HISTORIC RACING Technology

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Getting Colin's iconic Impreza WRC back onto the stages



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McRAE'S SUBARU

Getting Colin's iconic Impreza WRC back onto the stage

ON THE COVER

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68 In what can only be described as a monumental piece of work from the renowned automotive historian Karl Ludvigsen, *Reid Railton – Man of Speed* has just been published by EVRO Publishing. We are privileged to be allowed to publish just a small extract from the book to give you a flavour of what is an extraordinary story by an extraordinary storyteller

74 Book Review: *Reid Railton – Man of Speed* by Karl Ludvigsen

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2018 EVENT CALENDAR

MARCH	22	Masters Test Day	Brands Hatch Indy, UK
APRIL	20/22	Motor Legend Festival	Imola, Italy
MAY	26/27	Masters Historic Festival	Brands Hatch GP, UK
JUNE	22/24	The Most Historic Grand Prix	Most, Czech Republic
JUNE	22/24	Formula 1 Grand Prix de France*	Le Castellet, France
JULY	6/8	Formula 1 Rolex British Grand Prix*	Silverstone GP Circuit, UK
JULY	20/22	Silverstone Classic	Silverstone GP Circuit, UK
★ JULY	26/29	Portland Vintage Racing Festival	Portland International Raceway, USA
AUGUST	10/12	Oldtimer Grand Prix	Nürburgring, Germany
★ AUGUST	18/19	Monterey Pre-Reunion	Mazda Raceway Laguna Seca, USA
★ AUGUST	23/26	Rolex Monterey Motorsports Reunion	Mazda Raceway Laguna Seca, USA
AUG/SEPT	31/02	Historic Grand Prix	Zandvoort, Holland
SEPTEMBER	14/16	Spa Six Hours	Spa, Belgium
★ OCTOBER	5/7	CSRG Charity Challenge	Sonoma Raceway, USA
OCTOBER	12/14	Dijon Motors Cup	Dijon, France

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

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Encouraging young engineers

THERE is no doubt that historic motor racing is on an upswing providing many companies which specialise in the restoration and preparation of such cars with an enormous amount of work. However, there are one or two small clouds on the horizon which could prove to grow rather too large over the next few years.

Whenever I visit companies, one of the questions I ask is how do they find recruiting young engineers and technicians, and the universal response is with great difficulty, especially when it comes to recruiting young graduates. For those who have a degree in motorsport engineering, it seems that generally they have their eyes set on only one place and that is Formula 1. It's easy to understand why. It's wonderfully glamorous and high-tech and to be involved in a car competing at the highest level of the sport is exhilarating. Forget that you might just be a small cog in a large wheel it's nonetheless scintillating for them.

However, the argument put forward by those in historic racing is the reverse as the graduate can play a very major role and be totally hands-on across the entire car, not just a bit of it. The job satisfaction for true engineers and technicians is extremely rewarding, they argue, if not quite as glamorous. To be fair, though, some of the venues visited such as Monaco, Le Mans, Spa and other great circuits are pretty glamorous in their own right. You don't have to be part of a Formula 1 or World Endurance Championship team to visit them.

The trouble is that most motorsport engineering courses are understandably biased towards modern racing car technology but from what I understand, much of the hands-on skills are neglected as they tend to be classroom and computer focused. There is Formula Student and Formula SAE, of course, which are tremendous, but just a fraction of the students get involved.

As featured in this issue, the Oxford Universities Motorsport Foundation provides just such a hands-on experience for those students who want to get out of the classroom, who are prepared to get dirty fingernails and figure out how to race prepare a car. The trouble is that it's virtually unique, although there are a few other schemes run by universities and colleges, and it has absolutely no funding. It's a charity that relies on tooling and materials that as Alan Stoddart, who wrote the article quotes they have to "wangle" to get.

I'm not sure how, but surely there must be a way of formalising what OUMF and other such organisations are doing to enhance what they are already achieving with little or no resources. I have to confess that I am confused when it comes to apprenticeships. From what I understand, they aren't really cost-effective for smaller businesses that have to put more in than they can take out. When they are working on tight margins and where every person has to count, they don't have the luxury of training anyone. If this is the case, then the apprenticeship scheme should be reformed to make it more viable.

Quite where we go from here I'm not sure but in all honesty I cannot see anything changing in the short or even medium term. The historic racing industry is going to have to rely on the current workforce keeping going and hope that fresh blood is injected before they all retire and their skills are lost to us all. HRT

William Kimberley
Editor



NEWS

Motofest Coventry to stage record collection of classic cars and bikes

William Kimberley

MOTOFEST Coventry is set to stage the largest classic cars and bikes collection in the event's history thanks to a new five-year sponsorship agreement with the Coventry Business Improvement District (BID), the body that represents the city's retailers.

In ambitious plans to create a 'show within a show' the Coventry BID Classic will feature the largest representation of classic cars and bikes ever seen at Motofest Coventry, with the scope to feature over 1,000 cars and bikes at this year's event.

With the BID's long-term commitment to Motofest Coventry confirmed, organisers will work with the city's retailers to build a dedicated classic car and bike display area in Coventry's city centre area.

More than 1,000 cars and bikes are set to feature at this year's event on 2/3 June with classic vehicle enthusiasts, car and bike clubs across the UK all being invited to play their part in making Motofest Coventry 2018, the best classic car and bike the city has seen since the event started five years ago.

As in previous years there will also be classic car representation on the main sprint circuit with the classic car and heritage vehicles demonstration displays again beginning the four wheeled action on the track.

The classic cars and bikes will also end the show with the Coventry BID Classic Cavalcade seeing the static display vehicles leave their allocated slots and take to the sprint circuit for parade laps of the circuit – a final awesome display of classic machinery to thrill the crowds.

"We are thrilled to be sponsoring Motofest Coventry and working with the team again after the success of last year," said Coventry BID Director Trish Willetts. "Year on year, the event is a huge success, bringing in thousands of people to the city centre, which is why we decided to make a five-year commitment to help stage the Coventry BID Classic.

"Motofest keeps getting bigger and better and we are extremely excited for the 2018 event and everything that is planned.

"Head down to Coventry city centre on June 2 and 3, get involved with all the attractions and head into our wonderful businesses and see what they have to offer."

"We are delighted to have BID on board with Motofest as it will go a long way in supporting the sustainability and development of the event over the next five years," said James Noble, Motofest director. "Having the support of the BID is an incredible endorsement of Motofest's importance to the local economy.

"With the BID's backing we again look forward to developing an 'event within an event' that will showcase the very best of classic cars and bikes and in doing so provide a further thrilling element to the show."

Motofest Coventry 2018 is a two-day festival dedicated to the city's motoring heritage, which this year takes place on Saturday 2 June and Sunday 3 June. There will be a range of automotive activities taking place from pop-up and demonstration events to static displays and fringe events at Motofest, now the largest free urban motorsport festival in the UK. HRT



ABOVE There will be a strong presence of historic racing cars, some of which will be allowed to parade, at Motorfest Coventry



ABOVE The Reverend Richard Coles presenting the prestigious Museums and Heritage Award for Permanent Exhibition Award to Tamalie Newbery, Brooklands Museum's director & CEO, and Allan Winn, its vice president

Brooklands Museum wins major award

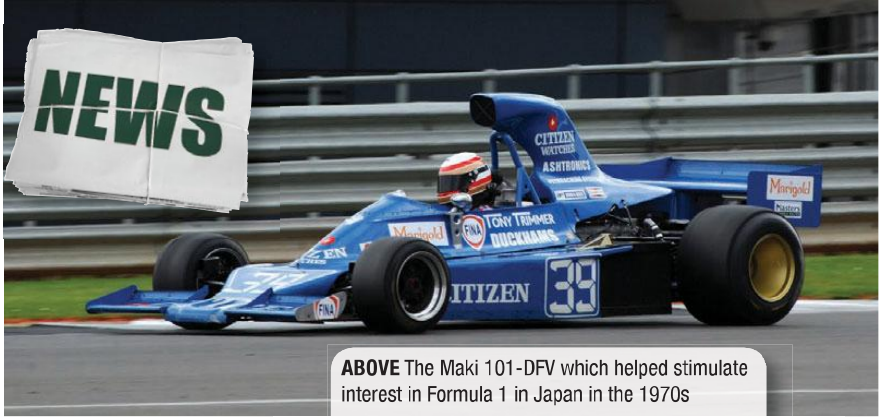
BROOKLANDS Museum has won the prestigious Museums and Heritage Award for Permanent Exhibition, seeing off stiff competition from some major national institutions such as the Science Museum Group and Natural History Museum. The award was announced at a gala awards ceremony in London on 16 May and presented by the Reverend Richard Coles.

The award was for the Brooklands Aircraft Factory and Flight Shed, the major £8.4m project that involved dismantling, restoring and relocating a Grade 2 Listed WWII Bellman Hangar and reinterpreting it inside as an aircraft factory. As well as restoring and re-profiling the section of original 1907 Race Track where the Hangar once stood, the project also included constructing a new purpose-built Flight Shed to display live aircraft with a new archive store and workshop beneath. The Aircraft Factory and Flight Shed opened to the public in November 2017.

The competition saw a broad range of entries from remarkable achievements of national institutions to projects crafted with limited resources and those championing their staff and volunteers who work hard to deliver inspiring visitor experiences. The Permanent Exhibition category included National Army Museum, Ashmolean Museum, London's Natural History Museum and part of the Science Museum Group, 'Wonderlab' on the shortlist. Other categories included Volunteer of the Year, Educational Initiative, Marketing Campaign and Project on a Limited Budget.

Brooklands is also currently one of five finalists for the Art Fund Museum of the Year Award which is the world's biggest museum award and will be announced on 5 July. The winner will benefit from a £100,000 prize, meanwhile the runners up will be given £10,000 to support future activity.

Stephen Deuchar, director of the Art Fund said: "Each one of these five finalist museums for the £100,000 Art Fund Museum of the Year 2018 prize has had an exceptional year. They are the engines of cultural development in this country – centres of innovation and pioneering new ways of engaging with the public. They represent the height of creativity and ambition, whether through the collections they display, the means by which they engage audiences or how they address the issues of the moment. I would encourage everyone to go and experience them at first hand." HRT



ABOVE The Maki 101-DFV which helped stimulate interest in Formula 1 in Japan in the 1970s

Hiro Toyoda becomes WDK Motorsports' agent in Japan

William Kimberley

WDK Motorsport, the FIA title-winning historic motorsport business noted for its work with 3 litre Formula One cars of the 1970s and 1980s, based in Stockbridge Hampshire, has appointed UKJP Limited as its agent for Japan.

UKJP Limited, a representation and engineering business consultancy company for UK automotive and motorsport businesses working in Japan, was founded in 2017 by Hiro Toyoda, the former managing director of Honda Racing's associate company in UK. He has enjoyed a long and distinguished career working in the UK motor racing industry for 25 years, including working for several automotive manufacturers in Formula 1 and endurance racing, on World Rally Car projects and in the establishment of the current Honda F1 base in the UK.

"WDK has already raced several of our clients' historic F1 cars in Japan, and are well aware of the fast-rising interest there in historic motorsport, so we had been looking for a way into the Japanese market, which Hiro provides," said Christopher Tate, WDK Motorsport's executive chairman.

"Having personally known Hiro Toyoda in his long career in international motorsport, it is my great pleasure to welcome him to WDK and the world of historic racing. We have exciting plans for Japan, and the ability to use our workforce's world-wide reputation for quality engineering, to expand into an exciting new market."

"Since establishing UKJP last year, we have been talking to WDK, and in view of the increasing levels of interest in Japan in not just collecting classic cars, but also in racing classic and historic cars," said Toyoda. "I'm sure that this is an excellent moment to launch this new service. For example, I was delighted to discover that last year, WDK rebuilt and now maintain, the unique Japanese 1970s F1 car, the Maki 101-DFV, a car which in many ways, led the growth of F1 interest in Japan back in the 1970s." HRT

Factory quality Gullwing parts again available

THE Mercedes-Benz 300 SL "Gullwing" (W 198) is still one of the world's dream cars. Between 1954 and 1957, just 1,400 units were built of the famous "Gullwing", which was voted "Sports Car of the Century" in 1999. The conservation of these valuable vehicles sometimes requires key body parts. Mercedes-Benz Classic has now reproduced these parts, with others in preparation.

They can be ordered by their part number from any Mercedes-Benz sales partner. The production process combines state-of-the-art technology with traditional craftsmanship. It guarantees a high accuracy of fit of the metal parts while minimising the need for subsequent work on the vehicle.

The metal parts are produced for Mercedes-Benz Classic by a certified supplier, whose expertise includes the highly complex construction of tools from optimised 3D data from original bodies. Metal parts produced on these tools are then worked into their final shape by hand using wooden mallets – another special process. The result of this symbiosis between state-of-the-art production technology and traditional craftsmanship is a high accuracy of fit that minimises the need for subsequent work on the vehicle.

The precise 3D tool data also provide the basis for quality inspection by means of painstaking false colour comparison. The measuring tool receives the data as a reference and uses false colours to visualise the measured deviations between the desired state and the actual state, thus making it possible for the measurement results to be unambiguously and quickly interpreted.

The body parts meet the high standards of Daimler AG and can be ordered by their part number from any Mercedes-Benz sales partner. Their surfaces are electrophoretically painted, which assures the highest technical and visual standards. HRT



ABOVE Key body parts for the Mercedes-Benz 300 SL "Gullwing" (W 198) are again available in factory quality


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NEWS

Iconic 911 race car flies the flag for Porsche Classic services

A RESTORED 1965 Porsche 911 race car will take to the race circuits of Britain and Europe this year in celebration of the 70th anniversary of Porsche sports cars and highlight the Porsche Classic programme for older models.

The innovative programme is managed by Porsche Cars GB and underlines the commitment of the Stuttgart sports car manufacturer to the continued enjoyment of the over 70 per cent of Porsches still on the road today; supported by 52,000-plus Classic Genuine parts from over 1,000 Classic suppliers.

Co-ordinated by the Porsche Classic team at the marque's GB headquarters in Reading, Berkshire, and prepared for racing together with the Porsche Classic Partner Centres in the UK network, the iconic, rear-engined, flat-six race car will make appearances at historic events through the year.

"Following the success of our similar 928 race car project in 2017, we were keen to find another initiative to tie into the upcoming celebrations of 70 years of Porsche sports cars," commented Jonathan Mannell, manager, Owner Services, Porsche Cars GB. "We are privileged to own a 1965 short wheelbase 911, which was last used for racing in 2013 as part of the 50th anniversary of the 911. Working with Porsche Recommended Repairer, Road & Race Restorations, a hand-picked team from the Classic Partner Centres will prepare and run the car in a series of races over the course of 2018 as a roving ambassador for the Porsche Classic business. Bringing our history and tradition alive in this manner is also a great way to help celebrate the 70th anniversary of the first Porsche sports car and to highlight the passion for Porsche Classic at both Porsche Cars GB and our Classic Partner Centres."

An exciting programme with the 911 coupe will include a presence at legendary events such as the Le Mans Classic in France, the Oldtimer Grand Prix at the Nürburgring in Germany, the Silverstone Classic, and the Brands Hatch Festival of Porsche in Kent in September.

An initial extended test at a HSCC race at Donington Park on 7 April saw the car perform strongly with former British Touring Car Championship ace Anthony Reid and 1970 Le Mans winner Richard Attwood behind the wheel. The team now plans the following calendar of activity, kicking off at Spa-Francorchamps this weekend in Belgium, where Anthony Reid will be joined by former Porsche Carrera Cup GB Champion Josh Webster.

17 June HSCC Guards Trophy, Silverstone, GB
6 – 8 July Le Mans Classic, Le Mans, France
20 – 22 July Silverstone Classic, Silverstone, GB
10 – 12 August OldTimer Grand Prix, Nurburgring, Germany
25 – 26 August HSCC Guards Trophy, Oulton Park, GB
2 September Porsche Classic Trophy, Brands Hatch GP, GB
21 October HSCC Guards Trophy, Silverstone, GB HRT



ABOVE A 1965 Porsche 911 has been restored to highlight the Porsche Classic programme for older models

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NEWS

Jenson Button to race at Le Mans Classic and Goodwood Revival

FORMER Formula 1 World Champion Jenson Button will racing cars prepared by JD Classics at Le Mans Classic in July and the Goodwood Revival in September.

At Le Mans he will drive the Jaguar XJR-9, chassis #688, the car that was built by Tom Walkinshaw Racing in 1988 to replace that year's Le Mans-winning car, and which has a number of incredible competition results to its name. In July 1988 it was placed third at Brno, driven by Johnny Dumfries and Jan Lammers, while in September that year it was driven to second at the Spa 1000 km by Dumfries, Lammers and Martin Brundle.

Button will line-up on the Le Mans Classic Group C grid against a number of other motorsport legends of the same era, including the Porsche 962C, Peugeot 905 EV1 and Nissan NPTi 90. At the last running of Le Mans Classic in 2016, the JD Classics team claimed four victories, a podium finish and a pole position against world-class opposition.

Following his drive at Le Mans Classic, he will again join the JD Classics team to race at Goodwood Revival in September, competing in one of the JD Classics entries over the race weekend, which have in the past included a Ford GT40, Jaguar E-Type Lightweight and Cooper T33.

Button began racing in Formula One in 2000 with Williams where he became the youngest driver at the time to ever score a point in F1. He then went on to race at Benetton, Renault and BAR, where he achieved a third place finish in the Drivers' Championship during the 2004 season. Three years at Honda followed before the team became Brawn GP in 2009, the year in which Button became Formula 1 World Champion. The following year he moved to McLaren and raced with the team until the end of the 2016 season, when he took a break from racing in F1.

"It's an absolute pleasure for us to have Jenson racing with us twice this season," said Derek Hood, JD Classics founder. "I know the talented engineers working in our race shop in Maldon are some of the best in the world so Jenson will have all the technical support he needs. We're proud sponsors of both Le Mans Classic and Goodwood Revival because we believe they deliver some of the best historic motorsport action on the calendar – having Jenson racing at both just goes to show why." HRT



Photo: Michael Bailie

BELOW 2009 Formula One World Champion Jenson Button will be driving two races with JD Classics in 2018

COMING UP

Recreation of a classic Camaro



ABOVE Over the next few weeks this car will be transformed into a replica of one of the famous Penske Camaros from 1967

ONE of the most famous Camaros ever was the 1967 Penske car that was driven by Mark Donohue. Altogether six were made in that year, each one bending the rules one way or the other, to the point that one car came third outright in the following year's Sebring race, outpacing Ford GT40s, Lola T70s, a Ferrari LM and a Howmet Turbine. Despite not quite adhering to the regulations at the time, these metallic blue cars caught the imagination and were universally admired.

The Anglo-American Oil Company based in the UK is working on recreating one of the fabulous cars in authentic livery and with modern running gear with a view to bringing it to Silverstone Classic in late July. There is still some way to go on the project but the following issue of *Historic Racing technology* will be bringing you the full story. HRT

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A TRIUMPH FOR INGENUITY

Alan Stoddart finds out how a mixture of passion, persistence and modern technology enabled a recreation of the only Triumph SLR ever constructed

HERE'S an interesting bit of trivia to whip out next time you're down the pub: the last car to leave the start line at Goodwood circuit, before it was revived for the Revival, was a beautifully rebodied Triumph TR4. The car was piloted by a chap called Neil Dangerfield, who was the scratch man in the final handicap at that last race.

This racing coupé started life as a brand new TR4 which Dangerfield bought from Hurrells SAH Tuning Concern in 1962. This TR4 was being looked after by Sid Hurrell, and was being raced with some success by Dangerfield. This included one notable excursion to Monza in 1962 when he drove the TR4 to the Italian circuit, raced in the three-hour GP support race and achieved second in class, and then drove the car home again.

The preparation of the car was then taken over by renowned Morgan tuner and racer Chris Lawrence. He, along with Dangerfield and John Sprinzel, another racing driver of some renown, decided to create a new low-drag racer by removing the TR4's body and replacing it with a svelte aluminium body crafted by Williams & Pritchard. This was possible at the time because before 1966, the regulations allowed all panels that were 'licked by the wind' – a very literal translation from French – to be changed without being homologated, which is what allowed things like the low-drag E-Types and the like to be raced. Since the TR4 underneath had been homologated, there were no regulatory hurdles to just putting on another body.

A UNIQUE CAR

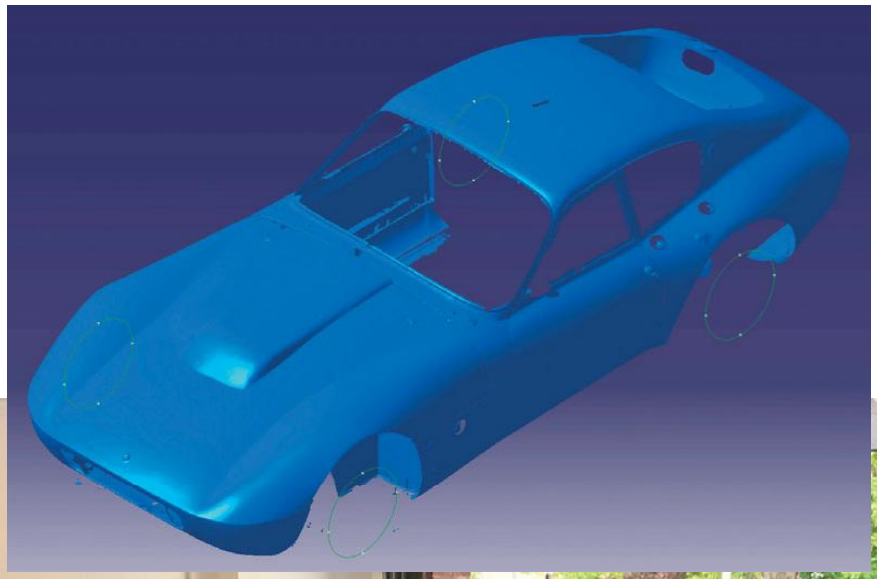
This new car was christened the SLR, after Sprinzel LawerenceTune Racing, and was the first of only four made, and the only one to be based on a Triumph TR4 chassis with the remaining three SLRs using a Morgan Plus 4 as a base. The Triumph SLR was campaigned by Dangerfield for a number of years, racing regularly on British circuits, and even being taken further afield to Spa ▶

> **"The racers reliably output 190-195 bhp – a tidy increase on the 105 bhp TR4s left the factory with"**





ABOVE How the original SLR was unveiled to the public at the Racing Car Show at Olympia in 1964



LEFT The scan revealed a number of anomalies, including the roof and windscreen aperture. While some aspects of the car could be mirrored side-to-side, others simply couldn't

BELOW The second SLR returned from the coachbuilders just as HRT went to press. The hope is that the first car should be up and running by the end of July

and the Nürburgring.

