HISTORIC RACING Technology

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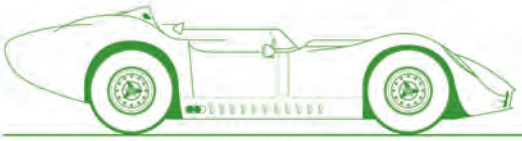

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“This is the most accurate E-type ever made”

Look who’s back

How Jaguar’s lightweight E-Type was reborn

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What's in a name?

THE collective terms we apply to old cars say a lot about the way they're regarded. Phrases like classic and vintage may relate to age, but their literal meaning is subtly different. Like a vintage year for wine or a classic album, the implication is that they stand out as something a little bit special. A high point in the history of their kind.

In the UK much of our rich tradition of messing about with old cars stems from the Vintage Sports-Car Club (VSCC). Set up in 1934, the original idea was simply to provide somewhere for cars over five years old to compete (with a rolling age limit in place). Dissatisfied with the way they saw the car industry going at the time, the club members later voted to impose a fixed cut-off date of 31st December 1930.

Things have changed slightly in the intervening 80 or so years, but on this side of the pond we still use 'vintage' more or less exclusively for pre-war cars. Stateside, the phrase is used more widely, while those ever-pragmatic Europeans have come up with the more inclusive term, Oldtimer. None of them really define what's meant by an historic car. The FIA, on the other hand, is quite specific on the matter: it sets the cut-off date at 1990.

The problem is that old cars are getting younger and younger (so to speak). The Super Touring scene, featured in this issue, is one of the fastest-growing areas of historic motorsport and the first cars didn't even appear until 1990. And it won't stop there. Inevitably, historic racing will have to open its doors to newer machinery as the automotive gene pool continues to grow.

The only question is how to deal with these more modern machines. Even by the end of the Super Touring era it took five million pounds and a dozen engineers to support one car for a season. Quite how a small private team will be able to run an Audi R18 or a Porsche 919 in 20 years' time remains to be seen. But you can be sure they'll find a way. HRT

Chris Pickering
Editor

NEWS

Wheel concern threatens Super Touring series

By **Andrew Charman**

THE burgeoning Historic Super Touring Series, featured in this issue of *Historic Racing Technology*, could face a major threat to its future, according to one of its leading competitors.

Jamie Cleland, who rebuilt and runs a 1997 Vauxhall Vectra for his father, twice British Touring Car Championship champion John Cleland, is worried that the cars could be prevented from racing simply due to a lack of wheels.

The Super Touring era lasted from 1990 to 2000 and in its latter years, when manufacturer teams were spending huge budgets, the wheels were all cast in magnesium, for its strength and lack of weight. However, magnesium also has a shelf life, according to Jamie Cleland of only five years.

One of the Alfa Romeos competing in the series at Oulton Park earlier this season felt it necessary to run on wet tyres despite the dry conditions due to concerns about its wheels, and another suffered an accident due to wheel failure. "The magnesium explodes – the Alfa at Oulton Park actually milled the five spokes out of the wheel," Cleland told HRT.

He has spoken to OZ, maker of the original wheels for his father's Vectra, but they have long ceased manufacture and destroyed the moulds. A further complication is that, particularly in the final years of Super Touring, there was little or no commonality between wheels, with rims made for one make of car being unusable on that of another.

"I'm currently talking to a company in Spain to make us 20 wheels for our race car – but 20 wheels is a small number so the price goes up," said Cleland.

"What we need to do is approach companies like that as a body, offer them a larger order with some specified for a Nissan, some for a Vauxhall, some for a Volvo and so on.

"In a short space of time we may not be able to take these cars out for something as mundane as not being able to get wheels for them, which is worrying." HRT

See historic Super Touring pages 36-43

Andrew Charman

ABOVE Wheels are a potential major issue for the Super Touring series, with the magnesium rims used in the 1990s reaching the end of a finite life

No go for helmet cameras

By **Andrew Charman**

UK historic competitors are being warned that fitting video cameras to their race helmets will likely contravene the regulations of motorsport governing body the MSA. The use of such cameras has mushroomed in popularity since the launch of the GoPro camera, a small unit now available at an inexpensive price, as little as £150 in some cases.

In its latest internal magazine mailed out to competitors, the MSA publishes an image of a race helmet that was recently presented for scrutineering with a camera mounting bracket attached to it. The MSA points out that in its yearbook (the 'Blue Book') regulation (K) 10.3.3(d) states that 'fitment of cameras to helmets by whatever means is not permitted unless an integral camera is provided by the helmet manufacturer and that model of helmet is approved under one of the accepted standards'.

Therefore any helmet with a camera mount attached to it would not be acceptable for any MSA-authorised event that requires the use of a helmet. HRT

ABOVE In the works: competitors running historic Jaguars can now obtain service direct from the manufacturer

Jaguar

Jaguar offers works service to historic racers

By **Andrew Charman**

TEAMS and drivers running Jaguars in historic events will now be able to have them serviced by the 'works' following the opening of a new heritage workshop. The facility, at Jaguar's spiritual home at Browns Lane in Coventry, has evolved from the recreation of six Lightweight E-type competition cars, as featured in this issue.

Servicing and restoration of all classic Jaguars up to the XK8 launched in 1996, race or road, will be on offer, and all work will be warranted. Customers will be able to visit the Browns Lane facility to observe progress on their vehicles and when complete, a photographic record of the work carried out and a Jaguar approved service logbook will be issued.

The Jaguar Heritage workshop intends to provide its service to classic Jaguar owners worldwide – cars can be collected and delivered from any location in the UK or, in the case of overseas customers, any UK airport or port.

In charge of the Jaguar Heritage workshop is Martyn Hollingsworth, a third-generation employee with the marque. He says the recreation of the six competition E-types has highlighted the unique skillset of craftsmen within Jaguar.

"I'm delighted the opening of our Browns Lane workshop means we're now able to make those same skills available to the benefit of our global customers."

To launch the new service the Heritage Workshop is offering a 20 per cent discount on labour rates for orders placed before 31st December 2014. Consultations or vehicle appraisals can be arranged by calling +44 (0)203 601 1255 or e-mailing heritage@jaguar.com HRT

See The cat is back pages 16-23

US historic bodies merge to broaden scope

By **Andrew Charman**

TWO leading US historic motorsport organisations have merged in a bid to increase the scope and quality of the sport across the country. Steve Earle's General Racing Ltd will merge into the Sportscar Vintage Racing Association (SVRA) and act as an advisor on the organisation of SVRA's programme of national historic and vintage events throughout the US.

Earle founded General Racing Ltd in 1970 and in 1974, with the support of Pebble Beach Concours d'Elegance organisers, launched the inaugural Monterey Historic Automobile Races at Laguna Seca Raceway. It was a huge success and sparked the interest for what would become one of the world's premier historic race meetings.

When its arrangement with the circuit finished in 2010, it migrated up the coast to become the Sonoma Historic Motorsports Festival that has since gone on to become one of the premier meetings of the global historic competition scene and has spawned further historic racing festivals across the country.

SVRA CEO Tony Parella has led a two-year reorganisation of the race promoter that has seen it stage events at major US venues including Indianapolis Motor Speedway, Sebring, Road America, Watkins Glen and the newly-created Circuit of the Americas in Austin, Texas.

One of Earle's immediate priorities will be the SVRA's 'Gold Medallion' programme that rewards owners who race in original condition, reflecting the organisation's commitment to historical accuracy.

Parella believes that Earle shares the SVRA's vision and focus on developing national vintage racing: "He [Earle] has shown himself to be an extraordinary leader throughout his career, and has a proven track record in identifying, encouraging and celebrating authentically prepared cars." HRT

#WMS14

For more details visit:
www.worldmotorsportsymposium.com

Top row, left to right: Cabinet members Kirsty Andrew, Martin Anayi, Prof Mark Gillan, Roger Griffiths, Bernard Niclot, William Kimberley, Fiona Pawley, Gilles Simon, Ulrich Baretzky, John Iley, Darren Cox, Bruce Crawley, Prof Joe Katz. Front row, left to right: Dominic Harlow, Dr Bob Larsen, Willem Toet, Soheila Kimberley, Pascal Vasselon, Alex Hitzinger, Peter Wright, Ben Bowlby

1st-2nd December 2014

DISRUPTIVE TECHNOLOGIES

The case for and against

Come and join the debate!

The question is fundamental to the future of motorsport. Does it have a role in exploiting new technologies, even if they are disruptive and can be costly, or should they be controlled and even discouraged?

Join **Ulrich Baretzky**, Head of Engine Development at Audi Sport and **John Iley**, Performance Director at Caterham F1 who once again will be chairing the 2-day debate.

Key Cabinet members who have confirmed their attendance include:

Bernard Niclot, Technical Director, FIA

Andy Cowell, Managing Director, Mercedes-Benz High Performance Engines

Gilles Simon, Engineering Consultant

Steve Eriksen, Chief Operating Officer, Honda Performance Development

Dialma Zinelli, Head of Aerodynamics, Dallara Automobili

Willem Toet, Head of Aerodynamics, Sauber F1

James Key, Technical Director, Scuderia Toro Rosso

Russ O'Blenes, Sr Manager Performance and Racing Engines, GM Powertrain

Roger Griffiths, Director of Motorsport Development, Andretti Autosport

Lord Drayson, CEO/Chairman, Drayson Technologies Ltd

Ben Bowlby, Director of Motorsport Innovation/LMP1 Team Principal and Technical Director, Nissan

David Lapworth, Technical Director, Prodrive

Arnaud Martin, Director of Powertrain, RML Group

Chris Aylett, CEO, Motorsport Industry Association (MIA)

Kirsty Andrew, Sales Director, Cosworth

Dr Sam Akehurst, University of Bath, Powertrain & Vehicle Research Centre

Sergio Rinland, Director, Astauto

Fiona Pawley, Former Formula Student Project Manager, IMECHE

Date: 1st-2nd December 2014

Venue: Birmingham City University, Thinktank
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Networking Awards Dinner
Date: 1st December 2014

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RACECAR GRAPHIC

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NEWS

Hewland spins off historic business

AS knife goes with fork or fish with chips, so Hewland goes with historic racers. Having been in the business of producing bespoke motorsport transmissions since it was formed in 1957, the company has by its very nature a back catalogue of historic racing gearboxes.

At the same time, though, Hewland Engineering is in the business of producing state-of-the-art transmissions for the current crop of racing machines which remains its primary focus. As a result, in late September it licensed a new company, Hewland Classic Ltd, formed by Peter Smith of PDS Racing, a longstanding official Hewland distributor, to provide support for Hewland products within the historic market.

This new company now has the sole global distribution rights for all Hewland products that were in production before 1990. It therefore caters for all H-gate transmission designs produced prior to this date, including the celebrated FT, DG, MK5/MK8, LD and VG variants that have become the de-facto transmission choice for classic and historic racing events throughout the world.

"We are delighted to announce the official launch of Hewland Classic Limited," said William Hewland, chairman of Hewland Engineering. "PDS Racing brings a wealth of experience to the Hewland family, which will ensure that our valuable classic gearbox customers receive the same excellent level of service and support as those running our more modern products." HRT

Goodwood dates announced

FOLLOWING a highly successful return to the calendar in 2014, the Goodwood Road Racing Club's Members' Meeting, is set to be repeated in 2015.

Held over the weekend of 21st-22nd March, the 73rd Members' Meeting will feature several new races, including one specifically for pre-66 versions of the Porsche 911 sports car and a race for the one-litre 'screamer' Formula 3 cars of 1964-70 – an era that produced F1 and Le Mans stars Emerson Fittipaldi, Derek Bell and Clay Regazzoni. The Gerry Marshall Trophy – one of the highlight's of this year's event – will return, as will the Salvadori Trophy for 1955-60 sports prototypes.

Alongside the races will be staged high-speed demonstrations for pre-1975 Formula One cars including those of the distinctive 'high-airbox' era, Group C Le Mans cars and even the 1995 Le Mans winning McLaren F1 GTR. While none of these cars raced at Goodwood, many ran at the venue during its days as a test facility before its revival as a historic circuit in 1998.

Goodwood has also confirmed the dates for the 2015 Revival meeting as 11-13th September, following a record year in 2014, which saw no less than 148,000 people visit the three-day event. RT

BELOW The Gerry Marshal Trophy for Group 1 Touring Cars proved a big success at Goodwood's inaugural Members' Meeting in March

Goodwood

New plans & nominations for Lister

LAWRENCE and Andrew Whittaker, the father and son team behind the re-launch of Lister Cars, have been nominated for the Personal Achievement Award at the 2014 Historic Motoring Awards. The news follows a successful year for Lister, which has sold nine of its limited run of 10 'Knobbly' anniversary cars, generating more than £3 million of orders.

Since its revival at the end of last year, the company has also established the Brian Lister Trophy, awarded to the most successful competitor campaigning a Lister car in the historic racing scene. Now, plans have been announced for an ambitious new project, which the company hopes will take it back to the forefront of low-volume sports manufacturing. "Over the coming years our ambitions are to create a world beating hypercar with a list price of somewhere in the region of £2 million," revealed Lawrence Whittaker, managing director of Lister Cars.

Company founder Brian Lister is understood to be an enthusiastic advisor to the project, which is currently seeking external investors. RT

ABOVE Documentary evidence: owners racing in international historic racing events face a bill

Pressure forces partial FIA climbdown over Historic Passports

By **Andrew Charman**

PRESSURE from competitors has seen international motorsports governing body the FIA amend its regulations on Historic Technical Passports (HTP), extending their validity from five to 10 years.

To take part in FIA-sanctioned international historic competitions, a race or rally car has to possess a HTP, whose sole purpose is to confirm that the car's specification is that of the particular model it purports to be, so that cars can compete with one another fairly. The HTP does not determine the authenticity, provenance or origins of a car, for example whether it is wholly original or even a replica of a certain car – the passport is only concerned with specification.

To obtain a HTP owners not only have to pay a processing fee but also arrange and pay for inspection of the car to determine its specification – a cost that can total more than £1,000 in some cases.

When the HTP was created by the FIA in 2004, no date for the expiry of a pass was stated and many competitors believed they would be valid for the car's competition life, but at the start of 2014 the FIA indicated that passes would only be valid for five years and that all passes issued before 2011 would expire at the end of the year.

The move is thought to have been made due to many cars being modified following the issuing of a pass, rendering them inaccurate.

The change would not effect most historic racers in the UK, as HTPs are not required for domestic meetings, while series that include just one overseas round would also likely escape the requirement as they are still considered a national rather than an international championship. However, owners wishing to compete in FIA-sanctioned events in Europe or beyond faced the prospect of a major bill, and many reacted angrily, some accusing the FIA of profiteering.

Now, in a partial climbdown the FIA has announced that new HTPs will be valid for 10 years, not five. However, it is still insisting that HTPs issued before 2011 need renewing in order to be eligible for the 2015 season. Meanwhile the FIA has set 1990 as its current cut-off date for a competition car to be described as historic.

The governing body's World Motor Sport Council decided that for at least the next decade no car built after 1990 will be considered an historic vehicle, FIA Historic Motor Sport Commission President Paulo Cantarella arguing that technically the year 1990 marks a logical barrier between historic and modern motorsport.

Cantarella is to chair an FIA working group to investigate the classification of post-1990 cars that are not considered historic but which no longer satisfy the FIA's latest safety criteria. The group plans to "investigate the best and safest way to have the cars from 1991 onwards racing." HRT

IN BRIEF

PORSCHE preparation specialist Autofarm has raced its former 'factory prototype' Porsche 911 for the first time – 30 years after purchasing it. Now in Group 4 'S/T' specification, the car was run by Josh Sadler and Autofarm technician Mark Henderson in Classic Sports Car Club rounds at Mallory Park. According to Sadler, the Porsche boasts two engine options making it a versatile race or rally

car eligible for a host of historic race categories. Former F1 driver Bruno Senna has also driven it recently, filming for a TV programme at Brooklands.

THE AUTOSPORT International Show at the NEC, Birmingham, UK will include a new historics feature in 2015 as part of its 25th anniversary celebrations. Held in conjunction with the Silverstone Classic race meeting, itself celebrating its 25th meeting in 2015, the feature will display iconic race cars alongside classic road cars, in a paddock and starting grid layout. There will also be key displays highlighting the thriving historic motorsport community. The show runs from 8th-11th January (8th-9th trade only) and Historic Racing Technology will be there. More details are at www.autosportinternational.com HRT

Money matters

Historic racing isn't cheap, but it needn't break the bank, argues **Julius Thurgood**

IF YOU were lucky enough to get a ticket for this year's Goodwood Revival, you could be forgiven for thinking that historic motorsport is the sole domain of multi-millionaires. Such perception is endorsed by Goodwood's post-event PR, applauding the fact that there was £150 million worth of machinery in the TT Celebration race alone. When some 400 or so historic racecars are showcased within the jewel-like setting of a world-class event such as Goodwood, it adds understandable weight to a commonly held opinion that all historic racing is beyond the reach of the average racer.

For sure, the entry level to historic racing is rising all the time - especially now that the classic car market has finally come of age and has a proper industry infrastructure to support it. This market buoyancy - particularly at the upper reaches of the market - has helped stabilise prices to a certain extent in the lower sectors. With specialist media supporting market credibility through informed value guides, it is now a relatively straightforward exercise to determine the market price of, say, an entry-level MGA roadster or any popular '50s or '60s sports or saloon car in very much the same way that one can establish the relative value of a blue-chip classic such as an original Ferrari 250 GTO.

I'm keen to get the parameters for this conversation correct from the start. We all know that motor racing is not a cheap sport - at any level. Getting involved carries a not inconsiderable start-up cost. Securing a race licence and all the necessary safety kit is just the start of what will be a noticeable claim to your disposable income. However, if we take an overview into accessing historic motorsport, one does not need to be one of Goodwood's multi-millionaires to embrace this seductive and glamorous sector.

I have just returned from racing at the Goodwood Revival and I'm no multi-millionaire. My Goodwood racecar is a 1956 MG Magnette ZA, which has some 40 consecutive seasons of competition to its credit. As a restored road car, such a model is worth up to £20,000 from a specialist dealer. As a racecar, a comparable example could be worth as much as double that - especially if it has good history - but that's still small change compared to the GTO.

BELOW Julius and his 1956 MG Magnette ZA at the Goodwood Revival

Jeff Bloxham

SAFE INVESTMENT

In relative terms, my investment to date is comparatively safe. I did my homework, bought a car with a good history and carried out a rebuild that gave me a racecar for a budget that corresponds with the cost of building a contemporary production saloon racer, yet with little or none of the depreciation risk. Here lies the attraction of racing a historic car over a contemporary one.

For whatever budget you can afford, be it at an entry level or indeed with the uber-high investment associated at the pinnacle of the sport, in most cases it will be the historic racer who will win financially over a period of time because the car is very unlikely to become obsolete.

Unlike a modern championship contender, the owner of a historic car can race at will, dipping in and out of race series or festivals without fear of devaluation. Should he then, for whatever reason, decide to take a sabbatical from racing, he can mothball his car in the secure knowledge that he can return to the sport without fear of regulation changes as the historic rulebooks are virtually written in stone.

The chances of being overtaken by upgrades, model changes or revisions to regulations are virtually non-existent as these potentially financially crippling factors rarely apply to historic racing. And for those with an eye to the market, judicious upward trading can often result in a very fine nest-egg when one finally hangs up one's race helmet, eschewing the idiom of the modern racer who made a small fortune out of motorsport ... simply by starting with a large one. HRT

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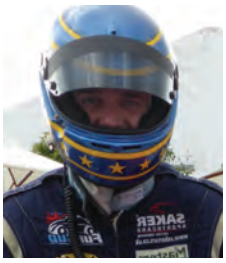

In the hot seat

F1? I'd rather be racing historics, says **Nigel Greensall**

THE last issue brought a smile to my face when I read Nick Mason starting his column with "hi, my name's Nick Mason and I'm a recovering historic racer". In my case it's "hi, I'm Nigel Greensall and no-one's discovered yet that I don't have a proper job".

Having started following motorsport in the 1970s, one of the fascinations I had was watching the top drivers getting the opportunity to drive many different cars. This has provided a real inspiration to the way I approach my racing. This year, for instance, I've now raced 19 different cars ranging from a Funcup Beetle to a Ferrari Daytona! As a fan of all motorsport, it would be great to see the current F1 guys have the opportunity to race in other categories.

As a kid, my hero was Ronnie Peterson. Watching him race a JPS Lotus one weekend, a BMW 3.0 CSL the following weekend and a Formula 2 car the next inspired me to race ... and race lots of different cars.

Spurred on, I completed a mechanical engineering course so I could understand how a racing car is built. Having left college, the first couple of jobs I had were a croupier in a casino and a debt collector; although both jobs provided some interesting sights and stories, neither paid enough to go racing. So I came up with a plan to raise enough sponsorship to rent a seven year old Formula Ford and do the Star of Mallory Park series in 1988.

Since then, I've raced full time every year, usually contesting around 35 rounds per season. This has included racing for Tyrell in the EuroBOSS F1 series from 1997 to 1999, winning the championship twice and later racing Michael Schumacher's World Championship winning Benetton.

Along with historic F1s I've had the opportunity to race a range of historic sports and saloon cars. This year, that has included a number of Shelby Cobras plus a Ferrari Daytona, a Lola T70 and a Lotus Cortina.

There are now even occasions where I drive two cars in the same race, which provides the commentators with plenty of entertainment when I attempt to overtake myself! This happened recently at Spa in the Masters series Gentleman Drivers' GT race, when I started in a Jaguar E-Type and finished the race in a Shelby Cobra, overtaking myself not once but twice.

THE ART OF ADAPTATION

The great challenge as a pro driver is jumping from one car to another. You need to adapt your technique and style to suit each individual car and get the maximum from it. You then have to relay this to the co-driver (usually the car's owner) to enable them to enjoy their driving experience and maximise their potential.

In historic racing, it is noticeable how varied the challenges are for the driver with such a diverse range of cars. Spending time understanding how to drive will significantly increase the pleasure you get from the car.

One of the tools I use a lot during coaching is an in-car video system. This allows me to watch my co-drivers' laps alongside mine. Being able to replay each lap helps all drivers understand how and where they can improve. I use the Video VBOX system, which just happens to be produced by Racelogic - the company owned by my VW Funcup co-driver, Julian Thomas. Together, we've just recently clinched our third championship, proving the effectiveness of good coaching and the right tools.

The great benefit of racing for a living is not only that you get to meet an eclectic mix of people, but also that you get to travel the world. So far this year that has included Daytona, Spa, Sebring, Sepang, Sonoma (...and Snetterton) all in a hugely eclectic variety of machinery.

Contemporary Formula 1 drivers might get paid an order of magnitude more than I do, but I wouldn't swap it for the world. HRT

Nikki Welsby

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VBOX LAPTIMER

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www.vboxmotorsport.co.uk

The cat is back!

John Simister looks at the engineering behind the sensational new Lightweight E-Types

You may well have read about Jaguar's new Lightweight E-type project. It involves the creation of six brand new Lightweights, using up the final six chassis numbers left over in 1963 after just 12 of the intended 18 cars had been built. The six new cars, all based on the original specification of the 12th and hitherto final Lightweight, are to be created as FIA-compliant 'continuation' machines, intended for historic racing. All have been sold, and all will be completed within the next year with the bodyshells finished by March.

Summarised baldly like that, the project seems little different from new, continuation batches of Lola T70s, Ford GT40s, Listers and others. Besides, other replica Lightweights, sometimes built around the identity of an existing E-type, already exist. So what's special about this one?

Simply this. Never before, to our knowledge, has a major car manufacturer set about re-making cars it made itself decades earlier, and on a site so close to the original production facility. It's not a matter of dusting off the old tools and raiding long-closed parts stores, however. For a current carmaker to put its name to a new car, that new car must not only be built to today's new-car standards, it must also be designed and engineered to those standards.

This has called for a fascinating amount of reverse engineering, with a complete car scanned and rendered into computer design programs in which it is digitally perfected to a degree not even imagined in 1963's world of science fiction, then deconstructed right back to the jigs required to make it the modern way. Will that make the continuation Lightweights too good? Or does it just mean they will be as good as they can possibly be, and as good as the originals could have been had their builders had the ability to confirm the accuracy of their measurements to the same degree?

