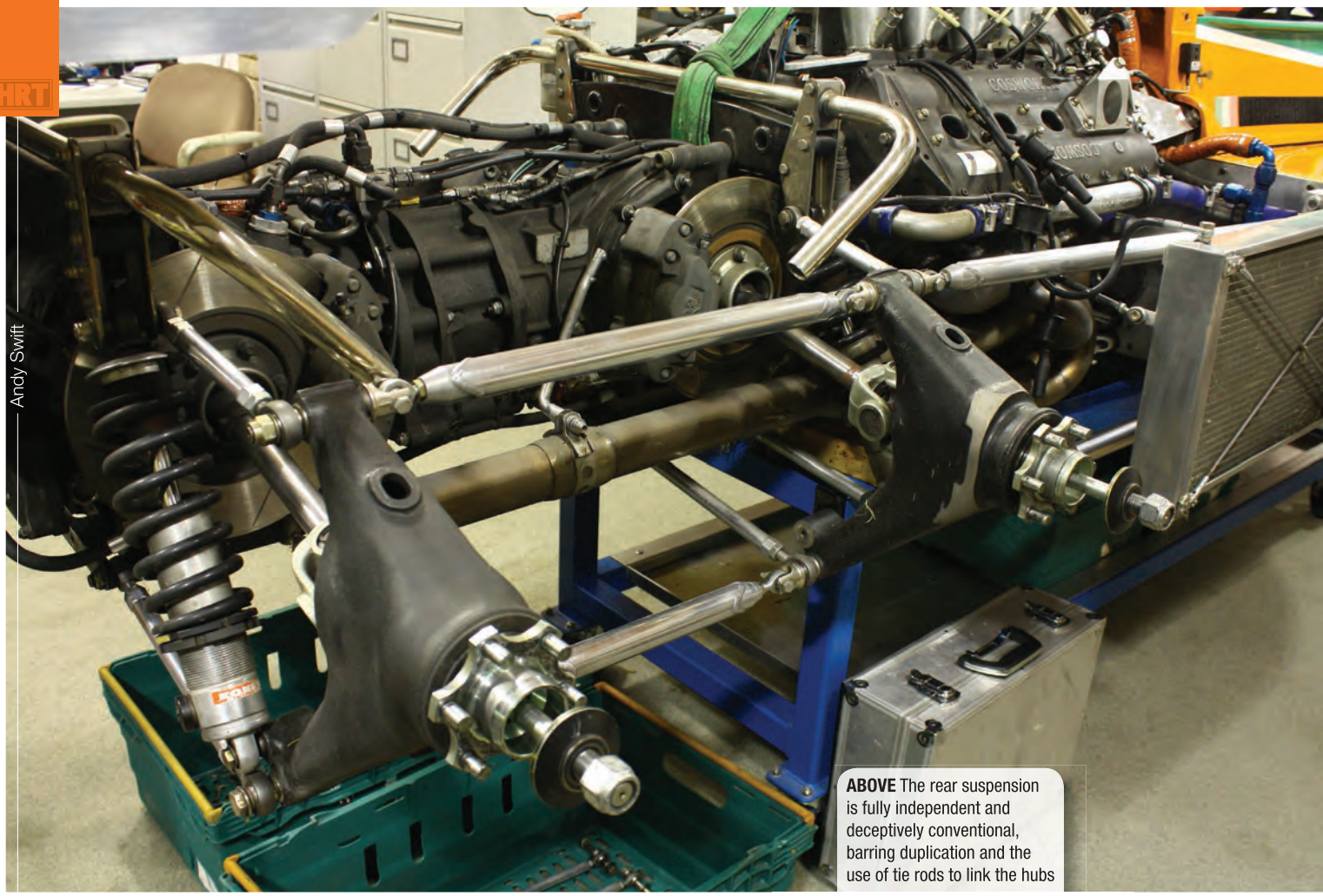
its lifetime. Uniquely, the continuity and identity lies solely in the gearbox and differential casings, not the tub. The drivetrain even spent time as a show car – much like the Mk I version.

The restoration of the 2-4-0 has been Smith’s retirement project but historic racing is a relatively recent hobby. With a professional background as a successful mechanical engineer, his first love is aviation. He combined these passions to restore, run and fly old aeroplanes and his workshop is decorated with photos of Supermarine Spitfires, P-51 Mustangs and Cold War-era Soviet jets. You name it, he’s owned it, fixed it and flown it. These strands of meticulous and rigorous engineering run throughout the car and there’s a quality and integrity to the workmanship and materials which is unusual, even in the exalted world of historic racing.

TAKING THE PLUNGE

Smith’s first steps into the historic racing scene were as much a means of spending time with his son, Jeremy, as anything else. Jeremy is a talented single-seater driver who raced up to British F3 level before a lack of funds dashed his ambitions. The pair purchased a March 782 historic Formula 2 racer which they prepared themselves and enjoyed some success with. As the ultimate customer car of the era, they found the March easy to set up and vice-free but soon yearned for even greater performance. A Surtees TS20 followed, with Jeremy taking an evocative win at the Oulton Park Gold Cup. After being made an offer it was impossible to refuse, the Surtees was sold but a Cosworth DFV was purchased, awaiting a future project.

Having located the 2-4-0, Smith deliberated for some time over whether to take the plunge and even spoke ▶



Andy Swift

ABOVE The rear suspension is fully independent and deceptively conventional, barring duplication and the use of tie rods to link the hubs

to Roy Lane for advice: "Roy was very encouraging actually. He raved about the steering and the traction – told me I'd love it. Roy's words really helped make the decision for me but I still remember getting everything back and putting it on the work bench here. I wondered what the hell I'd done!" Smith had purchased a tub, uprights, radius rods, both gearboxes and the gearbox spacer; the rest was up to him.

If every grand prix car can rightfully be considered a prototype, the 2-4-0 is a prototypical prototype. As it never raced in F1 and was never in anything resembling series production, strict homologation papers do not exist. Today's Masters Historic Formula 1 Championship is regulated by the FIA and that means cars must carry an HTP (Historical Technical Passport). This has been extremely challenging to achieve and the restoration as a whole was made more difficult because of a general lack of knowledge on the car in the wider industry.

Smith, however, applied a typically meticulous approach to the rebuild and the result is that the March 2-4-0 is now a successful and well-regarded historic Formula 1 racecar and finally the radical layout is having the chance to prove its worth in competition.

The tub is from a 751, now upgraded to 761 specification. For safety, the original rivets were replaced with solid aircraft rivets and the tub was glued for strength. While he is quick to praise Marches generally for ease of set-up, Smith notes that the quality of fabrication is not fantastic. As customer cars, replacement tubs would be produced at a far greater rate than, say, Ferraris of the period and this level of production is evident in the quality occasionally – and pity anybody who might wish to trace the definitive race history of specific chassis.

Many of the car's suspension components have been re-fabricated using modern, aerospace-grade materials. The strength and quality of newly-fabricated radius rods is in a different league to the originals, which Smith has retained. He elaborates: "I've tried to apply the same standards to the car as I do with my aeroplanes. Really, if Jeremy crashes this car, he could lose his legs or worse – I won't compromise on safety. For example, while I can weld reasonably well, I won't do any structural welding on the car as I'd prefer to leave it to an expert. Essentially, I do everything as I would need to for the Civil Aviation Authority, but without the requirement for certification."

Throughout are small hints at the attention to detail and level of engineering integrity which have gone into the car. NAS (National Aerospace Standard) hex head bolts and fasteners have been employed wherever possible – identified by their concave heads. These feature cold rolled, rather than died, threads for maximum shear strength.

The suspension at the rear naturally looks unusual. Each back wheel is suspended independently but with ball-jointed tie rods linking the rear hubs on each side of the transmission. The uprights are from an F2 car, which are lower than the contemporary F1 equivalents. These help to give ▶

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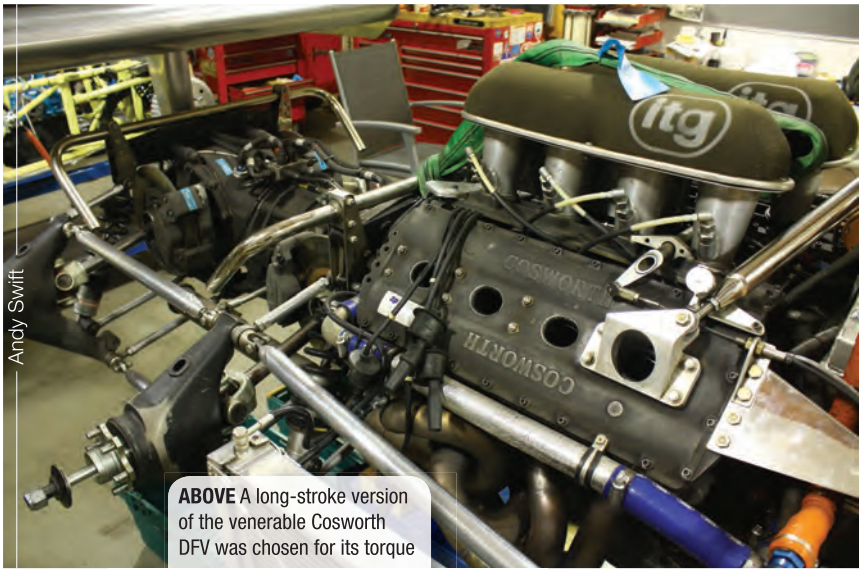
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the car a centre of gravity and roll centre about an inch lower than a conventional four-wheel March grand prix car of the period.

Each axle is linked side-to-side by an anti-roll bar. These are new parts constructed from T45 steel tubing – another legacy of Smith's experience in the aviation industry. T45 has also been used to form the roll hoop and associated structure. Setting up this rather complicated-looking suspension arrangement was apparently remarkably intuitive. "Corner weighting was fairly simple – even with only four scales," Smith grins.

The car is running a long-stroke Cosworth DFV engine built by Langford Performance Engineering that's producing in the region of 460 bhp. Early in the restoration, a long-stroke engine was chosen for its torque, in an effort to combat any drivetrain losses inherent in the four-wheel drive layout. The fashion in historic racers of the period is for powerful short-stroke DFVs, though the move to FIA Championship status has brought changes. A 10,000 rpm limit is now in place and each car is obliged to run the kind of engine it did in period. That means the slightly unfashionable long-stroke DFV will find itself redeployed in several cars.



ABOVE A long-stroke version of the venerable Cosworth DFV was chosen for its torque

Having enjoyed a less-than-stunning contemporary career, little was expected from the 2-4-0 by on-track rivals and race officials on the historic race scene. Smith laughs when he recalls how the scrutineers suddenly started checking parameters like the car's rear wing height once Jeremy scored his first wins.

One of the challenges facing the team that brought Tyrrell's six-wheel P34 into the historic race scene was that car's period bête noir: tyres. Fortunately control tyre manufacturer Avon was prepared to produce special 10" front tyres and various P34s have enjoyed considerable success with Martin Stretton, Mauro Pane and Roger Wills in recent years as a result.

Smith has faced no such problems with the 2-4-0: "I simply order six front tyres. For the Goodwood Festival of Speed, Avon has also been really cooperative. We've taken the car there twice, in 2012 and 2014, and Avon provided us with six uncut rain tyres. These are a really soft, sticky compound and great for hillclimbing as the distances involved ▶



BELOW The current tub started life on a four-wheeled March 751



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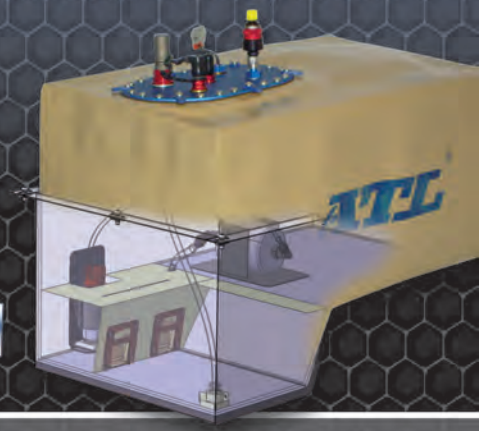
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are so short. We only do half a dozen runs over the weekend and take the tyres back to Avon where they cut them, leaving us with a full set of rain tyres for another event."

TRANSMISSION TROUBLES

The focal point of the 2-4-0 is, rather naturally, that unusual four-wheel drivetrain. The initial iteration suffered with excessive twist between the two differentials. This caused the pinion to chatter on the crown wheel, losing drive to the two rear-most wheels as a result. This became evident during early testing of the car, with Howden Ganley running with only two-wheel drive at Silverstone as a publicity stunt.

The Mk II transmission featured a considerably stronger spacer between the two differentials which was ribbed for torsional strength. There were, however, other engineering problems to overcome with the unusual design. The effect of two differentials working so closely together – and without the help of a centre diff as one might expect on a more conventional four-wheel drive vehicle – could have resulted in the two axles fighting one another, causing traction and handling issues.

Smith sought input from Quaife, who offered some valuable advice. The final set-up involves a cam and pawl diff at the front and a Salisbury diff driving the rear wheels. The theory behind this layout being that the cam and pawl diff would lock under load, with the Salisbury allowing a little slip. This would provide predictable traction and allow all four wheels to act independently, rather than in conflict with one another. The theory, apparently, works and everyone who's driven the March comments on how intuitive it is to drive.

The most serious issue with the transmission had plagued the 2-4-0 since its first running, including during its brief time hillclimbing with Roy Lane. In order to offer a resolution, Smith approached his friend Patrick Morgan of Dawn Treader Performance. Patrick's father, Paul, was a founder of Ilmor and the younger Morgan has worked as an engineer on F1 and CART projects for McLaren and Penske. His meticulous approach to mechanical engineering and passion for the project made him an obvious candidate to solve a bearing problem in the transmission.