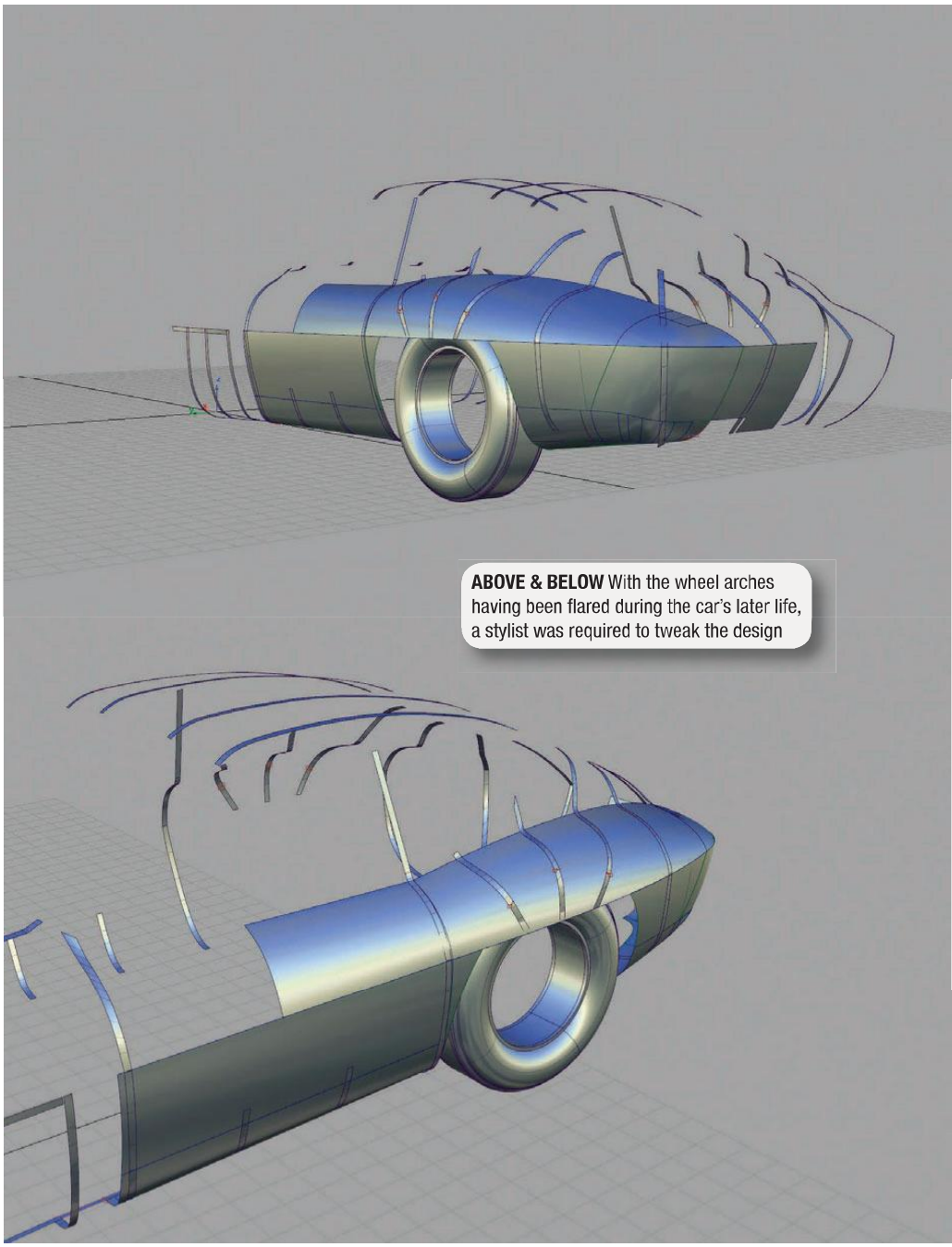
This original Triumph SLR was sold by Dangerfield in 1966, after which it was entered into a lot of club races, and free of the stricter regulations of the international events, underwent tweaks to the body such as widely flared wheel arches and the addition of lights to enable nighttime running. It was purchased by its current owner in 1986 and lovingly restored and has since been a regular at the Goodwood Revival and other events.

A few years ago the car came to TR Enterprises, a Triumph specialist in Nottinghamshire, for a complete engine rebuild. Fortune played its part, and after one of the workshop's regular customers asked about buying the SLR, TR made up its mind to recreate the unusual racer.

RESEARCH PAYS OFF

The first step in this recreation was about two years of research to try and find out as much about the SLR as possible, to ensure that the recreations the company made were absolutely perfect replicas of the original body. To this end a full scan of the original car's body was undertaken by A2P2, a company that specialises in reverse engineering, which was then used to create a CAD model of the bodyshell. This is where the research that TR Enterprises conducted really paid off.

The existing original Triumph SLR had had some fairly significant changes made to its bodywork during the 50 years between being made and TR deciding to resurrect the model. Chief among them was the flaring of the wheel arches and the removal of a very definite swage that ran the entire length of the car and squared off the top of the rear wheel arch. There were no period photographs giving a good view of these original rear wheel arches, but TR's digging had unearthed several pictures showing later bodywork, including one which proved particularly useful as it shows the car just after having the wheel arches extended, before they were painted. This allowed TR to see exactly what had been done.



ABOVE & BELOW With the wheel arches having been flared during the car's later life, a stylist was required to tweak the design

> **"Three thou can make all the difference between it running sweetly for 100 thousand miles or blowing its head gasket"**

This, as well as close examination of the metal in the original car's bodywork to look for clues about how it had been worked, helped inform the professional stylist employed by TR to make sure they got the shape just right.

The scan data, along with the tweaks made by the stylist, enabled bucks to be produced, against which RH Classics was able to actually do the metalwork; this enabled it to produce an exact recreation of the original car. Thanks to the precision of the scan, however, it was almost a little too accurate. As it turns out, one side of the car is about two inches further back than the other. "The car had had a bit of a prang at some point, so they had filled it, but we had to decide whether to keep the difference or not," says Simon Watson, one of the owners of TR Enterprises.

A decision that is perhaps more difficult than you might originally imagine, adds Watson. "The guy who did our scanning ▶



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was looking at all the top surfaces, and asked if we wanted all the pieces copying. He did a Lister Knobbly and the owner only asked for half to be done and for it to be mirrored. They did it and made a body from it but it didn't look right... so they basically started all over again, but keeping all the anomalies and that one did look right."

In the end, however, TR decided to square everything off including the window aperture and the roof aperture, which were also irregular, to make the SLR exactly as it was originally designed.

The differences in the original hand-built bodies also caused problems when it came time to fit the windscreen. TR Enterprises had heard that Brands Hatch Morgan had worked on one of the Morgan SLRs and had an extra windscreen made up. When this extra windscreen was installed in a different SLR, it was actually too small for the aperture and fell through.

In the end TR Enterprises took the original, because it knew it fitted, and sent it to Pilkington, which made up a batch of 10 heated screens for the project and its customers. Having heated screens will also provide a big advantage when raced, given the original car's propensity for misting up – it even put an end to one of Dangerfield's races, according to his log book.

"So our body shells will always fit our windscreens, and we should always be able to supply replacements to our customers," says Watson. "The actual jig has got a reasonably fixed, if not quite hammerform section, so the actual aperture is sufficiently accurate with the rubber. The bodybuilders have also got a windscreen so they can check it before it comes out. It's one of those critical things; the side windows can be made slightly differently, but the windscreens have got to fit."

As with the windscreen at RH Classics there are several checks along the way to make sure that everything is as accurate as possible. Another of these is at Safety Devices, which is responsible for installing the rollcage in the SLRs, as well as all the other cars TR Enterprises works on. When Safety Devices gets the body to install the roll cage, it scans the inside of the shell. Not only does this enable it to mock up the cage on the computer, it also helps to identify any slight variance between the shells, and alert TR at that earliest possible time.

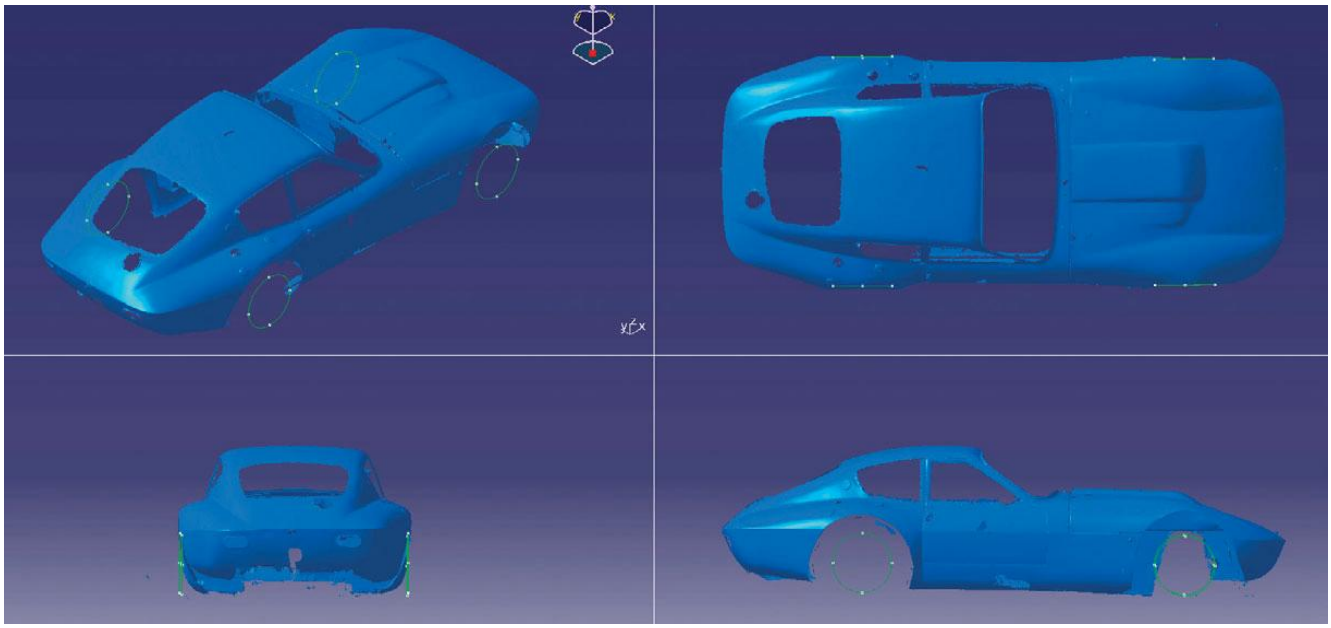
With the chassis, and drivetrain underneath the body entirely TR4, TR Enterprises is able to utilise its 30+ years of experience to make sure as much is eked out of the car as possible so that it can hold its own on the grid. Part of this ability to tune the engines is hard-earned expertise with regards to the best parts to use for any particular engine. It's no surprise that TR Enterprises, in seeking out and later relying on these parts has managed to build up a network of really high quality suppliers that the team can rely on.

Among these is Piper, which TR goes to for its camshafts. As well as offering a generally higher quality of camshaft than Triumph's original ones, thanks to far better manufacturing techniques which give much higher tolerances and improved performance, the camshafts used by TR Enterprises are bespoke, and use a unique profile. These benefits are compounded by the company also using uprated followers.

> **"When people in the future take the engine to bits, I want them to be impressed"**

BETTER THAN THE ORIGINAL

Elsewhere in the engine Venolia pistons are used. As with Piper's cams, these are of a much higher quality than the original Triumph pistons, so are far better suited to use in a race engine ▶



ABOVE Improvements in technology, such as the quality of the scanning, make projects possible that might not have been financially viable even 10 years ago

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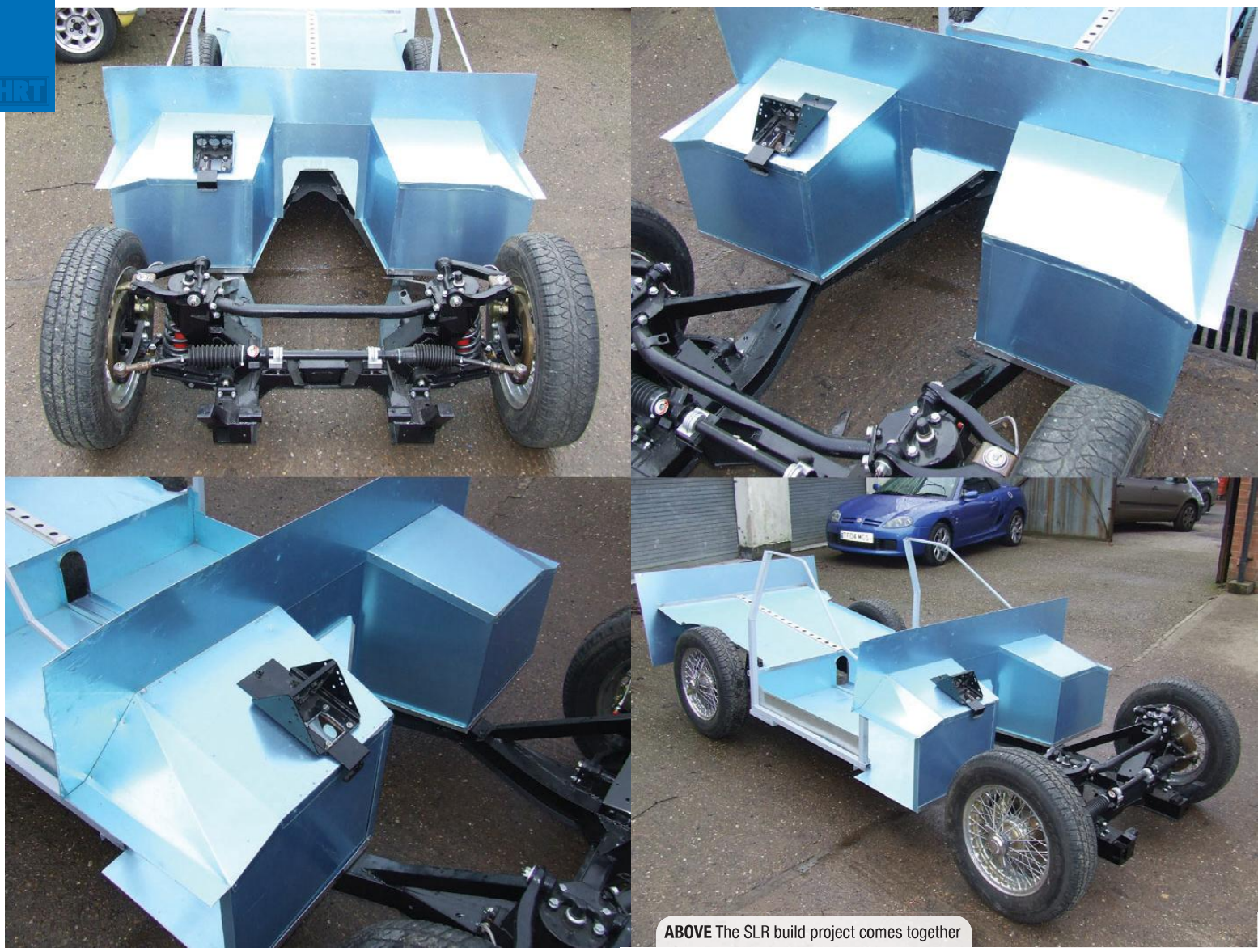
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ABOVE The SLR build project comes together

– as much because of reliability as anything else. Although TR Enterprises is willing to use different suppliers if it sees something else available that would also be suitable or even better, it does use JE Pistons on occasion for "bits and bobs".

"We're not blinded by just using one supplier," Watson explains. "We are happy to spread our eggs as it were, but only to a degree: there are certain things that are just a no-brainer. People are always ringing us asking if we want to use different parts, and I'm sure lots of them are fantastic... but it boils down to whether we charge our customer £500 less on a £15,000 engine, or try to take another £500 profit? The risk just isn't worth it. Our customers would rather pay £15,000 than £14,500 and have the right thing."

Also informing this mentality is the sense of pride TR Enterprises has in its work. It is for this reason that it strives to buy all the genuine parts it can, from gearboxes and differentials, right down to the RHP or Timken bearings used in the engine, rather than cheaper reproductions, even though they may arguably work almost as well.

IT'S THE FUTURE THING

"I always keep thinking that if you have to take the engine to pieces in the paddock, people will lean over and ask, 'Oh why did you fit those [reproductions]' even if they are fine, or in 20 years' time when the car comes to pieces, people will say, 'What did you fit that rubbish for, why didn't you fit the proper ones?' so we do it right there and then," he insists.

"A, it diminishes the chance for a problem, and B if you do have a problem, particularly in a paddock, the last thing you want is everyone crowding round and asking why have you fitted the cheap one... I always think of the legacy aspect, it's the future thing, when people in the future take the engine to bits, I want them to be impressed."

One of the other big steps forward made since the original Triumph SLR ran, that is perhaps often overlooked, has been the improvements made to oil. Oil affects everything in the engine so TR Enterprises uses the best 20w-50 it can get its hands on, which is Millers Classic Sport, or depending on if the customer wants oil from a bigger brand, Valvoline VR1. They are the two best oils TR has found in that grade, which is essential for the engine to keep running smoothly and reliably.

The expertise runs further than knowing simply which are the best parts to put on the engine, however, as there is a myriad of tricks that the company has built up over the 30 years of its existence. One of the key things learnt which is pertinent to the TR4/SLR's wet liner ▶

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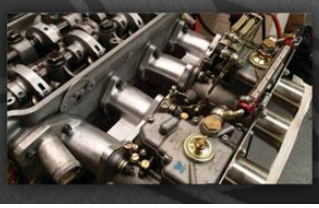
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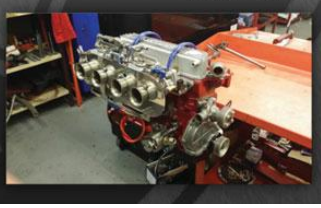
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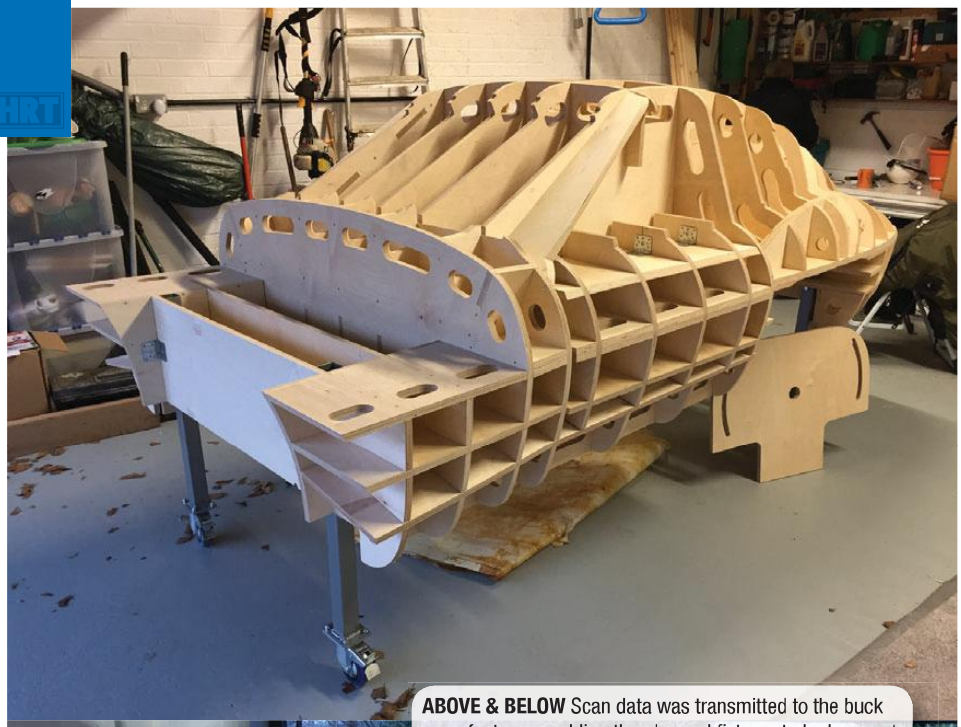
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ABOVE & BELOW Scan data was transmitted to the buck manufacturer, enabling the plywood fixtures to be laser cut

four-cylinder engine is the importance of the liner height and the relationship between the liners, the piston, the block and the head. TR sets the liner heights between five and seven thousandths. If they are much below that, then when the figure eight gaskets on which the liners sit, settle, the liners cede, the top of the liners go below the block and the head gasket won't seal anymore.

This situation has at least been improved by the use of steel gaskets. The originals in the Vanguard engines used a fibrous gasket, which gave really good purchase but they were crushed far too quickly. The next phase saw the gaskets made out of copper, which again tended to shrink and compress, until finally, they were made out of steel, which work well and are very stable – as long as the antifreeze is topped up to stop them rotting!

"Nine times out of 10 when somebody says oh the head gasket has blown, it's the figure of eight gasket that has rotted because the car's either been left with plain water in, or it's not been drained over the winter, and then these rot and crumble and the liners drop and that's it," Watson explains. "But you are only talking a matter of thou, five thou good, two thou bad, so three thou can make all the difference between it running sweetly for 100 thousand miles or blowing its head gasket."

Another of TR's tricks on the race engines is to Plastiguage all the bearings to ensure there is the perfect clearance to allow the oil to circulate. On an engine set for road use 2-2.5 thousandths is enough, but experience has taught TR to increase this on the race engines it works on because of the extra heat generated from the higher revs that are being used for longer periods.

Elsewhere in the engine, the Weber DCOE 45 carburettors which were originally reused are replaced by 48s, as this is allowed under Appendix K, which permits the use of any carburettor that fits the homologated inlet manifold. These carbs, the other changes and running an 11.5 to 11.75 to 1 compression ratio, with a fully gas flowed, modified head and TR Enterprises' four-to-two-to-one exhaust manifold, means that the racers reliably output 190-195 bhp, a tidy increase on the 105 bhp TR4s left the factory with.

OVER-CONSERVATIVE ENGINEERING

Other modifications made are to, as Watson puts it, "undo some of the over-conservative engineering that Triumph put in there in period", which is key to making the SLR as competitive as possible.

"The factory flywheel, for example, was just massively, massively too heavy, so we use lightweight versions," he says. "We go to about 5.5 kilos on the road cars and then down to 4.25 on the race car. We also use, where regulations allow, the smaller Tilton-type 7.14 race clutches, which are smaller so the moment of inertia is less, while being physically smaller and lighter as well helps them rev up.

"The clutch we choose is AP Racing. It just helps you release more of the engine's horsepower to the wheels and it also aids gearchanges as it helps the synchromesh to slow down. There is also less mass to slow down so it helps on the wear and tear side too."

A rather optimistic-sounding brochure uncovered during TR's research shows that, using overdrive, 'a speed approaching 150 mph should be obtainable under favourable conditions'.

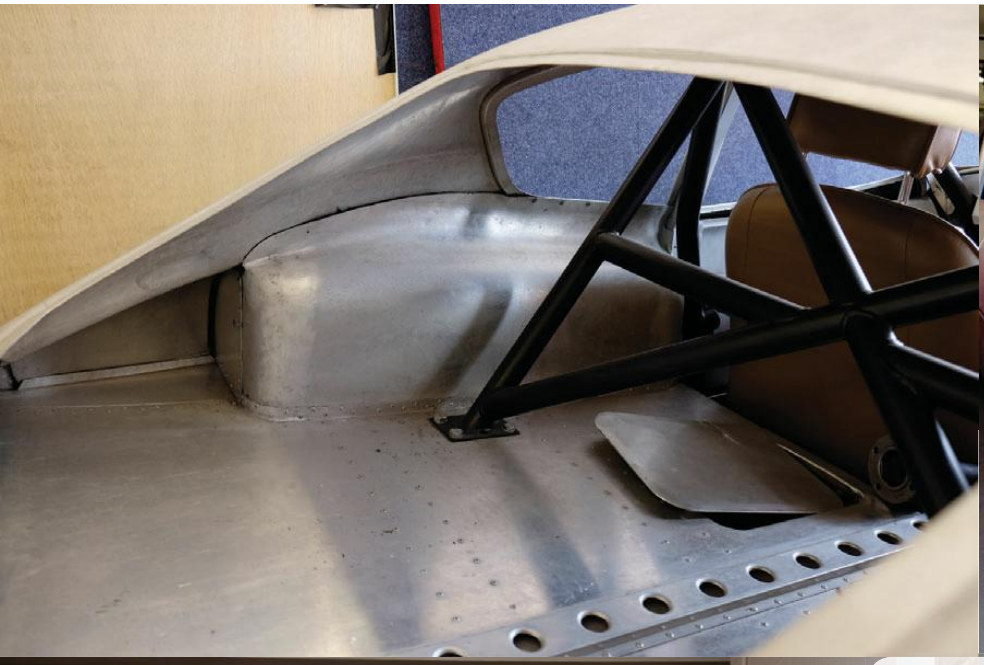
The brochure was also optimistic in expressing its intention for the SLR to race at Le Mans. That unfortunately never happened in period, but at least the hours of research and careful sourcing of parts means that the recreations should finally get their chance on the historic grids.