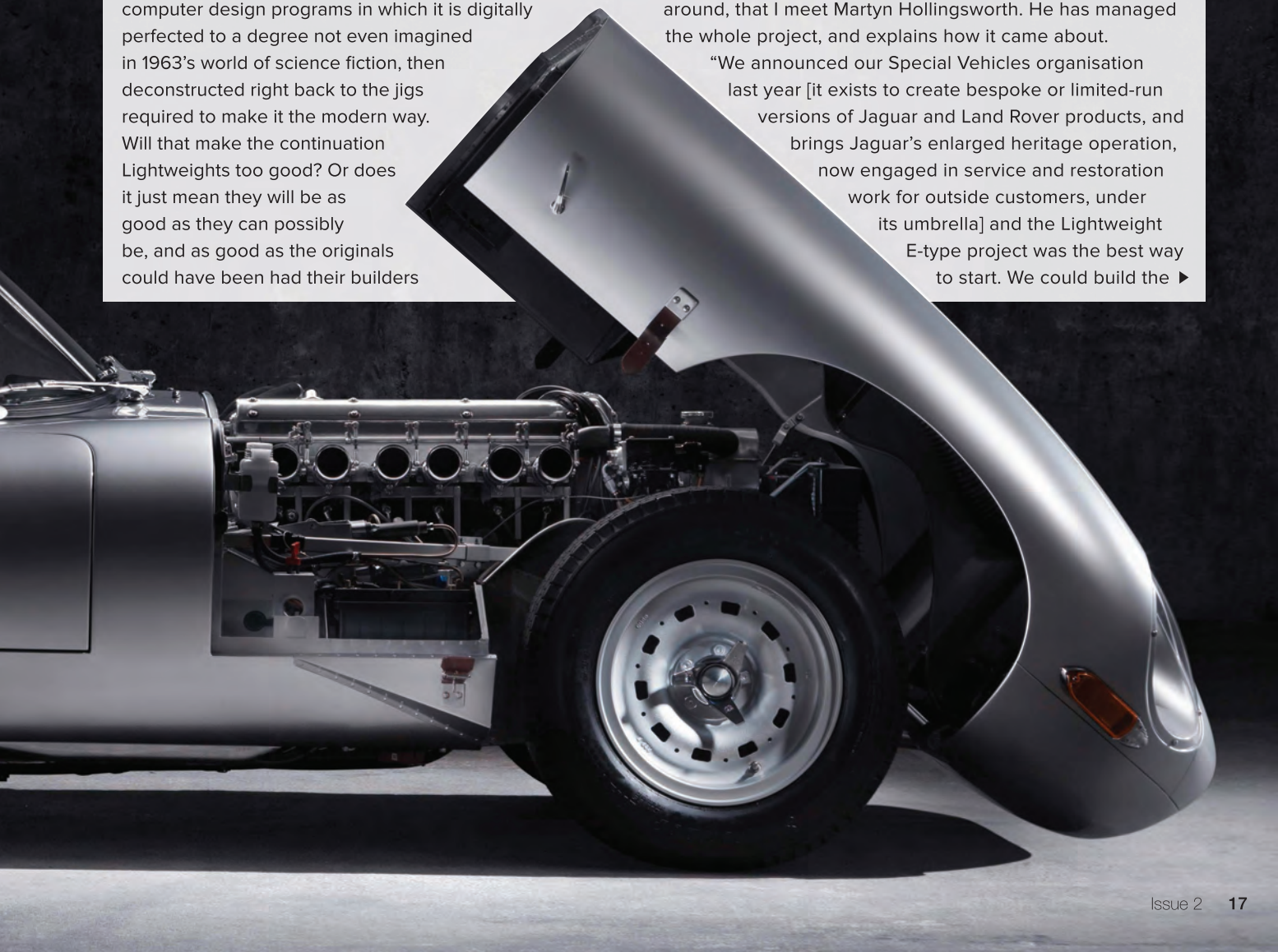
These will be E-types as their designers and engineers originally intended, with the layer of once-inevitable imperfection no longer standing between that intention and reality. That gives the new cars their own degree of authenticity, that of being closer to the blueprints than ever before. It's a whole new world.

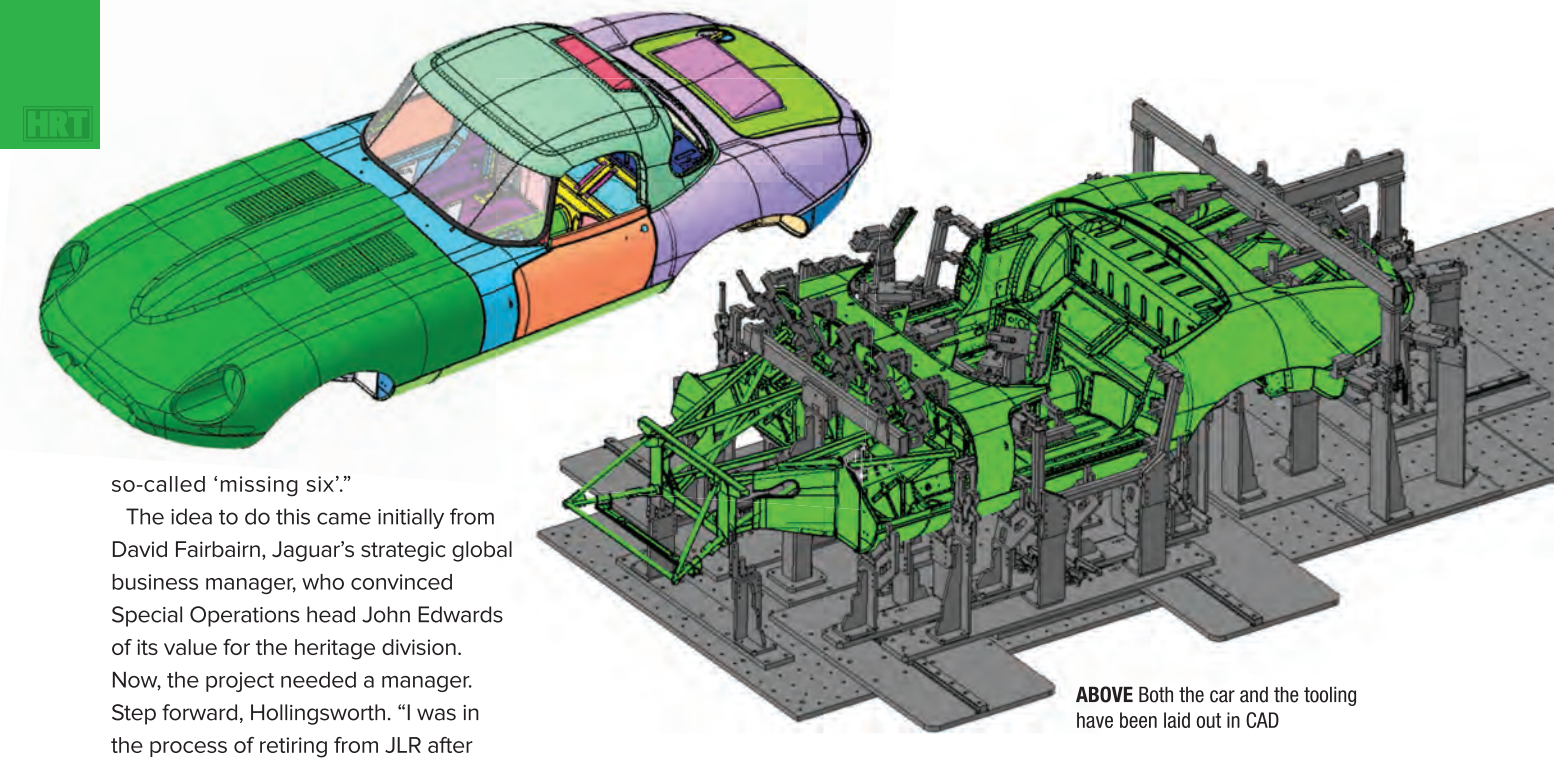
CAR ZERO

Actually there will be seven new Lightweights, not six. The completed example you see here is 'Car Zero', a prototype whose bodyshell and front subframe structure were built by well-known historic Jaguar specialist RS Panels of Nuneaton, using Jaguar's own original tooling bucks for some of the larger outer panels. The engine came from Crosthwaite & Gardiner, well known in the historic car world for its ability to reproduce, perfectly, almost any part of a historic car, and Car Zero was built up in Jaguar's new Heritage workshop within part of the former Browns Lane plant.

It's in this workshop, Car Zero sitting in the middle of the immaculate floor with other classic Jaguars (customers' cars and Jaguar's own heritage vehicles) being worked on all around, that I meet Martyn Hollingsworth. He has managed the whole project, and explains how it came about.

"We announced our Special Vehicles organisation last year [it exists to create bespoke or limited-run versions of Jaguar and Land Rover products, and brings Jaguar's enlarged heritage operation, now engaged in service and restoration work for outside customers, under its umbrella] and the Lightweight E-type project was the best way to start. We could build the ▶





ABOVE Both the car and the tooling have been laid out in CAD

so-called 'missing six'."

The idea to do this came initially from David Fairbairn, Jaguar's strategic global business manager, who convinced Special Operations head John Edwards of its value for the heritage division. Now, the project needed a manager. Step forward, Hollingsworth. "I was in the process of retiring from JLR after 30 years, but John suggested I lead a small team to create these cars. It was indeed a small team. Just me, and a small workshop," he explains.

So much for Hollingsworth's retirement plans. He pulled a team together to build the six cars to sell, but first he had to 'prove' the process in the way a new car is 'proved' through prototype builds. This was achieved by building Car Zero, which is not one of the 'six', does not bear a Lightweight E-type chassis number and will not be offered for sale.

"We asked RS Panels to build the body, but they allowed us access the whole way through so we could scan both sides of the panels and all the technical surfaces. That way we got a digital map of the car in CAD. Car Zero has some asymmetry [as E-types, and other cars of the era, generally do] so we took the better side of the car as our starting point and reversed it to create the other side."

The better side, after being appraised by Jaguar's design department for consistency of curves, accuracy and overall 'rightness', was the left one, as it turned out. Even so, there were still some minor surface contours to improve; they might have been as little as a millimetre too proud or too depressed, but this was the chance to remedy them before committing to Jaguar's new suite of press tooling.

The original Lightweights, all of them roadsters with all-aluminium bodyshells and aluminium hardtops, began at chassis 850658 and all were slightly different as knowledge grew. The 12th and final one, ▶

BELOW A Faro probe was used to define fixing points for the jigs based on the geometry of Car Zero

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850670, was originally bought by Phil Scragg and its build data forms the basis of Car Zero. It represented the Lightweight in its most-developed form, with various extra gussets and the best suspension geometry, but over time that car, too, has evolved so there was little point in using its current guise as the Car Zero template.

The new cars will be chassis numbers 850671 onwards, and there will be no more after the originally-intended extra six because, says Hollingsworth: "There would be no authenticity. They will be built by JLR technicians, some of whose parents and grandparents worked here, just 100 yards away from the original build shop."

Can they be road-registered? "We are not supporting that, because the originals were built for racing as these will be. As a manufacturer we couldn't do it," he says.

That's one potential area of controversy addressed. Here's another: given the expertise gained over the last half-century, and the expertise in aluminium that today's Jaguar possesses, was there a temptation to update the construction method? "We couldn't, because we have to keep it original to comply with FIA rules. We shied away from today's high-strength aluminium, and there's no bonding, just a little bit of fusion and spot-welding as in the original. We even copied the pitch of the original rivets.

"The cars will be at the point to which they were developed in the 1960s, with the wide track, fuel injection and a five-speed gearbox. We expect there'll be a bit more development once they are sold," adds Hollingsworth, pragmatically.

ABOVE Our man Simister chats to Martyn Hollingsworth from Jaguar Heritage

THE BODY BEAUTIFUL

RS Panels will make the outer body panels for the six new Lightweights, using its expertise and Jaguar's revised tooling. Crosthwaite & Gardiner will build the engines. But the bodyshell will be assembled at Whitley, home of Jaguar's design and engineering centre, and painted at Gaydon where Jaguar's show cars are prepared. Final assembly will be at Browns Lane.

Chris Burdett, Lead Design Engineer based at Whitley, has masterminded the bodyshell's reinvention via the digital world. He explains how it happened: "We scanned the RS Panels body back in March, before we'd taken the decision to make the new bodies in-house. It was an unknown entity: how feasible would it be for us to take on? There were known fitment issues around the windscreen, and the body wasn't symmetrical. Our parts would have to be wrong to be right, so to speak.

> **"We even copied the pitch of the original rivets"**

"However, it was a testament to RS's work that we could use it as the starting point. The shell was 3 to 4 mm out at worst, and we work to a maximum of 1.5 mm. But it was a brilliant job for a bodyshell created in free space."

The separate aluminium roof, though, was not so accurate: "The right-hand side of the window aperture was 15 mm further out than the left-hand side. RS had copied an inaccurate original roof very accurately..."

With all the data in CAD-world, as Burdett puts it, the team could see how the structure behaved under simulated stresses. He'd have liked to stiffen it with adhesives but that was impossible under FIA rules. Analysis did however reveal stress hotspots where the team could make especially sure of perfect welds and riveting – and those hotspots turned out to be in the area of failures that had happened in period.

UNPRECEDENTED ACCURACY

Having scanned the body as it was built - so data could be gathered from the inside parts inaccessible when the shell is complete - Burdett's team could average out every shape and flatten any ripples. "The next big worry," he says, "was how to break the structure down into a series of sub-assemblies, because I wouldn't have wanted to be involved in the project unless it was done this way. Then, after I'd stared at it long enough, the sub-assemblies leapt out at me."

Burdett terms these sub-assemblies zones; Zone 3 covers the dashboard area, Zone 5 the sills and main floor, ▶

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Zone 6 the upper and lower rear floors and chassis legs, while Zone 8 is the assembly of 3, 5 and 6. Each one will be built separately and accurately so that once they are all joined together, the resulting entity is also accurate. This is not how the E-type was built originally, nor how RS Panels builds them; instead, they were built cumulatively so that errors accumulated as the build progressed.

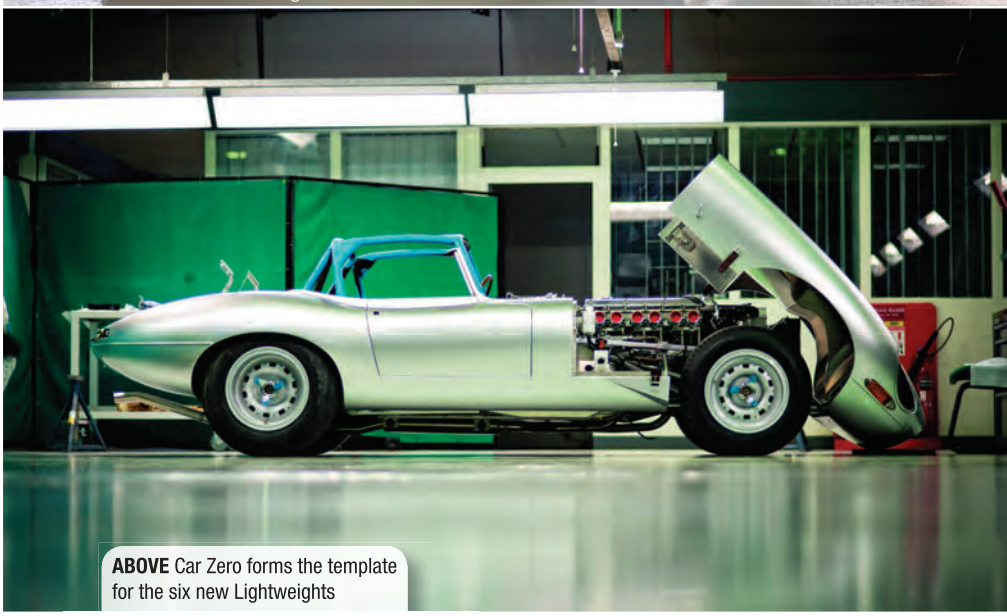
"E-types were quite bespoke, as the lead loading around the rear light apertures shows," Burdett observes. "We have reverse-engineered around 300 body components; we are the first people to understand an E-type structure fully! RS Panels have learned from what we are doing and would like to use our knowledge, so we have to manage how we do this."

From this data, Burdett's team could CNC-machine steel press tools for many pressings, what would be termed soft tooling by mass-production standards but fine for limited-run parts in aluminium. Some parts were subtly altered, for example to incorporate a joddled edge to accommodate a neighbouring, spotwelded panel and make a neater join, especially where three layers of aluminium might meet such as at the junction of the rear bulkhead, sill and inner rear wing. The two sections of the transmission tunnel and gear lever surround are another example. All the panels are designed to fit together perfectly first time, with no stretching, bending or beating into shape.

With the body components scanned and positioned in virtual space, Burdett could define the jigs required to hold the panels in position for welding, and then build them to minute (0.2 mm) accuracy using a mix of proprietary fittings and JLR's own laser-cut base and supports. They are positioned by a Faro articulated probe using the CAD data. Some panels also have holes to locate them onto the tools, some of them within extra tabs on the panel's edge which are cut off once the body is built. None of these were present on the original E-type, but only four of them will be visible on the finished car.

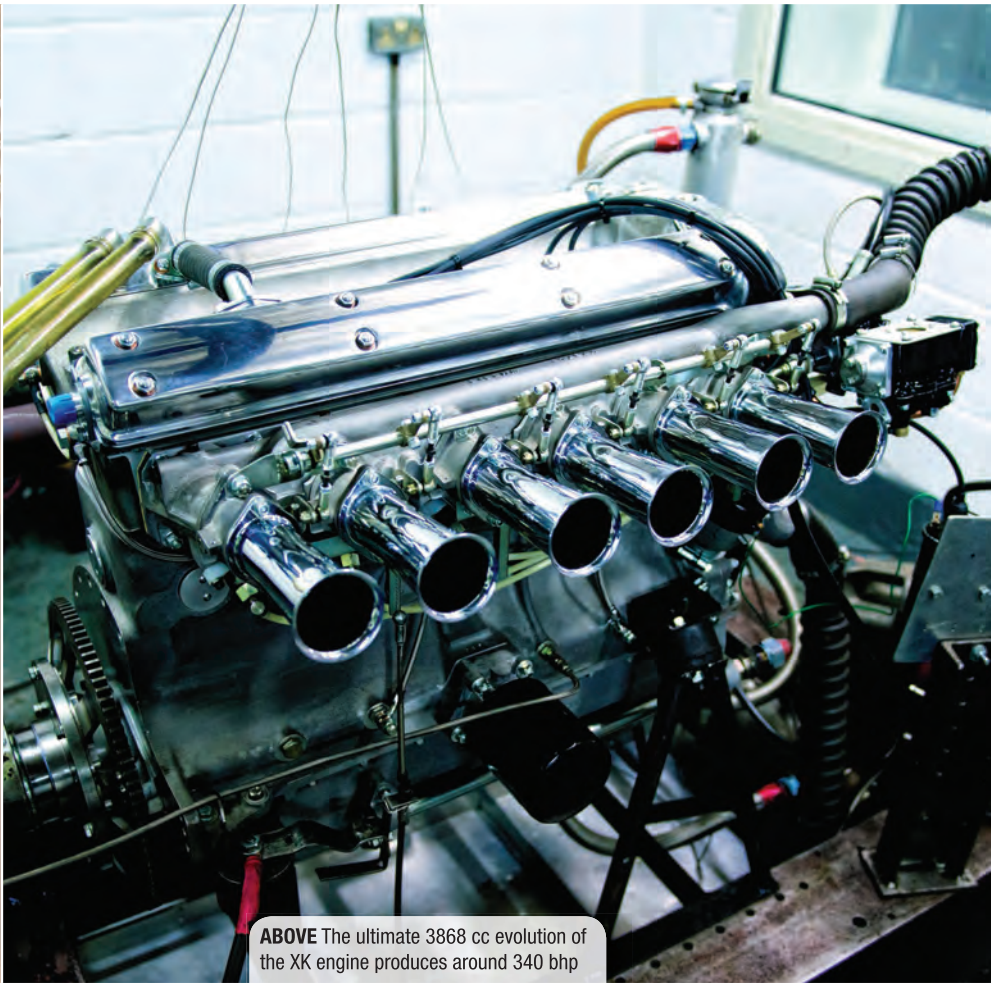
As we go to press, the first panels out of the presses are being assembled within

Chris Teagles



ABOVE Car Zero forms the template for the six new Lightweights

> “This is the most accurate E-type ever made”



ABOVE The ultimate 3868 cc evolution of the XK engine produces around 340 bhp

the jigs to make a ‘mule’ bodyshell which will not become a completed car. Instead it will become, chillingly, a ‘destruction’ vehicle whose 3000-or-so welds and rivets (both solid ones and blind pop-rivets) will be unpicked and analysed to check their strength.

“At JLR we haven’t done much aluminium spotwelding,” Burdett explains, “although there’s more now. So we have used Warwick University to help us refine the technique. For the Lightweight we use the old style of non-adaptive spotwelding, which uses the same current frequency and time for every weld, whereas our new aluminium cars use adaptive spotwelding which senses what is actually happening and adapts to suit.”

After the mule bodyshell, it will be on to the first of the six final Lightweights. This will, says Chris Burdett, be the most accurate E-type ever made.

UNDER THE BONNET

The mechanical components are a mixture of new parts from Jaguar’s own suppliers, some refurbished originals such as the steering rack – and that wonderful, ultimate-development, 3868 cc XK engine with its aluminium block, wide valve-angle cylinder head and dry-sump lubrication system.

“We’ve done Jaguar engines for 20 years,” says Ollie Crosthwaite. “It started with a customer who had an original Lightweight E-type. Its engine needed a rebuild, we had to make some parts, and then he wanted a new engine. We did it the old-fashioned way, with all the patterns for the castings made by hand with the help of a few original drawings.”

With two decades’ worth of accumulated knowledge, there must be a temptation to improve the design here and there. Crosthwaite & Gardiner, however, resists it. “We follow the original specs and comply everywhere we have to,” says Crosthwaite. But new technology can play a part, such as in the use of CNC machining for the cylinder head’s ports: “There’s been a lot of computer simulation to optimise the gas flow, and with CNC we can get the same result every time.”

Jaguar’s published specifications for the new Lightweight state 340 bhp at 6500 rpm, along with 280 lb ft of torque at 4500 rpm – enough to give the 1000 kg E-type a tasty turn of speed. That’s running on a trio of Weber 45 DCOEs, but Lucas mechanical fuel injection was the induction system of choice back in period and, says Ollie Crosthwaite, the better option now. Both will be offered on the customer cars.

The engine is set up to run on super-unleaded pump fuel, stored in a modern ATL fuel cell hidden inside an authentic 1960s outer casing. Modern electronic ignition isn’t allowed; it’s points and a condenser. As in 1963, the Lightweight E-Types use a dry sump oil system, closely related to that seen on the D-Type and now filled with Millers CSS 20W/60 semi-synthetic oil.

And the cost of this piece of the past perfected for the present? Jaguar won’t say, other than that it has seven figures and a ‘1’ is the first, but it surely must nudge the £2m mark given the vast design and development costs to spread over just six cars. “Let’s just say,” says Hollingsworth, “that the project will wash its face.”

And if this one covers its own costs, that might just open the door to some more re-makes of proud past Jaguars. HRT

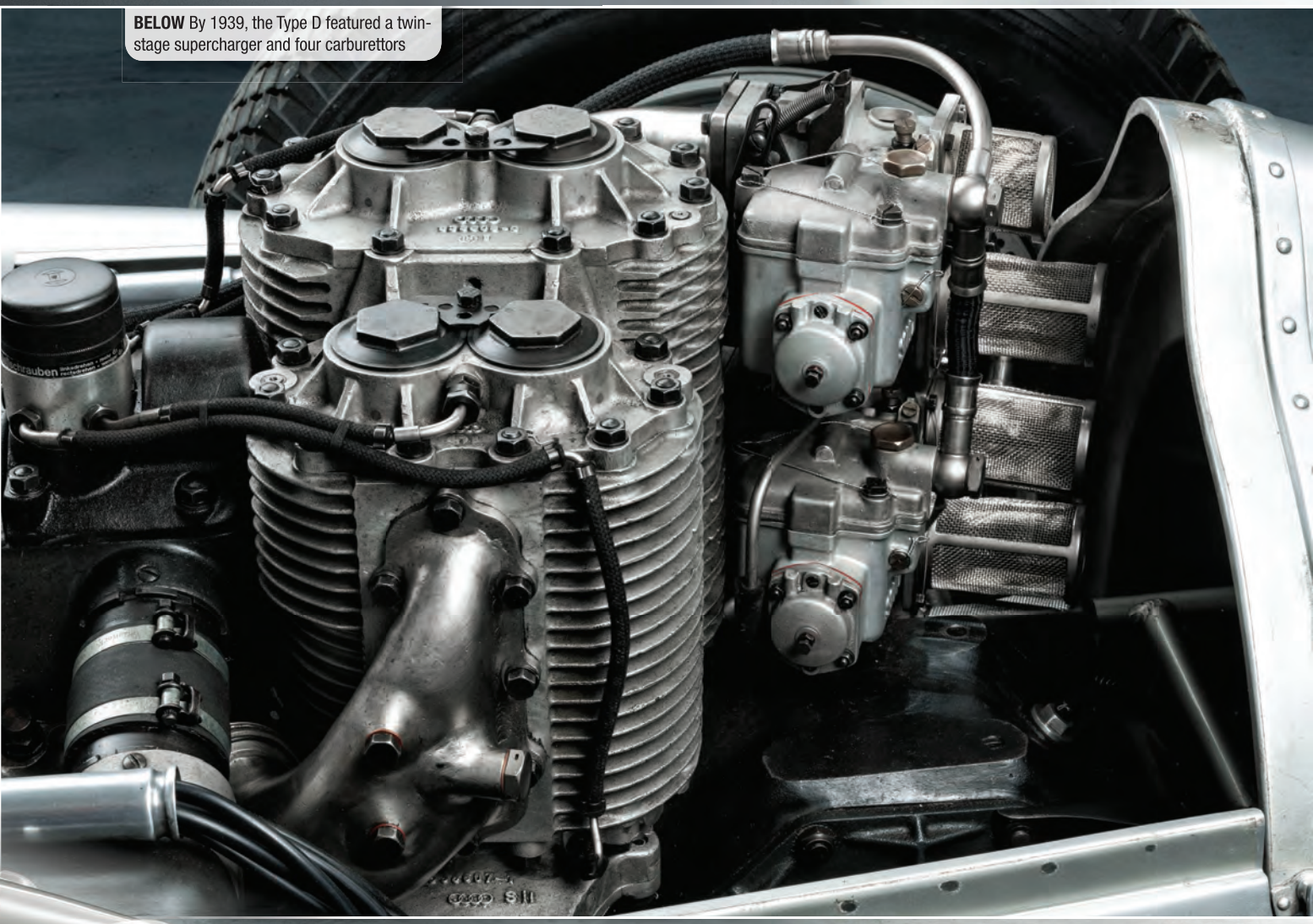
The time traveller

The engine wizard behind 14 Le Mans wins in the modern era also tends the ground-breaking Auto Union powerplants in Audi's heritage division. And he can't hide his admiration for what he has found. **Chris Pickering** reports

IT'S HARD to imagine what people must have thought when Auto Union racing cars burst onto the grand prix scene in 1934. Clad in gleaming silver aluminium, with a shape honed in the wind tunnel, a revolutionary mid-engined layout and a powerplant of fearsome power and complexity, they were decades ahead of their time. In an era where horses still outnumbered cars, they might as well have teleported in from another galaxy.