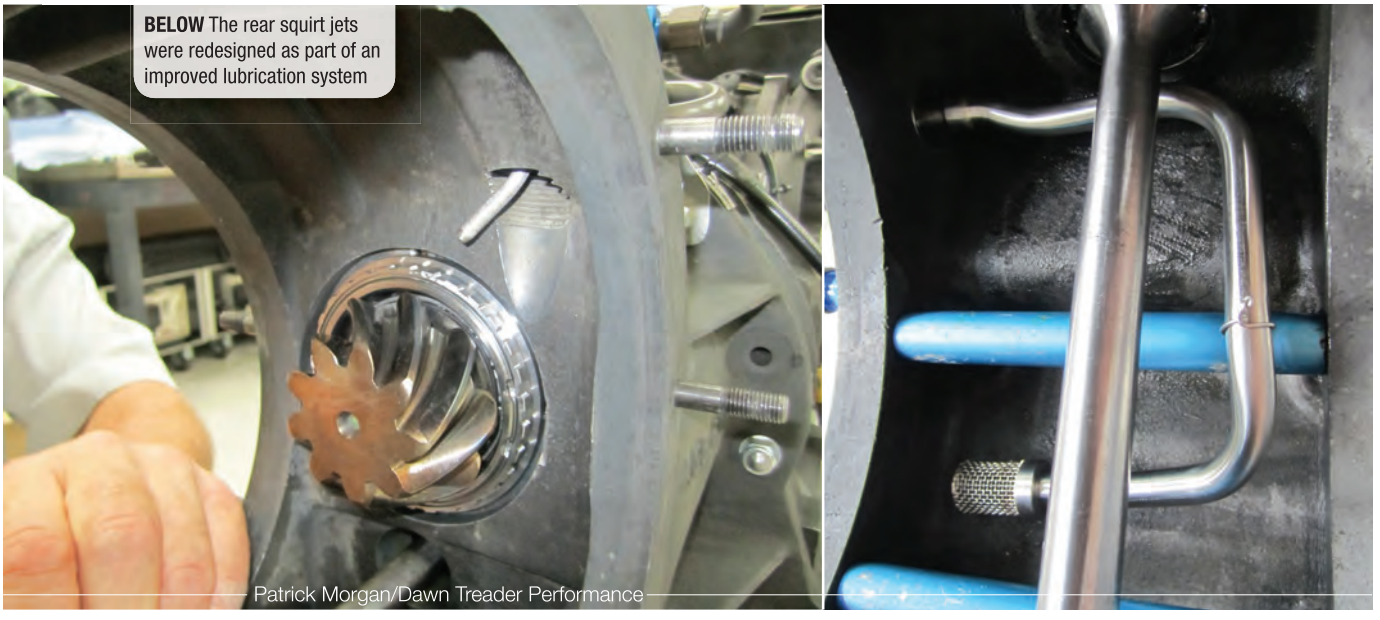
The outer bearings supporting the CV outputs were overheating, leading to catastrophic bearing failure. This was identified as being caused by a number of factors, the first being the gearbox oil. Being an extremely viscous oil, it was sticking to the gears but as a result of its viscosity was not dissipating heat away from the gears – as Morgan asserts, the oil's function is as much cooling as lubrication. The viscosity also meant that very little splash lubrication was reaching the CV output bearings.

There were also a couple of basic mechanical problems to overcome, as Morgan describes: "The oil from both differential housings is scavenged in series – the pump is at the rear of the gearbox. The oil pickup in the rear differential housing was approximately three inches from the bottom of the housing so would draw air most of the time and would require more oil than would be expected to raise the level in the system so that the pump could draw. Because of the series arrangement, if the rear pickup (nearest the pump) is drawing air, the front differential is not being scavenged."

Furthermore, the rear squirt jet was of an unorthodox design which was failing to distribute oil to the crown wheel and pinion where it was most needed. Due to the various failure modes, a number of solutions were required, starting with a more conventional oil that would better dissipate heat and move more easily around the transmission.

From there, Morgan designed a bespoke oil distribution system incorporating a number of changes: the oil pickup in the rear differential housing was moved so that it was submerged at the bottom of the gearbox casing; the rear squirt jet was redesigned and orientated to direct oil towards the crown wheel and pinion; restricted pressure feeds to the output bearings were incorporated.

Morgan elaborates on the system: "As



BELOW The rear squirt jets were redesigned as part of an improved lubrication system

Patrick Morgan/Dawn Treader Performance

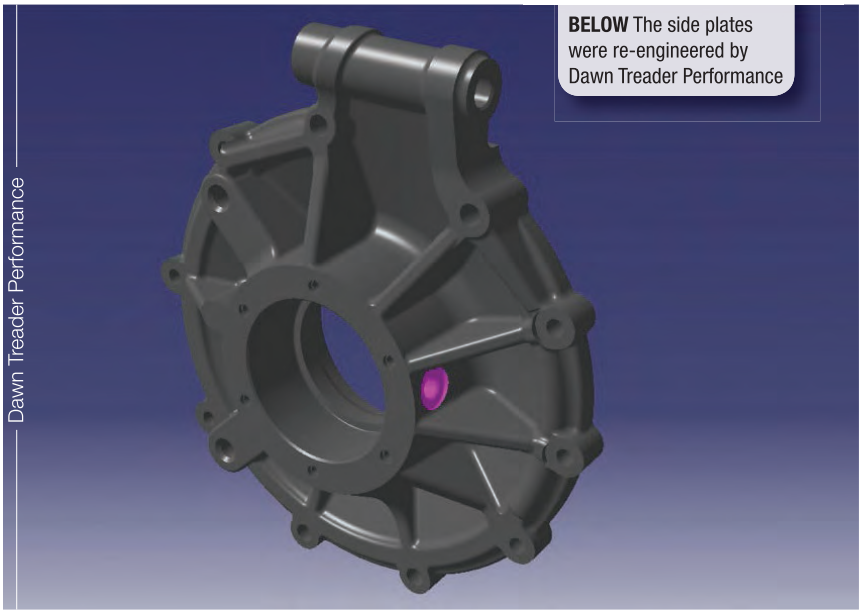


ABOVE The March 2-4-0 made its Goodwood debut in 2012

soon as the rear side plate was removed it was obvious what was happening. We tested the new system on a rig with the oil feeds at a range of RPM to ensure we were getting the flow rate we expected. The flow rate for the four output bearings could be adjusted via small restrictions in each fitting."

The problem was not necessarily specific to the March, but its layout did contribute, as Morgan identifies: "It could happen with any pumped gearbox where the oil pickup is not immersed although with the added heat of two differentials and four inboard-mounted brake calipers it would be more acute on the 2-4-0."

Morgan clearly relished the challenge of working on the 2-4-0 and expresses great satisfaction at solving a problem which had plagued the car throughout its history. While Smith has carried out much of the work on the March himself, he has been keen to engage only with others who share his passion and enthusiasm for the project.



Dawn Treader Performance

BELOW The side plates were re-engineered by Dawn Treader Performance

Smith has just commenced a winter overhaul on the March when we visit and there are plans to improve on a number of areas during the off-season. The DFV will be rebuilt using lightweight pistons with the hope of liberating a little more power. Cooling is currently safe but perhaps slightly marginal – with side-mounted radiators facing perpendicular to the airflow. The cooling system may need a little work to cope with any additional power. Smith also believes there is scope to remove a little more weight from the car and that further efficiencies can be made within the drivetrain as well.

The plan for 2015 involves racing at a number of the pair's favourite circuits – Spa, Zandvoort, Silverstone and perhaps a couple of others. Smith's eyes really light up at the mention of the Goodwood Festival of Speed: "We've got unfinished business there. I really hope we get invited back for another go with the fresh engine."

Wherever it ends up competing, the 'spontaneous' March 2-4-0 will continue to beguile spectators and, perhaps, prove that it was execution rather than concept which failed the car in period. Perhaps the engineers and marketing men both had the right idea all along. HRT


Chris Pickering


Mark Jones

A good walk spoiled

Some people take up golf for retirement. Others build their own aero-engined racing car, as **Chris Pickering** discovers

DEEP in suburban Surrey, something is stirring. Part car, part World War 1 fighter plane, it coughs into life with a series of percussive exhaust pulses, which slice through the crisp autumnal air. The early morning dog walkers crane their necks to watch as a machine from another time emerges from an inconspicuous garage across the road.

Cast against this backdrop of domestic modernity, the Berliet Curtiss Special looks elegant and incongruous in equal measure. It's the creation of John Dennis, grandson of one of two brothers who set up Britain's first purpose-built car factory not far from this spot in 1901. Since then, the family name has found its way onto trucks, busses and, most famously, fire engines. Engineering, it seems, runs in the blood.

When Dennis retired around 10 years ago he found himself searching for a project. He already had a small collection of veteran cars that were, in his words, "very old, very primitive and incapable of doing the 30 mph speed limit". What he wanted for the new project was something a bit more exciting.

It was at this point that an intriguing proposition came up. A dealer in Lancashire had imported a set of components from an enthusiast in South Africa, which included a 1907 Berliet chassis. The four-cylinder inline engine that would originally have sat on top of it had long since been lost, but included in the package was a Curtiss OX5 aero engine.

Dennis recalls: "I think the previous owner in South Africa thought it would be a weekend job to drop the Curtiss engine into the chassis and make a special. But when he discovered it wasn't, he sold the parts."

Undeterred, Dennis struck up a deal to acquire the bits. Alongside the engine and chassis was a variety of other components, including the wheels, steering box, both axles and, crucially, the transaxle gearbox.

MANGLED CHASSIS

The bodywork was missing when Dennis bought the package, and it's not entirely clear whether the somewhat mangled chassis even started life as a car or a truck. It's fairly typical of the period, with a simple ladder frame comprised of two U-sections and various cross-members.

Over the years the chassis had been



ABOVE It sure beats golf: the Berliet Curtiss Special seen in competition

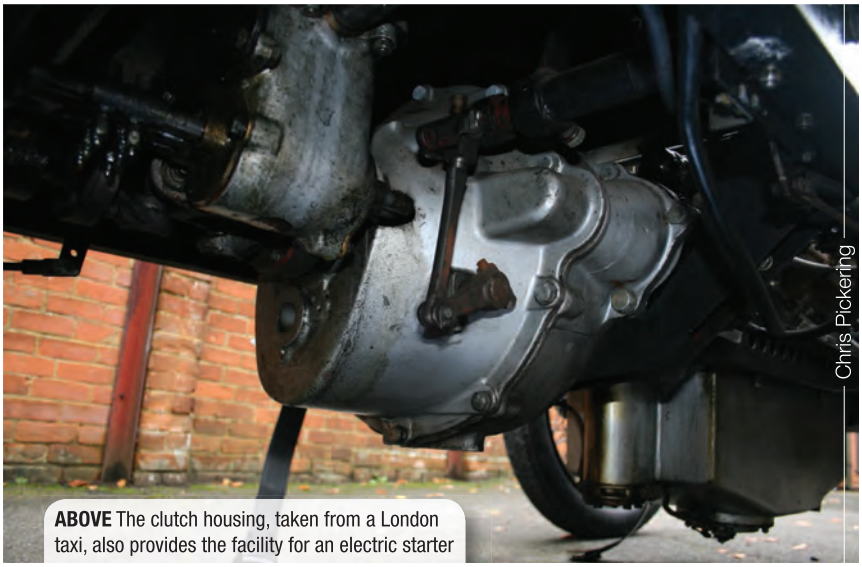
bent into a dogleg shape and twisted along its axis, so the first job was to straighten it out. There were also some 132 holes that needed welding up ("It was like a colander when we got it," notes Dennis). Despite this, the specialist chassis firm contracted to do the job made light work of it, he recalls: "I thought it was going to be a big problem, but the foreman looked at the chassis and explained he'd give it to the apprentice to do! When I saw the other work they were doing, I realised this would be a doddle."

The suspension is provided by half elliptic springs on the front and three-quarter elliptic springs on the back – both believed to be original. As befits a car of the period, the springs are used without dampers of any kind, although one leaf has been removed from each spring to soften it up a little to compensate for the reduced weight of the sporting body.

The biggest structural modifications came with the axles. As the build progressed it became apparent that the huge 880 x 120 beaded edge tyres would severely restrict the steering lock, so the decision was taken to widen the front axle. This was a straightforward case of cutting the hollow axle and welding a length of tube in the middle, with a section of steel bar to reinforce it.

At the rear, the car uses a drop beam arrangement. Due to the chain drive layout the axle itself is little more than a carrier for the wheels and sprockets; the differential and halfshafts both live in the transaxle. Rather than modify the rear axle to match the widened front track, Dennis commissioned Oliver Way Design to create a new one using the original hub ends.

Interestingly, the drum brakes that you can see in the images only serve as a handbrake mechanism; ordinarily the braking is handled (not desperately effectively, Dennis notes) by cable-operated band brakes on the transmission. "I always take the view that you need to start braking a village before you actually want to stop," he jokes. ▶


Chris Pickering

ABOVE The clutch housing, taken from a London taxi, also provides the facility for an electric starter

LONDON TAXI GEARBOX

The 8.2-litre Curtiss V8 is actually a remarkably delicate looking thing. As with a lot of early engines it has individually cast steel cylinders, grafted onto the somewhat spindly aluminium crankcase with nothing more than thin air between them. The whole thing tips the scales at only 360 lb (163 kg) – comfortably less than a modern V8 road car engine – and it doesn't take up a huge amount of space. Hence, physically accommodating it in the chassis wasn't going to be a problem. The question was how to mate it to the transmission.

Originally designed to face forwards in the nose of an aircraft, the OX5 came with an elongated crankshaft, tapered into a point to accept the propeller. It was never intended to be fitted with a gearbox or clutch and there were no mounting points for a bellhousing.