To get its Historic Technical Passport, which allows it to race in international events, the car must be running a standard 2.2-litre engine, with standard sized valves. Luckily, in period the SLR used a steel crank, so TR Enterprises is at least able to take advantage of that, albeit of billet rather than forged steel.

This meticulous approach to authenticity has been applied all over the cars, with even things like pedal boxes and door handles being pored over to ensure they are accurate. Of course, if the car is not set to be raced in international competitions, then depending on regulations there is a lot more freedom to change parts, with things like Carrillo con rods being one of the upgrades that TR would recommend, but even new Penske dampers and re-boring the Vanguard engine up to 2.4 litres are options.

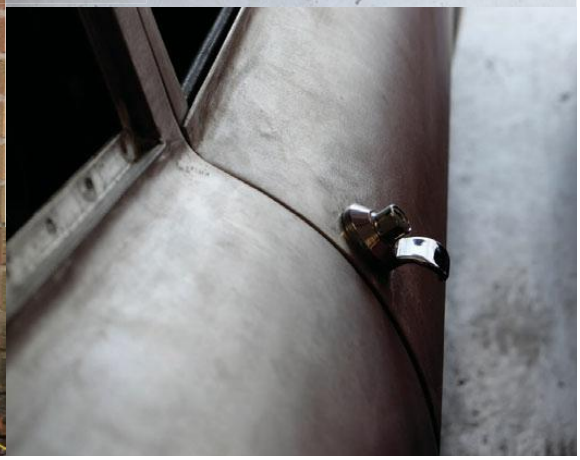
Neil Dangerfield returned to Goodwood in 1998, driving the original SLR at the very first Revival. Thanks to the SLR's fascinating history and historic ties to the iconic West Sussex circuit, TR Enterprises' meticulous recreations seem likely to be invited back. Before that though, one of the cars, number two, is set to be given a proper shakedown at a three-hour race at Donington over the summer, before being raced in anger (as it were) at the Spa Six Hours in September.

TR Enterprises can't wait to see the beautiful coupés racing on track again. Watson hopes that finally, thanks to the company's painstaking work, "The Triumph SLR will be able to deliver on the huge potential it showed in period." HRT









ABOVE & BELOW A meticulous approach to authenticity has been applied all over the cars, even down to aspects such as the door handles

THE MILLION DOLLAR QUESTION

William Kimberley visits a company that specialises in some of the most beautiful race cars ever made



"**IT'S** about a million quid," was Gary Spencer's answer to the question about how much was the Cobra that was casually parked at the entrance to his worshop. "It's a real one with some history, both back in the day as well as a more modern one." That he was not overawed by the value of such a car is a reflection on just how far the historic market has come in a relatively few years.

Classic Racing Cars (Engineering) is typical of the myriad of SMEs that service the historic racing market, working on cars that have seen their values go through the roof and yet more and more people want to race them.

Even when Spencer started to get involved in historic racing many years ago, it was pretty serious, but as each year goes by, it becomes incrementally so. "I first got involved in motor racing with Chris Chiles who had bought an Austin Healey 3000 to go classic rallying," he says. "He had never rallied in his life but went ahead and bought this car through a mutual friend, met me and asked whether I would like to work on the car at rallies. The first one he entered was the RAC!

"It was a very nicely prepared car and I remember trying to jack it up on snow and my hands were freezing. This really nice car had gone through a forest section and it was smashed to pieces underneath and it was then that I thought that rallying wasn't for me. We did a few more including the Monte Carlo Challenge, but I just couldn't see the attraction so persuaded Chris to let me work on the car at home and see what we could do with it as a race car. He agreed to this and it turned out to be pretty successful.



Jeff Bloxham

BELOW The first Daytona Cobra that CRC worked with provided a startling demonstration of the car's abilities. James Cottingham won the Graham Hill Trophy for 1960-66 GT cars at the Goodwood Members meeting

> **"If you were the owner of an original, would you really want to go through Eau Rouge at Spa in a 1965 chassis?"**

ANSWERING THE CALL

"At the time I had a full-time job when over a pizza in Australia, where we were competing in the support race to the Melbourne Grand Prix, Chris told me that obviously I wasn't happy in my job, which I have to confess was news to me, and he suggested that I go full-time on his car.

"I rented a space in a garage and it was just Chris, myself and the Healey. We campaigned the car everywhere, including the Nűrburging and the Spa 6 Hours in the years when there weren't any GT40s. Eventually, though, the Healey had had its time and it was replaced by a GT40. At that time I was still in full-time work so the car was run by Racing Fabrications and I would just assist at meetings. However, I then took the life-changing plunge and left my job to solely work on the car."

The car was successfully campaigned ▶



ABOVE Flying machine: One of CRC's Daytona Cobras meets a Buccaneer during testing at Bruntingthorpe

in various European events, including winning the Tour Auto in 2002 and 2003 and Tour Espana to the point where they felt they couldn't do any more with it. The question was what to replace it with, which is when the Cobra came into Spencer's life.

"I went to Germany to collect the one Chris had bought there and remember looking at the suspension and thinking that this was going to be hard work," he recalls. "However, to my surprise Chris, with co-driver Paul Ingram, won its first race straight out of the box. From then on we developed the car and as with the GT40s, ended up getting a reputation with the Cobras, leading to us building more of them.

INHERENT PERFORMANCE

"Funnily enough I was never one to look at Cobras and go wow! as my boyhood dream. However, after working on them after so many years, they are really good cars. They handle well and the feedback from top drivers is just how sensitive they are. If you look at the car's configuration, though, it has leaf springs and some tubes – it's a 1965 design – but it's just so well balanced. They are inherently a solid car with a good, strong V8, a very strong gearbox and differential, and they always have good brakes.

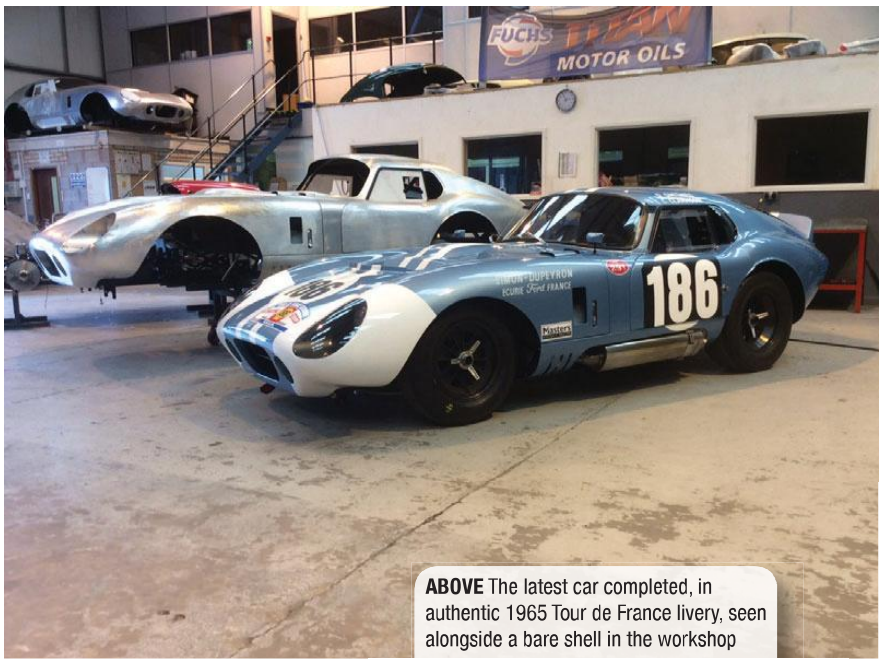
"However, they're in the same class as the GT40s in long-distance events such as the Spa 6-Hour race and while the fundamental dynamics between the GT40 and the Cobra are comparable in that they both use the Ford 289 engine and have very good brakes, above 100 mph the GT40 just disappears into the distance due to its superior aerodynamics and cornering speed. This led to our looking at Peter Brock's Daytona Cobra, a car I always wanted in the workshop. It was what I thought a '65 GT car should look like. For me it is stunningly beautiful and absolute perfection."

The first Daytona Cobra that Spencer got was actually built in Sweden for James Cottingham. "We had a good couple of test sessions and ironed out any problems we found and then took it to the Members Meeting at Goodwood where James actually won, chased home by another Daytona. This was the very first time I had seen the potential of the car. There were a lot of very good drivers in that event, but within three laps the two Daytonas had the Start/Finish straight on them all, which I had never seen before. There and then I thought we needed to get another Daytona and from that point I started looking at them in greater detail."

> **"Chris told me that obviously I wasn't happy in my job, which I have to confess was news to me!"**

Sitting in the workshop at the time of the visit in April was a bare Daytona alloy chassis and body unit. "Along with the other two we have built, they are built to precisly the original specifications – and they have to be to get FIA papers – but that's just the basics and is the starting point," he says. "It's a kit of parts with some components being supplied while we make the rest in-house.

"It's a bit like Marks & Spencer," continues Spencer, "where you can buy a perfectly good suit or you can go to Saville Row and feel a million dollars. I know there is a difference in price but ▶



ABOVE The latest car completed, in authentic 1965 Tour de France livery, seen alongside a bare shell in the workshop

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ABOVE Beneath the skin of a Daytona Cobra. Note the familiar Alan Mann Racing livery

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"Ours is a representation of a car made in 1965 using the same materials as much as possible. I understand the opinions of the owners of the real cars as well as those of the Continuation owners. I don't believe there's a right or wrong answer as there's an argument for both. What I would say is that if we didn't build these Daytonas, then very few people would see them race. My question is that if you were the owner of an original, would you really want to go through Eau Rouge at Spa in a 1965 chassis? People say that you shouldn't be going so fast in a car that was built in the 1960s, but it's racing, that's what people do. They push their cars to the limit.

RACING TO THE REGS

"When you build any race car you always start off with the homologation papers that tell you what you can do, and if something isn't in there, then you cannot use it. However, while we have to comply with the letter of the law as defined by the FIA and its Historic Technical Passports, which is well and good to maintain the integrity of the cars, things like the tyre compounds, brake pads and track surfaces are not what they were 40, 50 or 60 years ago. They are very different and have a massive influence on the car.

"I remember that when we put Yokohamas on Chris' Healey, we were suddenly four seconds a lap quicker, but we then ran out of brake pads which should have done at least triple the distance. Everything in these circumstances gets more and more pushed. If you take two or three seconds off a lap time, it has a knock-on effect."

The Historic Technical Passport sets out in great detail precisely what the car represents, what materials must be used in its construction and exactly what callipers, ignition, fuel system, wheel size, dampers and so on must be used along with things like ball joints. The dampers on the Daytona, for example, must be steel and they must be oil, but bump and rebound can be adjusted, which means that the valving is free.

"The rear leaf springs can be changed which is just as well," says Spencer, "as they're not like coil springs. They have a life and as soon as fitted to a car, they start to sag, even if it's minutely. Over the years we have gathered quite a bit of knowledge on how they age and how we can decrease that to a point and are lucky because not very far from us is a company that makes them for us, to various specifications."

The engines come from Steve Warrior Motorsport. "They are exhaust-led; in other words, all the power is in the exhaust," says Spencer. "We have a stock of original transmissions but we have a specialist go through and blueprint them as we are always looking for reliability."

Spencer swears by Fuchs Lubricants and works closely with them developing oils. "When one of the engines went back to Warrior for a rebuild, we were asked what lubricants we were using as they had never seen anything like it. Although it's expensive, we do tell our customers that engine rebuilds are advisable if they are racing their cars as the cost of replacement internals is expensive.

"We bring a professional in to do the electrics. We have seen people using original wiring but you know it's going to fail. They are the worst problems to have. We try to make them look period and use the correct switches on the dashboard from vintage aircraft and we will always use a bag tank for safety from Willans or Premier."

AN ACCURATE WEAPON

Spencer says that one of the interesting things about the Daytona is the handling. While the Cobra is sensitive to up rebounds and suspension setups, the Daytona is a different proposition: "With the Cobras, the instruction to the drivers in long-distance events is to treat every lap as a qualifying one. The cars were strong and could take it whereas the GT40's Achilles heel was its gearbox, so we had to push them. With the Daytona Cobra, we now have a car that can match the GT40's aerodynamics which also means better fuel economy,

although in the first couple of tests we were all over the place in setting it up.

"The feedback we got was that it didn't handle like a Cobra, and more like a GT car. You don't slide them around, they're more accurate and they're much kinder on tyres. Instead of having a car that oversteers naturally, the Daytona turns in very sharply and keeps its grip. A by-product of that, particularly in long-distance races, is that it's much kinder to its tyres and because you're not playing with the thottle on opposite lock, it's less physical to drive."

Spencer is very proud of the role his company plays in keeping historic motorsport going. "We are passionate about the cars we produce and look after," he says. "Apart from providing huge satisfaction for the owners, they are also appreciated by the huge crowds who flock to historic events, and long may that continue." HRT



ABOVE The cars are built to precisely the original specifications – as they must be to earn the FIA Historic Technical Passports



ABOVE A thing of beauty: a CRC Daytona Cobra in action

Jeff Bloxham

A lesson in engineering

Alan Stoddart is dispatched on a farmyard visit with a difference, discovering students benefiting from front-line engineering experience

TUCKED away down a hidden lane, not far from Oxford city centre, is a small farmyard encircled by sheds, which until not too long ago were dilapidated, with collapsed walls, damaged roofs and dirt floors.

It is here that the students of the Oxford Universities Motorsport Foundation build, maintain and upgrade its historic race and rally car projects. The foundation was established by students, for students, to provide practical hands-on engineering experience.

Many of the students in the foundation, who come equally from Oxford and Oxford Brookes universities, feel that they want to supplement their predominantly theoretical courses with oily-fingered and skinned-knuckled motorsport experience. All of this is done on a budget of "effectively nothing", which means that not only does all tooling and materials have to be, to use the technical term, wangled, but nearly all of the components used on the project cars are supplied by companies that are aware of the alarming skills gap, see the benefit of the foundation's activities, and want to support it.

As well as providing sound practice for the engineers who could well end up controlling tight budgets as managers in a cash-strapped race team, these limitations mean that the foundation's members, in the finest tradition, need to get creative. They must figure out ingenious solutions to be able to hold their own against better funded rivals – a good time to put all that theory to the test then. This philosophy also means that any and all ideas are encouraged, and with students continually progressing through the foundation, it means that there are always a plethora of new innovations to consider.

While their current main project is a British Motor Heritage/Halls Garage-sponsored 'Sebring' Sprite race car, the main test beds for all these ideas have been a Mk 2 Golf and a pair of Riley One-Point-Fives, one of which is kitted out for circuit racing and the other set up for rallying. Into the Rileys, which have both been imposingly painted in Lesonal 'North Korean Racing Grey', there have gone an astonishing number of modifications and improvements. The engine in the racer particularly has been extensively fettled, with the team even going as far as cutting another engine into slices to be able to look inside and identify where problems may originate, and where advantages be gained.

BATTERY EXPERIMENT

One of the recent experiments has been made possible thanks to SuperB's batteries. It all started last year when the battery maker decided to support the foundation by giving it one of its lightweight lithium ion motorsports batteries. This in itself was quite an improvement, immediately taking nine kilograms out of the Riley Racer, which weighing in at around 865 kg, is already a big chunk and the single biggest piece of lightweighting the team did last year.



Jeff Bloxham





ABOVE & BELOW The students are fortunate to be racing with, and learning from, some of the best. Here the OUMF Riley leads the Jordans' A40 at HRDC Thruxton in 2016 en route to its first overall win



> **"Once you explain that the Riley is basically a current touring car, but in granddad's clothing, you have their attention"**

However, the team has since switched to a slightly bigger battery from SuperB, which has enabled it to experiment with running the car on a total loss system.

Usually on the 'B' Series engine, both the water pump and the alternator are driven by the crank. "THINK Automotive and Davies Craig donated an electric fan and water pump system respectively, which makes the original pump redundant, so with a SuperB battery fitted, the power-sapping drivebelt can be removed," says Oxford Universities Motorsports Foundation founder Ding Boston.

One of OUMF's members, Vlad Ardeleanu, continues: "The thing is, you have some losses through the belt, so we decided to take it off and just run the car off the battery. We calculated the losses through the belt, and worked out how much battery power we'd need to deliver sufficient charge for the length of a race."

Impressively, it all worked at the opening round of the HRDC at Silverstone. The car was not only able to complete the warm-up and make it home after a 30-minute race, but the team also managed to win their class. They have since had class wins in both HRDC races at the Donington Historic Festival – running with a belt – so the jury is still out as the research continues. It still remains for the team to see how running total loss affects the all important output figure. Last time the engine was dynoed, it was putting out around 133 horsepower, which is an already significant gain over the engine's originally quoted 95 hp, but the team is excited to see how the total loss system and other small modifications have changed that figure.

REVELATION

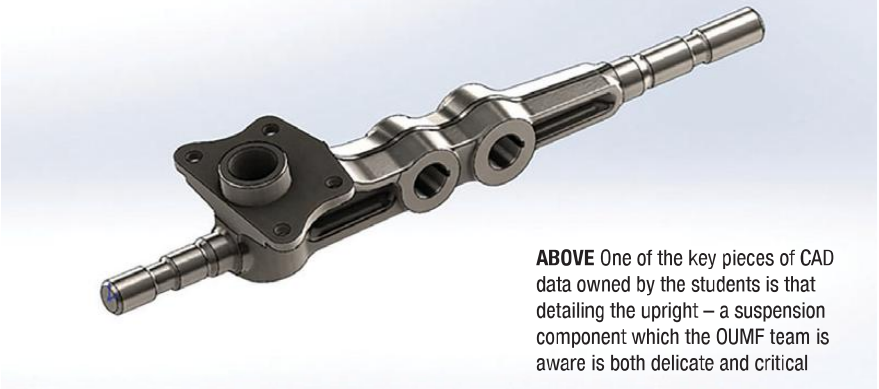
Even things as simple as cleaning the engine properly inside have been revelatory. Looking inside the sliced up engine block, it is possible to see the build up of rust and other deposits in the water galleries, which is impossible to reach manually. It is only by cutting the engine up you can actually get an appreciation for the scale and significance of the rock hard deposits of muck. Additionally, emphasises Boston, "This is on a block that was totally rebuilt around 1800 miles before we got to it. To all intents and purposes this is a block that has been built fairly recently to the best abilities of the engine builder, but look at that build up round the liners and how it might compromise the cooling of the cylinder."

The solution, he says, is Lenton ▶



ABOVE Vibration Free helped balance the crank and flywheel to 0.12 g/mm

Treatments. Its unique process, which involves dipping engine castings in a hot caustic solution, is able to get in all of the otherwise inaccessible galleries within the block and bring it back to an as-new condition, without any damage or distortion. "And do you know how much they charge to leave the block as naked as the day it was made? From around 40 quid!" he enthuses. "You try and clean a block as well – which by the way you can't – for that!"

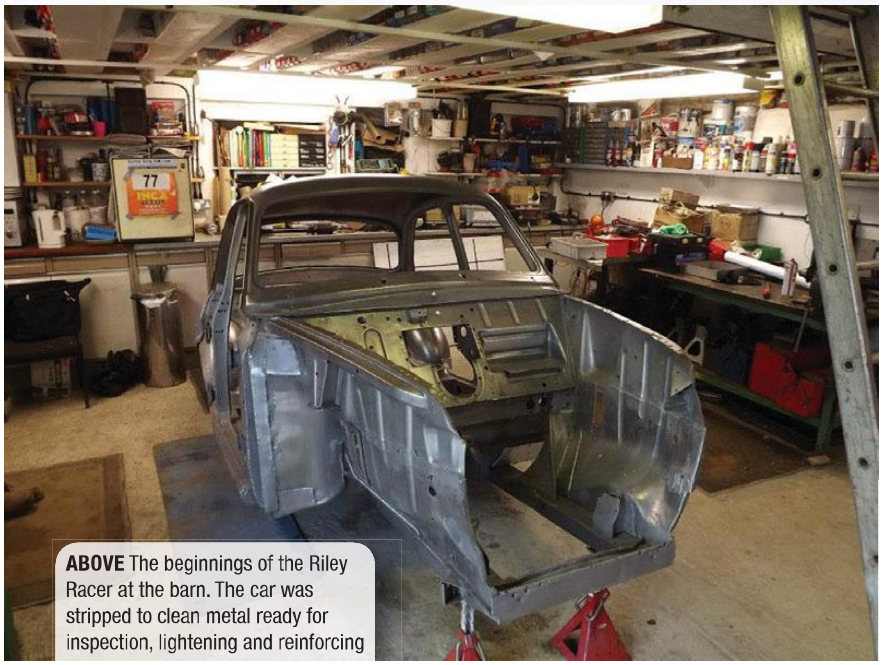


ABOVE One of the key pieces of CAD data owned by the students is that detailing the upright – a suspension component which the OUMF team is aware is both delicate and critical

AWKWARD INCLINATION

A similar story can be told of plugged drill access holes within the block. Cutting open an engine showed that some of these holes were at such an inclination that sediment would gather in them and fill them up to the brim. This is particularly problematic if the engine is subject to any unusually extreme forces, in the event of an on-track knock for example, and all this grot is dislodged straight into the oil. Not good. After identifying the problem, however, the access holes were drilled out and tapped, then grub screws inserted to ensure that they could be thoroughly cleaned in future.

These incremental gains are endless. The team runs the Riley with an 1860 cc five-bearing MGB engine in HRDC Class



ABOVE The beginnings of the Riley Racer at the barn. The car was stripped to clean metal ready for inspection, lightening and reinforcing

B, but during its initial build, they saw the chance to do some lightweighting with a powerfile (no prizes for guessing that tool's workshop nickname!). Casting marks, unused bosses and even the '1800' engine size digits were removed, all saving around half a kilo. Before it was painted, a student wag cast up a '1500' in epoxy and glued it in place – enabling him to boast that the team had the only five-bearing 1500 'B' series engine in existence!

DIMINISHING RETURNS

A good joke, perhaps, but it does show the extent to which the team is having to get creative to further take weight out of the car, one of the areas where the cutting edge skills from university can be very valuable. "What we plan to do soon is a finite element analysis to ascertain where you can safely take more weight from. Andy [an OUMF member and Masters student] is convinced that if you carefully take weight from appropriate points lying outside of a triangle which takes in the crank longitudinally, it can be advantageous and may avoid the drawbacks you might expect," says Boston.

"It's tempting to take a powerfile to a thick part of a casting, but if you took off material from some places, yes you'd lose weight, but you'd also lose critical stiffness. This could cause engine failure through flexing – or we'd need to put a block plate back on to stiffen it all back up again. It's often diminishing returns when you are trying to lose weight."

Other gains are more concrete, even if the biggest advantage isn't necessarily what was intended. This has been the case with the Zircotec coating the team has had put on the Riley Racer's beautifully crafted BTB Exhaust manifold. While it does do all the things it advertises, like keeping heat from under the bonnet and protecting other components and the paint in the engine bay, the main advantage OUMF has found is that it actually allows the car to be worked on far, far quicker than they could without it. When there is a problem between qualifying and the race, for example, just a few minutes can make the difference between making it back on track or watching the race from the pits. Just by using Zircotec, the team is now able to work on the engine after about two minutes of it being switched off – a very precious benefit in adverse circumstances.