Since then, few moments in motor racing have even come close to the shock generated by the arrival of the Auto Unions. Ironically, Audi – one of the four companies that grouped together to form Auto Union – perhaps came closest, when it brought diesel technology to sports car racing in 2006. Since then, every single Le Mans 24 Hours winner has been powered by a diesel engine and all bar one of them has come from the German manufacturer.

Photos: Stefan Warter



BELOW By 1939, the Type D featured a twin-stage supercharger and four carburettors

Fittingly, the man behind these incredible engines (not to mention those used in the petrol-powered Audi R8 and the Bentley Speed 8 which won previously) is also charged with looking after the Auto Unions on Audi's heritage fleet.

In total, Ulrich Baretzky has overseen the development of no less than 14 Le Mans-winning powerplants. He's also a straight-talking Bavarian, known for his razor sharp wit and not generally given to

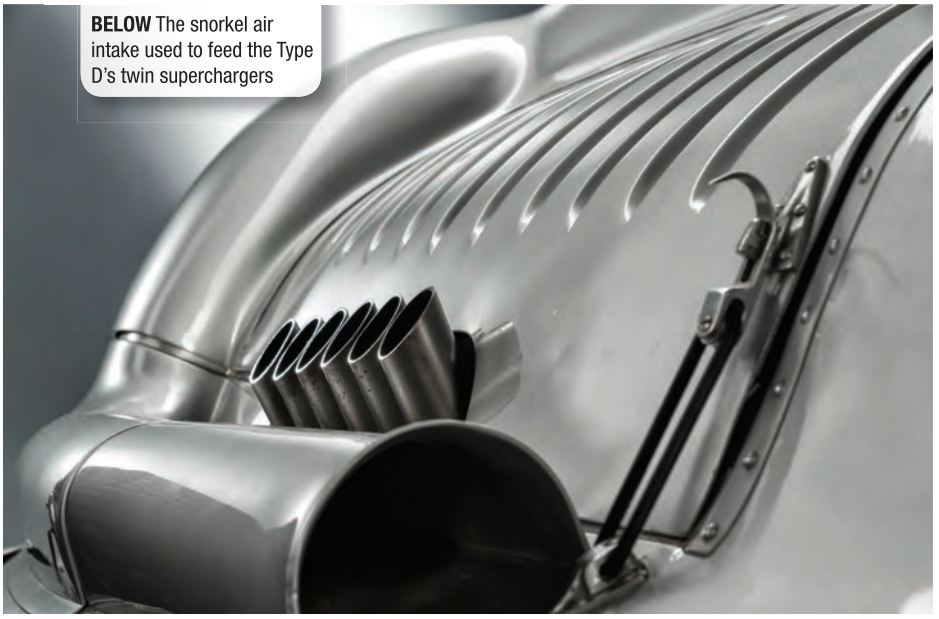
> **"Decades ahead of their time"**

dramatic displays, yet the reverence with which he talks about the Auto Unions and the team behind the project is palpable.

"You have to remember they were doing everything for the first time," he says. "There was no computer-aided design, just very simple calculations and experience. Making a mid-engined car with 16 cylinders and [eventually] nearly 600 bhp must have been a huge adventure. In comparison, we haven't ▶

progressed that far since. You have to take your hat off to them – it took a lot of courage to go out and do that with the materials and the machinery they had available at that time."

Audi Tradition now owns three of the five surviving Auto Union racing cars. The first to be acquired was Hans Stuck's 1938 Type C/D hillclimb car, which survived the war in remarkably intact condition, hidden in a coal mine, only to be requisitioned by the Soviet army and stored in the Zil car factory for many years. The story of that car alone has the makings of a good Cold War thriller, with Communist Party officials and even the local KGB head involved in its liberation. The other two



BELOW The snorkel air intake used to feed the Type D's twin superchargers

are the so-called 'Karassik cars' – 1938 and 1939 Type D cars assembled from original parts smuggled out of the Soviet Union by Serbian-born car collector Paul Karassik and his wife Barbara.

The two Karassik cars were rebuilt by British restoration specialist Crosthwaite & Gardiner, using the original parts where present and filling the gaps using drawings and expertise provided by Audi Tradition. Both use original chassis and engines, while the bodywork comes from Rod Jolley Coachbuilding in the New Forest.

Alongside the period cars, Audi has three replicas, produced by Crosthwaite & Gardiner with bodywork from Roach Manufacturing. Perhaps the most striking of these is the Type C Streamliner, which mirrors the car that Bernd Rosemeyer reputedly drove to around 270 mph (430 kph) in 1938. Its two companions are based on an open-wheeled Type C grand prix car and a twin supercharged Type D.

After the war, Auto Union's competition department at the Horch plant in Zwickau found itself in Russian-controlled East Germany. Any documents that might have survived the conflict disappeared in the chaos that ensued and it has left Baretzky and his colleagues with a monumental task. Every part of the car has to be documented and meticulous records are now kept of all work carried out, along with any previously undiscovered documentation that comes to light.

"One of the biggest challenges is to work out why things were done in a particular way," he explains. "Initially we tried to use modern techniques [to make replacement parts], but we found out that if you don't make it the same way, it won't work. You have to ignore things like CNC machines and go back 80 or 90 years to consider how you could manufacture things with the equipment of the time."

The reverse engineering process starts with a visual inspection of each part to determine whether it was cast or machined. It's then sent to the laboratory to identify the material, which is typically an aluminium alloy for major components such as the engine block and heads. At the time this was a state of the art material, more commonly found in the aviation industry, although analysis has shown it to be a relatively crude alloy by modern standards.

It doesn't help that the cars are all unique. No two examples are completely the same, meaning there's simply no such thing as an off-the-shelf part for an Auto Union.

Detailed records are kept tracking the running hours of every engine and gearbox. Normally they are kept together as complete assemblies, so there's less requirement to track individual components. A book lists when and where each assembly has been used, along with any notes or remarks. Often it's months between runs, so it's vital to keep a record of any issues for the next time each car is run.

Depending on the sort of work the car has been doing, the timescale between rebuilds varies from around six to 12 hours. The sheer rarity and value of these engines places a huge emphasis on preventative maintenance and the Audi technicians use techniques such as endoscopy to look into the engine, checking for signs of piston damage or other issues that might point to an imminent rebuild.

"You have to remember these are not taxi engines, they are race engines," comments Baretzky. "Today they are still race engines – a demonstration drive at Goodwood or somewhere is no different from racing on the Nürburgring; the parts are heating up, they're moving and the surfaces are wearing. The car doesn't know any different."

A FAMILY AFFAIR

The Auto Union racing cars underwent a phenomenally rapid process of evolution between 1934 and 1939. Initially, the Type A was built to contest a formula where a *maximum* weight of 750 kg was stipulated and just about everything else was left free to the engineers. The thinking at the time was that this would limit the size and weight of the engines, capping the cars' performance, but that turned out to be a monumental error of judgement on the part of the organisers.

Just about every other grand prix car of the era used a straight eight engine. ▶

Arch rivals Mercedes, it has to be said, did so rather successfully in the W25 and W125, but this remains a fundamentally flawed layout – long, heavy and prone to torsional vibration issues that limit the maximum engine speed. Auto Union, on the other hand, opted for a radical V16 layout, with two banks of cylinders separated by a very narrow 45-degree vee angle. This provides a very compact package (still eight cylinders long, but with a smaller bore diameter) plus an inherent balance, which allied to lighter individual components, allows the engine to rev to much higher speeds.

The Auto Union Type A began with a 4,358 cc engine, fitted with a single Roots-type supercharger producing around 290 bhp. Relatively minor revisions for 1935 saw the capacity grow to 4,956 cc, along with an increase in boost pressure which took the power to 370 bhp. The ultimate evolution of the 16-cylinder engine was to come with the 6-litre Type C cars of 1936 and 1937, which eventually boasted over 570 bhp.

For 1938 it was all change. A sliding scale was brought in for the minimum weight limit, while supercharged engines were pegged back to three litres. Faced with the capacity limit, Auto Union developed a V12, which was fitted with an ingenious two-stage supercharger system in 1939, restoring the ▶

Behind the wheel

NOT only do the surviving Auto Unions have a works team in the form of Audi Tradition, they also have a works driver. Having owned and driven a huge variety of historic machinery, Nick Mason was approached in 2007 to demonstrate the cars at the Goodwood Festival of Speed. Since then, he's clocked up more hours behind the wheel than anyone else.

So what's it like to drive a machine that could crack nearly 200 mph when the average family car would have struggled to reach 50 mph? "It's mind-blowing," he says. "Particularly with the 6-litre cars, you've got almost twice the power of some of their competitors."

The Auto Unions aren't without their foibles, he explains: "The driving position owes more to a London taxi than anything else – the steering wheel is vertical like a ship's wheel. And a bit like a Porsche 956, you're slightly conscious of your legs sticking out the front of the car if things go badly wrong. You can feel the rearward weight bias at work too. There's an awful lot of weight behind you and it definitely feels like a rear-engined car rather than a mid-engined car."

In a lot of other respects, the experience is surprisingly modern, he continues: "The engine is far more tractable than I expected. I'd anticipated a much more peaky power delivery, but the supercharger is very progressive. Driving the car in the wet at Goodwood a few years ago with twin rear tyres I was really surprised by how much grip it had."

Such is the reverence attached to the few remaining Silver Arrows that they've managed to avoid the modern 'improvements' made to a lot of historic racers. Running on pump petrol rather than the original 1930s 'rocket fuel' has also curbed the power outputs somewhat, which has reduced the performance gap to some of their contemporaries. Nonetheless, driving the cars still gives a fascinating insight into what it must have been like in the 1930s.

"When you drive the car at somewhere like Goodwood today and you get up to third or fourth gear you end up wondering what it would have been like at the Nürburgring on a much rougher road surface," says Mason. "You have to have enormous respect for the people who drove these cars flat out." HRT

Goodwood

BELOW Nick Mason demonstrating an Auto Union at the Goodwood Festival of Speed

ABOVE Earlier engines require one spark plug for each of their 16 cylinders

power to more like 485 bhp.

The reason for this statistically-charged history lesson is that it's almost impossible to keep track of the various engine configurations otherwise. It also illustrates the sheer pace of development, with the V16's power output almost doubling over the course of its three-year career.

Baretzky is in little doubt that Ferdinand Porsche designed the V16 with future development in mind. "The first engine was primarily made to last," he comments. "If it had broken after 10 minutes you'd never have seen the performance. It was risky enough in concept, so he didn't take too many further risks. For sure, he had an idea of how he could increase the power over time if it worked, though, the same as we do today."

This is something that resonates particularly strongly with Dr Porsche's modern day counterpart: "I will never forget when I took over the responsibility for the race engine department. My boss at the time said, 'Listen Baretzky, you can lose races, you can come in second or third, all that is fine, but I never want to see a smoking engine on TV,' and that's a promise I've kept until now. Even if we didn't win the race, it's never been due to engine failure and I think that was the philosophy of the Auto Union engineers too."

ALL ABOARD THE VALVETRAIN

Both variants of the Auto Union engine use somewhat unusual valvetrain layouts. The V16 features a single overhead camshaft, positioned in a rocker box between the two heads. Due to the narrow vee angle, the cam is able to operate directly onto the rockers for both sets of intake valves. Two sets of pushrods are then used to actuate the exhaust valves, via rocker assemblies that live in the heads. As a curious by-product of this arrangement, the V16 engine has three rocker box covers.

Double overhead cam engines were already relatively commonplace in grand prix racing, so it's something of a mystery as to why Porsche chose the single cam design. "I'd like to know why they went for this option," observes Baretzky. "There are lobes everywhere in order to control all 32 valves from one camshaft and it makes the cam design very complex in a way. It may have been because the cam was driven by a single shaft, which also drove the supercharger, so it's a very efficient design. It prevents the complexity of [the rest of] the engine becoming even greater."

The later 12-cylinder engines use three separate camshafts. An overhead camshaft on each bank controls the exhaust ports, while a third centrally-mounted cam – similar to that on the V16 – controls the intakes. Again, it's not entirely clear why. "The engine speeds went a lot higher – the red line on the 12-cylinder was more than 8,500 rpm – so one element was certainly to reduce the mass," says Baretzky. "The stiffness of the valvetrain may also have been a concern."

RECIPROCATING ASSEMBLY

It's clear that the Auto Union engines remain a source of fascination for one of the pre-eminent race engine designers of our age. With that in mind, I ask which aspect of these incredible machines holds the greatest interest.

"For sure, it's the 16 cylinder crankshaft," Baretzky replies. "It's a multi-piece design, built with roller bearings. At that time they probably weren't thinking too much about friction reduction; they used them simply because the conventional bearing shells and the oils were of such low quality that it was the only way they could engineer reliable bearings."

Classic flat bearings simply wouldn't have coped with the loads generated by the V16 on contemporary oil. "The only thing you'd use 1930s oil for today is making salads," he jokes. "It had none of the modern additives that you'd use to optimise the engine."

The crank itself is a work of art, comprised of no less than 65 different ▶

pieces. Each pin requires screws to attach it and shims to locate it, so by the time you've taken into account the conrods and bearings, the complete assembly includes a mind-boggling 1,625 parts. Consequently, the whole thing is peppered with holes to provide the necessary tool access.

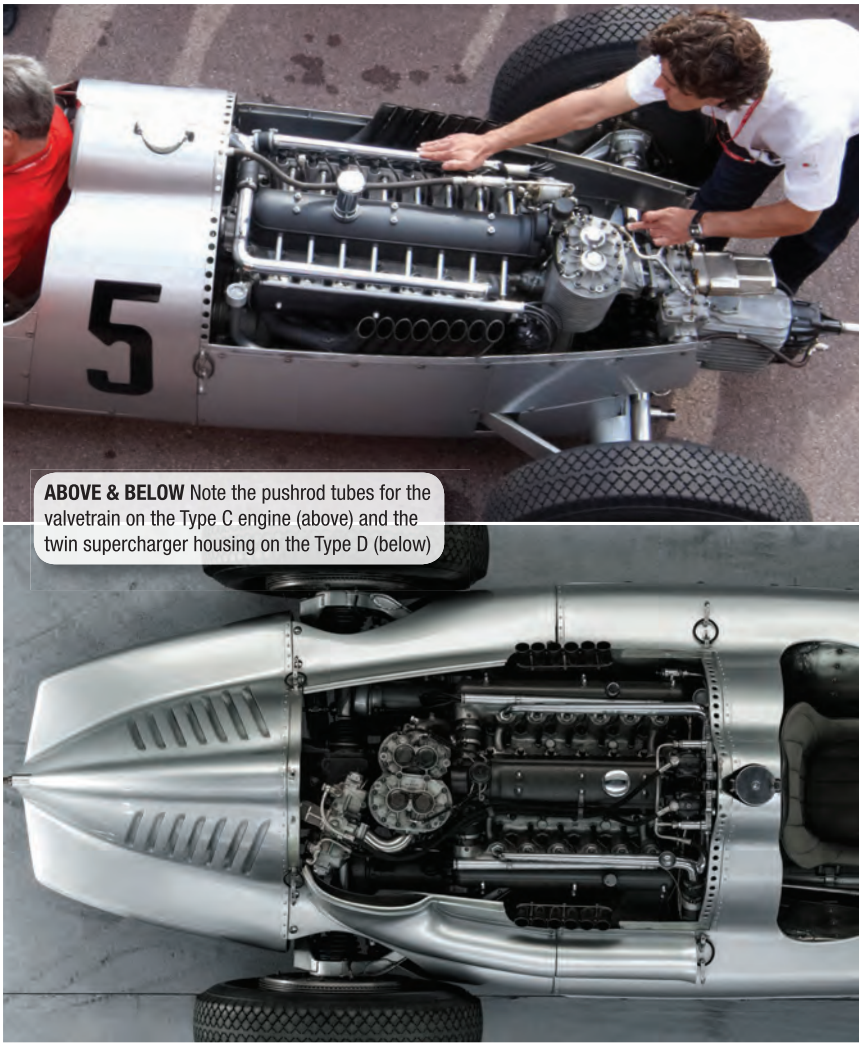
In a rare concession to modernity, Audi's D-Type replica uses shell bearings in place of the original rollers, to extend the rebuild life. Even so, it remains a hugely intricate piece of equipment. "What we learned when we started making replacement crankshafts was that you cannot machine the parts individually because of the distortion when they're joined together with the correct torque," explains Baretzky. "You have to leave excess material on them, assemble the crankshaft and then grind the pieces. The moment you take them apart they distort again."

CYLINDER HEADS

The power generated by the Silver Arrows was utterly unheard of at the time. Incredibly, it wasn't until the turbo era began in the late seventies that their outputs were bettered in Formula One. Successfully producing all this power basically comes down to three things: providing enough air flow through the engine; getting the reciprocating components to withstand the velocities and accelerations involved; and ensuring that stable combustion is able to take place without detonation.

Both variants feature very wide valve angles and large combustion chambers (presumably to maximise the port area and improve gas flow). With the benefit of hindsight, this results in a very long flame path, which means there's more time for any pockets of unburnt mixture to reach sufficient temperature and pressure to ignite. Likewise, this geometry also leads to a relatively poor surface-to-volume ratio, making it harder to cool the combustion chamber. Both these factors make the Auto Union engines quite knock-sensitive by modern standards, but at the time they were considered state of the art.

In the thirties, virtually all road car engines used cast iron cylinder heads. The Auto Union engineers, however, used aluminium in their grand prix engines. Doing so required the services of a highly skilled casting company – and indeed still does – but it came with several advantages. As well as reducing the engine's weight and centre of gravity, aluminium has four or five times the thermal conductivity of cast iron, which dramatically improves the heads' cooling abilities.



ABOVE & BELOW Note the pushrod tubes for the valvetrain on the Type C engine (above) and the twin supercharger housing on the Type D (below)

As with any engine, the fuel vapour also provides a degree of charge cooling. "You have to bear in mind there were no intercoolers at this time," comments Baretzky. "You only had a carburettor to mix the fuel and the air, and this mixture then gets taken the whole way through compressors. The idea is that the moment you mix the fuel and air, the charge temperature drops due to evaporation. This is one of the secrets of how the system can survive – the intake temperature is much lower than the ambient temperature due to this process, so even after all that compression you still have a reasonable charge temperature.

"They really understood the requirement to cool the combustion chamber, which was very unusual at that time," he continues. "Today we've gone full circle and we're now trying to reduce heat loss, but that's only possible with modern knock control."

In period the Auto Union engineers overcame these issues by combining the extremely volatile petroleum of the day with chemicals such as methanol, ethanol and benzene. Baretzky likens this concoction to rocket fuel – it comes with a number of unpleasant properties, including the tendency for spillages to burn with an invisible flame – and he says he's in no hurry to use ▶

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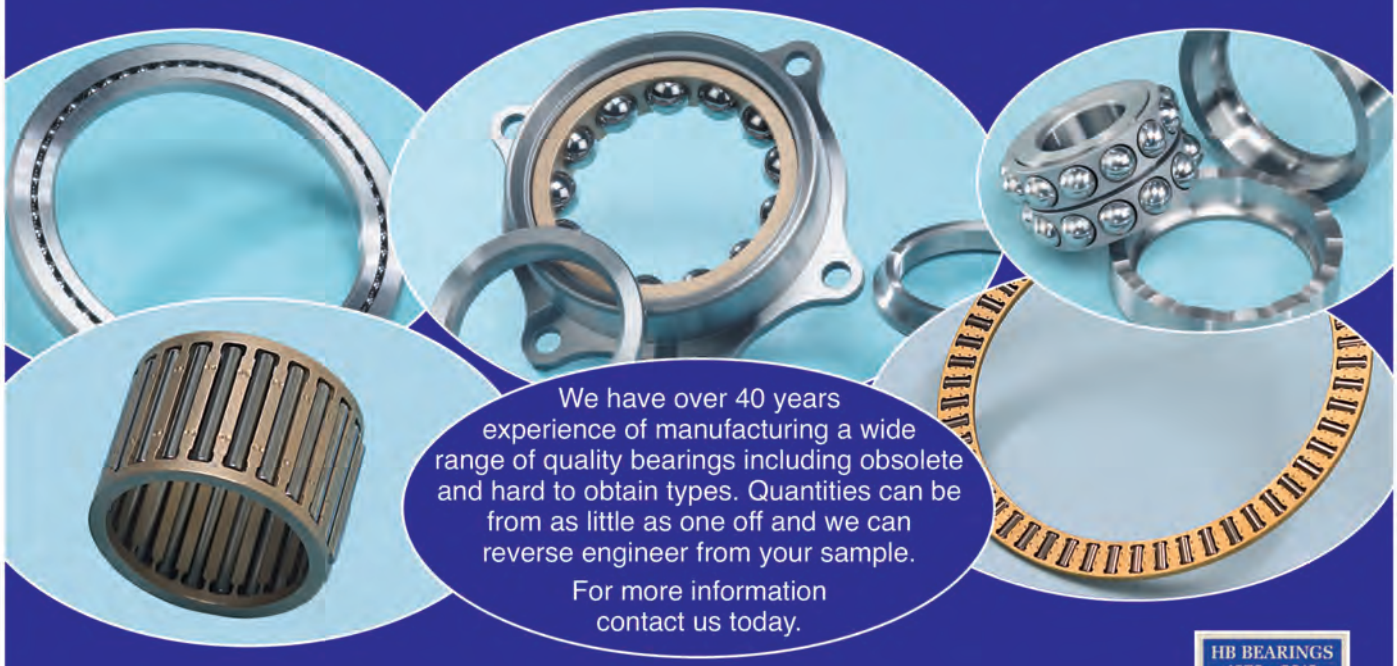

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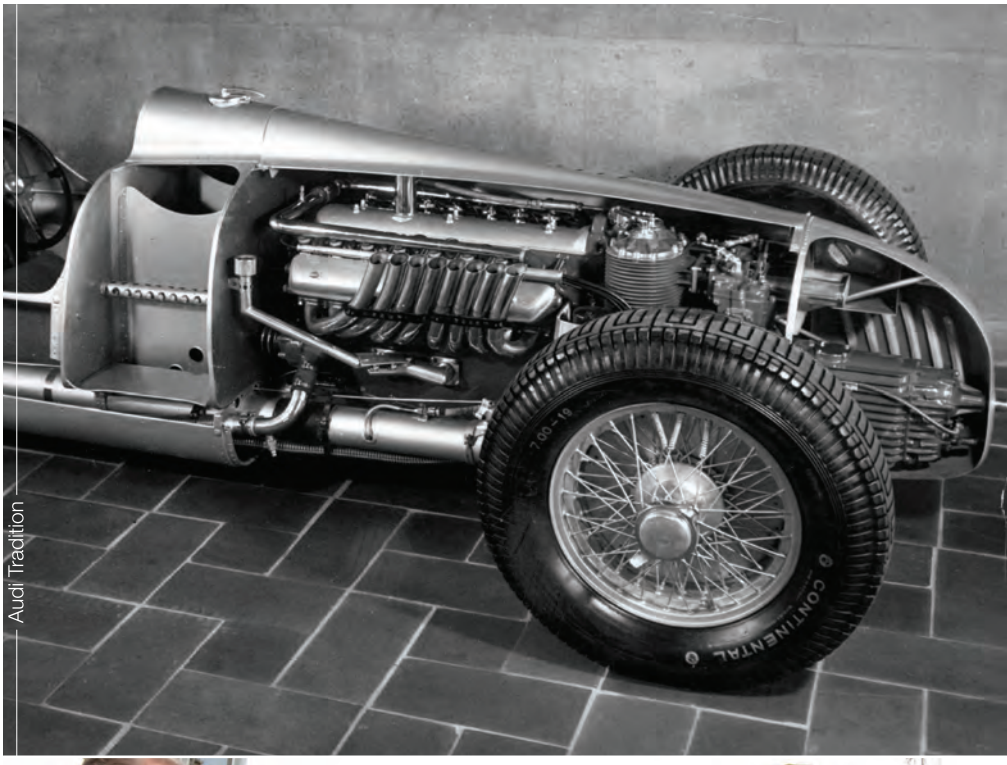


Audi Tradition

anything like that today.