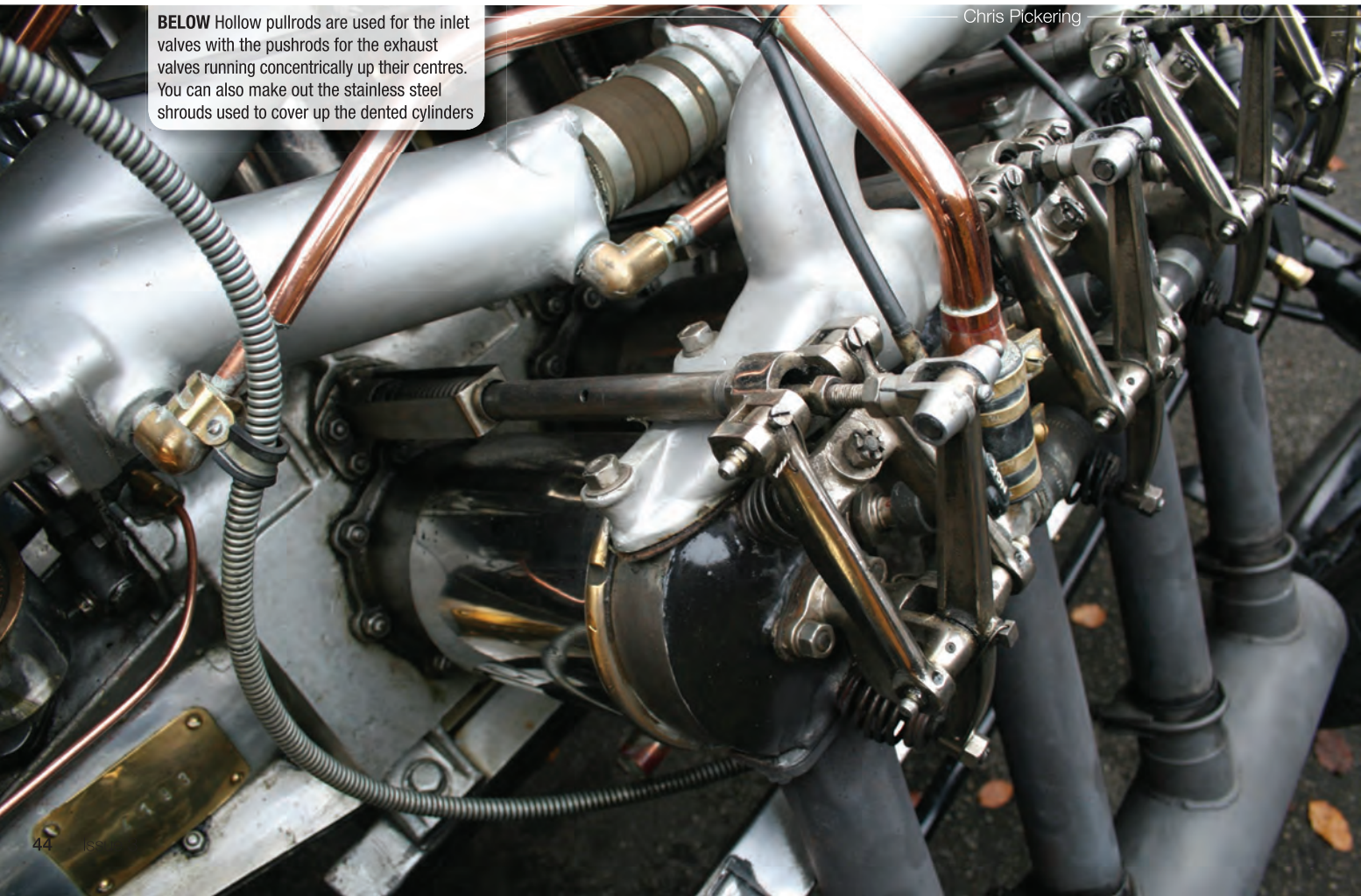
A solution was found in the unlikely form of a London taxi gearbox. The donor unit was literally cut in half using an angle grinder to produce a housing that contained the clutch and flywheel assembly. This was then mounted to a cross-member in between the two chassis rails, while the crankshaft was shortened and machined down to accept the flywheel. A short engine-speed propshaft carries the drive back to the transaxle from where it's sent to the rear wheels by a pair of chains.

"With the exception of putting in heavier pressure plate springs and re-lining it we haven't had to do anything with the clutch," explains Dennis. "The bellhousing also has the facility for a starter motor, so all in all it was a very lucky combination."

One of the more surreal moments of our visit is watching him hop up onto the rather lofty driving seat and casually thumb the button for the electric starter motor, just as you would on a modern car. This is a machine, don't forget, that can trace its origins back to an era of horse-drawn carts.

CURTISS ENGINE

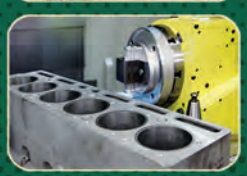
Curtiss produced the OX5 in large numbers around the time of the First World War, many of them finding their ▶


Chris Pickering

BELOW Hollow pullrods are used for the inlet valves with the pushrods for the exhaust valves running concentrically up their centres. You can also make out the stainless steel shrouds used to cover up the dented cylinders

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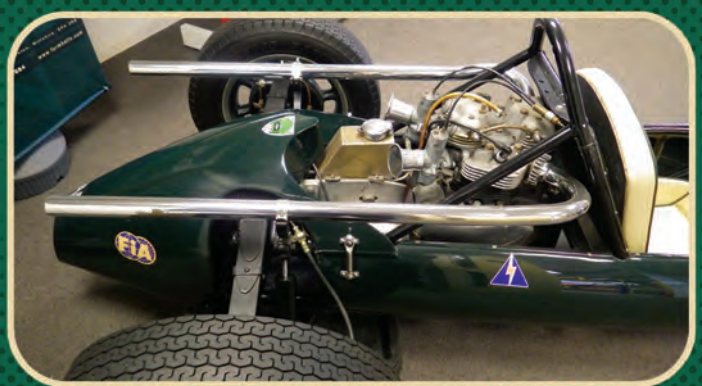
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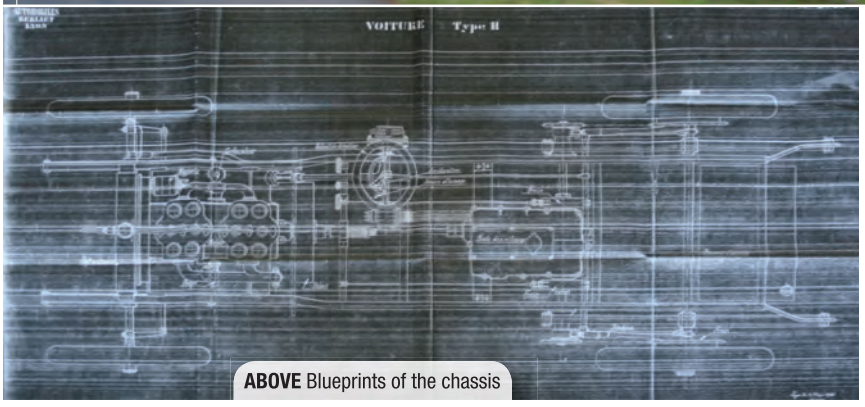
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Gavin Johnson

BELOW The buffeting of the exposed seating position, allied to the long braking distances, hasn't tempted Dennis to explore the limits of the car's theoretical 100 mph top speed



ABOVE Blueprints of the chassis

way into the Curtiss Jenny trainer. It's thought that this particular example started life in 1916, but little is known about its identity beyond that. The only clues are a series of substantial dents in the cylinders' water jackets (now hidden by stainless steel shrouds) which point to it having been involved in a crash at some time. It's tempting to imagine one of those pioneering aviators getting things a bit wrong on landing and facing a difficult conversation with their instructor afterwards!

Dents aside, the engine arrived assembled and remarkably complete. After a thorough strip down and inspection most of the existing components were re-used, including the 98-year-old pistons and connecting rods.

One of the more curious aspects of the OX5 engine is its valve gear. "It's the one thing that seems to fascinate anyone with any technical knowledge; you see people staring at it for ages," says Dennis. "Only one person has ever come up to me and said, 'I know how that works'. He was over 100 years-old and he'd worked on them in-period."

Viewed in isolation, the exhaust valve arrangement seems fairly typical of a pushrod-operated V8. It even appears quite modern in some respects, with a single camshaft located in the middle of the vee and pushrod-activated rockers controlling the overhead valves. But it all gets a bit bizarre on the intake side. Here, the lobes on the camshaft are concave with spring-loaded *pullrods* acting on half-length rockers. These share their mounting points with the exhaust rockers, but instead of the usual seesaw motion they simply pivot at one end, pulling the inlet valve down when the rod retracts. What makes things particularly confusing at first glance is that the pullrods are actually hollow tubes, with the pushrods for the exhaust valves running concentrically up their centres!

This unorthodox system isn't without its drawbacks, Dennis explains: "It works pretty well in general, but the rockers are all-aluminium and they have a tendency to fracture. We had to replace some of those, but fortunately there's quite a following for the Curtiss engine, so we were able to club together and get a small batch produced."

The rockers were originally cast, but the new ones are machined from solid and they're now significantly stronger. In-period they would have been hand-lubricated before the engine was run and they would have relied on drip feeding. Eager to avoid a face-full of castor oil, however, Dennis has drilled holes in the rocker shafts, so they can be packed with grease.

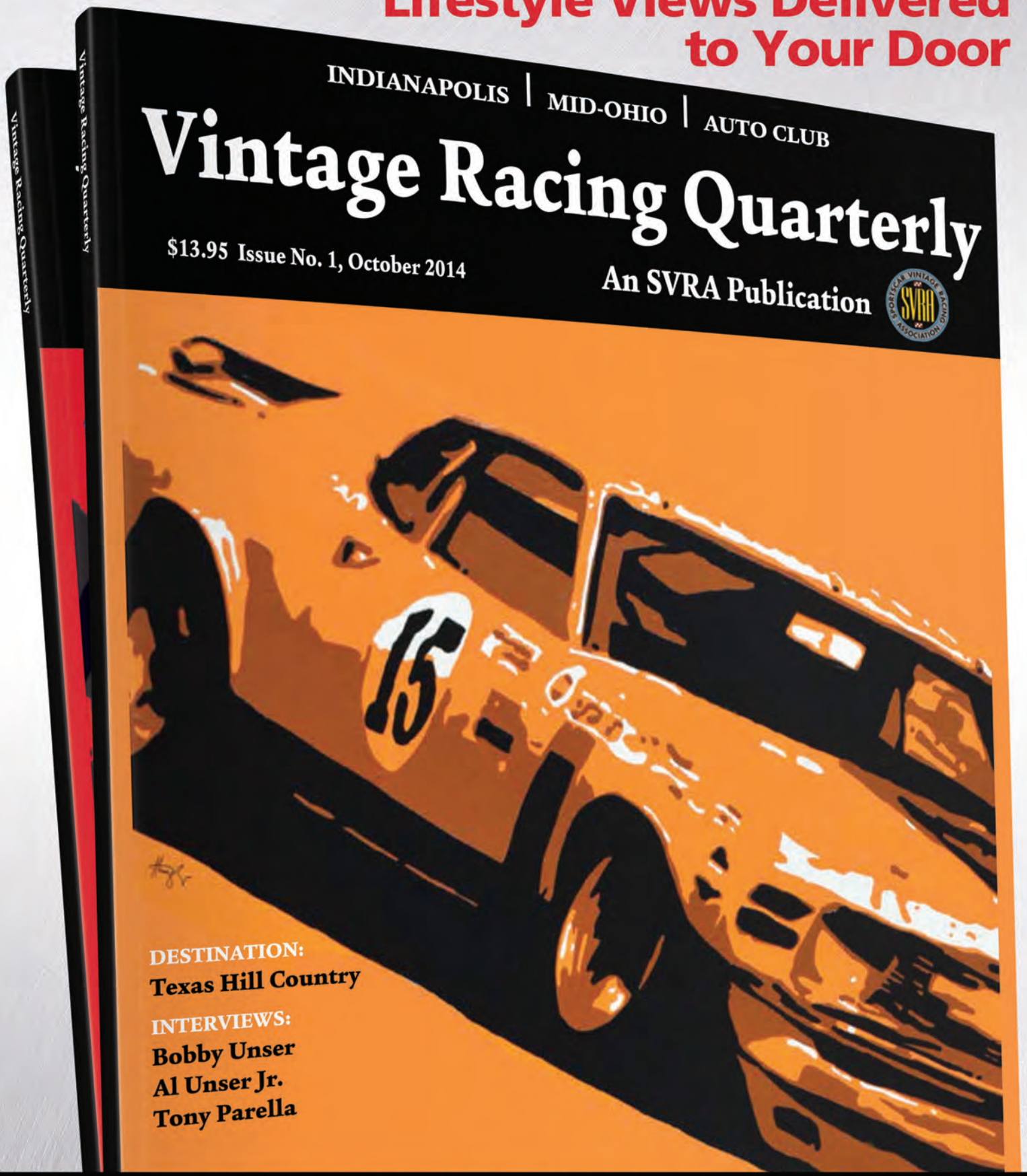
Just about the only parts missing from the engine were the carburettor and the magneto. A fellow Curtiss enthusiast was able to source the appropriate twin-choke Zenith carburettor, while the notoriously unreliable Berling magneto was substituted for a BTH unit with a step- ▶



Chris Pickering

BELOW The OX5 will rev to comfortably more than 2,000 rpm without the propeller

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down gear drive. As it happens, this also turned out to be problematic, so it was replaced with the distributor from a Ford Pilot V8, running through a right-angle drive. Initially intended as a temporary measure, this proved so successful that it has remained in place to this day, along with a modern ignition coil.

There are a few other concessions to modernity – relatively speaking – on the car. The fuel pump is an electrically-driven item, coupled to a fuel pressure regulator that can be manually adjusted for sustained high loads. "If you're belting round somewhere like Goodwood you can step the pressure up," Dennis explains. "To start with we found it was getting a bit starved of fuel, but we can now take it up to about 4 psi, which seems to relieve the problem."

Deprived of its giant propeller, the engine now uses a Kenlowe thermostatically-controlled fan to draw air through the radiator. "Ticking away in the paddock on a hot day the engine will boil over without the fan," he says. "It's not strictly original, but it keeps the engine working."

Currently the exhaust stubs empty into a pair of silencers. These have to be fitted for certain events (the car still bears a 105 dB scrutineer's sticker from Goodwood, for example) but it only takes four clips to remove them. "One of the nice things about running on open pipes is that you can feel the exhaust pulses from each individual stub," says Dennis. "If you think one of the cylinders is misfiring, you just put your hand over the end. If you don't burn yourself, you know that's the one giving problems!"