ABOVE HRDC chief Julius Thurgood (left) and OUMF founder Ding Boston have both steered the team in the right direction



ABOVE Contour Autocraft's Bruce Macleod is one of the star guests to have passed on their skill and experience to the students, teaching them a few tricks on the English wheel

STAGGERING SCRUTINY

Thanks in part to generations of students coming through the foundation, the engine has been subjected to a staggering amount of scrutiny with even specialist balancing company Vibration Free helping to try and iron out the smallest imbalances. Despite this, the foundation's members still find things don't always go to plan.

One of the engine issues the team has had recently has been when switching over to ARP bolts. Boston stresses that ARP bolts are much better and much more reliable than the originals they previously used, but explains that this didn't stop OUMF's lack of knowledge causing difficulties. What the team didn't realise is that the extra torque recommended to tighten ARP's bolts is sometimes enough to distort the main caps and alter their tolerances.

This became apparent when the team was invited down to Swiftune's Kent headquarters to learn the dark arts ▶



ABOVE Ah, the glamour! As an unfunded initiative, OUMF is entirely dependent on sponsorship and donations, be they in the form of workshop consumables and tools or finance

of 'A' series engine tuning from Nick Swift. Before their visit Swift insisted that the team completely dry build the Sebring Sprite's engine, so that it would just be a question of him having the engine there to check and assemble the component parts. So, diligently, before travelling to Swiftune, OUMF had Owslebury Crankshaft Services machine it ready for Swift to go through it with a fine-toothed comb.

BIG SURPRISE

Well, when OUMF dry built the engine they used brand new standard bolts and bearings and it "spun like a dream", but having gained the backing of ACL via Engine Parts UK for the bearings, it seemed a good time to make the switch. However, when the ACL bearings went in – which were, on paper, exactly the same size – the crank wouldn't spin freely. It turns out that the tolerance on ACL bearings is just that much tighter.

"So that was it, and assembly was put on hold. Nick uses nearby Gosnays Engineering and asked them to help to line bore the block to suit because it was just picking up. It came as a great surprise to us all that the varied torques and tolerances between fixings and bearings from different manufacturers is so specific that even a one thou difference between similar components can create a critical problem," says Boston.

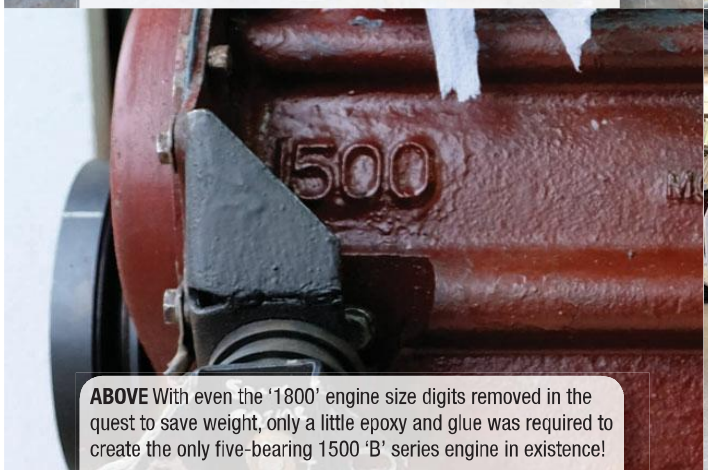
"Nick said we couldn't go any further with it because he wasn't prepared to put his name to it. I asked if we couldn't just fettle it? He replied that if there was such a thing as 'line fettling', or we were in the paddock with a race to win, then yes, we could, but unfortunately, it's called 'line boring'!

"We were all bowled over by witnessing Swiftune's attention to detail first hand. When this is coupled to its legendary customer support – and the results his cars get on track – it's easy to ▶

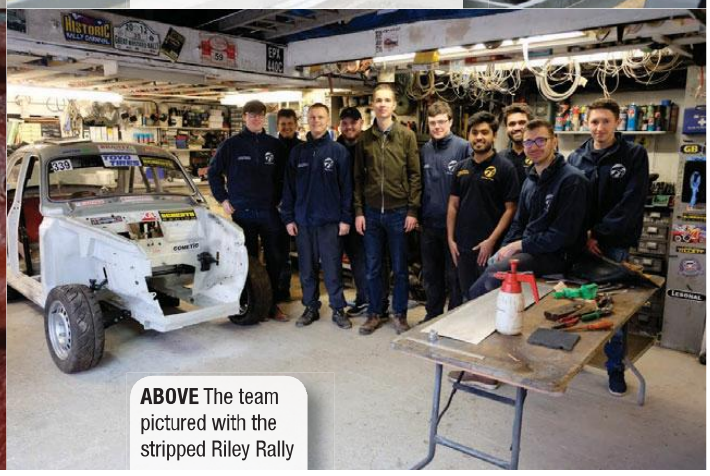

ABOVE The team went so far as to slice up an engine to identify where problems may originate or advantages be gained



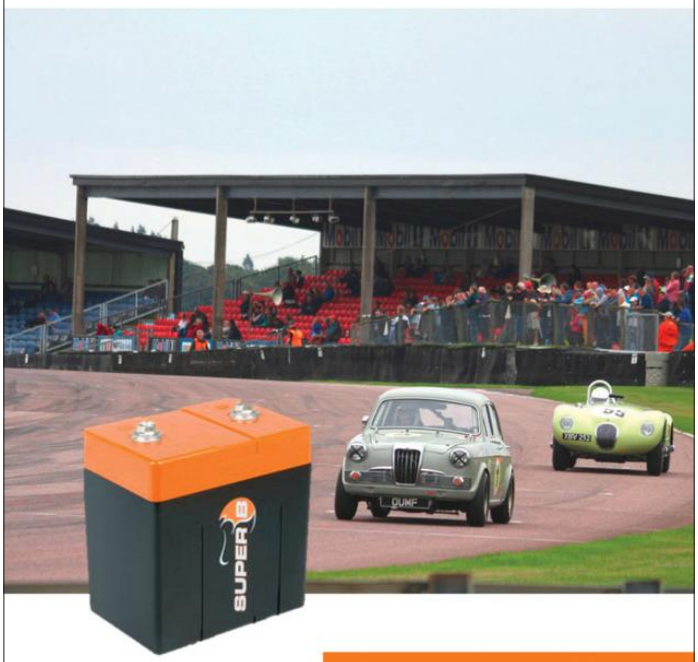
ABOVE The 'Sebring' Sprite race car is one of the current projects



ABOVE With even the '1800' engine size digits removed in the quest to save weight, only a little epoxy and glue was required to create the only five-bearing 1500 'B' series engine in existence!


ABOVE The team pictured with the stripped Riley Rally

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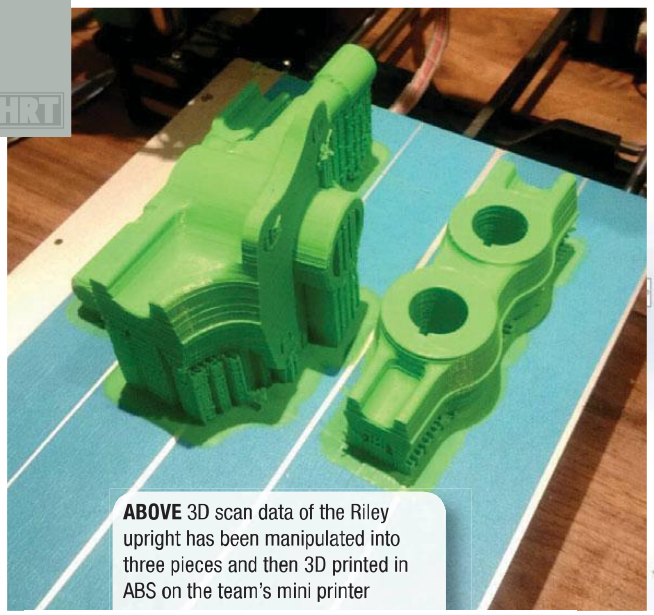
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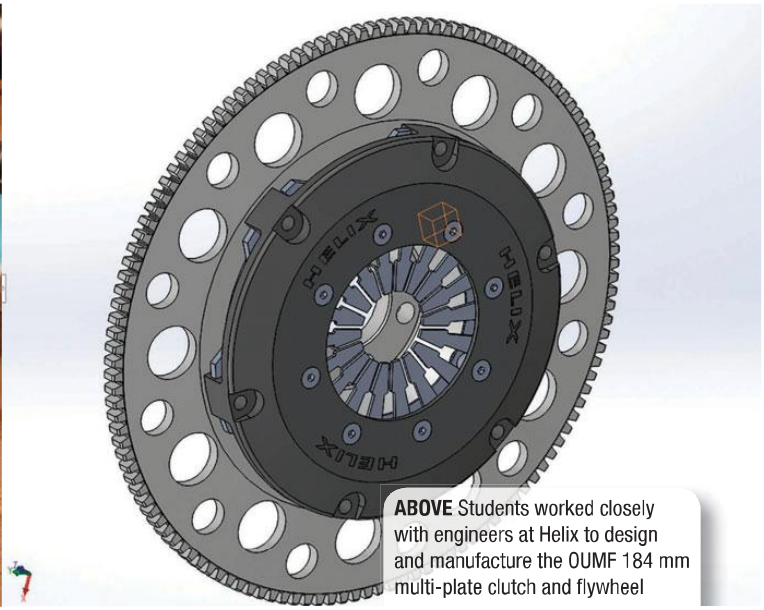
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ABOVE 3D scan data of the Riley upright has been manipulated into three pieces and then 3D printed in ABS on the team's mini printer



ABOVE Students worked closely with engineers at Helix to design and manufacture the OUMF 184 mm multi-plate clutch and flywheel

see why the 'A' series world beats a path to Nick's door!"

Gains haven't just been made in the engine though. Right at the front of the car, the grille and other bits of chrome trim, which are no doubt a grand way to adorn the nose, are rather on the heavy side – especially since all that weight is hanging out in front of the wheels. They are increasingly expensive, which is at odds for a team running on the aforementioned shoestring.

In the HRDC series most chromed bumpers, over-riders, and the like are made of moulded fibreglass. As such the students are presently trying to remake such chrome trim out of 'lifed', out of date composites, supplied by ex-OUMF members now working in race teams. All old members are invited to come back and to pass on new skills and experience to the current students, which also allows the team to expand on their very limited experience of working with such materials at university.

MODERN TECHNOLOGY BENEFITS

Soon, they hope that OUMF's Riley Racer will sport a front grille and other precious and vulnerable chrome trim made from inexpensive materials. They will not only be lighter, but – more importantly – the team will have a mould for the grille and other rare parts should they have an incident which means that they need to be replaced.

Modern technology and techniques have been adopted elsewhere in the car too. One of the things helping them to develop the car into a really serious racer is the Cartek electrics, and the sensors and data logging system installed with the help of Julian Thomas at Racelogic and Peter Trevor at KA Sensors. This has allowed the team to enjoy similar benefits as better financed professional competitors on the grid, and allowed them to experiment with the set-up of the car when practising and testing. At present, the 2k VBOX ▶



ABOVE Data logging is one of the tools the students learn to exploit. This graph shows the relationship between oil pressure vs throttle position

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ABOVE With budget constraints forcing the students to get creative, the Riley Racer has provided a platform that has been subjected to many experiments

must be removed from the Riley Racer for the actual races, but at all other times it allows the students to watch the on-board video and interpret the data plots. By creating traces showing graphs such as speed vs time, and highlighting delta T where time is being lost at key points around the circuit, the team gets a much clearer understanding of what the car is doing.

DATA LOGGING CLUES

"We record everything from air temperature, to brake pressure, steering wheel position, damper movement, the force through the Panhard rod, throttle position, exhaust temperature, and lambda readings," says Ardeleanu. "It's a great help to have a lot of data and a lot of practice making sense of it, because you don't always have the same problem."

It can help the team work out whether they need to change something mechanical because it is not behaving as it should, whether changes in set up can be made to accommodate a different driving style, or whether the driver needs to do things differently to get the most out of the car. Moreover, it is great for getting new students involved in the foundation as data logging experience is so important in modern motorsport.

"Once you explain to a fresher – who's looking at the Riley as just an old car – that in respect of data it is basically a current touring car, but in granddad's clothing, you have their attention. And when you tell them they've got the chance to play with it and learn all about data logging from all the various sensors on it, they suddenly realise, 'Wow, this car is really exciting'!" Boston adds.

> **"An astonishing number of modifications and improvements"**

A recent additional resource is a rudimentary 3D printer donated by an old OUMF member. It is used to make small prototype components, like brackets, which means that students can now use the CAD skills which they learn every day as part of their degree courses to actually make parts to confirm fit or function, and if the designs are successful they can then be made on the lathe or mill. Having this printer meant that when top prototyping company Chasestead offered a full 3D scan of the Riley, a front upright was converted to a 3D CAD file, and then the team 3D printed it in plastic.

Technology has had a big impact on what goes inside the engine as well. Fuchs Lubricants not only provides the team with all the TITAN Race oil it uses, but its lab technicians also analyse the car's oil after every race to look for incipient signs of problems and tell the team what state the engine is in. Fuchs also advised the team to defy conventional wisdom and switch oil grade from a 20/50 to a 10/40.

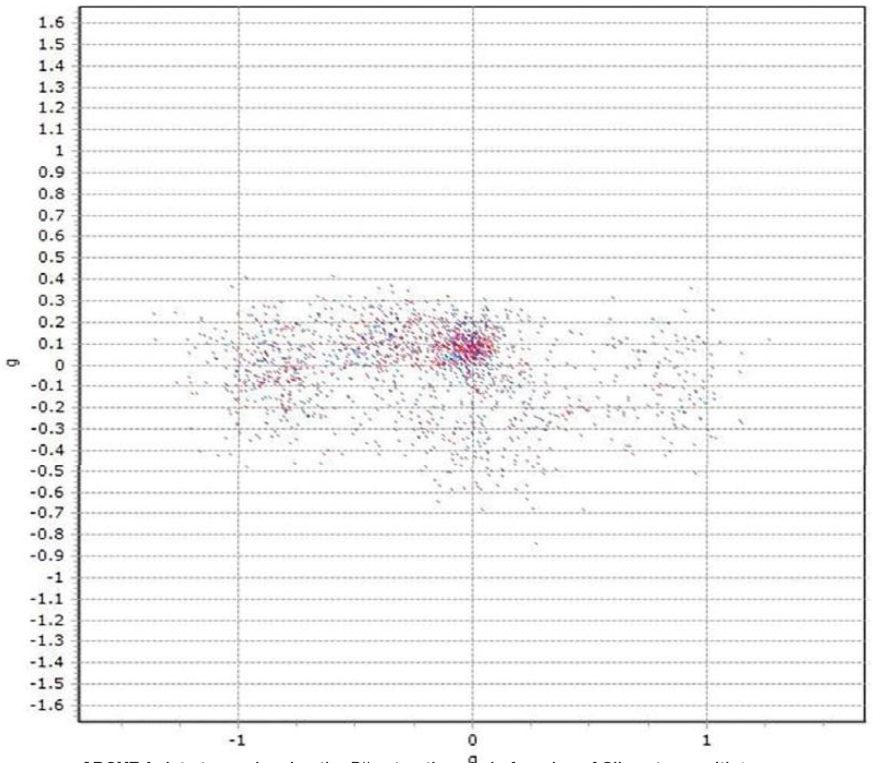
"Most advice about what oil you should run in 'B' series engines is a good classic 20/50," says Boston. "No way! When the team were given a tour of Fuchs' headquarters in Stoke, followed by a comprehensive lecture, it was explained to them why this is simply not the case anymore. They have worked with us to establish that what we actually needed was 10/40

– not 20/50, or even 10/60. That's the optimum oil for this particular engine. Maybe not what many people would advise, but for us the difference in reliability has been huge."

For the students, these modifications and changes, and the accompanying detailed study of the rules, is all excellent 'real life' experience and practise for when they embark on their professional motorsport careers. Boston thinks it vital that students learn to develop lateral thinking, and engineering skills and insight to allow them to exploit a situation to the fullest. That is part of what the foundation offers: actual front-line engineering experience.

Ding is, however, very careful about encouraging students in a way which, although sometimes audacious, is never abrasively so. "We joke like crazy about modifying and fiddling about in general, but always with regard to the spirit of the whole sport too. You have to be aware of it and respect it," he emphasises.

"Creative students continually suggest things that could be done, but the rulebook is their guide, and lines have to be drawn."



ABOVE A data trace showing the Riley traction circle for a lap of Silverstone, with two different suspension setups for direct comparison. Testing was originally performed as part of a student's thesis on the rear suspension setup of the Riley historic touring car

ROLE MODELS

For Boston, this line falls in a place that allows the students to get experience with a car that is beginning to be able to hold its own against far more professional outfits, without taking liberties with the amazing opportunity they have been given by Julius Thurgood (HRDC's founder and race director). "The point is," he continues, "that professionals like the Jordans [Andy and Mike of the Jordan Racing Team, one of the HRDC's most successful outfits] have the means and experience to optimise everything to a far greater extent than we are able to – through relentless practice, data acquisition, and peerless preparation of their own and their customers' cars. They are fantastic guys and tremendous role models for the students to try and emulate. The students know how lucky they are to have the opportunity to be rubbing shoulders with such respected figures in motorsport, both on and off the track.

"OUMF is voluntary and self-funded, and obviously everything must take second place to the students' degree work, so we can't compete in time or money. But we can try and learn as much as possible from others and make up for it in our ingenuity, relentless checking for reliability, never say die enthusiasm, and the fantastic encouragement of our generous supporters with tools, parts and services. Without these strengths, the students wouldn't even get a chance to, say, try data logging," concludes Boston.

He adds that the team would not be able to function without the level of industrial sponsorship and a supporters' network which it works tirelessly to maintain by frequent team visits to top motorsport companies like Quaife, TOYO Tires, Lifeline, and NGK. Some, like Bilstein, Helix Autosport, Thermex, Eurolec, and Crossthwaite & Gardiner, work closely with the students, developing products for historic competition cars, and having OUMF members on one-year placements. This gives the students access to, and knowledge of, a wide range of processes – from CNC machining and dynamic balancing, to say, foundries and laminators. Students can find themselves spending a day at G&S learning how valves are made; gas-flowing and building a race head with Dave Crisell at All Stage; or visiting the Pilkington Auto glass factory. It is this mixture of social networking and industry experience which Boston believes sets OUMF apart from any other historic race team or student project in the UK.

What the team has achieved in its once-dilapidated farmyard is impressive. The tireless building and rebuilding of the car, the stream of students coming through the foundation and their voracious appetite for learning from the very best companies in the business, has meant that the team and its cheerily resilient Rileys have been able to achieve some pretty spectacular results; as have many of the foundation's growing number of alumni, who are making great strides throughout the world of motorsport. HRT

‘RUBBER DUCK’ READY TO FLY



Chris Pickering investigates a pre-war car that became the go-to machine for home builders

IT may not be the rarest or the fastest car around, but the Austin Seven might just be the most influential model in motorsport history. That’s a bold statement, but allow me to explain.

While they may have been overshadowed by the larger grand prix cars, a small army of Austin Seven sports cars and single-seaters raced almost continuously throughout the 1920s and 1930s. Around the same time, the companies that were to become Jaguar and – perhaps surprisingly – BMW both started out producing cars based on the Austin Seven.

After the war, it became the default choice for the builders of homemade Specials, with the first Lotus and the first McLaren among literally hundreds of cars based on these humble underpinnings. To this day, it remains almost certainly the most numerous pre-war car out there in competition (not to mention the most accessible).

The car you see here spans those three eras. Little is known about its pre-war history, but there’s evidence to suggest that it may have started life as a factory-built sports model. Sometime around 1960 it was acquired by noted motoring journalist and long-time *MOTOR SPORT* correspondent JEB ‘Bill’ Little who converted it into a special. It then evolved into progressively wilder iterations as a racing car, with a Fiat 1100 Balilla engine later installed. Now, however, the car has been restored to



ABOVE A thousand hours have been invested in the restoration process

Bill Little's original vision of a 1930s-style single-seater and it's poised to return to the track.

The car is owned by Peter Loxston, a lifelong petrolhead who spent decades racing motorcycles. In 2016 he began looking for a vintage sports car to have a go at competing on four wheels. Fellow racer Tim Whellock and pre-war car specialist Tim Miller pointed him in the direction of a machine described as 'the Austin-Fiat Special', which had been unused for the best part of a decade.

The owner was understandably reluctant to sell the car to anyone who might speculate on it – so much so that Loxston was invited for an interview to determine whether he would be a suitable candidate. Having passed with flying colours, he arranged to buy the car minus the Fiat engine.

Searching through its documentation confirmed the car's identity. There was also a letter from Little to a previous owner revealing that it had been based on the streamlined Austin works racers of the early 1930s – affectionately known as Rubber Ducks or Dutch Clogs due to their high backs and cutaway cockpits.

Loxston's next move was to contact the Vintage Sports Car Club. The message from the eligibility committee was that the car would be welcome to compete providing a period Austin Seven engine was installed and that nothing too dramatic was done to the remainder of the package.

Shortly after he acquired the car, Loxston missed an apex coming into the esses at Shelsley Walsh in a motorcycle event. He mounted the bank on the second part of the corner and ended up in hospital. It convinced him that he was ready for a change of scene, and the Austin Seven project began in earnest.

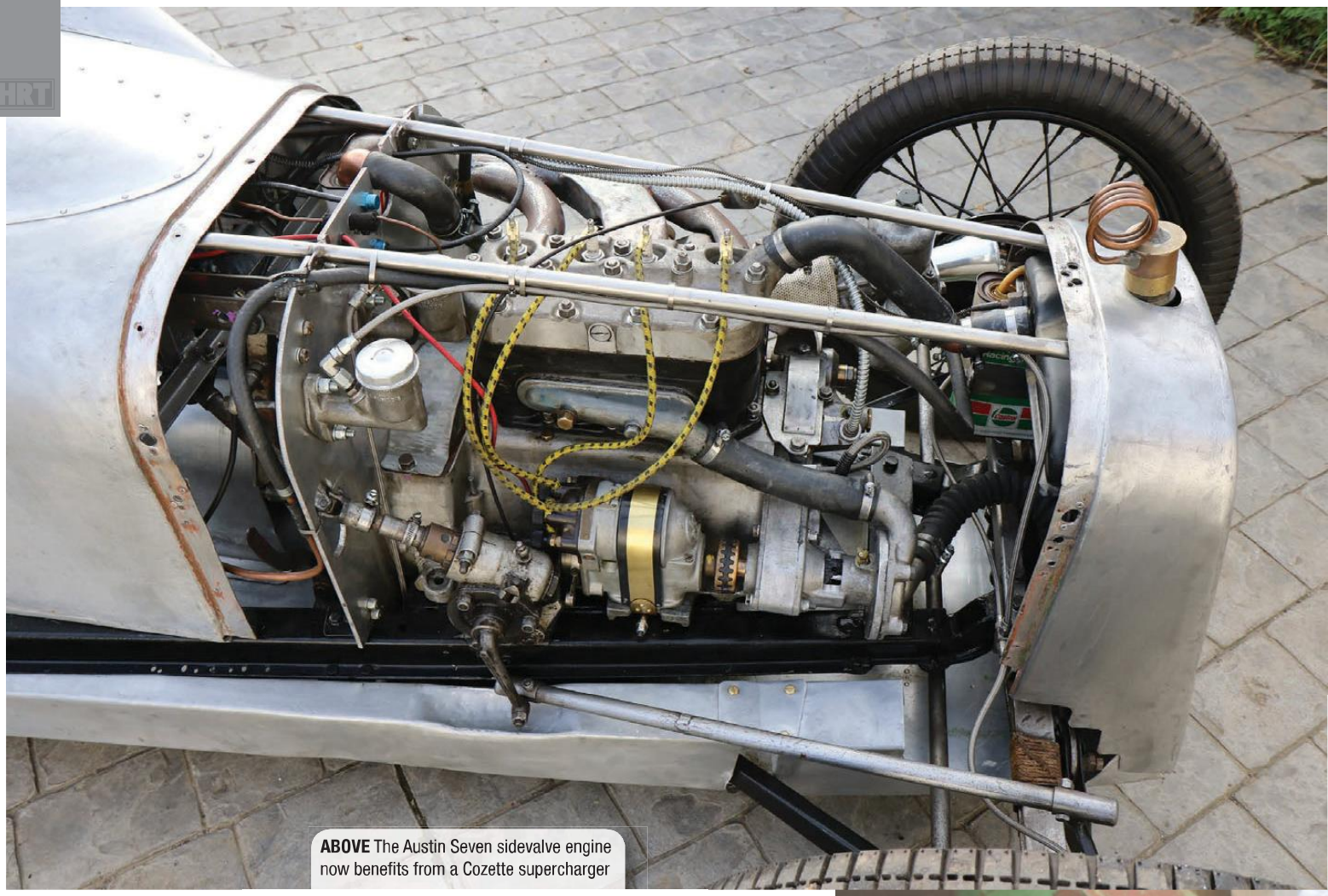
A CRANK OF GENIUS

With the car now shipped to Loxston's workshop in Somerset, the first job was to strip everything down, starting with the back axle and the differential. Next, he set about creating a shopping list that would enable him to return the car to period-spec.