"These days we're not competing against Mercedes or Alfa Romeo anymore so it's no longer important to get the maximum power out of the engine, we just want to make it as clean, smooth and comfortable as possible," he comments.

Faced with using standard fuel, Audi uses subtly revised pistons to reduce the compression ratio. Fortunately, the large valve angle gives a huge volume to the combustion chamber, which the piston crown almost fills at top dead centre. This gave the engineers plenty of scope to remove material, without deviating too far from the original design, while the material itself is a modern alloy in place of the original grade, which is no longer available.

BANG AND BLOW

One of the most forward-thinking concepts employed by Auto Union was the twin-stage supercharging seen on the later Type D cars. When the downsized V12 engine first appeared in 1938 it used a single supercharger, much like the V16. Faced with squeezing more power out of it the following year, the engineers had basically two options: more revs or more boost.

The V12 was already pushing the envelope when it came to engine speed, Baretzky points out: "Engine speeds over 10,000 rpm weren't even imaginable at that time. The materials didn't last, the bearings didn't last, the heat treatment and the surface of the camshaft didn't last. Plus, they didn't have the technology to control the valve movement at high rpm the way we do today."

Instead, the 1939 cars ran almost twice the boost, using two Roots-type compressors enclosed within a single supercharger casing. This follows very similar principles to the multi-stage turbocharging seen in a wide range of high-performance petrol and diesel engines today and the thinking appears to have been very much the same.

"If you keep enlarging the size of [a single] compressor, eventually the only thing you generate is more heat,"

CLOCKWISE FROM ABOVE The 6-litre Auto Union Type C, demonstrated here in Monaco, produced well over 500 bhp

explains Baretzky. "You have a ratio of the ambient pressure to the charge pressure, which is limited by the technology of the compressor. If you exceed a certain limit you have too much back-flow because there is no density left. If the pressure ratio goes too high you cannot improve it. The only option was to switch to multiple compressors, the same as we do today. The air is compressed by one large supercharger and then compressed further by a second smaller one. These days it's normal, but at the time it was revolutionary."

> **"You cannot buy success with money. You still need great ideas"**

The twin-stage supercharger on the Type D is fed by a single shaft, split with gears. The speed ratio between the two is fixed and the volumetric ratio has to be the same, so the smaller compressor is geared to run much faster than the bigger one. "Calculating the speed ratio is not easy. I don't know how many tests they had to do, but I can only imagine they had some very clever engineers working on the project," notes Baretzky.

LEGACY

It's no secret that the Silver Arrows of Auto Union and Mercedes received substantial backing from the German government. Hitler reputedly allocated 500,000 Reichsmarks to be shared equally between the two companies with bonuses for each victory, although some say these figures have been exaggerated.

Either way, it certainly wasn't the open cheque book situation that's sometimes made out. When the Berlin Wall came down, Audi was able to reconnect with some of the surviving members of the Auto Union team and many turned out to be long-term Horch employees, who'd grown up in the area.

"You cannot buy success with money. You have to have a dedicated group of people and you have to give them enough resources to make it possible, but still you need great ideas," comments Baretzky. "Don't forget that Auto Union was not what Audi is today. In 1932 all four brands that made up the group were bankrupt."

Fundamentally, it was the ideas and the attention to detail behind the Auto Unions that set them apart. There's no doubt that Ferdinand Porsche and his colleagues truly understood the benefits of a mid-engined layout decades before the idea would return to grand prix racing. They also developed some of the most sophisticated engines in the world at that time.

Baretzky clearly has a great deal of admiration for his illustrious forebears, so I'm keen to find out how they've influenced his own career. "I wouldn't say they've been an inspiration, they've been a burden," he replies. "Not so much with the diesel, but when we made the 3.6-litre V8 petrol engine for the R8 Le Mans car it was the first purpose-built race engine to come from Audi since the Silver Arrows. Every other competition engine the company had done since was in some way based on a production engine and I was very much aware of that."

Three-quarters of a century after they burst onto the grand prix scene, it's unclear whether the impact of the Silver Arrows will ever be rivalled. But after decades hidden and neglected behind the Iron Curtain, they're now captivating a whole new generation. HRT

Silverstone Classic

ABOVE The appeal of the HSCC Super Touring series: 2000 Ford Mondeo, 1991 BMW M3 and 1999 Nissan Primera, all in original livery

Back by popular demand

Andrew Charman analyses the challenges of running a Super Touring car in today's mushrooming historic championship

THE HSCC Super Touring Car Championship is currently without doubt one of the fastest-growing series in the historic arena. Conceived as a guest race at the Silverstone Classic meeting just two years ago, the series became a five-round Cup in 2013, bolstered by former BTCC stars John Cleland and Patrick Watts coming out of semi-retirement to take part. This season it has evolved into a full-blown championship under the umbrella of the HSCC.

At the Silverstone Classic meeting in July the Super Touring grid numbered more than 40 cars, outdoing the 29-car field assembled a month earlier for an unprecedented guest slot on the support bill to the current British Touring Car Championship (BTCC) at Oulton Park. The latter was a meeting in which the crowds displayed enthusiasm for the historic cars to a level that clearly surprised those running in today's BTCC.

The collapse of Super Touring in 2000 rendered redundant some of the most complex racing saloons ever built. Brimming with exotic materials, these cars had been tended by motorsport minds to the highest technical calibre, who simply moved on to teams in F1, the WEC and IndyCar. Now, little over a decade on, these same cars are being dusted down and raced again, by what are generally club competitors. How can they do it? To find out, HRT spoke to those involved.

CHOOSE CAREFULLY

The first challenge to the growing number of drivers wishing to get involved in the series is finding a car. Besides the BTCC, during the Super Touring era there were high-level championships in countries as far apart as Germany, Japan, Australia and the USA, as well as several smaller series. The top level manufacturer teams completely renewed their cars every season – so in theory there are plenty of cars about. But according to series co-ordinator Jonny Westbrook, it's about finding the right car.


Jamie Cleland

ABOVE Jamie Cleland rebuilt the 1997 Vauxhall Vectra raced by his father after he found the car while surfing Facebook

"Various cars are better supported than others," Westbrook says. "There are a number of Nissans in the series for example, so the chances of your pal having spares for your car are higher than say they would be for someone running a Volvo. You have to put quite a lot of thought into finding the correct car for the correct money."

Westbrook has bought several cars himself, and for him condition is not a vital factor. "If it's complete, I hit the start button and it has oil pressure, then it's going on the trailer," he says. "Its condition is not essential as I know I can fix it, but if you buy an incomplete car – perhaps that needs a new engine or a gearbox – you will be needing such items as wiring looms or sensors. Once you start buying those individual parts you are into a massive amount of money."

Cost is also becoming a more pertinent factor, the growing popularity of the series inflating prices: "We've made a rod for our own backs really – a dusty old car someone has had sitting in the back of a garage for 15 or 20 years has suddenly become more valuable.

"Currently prices vary from £30,000 right up to around £175,000 – and rising. A certain model of BMW sold for a figure last year and the next two of the same type sold for double the amount, the next even more. The real blue-chip cars are fetching big money and everything else is going with them."

The reason Westbrook does not worry too much about a car's condition ▶

Silverstone Classic

BELOW The Super Touring line-up at the 2014 Silverstone Classic. The series has caught the imagination of both competitors and spectators

is that most competitors completely rebuild their car before racing it. When undertaking this, the mega budgets the cars were constructed to – up to half a million pounds in the final years of the formula – offer both advantages and disadvantages.

Westbrook is proud of the fact that his Audi boasts very high quality components – Pankl Racing Systems titanium flanges and shafts, and Bosch management to mention just two. And because the cars were built to such high standards, many of the components can be refurbished, no matter how tired they might appear. And this is very desirable, because in many cases obtaining new replacements is well nigh impossible.

Jamie Cleland, who prepares the 1997 Vauxhall Vectra built by Triple Eight Race Engineering and driven by his father, 1995 champion and BTCC legend John Cleland, regards the Super Touring years as technically a very strange era of motor racing. "It was a throwaway attitude," he says. "It didn't matter what it cost: if it produced the extra hundredths of a second, they ▶

The Super Touring sensation

SUPER TOURING'S revival is all the more remarkable for the fact that the series caters for cars from a very short, but tumultuous period in the history of Touring Car racing – the 2-litre formula, soon dubbed Super Touring, lasted a mere nine years.

Conceived in 1990 as a class in a BTCC dominated by flame-spitting 5-litre Sierra Cosworths, the 2-litre formula took over just a year later. The Cosworths made way for what were basically reps' cars, such as the Ford Mondeo, Vauxhall Cavalier and Renault Laguna.

The view was that fans would identify with recognisable cars they drove themselves and within two years this concept was emphasised by the insistence on at least four doors, removing such cars as BMW's M3 from the mix. The fans indeed loved it, the TV coverage became must-watch, other countries followed suit, and car manufacturers clamoured to join in. By 1994 there were an unprecedented 10 works teams competing in the BTCC.

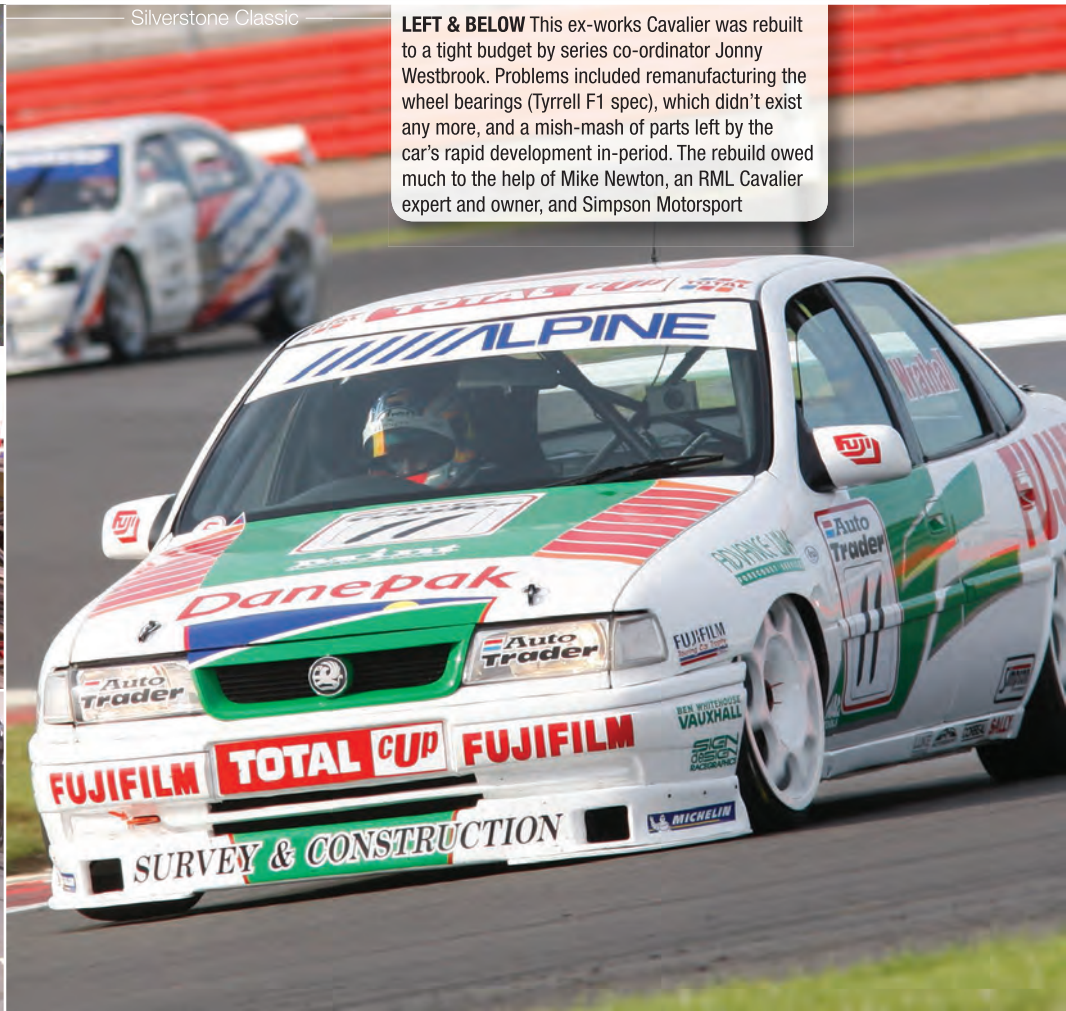
With the manufacturers, however, came huge budgets and pushing the envelope to the nth degree. Alfa Romeo's clever and controversial reading of the aerodynamics rules in 1994 (detailed in the November edition of our sister magazine *Race Tech*) resulted in wings and splitters being mandated for 1995.

Budgets mushroomed as top international teams and former F1 drivers came to race in the BTCC. Renault's cars, to give just one example, were run by the Williams Formula 1 organisation, the team manager Ian Harrison's previous charges having been Ayrton Senna and Damon Hill.

By the end of the 1990s manufacturer budgets were in multiples of millions. Some simply couldn't afford it and dropped out, the trickle soon became a flood, and in a remarkably short space of time Super Touring died; the 2000 season was the last for a formula killed by its own excess. HRT

Jonny Westbrook

Silverstone Classic



LEFT & BELOW This ex-works Cavalier was rebuilt to a tight budget by series co-ordinator Jonny Westbrook. Problems included remanufacturing the wheel bearings (Tyrrell F1 spec), which didn't exist any more, and a mish-mash of parts left by the car's rapid development in-period. The rebuild owed much to the help of Mike Newton, an RML Cavalier expert and owner, and Simpson Motorsport

would spend a million on it; if it didn't, they would put it down and spend another million on something else."

The excess was illustrated very clearly to Jamie by a former Triple Eight mechanic. "The bottom drawer of his toolbox was full of bearings and nuts and bolts that I would kill for now, and after every race they would throw away the suspension; after every half-season they would re-nut and bolt the whole car. A little quarter of an inch bolt was worth £15, with a thousand of those across the car – a huge expense, unbelievable."

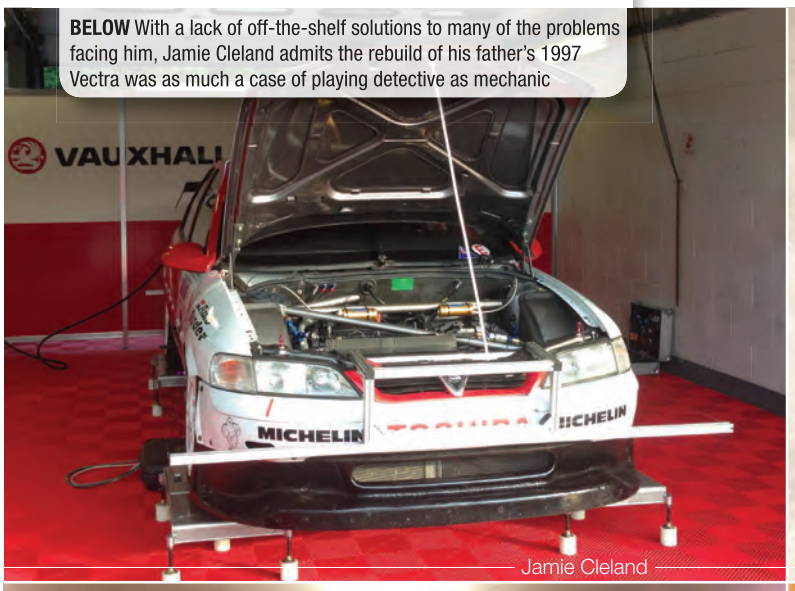
Contacting the teams that originally ran the cars is generally a waste of time as they have no spares and no records. Super Touring is recent history and many of the teams are still in the sport in some form and focused firmly ahead. Triple Eight, for example, currently runs MG's BTCC campaign. "Triple Eight worked on a 12-month basis and moved on," Cleland says. "All the spares from 1997 were sold to Scandinavia, and they washed the floors and started again in 1998, and probably again in 1999."

Westbrook adds that many competitors are now having to re-engineer elements of their cars, with the emphasis switching from outright pace to durability. "There are drawings about but it is often easier to reverse-engineer and go with what you have already. To give an example, those that have been using Del West titanium valves are going to steel: it minimizes the risk and we won't notice a difference in performance, whereas back then they would have done."

Meanwhile time has made some components more accessible. Dave Jarman is currently racing his third Super Touring Nissan Primera, the 1998 Team Dynamics car of Matt Neal. Jarman recalls with a smile a piece of BTCC TV coverage when Neal's father Steve, head of Team Dynamics, complained that a carbon-fibre splitter that had been wrecked on the car had cost him something like £5,000. "Carbon is not an exotic material now, it's normal, you can get anything you like made in carbon."

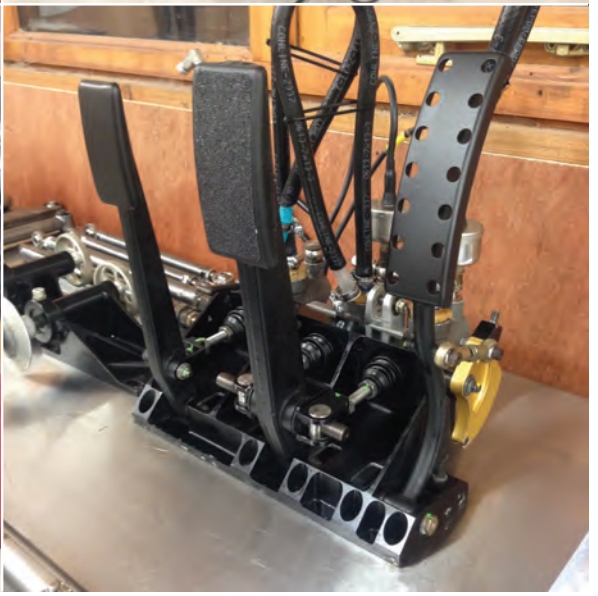
NUMBER-CRUNCHING

Once a Super Tourer is ready to race, getting the most out of it at the circuit ▶



BELOW With a lack of off-the-shelf solutions to many of the problems facing him, Jamie Cleland admits the rebuild of his father's 1997 Vectra was as much a case of playing detective as mechanic

Jamie Cleland



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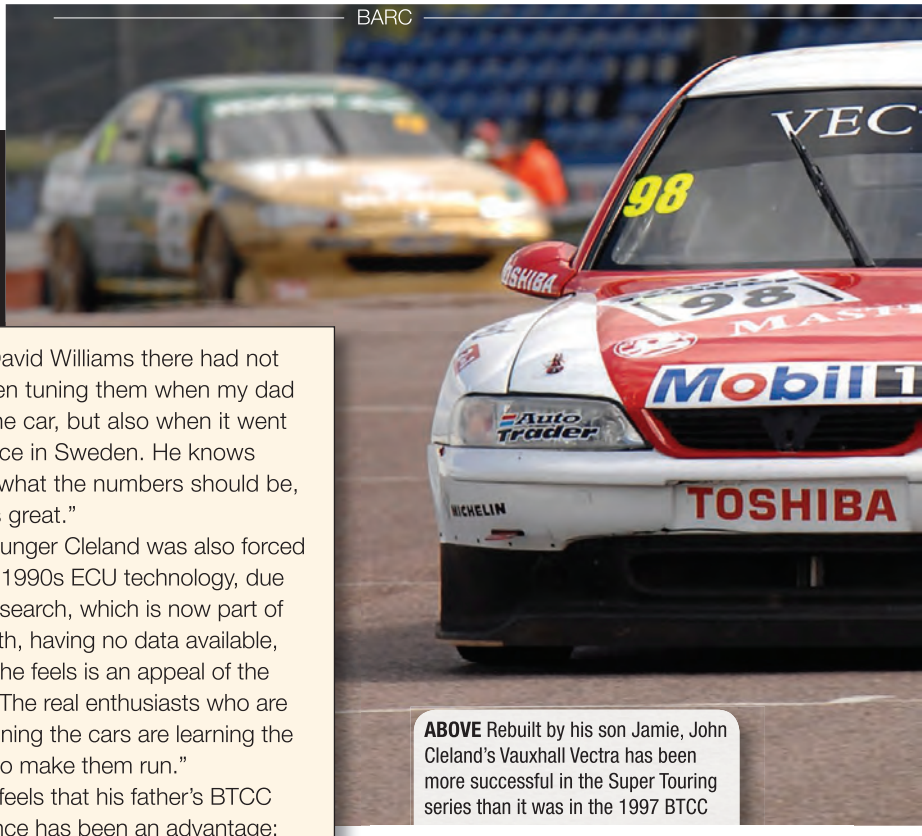


ABOVE Rebuilt by his son Jamie, John Cleland's Vauxhall Vectra has been more successful in the Super Touring series than it was in the 1997 BTCC

CASE STUDY
John Cleland – 1997 Vauxhall Vectra

THE arrival of BTCC stars John Cleland and Patrick Watts added extra kudos to the Super Touring series, but Cleland had no plans to return to racing until his son Jamie found the car while surfing the Facebook social media site.

"I had no intention of buying a car, though I knew the series existed," John says. "But it was definitely my car, chassis #1 from the Triple Eight days, so it had all of those things going for it."

Before long the Clelands had bought the car, and Jamie set himself the task of rebuilding it. "I've been involved in motor racing for many years, but always in single-make series, modern road car-based technology such as the Porsche Carrera Cup," he says.

"The last time I saw a Super Tourer I was eight years-old, so to open the bonnet and look under the arches was amazing. It took me some while to get used to it because it was so radically different to anything I had seen before."

As he rebuilt the car, he learnt about it: "I looked at old 1990s part numbers; it was more like being a detective than a mechanic. You can't buy anything off the shelf for these cars, everything comes bespoke. For example, we sorted the leaking power steering rack with seals from a 240Z Datsun. It was a nightmare but also great fun."

Jamie admits that the gearbox caused the most issues: "It's an Xtrac gearbox and the technology has moved on so fast, the castings are a thing of the past. Everything was magnesium too so can barely be repaired. I can fabricate anything I need for the suspension but magnesium gearbox casings are a problem."

He adds that the easy accessibility of the 'box, so as to aid rapid ratio changes, has a flip side. "They tend to get damaged very easily in a shunt – usually it's the gearbox casing that suffers."

Other aspects were less difficult: "I phoned Aurok Ltd about tuning the dampers and discovered that a guy called David Williams there had not only been tuning them when my dad raced the car, but also when it went on to race in Sweden. He knows exactly what the numbers should be, which is great."

The younger Cleland was also forced to learn 1990s ECU technology, due to PI Research, which is now part of Cosworth, having no data available, but this he feels is an appeal of the series. "The real enthusiasts who are now running the cars are learning the means to make them run."

Jamie feels that his father's BTCC experience has been an advantage: "The engineer was paid to crunch the numbers, how many degrees of camber and such like, but dad has a good enough technical understanding, and was in the series all his racing life, so he can say when it needs a click of rebound, a click of bump steer. That and my mechanical background enabled us to get a baseline setup.

"Fortunately, a guy called Mark Way, who was dad's engineer in 1998, had some information about spring rates and such like, which proved what we were doing was right. It gave us confidence when we arrived at the circuit, because you don't have the happy-hour Friday test sessions of the old days – you have two 15-minute sessions and if you don't get it dialled in during the first one, you are already on the back foot."

Jamie's first season preparing a Super Tourer produced two wins for his dad and a championship runner-up spot, both convinced that the younger age of the Honda Accords they were racing was the decisive factor.

Having proved himself, Jamie would like to secure a customer car in 2015 to run alongside his dad's. "It was our rookie season and while we had the driver, I was new to the series, so I want to get someone off the back of that and run two cars, perhaps an Audi or a Renault." HRT

is a whole new challenge. Particularly in the later years, Super Tourers were exotic cars, with very highly paid and skilled race engineers spending swathes of their race weekends crunching data. So it's no surprise that today the cars are not run to the level they were in their heyday.