THE BODY BEAUTIFUL

Even underneath the grey autumnal skies, the Berliet's hand-built aluminium body gleams. The elegant beetle-backed tail was expertly formed by Dave Bicknell of Gartrac Motorsport, while the perilously exposed leather-lined bucket seats come from local trimmer Dave Strange.

The whole package is fantastically evocative of the heroic age of motor racing. You can almost picture the driver and ride-on mechanic hunched over the controls; their fur coats bellowing in the wind. Strictly speaking, however, it's a product of the 21st century. When it comes to the body, only the varnished wooden bulkhead remains from the car's original incarnation.

The Curtiss engine's 90-degree vee produces a very low bonnet line for an Edwardian racer – most of which contained great monolithic inline-fours, sitting bolt upright in the chassis. This results in quite a distinctive silhouette, more svelte than you might expect from an aero-engined leviathan.

The body started off as a series of sketches, based loosely on images of original Berliet competition cars, Dennis recalls: "It was quite functional to start with. I wasn't entirely happy with the shape of it, so I modified it once and then came back and modified it again. The rear end that's on the car now is the third attempt."

Warren Hanratty



ABOVE The elegant tail belies the number of sketches discarded along the way

Berliets of that period tended to have a large radiator mounted above the chassis rails. This results in quite a high bonnet line, which would have looked somewhat ungainly – particularly given the compact stature of the 90-degree V8 that now lies beneath. Instead, Dennis had a narrower replacement made by Jess Dilley of CPA Services, which now sits between the chassis rails. The result is a suitably rakish profile that suits the performance.

Officially, the OX5 is rated at 90 bhp at 1,400 rpm. Without the propeller it will rev to comfortably more than 2,000 rpm, but the limiting factor becomes the springs' ability to retract the inlet pullrods, explains Dennis. Even so, it should be good for around 100 bhp in the current installation, which is more than enough to pull the car's 1,180 kg mass with aplomb.

One of the benefits of running an external chain drive is that the final drive ratio can be changed in minutes. The larger of the two sprocket sets that Dennis uses gives the car a theoretical top speed of around 100 mph. "Quite frankly, I've never done it," he admits. "You're sitting in an armchair being buffeted like crazy and you've only got two wheel brakes with tyres that are rated for about 75 mph. I've only ever done about 80 mph, but you can feel that it has more to give.

"It's not as quick as some of the Hispano-engined cars or the very big aero-engined specials, but it tends to midfield in the Edwardian category at the sprints and hillclimbs. You can spin the wheels going off the line at Prescott, whereas most cars on the Brighton run would struggle to do 20 mph."

A decade after the bits first arrived at their new Surrey home, the Berliet Curtiss Special is going from strength to strength. What started out as a retirement project is now a well established fixture on the UK vintage scene. As Dennis concludes, "It's far more exciting than hitting a white pellet round a golf course". HRT

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Coventry Climax



FIRE POWER

From its famously unorthodox origins, the Coventry Climax range went on to power a whole generation of racing cars. **John Simister** talks to some of the engine builders working with these miniature powerhouses

Chris Teagles

COVENTRY Climax. If you're a certain age, you'll remember how 'Climax' suffixed the marque name of a great many British racing cars of the 1950s and 1960s. Most British Formula 1 cars of the 2.5-litre era's later years, and through all of the 1.5-litre era, were Climax-powered if they weren't BRMs or Vanwalls, and so were many sports cars. For a company which, post-war, made only one road-car engine for a very low-volume road car (the Lotus Elite), it had an enormous presence in a car enthusiast's mind.

In the end, a Climax design did take to the roads in big numbers, but that's a story we'll allude to separately. Today, Climax engines are still raced with vigour, be it versions of the archetypal, firepump-derived, single-cam 'four', the twin-cam FPF or the Formula 1 V8, and there's plenty of support for all of them. That big-numbers road derivative is also raced hard and often; racing Hillman Imps and Ginetta G15s still produce remarkable power for their capacity, and routinely rev to 10,000 rpm.

Yes, the firepump. It's central to Coventry Climax lore, 'the firepump that wins races'. The FW (for 'featherweight') series began as a lighter, better pump engine in 1951, and a marinised version caught the eyes of Colin Chapman, John Cooper and others who saw racing potential. That had not been the role that co-designer Walter Hassan had intended, despite his rich motorsport credentials, but he and design partner Harry Mundy were readily persuaded, encouraged by Climax boss Leonard Lee.

As a firepump, able regularly to go straight to 3,500 rpm from a cold start without disaster, the FW produced 38 bhp from its 1,022 cc. An overbore to 1,098 cc suited the FWA (for 'automotive') version for 1,100 cc-class racing, and with better breathing, twin SU carburettors and a forged steel crankshaft it happily yielded 72 bhp at 6,100 rpm. Before long this was up to 96 bhp, after which the enlarged, 1,460 cc FWB took it to 100 bhp and beyond.

That Lotus Elite version was the FWE, with 1,216 cc and a subsidiary career in Jack Brabham's road conversions of Triumph Heralds and Austin-Healey Sprites. All told, 1,988 automotive FWs were made until 1963's end of production, 1,355 of which were FWEs. Later firepump engines, designated FWP, continue to be valuable spares sources.

LIGHT FANTASTIC

What, then, makes the Climax FW so good in a racing car? It's light, thanks to its aluminium cylinder block and head. Its valvetrain has a low inertia, thanks to its overhead camshaft and bucket tappets, which have the subsidiary advantage of imposing no side loadings on the valves and guides. It has a short stroke and a large valve area within its wedge-shaped combustion chambers. It's simple, and it's strong with a crankcase extending well below the crankshaft's axis.

The block has a closed top deck with stepped openings to locate the top lips of the separate, push-in, iron liners. It's all very neat and straightforward, and revolutionary for the time in being Britain's first production all-aluminium, ▶

overhead-camshaft, four-cylinder engine. And it looked lovely.

Naturally, the racing car makers soon wanted a bigger and better Climax engine, something with which they could tackle Formula 1. Coventry Climax had already attempted a 2.5-litre Formula 1 engine in the form of the one-off, and ill-fated, FPE V8, but it also had a new four-cylinder FPF engine on the stocks, with a 1.5-litre capacity, twin overhead camshafts and a five-bearing crankshaft. It was a design ultimately stretchable to as much as 2.7 litres, via increments at 2.0, 2.2 and 2.5 litres. Initially designed by Harry Mundy using one of the FPE's cylinder heads, the FPF began its career in 1956.

It proved very successful in the 2.5-litre formula in redesigned and stretched form, and even made a resurgence at the start of 1966's 3-litre formula in that final 2.7-litre size. Dan Gurney's beautiful Eagle, for example, began with this engine before gaining its intended Weslake V12. The maximum stretch of bore and stroke possible with the original block casting gave 2,207 cc, so the next 2.5-litre stage – with which Cooper won the 1959 and 1960 Formula 1 world championships – called for a new block with cross-bolted main bearings. Initial power was 220 bhp, rising to 240 bhp by the end of the formula.

With its longer stroke, the 2.7-litre FPF initially used a spacer between block and head, but later examples have a taller block. The 2.7 was initially intended for Indianapolis but had a second life, as mentioned, from 1966 reaching a peak of 252 bhp. The 1.5-litre version, too, saw top-level reincarnation (in two different bore/stroke ratios) in Formula 1 from 1961, because the FWMV V8 wasn't ready at the formula's start.


Stuart George

ABOVE The Coventry Climax FWMV powered numerous Formula 1 cars in the early '60s


Andy Swift

ABOVE The Lotus Elite uses the 1,216 cc Coventry Climax FWE



ABOVE The Lola Mk1 uses a 1,100 cc FWA engine

BURNING BRIGHT

The Coventry Climax company is long gone as a manufacturing entity. It was bought by Jaguar in 1963, bringing Hassan and Mundy back into the company in which they had worked on the XK engine (bucket tappets and shims there, too), and racing engine production was over by 1966. During and after the Leyland years, from 1968, the Climax company gradually fragmented with the firepump business hived off as Godiva Fire Pumps (Lady Godiva had always been the Climax motif), the forklift business ending up with Lansing Bagnall and the engine side going to Horstmann Defence Systems before disappearing.

However, there are plenty of FWs, FPFs and FWMVs racing today and there's a rich pool of expertise to keep them fit. The company line of descent leads us to Climax Engine Services run by Tony Mantle in Broadway, Worcestershire. "We inherited all the tooling, drawings and sales records from Jaguar during the late 1970s and early 1980s when they shed everything to do with competition Climax engines," he explains. The idea was to have some continuity and not upset customers too much. And along with all that came some of the historic engines. Including, fascinatingly, the last competition Climax engine: the never-raced 1.5-litre flat-16.

"The factory produced 274 FPFs, going by the serial numbers, and we've made another 30 using original patterns. We were using castings from the original supplier, Birmingham Aluminium, before they closed. There's not generally as much of a market for new FW-series engines, because they're highly similar to later firepumps which can provide major donor parts including the block and head, and there's always one on eBay! And you'd replace the innards anyway, using modern components such as forged pistons, connecting rods and bolts made of better steel, and better valves to cope with modern fuels.

"As for the FWMV, Coventry Climax made 30 and I look after three of them. We're not far away from making a new one."

Mike Brotherwood in Calne, Wiltshire specialises more in FW-series engines, ▶



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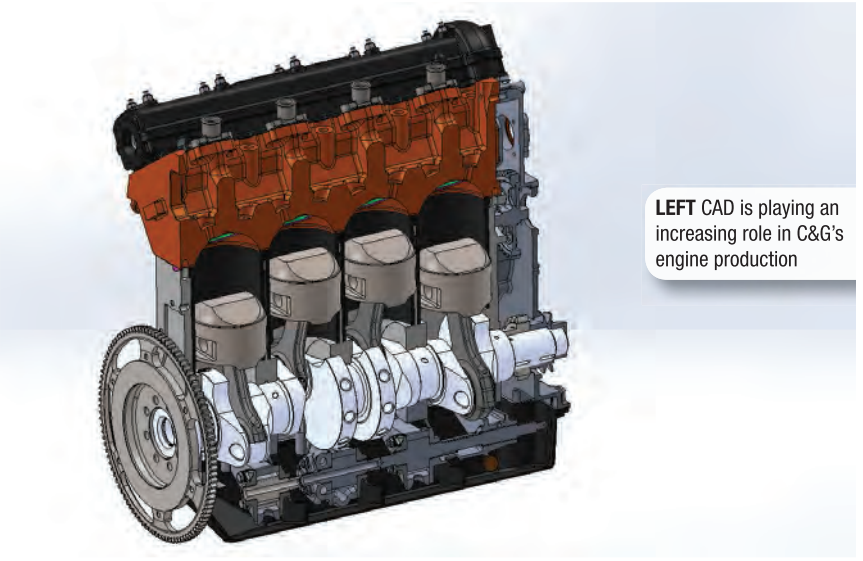
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LEFT CAD is playing an increasing role in C&G's engine production

supplying parts, rebuilding engines and offering various modern camshaft profiles for extra power or a broader torque curve. "If there's a weakness it's that the block flexes at high revs, so we use a thick aluminium sandwich plate dowelled to the bottom of the block," he says. "It has a three-bearing crankshaft so there's a lot of pressure on the centre main. We put in a deeper bearing cap and bolt this through the plate.

"We can use modern billet rods and crankshafts, lighter valves, springs and tappet buckets, alongside more lift and longer dwell in the camshafts. The head is fairly restrictive but there's scope for better gas flow. A 1460 produced not much more than 100 bhp in the day, but now it can get close to 140 bhp largely because you can rev it more."

There is one other big player in the Climax world, the versatile Crosthwaite & Gardner based in Buxted, Sussex. C&G (as it's known) has specialised in FPFs since the 1990s. "The engines were all wearing out and an American customer persuaded us to make him a new 2-litre," says Ollie Crosthwaite. "He had tooling for it so we bought it from him. The engine you see here is a 2.5-litre for a Cooper. Almost everything in it is slightly different from a 1.5 or a 2.0."

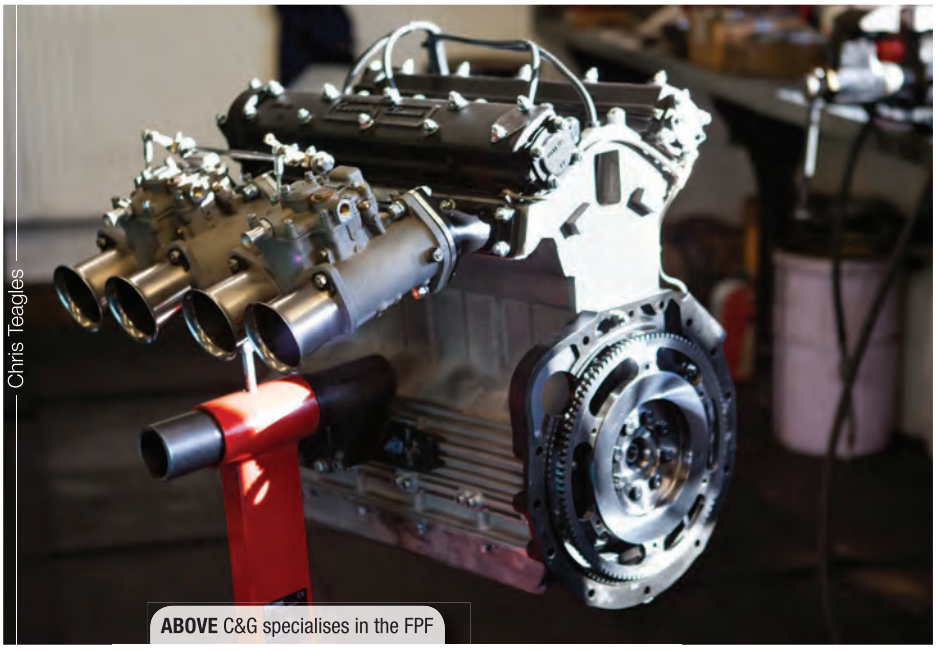
It's clear that the design brief for the FPF was very different from the FW's. A low-maintenance firepump engine probably wouldn't have straight-cut-gear-driven camshafts with five gears involved and careful setting-up required to maintain the correct distances between their centres. If the head is skimmed, then the cylinder liners must be replaced with taller ones to make up the difference. The FPF has dry-sump lubrication with a pressure pump flanked by two scavenge pumps. The cam carriers are of magnesium, with – originally – iron liners for the tappet bores. Nowadays the liners are aluminium, with steel tappets.