The scrutineers had advised that the later four-speed gearbox would need to be replaced with a three-speed 'crash' gearbox, as fitted to pre-1932 Sevens. Loxston managed to acquire one of these with a close ratio gear set from Andrew Bird Engineering, which uses the original Ulster gear ratios in a standard casing.

Next came an early magneto-equipped 747 cc Austin Seven engine, thought to date to between 1924 and 1926. This was in a very poor state when it arrived – so much so that an oxy-acetylene torch had to be used to warm the bearings and shafts up to dismantle it. Essentially what remained was an empty crankcase, which was to form the basis of the new engine, alongside a little-used cylinder block sourced elsewhere.

Austin Seven competition engines are notorious for breaking crankshafts, so the first move was to commission a counter-balanced crank from Hadley Engineering, which was machined from EN40B steel, gas nitrided and cone hardened. Part of the reason for adopting a counter-balanced design – in contrast to most road-going Sevens – was that it mirrored the construction of ▶



ABOVE The Austin Seven sidevalve engine now benefits from a Cozette supercharger

the Rubber Duck engines. However, it also allowed for a very precise degree of balancing – the current item is balanced to less than 1 gram per centimetre.

"The crank is such a fine piece of engineering that it's almost a shame to hide it inside the engine – it'd look great mounted on a couple of blocks on the mantelpiece," he jokes. "It's vastly different from a normal road-going Austin Seven crank, though. So much so I had to modify the crank case to get it to fit."

A new set of forged beam steel connecting rods and lightweight slipper pistons from Tony Betts at 7 Counties Austins complete the reciprocating assembly. It's thought this package should be capable of revving to well over 7,000 rpm, although Loxston has set the red line at 6,500 rpm.

A reproduction of a period Watmough-Hewitt cylinder head was supplied by John Barlow at Austin 7 Spares, while a replica Cozette Number 4 supercharger was sourced to complete the 1930s aesthetic. For the camshaft, Loxston ground his own bespoke profile using a cylinder grinder designed for sharpening lawnmower blades. He followed a well-documented process, skimming around 50 thou off the cam lobes to increase both the lift and the overlap.

The engine now uses heavily oversized valves, with extensive porting to improve the breathing. This work was also carried out at home, he explains: "The cylinder block from the earlier engine was beyond repair, so I used a grinding tool to cut through the port until I hit the water jacket. From that, I was able to measure the thickness of the casting and work out how far I could go on the other block."

Loxston carried out the engine rebuild at home, having already tuned and built a string of engines throughout his motorcycle racing days. "It's a relatively easy engine to work on," he notes. "It's a single cam sidevalve, so there's nothing especially complicated."

A replica of the Austin works exhaust manifold was produced using off cuts of period tubing from a 1930s BSA motorcycle, while the supercharger's



inlet manifold was modified to suit. The end result is a very free-flowing big-bore system, based on a combination of intuition, period photographs – and to a certain extent the materials that were available. The distinctive trapezoidal silencer, for instance, comes from a BSA Sloper.

DRIVELINE QUIRKS

In order to make the most of the carefully-balanced engine's high revving capability, a dramatically lightened flywheel was fitted, along with a homemade duralumin clutch pressure plate.

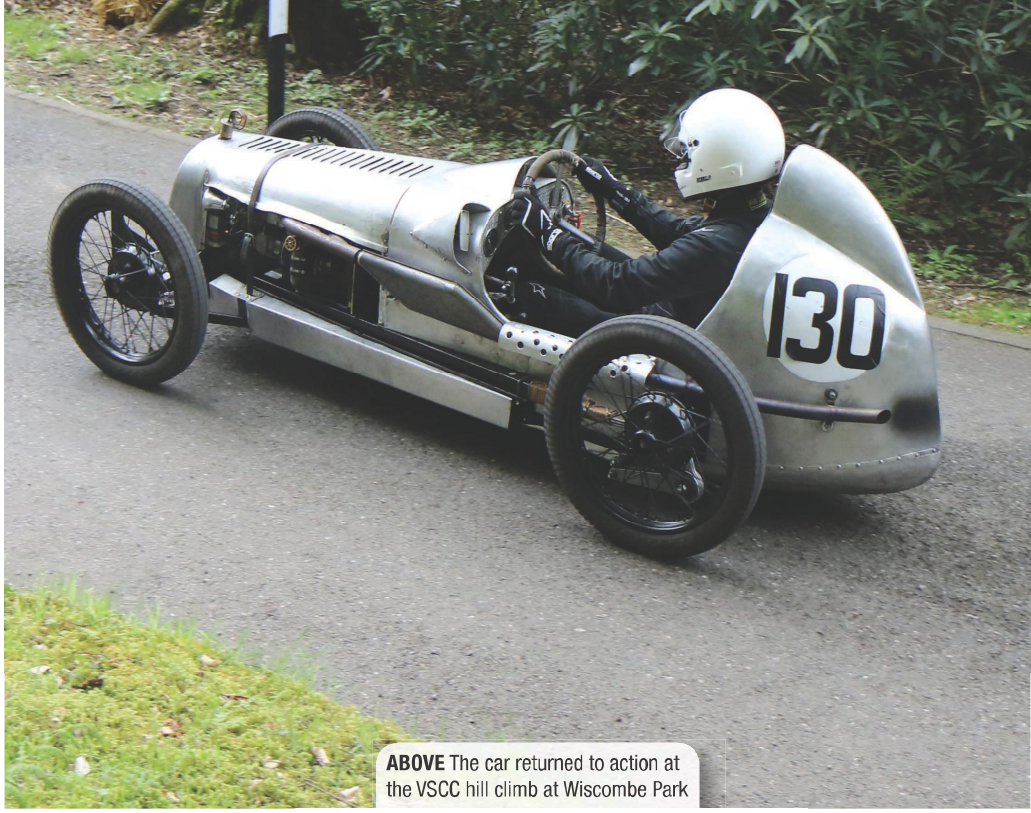
"In total, the clutch and flywheel assembly now weighs less than 10 lbs, which means the engine picks up revs and loses revs very quickly," notes Loxston. "I may lose some torque, but I don't think that will be a problem as long as I keep the engine spinning. When we first put it on the dynamometer it was producing just shy of 40 bhp at the crank. I'm hoping that should be a genuine 40 bhp once things have loosened up and we've got the carburation and the ignition sorted."

One of the more unusual features on this particular Seven is its mid-mounted transfer box, which sits under the driver's left leg. Rather than using an offset engine – as often the case with Austin Seven single-seaters – the gearbox remains on the centreline of the car. Instead, the propshaft runs for about a foot behind the gearbox, before entering a neat self-contained transfer box. Inside, a chain and a pair of sprockets sends the drive through a dogleg, exiting on the left-hand side of the driver's seat. From there, a second propshaft runs back to an offset differential in the back axle, which sits roughly inline with the driver's hips.

"It's a one-to-one ratio inside the transfer box currently, but I do actually have some alternative sprocket sizes," he comments. "You can also change the crown wheel and pinion sizes in the differential – currently at 5.25:1 – which means there's quite a lot of scope for adjustability." ▶



ABOVE The Austin Seven's high back and cutaway cockpit earned it the 'Rubber Duck' and 'Dutch Clog' nicknames



ABOVE The car returned to action at the VSCC hill climb at Wiscombe Park

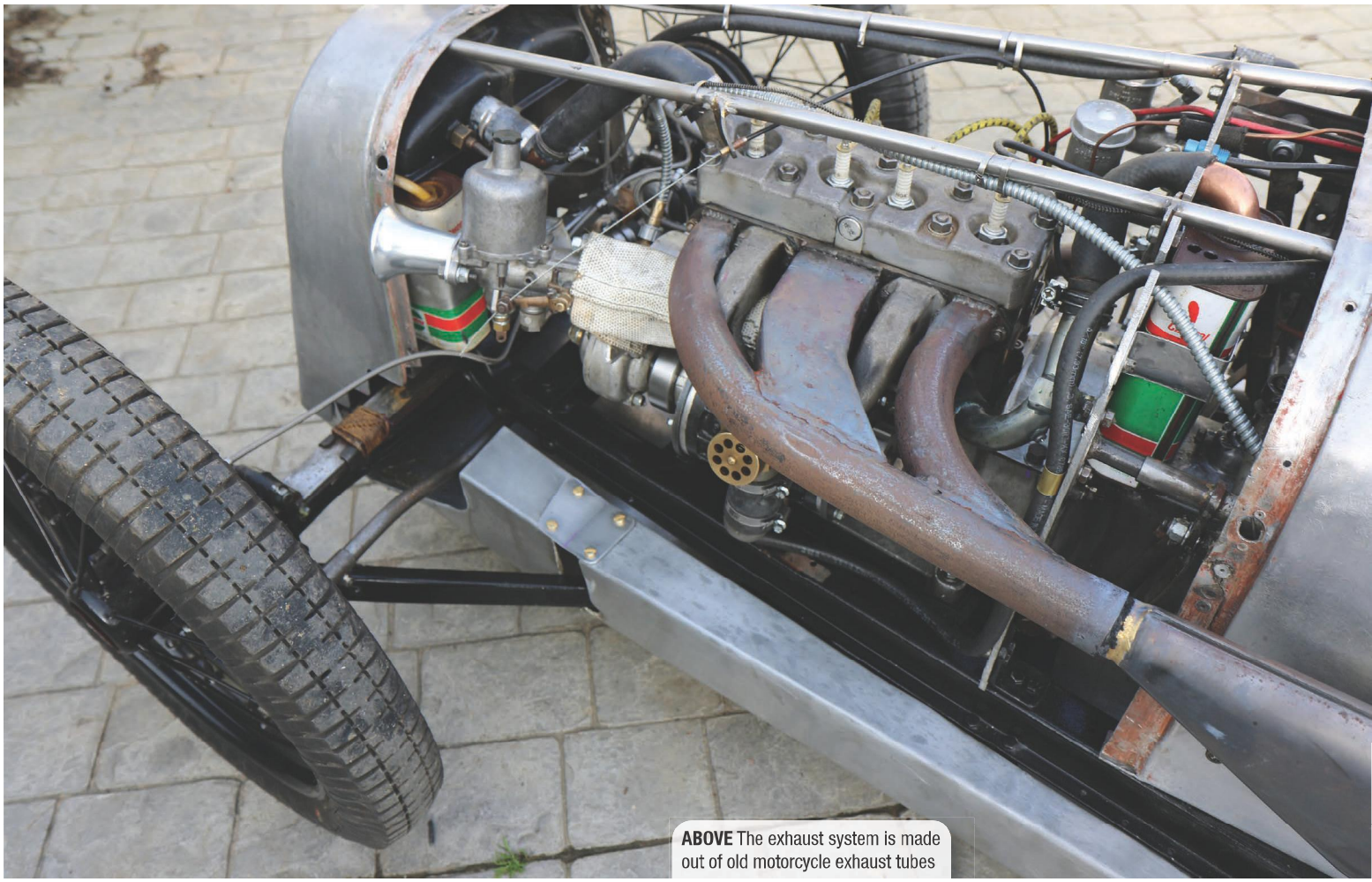
The remote gear change itself is also quite a neat feature. Fitted at some point in the past, it uses a series of rods and bushes, and works remarkably well according to Loxston: "It sits very nicely to hand and the shift quality is very good considering it's a 1920s gearbox and clutch."

A HANDS-ON APPROACH

The chassis is believed to date from 1930. It's essentially a standard Austin Seven A-frame, with the production crossmembers. Unlike a lot of Specials it's never been boxed or reinforced in any way, although the engine has been moved back by around six inches.

The suspension follows the classic Austin Seven configuration of leaf springs at the back and a beam axle with a transverse leaf spring at the front. While the front axle has an A-frame arrangement created by twin radius arms, the rear axle is simply hung off the springs. This car benefits from a set of Hartford-style mechanical dampers front and rear, plus the springs have been bound up with cord to increase their stiffness despite running a reduced number of leaves.

During the original 1960s conversion, the leaf springs had been flattened and re-hardened. As a result it now sits significantly lower than a normal Austin Seven. There's also an Ulster-style dropped axle at the front, with lowered and stiffened radius arms to give it more castor. Following a common modification, one of the radius arms has also been locked to the front axle to prevent the lateral movement that can otherwise take place. ▶



ABOVE The exhaust system is made out of old motorcycle exhaust tubes



FORMULA 1 2015/2016 Technical Analysis

Giorgio Piola

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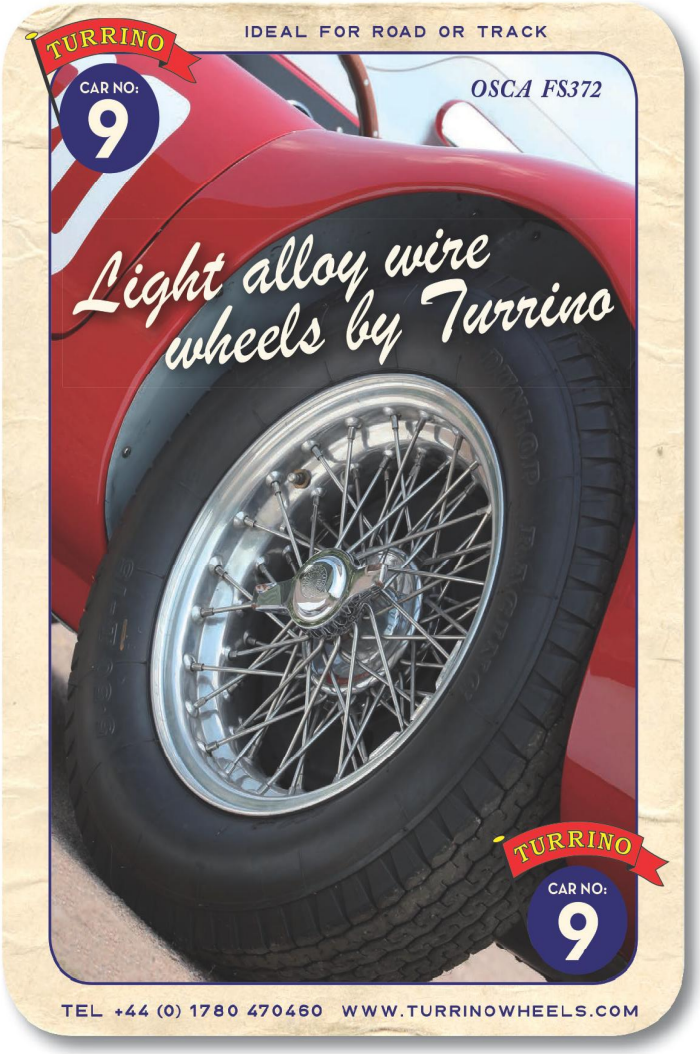
As with previous years, 2015 was one in which Mercedes-Benz dominated both the drivers' and constructors' championships. The German manufacturer confirmed the technical advantage it had derived from the introduction of the revolutionary power unit, which first appeared in 2014. In place of Red Bull, which fell into disgrace after a media conflict with engine supplier Renault, it was Ferrari that attempted to stand up to the Silver Arrows. Side issues were the stories of a Williams wanting to come back and battle for the title; McLaren with a new but not very effective Honda engine, which touched the lowest point in the Japanese manufacturer's long history in F1; and the other leading teams of a season that ended with the official announcement of Renault's return, having acquired Lotus.

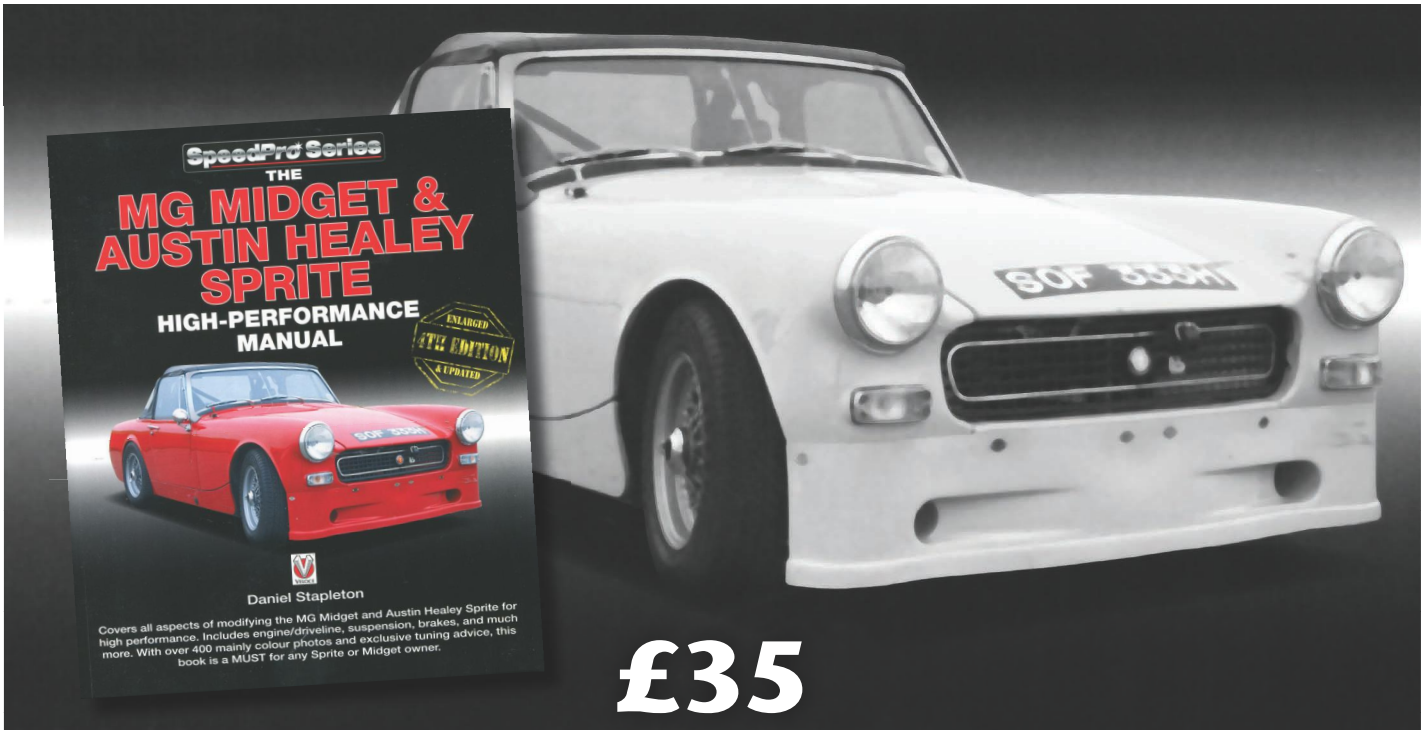
Offering a precise analysis of this latest F1 championship, especially from the technical point of view, there is once again Giorgio Piola. A hundred or so all-colour illustrations document the development of the various cars throughout the Formula 1 World Championship, and offer - as always - a wealth of information anticipating the 2016 season.

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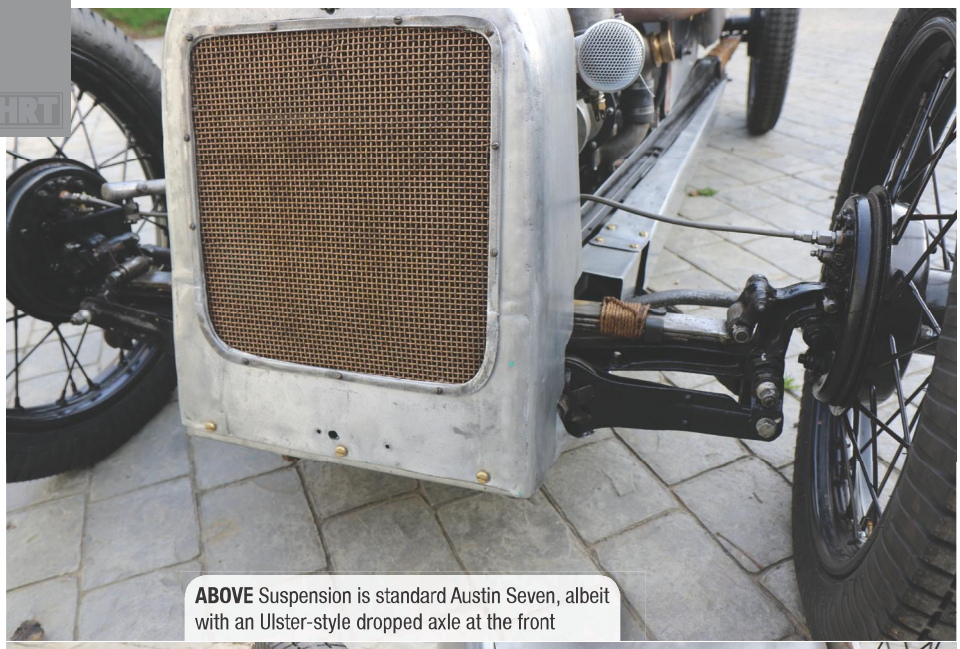


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ABOVE Suspension is standard Austin Seven, albeit with an Ulster-style dropped axle at the front



ABOVE Springs bound up to increase stiffness

BACK ON TRACK

In a letter to the previous owner, Bill Little confessed that the car hadn't turned out quite as he intended. Part of the ethos behind Loxston's rebuild has been to bring the car back to that original vision, placing it even closer to the pre-war Duck racers.

With that in mind he took the decision to lower the bodywork somewhat relative to the chassis, in order to restore the proportions with the flattened springs. He's also fitted a streamlined skirt, which sits below the level of the chassis, similar to those used on the works cars (one of which clocked an impressive 122.74 mph at Southport Sands). This has been done largely for the sake of aesthetics, but it is thought to have an appreciable effect on the car's drag characteristics too.

The panels themselves are largely unchanged. The only modification is a patch on the bonnet, which restores the original shape, covering a hole cut for the Fiat engine's twin carb setup. In its place, the Austin engine now runs a single 1½-inch SU carb, thought to be post-war, but essentially built to a period design.