"In terms of setup data it depends on what package you have gone with," says Westbrook. "Sometimes, if you get a really good deal, a couple of setup sheets will be included; sometimes you can speak to someone and they still have something on their system. Sometimes someone will try and rip you off and sell you a load of information that may or may not be any good."

He quotes as an example the 2000 Honda Accord of Stuart White, eventual joint runner-up in the 2014 championship with John Cleland. "Stuart is still trying to learn his Honda and it is not currently going any quicker than his 1996 car, because the later the cars got, the more twitchy they got and the more you needed all of the people around you to get them into the window in which they worked.

"The earlier cars were more driver-friendly – at the level that we are running, you can possibly get the same out of an earlier car as you can a later car."

Andrew Charman

ABOVE The engine bay of Dave Jarman's Nissan Primera – in many cases engine preparation is being carried out by the same specialists who built the units in the 1990s

John Cleland, who of course knew the period intimately, concurs: "The drivers today are driving these cars to a degree where they are comfortable, and when these cars, particularly the later ones, were going quickly they were never comfortable – they were on the ragged edge, nothing else left. You had to be there to be at the front.

"Today they are being driven quickly, but if the drivers of the day were to step back into them they'd go quicker still. That's the difference."

According to Cleland Triple Eight invoiced Vauxhall £395,000 for each example of the Vectra he races. "They cost £5m to run; now we are running them on £50,000. Everything was lifed, and thrown away – we have to make them last. Electronics-wise we struggle to interrogate the data as all the programs are gone. We don't have the old computers and their software."

Westbrook adds that the later cars are definitely more difficult to run: "They are the result of many years of progress, and budget. A 1992 budget was probably a tenth or less than what they spent in 2000.

"I can easily run my 1995 Cavalier myself, but take for example the 1999 Lagunas that have come into the series this season: they are on a combination of Magneti Marelli and Williams ECU data – it's very difficult to work out. The team had to fly a guy over from Serbia who knew that system simply to get the cars working.

"The early cars are equally popular. While you will always have guys that are desperate to run at the front, we've built a really strong class structure to provide something for everyone."

As the series evolves, historic preparation specialists are getting involved. "Simpson Motorsport has come to the series and is now running cars," notes Westbrook. "Historic preparers such as Simon Hadfield are expanding to include Super Tourers and learning their way like the rest of us. Mardi Gras is now running a 156, for example."

He expects the series to evolve further next season, but adds: "We are trying to keep the number of races fairly low so we don't put too many miles on the cars because we know how much they cost."

MORE CARS

Dave Jarman believes it is essential to persuade more cars into the series as this could help reduce costs: "We have 20, 25 raceable cars now; if we had 40, 45, then costs would fall – for example a remanufactured hub might suit six to 10 of them."

Westbrook agrees that more re-engineering lies in the future, as do more series-wide measures. "I can see us going the way the Group C historic series has in terms of safety, with more crack testing of corners, uprights and such like. It's very expensive but at the end of the day we are looking after our own group of drivers. It probably won't be next season but perhaps the season after.

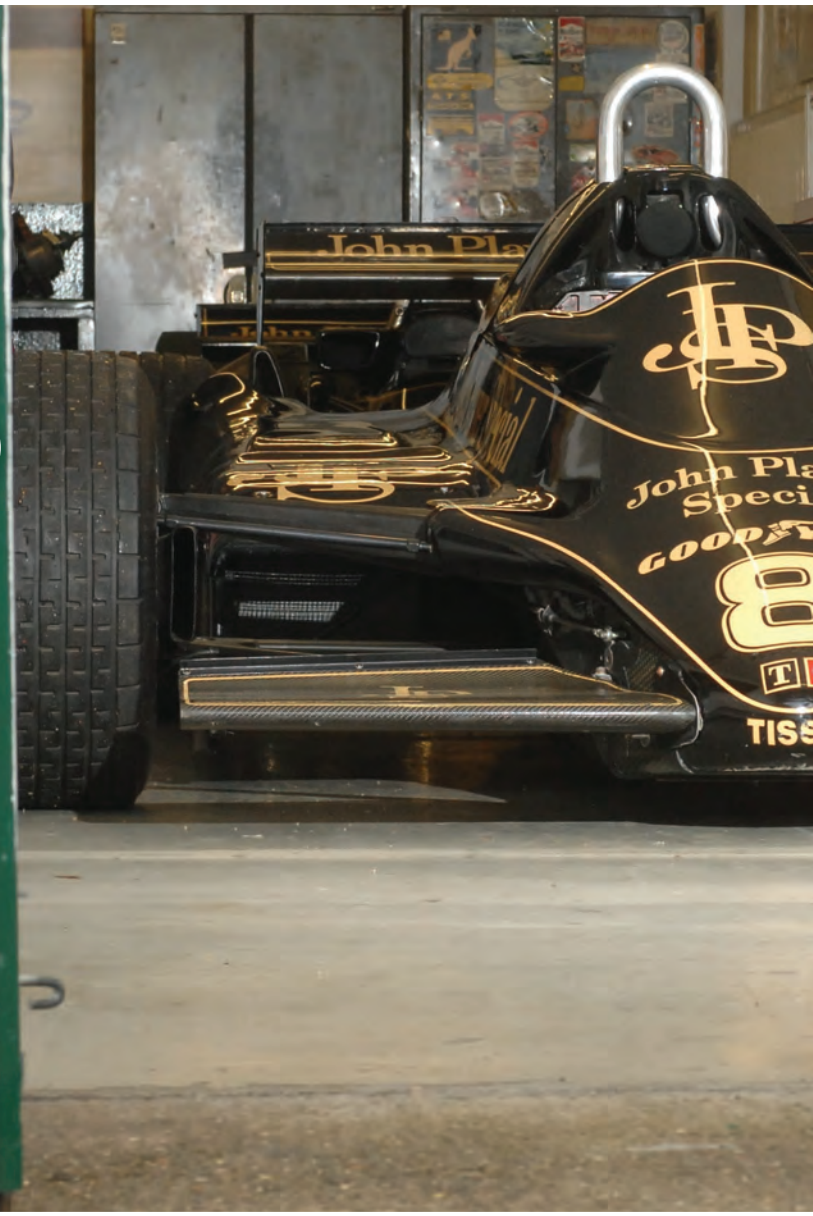
"We all try and help each other as much as we can. We are quite a small entity and it is in our interest to keep as many cars on the grid as possible." HRT

BELOW The Super Touring reign left us the legacy of some of the most complex racing saloons ever built

Silverstone Classic

THE FULL WORKS

Classic Team Lotus holds a unique position within historic racing. **Andy Swift** pays the team a visit to find out more

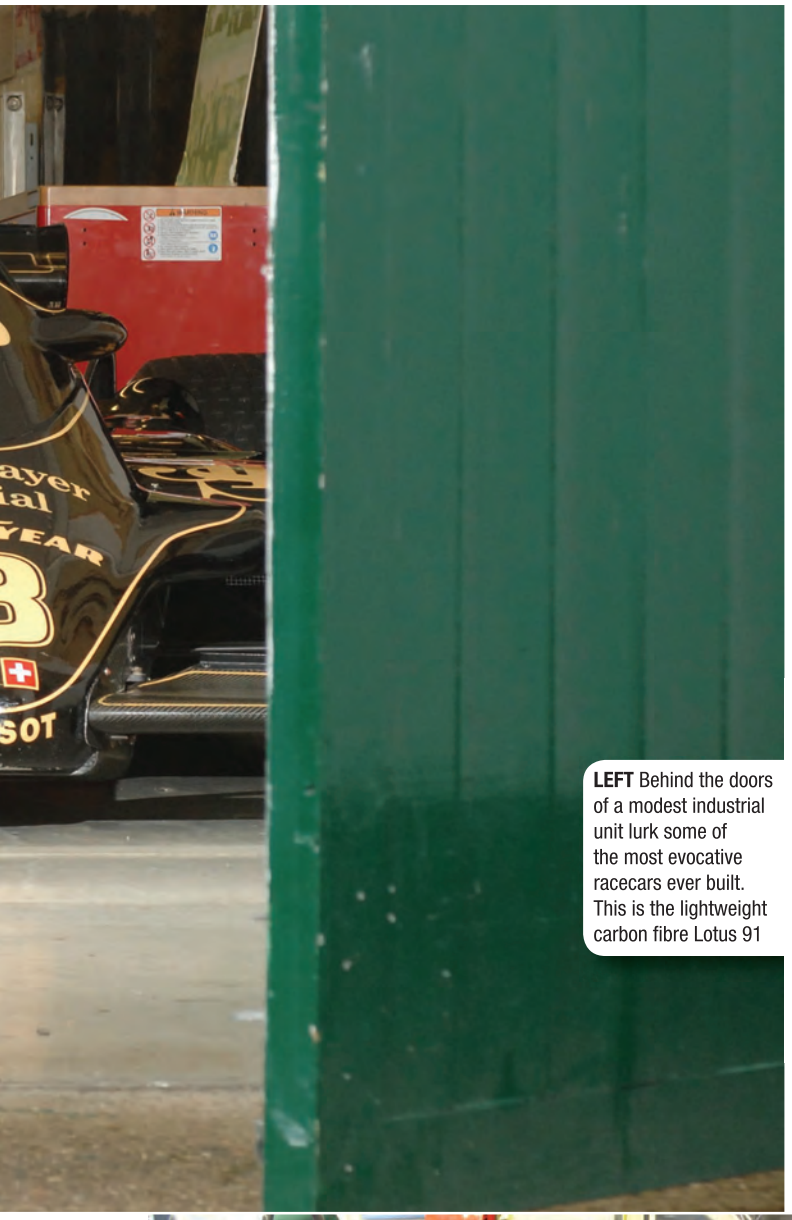


OCCUPYING a relatively anonymous industrial unit in deepest rural Norfolk is Classic Team Lotus (CTL) – perhaps the only outfit in the UK with a claim to being a true works team in historic racing. The company restores, operates and prepares some of the most innovative and evocative cars from grand prix history and it's still winning races today under the guidance of Clive Chapman, son of Lotus founder Colin.

This lineage is perhaps the most striking difference between CTL and the majority of other historic race teams. Operating from the original Team Lotus workshops, just across the road from the current base for Lotus Cars, CTL retains the full archive of period drawings and spare parts. Not only that, but the team retains close links with period staff such as Eddie Dennis, once Mario Andretti's chief mechanic, Martin Ogilvie, former chief designer at Team Lotus, and Bob Dance, a personal friend of Bernie Ecclestone who has worked on Team Lotus cars almost continuously since the early 1960s.

Dance was Jim Clark's mechanic during the team's heyday and he still works three days a week in the workshops, as well as supporting trackside operations. Clark's 1963 title-winning 25/R4 is one of the most revered cars in the marque's history, carrying the Scot to seven wins. CTL now runs the car for its current owner in historic events and Dance remains the sole mechanic allocated to this special machine. We find him, spanner in hand, tending to 25/R4. "We're just waiting to get the engine back from the builder then we can slot it in and have a go at winning the next race," he quips.

The workshop itself comprises informal bays, with each mechanic taking his own area. From there, each man might tend to up to three cars, but each car will only have one mechanic. CTL's events manager Sapphire Whitbread believes this is a key aspect of the team's performance. "Every mechanic has very specialist knowledge of the cars they work on," she comments. "They offer a single point of contact for a driver, enabling them to build up a special



LEFT Behind the doors of a modest industrial unit lurk some of the most evocative racecars ever built. This is the lightweight carbon fibre Lotus 91

relationship. We believe this approach is part of the reason for our good finishing record and probably sets us apart from other, similar, companies."

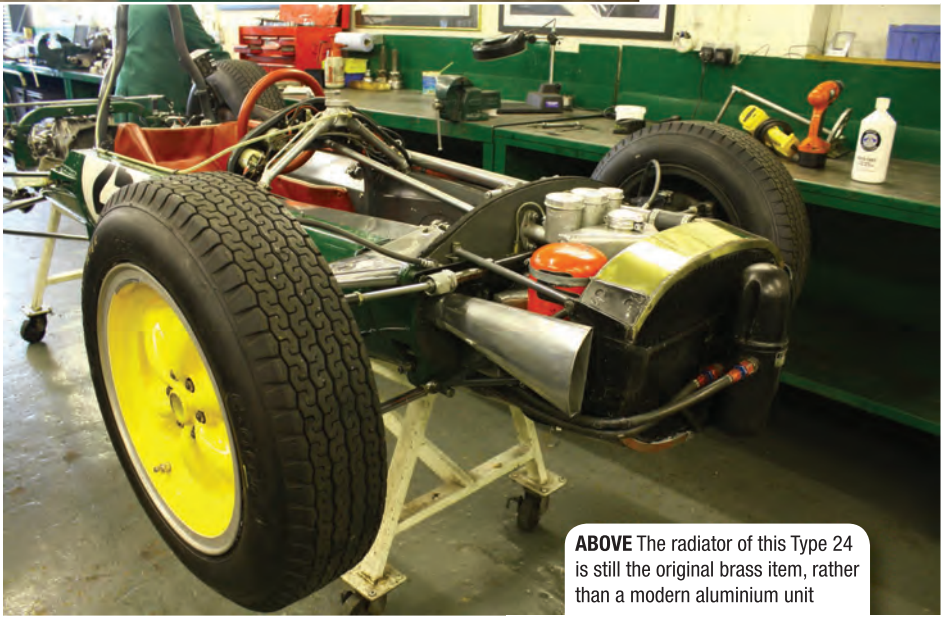
In spite of the inherent quality control of each car taking a designated mechanic, CTL team manager Chris Dinnage is also a hands-on part of the team. Dinnage joined Team Lotus in 1982 and acted as one of Ayrton Senna's senior mechanics during the Brazilian's stint at the team. Prior to any car leaving the premises, it is personally shaken down by Dinnage on the test track at Lotus Cars, only a few hundred metres down the road. With a rural location and accommodating neighbours, this offers the opportunity for the team to run virtually every car unsilenced at its convenience – just as Team Lotus did in period. Not only is the facility itself a fantastic blessing but having an experienced driver like Dinnage carrying out the work provides a useful datum for customers when they take to the wheel themselves.

WARM-UP ROUTINE

This unique capability is demonstrated during our visit. Noted Spanish historic competitor Joaquin Folch is also on site preparing for a run at the Goodwood Members' Meeting. Folch is to drive Ayrton Senna's first ever grand prix winner – the 1985 97T, in menacing JPS livery. It is wheeled into the car park to be warmed up, an operation performed by Dinnage himself – just as he did for Senna during the 1980s. The spectacle of this ludicrously loud and priceless slice of F1 weaponry being revved in the car park of a provincial industrial unit is every bit as incongruous as it sounds. Shortly its distinctive V6 timbre can be heard performing rapid laps of the nearby test track. As a demonstration of CTL's facilities, it's as evocative as it is articulate.

Our tour brings us to another JPS-liveried car. The introduction of flat-bottomed regulations to replace ground effect for the 1983 season was announced late in 1982, banning skirts and mandating a flat undertray from midships through to rear axle. The change was announced so late that many teams were forced simply to update their existing cars, including Team Lotus. The 1982 ground effect 91/5 was converted to Type 92 specification for the 1983 season, with a flat undertray and shorter sidepods as visual give-aways.

This particular 92 has enjoyed a successful career in historic racing, winning the 2013 FIA Historic Formula One Championship in the hands of owner Greg Thornton. Thornton has since commissioned CTL to retro-engineer the car back to its original 91/5 configuration. Lead mechanic for the car Ted Fiddy has overseen a process which has utilised the full breadth of the ▶



ABOVE The radiator of this Type 24 is still the original brass item, rather than a modern aluminium unit

team's facilities and capabilities.

Being in possession of the original drawings for the 91, the firm's in-house composite team was able to produce a brand new flat carbon fibre floor, exactly to the original drawings. "We actually used a wet lay technique, rather than pre-preg using an autoclave," explains Fiddy. "This means our parts might be a fraction heavier than the originals, but this process offers us a number of benefits. Firstly it's cheaper than out-sourcing, but also, crucially, enables us to manage our own timescales. We can control the whole process ourselves and we aren't dependent on third parties. As well as that, with wet lay we can easily make repairs if required – we can cut sections out and bond in new ones pretty quickly and easily."

and a race weekend is so busy that we haven't got the spare time to properly analyse the results."

The level of data logging the team does use varies from car-to-car but the DFV era cars typically run a Stack system. This displays parameters such as revs, oil temperature, water temperature, oil pressure and water pressure on analogue dials, as well as measuring wheel speed. The data is available to download onto a laptop if required.

"We use electrical sensors now with the Stack system, rather than the old mechanical sensors, though you can still see where they were situated. Today the regulations prohibit the use of brake and damper sensors for racing, though I suppose they could be used for testing," comments Fiddy.

against the grain for a company which prides itself on its authenticity.

The 1960s racers such as the Type 21 and Type 25 would never be permitted modern Stack display units, purely on aesthetic grounds, and this approach runs through every part of the cars. One of the most celebrated chassis is the Type 21 which took the team's first victory, at Watkins Glen in 1961, driven by Innes Ireland. It now belongs to arch Lotus enthusiast and loyal CTL customer, Dan Collins. He's not the only person with his eye on it, though. "This is a very special car for us and we'd really quite like it for ourselves," jokes Whitbread. "Unfortunately Dan is rather attached to it, but we still get to run it for him."

Underneath the bodywork, the authenticity remains. Rather than using

LEFT TO RIGHT Three CTL charges in action: the 102-Lamborghini; the 97T in which Senna scored his first GP victory; and the mid-engined Lotus 38 Indy 500 car

Also in attendance on the day is sign writer Paul Banham. Living and working locally, Banham worked on Team Lotus cars during his 1970s apprenticeship and now does all the team's livery work. This includes any decals and hand painting required for 91/5's bodywork which he is surveying during our visit. These small factors all help contribute to the authenticity of CTL's work.

Even in club-level motorsport, data logging and analysis is becoming ever more prevalent and more affordable. The concept is a broad one, though, as Chapman points out; a data logging device could be something as simple as a tell on the rev counter.

CTL does embrace the basics, but for reliability reasons, rather than outright performance, as Fiddy describes: "There's a limit as to how much use data logging can be for us. Even the very best amateur drivers simply aren't quick enough to benefit enormously from it

Chapman offers some more perspective: "Really we're aiming for reliability – our customers don't want to have to rebuild engines more often than they need to. In fact from that perspective, rev limiters controlled from the spark box have probably made the biggest difference. We're not aiming for the last drop of performance and a DFV can now run up to 1,000 miles between rebuilds."

DAWN OF THE DIGITAL AGE

With the later cars, at the genesis of the computer age, 1980s software and hardware can be a headache. At the time, reel-to-reel computers were used and Renault Sport retains the only fully operational computer for its EF4 turbocharged F1 engine, something which CTL has had the use of previously. Modern ECUs can be substituted for the period devices, but that rather goes

modern plastic cable ties, the team uses simple black electrical tape to allow hoses to run parallel to spaceframe tubing. The hoses themselves are made to CTL's own specification to ensure they offer the right period look. While Collins' Type 21 now runs an aluminium radiator, rather than its period brass item, it's secured in place with bungee cords – just as it would have been when Ireland was driving it over 50 years ago. If these details all sound a little low tech, they're employed because they function perfectly, while maintaining that 1960s aesthetic.

The Type 21 also features a couple of subtle additional safety features which can be easily reversed. A modern Willans six-point racing harness has been installed, while an auxiliary roll cage is fitted above the original. Using common mounting points and painted the same battleship grey as the rest of the car's tubular frame, only the new roll hoop's greater diameter and thicker ▶

ABOVE CTL also supports trackside operations. Here the revolutionary Type 25 is put through its paces at Oulton Park by Nick Fennell

gauge steel belie its modernity. With three bolts it can be removed for display purposes – the Type 21 looking exactly as it did in period once more.

In an adjacent bay, another significant racer from Team Lotus's past is being worked on – though Chapman requests that its identity not be revealed to maintain customer anonymity. Here the old world meets the new. Three mechanics are preparing the car for its visit to the paint shop, where its period hue will be renewed. Aluminium air intakes are gently shaped with a mallet and rivets reinstated as necessary.

Poking out from the monocoque, though, is a piece of cardboard – a sign of a close relationship with fuel cell manufacturer ATL. The team buys exclusively from ATL and utilises an unusual prototyping process. The original manufacturing drawings are sent to ATL, which then produces a cardboard prototype of the fuel bag which is dimensioned exactly to the drawing. This is sent to CTL which installs the prototype for fit. The appropriate mechanic can then mark up any alterations required before ATL commences final manufacture of the tank.

This process might involve slightly more work up-front but it ensures a perfect end product – and acknowledges that even CTL's virtually exhaustive supply of drawings cannot account for any ad hoc modifications made to cars during their lifetimes. It also highlights the benefits of working with a small supply chain comprising long-term, loyal, partners.

UPHOLDING TRADITION

One area where CTL is entirely dependent upon its supply chain is engines. Unlike rivals Ferrari, Matra and BRM, Lotus never produced its own F1 engines in period and that tradition is upheld. A mixture of new and original Cosworth DFVs is maintained by various DFV specialists, while the jewel-like 1.5l Coventry Climax V8s from the mid-1960s are handled by Tony Mantle. This not only ensures each engine is being looked after by a specialist who is preeminent in his field, but removes control of the process from CTL. This is, not unexpectedly, a particular issue during the winter months when many teams send their valuable motors away to be fettled in preparation for the forthcoming season.

Along with the installation of rev limiters and water pre-heaters, various sporting factors have contributed to make the old

BELOW The Lotus 92 in the foreground has been retro-engineered to its original Type 91 configuration. The sideskirts are newly-fabricated parts and are fixed perpendicular to the new carbon floor

racers more reliable than ever before. Today, an historic F1 race is typically of 25-minute duration, resulting in lighter fuel loads compared to how the cars ran in period, when races lasted upwards of two hours. Modern circuits are smoother and more forgiving than the likes of the Nürburgring or Montjuic Park and even the best amateur isn't working his pride and joy as hard as Ronnie Peterson or Emerson Fittipaldi did in period.

SENSATIONAL

In spite of which, the cars are still stripped down and thoroughly inspected after every event. Moving parts such as bearings and transmission components are regularly condition checked. As such, though, there is no 'lifing' process as one might find in the aerospace industry, for example. The aluminium monocoque in Type 25/R4 is the very same one which carried Jim Clark to so many sensational victories, though minor repairs such as rivet replacement will be carried out as necessary. It's a process of frequent and careful monitoring by skilled and experienced mechanics.

We close our tour in the company of Chapman who discusses a couple of the projects which have been most challenging to the team at CTL. The first is the major restoration of Type 38/1. This is the car in which Jim Clark dominated the 1965 Indianapolis 500 to take a famous victory. It is now owned by, and resides in, the Henry Ford Museum in the United States. "The restoration of the 38 was the pinnacle of my career, but it was extremely challenging. The Henry Ford Museum considers itself to be the 'conservator' of the car. This means that anything added to the car had to be considered for its impact over the next 100 years," comments Chapman. "While we take great care in preserving our cars, we are usually preparing for the next race, not the next 100 years! I don't think it fundamentally altered the way we work now, but it certainly added additional considerations to the scope of the project."

The other project which Chapman singles out for special mention is the ongoing restoration of Type 72/5. This chassis was shown in public for the first time in over 40 years at the 2014 Autosport International. It won several races in 1972 in the hands of Emerson Fittipaldi, confirming Fittipaldi's World Championship win before being heavily damaged in an accident at Zandvoort in 1973. From there it ended up in the Team Lotus stores, escaping being destroyed on a number of occasions and even passing time in the piggeries.