"The engine is a bit too hefty," says Crosthwaite, "so a 1.5-litre one weighs much more than an FWB but produces only an extra 10 or 15 bhp. That said, the block was too thin around the main bearings and the studs could pull out, so the bigger blocks had steel bearing caps and transverse cross-bolts. Also, the original crankshaft design was not good and we were getting breakages. So we bolt heavy tungsten-based Mallory metal to the counterweights to improve the balance – we can't just make a crankshaft with bigger counterweights because there's no room in the block."

Other modifications? After all, if these are brand new engines built from scratch, there must be plenty of scope even while staying within the rules. "The liners were originally sealed to the head with Cooper rings but we use more reliable C-section rings made from Inconel, a nickel-chromium alloy. We used to machine new crankshafts and connecting rods but they are now done by Arrow, and we use standard off-the-shelf bearing shells which are slightly thicker for the same crankshaft dimensions.

"The rear crankshaft seal originally used a design like a piston ring but we now use a normal flange and oil seal. And we use our own experience in porting the heads. We make the engines six at a time – they can take a few years to sell – and these are the last porting jobs we've done by hand. We'll move to CNC for the next batch; the higher quality is worth the cost. We don't just scan a hand-done port and reproduce it in CNC. We draw it on the computer so we can optimise it before the CNC operation."

Crosthwaite & Gardner has, however, been making these engines too long for CNC to have played a part in the basic sand castings, as the boxes of wooden patterns reveal. "We had a pattern-maker who made these," comments Crosthwaite. "Nowadays they would be ▶



Chris Teagles

ABOVE C&G specialises in the FPF

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ABOVE C&G still uses wooden patterns for sand castings

CNC-machined from resin, but this was a bloke with a hammer and chisel. You can tell the difference. The eye picks it up."

To buy a brand new FPF outright costs around £45,000, for which you get everything including the appropriate Weber DCOE carburettors. Not the 2.5-litre's period-correct 58DCOs, though; these, the largest in the DCO series and extremely rare, are a heady £10,000 a pair. As for specification, there are various options beyond the obvious choice of engine capacity.

"The original camshaft profile is very good," reckons Crosthwaite, "but we are about to develop some more. On the original camshafts this 2.5-litre engine has 245 bhp at 7,000 rpm and plenty of torque, but it's a very good one with lighter reciprocating parts and, we think, a better port shape. We've done two engines to this spec. Normally they make around 230 bhp.'

THE ROOTES CONNECTION

That's the expensive end of the Climax racing world. But in parallel with this is the legacy of the FW-series' baby brother, the FWM. This engine, with a simple chain drive to the camshaft instead of a two-stage gear-and-chain with a jackshaft, was originally conceived as a 653 cc outboard motor (hence M for 'Marine'). It grew to 742 cc, suitable for racing (as the FWMA) in the 750 cc class but also used for industrial pressure washers, and in 1959 Climax made an 875 cc version producing 44 bhp for a firepump and 76 bhp for racing.

The Rootes Group, meanwhile, was developing its Apex project which became the Hillman Imp, and development engineer (and racing driver) Mike Parkes thought the FWMA could form an excellent basis for its engine.

Rootes engineers, including Leo Kuzmicki (late of Vanwall), redesigned the FWMA for mass production with die-casting for the head and the now open-deck block, in which dry cylinder liners had the aluminium block cast around them. Amazingly, Climax made no charge to Rootes for the design, but Leonard Lee did get a free Imp.

In production 875 cc form the Imp engine made 39 bhp, or 51 bhp in lightly-tuned Sport form. But the Rootes competition department and others quickly improved on that, most obviously by enlarging the bores to give 998 cc. This involved machining the dry liners and their aluminium surroundings away completely, and inserting larger wet liners bonded to the block under pressure at their bases. The liners sat slightly proud of the block, to increase the clamping force on the head gasket, and for higher-output engines the gasket was replaced by Wills rings located in grooves machined in the head.

With the right camshaft, carburation (or injection), valve sizes and exhaust system, the engine made a reliable 113 bhp at 9,600 rpm when it helped Bill McGovern win the early-1970s BTCC three years in succession in George Bevan's Imp. That followed fair success in the 1960s, notably by the Fraser Imps which latterly used a 'deep' head with less of a bend in the ports. This was based on a Climax design commissioned by Rootes, mounted on 1-litre Imp block with an alternative design of dry liner. Coventry Climax designated the engine FWH – for 'Hillman', perhaps – and built four of them. 'Deep' heads are ultra-rare and much prized today.

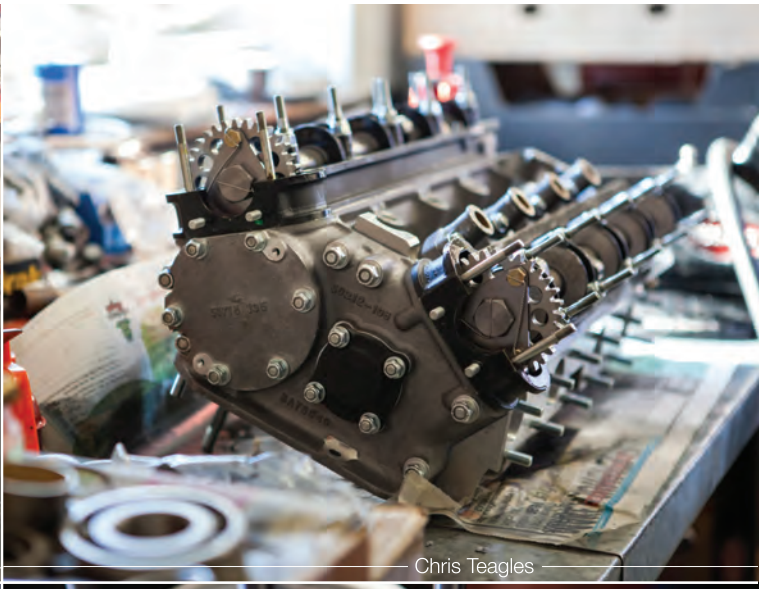
The engine specification which served the Bevan Imps so well is little changed for most of today's racing Imps. One notable departure is that developed by Andy Jones of Shrigley Engineering, who uses a thick spacer between the camshaft carrier and the cylinder head to allow valve guides lengthened by a quarter of an inch (and longer valves to suit). This has two benefits: pooling oil is less likely to find its way down the valve guides in an engine inclined at 45

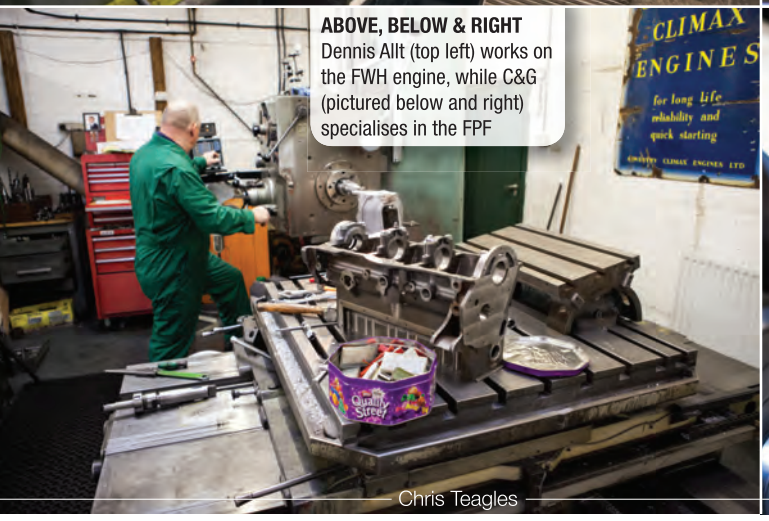
BELOW The Coventry Climax race engine was reprised in the form of the various competition Imps



Andy Swift

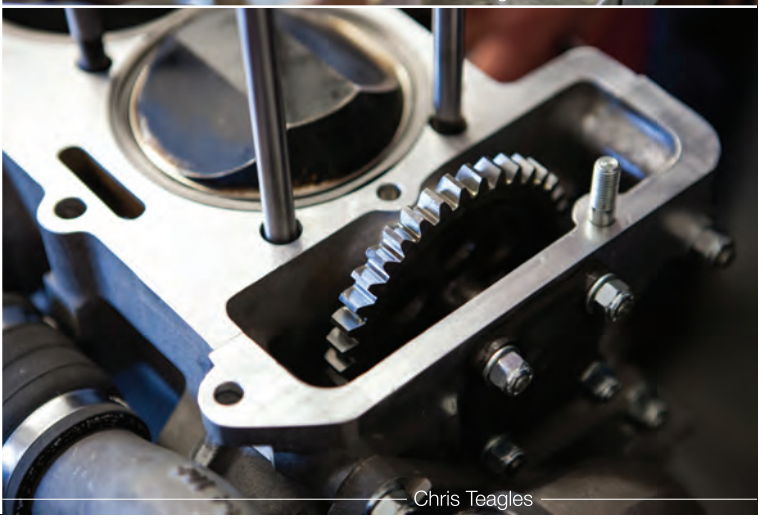

John Simister


Chris Teagles



Chris Teagles

ABOVE, BELOW & RIGHT
Dennis Allt (top left) works on the FWH engine, while C&G (pictured below and right) specialises in the FPF


Chris Teagles

degrees and it's possible to use a higher lift camshaft without the valve springs becoming coil-bound.

It's a neat idea, but Dennis Allt based near Hemel Hemptead, who has built very fast Imp engines since the days when he was famous Imp engine builder Ian Carter's right-hand man, is not so keen – and out on the track, cars with his engines do seem evenly matched with the Shrigley-powered ones. "I've just kept to the tried and trusted things," he says, although he has developed a new high-lift, high-torque camshaft for road rallying: "There are four of them out there now."

Allt keeps to the same ports and flared-out chamber design that Ian Carter developed, because they work well and the Carter/Allt engines have proved impressively reliable. They were often faster than the Bevan engines in period, too. "Ian did smoke tests on the chamber shape at a London college to work out the swirl patterns," Allt recalls, "and he came up with fluted inlet ports in which a peak runs up to the side of the valve guide."

One of the best Carter 998s made 117.5 bhp with a Greetham Engineering (now Chesman Engineering, but no longer involved with Imps) GE3 camshaft. This had a 'spread valve' head in which the valve guides are offset to allow bigger exhaust valves – and a special camshaft carrier to suit. Nowadays Allt keeps the extra-large exhaust valves but goes down on the inlet valve size, because the maximum 1.4 in gives little advantage over the 1.3125 in he uses. Other features of an ultimate Allt engine are billet steel connecting rods from Robson Engineering and pistons from Mark Maynard who has reproduced the original Hepolite design made until recently by FJ Engineering.

He is also experimenting with a new design of Kevlar head gasket from Australia. "It costs twice as much as a Wills rings set but you can re-use it up to five times," he reports.

A 998 cc Imp engine has a 72.5 mm bore and a 60.4 mm stroke from the standard forged steel crankshaft, but the biggest one Allt has built used a 76.2 mm bore and a 70 mm stroke (from a billet crankshaft) to give 1,304 cc. An 1,120 cc engine is fairly easily achieved, at a cost, and Ian Carter created a long-stroke 1,150 cc unit for a works Davrian which produced around 135 bhp. "It lapped Thruxton at over 100 mph," Allt recalls, "so the power must have been significant."

Allt's ultimate specification, were it allowed, would be a five-bearing block (as used by Fraser), a 'deep' head with the ultimate 1.5 in inlet and 1.25 in exhaust valves, and an 1,150 cc capacity. "That could win races outright," he muses.

The last Imp-based production engine was built in 1981, by then of 928 cc and mounted vertically in the front of a Talbot Sunbeam. And with that, the Climax car-engine story came to an end. In racing, though, its legacy is as strong as ever. HRT

Playing it safe

Chris Pickering takes a look at some of the products that are helping to make historic motorsport safer than ever before

BACK in the era from which most of the cars in this magazine originate, motor racing could be a somewhat grizzly affair. It's not that accidents were any more common than they are now – certainly not if you compare like with like – but rather that the consequences tended to be far more serious. To quote one famous racer from the fifties: "If you got it wrong, you knew it was going to hurt".

It wasn't until the 1960s that designers started paying real attention to crash protection (still somewhat begrudgingly compared to the pursuit of outright performance).

Early efforts at roll protection were often hopelessly inadequate. A quick glance at a Formula One car of the early '60s with the driver's head sitting a couple of inches above the roll cage makes you wonder why they even bothered. Fortunately, it wasn't long before the designs began to improve, and not a moment too soon as the advent of downforce and slick tyres saw the cars travelling ever quicker – sometimes on circuits that hadn't changed much since the 1930s.

Fire extinguishers became mandatory in Formula One in 1969, followed by aviation style 'bag tanks' in 1970. These no doubt helped to dispel the old assumption (by that point already a myth) that it was safer to be thrown from the scene of the accident, although amazingly, it wasn't until 1972 that seatbelts finally became compulsory in the series.

From there, the pace of development continued to accelerate. Vastly improved helmets and race suits, anti-intrusion panels, deformable crash structures and greatly improved harnesses. The list goes on.

The vast range of safety equipment now available to the historic racer would fill a magazine on its own, but in this issue we take a look at some of the latest developments from this critically important area of the industry.

FIRE FIGHTING

Fire was once the great terror of motor racing, but its now mercifully rare. All cars competing in races or hill climbs are required to carry some means of tackling fire, at least in the UK or under FIA regulations. In most cases this has to be a plumbed-in system, although some earlier cars are permitted to run a handheld extinguisher.

"Some of the people running older single seaters prefer the idea of a handheld, but that's not always a wise move," comments Jim Morris, managing director of Lifeline Fire and Safety, and a keen historic racer himself. "They tend to tuck them out the way, so it's not that easily accessible. A single seater isn't like a saloon car where you can just grab the extinguisher as you get out; normally you're sat on top of it, so you physically have to go back to the car to get the extinguisher."