"When I first got the car there were quite a few components of modern appearance – things like jubilee clips and an electronic rev ▶

Loxston applied a distinctly hands-on approach to suspension tuning, he recalls: "Initially I stood in the car and jumped up and down, but it was just rock solid – there was no suspension movement at all. So, I just removed leaves until it felt about right on both ends and then bound the springs up with cord. That's given me a baseline and I can now adjust the behaviour on the friction dampers."

As with most racing Sevens, the original cable brakes had long since been replaced with a hydraulic setup. This uses modified Morris Minor cylinders running inside the original drums and back plates. Unusually, however, it was built with a dual circuit system and a bias bar, making it possible to fine tune the brake balance front-to-rear.



ABOVE The boost gauge reputedly came from a Spitfire fighter aircraft

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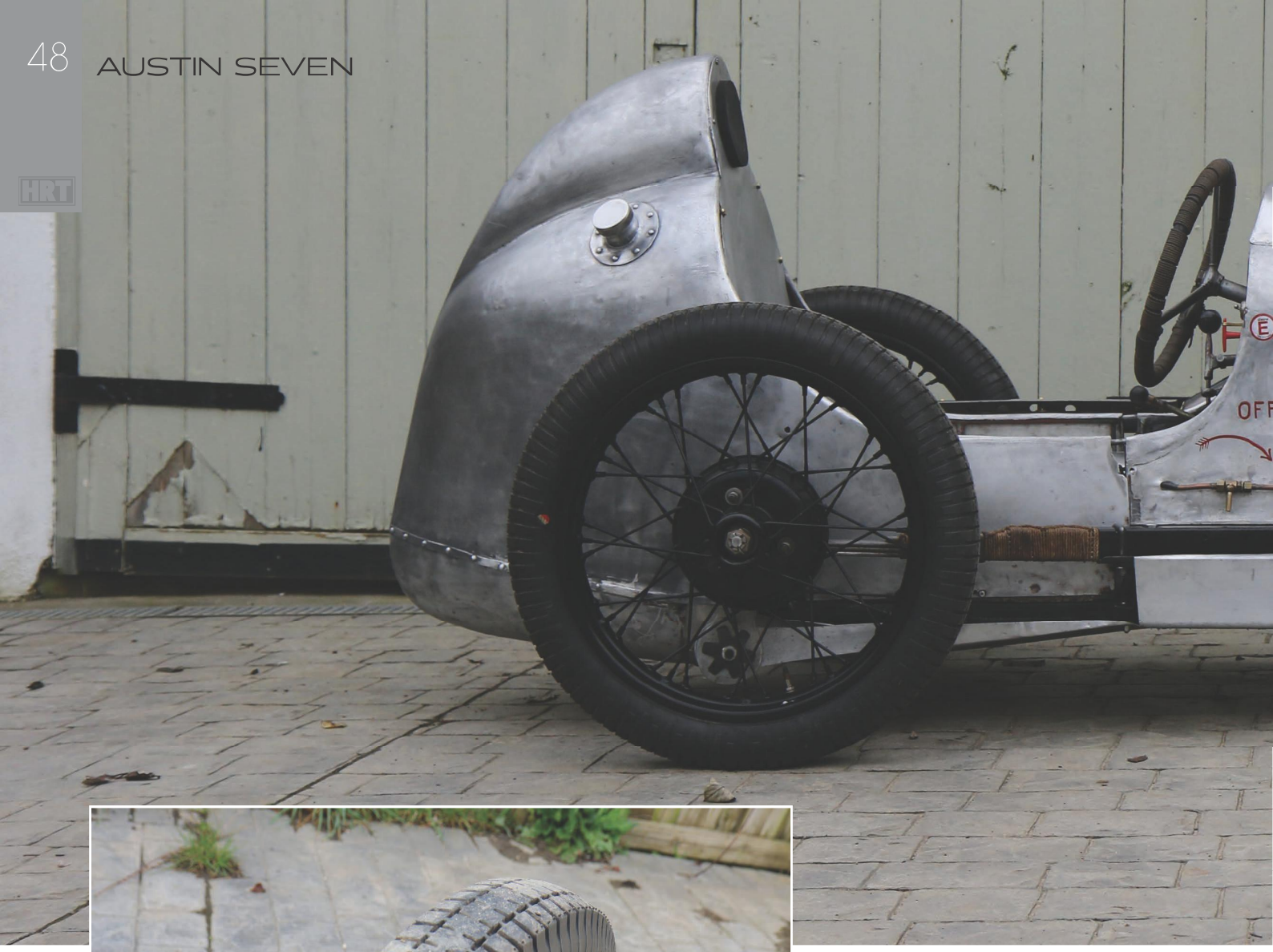
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ABOVE The brakes are original A7 drums with Morris Minor internals

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counter. I’ve tried to replace those with period-correct parts wherever possible,” comments Loxston. This includes a Jaeger analogue rev counter and a boost gauge reputed to have come from a Spitfire (the fighter aircraft that is, not the sixties sports car). Another interesting talking point is the seat the car was originally supplied with, believed to have been fabricated for a Cooper raced by Stirling Moss.

As supplied, the car was running on 15-inch wheels – a common mod for later specials – but it now sits on 19-inch rims, as recommended by Julian Majzub of Blockley Tyres. “Julian was adamant when I spoke to him that a vintage Austin Seven Special should be on 19-inch wheels and that it would handle



ABOVE Note the aerodynamic skirt below the level of the chassis rails – as used on the original Duck racers

Austin Seven 'JEB' Special

Gross weight:	350 kg dry
Power:	40 hp at the crank @ 6000 rpm
Engine configuration:	747 cc single cam sidevalve with modified block and extensive porting
Cylinder head:	Watmough-Hewitt replica cylinder head by Austin 7 Spares
Valve springs and retainers:	Modified Pigsty Racing items
Pistons and connecting rods:	7 Counties Austins
Camshaft:	Original Austin Seven item hand ground, run with flattened cam followers
Crankshaft:	Pressure lubricated counter balanced crank from Hadley Engineering
Carburettor:	Single 1½-inch SU
Timing gears and front engine casings:	Dave Dye Engineering
Gearbox:	3-speed Austin Seven gearbox with Ulster spec ratios from Andrew Bird Engineering
Wheels:	19-inch wire by Nick Mouat
Fire suppression system:	Lifeline
Tyres:	Blockley crossplies 3.50 x 19

well with that setup," notes Loxston. "He's been absolutely right and it really helps the proportions."

Part of the beauty of the Austin Seven is that it's such a simple design with an abundance of spare parts and technical advice available. As such, Loxston says, the major parts of the build were relatively straightforward, but it did pose some unexpected challenges.

"It's the little things that often prove more difficult," he says. "One of the hardest jobs was actually fitting the fire extinguisher as there wasn't really anywhere to put it. It now has a plumbed-in 2.25 kg Lifeline system, which is quite a substantial unit to accommodate on such a small car. Getting the new exhaust to fit around the inlet manifold, while maintaining a period look to the design was also tricky."

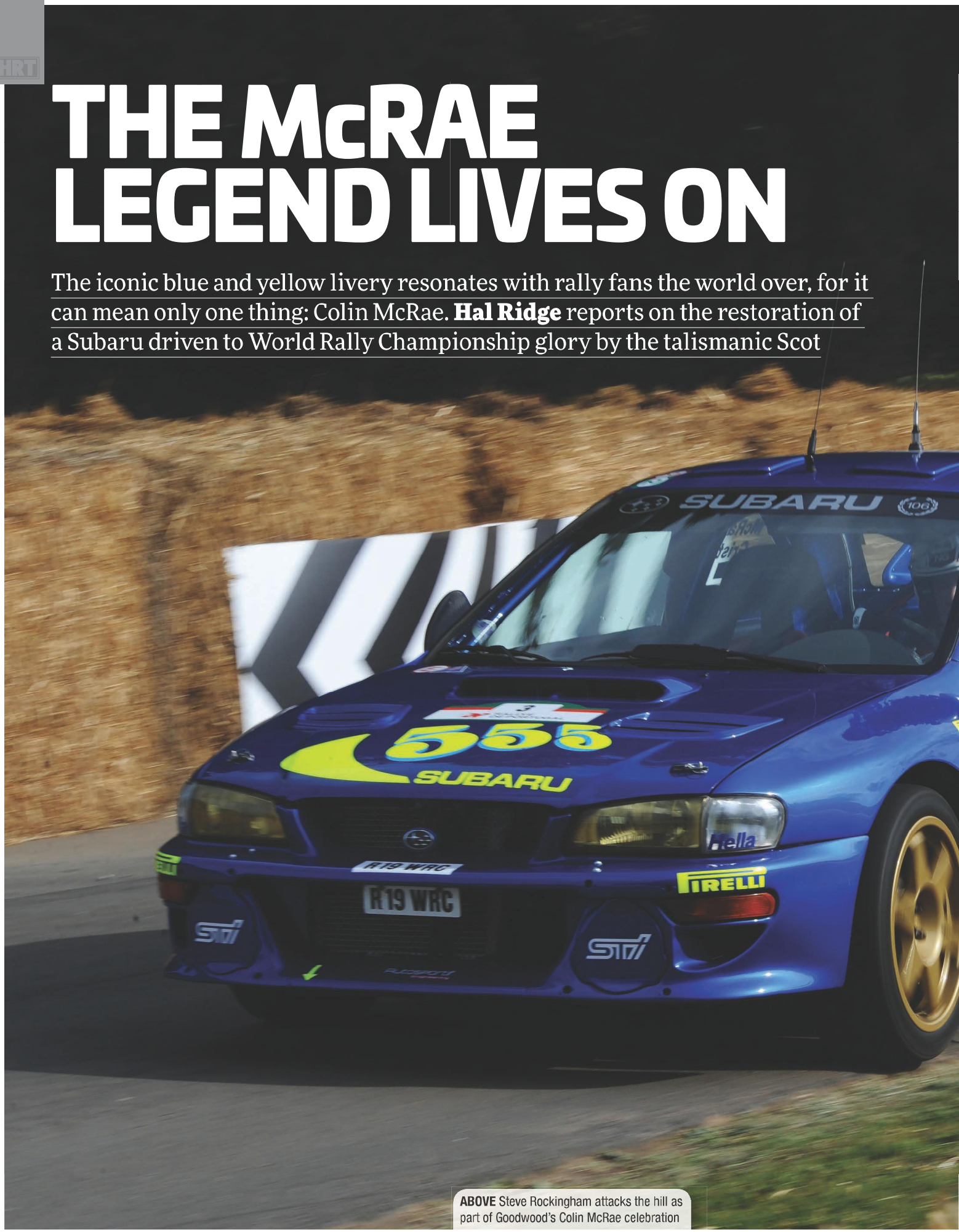
The restoration work took around 1,000 hours of evenings and weekends, finishing in the spring of 2018. Loxston wasted no time in getting the car out to a local airfield for a shakedown, which is said to have gone very well.

"The only testing I've done so far has been at low speeds on a very twisty course, but on the evidence of that, it handles remarkably well," he says. "The turn-in is really good and it's easily controlled. It only weighs 350 kg, so the performance is quite sprightly. Even with only 40 bhp there's more than enough power to spin the wheels coming out of the slower corners."

As we went to press Loxston had entered his first ever competitive event on four wheels, with the VSCC hill climb at Wiscombe Park providing the stage for the car's return. It marked the start of a new chapter for this particular example, and indeed its owner. In other respects, however, it's business as usual with yet another Seven returning to the arena where scores of engineers and drivers have cut their teeth. HRT

THE McRAE LEGEND LIVES ON

The iconic blue and yellow livery resonates with rally fans the world over, for it can mean only one thing: Colin McRae. **Hal Ridge** reports on the restoration of a Subaru driven to World Rally Championship glory by the talismanic Scot



ABOVE Steve Rockingham attacks the hill as part of Goodwood's Colin McRae celebration



Jeff Bloxham

ASK a casual sports fan to name a rally driver, the chances are they wouldn't come out with the sport's most decorated star Sebastien Loeb, or his successor Sebastien Ogier. The most likely scenario is that the name that would spring to mind would be of a Scotsman who became Britain's first World Rally Champion in 1995 and sadly lost his life just over a decade ago in a helicopter accident.

Colin McRae was the man responsible for taking the niche discipline of rallying to the masses. He achieved that feat not only with his exciting, flat out, no-holds-barred approach to driving, but also as the face of the Colin McRae Rally PlayStation game phenomenon, which still exists today, albeit in a revamped form.

Despite driving Ford's Focus at the turn of the millennium dressed in an iconic Martini livery, it's the Subaru Imprezas of the mid-90s that the McRae name is most associated with. It's that familiar blue and yellow livery that has been restored to adorn R19 WRC, the car with which McRae won Rally Portugal in 1998, his final year with the Prodrive-operated Japanese marque before switching to Ford.

R19 WRC (Impreza WRC chassis 019) made its WRC debut in the hands of Kenneth Eriksson on Rally Finland in 1997, the first year of the new WRC regulations taking over from the previous Group A rules. It was campaigned twice more by the Swede in Britain and Sweden, before McRae drove it to a Rally Portugal victory in March 1998, co-driven by Nicky Grist. The pair also achieved glory on Rally China, a round of the Asia Pacific series, in June of the same year.

PLAIN WHITE LIVERY

Subsequently, chassis 019 was used by Frenchman Frederic Dor in the WRC and French tarmac championship, until exchanging hands several times from the turn of the century. When current owner Steve Rockingham acquired the machine, it was still in the plain white livery of privateer Dor. Having used it on a number of rallies in the same trim, engine problems on the Eifel Rallye meant a visit to Subaru preparation experts Autosportif Engineering in Bicester, based in the workshops of former Formula 1 team, March Engineering.

However, what was originally intended to be a relatively straightforward rebuild of the flat-four 2.0-litre engine, then turned into a full restoration.

"The only thing that had really been changed when we got the car was that it had gone from left to right-hand drive," says Rockingham. "We rallied it for a few years and had so much fun with it, then we did the Eifel Rallye and it was breathing really heavily, ▶

“It’s a wonderful thing to drive. Whatever bit of talent you’ve got, it flatters it”

with a puddle of oil on the floor. I took it to Howard [Dent, Autosportif Managing Director] to pull the engine out.”

The problem was diagnosed as a broken piston ring. But while the engine was being rebuilt, it was decided to convert the car back to left-hand drive. During that process, it was then decided that it was the perfect time to restore the car’s original colour too.

“We stripped it to a shell so it could be assessed at the bodyshop, then once it was blasted we had it back and decided what we wanted them to do,” says engineer Jon Hall. “They did all the welding repairs it needed, which was not a lot but there was some localised stuff, a floorpan and things for the left-hand drive parts. These always need some repairs because they’ve got floor guards on and when you take them off, there’s crud underneath that hasn’t been repaired, so there was a bit to do.”

Converting a car from right to left-hand drive, even on a machine that has had the opposite switch carried out previously, isn’t as straightforward as just moving the steering column and pedal box.

“There’s quite a bit to do because the wiper and wiper arms go on a different side too,” says Dent. “The brake lines are slightly different down the [transmission] tunnel because the pedal box has moved, and you obviously need to supply a new steering rack. You need a new dash top, although the dash panel is the same and the loom does swap over. There’s quite a lot of little bits and pieces that are wrong when you do that, so have to be modified. Then there were the carbon fibre parts for the heater and stuff that all needed changing. You’ve got to find the right bits or modify stuff to go back because when the conversion to right-hand drive was done, chances are the original stuff was taken out and launched.”

Never interned to be adapted, prior to 2003 Prodrive’s WRC Imprezas only left the firm’s Banbury workshops in LHD specification.

With the two-door bodyshell painted and the bulk of the hard restoration work done before the car could be ▶



Hal Ridge

ABOVE & BELOW The amount of fuses and switches involved means the cockpit bears closer resemblance to that of an aircraft than a racing car



Prodrive

ABOVE Portugal marked one of Colin McRae's three WRC victories with Prodrive during the 1998 campaign





ABOVE & BELOW The bodyshell is the same shape as its road-going cousin, but the similarities pretty much end there





Autosportif/Jon Hall



BELOW The familiar gold 18" Speedline wheels accommodate Tarmac specification AP Racing six-pot brake callipers

reassembled, bolt-on components also having been restored off the car at Autosportif and subassembly completed, a stumbling block emerged. "It was nearly finished and we were stood in the workshop looking at it as a rolling shell," says Hall. "It had a single roof vent, which was '98 spec, but when McRae drove it in Portugal it still had the '97 roof vents, so we asked Steve if we could change the roof. It was the last chance." A roof skin was sourced from Japan and was immaculately fitted by the bodyshop.

"HORRIBLE EXPERIENCE"

"The car came back here with a brand-new roof which we then had to cut two holes in to put the roof vents in, which is a horrible experience," Hall recalls, referring to taking a jigsaw to the iconic machine's lid to fit the original Prodrive vents. Another reason for the roof vent switch was in order to fit the two aerials that had been used on the car in Portugal '98.

The bonnet skin was also modified to fit larger period vents. Rather than just sticking them over holes in the panel, they were cut into the bonnet as in period by a fabrication expert, including adding the as-original aluminium lamp pod bobbins.

The stunning attention to detail is capped off by the Rally Portugal livery, fitted by the man who applied the same graphics to the works cars in period. "That is exactly how it finished Portugal," says Dent. "Because there's different stickers on the car on the finish ramp to when it started the rally, that's how it finished. We deal with the guy, 'Sticky ▶



ABOVE The familiar boxer engine powers the Impreza

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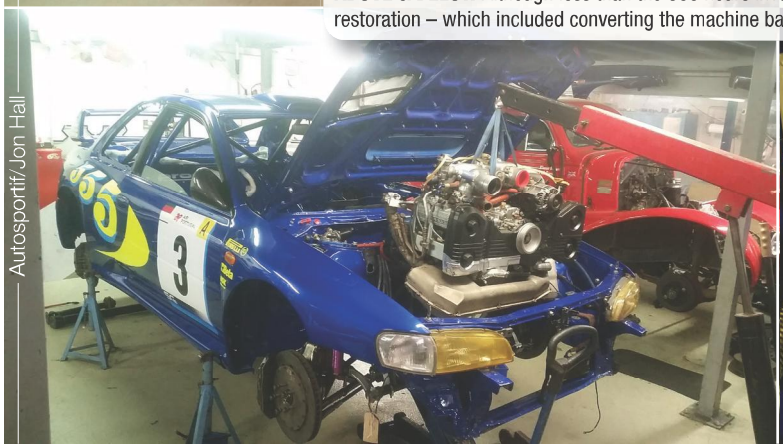
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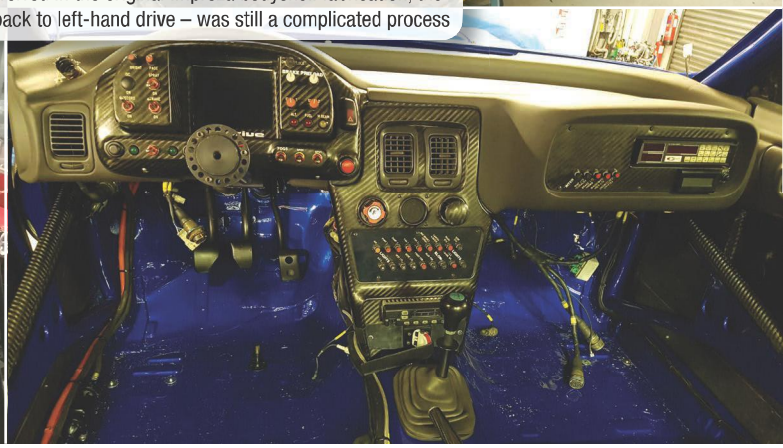
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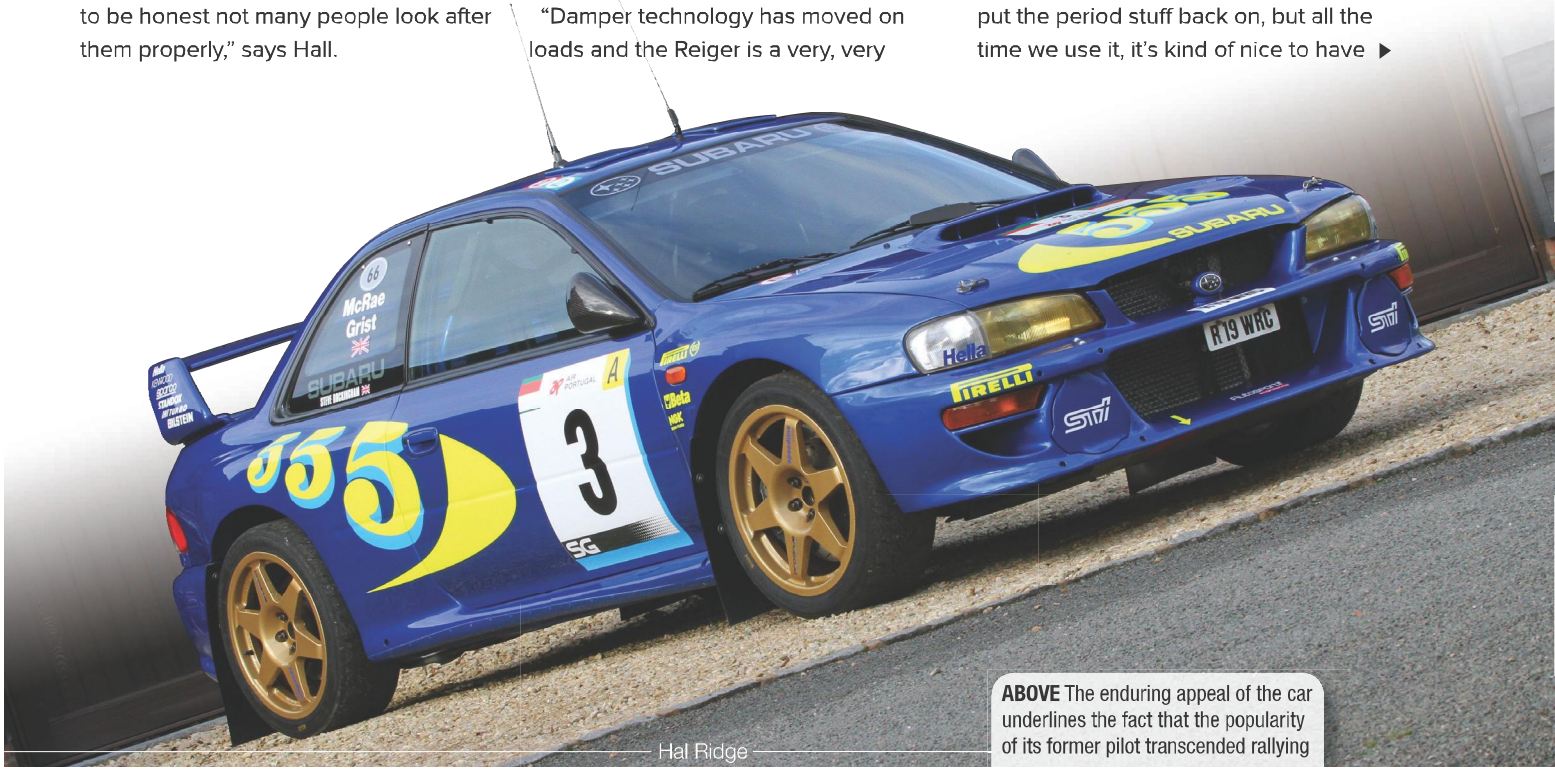
ABOVE & BELOW Although less than the 300 hours involved in the original Impreza bodyshell fabrication, the restoration – which included converting the machine back to left-hand drive – was still a complicated process

Dave', who put the liveries on in period."