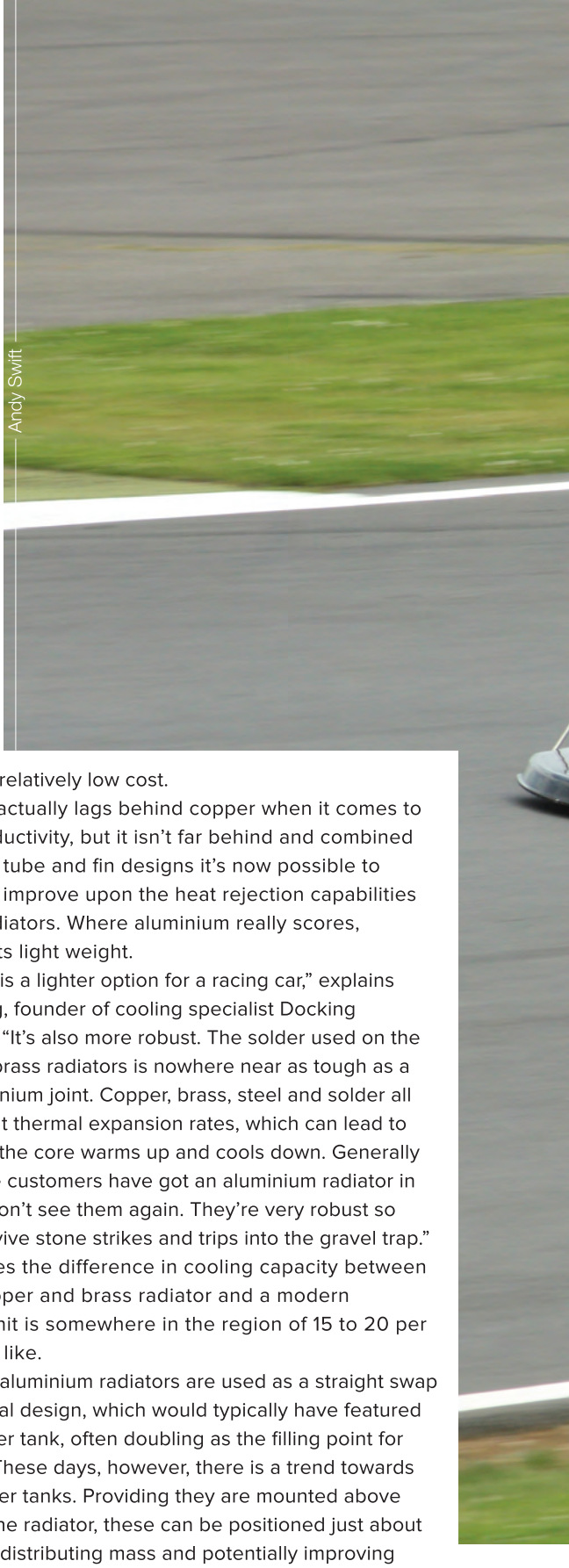
Today it is slowly being rebuilt to demonstration standard, as Chapman describes: "We have the original monocoque, wings, gearbox and quite a bit of bodywork. The chassis was extremely crumpled but we sent it to Competition Fabrications, a local company established by a former Team Lotus fabricator, which has done a remarkable job of straightening it out.

"We're going to keep the car as close as possible to its original specification. It's a nice project as there's no deadline – that means no time pressure and we can be really meticulous. It's been fascinating to learn more about the car. At one time we discovered some tie wraps holding some suspension components in place. This seemed unusual so I called Eddie Dennis, who was a mechanic on the car in period. He knew immediately why they were there. As Eddie is famous for saying, 'There are no mysteries in motor racing'."

> **"It escaped being destroyed on a number of occasions and even passed time in the piggeries"**

It may be true that there are no mysteries in motor racing, but accessing the expertise to dissect the sport's glorious history is often troubling. Classic Team Lotus occupies a unique position in the old car world, solving mysteries and sharing with the public some of the sport's most evocative and ground-breaking racers, and doing so in its own unique way. Just as Team Lotus itself always did. HRT

Playing it cool


Andy Swift

Improving the cooling system is one of the simplest and most effective means of safeguarding an historic engine, report **William Kimberley** and **Chris Pickering**

TO SOME, the idea of fitting an electric fan to a 1930s grand prix car, or swapping the copper and brass radiator from a 1960s GT for a modern aluminium design, might sound like sacrilege. But once the temperature needle starts to rise, these precautions can become a vital part of the engine's safety. Something as simple as a coolant additive or a more reliable hose can eradicate a weak link in the system that might otherwise lead to major damage.

As with all things, the level of modernisation (whether overt or carefully concealed) comes down to the owner's preferences and the regulations of the category in which they compete. Even in the more tightly-controlled classes, there can be considerable potential to improve matters. All the while, the original components can be stored on the shelf to preserve originality for road use or display.

Of course, this becomes all the more critical when the engine has been modified beyond its original specification. More power inevitably means more heat, and with historic engines often running at higher engine speeds than they did in-period, the extra strain on the cooling system can be considerable.

LIGHTER, FASTER, STRONGER

Undoubtedly, one of the most significant changes to radiator design of the past few decades has been the widespread adoption of aluminium. Strictly speaking this isn't a new idea – the Jaguar D-Type, for example, had an aluminium radiator in the mid-'50s – but early attempts were often a mixed success and they tended to be very expensive. As a result, most cars continued to use copper and brass radiators held together by solder.

These days aluminium is relatively cheap, while new brazable alloys have made it far more practical to work with. The tubes, fins and headers that make up the core can be brought together in a brazing oven and produced in huge quantities at relatively low cost.

Aluminium actually lags behind copper when it comes to thermal conductivity, but it isn't far behind and combined with modern tube and fin designs it's now possible to substantially improve upon the heat rejection capabilities of classic radiators. Where aluminium really scores, however, is its light weight.

"Aluminium is a lighter option for a racing car," explains Alan Docking, founder of cooling specialist Docking Engineering. "It's also more robust. The solder used on the copper and brass radiators is nowhere near as tough as a brazed aluminium joint. Copper, brass, steel and solder all have different thermal expansion rates, which can lead to problems as the core warms up and cools down. Generally though, once customers have got an aluminium radiator in the car, we don't see them again. They're very robust so they can survive stone strikes and trips into the gravel trap."

He estimates the difference in cooling capacity between a classic copper and brass radiator and a modern aluminium unit is somewhere in the region of 15 to 20 per cent, like for like.

Sometimes aluminium radiators are used as a straight swap for the original design, which would typically have featured a large header tank, often doubling as the filling point for the system. These days, however, there is a trend towards remote header tanks. Providing they are mounted above the level of the radiator, these can be positioned just about anywhere, redistributing mass and potentially improving packaging issues.

Of course, there's more to the cooling system than the radiator, Docking points out: "If people have an overheating issue on their car the first thing they go to is the radiator, but there are so many issues you need to consider. Apart from the water radiator, you've got the temperature of the oil to consider as well as more fundamental problems with the engine. You get people blaming radiators when in some instances it's actually the head gasket." ▶

ABOVE & BELOW Docking Engineering has produced radiators for cars ranging from vintage Bugattis to this March 2-4-0

LIMITLESS POSSIBILITIES

The switch from traditional copper and brass to aluminium has opened up new options in the brazing process used to join the tubes, fins and headers. This means that modern radiators can be tailored more precisely to their given application, explains Tully Esterline, engineering manager at cooling specialist C&R Racing: "There are a lot of niche [radiator] core builders that have entered the market, offering a variety of tube and fin combinations in almost any size. This offers an almost infinite number of combinations."

"Modern aluminium cores are thinner than copper and brass cores," points out C&R's aftermarket specialist Paul Hammond. "Today it is common to outperform four-row copper and brass radiators with single-row aluminium cores."

The tanks and cores can be shaped to fit just about anything, he explains: "In the past, for example, we've built radiators for Indy roadsters, which were originally four inches thick, by welding two cores together."

Aesthetically, it is possible to spot modern aluminium radiators, but these can be 'disguised' to some extent using traditional black paint. For custom jobs C&R also offers a black anodised finish, which requires the use of special rods in the welding process. "Usually customers will either want to match the OE spec as close as possible, or go with an all out custom build," notes Esterline.

Of course it's not just the radiators. Modern brushless electric fans are far more powerful than their recent predecessors. They also give a far greater degree of control and consume a lot less current.

TO PROTECT AND TO SERVE

If the tubes and hoses of the cooling system are akin to veins and arteries, then the coolant is the blood that flows within them. And just as with the human body, this serves as more than simply a fluid. The right ingredients can help to maintain the internals of both the engine and the cooling system itself.

Recently Millers Oils, well known for its groundbreaking range of nanotechnology lubricants, has come up with a product that not only protects the arteries but also improves the flow.

In fact, it started life as a product for the military that required some type of protection treatment for its armoured vehicles and troop carriers that periodically get mothballed (not unlike a competition car at the end of the season). Being adept at spotting niche opportunities, though, the clever management of this independent Yorkshire-based oil company recognised that there was also an application in the classic car world.

"We realised that ▶

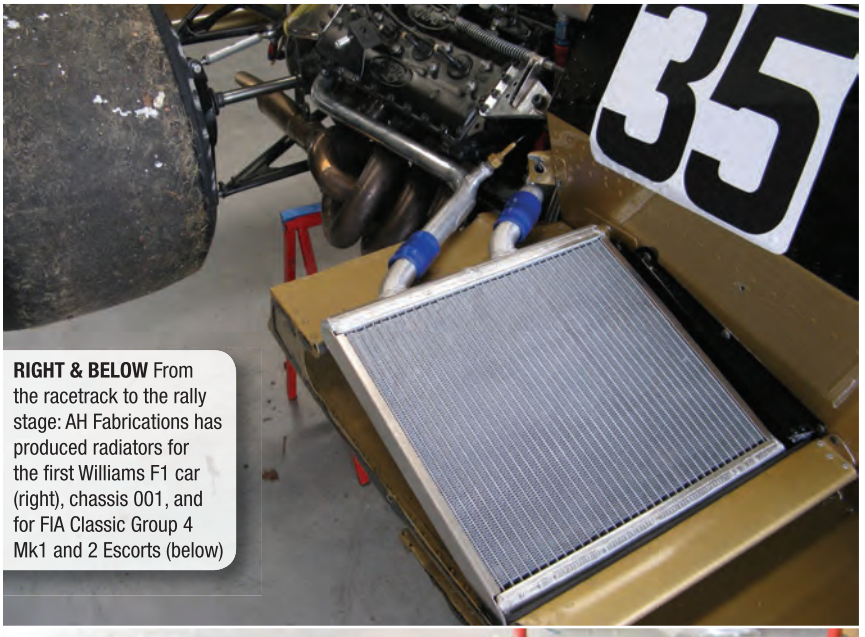
RIGHT Extra Cool started life as a product for the military but Millers Oils was quick to recognise the implications for the classic car world

ABOVE Cooling specialist C&R Racing at work

many classic car owners garage their vehicles over the winter months," says Martyn Mann, Millers Oils' technical director, "and as a result don't feel the need to put antifreeze into their cars. What they don't realise, though, is that by not adding it they are denying their vehicle a corrosion inhibitor.

"What we have done is come up with a product called Extra Cool that mimics the corrosion protection of antifreeze but just using water as the heat transfer medium. Importantly it passes the BS 6580 multi-metal corrosion test that assesses whether there are metal-to-metal contact patches in a coolant system."

Other important features include maintaining coolant flow and reducing deposit formation in radiators. "One of the things about propylene glycol that is an essential component in antifreeze is that its heat transfer properties are about half as efficient as those of water, so the product we've produced is far more effective in ensuring vehicles run cooler," says Mann. "In fact, it can help reduce coolant temperatures by up to 15°C. Extra Cool also acts as a coating that helps protect whatever the water touches, not just with immediate effect but with long lasting results even when the water has evaporated."



RIGHT & BELOW From the racetrack to the rally stage: AH Fabrications has produced radiators for the first Williams F1 car (right), chassis 001, and for FIA Classic Group 4 Mk1 and 2 Escorts (below)

Unlike antifreeze, which is generally added on a 50:50 basis with water, the Extra Cool ratio is just two per cent – one part to 50 parts water – for a suitable level of corrosion inhibition and deposit reduction of a vehicle's cooling system. There is no need to drain a car should it already have antifreeze as Extra Cool mixes with all good quality ones.

One area that has taken Millers Oils a little by surprise is the interest it has received from some Formula 1 teams who see the value in its increased coolant flow and coating properties. "Their interests of course are completely different because an F1 car has as small a radiator as possible and it's all about maximising its efficiency. A function of the Extra Cool is that it's a water wetter, so any air bubbles and surface tension are minimised for maximum contact of the coolant.

"They flush the engines through with it and even when the radiator and coolant system are emptied for the long haul flights to the intercontinental races, the coating remains effective and will remain so for the entire season," says Mann. "In fact, we provide two different coloured fluids as one is for the engine coolant and another for KERS, so if a leak occurs somewhere they can identify which system to check.

"Our main market with Extra Cool, though, is the classic car owner who wants to keep his vehicle in tip-top condition, no matter the season."

WELL-OILED OPERATION

Herefordshire-based AH Fabrications has a 25-year track record in the production of cooling system components. During that time, the company has supplied everyone from classic car owners to contemporary ▶

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Formula 1 teams.

In an attempt to boost efficiency, the company has adopted ever-thinner wall thicknesses on the water tubes of its radiators, explains company founder Alex Hanczarski: "We're down to about 0.32 mm wall thickness, which is the thinnest we've ever done. Radiator development tends to be an evolutionary process. It tends to be a combination of fin height, water tubes per inch and the thickness of the tubes."

In some cases Hanczarski deals with requests for a specific level of heat rejection, but in others the process begins with a few details to determine the cooling system's requirements. Based on the average operating speed, the ambient temperature and the flow rate of the coolant, it's possible to estimate the rate at which you need to dissipate energy.

"You have to bear in mind that the engine isn't running at full power a lot of the time," he says. "The moment you take your foot off the throttle, the amount of heat that's being produced goes down. Very broadly, you need a cooling system that can dissipate around a third of the power of the engine."

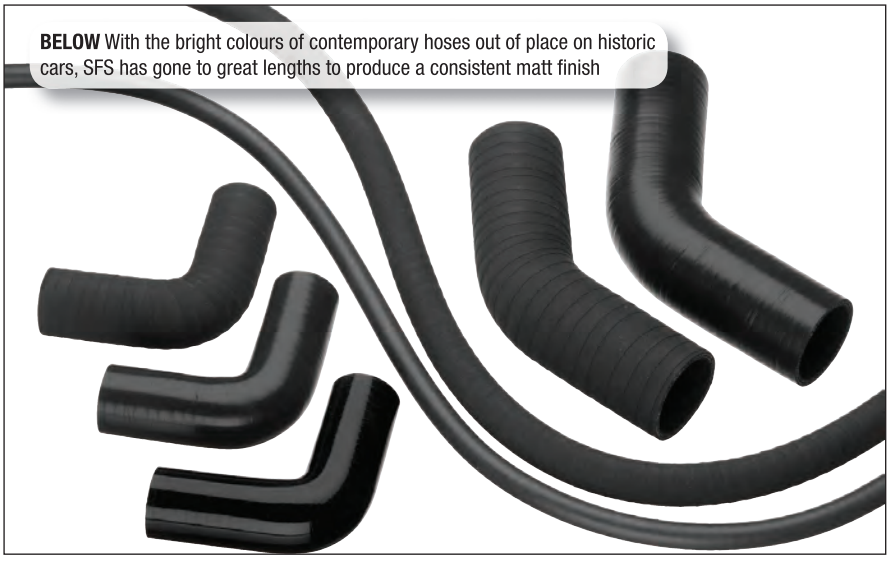
AH Fabrications also specialises in oil-to-water coolers. A normal 'bar and plate' oil cooler, of the type originally fitted to a lot of competition cars from the '60s onwards, relies solely on the air flow through its tubes and fins to dissipate heat. Inside a water-cooled heat exchanger you have much the same arrangement, except it's encased in a water jacket.

The oil cooler sits in series with the rest of the cooling circuit, in between the engine's water outlet and the radiator, using the same fluid. This provides a far more stable temperature than air cooling, typically pegging the oil temperature to within 5 or 10 deg C of the coolant temperature, Hanczarski explains, while on air-cooled systems it can fluctuate by as much as 50 deg C.

"If you're coming off a rally stage or into the pits after a race, the temperature can spike quite alarmingly when the air flow disappears," notes Hanczarski. "With a water-cooled oil cooler you don't have the same problem. They are almost always a better bet if the regulations allow them. With rallying Escorts, for example, they're allowed in some classes but not others. It's certainly worth asking, as they can make a huge difference."

Another advantage of the water-cooled systems is packaging. The cooler no longer needs access to airflow, so it can often be placed closer to the oil pump. The positioning of traditional air-cooled oil coolers, on the other hand, can sometimes interfere with the air flow to the main radiator.

Inevitably, adding an extra stage to the cooling circuit imposes a little more drag on the water pump. It also requires a little more capacity from the radiator, although Hanczarski says it's usually possible to install an oil-to-water cooler without uprating any of the existing components if the installation is designed carefully: "As long as you don't cause a restriction on the water side, you should be able to add an oil cooler without changing anything else. The only thing to watch is whether the radiator is able to dissipate the extra heat, as it will put 10 or 15 deg C into the water temperature."



BELOW With the bright colours of contemporary hoses out of place on historic cars, SFS has gone to great lengths to produce a consistent matt finish

PLASTIC FANTASTIC

SFS Performance has been manufacturing silicone hoses for the classic market for many years. Initially, the company supplied universal parts, but more recently it has expanded its range with specifically designed car kits for a number of popular applications.

Contemporary hoses tend to be produced in bright colours, which can look out of place on historic cars. In order to address this, SFS introduced a fabric wrap finish to its classic range, which gave the hoses a matt stippled effect. This was an improvement, but it still didn't provide the authentic look the company was searching for.

"The true look needed was a smooth matt finish which we initially managed by coating the hoses in talc before the taping process, but this method gave better but inconsistent results," explains SFS sales manager Anthony De Caux. "The final breakthrough was a special tape which, when applied, produces a consistent matt finish with a smooth surface. We also manufacture the hoses without logos, so they look like an OEM hose, but perform with all the technical benefits of silicone."

Gone are the days of hoses degrading, cracking, splitting, swelling and bursting, leaving you on the side of the road or worse still with a damaged engine, he argues: "Multi-layer re-enforcement prevents the hoses from swelling, so your coolant will flow better and maintain its pressure more consistently. We use the same technology in these hoses as we do in our Formula 1 hoses." HRT

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Casting call

Chris Pickering reports on the space age techniques revolutionising the casting industry

ABOVE This Bugatti Type 35C (in red) and Type 35 (in blue) both feature new cylinder blocks from Ivan Dutton, cast by Grainger & Worrall

CASTING is one of the oldest concepts in engineering. The idea of pouring molten metal into a pre-defined shape goes back at least 6,000 years and even some of the techniques in use today can trace their origins back a century or more.

With that in mind, it's perhaps surprising to find out that 21st century technology is having a major impact on this ancient art. What's more, some of the recent advances could have been tailor-made for the historic racing industry.

Castings appear everywhere in cars and arguably the older something is, the more likely it is to have parts that are cast rather than fabricated or machined from solid. By harnessing these modern techniques it's possible to create stronger, more durable parts without compromising the authenticity of the material or the design. It can also make the sort of one-off parts and small batch production often employed in the historic motorsport industry far more practical.

ARTISTIC LICENCE

Something that crops up time and again is the subject of reverse engineering. In the case of particularly old or rare machinery, the original blueprints haven't always survived. And even when they have, they're not always entirely accurate.

Charlie Bamber of casting specialists Grainger & Worrall gives the example of one of the more unusual projects the company has worked on – the 27-litre Rolls Royce aero engine from a Supermarine Spitfire: "The Merlin engine is a prime example. The initial engineering drawings of the engine don't truly reflect what was running at the time. You had skilled craftsmen on the shop floor who appear to have made modifications, so the finished product differed from the surviving drawings. Looking externally, you'd have no way of knowing if someone identified a cracking issue 70 years ago and decided to increase the radius on the sand cores, for example."

Clearly this presents something of a problem. Without some means of 'seeing' inside the casting you can't be sure of exactly what modifications might have been carried out. Theoretically, you could cut a series of sections through an existing example to expose what lies inside – and traditionally this was used as a means of quality control on mass produced parts. It's fair to assume people would get a bit annoyed if you did that to one of the few remaining Spitfire engines, though, let alone the heart of a BRM V16 or an Auto Union. Instead, Grainger & Worrall uses computerised tomography – better known as CT scanning.

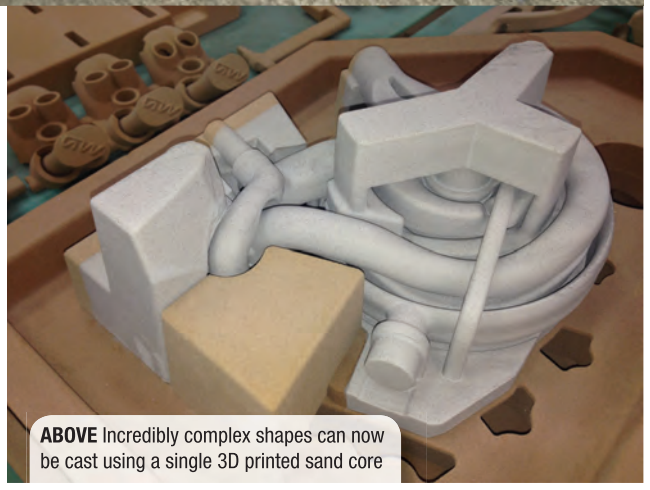
> **"Reverse engineering has become considerably easier and a lot more practical thanks to CT scanning"**

Just like the machines used in medicine, the company's CT scanner takes a series of x-ray images one millimetre apart through the thickness of the material. These are then pieced together using software to create a 3D model, which shows the precise dimensions of both the internal and external portions of the casting.

The main benefit of this is that you don't have to take a hacksaw to the part: it is completely non-destructive so you can scan parts while they're still functional and in-service. Furthermore, because the industrial CT machines don't have to deal with living tissue, you can turn the wick up considerably.

Grainger & Worrall's 450 kV machine can penetrate to a depth of about 250 mm in solid aluminium (or roughly the same combined depth with air gaps in between). Stood on end, this makes it possible to get complete coverage of most aluminium engine blocks, not to mention cylinder heads. Denser materials like cast iron can also be scanned, although the level of penetration goes down to about 80 mm, which generally limits the technique to things like exhaust manifolds and turbocharger housings.

Reverse engineering has become considerably easier and a lot more practical thanks to CT scanning. In practice, though, the technique was primarily developed for quality control and this applies to historic projects too.

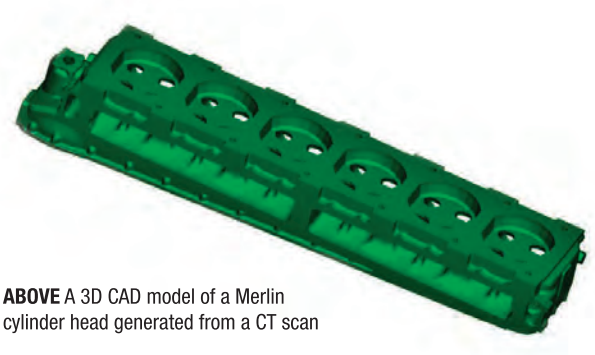


ABOVE Incredibly complex shapes can now be cast using a single 3D printed sand core

"Strictly speaking, there's no such thing as a perfect casting," Bamber points out. "Every example has a certain level of imperfection and for any given job it's a question of managing the probability and severity of those potential internal defects. Even in the aero industry it's accepted that there will be some micro porosity. With the CT scan you can see things like bubble trails or micro porosity very clearly down to around 0.25 mm diameter, where previously you'd have needed to section hundreds of castings to be completely sure. And because this is a non-destructive technique, you can scan every single casting coming off the line. That means none of them go out with an unacceptable level of porosity, enabling the delivery of what is essentially a defect-free casting."

RAPID RESPONSE

Another recent advancement is the use of rapid casting. The name is perhaps slightly misleading as the casting process itself remains more or less unchanged, as does the material of the finished part. Instead, it's all to do with the production of the sand cores used inside the mould.



ABOVE A 3D CAD model of a Merlin cylinder head generated from a CT scan

When the molten metal flows around these cores they define the voids in the casting that will later form the basis of things like ports, cylinder bores or water passages. For about a decade now, casting companies have been using rapid prototyping machines to 3D print these cores. For prototypes and small batches this can prove both quicker and cheaper than traditional tooling, particularly if you're working to an existing CAD model.

It also allows you to create geometry that simply wouldn't be possible with traditional tooling, explains Bamber: "With conventional techniques you end up with limitations in the tooling geometry because you have to have draft angles to remove it from the mould and various radiuses built into that in order to build the tool that you use to make your sand core. With a printed core you remove those limitations. It opens up the possibility of using shapes that would previously have been unfeasible."

While rapid casting is now a fairly well-established technique, recent advances in resin technology have seen it take another major leap forward. During the 3D printing process a sand-infused resin is deposited by the printer, layer by layer. Previously this technique had been confined to aluminium castings due to the low melting point of the resin, but new materials have now enabled it to be applied to iron and steel.

"Printed cores have great value for historics," says Bamber. "You can save something that might otherwise become extinct by printing a one-off core and creating a casting, or a small batch of castings, where previously the tooling would have been prohibitive."

Over the years, Grainger & Worrall has brought its innovative casting methods to a wide range of historic projects (not to mention scores of contemporary applications spanning everything from Formula 1 to NASCAR). Recently, the company has been working with Swedish engine builder Gunnar Axelsson to build new cylinder heads for the classic Volvo B18 range, based on his original twin cam conversion from 1973. In competition spec, these engines are capable of more than 220 bhp. Elsewhere, Grainger & Worrall has a long-standing relationship with world-renowned Bugatti specialist Ivan Dutton, producing replacement cylinder blocks for cars like the Type 35.