Modern fire suppression systems are now an accepted sight in historic cars, but Lifeline is nonetheless



BELOW Modern fire suppression systems provide greatly improved protection



ABOVE Zero 360 fire suppression system installed in Lifeline MD Jim Morris's Gipsy sports racing car

working on ways to integrate them more subtly. The company has recently produced an MSA-approved system with modern working parts designed to resemble a Heismann design from the early 1970s, as fitted to the original magnesium-bodied Porsche 911 RSRs. This was originally a one-off project for a customer, but around 50 units have since been produced.

Lifeline's Zero 360 range uses clean Halon-free gaseous agents. Unlike earlier 'wet' foam systems, which work by cooling and smoothering the flame on contact, these rely on a chemical reaction that deprives the fire of its oxygen supply. As a result the gaseous systems don't require direct 'line of sight' to the flame, instead they will expand out to fill the whole volume of the car.

> **"Remote-charge extinguishers can be smaller and more discrete"**

In some instances, a separate CO2 cartridge is used to activate the system. Without this, an extra 25 to 30 per cent volume has to be reserved for the propellant, so the remote-charge systems can be smaller and more discrete. The downside, predictably, is increased cost compared to a conventional 'stored pressure' system.

"Some of the historic single seaters that were never designed for a fire suppression system can be very space-critical," Morris notes. "In those cases a remote-charge system can be very useful."

As with everything else, the regulations can vary. Morris says that most of the systems they supply to historic customers are fully-FIA compliant: "A lot of historic competitors ▶



Jeff Bloxham

BELOW A lucky escape! Tim Davies actually managed to avoid the wall here, but others aren't so lucky

go abroad to compete. Not many follow complete championships, they tend to pick and choose events, so it's easiest to make sure all your kit is up to FIA standard [even if most of the events you do are only national]."

The big news for 2015 is that Lifeline now plans to introduce an off-the-shelf 'retro' range. Details have yet to be confirmed, but it will combine state of the art technology with a discrete, traditional appearance.



ABOVE ATL can make fuel tanks to fit any application

BUILT LIKE A TANK

For many years racing fuel tanks were simply aluminium containers. Generally, if one of these was fitted in-period it can be retained, albeit with foam inside and the appropriate non-return valves. The use of separate bladders is heavily encouraged, however, and there are rumours that this could become mandatory in the not-too distant future.

Foam blocks are used inside virtually all racing tanks. These act as a baffle to prevent the fuel sloshing around under high G-loading, but more importantly they reduce the risk of explosions. Liquid fuel is, in fact, surprisingly inert without a sufficient amount of oxygen, and the foam breaks up the volume that would otherwise be occupied by air as the fuel level goes down. This dramatically cuts the chances of a potentially-explosive vapour forming. In total, it can occupy up to 80 per cent of the tank, with the fuel free to permeate through it like a sponge, while clever design ensures it doesn't compromise filling or internal flow within the tank.

"You can't just throw foam into a tank," points out James Gornall, sales manager for ATL. "If it's not in there properly it can damage components inside the tank (where used) such as pumps and hoses." Meanwhile, the non-return valves (dubbed 'flappers') prevent fuel from running out of the filler neck or any breather vents if the car turns over.

In many cases it's possible to insert a modern bag tank into the original shell or an exact replica. This is done by simply cutting a hole in the old tank, pushing the new bladder in and then re-sealing it. The only thing is that most regulations state that the container must remain air-tight.

> **"Foam-filled tanks dramatically reduce the chance of explosions"**

Of course, the other option is to create a whole new unit, complete with a new outer shell in aluminium or composite. This is something ATL has extensive experience of doing, with off-the-shelf designs for a range of classics, as well as a custom build service. Virtually any shape can be catered for, thanks to an in-house CAD capability, while the company can even supply cardboard mock ups for clearance checks.

"We can make tanks to really complicated shapes," comments Gornall. "Sometimes we will simplify them, which can work well. If you look at the Ford GT40, the original tank was a horrendous shape with all sorts of cut-outs, which isn't really practical these days. For a start, a complex shape makes the tank a lot more expensive. It also makes it harder to pull the fuel cell in and out of the casing, which raises the risk of damage."



ABOVE ATL built the fuel tank for this Ferrari 512S

The FIA essentially defines three different grades of fuel tanks. By far the most common category is FT3 (or FIA FT3-1999 to give its full name) which is used in everything from the British Touring Car Championship to FIA GT3. It's the only grade you're likely to see mandated in historic racing, with FT3.5 used for contemporary LMP cars and FT5 typically only seen on top-end modern single seaters such as Formula One.

Cost-aside, there's nothing to stop people fitting FT3.5 or FT5 tanks, unless the organisers specifically forbid it. That said, it's not unknown for the higher grades to be outlawed on the grounds of cost control, with one racer we spoke to actually forbidden from upgrading the standard road car fuel ▶

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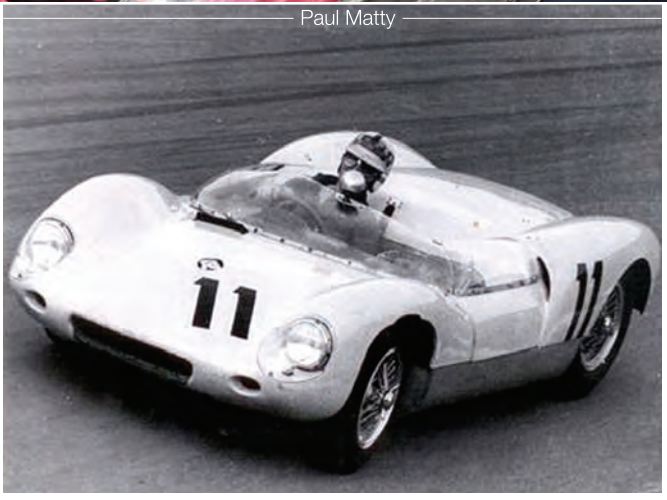
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Tolman Motorsport



Paul Matty

ABOVE & LEFT
Tolman Motorsport's Lotus 19 recreation comes with FIA-approved roll bar, fire extinguisher and battery cut off; in-period these cars had none of those

tank in the production-based series in which they compete.

The exact materials used for the bags is a closely guarded secret. ATL's FT3 tanks are usually made from a proprietary material known as 810-C, which comprises of a woven ballistic nylon core coated in a synthetic elastomer. This was chosen for its combination of high strength and light weight, but further weight reductions can be achieved with the company's Kevlar/Aramid-based 826-A material. This is also a more flexible material, which makes it easier to install through small apertures, and allows a greater fuel capacity for the same external volume.

Modern fuel tanks are stamped with a date of manufacture and they are certified for five years from that point onwards. It is possible to re-certify the tank for up to two years (not exceeding seven years in total) although beyond that the tank must be replaced if the series requires FIA certification. At the other end of the spectrum, some vintage racing cars have run the same basic metal tank for the best part of a century.

Another thing to consider is the fuel itself. For cars that run on pump blends the increasing use of ethanol has led to the development of new materials. "The fuel is different these days, so we've had to ensure that we move with the times too," says Gornall. "We homologate materials at a rate of about one a year. They've become a lot stronger over the years and they can deal with a wide range of fuels."

ROCK AND ROLL

Most historic race events now require the use of roll over protection systems. The requirements vary, from a simple hoop to a full cage, as do the manufacturing and material standards.

Cars that featured some sort of roll protection in-period are often free to retain the original setup. However, if the roll cage needs to be repaired or modified it can be tricky to source the correct materials.

"In Britain, in particular, grades like T50 are no longer available. Even tube manufacturers would struggle as the alloys often simply aren't made any more," explains Barry Tennant, managing director of Tennant Metall & Technologie. "We try to help people where possible. If they can send us a sample of the original material we can run a chemical analysis to try to determine what it was."

The analysis process involves flattening the tube and milling an area around a square centimetre to create a level surface. A seal is then established around the flattened section and the gap to the probe is flooded with inert argon to purge it of other gasses that could affect the reading. Finally, an optical scan is used to deduce the chemical constituents of the tube.

It's rare for customers – or governing bodies – to demand strict adherence to the original roll cage material, but it does provide a base point. Tennant also supplies vintage aircraft restorers and where the original material is no longer available this technique allows them to recommend a similar modern alloy with CAA approval.

Modern materials – where allowed – offer considerable advantages over those used in, say, the 1970s or '80s. It's entirely possible to achieve twice the strength with a modern steel, which means the thickness (and hence the weight) can potentially be halved for the same level of protection.

There are, of course, a few caveats. For a start, just because that level of protection was deemed appropriate in-period it doesn't mean it shouldn't be increased to take advantage of modern materials. And what's more, while the outright strength of the thinner material may be the same or greater it won't provide the same level of stiffness. The resulting deflection shouldn't be enough to compromise the cage's safety, but it does mean it won't bolster the chassis stiffness in the way that thicker tubing could do. ▶



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ABOVE Minispares uses Schroth harnesses in its historic rallying Mini

"All steels have more or less the same elasticity up to their yield point," Tennant points out. "To start with a thinner tube will flex more easily, irrespective of its outright strength. Of course, you don't care about that when you're about to have a big accident as long as it doesn't break or bend. And if the yield strength is higher then it's not going to deform. In theory, that means you could replace a 40 x 2 mm tube with a 40 x 1 mm tube and halve the weight of a substantial structure that sits high up in the car."

CLUNK CLICK EVERY TRIP

Fitting effective harnesses to an historic racecar can be deceptively tricky. Modern roll cages often provide mounting points where none existed in-period, but for older cars or those without a full cage it can be a real challenge.

"We've done a lot of work with older cars where it's just not possible to install a belt to FIA standard – the anchor points just don't allow an homologated belt for that type of vehicle," explains Tom Myers of Schroth Racing. "We've just built a harness for a 1957 Jaguar D-Type, which was custom made for that vehicle with the latest safety technology, even though it's not an FIA homologated belt."

Six-point harnesses are highly recommended for most forms of racing, but these can be virtually impossible to install in a lot of historics, Myers points out. Instead, the company has developed a four-point restraint with an anti-submarining technology that offers much the same benefits.

Submarining refers to the tendency for the driver's pelvis rotate down and forwards during an accident, allowing the lap belt to slide over the pelvic bones into the soft abdominal tissue. This can result in major leg, abdominal and spinal injuries and it's the principal reason that modern six-point harnesses come with crotch belts (sometimes known as anti-submarining straps).

Where a six-point harness isn't feasible, Schroth's answer is a rip-stitch system that's employed in one of the shoulder belts. During a frontal impact this essentially elongates that side of the harness, allowing the body to turn just enough to load the hips and the pelvis asymmetrically. The result is much like a three-point belt in a road car; with one shoulder allowed to move the lap belt tightens a fraction of a second quicker than it would symmetrically.

Ultimately, it comes down to what the scrutineers will accept at any given event. Matching the FIA requirements for strength is not a problem and harness manufacturers can provide a certificate confirming that that the material meets those criteria, but that doesn't necessarily mean it's fully homologated.

"I think something the historic community needs to think about is whether a manufacturer's certificate of conformity can be accepted rather than forcing drivers to use a homologated belt that's not right for the application," comments Myers.

Getting the angles right is another challenge. Shoulder belts, for example, should be flat against the driver's chest, but mounting points were very much an afterthought in a lot of older cars (assuming they were present at all) and this very often isn't the case. HRT



Andy Swift

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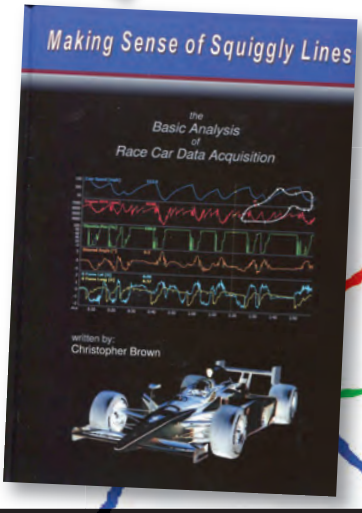
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ABOVE The group handles an astonishing variety of machinery

Back to the future

Chris Pickering thinks he knows what he's in for when he visits the UK's largest dedicated historic racing business. But he doesn't...

THE cottage industry is a recurring theme in historic motorsport. Ask someone to describe the archetypal classic car business and you'll probably get a very literal rendering of that concept: a converted barn out in the shires somewhere with dedicated artisans tinkering away. And of course this is more or less how a lot of the top specialists in the industry do operate. But not all of them.

Based in a series of starkly modern industrial units on the south coast of England, the Jim Stokes Workshop Group couldn't be more different. Clad in aluminium and smoked glass, these buildings house the four main constituents of the group: The Jim Stokes Workshop, which focuses on the restoration, race preparation and recreation of high-end exotics; manufacturing arm Triple M; body builders South Shore Coachworks; and a new addition, dedicated to more affordable marques, known as Classics by JSWL.

Together they handle an astonishing quantity and variety of machinery. Pre-war Alfa Romeos are something of a favourite – you practically end up tripping over them, such is their ubiquity here – but there are also Ferraris, Astons, Lancias and even the odd Allard in the workshop. And those are just the ones we can talk about. Many more are hidden from prying eyes, including the contents of two so-called 'quiet rooms' where projects bound by non-disclosure agreements are held under lock and key.

It's all deeply impressive stuff. The last facility I visited on this sort of scale was the Marussia Formula 1 team and the combined mass of JSW would dwarf most modern touring car or GT racing outfits.

Of course, it didn't start out that way. Stokes started out in historic racing as part of his apprenticeship more than 40 years ago. He worked for Marsh Plant Hire for over a decade, looking after Geoffrey Marsh's impressive collection of historic racing cars. When Marsh pulled out of racing in 1981, Stokes set up shop for himself, initially taking on odd jobs while working as a mechanic for a number of sports car racing teams.

"Alongside my own business I was working with Nimrod on the Aston Martins and Chris Crawford at ADA with the Gebhardts," he recalls. "I would get a phone call on a Monday asking if I wanted to do the 1,000 km race at Fuji. I'd fly to Japan for the weekend, do the race, then fly home and carry on doing the historics."