As part of the restoration process, the wiring harness was also rigorously checked by expert Robbie Durant, who removed any retro-fitted wires that had been added as temporary measures at some stage in the machine's 20-year life. "It's nice when you get in a car like this, turn everything on and it does what it's meant to. A lot of them don't, because to be honest not many people look after them properly," says Hall.

In the same vein, all rose joints and bolts were also changed in critical areas like the suspension, to ensure reliability. Originally fitted with MacPherson Bilstein dampers as a Prodrive factory car, R19 WRC has been upgraded to more modern multi-way adjustable Reiger dampers (for high and low-speed bump and rebound, for instance) at each corner, attached to Prodrive's uprights.

"Damper technology has moved on loads and the Reiger is a very, very good damper. They are better than the originals," says Hall. The remote canister is located at the bottom of the strut. The change was implemented not only to improve the general driving characteristics, but also to make it competitive when it is used in events. "I still have the original dampers too, but the Reigers are so good. The car handles beautifully like it is. We could always put the period stuff back on, but all the time we use it, it's kind of nice to have ▶



Hal Ridge

ABOVE The enduring appeal of the car underlines the fact that the popularity of its former pilot transcended rallying

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it working at its best," says owner and driver Rockingham. The rear windows (made of thinner glass than standard, to save weight) are removable to enable adjustment to the rear dampers.

Although Rally Portugal was, and still is, a gravel event, the car currently sits in Tarmac specification, to suit what Rockingham most wants to use it for. As such, within the Pirelli-clad iconic gold 18" Speedline wheels sit Tarmac specification AP Racing six-pot water cooled brake callipers and 365 mm discs at the front. Four-pots would be used in gravel trim, the same as those found on the rear of this car, using a marginally thinner disc.

Aside from a recent refresh, the Impreza's two-litre, four-cam, turbocharged (with regulation 34 mm restrictor) boxer engine remains much as it would have been in period, with a 92 mm bore and 75 mm stroke. The water injection and front-mounted intercooler are also as period to produce around 300 horsepower at 5,500 rpm and 471 Nm torque at 4,000 rpm. Such figures mean the Impreza is capable of reaching 60 mph from a standing start in around 3.9 seconds.

EGR VALVE

"In '97 they carried over the Group A turbo, but for the '98 car it was different. This is one of the areas [differentiating] a works car and a customer car, but Steve's car is mechanically customer spec," says Dent. "The turbo is effectively Group N, but with a different compressor and exhaust housing. There's no anti-lag on a customer car, but it has an EGR [exhaust gas recirculation] valve which feeds compressed air from the turbo off-throttle back in under the turbo and keeps it spinning.

"It makes it a really driver-friendly car. This engine is still very similar to the last of the Group A engines [run in 1996], albeit with different cam pulleys, timing belt arrangement and a slightly different sump, but essentially it's much the same."

The six-speed H-pattern gearbox, fitted to the rear of the longitudinally-mounted engine, is a fully active magnesium-cased Hewland unit. Its hydro-mechanical differentials give electronic-hydraulic control of the centre and front diffs, but with a non-active rear and a 50:50 torque split. The multi-plate ▶



BELOW Hold breath now: taking the cutters to a pristine roof, in order to replicate the vents used in period, made for a heart-in-mouth moment

Autosportif/Jon Ha

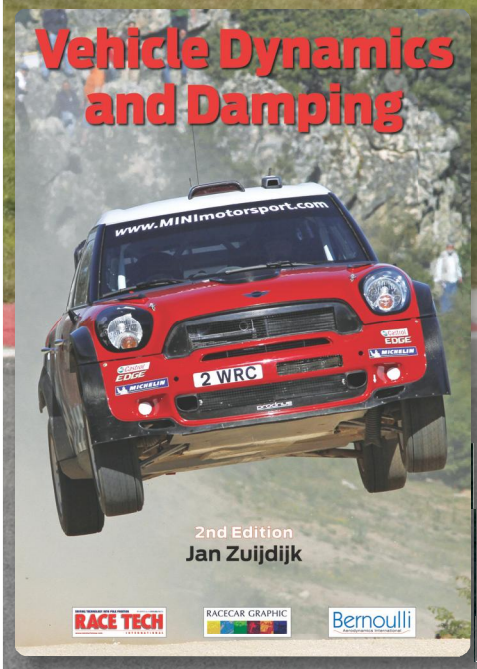
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"THE GEARBOX EVERYBODY WANTED"

Once top secret, Prodrive's trick gear selector can be found on one of the permanent residents in Autosportif's workshop. **Hal Ridge** reports

ONE of the permanent residents in Autosportif's Bicester workshops is an S6 (2000) WRC Impreza used in a handful of events each year by experienced campaigner Roger Duckworth, who finished third overall on the Wales Rally GB National rally for the last two years. He won the event in 2011.

W23 SRT was formerly a works car, but as a customer version sold by Prodrive, like all S6, S7 and S8 Imprezas, it came fitted with a different gearbox. As a factory machine it would have run a semi-automatic H-pattern gearbox that was introduced from 1999. Customer cars, however, were sold with a redesigned sequential gear selection mechanism and a pressure-to-unlock active rear differential.

For the S8 Impreza (2002) customer demand dictated that like the works cars, customer machines were fitted with paddle shift. However, rather than use the works H-pattern gearbox, a hydraulic actuator was fitted to the sequential 'box.

The works cars, meanwhile, used a trick selector on the H-pattern box. Prodrive was the only firm to implement such a system, which encompassed a pair of actuators, one for left to right, the other for backwards and forwards.

"It's a fantastic piece of kit," says Howard Dent, Autosportif Managing Director. "When you're in the car and changing gear with the paddle, it's the same as any sequential car up and down the gearbox, but if you spin, there's a knob on the centre panel so you can turn it to get neutral, first or reverse.

"That was the gearbox everybody wanted. The works cars used them from '99 all the way through until 2004. By then, when they got to the S10 (2004) model, the works gearbox was super reliable and it wasn't a secret anymore, so anyone could have it."

Thereafter, the major upgrade for S6 and S7 machines was to use the works-run gearbox. "Very few cars still have the original gearbox," says Dent. "Roger always had his and it was fine, but an S10 gearbox came up for sale and it was a no-brainer really. It fits straight into the car; the wiring harness should all work and you just need to programme the ECU."

But, as is often the case, while making the switch in transmission, more work was undertaken to Duckworth's machine in other areas too. "Because of the speed of the shift, one of the things Prodrive did was to use a twin cambelt system, so we converted the engine," says Dent. "Then we thought while we were at it, we could fit the rocket in the exhaust and the later S12 turbo, which meant changing the ECU. We got an ex-Prodrive engineer involved to help with that. This has a different ECU to any of the other cars. It's still GEMS but has the later launch control and now a pressure to lock rear diff which makes it quite a lot nicer to drive, but uses the same crownwheel, pinion and casing. Other than that, it's pretty much as it should be."

Aside from keeping safety features like seats and fire extinguishers up to date, W23 SRT also uses latest specification XTE suspension. "It's a nice old thing; the gearbox is just fantastic and the launch is out of this world," concludes Dent. HRT



BELOW Roger Duckworth's Impreza in action



Jeff Bloxham

ABOVE The technology harnessed within means the car is now arguably even better than it was when first built

carbon clutch is courtesy of AP Racing.

Although there were various options on Subaru WRC fuel tank capacities from Prodrive's factory – a Safari Impreza having the biggest at 120 litres, and the smallest being 65 – space also had to be made underneath for water tanks. This car has just one tank for the water injection system, located under where the back seats would usually be. The fuel tank sits in the boot, together with the spare wheel.

Inside, the crew sit aboard a pair of bespoke Prodrive Sparco seats with Sabelt harnesses, looking at the Momo steering wheel just in front of the carbon fibre clad dashboard, housing an LCD driver display and enough fuses and switches to make it look more like an aircraft than a more modern racing car. A period C-Giant trip meter was also sourced and fitted to the car, while a lifeline fire extinguisher system is installed behind the seats. Inside the rear quarter panels are tools and small parts for repairing the car at the roadside. In period, aluminium drinks bottles would also have been full of various fluids. Unlike in the Group A Impreza, the WRC version didn't carry a spare turbocharger...

Like most factory-built competition machines, Prodrive's WRC Impreza shares few components with its road-going cousin. "The thing is based on a road car, but there's very, very little [left] isn't there? On the engine there's virtually nothing although the cam covers are the same," says Dent. "The bodyshell is the same shape, but all of the mounting holes have got bobbins welded in bigger bolts; all the suspension's fabricated [to have a wider track]. It's like looking at a modern touring car, really. Even the front badge was different: it's bolted to the bumper."

"A MILLION BITS"

A 1997-98 Impreza bodyshell took around 300 hours to fabricate. Although the timescale of this restoration was rather less, it was still an involved process. "I don't think I could say how long we spent on it," says Dent. "It's three days' work to get a car into a million bits, then it's probably three months to put it back together again. But, the biggest thing about that car is the initial look when you see it or open the door. You know, when you walk into your bathroom and there's a crack in the tile, it bugs you straight away. You can't have that. It's the initial look that makes you go, 'Ah, it's brilliant'."

There's no sense of arrogance about the job done by Dent's firm in that statement. Instead, it's just the appreciation of the effort that has gone into making one of the most iconic rally cars ever built not only as good as it was when it was first winning in the hands of an all-time great 20 years ago, but now arguably even better.

"To own a McRae car is a bit of a privilege," admits Rockingham. "Let's face it, there's not many cars that Colin actually won a round of the world championship in, so that's quite nice. Like the early Group A cars, the early World Rally Cars are just fantastic, and it's a wonderful thing to drive.

"Whatever bit of talent you've got, it flatters it; it does everything for you. It would be a crime not to use it. It's so much fun I couldn't just leave it sitting in the garage and look at it. Wherever you go with that car everyone just adores it, they all want to see it because it's a Colin car. No matter where you are in Europe, he's just a superstar and they all love anything to do with McRae, they go crazy for it." HRT

ACTION STATIONS

William Kimberley visits a site that has played a role in many conflicts but is now home to an emerging force in automotive engineering

THE Bicester Heritage Centre is rightfully regarded as the go-to location in the UK for pretty well anything to do with historic car restorations and refurbishments. However, just 25 miles due north of it is another site that could well become a rival.

Weedon Bec is pretty well in the centre of England, just about equi-distant from coast to coast. As with nearly every other town, it has a trading estate, one that it's actually difficult to find, but go through the gates, you suddenly enter a different world, one that's steeped in history. In fact, it dates back to the turn of the 19th century when an Act of Parliament in 1803 was passed for the purchase of 53 acres in Weedon, Northamptonshire for 'erecting buildings thereon for the service of His Majesty's Ordnance'. It was a direct response for Britain to gear up following Napoleon's very real threat of invading the country. It was even rumoured that one of the buildings was set aside for King George III should the invasion have taken place.

A secondary canal from the Grand Union was fed into the walled Garrison, as it was and is called, in order to move ordnance in and out more efficiently and which just about still exists. It also had a rail link to the main line going north and south, but which has since been torn out.

A continuous history over the next century and a half saw it play an important role in the many of the conflicts in which Britain was involved. In the First World War, for example, a large proportion of Kitchener's arms was clothed from there as a local historian puts it, and in the 1930s it not only became the Central Ordnance Depot for small arms and machine guns but also the Army Bicycle Section that had been transferred from Didcot to Weedon.

When the site was sold off in 1965, it could have gone the way of many historic sites and been subsumed into a shopping mall or be bulldozed to make way for modern buildings that the-then customers moving to a modern trading estate would demand. Fortuitously that did not happen.

With the buildings still in place, one gets a real sense of history when entering the site through the original gates. The



> "We pay a great deal of attention to friction, which means that our engines tend to run cool"

ABOVE Powertrain is one of the three pillars of the operation

canal, or what's left of it, is bordered by the long, low buildings; the clock tower is still in place, as is a portcullis. What is particularly pleasing, or should be to readers of this magazine, it is populated with businesses renovating, restoring and tuning old cars. One such is Advanced Motorsport & Engineering, which perhaps fittingly is partly housed in the old chapel.

ALADDIN'S CAVE

Owned and run by Dan Turner, it is a haven of automotive engineering with a wide variety of cars being worked on. It is a veritable Aladdin's cave of cars and engines. It might be a Mk1 Jaguar, a Ferrari 360 Challenge car or even an Isetta three-wheeled Bubble car. And no names, no pack drill, the chassis dyno is used by one or two leading Formula E outfits. Nothing is too much for this company.

"Because of our eclectic work we do here, upon first meeting us, people ask what do we do? If you take all the engineering out of it, we tend to make people smile," says Turner. "Our satisfaction is seeing a customer drive down the pit lane with a wide grin on his or her face."





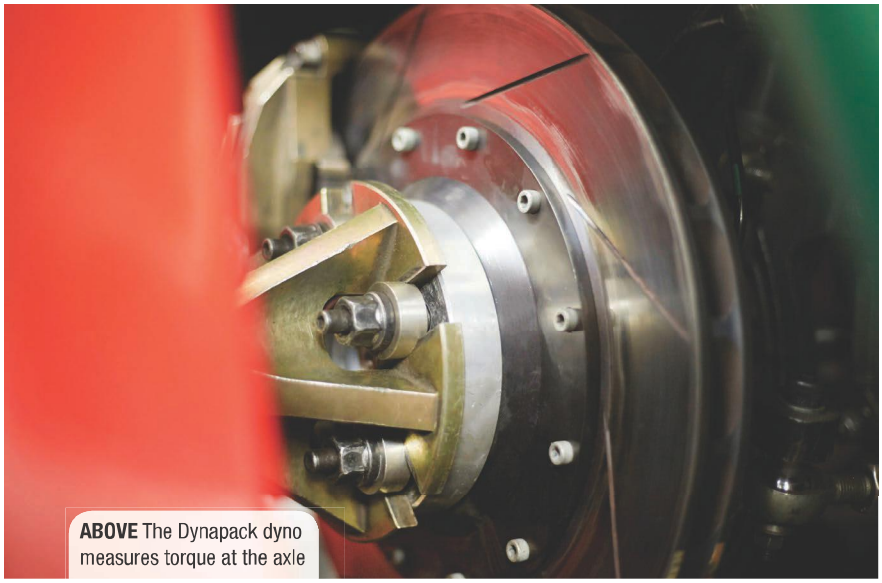


ABOVE & BELOW From a Mk1 Jaguar to a Group C car or even Formula E team, Advanced Motorsport & Engineering is proving a lure to a wide variety of clients

Turner himself, although only in his late 30s, has a long history in performance engineering. As he proudly says, he was the very last of the craft apprentices when he joined Cosworth at the age of 16 in 1996. "The first engine I was involved in was the HB Formula 1 engine, building sub-assemblies and taking them apart. During my Cosworth time I covered British Touring Cars, SuperTouring cars, CART IndyCars and I even built a NASCAR engine, thinking this was normal."

From Cosworth he was headhunted by a couple of former Cosworth engineers who were developing a "very bizarre and weird" airplane engine that had a propeller attached to the crankshaft, which was located at the top, ball socket piston joints, supercharged and turbocharged and a 2-stroke diesel cycle. "It was great because it meant I went from being involved in making the best engines in the world to something that didn't exist and then had to learn how to apply engineering and make things that don't exist, exist," he says. "The beautiful thing about working on an airplane engine is that reliability and durability are first and foremost. That's where sitting on a runway in a development airplane next to a test pilot with an engine that I've built brings it home to you."

Turner has also worked in the automotive industry for Rolls-Royce and Bentley as well as Jaguar Land Rover. "I then accidentally fell into electronics and became a powertrain liaison engineer ▶



ABOVE The Dynapack dyno measures torque at the axle

between Denso and Jaguar Land Rover," he says. "I was young enough to talk about computers and knew enough about engines to have a good conversation. I then got a job in British Touring Cars with Neil Brown, doing the engine development for the Honda Civic Type R, doing the mapping at the circuit.

BACK AT THE CUTTING EDGE

"From there I got called back to the automotive industry because of money, but after a while I got bored and started working for myself building engines in my garage, getting backing from a wealthy individual. After a while, though, we pulled the plug on the business for various reasons, but I walked straight into a job at Prodrive as a development engine builder for the Aston Martin and the Ferrari V12 project, so I was back into the cutting edge of durability performance engineering at the highest level."

It is all this experience and knowledge, plus a brief and rather unhappy sojourn in London, that opened his eyes to the way that things shouldn't be done. He also learned from his time as "Dan with a laptop" who "wandered from dyno to dyno around the world", building a reputation that he has brought into his business, Advanced Motorsport & Engineering, which he proudly says is his and his alone without any backers, secret millionaires or investors.

Apart from his own experience, he also credits his father, "the car whisperer" – who spent nearly half a century in motorsport engineering working for among others Roger Dowson Engineering, which ran the works Mazdas in the British Touring Car Championship – for the way he can make cars behave properly.

Turner junior is as passionate as his father about engineering and understanding how things work. For him it is a never-ending quest to understand the problem and solve it. Nothing is impossible, he says, and it's not magic. "It's almost as if we have a crystal ball, but of course we haven't. We've got good engineering understanding, experience of looking at things and the ▶



BELOW Repeatability is one of the dyno's big assets



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desire to apply them."

Never one to stop learning, a couple of years ago he went into computer programming so that he could understand how it works and extract the best from it so that he can apply it to his engines. "Perversely," he says. "I like problems and fixing things. Nothing is a mystery."

Aided and abetted by Jeremy Le Fol, who is the business development manager, allowing Turner to get buried in his cars and engines, there are three basic pillars to the business: chassis development, with the Dynapack chassis dyno being the invaluable tool; powertrain; and mechatronics/electronics. The company also offers a race car consultancy.

THE ESSENTIAL BUILDING BLOCK

The Dynapack chassis dyno was virtually the first piece of important kit that Turner acquired when he set the business up, but it came about quite fortuitously. Growing tired of travelling the world with his laptop, he based himself in Milton Keynes in a facility that had the dyno, but it was barely used by the owner. As business grew for Turner and it was time to move out, he was offered the opportunity to acquire the dyno and so it formed the first part of the building block.

"The Dynapack dyno measures torque at the axle, which is the one that accelerates the vehicle, the mass of the car – it's not the horsepower or the torque of the engine," says Turner. "The dyno itself is one of the best tools for reliable data so we try to put all our customers' cars on it before a race weekend to see if there are any issues. It's also very nice for our customers to have the absolute certainty that they can bring the car back at any time and know when the power disappeared."

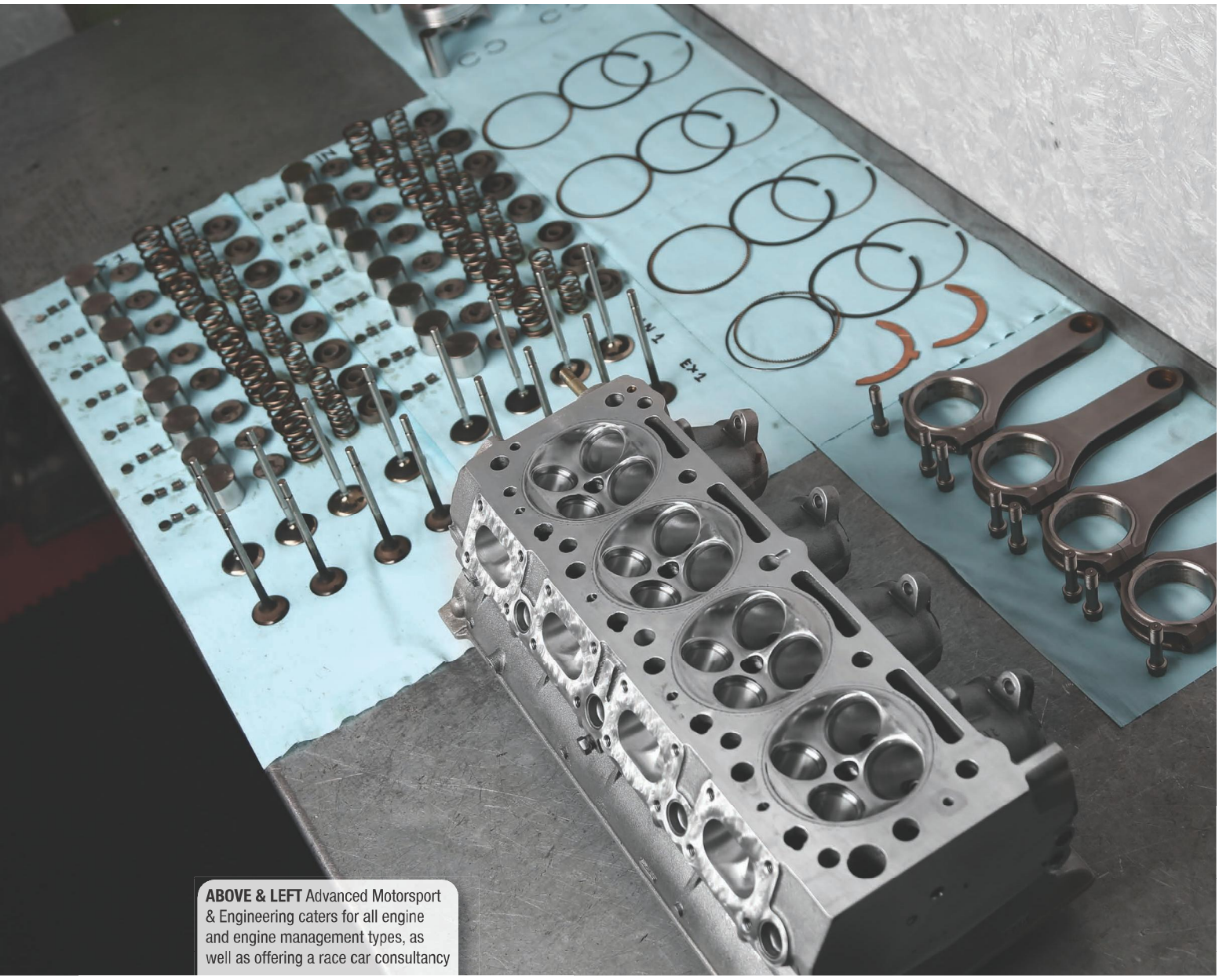
He says that another important point is that in testing the engine through different gears, it provides the precise moment of when to change gear. "As you go up through the gears there are significant advantages of getting the shift absolutely right," he says, "which translates into better lap times."

Repeatability is another huge asset, which is why professional race teams, including some from Formula E, come to AM&E. "Although a generalisation, if you consider that electric machines are 98 per cent efficient, it means that there isn't a huge amount of efficiency to be found, although there is something, and that's what they're looking for. However, another huge advantage is that they're not risking the car or even the building as the car can't spin off out of control as it's not a rolling road."

QUANTIFYING DIFFERENCES

The dyno is also used to measure lubricant performance. "One of the interesting things about the Dynapack is that is can verify and measure the differences in lubricants because there's no inertia in the dyno itself," he notes. "For example, if you take a modern car that has a lambda sensor, it will either say rich or lean. The resultant chemical energy that's released from cycle to cycle relates to torque fluctuating, so when you run the car on the Dynapack, you can watch 0.2 or 0.3 horsepower flickering up and down.

"We've done some work with the World Rally Championship teams which are desperate to find three quarters of one horsepower improvement, so we carry out dyno tests on different lubricants in certain conditions. Repeatability is a big feature of this dyno, so we can carry out tests at a specific temperature on a lubricant, measure the performance at the hubs, perform the same test on another lubricant, and then repeat it all again on the original – one of the engineering principles is never believe the instantaneous data – you have to build up a pool and then take it from there. It means we can quantify tiny little differences."