By drawing upon these ingenious 21st century ideas, casting companies are able to offer ever greater quality to the historic market without compromising authenticity. With a bit of luck it's an art form that will still be alive and well in another 6,000 years. HRT

No future without the past

William Kimberley looks at how some of the automotive industry's biggest players are re-discovering their heritage

PRETTY well every carmaker has a past they look back on with affection, some with justification, others less so. It's good for image, business and marketing. When it comes to the supply chain, though, it's far more patchy. In most cases it is because the supplier – Lucas being an obvious example – has disappeared or has been subsumed into a larger group and if lucky has become a brand. However, there are some that buck the trend.

While it tends to be the British who are adept at exploiting their heritage, in the case of the suppliers, it's the Germans who are leading the way – Bosch, ZF and TMD Friction Group all highlighting their long history in the automotive industry and racing world.

Bosch Automotive Tradition has been in existence for nine years, its mission being to offer economical parts, expertise, service and what it terms 'enthusiasm' for classic cars of all ages. It is currently concentrating on its home market in Germany along with Switzerland and Austria but it has its eyes on the lucrative US and UK markets which are currently served by just an online presence.

BELOW Bosch organises its own road rally, the Boxberg Klassik

"Since the birth of the car, Bosch has been connected to numerous inventions and patents, to mobility and vehicle manufacturers," says Fritz Cirener, a veteran Bosch Automotive Tradition executive who heads up the operation, "and in order to appreciate Bosch's origin – a future wouldn't be possible without it – Bosch Automotive Tradition was founded."

Having been in business for 128 years, Bosch has an inventory that stretches back to the dawn of motoring. Of course, not every part is available but what Bosch does have are the original designs, drawings, specifications and documents from the very beginning. Founder Robert Bosch was absolutely fastidious in publishing an annual handbook and it's a practice that continues to this day. It means that pretty well any part on a car is accessible as long as Bosch was the original supplier. Naturally this means German cars in particular, especially before the war and into the 1950s, but as the German car industry began to assert itself in the late '60s, it means a massive range of cars that now fall into the classic car category.

"We are an indispensible part of the classic and vintage car community since almost every car produced in Germany contains a Bosch part of some sort," explains Cirener. "However, this isn't a hobby for us but a business. We are part of the aftermarket division and have to make our own way. We can bring a part back into production, but we aren't in the position to revive whole product lines on the offchance that there are customers out there waiting for it."

However, it isn't just a question of dusting down the old design papers and gearing up for production as some thought goes into whether the original design can be suitably modified to make it more efficient and reliable, taking into account more modern materials and production methods. So it might look the same externally but the internals might have been heavily modified.

"Whenever possible, we go for

ABOVE The stunning Mercedes-Benz 300 SLR prototype uses a Bosch pump for its direct injection system

functionality over originality," explains Cirener. "For example, working with Mercedes-Benz, we produced a new alternator for the 300SL gullwing that doubled the electrical capacity using more modern material, but in the same housing and the same design. We tested it on a car in the Mille Miglia and put it through an extensive testing regime including temperature and loading to prove it out and it was so much better and rugged than the original.

"Admittedly this was a special development, but for more modern cars we just do a functional replacement that looks like the old one but with new technology inside. For the purist, it looks just fine while delivering greater efficiency and reliability."

Cirener also highlights one of the issues that he regularly has to face. Where a part might originally have been produced by the hundreds of thousands or more on an annual basis, the production run for such a part nowadays is likely to be in terms of just the hundreds, if that, so the production process is entirely different. "In most cases it means making something by hand to order rather than on an automated production line. One thing that's vital, though, is that however it is manufactured there cannot be any drop in quality. If anything, it has to be better than the original.

"Taking all this into account, it is sometimes a juggling act to make a business case in producing a part that has gone out of production."

Obviously supplying parts is largely what the business is all about but Cirener is keen to emphasise that it is not the only thing with "knowledge, services and emotion" being all part of the mix. He explains: "Bosch Automotive Tradition is able to search Bosch inventories around the world at any time for appropriate original parts as in many cases the refurbishment of original parts is the only option that's economically or technically feasible. We also provide a comprehensive information service."

The emotion in the mission statement is in supporting events like the Jim Clark Revival meeting at Hockenheim or its own Bosch Boxberg Klassik and Bosch Vino Miglia. "The idea is to engender the non-business side, to enjoy and appreciate the cars that we provide parts for." ▶

> **"Whenever possible, we go for functionality over originality"**

ABOVE A Porsche Safari 911 RS replica competing at the Eifel Rallye Festival

LONG LEGACY

ZF is another German company that has embraced its past by creating ZF Tradition which employs an internal network of ZF experts from the various divisions to answer questions from owners and enthusiasts. When it comes to motorsport, it is the responsibility of ZF Race Engineering being the division that incorporated the Sachs name into its portfolio a few years ago.

"As such, we can claim to have been in racing for over 104 years," says managing director Norbert Odendahl, "since Ernst Sachs, the company's founder, finished third in the Prince Heinrich race in 1910 and either through Sachs or ZF, we have been involved in motorsport in one form or another until today. For example, Mercedes had its first motorsport success in 1914 in a grand prix running on Sachs ball bearings. In 1937, the legendary Mercedes Silver Arrows were equipped with Sachs alloy ribbed shock absorbers and clutches and ZF self-locking differentials and in the '50s, the Silver Arrows achieved more success with Juan Manuel Fangio.

"We have also supplied gearboxes, clutches and dampers to everything from Formula 1 to trucks over the years and can still supply some parts, depending on what they are, when asked by customers. It's an area that's growing with our long heritage with both the ZF and Sachs names."

Recently TMD Friction, the world's largest manufacturer of original equipment brake friction material for passenger cars and commercial vehicles, launched a dedicated exhibition showcasing the history of vehicle friction from 1878 to the present day and beyond at the National Motor Museum at Beaulieu in England. Over the next five years it is scheduled to be run, it will be continuously updated with key developments and milestones as they happen and be linked with the vehicles actually on display within the museum.

"With our various brands, we have a lot of firsts," says John Hudson, TMD Friction Group CEO and president, "and we wanted to highlight them to the general public as we are proud of our heritage. For example, we provided brake pads for the first Model T Ford in Europe, on the first Mini and then moving to relatively modern times, we also worked closely with Porsche to provide the first friction material for ceramic discs.

"When it specifically comes to racing, Mintex will be well known to many historic racers and traditionally has been a very strong supporter of the race scene in the UK. For example, Mintex pads were used by Bentley when it was competing at Le Mans in the 1920s. It was also on the Le Mans-winning Jaguars in 1951 and '53 and on Mike Hawthorn's Ferrari when he won the drivers' World Championship in 1958. In Germany, the Mercedes-Benz 300SL gullwings used Textar friction material, another of our brands, and, of course, we have Pagid which is still very active in motorsport. We have a long and proud history and it is something we want to highlight." HRT

BELOW The Mercedes W125 used Sachs alloy ribbed shock absorbers and a ZF self-locking differential

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Race Tech is offering a number of books that it considers an essential requirement in the motorsport engineer's library:

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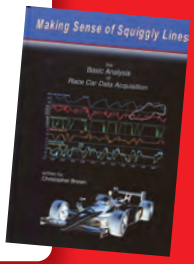
This is a very erudite book that explains in quite some details the physics of performance driving. It will not be everyone's cup of tea but for those who want to know how it all works from the point of view of physics, this is a must-read book.

MAKING SENSE OF SQUIGGLY LINES



The Basic Analysis of Race Car Data Acquistion
By Christopher Brown
144 pages
Hardback: £40.00 Softback: £30.00

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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This book combines clear explanations, illustrations and photos to help the enthuisiast understand a complex subject, with invaluable reference material – including equations – for the professional race car engineer.

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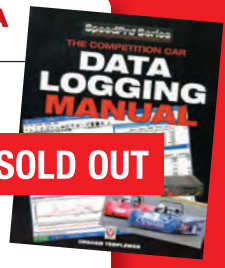
This is a very fine book and along with the two books reviewed on this page should form the basic building block for any budding motorsport engineer's library.

THE COMPETITION CAR DATA LOGGING MANUAL



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By Graham Templeman
Softback 128 pages
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An eminently readable introduction to club-level data logging from Race Tech's own Graham Templeman. This book takes a practical approach to the subject, explaining how and where data logging can be used to good affect and imparting many excellent tricks of the trade.

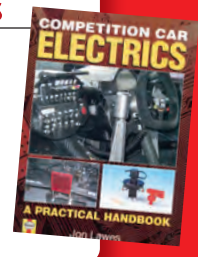
ENGINEER TO WIN

By Carroll Smith
Softback 280 pages
£19.99
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.

HOW TO BUILD MOTORCYCLE-ENGINED RACING CARS

By Tony Pashley
Softback 128 pages
£24.99
This book provides a superb guide to designing and building your own racecar. As the title suggests, there are plenty of tips aimed specifically at motorcycle-engined cars – things like chain drives – but it also covers general principles, from kinematic suspension design to fabricating aluminium honeycomb chassis.

COMPETITION CAR ELECTRICS



By Jon Lawes
Hardback 160 pages
Hardback: £25.00
Competition car electrical systems increasingly differ from their road-going counterparts and this book is aimed squarely at the motorsport market. It provides a general overview with some great photographs and a refreshing lack of jargon.

To order these fine books and many others, please go to **www.racetechmag.com/store** or phone +44 (0) 20 8446 2100 where our friendly staff will take your order.

White magic

Often likened to a black art, the traditional skill of white metalling is being revived for the 21st century, explains **Chris Pickering**

WHITE metalling (known as Babbitting in the States after the Massachusetts goldsmith who invented the technique) was once a key skill in the automotive industry. Thousands of cars produced up to the 1950s used white metal bearings in their engines, but the skills required to cast and produce white metal were, until recently, dying out.

Effectively, white metalling is a coating process. Usually used for plain bearings made from bronze or steel, a thin layer of tin is applied to the bearing surface followed by the white metal itself. This two-part coating provides an extremely low coefficient of friction, thanks in part to its ability to sustain an oil film around the surface of the bearing.

It sounds simple, but the practice of white metalling is anything but straightforward. Over the years, it has virtually disappeared in the car industry and the only remaining practitioners are a handful of specialist engineering firms.

One of the best known is Formhalls Vintage & Racing. Founded 15 years ago by engineering lecturer and grass track motorcycle racer Terry Formhalls, the company began more or less as a hobby. Originally stationed in Terry's back garden, it now occupies three large industrial units in the Wiltshire village of Downton.

ABOVE Crowd-pleaser: Formhalls provided bearings for the 42-litre Packard Bentley, rebuilt in 2010

These days Formhalls is very much a professional outfit with nine full-time staff and a brand new casting shop. Around 10 years ago the company took the unprecedented step of guaranteeing all its bearings against casting and material faults for the life of the engine. This is no mean feat, especially when you consider that white metal bearings were once regarded virtually as service items.

DEVIL IN THE DETAIL

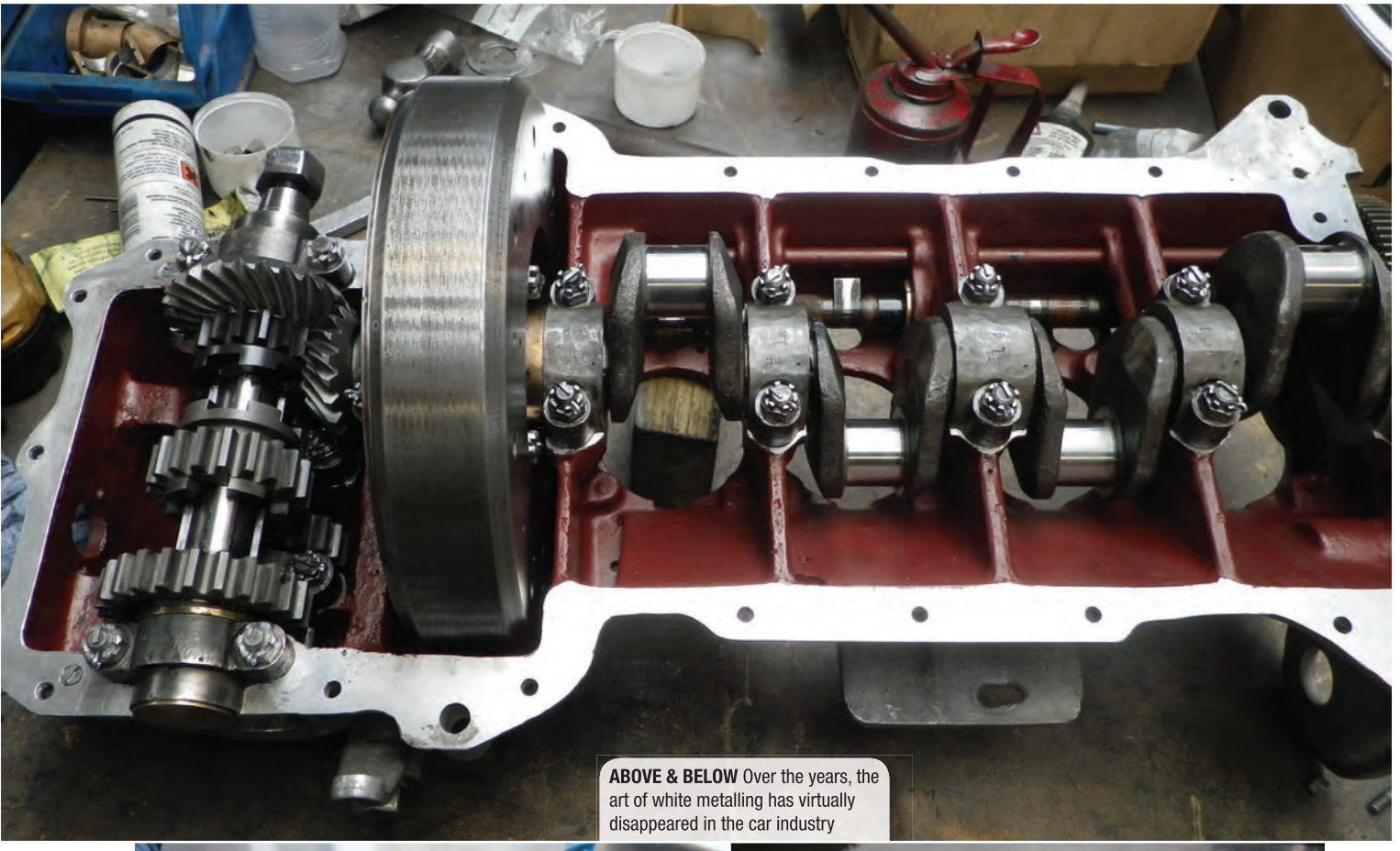
Typically the process begins by measuring the bearing housings. White metal bearings are held in place by an interference fit, so the outside diameter needs to be slightly oversize relative to the housing – usually by about two thousandths of an inch.

"If you started with a bearing housing that was 2.169" in diameter then you would want the bearing itself to be about 2.171"," explains Formhalls' workshop manager, Charles Tanner.

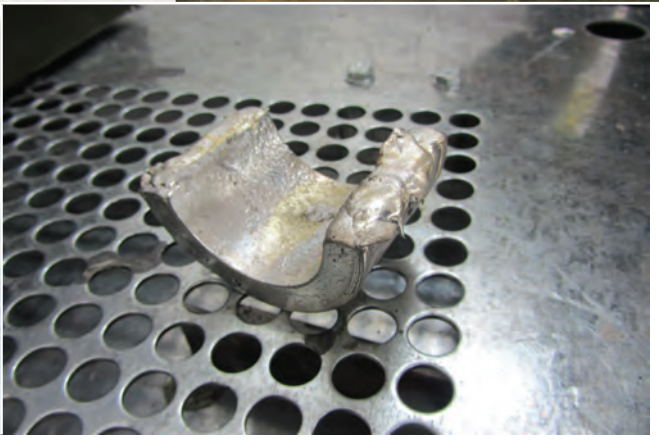
The oversized bearings are squeezed into their housings by torquing down the bearing caps. This is known as nipping the bearings and the degree of 'nip' is dependent on how much pressure is applied. It's not unknown for previous owners or mechanics to have filed down the mating face of the bearing caps in an attempt to recover this 'nip', so these also have to be inspected.

Formhalls has the ability to manufacture its own bearings from scratch. The main body is usually bronze or steel, machined from billet. Often, however, the company is asked to re-metal existing bearings. Here, the old coating has to be carefully removed by heating the bearing in a crucible, but thereafter the process is much the same.

"The first stage is to give the bearings a thorough wash, after which they're prepared by blocking off any holes and painting the surfaces that aren't due to be coated," says Tanner. "The bearing surface is then ready to be tinned. This is done by hand, with the tin basically painted onto the surface. You've got to make sure there's no dirt



ABOVE & BELOW Over the years, the art of white metalling has virtually disappeared in the car industry



or imperfections in the bearing. You also want a nice thick, even coating across the surface. If you don't have that, it's so easy for the metal to suddenly give."

Up to this point everything can take place at a reasonably relaxed pace. The casting process which follows, however, needs to be done quickly. The bearings have to be set up in a mandrel, the white metal has to be poured in and all the while the surface and the material have to be checked for temperature and consistency. If there's any sign of the material failing to adhere then there's no going back: the bearing has to be re-done from the start.

This is where much of the skill comes in, explains Tanner: "Temperature is crucial. Everything has to be hot, including tools; if there's too much variation it poses a health and safety risk and can lead to problems with the casting. For this reason, we have two or three pots of white metal on standby at any one time, kept at different temperatures. Once one pot gets too hot, a second cooler pot can be brought in and so on."

The temperatures are monitored using a variety of specialist gauges sourced from old garages, he explains: "A lot of our tools are original. They suit the sort of bearings we're doing and the equipment we're using. We also only use pure ingots of Hoyt 11R and 11Z3 [white metal] – we've found that to be the best alloy."

At this point, the bearing is still pretty rough. The white metal has a tendency to overflow in the mandrel, covering the mating face of the bearing halves and sometimes the bronze backs. All this excess material has to be removed without touching the bronze as this can distort the bearing and prevent it from fitting in the housing. Initially, this is done by hand using a file. A milling machine is then used to skim the top faces, before the bearing is transferred to the lathe to bore through the inside diameter (leaving, say, 100 thou for line boring). It's at this stage that any oil grooves, inlets or dowel holes are cut into the surface. ▶

ABOVE As Formhalls has diversified, a number of fascinating projects have been entrusted to it

RE-FITTING

Setting the bearings back into their housings is another extremely skilled process. This falls to Ross Formhalls, a mechanic of over 30 years' experience who also happens to be the brother of company founder Terry. Each bearing has to be fitted individually, ensuring the surfaces are flat, rubbing down the mating faces until the required degree of 'nip' is achieved. This alone can be eight to 10 hours' work.

The next step is to line bore the located bearings. Once again, preparation is key. The block has to be clamped onto the line boring machine in six different places. Two adjustable heads are lined up along the exact centreline of the bearings; the boring bar itself runs within these heads, with the cutting tool used to remove 10 to 20 thou at a time. Much like the casting process, this is monitored step-by-step, looking out for any faults that become apparent as the remaining material is removed. "We're always doing our quality control; always making sure that the bearings are the right size," notes Tanner.

After the bearings have been removed and de-burred, the Formhalls engineers file what's termed a mud gully into each bearing half. This is a very slight angular groove, running across the mating face of the bearing, which spreads oil out from the main oil channel. Finally, the new cutting is de-burred before the bearings are assembled back into their housings and torqued down with the crankshaft in place, ready for inspection.

In theory, the bearings could be rough cast and sent out to the customers to fit. Formhalls does offer this option, but usually only to professional machine shops and other white metallers. "You come across a lot of problems that can only be solved with experience," notes Tanner. "If we have access to the short engine then we can do a trial assembly to ensure everything is trouble-free." HRT

Manifold talents

LIKE a lot of specialist engineering companies, Formhalls prides itself on its flexibility. Projects have ranged from a 1910 Bugatti to the 350 hp Sunbeam Land Speed Record car and a smattering of vintage aero engines.

White metal bearings remain Formhalls' stock-in-trade, but the company has since diversified. Race preparation and chassis work has taken the firm into new territories, with comparatively recent Ferraris and Lamborghinis now rubbing shoulders with the pre-war machinery that often dots the workshop. As we speak, there's a Derby Bentley in for a complete nut and bolt restoration, which is also having power steering and an overdrive system fitted.

"Main bearings are the heart of the engine and they're such a critical part that people soon started trusting us with other important aspects of the engine assemblies and the machining," says Tanner. "Next thing we knew, we were getting a lot of short blocks where we were fitting the crankshaft, the pistons and the rods. From there people started asking us to undertake full engine builds and eventually chassis restoration as well."

These days, Formhalls even designs its own pistons and conrods. Some of the manufacturing processes for these have to be outsourced, but much is carried out on-site. State of the art CNC machines mean there isn't much that can't be done in the Downton workshop, with machining jobs as small as kingpins and as large a complete cylinder blocks tackled in-house.

Race preparation is another rapidly developing niche, explains Tanner. All work is carried out to the customer's bespoke requirements, but typically it follows a set pattern, the engine being stripped and inspected to determine whether there is any potential to increase its bore or stroke. Where required (and allowed by the rules) a counter-balanced crankshaft can be fitted, along with modified pistons to raise the compression ratio. After that it's on to cam profiles (also designed in-house) and often new valves made of a more modern material. The finishing touches come with a painstakingly precise re-assembly process, using high quality bolts and fasteners and a rigorous inspection programme. HRT

ABOVE Sir Malcolm Campbell's grandson, Don Wales, in the record-breaking 350 hp Sunbeam. The modified aero engine, an 18.322-litre V12 Manitou Arab, was rebuilt with Formhalls bearings in 2008

Building the perfect body

ABOVE Traditional coachbuilding is a highly complex process but, as you can see from this Lancia-Ferrari D50, yields stunning results

Chris Pickering discovers that beauty really *can* be skin deep but it's the end product of painstaking work

TRADITIONAL coachbuilding is one of the most important skills in the vintage car industry. Before the advent of pressed steel or composites, virtually all sports and racing cars relied on armies of craftsmen shaping their contours by hand.

These days those skills are being kept alive by companies like Roach Manufacturing. Based on the edge of the New Forest on England's south coast, the business was established in 1953 by Ron Roach. At the time, Roach's main line of work was precision manufacturing (hence the name) but that all changed when his son Keith joined the business.

Like a lot of young British engineers, Keith Roach cut his teeth working on Austin Seven Specials. It wasn't long before other people started approaching him for his services and the family business promptly diversified into car body production. Since then Roach Manufacturing has gone on to work on some of the most valuable and exquisite racing cars ever produced. Several of the Auto Union grand prix cars featured elsewhere in this issue have passed through its workshop, as has the Fiat S76 from issue one.

Keith's son Stuart is the third generation to lead the family firm, which appears to be going from strength to strength. As we speak, the sounds of hammer blows are echoing from the workshop and a De Tomaso Mangusta is being painstakingly brought back from the dead. The majority of the firm's work is still pre-war machinery, however. Fittingly, this includes no less than four different off-the-shelf body styles for the Austin Seven, alongside more exotic automotive work and jobs as diverse as architectural copper panelling for a bar in Bardados.

BACK TO THE DRAWING BOARD

Over the years, Roach Manufacturing has tackled just about every conceivable historic project, including restoration work, replacement bodies and replicas. In the case of bodies built from drawings or photographs where a physical reference no longer exists, the first job is to create a full-size wire frame on the rolling chassis, Stuart explains. That way, the owner can stand back and take a look at the lines or sit in and try it for size while there's still time to make modifications.

Once the wire frame has been finalised it can also be used as a guide for the shaping process if the car is a bespoke design. Alternatively, where the contours of an existing shape need to be followed exactly, a traditional 'egg box' solid buck can be produced by the company's carpenters.