Stokes' first job after striking out alone was rebuilding one of the fiendishly complicated BRM V16s. "When you're presented with something like that you just have to roll your sleeves up and get on with it," he says. And that seems to have set the tone for the next four decades,

with a mixture of engineering skill and entrepreneurial ambition powering the company. The latter he attributes to his wife and business partner Hilary: "We never envisaged the company being the size it is now, that wasn't part of the game plan. Hilary is the real entrepreneur."

OLD MEETS NEW

Traditional techniques are still very much alive here. The group has no less than five people who are skilled in the use of the English wheel (three of which can be found in the body shop). Metal fabrication, fibreglass composites and even upholstery can be handled on-site.

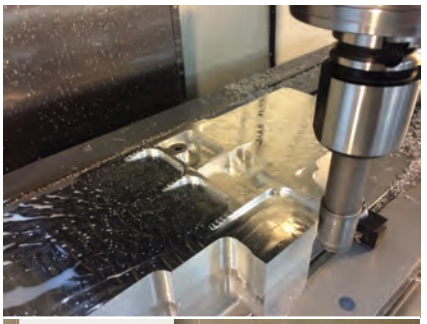
"We try to do things in-house as much as we can within economic bounds," says Stokes. Although various specialist jobs such as casting are outsourced to a small band of trusted suppliers, the vast majority of work takes place on-site. Perhaps the most extreme examples of this have been the Alfa Romeo 8C 2300 and Lancia D50 recreations produced by the company from the ground up: "We've built 8Cs where we've been involved in some way with the manufacture of every single component: engine, gearbox, axles, chassis... even the instruments."

Around 50 people now work here, making it the UK's largest dedicated historic racing business. Many of them have brought new skills that the company has been quick to embrace. As we speak, for example, a fibreglass shop is being set up by a new fabricator who turned out to have a distinguished history of working with the material.

Over the years, JSW has also sponsored a string of apprentices. Virtually all of them have either stayed or subsequently returned to the company, Stokes explains with something close to paternal pride.

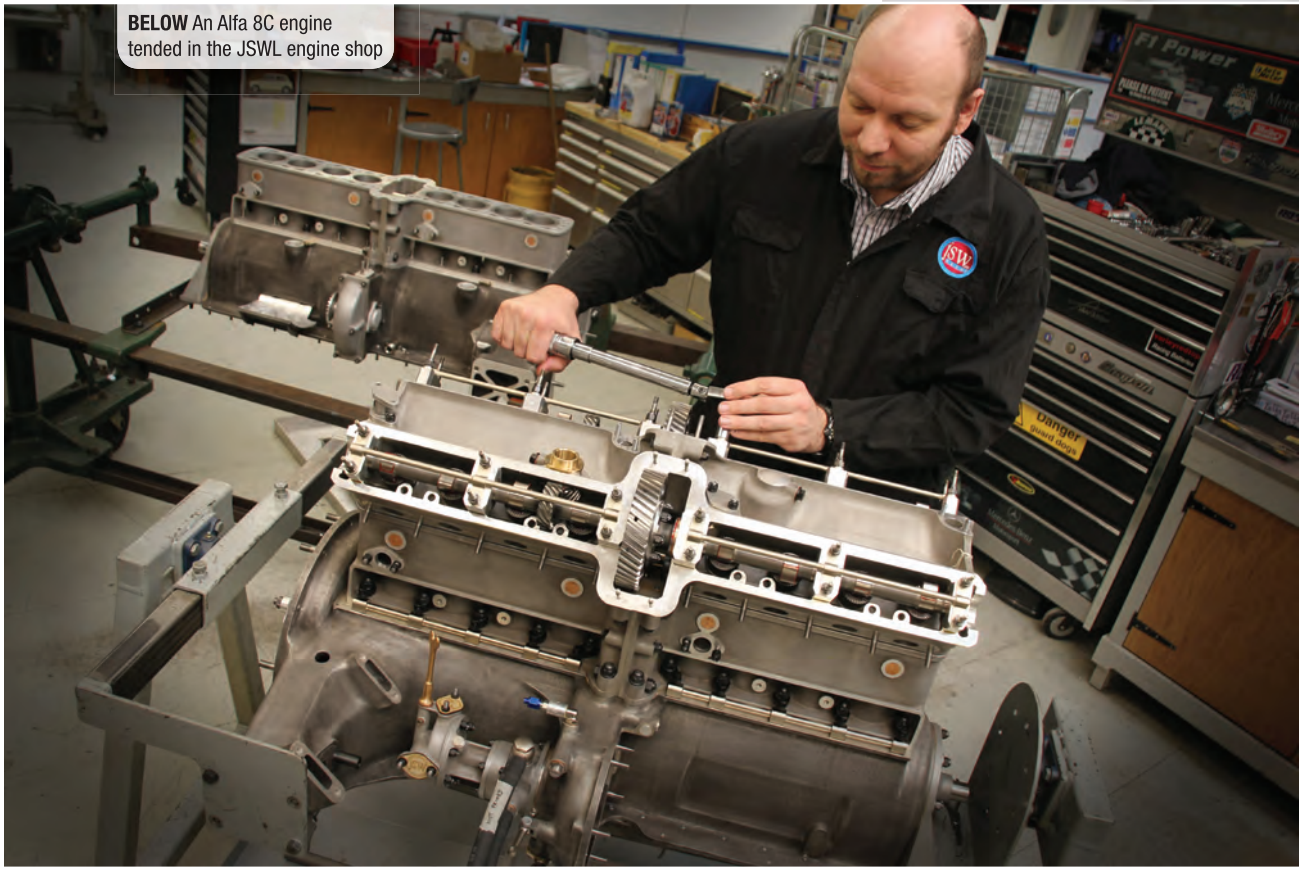
While the values may be traditional, much of the engineering is truly cutting edge. We start our visit in the machine shop, where a collection of HAAS four-axis CNC machines are busy carving out brand new cylinder heads for the AC straight six.

The largest of these is capable of machining components of up to 1.6 metres, which allows it to take on jobs like the metre-long crankcase of the Alfa 2300 and 2900 engines. That might not sound huge, but it's something of a shock the first time you see one complete and realise ▶





ABOVE From the early stages of a Bugatti gearbox casing (above), to the completed item (below)



BELOW An Alfa 8C engine tended in the JSWL engine shop



ABOVE A Bristol 405 being converted from saloon to a drophead

that they are – understandably – twice the length of a comparable inline four or V8.

Another neat trick is the digitising function on one of the machines. This is a physical measuring process, using a ruby-tipped probe, which 'feels' its way across the surface of the part to build up a digital map of the geometry. "This can be used to duplicate shapes," Stokes explains. "So, if for example you've had to weld one of the combustion chambers on a cylinder head, you can digitise one of its sister-chambers and then machine out an exact copy."

It's a deceptively simple technique that JSW has been employing for over 15 years. The part doesn't even have to leave the CNC machine between the digitisation process and the cutting. "The only thing you need to do is put discs in to cover the valve seats and the spark plug holes. It will just pick up the whole of that shape, export the data and then you just need to work out what cutter head size you're going to use."

The company also has an in-house optical scanning capability and a Microscribe measuring arm for other reverse engineering jobs. Upstairs the drawing office has a new seat of SolidWorks, while the Machine shop has two seats of SolidWorks and CamWorks along with Mastercam.

Back in the workshop, something catches my eye. Against the wall sits a bright silver block of aluminium, shortly to be turned into the gearbox casing for a Brescia Bugatti. This is part of a batch that originated as a one-off project, Stokes recalls: "The gearbox casing on the customer's car had basically broken up. It had been welded before and we considered doing so again, but by the time you heated it up there was so much oil coming out of the casting that it just wasn't viable to do so again. Even keeping it pre-heated the weld just cracked, so we spoke to the customer and took the decision to make a new one."

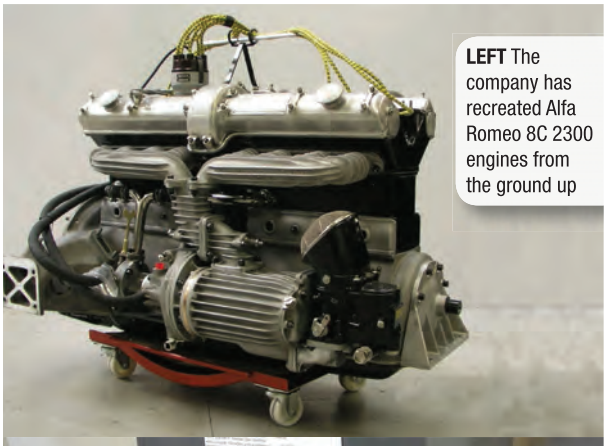
The finished structure is surprisingly intricate but it proved easy work for machine shop manager Tony Fairbairn, whose back catalogue includes machined structures for spacecraft amongst other things. Shot-blasted with 120 aluminium oxide prior to final machining, the outer surfaces now look like a period casting.

Laser welding is another 21st century technique frequently employed by JSW. It allows new material to be laid down on steel, aluminium and even magnesium parts where the original structure has been damaged. This technique enables you to get the weld into incredibly tight spots and, using steel, it's possible to go up to 66 Rockwell in hardness without putting too much heat into the structure, Stokes explains: "If you're repairing a first motion shaft on where the spigot bearing has run and damaged it, you can build it up with laser welding, grind it down again and you wouldn't even be able to tell that it had been repaired."

The company also uses cryogenic heat treatment. This works by cooling the metal down to the point where the molecular movement within it slows to such an extent that the material begins to fuse together.

"If you're welding aluminium cylinder heads or things like that, it usually destroys the original head treatment. The weld material is also very soft – it's like marzipan – so it doesn't machine well at all. If you put the same material through the cryogenics process it machines just like heat-treated LM25 TF and you can't tell where it joins."

The list goes on with rapid prototyping, hard-anodizing and DLC coating all called upon at various times. These, admittedly, require a degree of outsourcing, but it's JSW's willingness to move with the times and adopt new methods that mark it out. "We use a lot of the same techniques as the current Formula 1 teams do... just working on cars that are 80 years old," Stokes concludes. HRT



LEFT The company has recreated Alfa Romeo 8C 2300 engines from the ground up



ABOVE The company has 4-axis CNC capability. Here an AC cylinder head is worked on by Triple M

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Life through a lens



ABOVE Video loggers like the VBox Pro provide a powerfool tool for driver training

Video and data logging combine to make a powerful tool for driver tuition, professional coaches **Nigel Greensall** and **Rob Barff** share their experiences

THE 'Gentleman Driver'. It's a phrase often heard within the offices of Buckingham-based Racelogic, especially when a training day is taking place. Gentlemen they may be, but racing and winning is just as important to them as it is to a professional. Many racing drivers, of all abilities and in a vast array of cars have begun to realise the advantages of using video-based data logging. So have a number of instructors who now use it as a part of their coaching.

Nigel Greensall, professional racing driver and a previous columnist in these pages, certainly thinks so. "It doesn't matter what you're racing," he remarks, "the principles that get you on the podium remain the same. Video and data logging help you to understand and apply these much faster than you ever could before. In other words, even those who compete in classic motor racing can benefit hugely from the latest technology."

Greensall describes how he helped his driving partner during the Masters Gentleman Drivers GT race at Spa a couple of years ago. During qualifying in their Shelby Cobra, his co-driver was struggling with the Bus Stop chicane and consistently losing time. Checking the video and data quickly confirmed the problem.

"Lots of drivers turn into the Bus Stop at too high a speed," Greensall explains. "He was doing this and consequently tightened up the exit onto the start-finish straight. Using the video, we could see that he wasn't far enough over to the right to be able to accelerate quickly out of the next left hand corner. Once we'd worked this out and got him going through the first part of the chicane more slowly, his entry speed onto the straight was much greater. Overall, this change was worth a quarter of a second each lap, over a distance of only 250m.

"Often I find that those who compete in historic events are the most fiercely competitive. Never mind the fact that the car they're driving is a classic – they aren't there to make up the numbers. They want to win, and using current coaching methods gives them an edge. Old cars yes, but campaigned with modern thinking."

Nigel's thoughts are echoed by another successful coach, Rob Barff, who explains how he now gets his protégés up to speed much faster than he ever could before: "There are techniques that you can learn by yourself, but it will take years to do so; using the video and data massively shortcuts that process.

"Practice does make perfect with good coaching. But with the data interpretation we now get very detailed analysis on a lap by lap basis, whereas in days gone by when driver coaches were just sitting alongside the clients, they'd only get a general overview from the coach. Now they get that broad perspective, plus – over a cup of tea and in very much more a productive state of mind – they can analyse driving patterns, general areas of competence that can be left well alone, and areas of concern."

One of the most telling phrases here is 'areas of competence that can be left well alone'. Video and data presented through an easily interpreted software package not only aids the driver in addressing their problems, it also helps to dial out the 'false positives' of already-attained ability. Never before has an amateur driver had so much bench-marking so readily accessible. HRT



ABOVE Gentleman driver Hugh Colman in his Chevron B8

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Necks Generation Restraint

NECKSGEN has taken its head and neck restraint system a step further with the new NecksGen REV. Designed to improve comfort, helmet clearance and fitting, the new device has no need for a frontal yoke. This, says NecksGen, means there is no frontal interference with the helmet and hence no chance of the device causing any injury to the chest or collar bone.

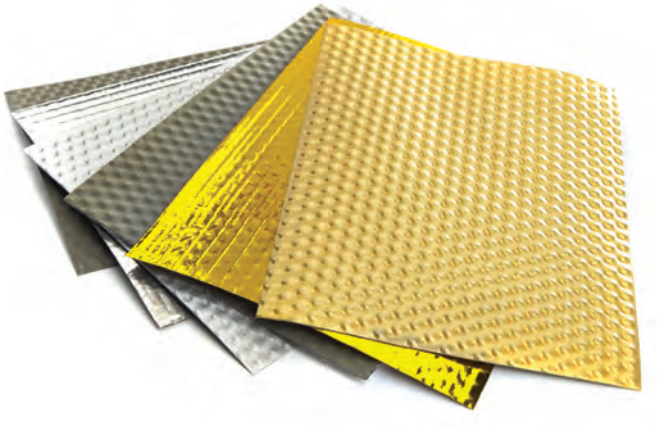
SFI-certified in the United States and exceeding the requirements for SFI 38.1, the backbone of the product is the company's the Tension Neutralizing Tether (TNT) system. This proprietary design is intended to increase the range of head motion while providing improved frontal and side impact protection.

Weighing in at just over a pound (0.45 kg) and featuring a low profile design, the new NecksGen REV is also said to give the driver greater ease of movement should they need to exit the car in a hurry.



New Heatshield Material

ZIRCOTEC'S new, rigid stainless steel heatshield material ZircoFlex Form is designed to combine the thermal properties of the company's ceramic coatings with the ability to form freestanding structures. Zircotec claims it offers higher levels of thermal protection than existing pressed aluminium and stainless steel products, while retaining their light weight and strength.



Autofarm Fuel Pump for MFi 911s

WITH the factory fuel pump for 1969 to 1975 Porsche 911s fitted with mechanical fuel injection currently unobtainable, independent specialist Autofarm now offers a cost effective and easy to fit alternative.

The Autofarm pump fits in the same location, without any modifications to fuel pipes or brackets. It also has the correct pressure and delivery rates for the MFi engine and a usefully reduced current draw of 3A over the factory unit.

Supplied complete with fixings and link lead if required (allowing the original wiring to stay intact and unmodified), Autofarm's fuel pump also costs substantially less than the Porsche item.



MillerCare Oil Analysis

MILLERCARE from Millers Oils brings the sort of diagnostic data normally reserved for big-budget teams to club racers and home enthusiasts.

It's based around a sampling kit, which allows small quantities of engine or transmission oil to be collected and sent back to the Millers Oils laboratory for analysis. A detailed report is then sent back, quantifying the presence of wear metals, additives and contaminants in the lubricant.

This gives invaluable information about the health of the engine or transmission. For example, an abnormally high silicone content would suggest that the air filter needs replacing, while an excess of iron could point to the deterioration of cylinder liners or piston rings. The analysis also tests the viscosity of the oil to ascertain if it has been exposed to excessive heat or contaminated by foreign materials, such as fuel or coolant.



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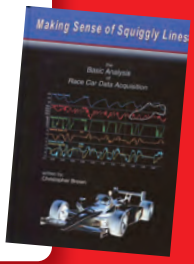
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The Basic Analysis of Race Car Data Acquistion
By Christopher Brown
144 pages
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As the author writes, this book has not been written to explain vehicle dynamics or give instructions on how to adjust a racecar, nor was it written to coach drivers. The goal is to help the reader make sense of the data that has already been collected on the racecar – and in that is fully succeeds.

RACE CAR AERODYNAMICS



2nd editionn By Joe Katz
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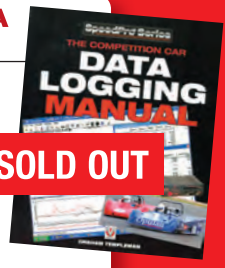
COMPETITION CAR AERODYNAMICS



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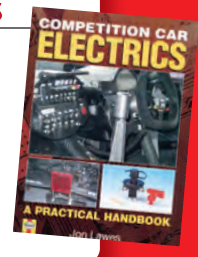
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Engineer to Win's tagline 'understanding race car dynamics' is perhaps a tad misleading as only part of the book focuses on vehicle handling and aerodynamics. In reality there's far more to it than that; it touches upon everything from metallurgy to budgeting. Highly recommended.

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Powerlite Dynalite Alternators

CLASSIC electrics specialist Powerlite has recently expanded its range of Dynalite alternators to include a high power 60A version of the popular Lucas C45-type Dynalite units. The RAC033 Dynalite alternator provides a 60A self-regulating alternator with the external appearance of an original Lucas C45-type dynamo. Weighing in at just 3.8KG, however, it provides a significant weight advantage over the original unit.

The RAC033 has been developed to meet the demand for a higher output compared to the standard 40A units. It is ideally suited to both road and competition vehicles where an original engine bay appearance is required. The significant increase in output over the dynamo is designed to cope with heavily uprated electronic systems, such as cooling fans, high power lighting and electric power steering systems.

Powerlite also offers a range of pulleys and fitting accessories for the Dynalite series to ensure that units are correctly installed. The range now includes alternator versions of all the popular classic Lucas dynamo units and an extensive collection of non-Lucas and European fitments.



New Handheld Scanners

CREAFORM has added two new models to its range of handheld 3D scanners with the Go!SCAN 20 and Go!SCAN 50. Claimed to offer 'the easiest 3D scanning experience on the market', the new scanners work on a point-and-shoot basis, with no specific preparation required.

The Go!SCAN 50 was designed to measure the shape of medium to larger parts and offers greater flexibility, while the Go!SCAN 20 delivers higher resolution (down to 0.2 mm) for capturing intricate details. Both scan straight to colour with self-positioning systems and fast turnaround times.



Varley Red Top



THE Varley Red Top battery range is a popular choice in historic racing. Using an Absorbed Glass Mat (AGM) construction, it promises a number of advantages over conventional 'wet' lead acid batteries.

Inside an AGM battery the electrolyte is absorbed within a matting material that separates the positive and negative plates that make up the cells. The lead plates themselves are formed to allow greater capacity for their size and to ensure a fast delivery of the power to the terminals. This leads to very small, light unit by lead acid standards.

Another benefit of the AGM construction is that the batteries can be installed upright or laid flat without risk of leaking acid. Furthermore, because the electrolyte is absorbed within the matting there is very little risk of acid leaking should the battery casing become cracked or punctured.

The arrival of lightweight lithium ion batteries - including the company's own Varley Lithium range - has created stiff competition for these lead acid units. It's worth bearing in mind, however, that lithium ion batteries are outlawed under the FIA's Appendix K regulations, with a number of other series organisers set to follow. As a result, it's likely that lead acid batteries will continue to dominate in historic racing for the foreseeable future.

Hillman Imp Dampers

NOT only was the Hillman Imp the last bastion of the Coventry Climax race engine, it is of course a popular competition car in its own right. Now, suspension specialist GAZ has produced a double adjustable coilover race damper specifically for Hillman Imps used in competition.

The body of the damper sports two multi-point adjustable control knobs; one for bump and one for rebound. Meanwhile, the dampers themselves are manufactured from high tensile alloy with induction hardened piston rods. They're filled with high viscosity index fluid to help prevent fade and they feature an internal gas cell to alleviate cavitation.

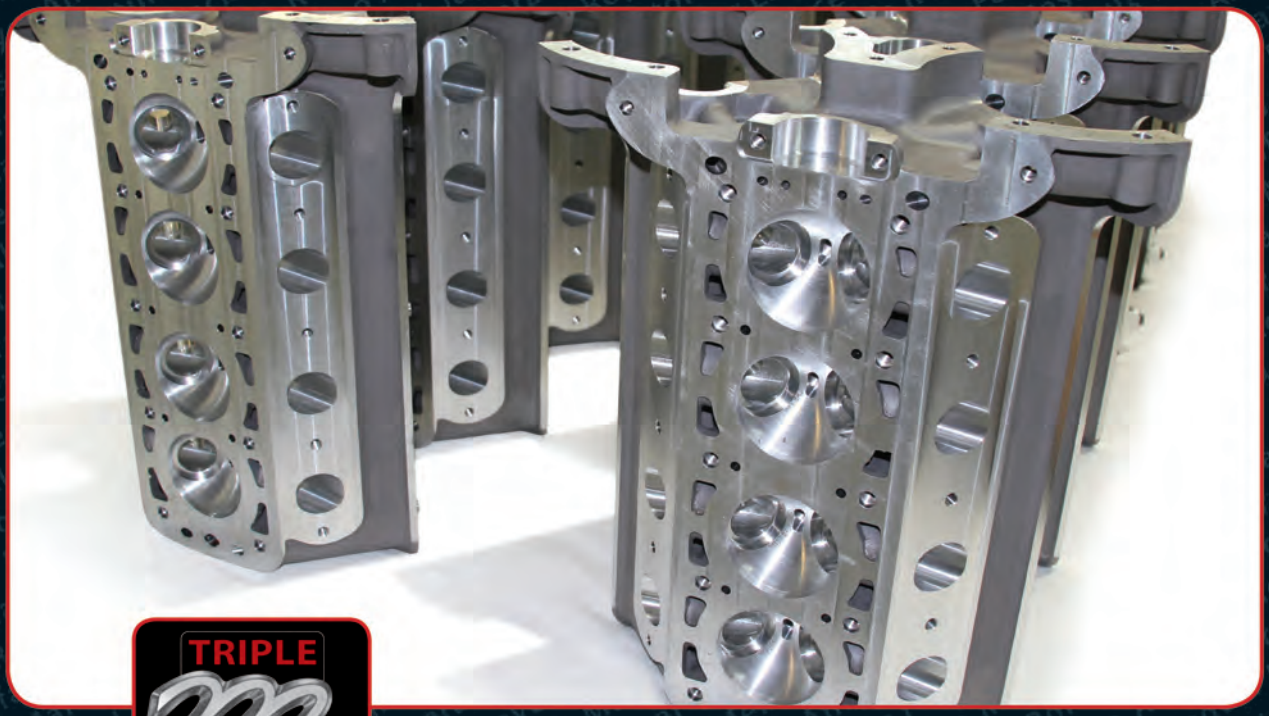
Self-lubricating spherical bearings and progressive bump stops are available as options and the dampers come in a range of body diameters, strokes and lengths. Springs can also be supplied upon request.



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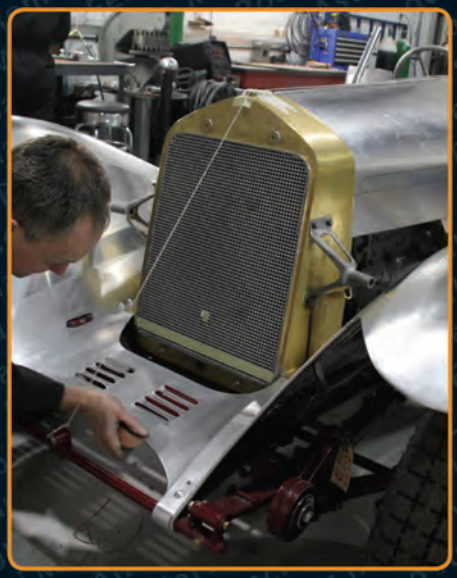
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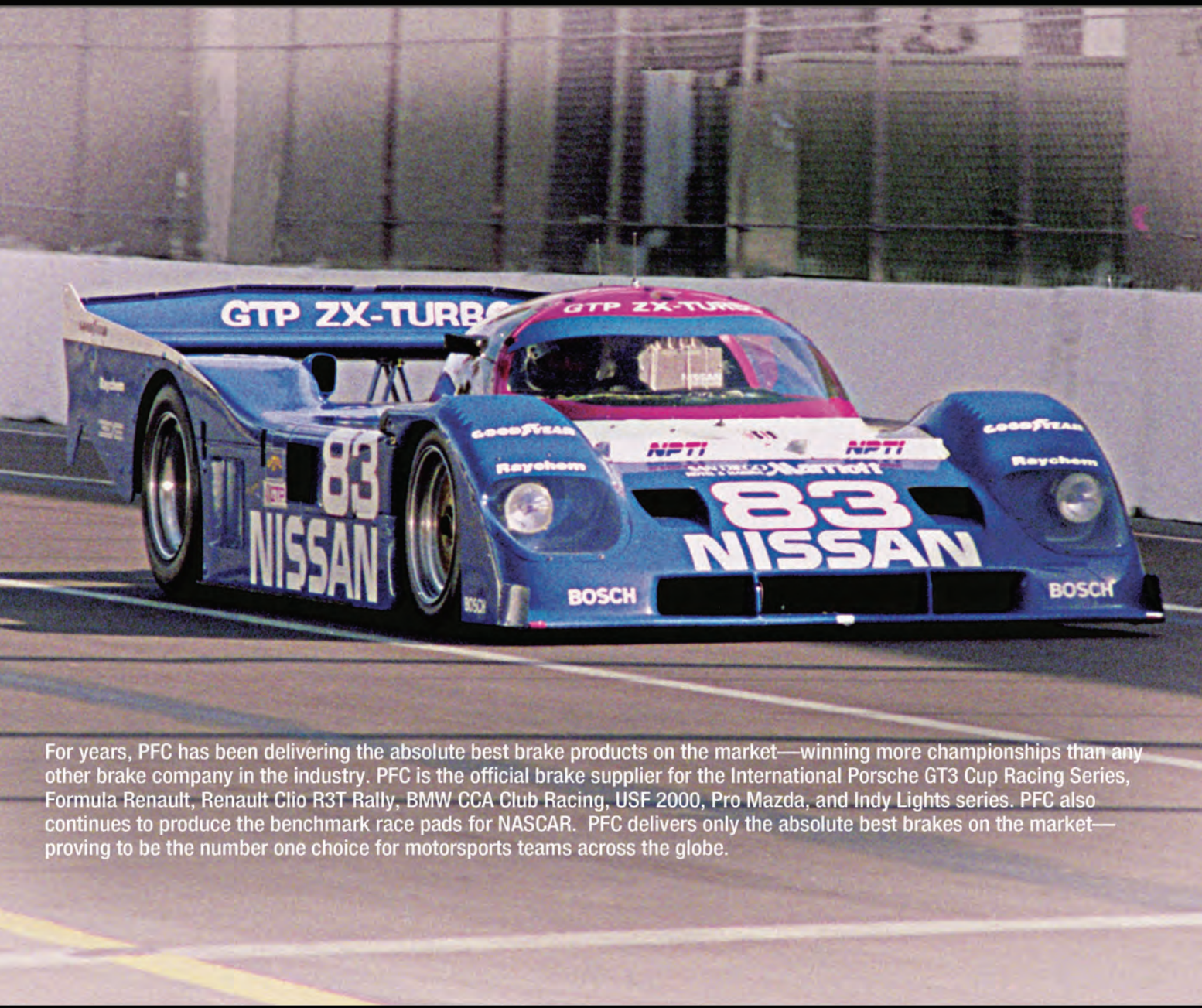
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