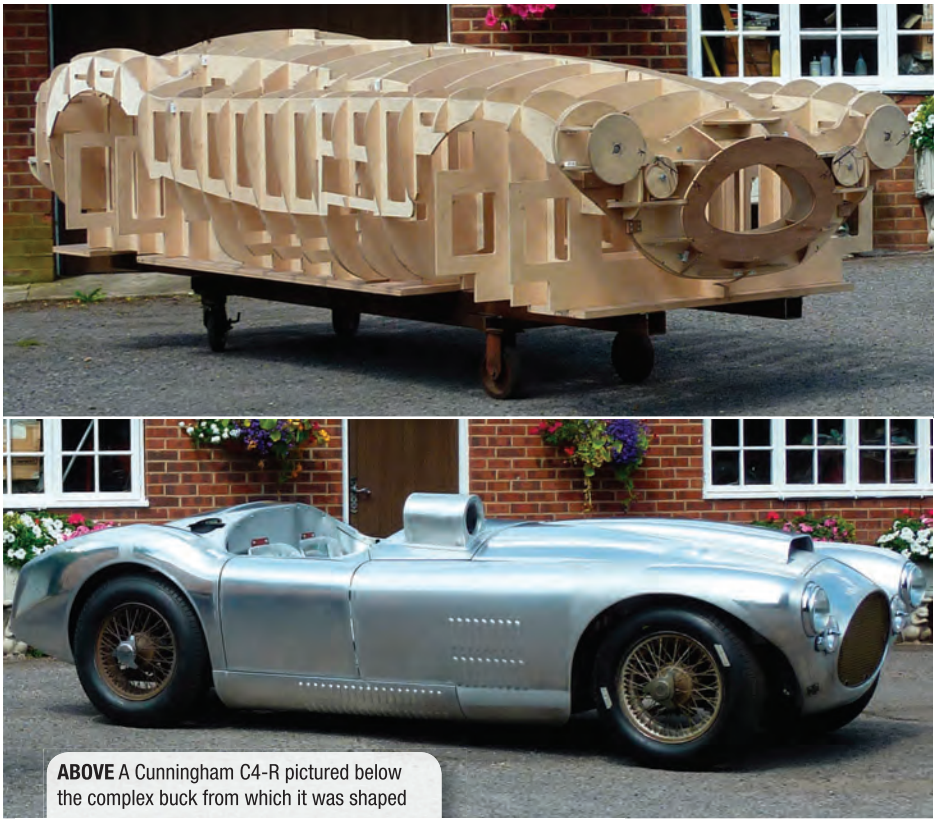
Looking at the sturdy appearance of these bucks you'd be forgiven for thinking that the aluminium is somehow moulded to the shape of the surface, but in fact they're used purely for reference, just like the wire frames. Every time the

shape of the panel is altered, it's offered up to the buck to see which areas conform to the correct shape and which need re-working.

The aim is to get the whole panel to sit flush with the contours of the buck, Stuart explains: "Say you're shaping the pointed tail on a vintage single-seater and it's touching the buck at one point but it's away from the surface at another. You'd go back and put more shape at the point where it's touching to allow the panel to go over more. Conversely, if the outer edges were touching but it was standing proud in the middle, then you need to let a bit of the curvature out."

The shaping process relies on a device called an English Wheel. This is something of a misnomer, however, because it's actually two wheels: one large and flat; the other small and domed. With the sheet metal squeezed between the two, it's a bit like rolling out pastry: the large wheel, with its greater contact area, stretches the top surface of the material out further than the smaller wheel on the bottom, forming a natural curve.

By repeating the process and changing the direction of travel or the amount of pressure on the wheel, it's possible to build up a variety of shapes and radiuses. Large or particularly complex panels are often made in multiple pieces. They're then welded together before the joints are seamlessly blended in using an English Wheel or hammer in a process known as planishing.



ABOVE A Cunningham C4-R pictured below the complex buck from which it was shaped

Part of the skill comes from managing the overall shape. As the material is worked it doesn't just change shape at the point of contact. Raising or stretching part of the panel can cause adjacent areas to sink and vice versa.

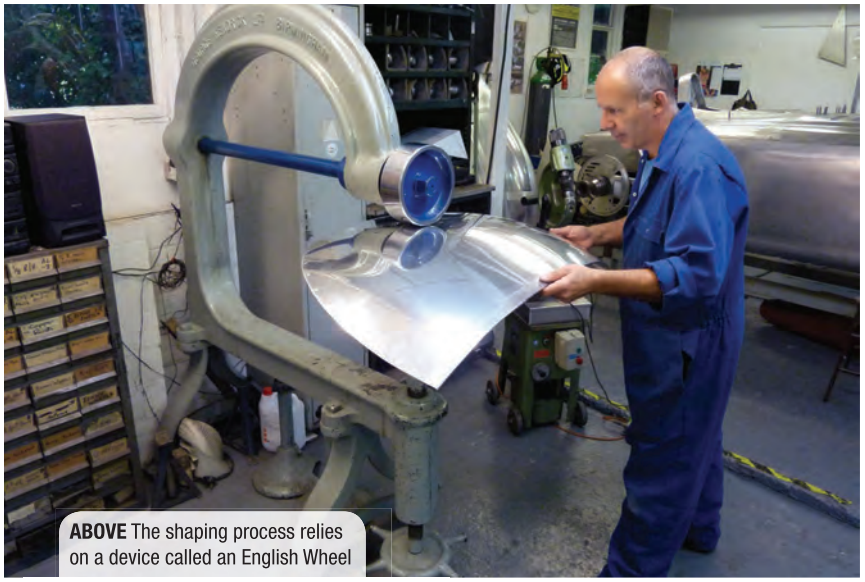
FRAMING

Shaping the panels is, of course, only part of the job. Traditional coach-built bodies rely on an underlying structural framework. In pre-war cars this tends to be traditional ash, while more recent classics sometimes feature tubular or angular steel. This picks up on various hard points and also tends to follow the curvature of the sheet metal at key points like the wheel arches and the cockpit surrounds. At the edges the aluminium is wrapped round the frame and riveted on by hand.

Restoration jobs typically begin with the process of peeling the aluminium skin carefully away from the body frame. New pieces of ash or steel can be spliced into the frame to replace broken or rotten parts, where required. Alternatively, a whole new frame can be supplied. Where possible the original panels will be repaired and fitted with new edges before being wrapped back around the frame.

It's all part of a complex, multi-skilled process, Stuart explains: "There are some very specialised skills involved in the production of a body and it's very hard for one person to do all of it. A carpenter who makes ash frames wouldn't necessarily be able to produce double curvature panels in a wheeling machine."

With such skilled jobs it can be difficult to find staff. Roach employs seven people currently, two of whom are apprentices taken on to fill the skills shortage. "In the past we used to get a lot of people from the aircraft industry or the rail industry, but they're all switching to composites," he says. "Now it's down to us to train our own." HRT



ABOVE The shaping process relies on a device called an English Wheel

Ford GT40

1964 onwards (all marks)
Owners' Workshop Manual
An insight into owning, racing and maintaining Ford's legendary sports racing car
Gordon Bruce
Published by Haynes Publishing
ISBN 978 0 85733 114 4
156 pages (hardback)
£25.00

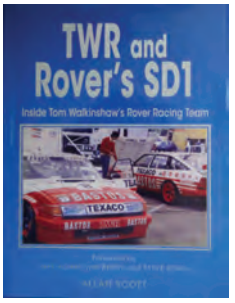
The only book publishing that Haynes Publishing does nowadays is its popular and valuable Owner's Workshop Manuals that have been the basic prop for many a home mechanic for decades. However, to think that this book on the Ford GT40 follows the same format with wiring diagrams and cut-outs of fuel pumps and engine assemblies would be a mistake, because it is much more of a history.

The heart of the book for those who really want to know the nitty gritty of the GT40 is chapter 3 that looks at the different areas of the car in great detail. It includes, for example, the body and engine and also the exhaust and fuel systems, the transmission and suspension, all extremely well illustrated. Chapter 6 will also interest readers of this publication because it covers restoration and historic racing, author Gordon Bruce delving into the engine rebuild procedure, restoration projects and obtaining spare parts.

The book is extremely well illustrated and beautifully written which is to be expected of someone of Gordon Bruce's calibre, the owner of a few historic cars himself, who has spent his entire working life writing about cars, both as a qualified engineer and as a former road test editor of Motor magazine in the '70s, not to mention a former club motor racing champion. This book would be a valuable addition for any Ford GT40 enthusiast. HRT

TWR and Rover's SD1

Inside Tom Walkinshaw's Rover Racing Team
Forewords by Jeff Allam, Win Percy and Steve Soper
Allan Scott
Published by ASM Publishing
ISBN 978 0 473 28128 1
372 pages (hardback) £49.99



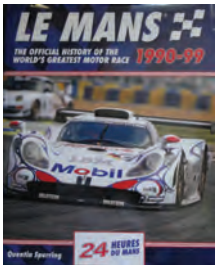
Author Allan Scott must be congratulated on writing and producing such a beautifully comprehensive book on a subject that is not ever going to be mainstream, but which is going to fascinate those of a certain age who were around when the TWR Rovers were racing.

As a former employee of Tom Walkinshaw Racing for 15 years, establishing its successful Race Engine Division in the process, Allan Scott gives a real insight into what went on behind the scenes in preparing these cars for the track with anecdote upon anecdote thrown into the narrative. One thing it is happily not, though, is just a race-by-race report of the cars because being an engineer, the author also focuses on the technical details – and that is a real treat.

Another superb feature of the book is the high number of original documents that are reproduced. For example, there is the handwritten data setup sheet for the Group A Rover in 1984 and a handwritten engine test card showing all sorts of fascinating figures. One of this reviewer's favourite documents, though, is not at all technical but gives a fascinating insight into the Austin Rover/TWR relationship. John Davenport, Austin Rover's Director of Motorsport writes to Tom Walkinshaw in June 1985 complaining that following a meeting with Texaco in Brussels he had only then discovered that TWR had already received a supply of fully synthetic oil from Texaco the previous month for the racing Rovers and that he found it rather embarrassing that he had to learn of it from Texaco rather than from TWR. There is more to it than that, but that gives the tone of the letter and it is items like this that make this book such a great read. HRT

Le Mans

The Official History of the World's Greatest Motor Race 1990-99
Quentin Spurring
Published by Evro Publishing
ISBN 978 0 9928209 1 6
384 pages (hardback) £50.00



Officially licensed by the Automobile Club de l'Ouest, Quentin Spurring's comprehensive book is a year-by-year review of the Le Mans 24 Hours in the 1990s. It is not particularly technical but it is absolutely packed with information on cars and teams that have been long forgotten, and it is this, along with the superb pictures that make this book so invaluable.

Inserted throughout the book are updates on what Spurring refers to as 'Organisation', whereby he looks at the overall state of sports car racing at the time and the way the governing bodies regarded it. For example, in 1994, there is a page on how FISA has made it clear that it regarded GT racing as the future, touching upon the one-make series in Germany and Patrick Peter and Stephane Ratel's one-make series in France.

There are a number of pages at the back of the book that detail which marques started the race in that particular decade and their results, driver records, and then a number of bar graphs for fastest qualifying laps, fastest race laps, winning distances and so on.

For those who want a comprehensive record of the cars that raced at the Le Mans 24 Hours in the last decade of the last millennium, then this has to be a book for you. HRT

Formula 1

Technical analysis 2013/2014
Giorgio Piola
Published by Giorgio Nada Editore
ISBN 978 88 7911 579 1
128 pages (softback)
£29.95

While this book obviously doesn't really fall into this magazine's remit, such is the technical content that it cannot fail to be of interest, even if it is only for the fact that they could be regarded as future historic racing cars.

The format is a well-proven one for this series, published in Italy but written in English, with page after page of intricate line drawings of the 2013 and 2014 Formula One cars, together with an explanation of what you are looking at.

New developments seen on the cars in 2013 include such things as the narrower sidepods on the Sauber C32 compared to the previous year's C31, which is clearly illustrated by a top down rendering of the 2012 and 2013 car side by side so you can precisely see the difference. Then there is a chapter covering the controversies of 2013 that include Red Bull's so-called 'T-Tray' that was contested on more than one occasion.

If ever you have wondered what all those dials on the modern Formula One steering wheel mean, then this book explains all on a car-by-car basis, while brakes, tyres and, of course, engines are gone into in huge detail. There is also a team-by-team analysis showing how the cars subtly change over the course of a season, illustrated by highly detailed line drawings.

While the 2013 cars account for most of the pages in the book, there is also a late chapter on this year's cars that include this season's controversies such as the front-rear hydraulic suspension interconnection corner (FRIC) that got banned in mid-season. There is an explanation in detail of the new for 2014 regulations plus any new features seen on the cars at the start of the season before the book went to press.

Once you have read this book, you will be an instant expert on the modern Formula One car. HRT

John Surtees

My incredible life on two and four wheels
Forewords by Valentino Rossi and Sebastian Vettel
John Surtees with **Mike Nicks**
Published by Evro Publishing
ISBN 978 0 9928209 2 3
304 pages (hardback)
£50.00

There is something about John Surtees that sets him apart from other drivers of any era, a certain mystique surrounding him, which makes him such a popular person, so to have what is in essence a pictorial biography of his life is something that any fan will want to have. There is page after page of wonderfully nostalgic photographs on both two and four wheels and because he rode and drove such a variety of bikes and cars, every page brings its own reward. It is not particularly technical, but the fact that it is a book on John Surtees and that royalties from the sale of the book go to the Henry Surtees Foundation should place it high up on the list of anyone interested in historic racing. HRT

The First American Grand Prix

The Savannah Auto Races, 1908-1911
Tanya A Bailey
Published by McFarland & Company, Inc
ISBN 978 0 7864 7697 8
228 pages (paperback)
$39.95

Award winning motorsport historian and journalist Tanya Bailey, who also owns and is the curator of the Great Savannah Races museum in Savannah, Georgia has written what can only be described as a labour of love on what will be virtually unknown territory for so many people, even in America. However, it is an invaluable piece of work that brings back to life the dawn of motor racing in the US.

The book covers the pre-history of Formula one in Savannah with the Grand Prize and Vanderbilt Cup races. Along with exploring Savannah's connections to the earliest French, Italian and German grands prix, it also covers the grand prix cars of Fiat, Renault, Benz, Mercedes, Buick, Itala, Isotta-Fraschini and many more which competed. A large portion of the book is also dedicated to profiling the drivers of the early grand prix races such as Louis Wagner, Felice Nazzaro, Victor Hemery, David-Bruce Brown, Ralph Mulford, Ralph De Palma and Ray Harroun. There are more than 105 pictures plus maps and race results charts. The author also explores theories of how Savannah was selected for hosting the first grand prix race and why road racing died out shortly thereafter.

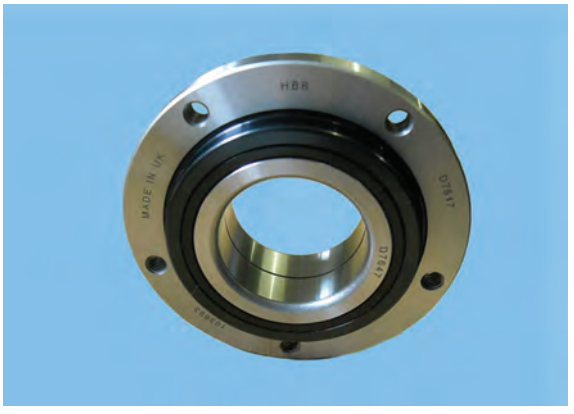
This book will be a must-have for all history buffs as it uncovers a great deal of information and images never before seen that tell the story of how international grand prix racing crossed the Atlantic. HRT

HB Bearings

FOR over 40 years, HB Bearings has supplied all manner of specialist bearings to the historic car industry. Catering to bespoke requirements, the firm can produce ball, roller, thrust, angular contact and even combination bearings, ranging from one-offs to large batches.

"If a customer has a worn or damaged bearing, we can reverse engineer a new part from their sample," explains HB Bearings' Michael Hales. "If no actual bearing is available then a manufacturers' name and reference number or a drawing can often be sufficient information for us to proceed. We have a vast reference library of bearing information enabling us to quickly locate the specifications. Much of the data relates to the old Hoffmann and Ransome & Marles bearing companies."

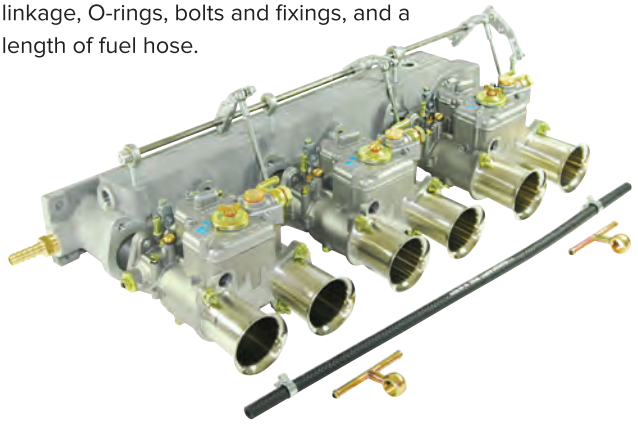
The firm also keeps a wide range of bearings in stock, including an equivalent design for the 441933E wheel bearing used in the Ford RS200 and the Metro 6R4. Manufactured to the original manufacturer's specification in high quality bearing steels using the latest CNC machinery, it provides a fresh source for these previously unobtainable parts.



Webcon Conversion Kit

NEW from Webcon comes this triple 45 DCOE carburettor conversion kit for the Jaguar 3.8 and 4.2-litre engines.

The conversion features a cast alloy inlet manifold with water jacket, three pre-assembled genuine Spanish Weber 45 DCOE carburettors jetted to suit the Jaguar engine, plus throttle linkage, O-rings, bolts and fixings, and a length of fuel hose.



PT Classics

PT CLASSICS is a family run business with over 30 years' experience in classic car restoration and motorsport preparation, specialising in Jaguar, Bentley and Rolls Royce.

Company founder Pat Twinley has worked on a wide range of competition Jaguars spanning 1945 to 1990, including Group C and GTP cars. He's also worked on Ferraris covering three decades and a variety of touring cars. Somehow, in between all this, he's found the time to run several class-winning LMP2 entries in the Le Mans 24 Hours.

Based in Essex, PT Classics offers full service facilities, along with an engine and transmission build shop and a fully equipped fabrication shop. Powder coating, plating and painting can also be arranged, with a full photo record of all work carried out. Delivery and collection is available right across Europe and vehicle appraisals can be carried out worldwide.

"We can build any body or chassis part in aluminium, steel or carbonfibre," says Twinley. "Our team can also repair or manufacture new wood for dashboards, doors or frames and we can re-trim complete cars in leather or cloth.

"Recently we were asked by Complete Motorsport Solutions to investigate an engine problem with their semi-Lightweight E-Type," he continues. "The engine arrived in our workshop, whereupon we stripped it down, compiled a full report and found it to be in need of new liners. Four days later it had been machined, repaired, re-built and delivered back to the customer in time to successfully compete in the Spa 6 Hours. This is the commitment we give to all our customers, whether it's a road car or a racecar."

Virkler & Bartlett

VIRGINIA-based historic motorsport specialist Virkler & Bartlett has introduced a new range of clutches with integrated starter motor assemblies aimed at the historic road racing market.

The clutch assemblies are available with single, twin or triple friction discs in popular diameters of 4.5, 5.5 and 7.25 inches. They are offered either in sintered metal or carbon, with a range of diaphragm spring pressures. Fasteners and other parts are mainly produced from aircraft-quality metals, including the chrome moly steel starter motor ring gear.

V&B says the aim is to provide a full season's use, including frequent standing starts, without any clutch maintenance.

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Turrino Wheels

SAS Turrino is one of the world's leading wire wheel specialists. The Northamptonshire-based company has been manufacturing and restoring wheels since 1980, with the Turrino range of alloy rims launched in the 1990s.

The process of producing wire wheels has remained largely unchanged since the 1920s. The rims are spun from steel or aluminium, while the centres are forged and the spokes are produced from carbon steel or stainless.

Turrino can produce wheels in virtually any size or offset to suit cars of all ages. Alloy rims provide low unsprung weight, yet they are capable of handling high power and torque.

Although the popularity of wire wheels began to dwindle in the mid-sixties, Turrino has built sets for GT40s and Cobras, not to mention modern high performance cars such as the Eagle Speedster and Ian Callum's recent re-imagining of the Jaguar mk2. At the other end of the scale, the company has also produced 10-inch wire wheels for Minis and the diminutive 1000cc Formula 4 cars of the 1960s.

Optima comes to the UK

SUNOCO Optima is an ethanol-free unleaded fuel, free from MTBE and oxygenates. As a result it's more or less chemically inert, allowing it to be left in a car's fuel system for three years or more, making it ideal for cars which are stored for long periods between use.

From Novmber, the Anglo American Oil Company will be bringing Sunoco Optima to the UK in 25, 50 and 200-litre drums. It will also be appearing at the PMWE show in November, as part of the company's range of fuels, oils and brake fluids.

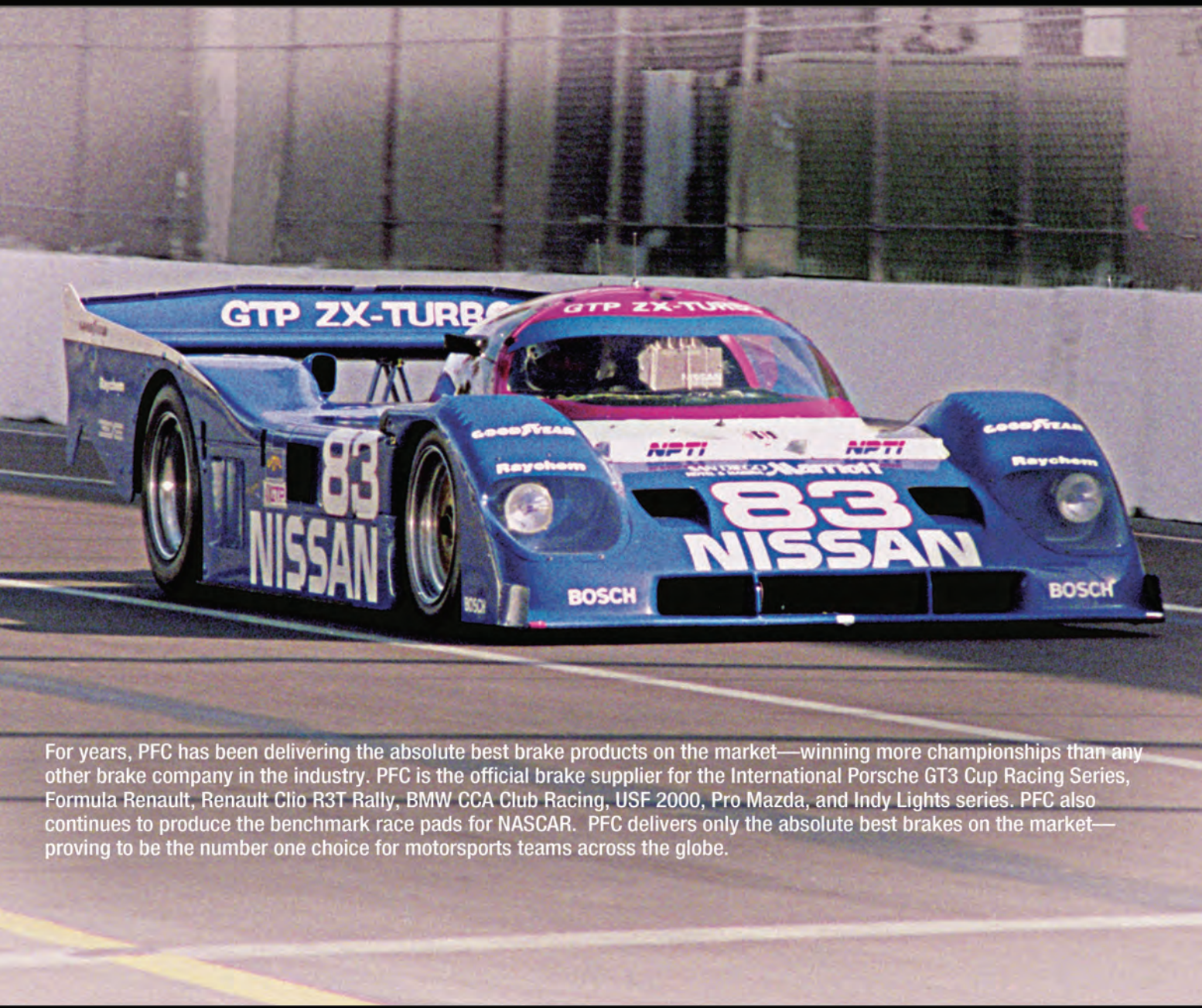
Swiftune Competition Condenser

THE Swiftune Competition Condenser is designed for use on all engines running conventional points ignition. In particular, it provides a reliable, high performance alternative to the Lucas condensers that were once used on virtually all British cars.

The Competition Condenser is FIA Appendix K compliant. Swiftune says it has completely eradicated condenser-related misfires on all engines it's been used on, with race victories picked up in machinery as diverse as Cobras, Minis and GT40s.

Suitable for both positive and negative earth cars, the Competition Condenser comes in an easy-to-fit kit that includes the P-Clip and wires with heat shrunk connections for the coil and earth.

It's Quicker™.



For years, PFC has been delivering the absolute best brake products on the market—winning more championships than any other brake company in the industry. PFC is the official brake supplier for the International Porsche GT3 Cup Racing Series, Formula Renault, Renault Clio R3T Rally, BMW CCA Club Racing, USF 2000, Pro Mazda, and Indy Lights series. PFC also continues to produce the benchmark race pads for NASCAR. PFC delivers only the absolute best brakes on the market—proving to be the number one choice for motorsports teams across the globe.

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