ABOVE & LEFT Advanced Motorsport & Engineering caters for all engine and engine management types, as well as offering a race car consultancy

The dyno is also used in the development of exhaust systems: the Dynapack, which is mobile and so can be moved around and even taken away from the premises, is mounted above an open pit. This therefore allows the exhaust pipe to be dropped down and then measured on the dyno to arrive at the most efficient length. Once that has been decided, it's then a question of packaging the exhaust into the car itself. He gives as an example a Porsche Cayman where the customer bought the best possible exhaust system for it, but after running it on the dyno and adjusting the length, they were able to find a further 40 lb/ft of torque while also getting more horsepower at the top end.

The engine side of the business is comprehensive. Scattered around the facility are engines in different states, some undergoing a simple rebuild, others being totally re-engineered. Nothing is too daunting so if it means re-profiling the cams or even moving them, then it's done. Turner's hands-on policy of working on the engines himself and fully understanding them is the biggest asset.

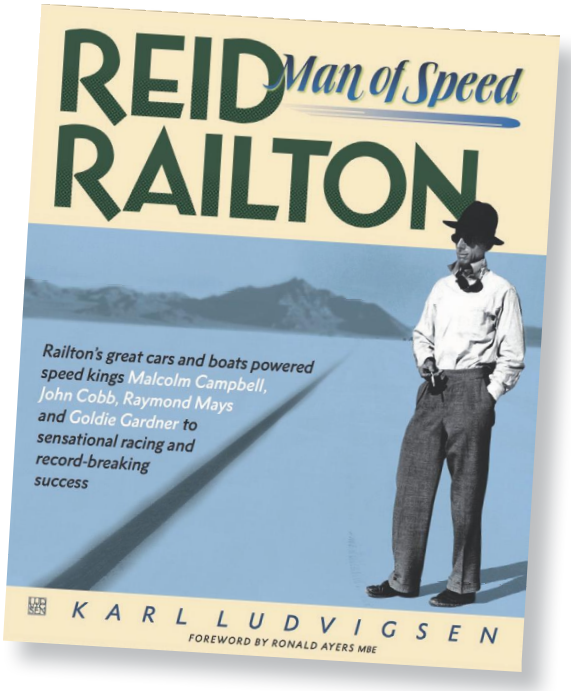
He says that his engines have a tendency to run quite cool, but there's a reason for that. "We pay a great deal of attention to friction, which means that our engines tend to run cool. It means that we find in many cases we need to run a lower spec lubricant than you might expect. We favour Petronas products for probably around 50 per cent of the race cars and all the high-performance cars that go through our hands. On certain high-value engines, though, we tend to use products from Millers Oils."

During the rebuild process, absolutely everything is recorded, from the materials themselves even to items like torque. "We record the torque it takes to turn every component," says Turner. "Anything that moves and we record the torque. Nothing is missed out so that we have a full and comprehensive record of every engine that goes through our hands."

The wire harnessing is done in-house. "Often in projects you find the wiring guy blames the engine guy for providing the wiring information, so we avoid all that by doing it ourselves," he explains. "We also record everything and have a very comprehensive operations manual. It takes us longer to do the work but the way we do it is of benefit later."

Quite what the cyclists of the Army Bicycle Section or the ladies who packed the 'Beach Maintenance Packs' in preparation for D-Day would think, we can only guess. Hopefully they would applaud the craftsmanship that continues in the same location where they did their duty for their country. HRT

Ultimate Velocity the Aim



In what can only be described as a monumental piece of work from the renowned automotive historian **Karl Ludvigsen**, Reid Railton Man of Speed has just been published by EVRO Publishing. We are privileged to be allowed to publish just a small extract from the book to give you a flavour of what is an extraordinary story by an extraordinary storyteller. A review of the book continues after this extract.

Esemplastic *— having the ability to shape diverse elements or concepts into a unified whole: the esemplastic power of a great mind to simplify the difficult. The word is not in Johnson nor have I met with it elsewhere. I coined it myself!*— **Samuel Taylor Coleridge**

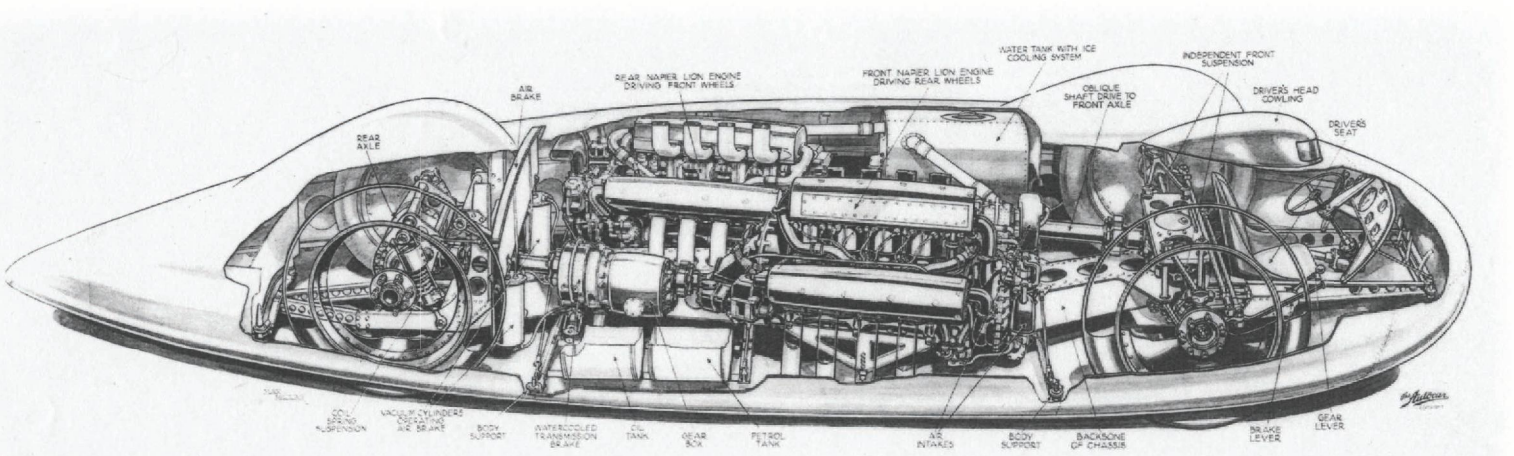
When John Cobb walked into Reid Railton's office at Thomson & Taylor in October 1935 he found the engineer sketching the hull plans of Campbell's new Blue Bird K3 record boat. As usual Sir Malcolm had stressed the need for economy. 'Looking after the purse strings again?' said a smiling Cobb. He knew how manfully his friend had to struggle with the costs and adaptations of Campbell's speed-record vehicles. Reg Beauchamp recalled the occasion:

"Cobb leaned back against a drawing cabinet, hands deep in the pockets of his long coat, looked across the desk and said, 'Look, if you had a reasonable amount to play with, what would you need to come up with something to raise the land-speed record?' Reid leaned back in his chair, cupped his hands behind his head and sort of looked at Mr Cobb from under his eyebrows and said, 'A clean sheet of paper would come as a breath of fresh air, if you're serious.' I think we had four or five sketches done before they left for lunch."

Some time elapsed before Railton delved into the detail of this new land-speed contender for John Cobb. Campbell's boat was a priority while Cobb was still breaking records with his Napier-Railton. We may also assume that Cobb needed time to set aside the necessary cash. Not until early 1937 did Reid's design notebook begin filling up with sketches and calculations for the new car's components and systems. All T&T's drawings carried a 'Q' prefix for what it listed as Project Q-5000.

In the meantime Reid Railton's grey matter fizzed with ideas for his perfect record-breaker. Indeed, for the first time since Cobb's Napier-Railton 'a clean sheet of paper' awaited his inspirations. As he well knew, the category imposed few constraints. "It is interesting to note the criteria for the land-speed record as determined by the international governing body, "Railton remarked many years later. "First off, the car must have four wheels. Second, the car must be propelled by the wheels, not by a jet engine for instance. Third, the car must make two runs in opposite directions to avoid the possibility of help from any wind that might happen to be blowing. Lastly, the car must complete both runs within one hour."

In his design for John Cobb, Railton faced only one constraint. The car's engines were a given. Reid knew them well. They were a pair of supercharged W-12 Napier Lions, the same Type VIID that Railton had installed in Campbell's Blue Bird III. Twenty years old by the time Cobb used them, the two twelves were a present from Marion Barbara 'Betty' Carstairs after she gave up powerboat racing in 1930. Reportedly costing $75,000, equivalent to almost £16,000, the two of them she used to power her Harmsworth Trophy motorboat Estelle V were the engines gifted to Cobb.(The fabulously wealthy Standard Oil heiress could easily afford to make a present of the engines.) Cobb would have to muster the funding for overhauls and modifications. With each Napier capable of more than 1,200 bhp, Cobb and Railton could count on nearly 2,500 bhp for their record challenge.



ABOVE When viewed as a whole it is possible to grasp the concept of Cobb's new Railton Special. How she got that way is a saga as fascinating as the vehicle itself

Years earlier Reid Railton had decided on one major feature of his record-breaker. Sir Malcolm's struggles on the Daytona Beach sand convinced the engineer that rear-wheel drive was no longer adequate to power a car to the speeds needed to set new records. He had given Blue Bird V double rear wheels and tyres to enhance the traction of that big and heavy machine. "In fact, "Railton remarked, "it seems probable that 300 mph represents somewhere about the limit of what is likely to be achieved with two-wheel drive."

Existing land-speed-record challengers, added Railton, "have already approached the point where it takes all the available adhesion of the driving wheels to propel the car against the enormous wind resistance, even though that resistance is reduced as much as possible by streamlining. In order to get the friction necessary to transmit the large powers used, the driving wheels have to be heavily weighted down, thus adding to the difficulties of the already hard-pressed tyres.

"With two-wheel drive," Reid explained, "only a little more than half the total weight of the vehicle is on the driving axle and available to provide the frictional grip, or adhesion, to propel the car. If, on the other hand, all four wheels are driven, the whole weight of the car is available for adhesion and the engine can develop nearly twice as much horsepower without wheel slip. If four-wheel drive were employed, the total weight of the vehicle could be reduced and its acceleration and the life of the tyres improved.

"There are no special mechanical difficulties that have not already been fairly satisfactorily overcome in existing front-wheel drive cars, "Railton elaborated. "It is, of course, necessary to provide some form of differential gear between the front and rear driving members as, on turning a corner, the front wheels travel farther than the rear wheels, in the same way that the outer wheels travel farther than the inner ones. The construction is almost bound to be heavier than the orthodox type, a drawback which, in conjunction with the slight loss of power in the extra gearing, might be felt appreciably at the higher speeds."

Here Reid Railton played a card that drew gasps of admiration from his contemporaries. He omitted this inter-axle differential gear entirely. Taking advantage of his two engines, he assigned each to the driving of a given axle. The connection between them was the road. Otherwise they functioned entirely autonomously. The penalty of this was small in the form of the car's need for two gearboxes, one ▶



ABOVE Reid Railton, engineer extraordinaire

for each drive train, and the associated duplication of controls — which would have been needed anyway.

How these components were arranged was a function less of mechanical engineering than of esemplastics as defined in Coleridge's epigram heading this chapter. That Reid Railton was capable of such profound thinking was convincingly illustrated by Project Q-5000, which was designed not from the inside but from the outside. "The final body shape, " he explained, "is determined by wind tunnel experiments to make sure that it offers the least possible resistance to the air. The air resistance is in fact enormous at full speed, but even so it only represents about half of the total forces holding the car back.

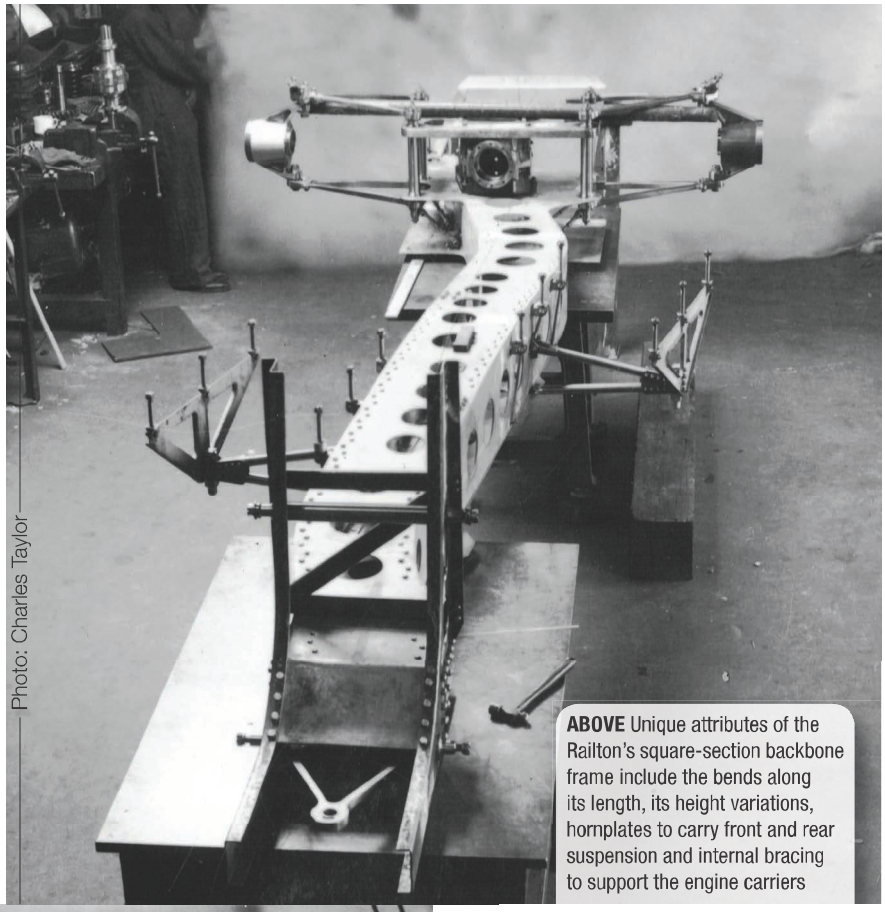


Photo: Charles Taylor

ABOVE Unique attributes of the Railton's square-section backbone frame include the bends along its length, its height variations, hornplates to carry front and rear suspension and internal bracing to support the engine carriers

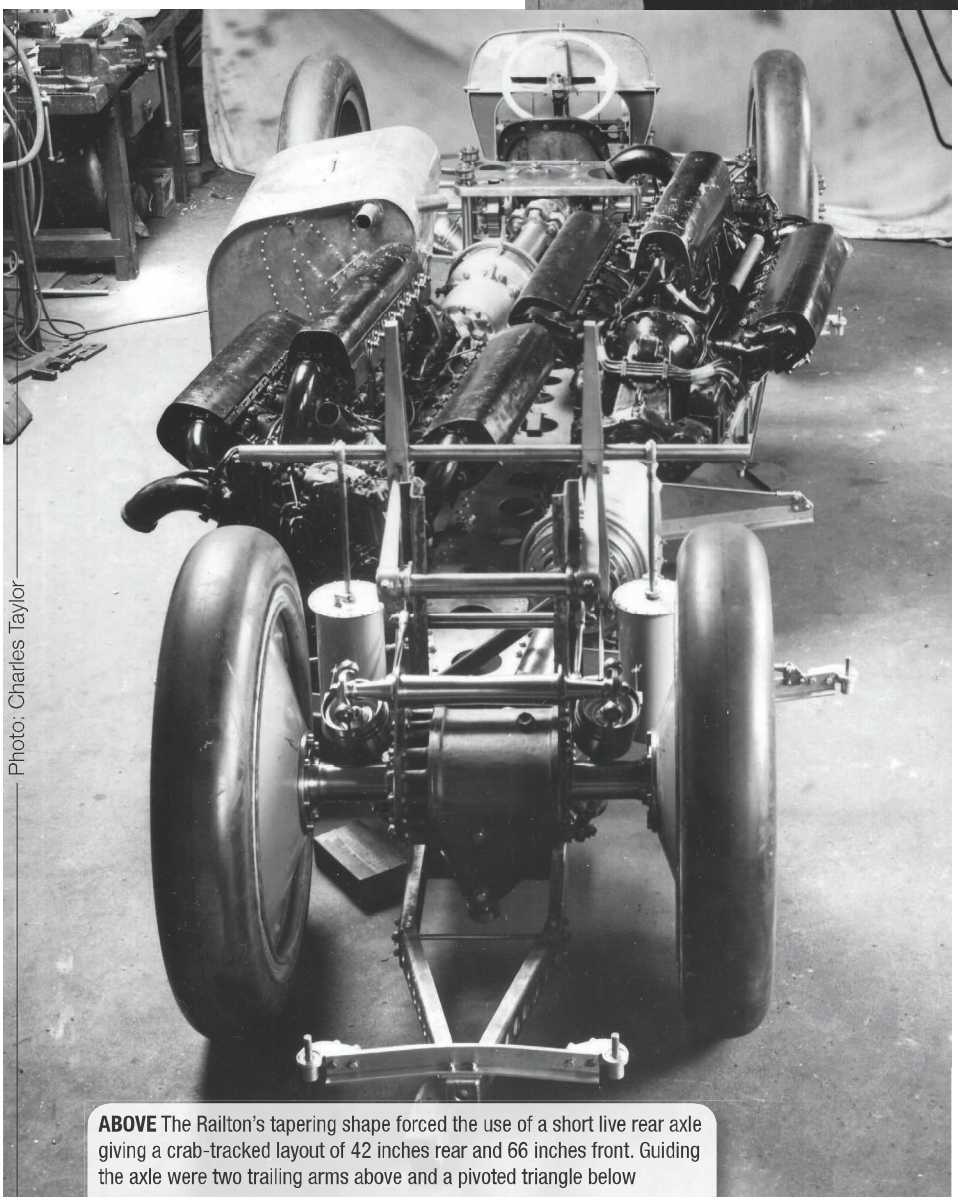


Photo: Charles Taylor

ABOVE The Railton's tapering shape forced the use of a short live rear axle giving a crab-tracked layout of 42 inches rear and 66 inches front. Guiding the axle were two trailing arms above and a pivoted triangle below

"The rest," Railton added, "arises chiefly from the rolling resistance of the tyres. In other words, the force required to keep the wheels rolling along the track. For reasons that are not fully understood the rolling resistance increases very rapidly with the speed. To roll a pneumatic tyre along at 300 mph requires about 25 times the power required at 60 mph. This big factor of rolling resistance also varies with the weight on the tyre. It is for this reason that it is extremely important to keep the car as light as possible.

"Surprisingly little is known," Reid continued, "of either the nature or the amount of the rolling resistance at high speeds. Combined aerodynamic drag and rolling resistance can be assessed from car performance but separating the two is a problem. Forecasting them in the design stage is yet more difficult. We do know that rolling resistance of a tyre on the point of disintegrating, due to excessive speed and load, increases enormously. It's also known that going to the maximum inflation pressure the material can take minimises both disintegrating tendencies and rolling resistance."

Five scale models were produced to be wind tunnel tested. "Thomson & Taylor gave them evocative names," said Ayers: "Cigar, Three-wheeler (which is baffling as that wouldn't have been ▶

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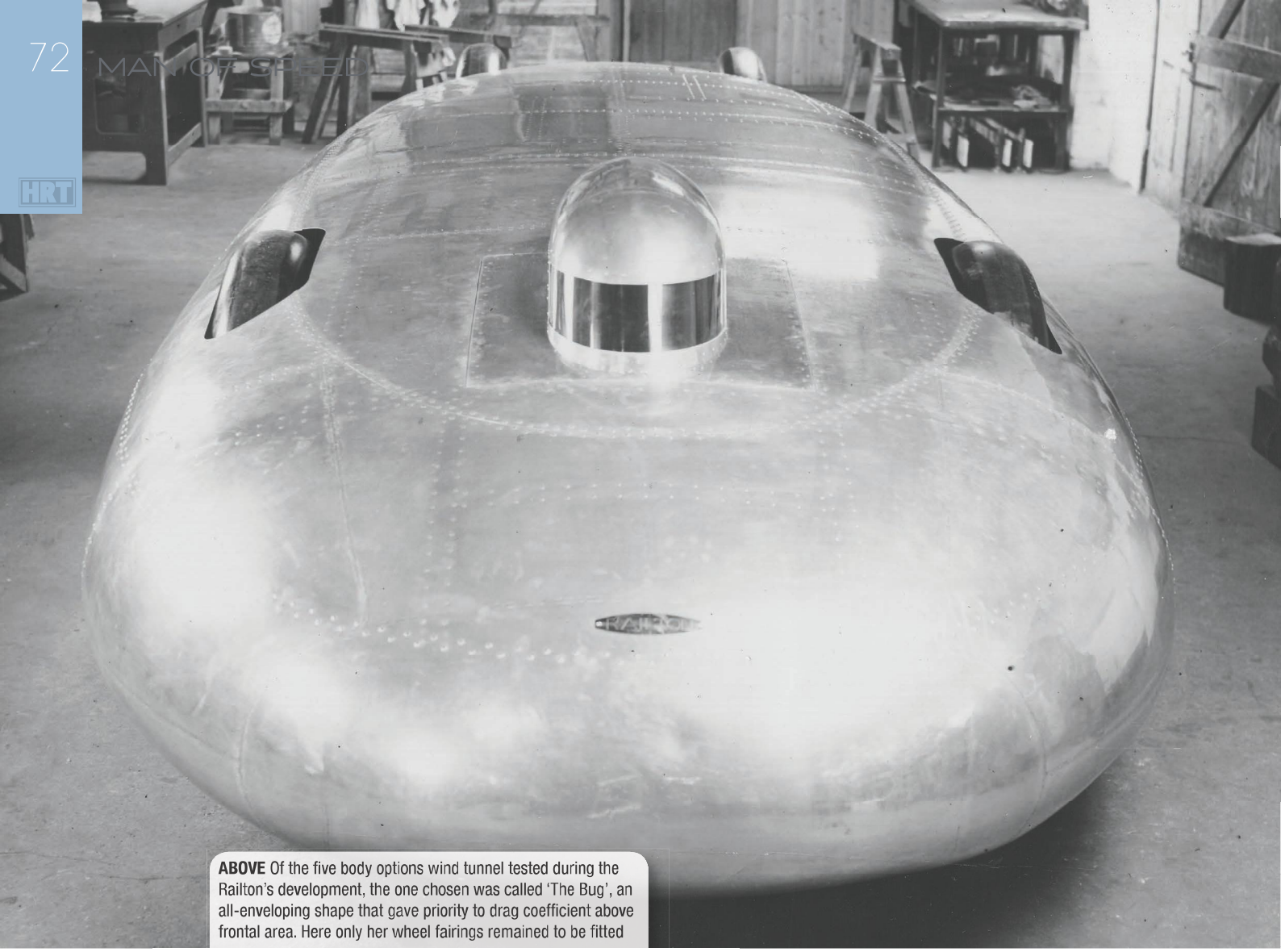


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ABOVE Of the five body options wind tunnel tested during the Railton's development, the one chosen was called 'The Bug', an all-enveloping shape that gave priority to drag coefficient above frontal area. Here only her wheel fairings remained to be fitted

legal), BB with Troughs (BB is clearly Blue Bird; troughs I interpret as making it look like Golden Arrow), Long Tail (which I can't quite envisage) and The Bun. The last was chosen because although it did not have the smallest frontal area it had by far the smallest surface area and, therefore, the lowest skin friction."

As if to test these widely varying concepts in neutral territory, during 1937 Railton left Brooklands to subject them to the rigours of one of the wind tunnels at Teddington's National Physical Laboratory, where a maximum speed of 75 mph gave a good indication of the relative drag of the respective models. The chosen design was a variation of The Bun, a shape that had no precedent in the making of automobiles and few in any other genre. The nearest might be in nature, where the pumpkin seed perhaps comes closest to the exquisite contours of the body of Cobb's machine. Only five blisters marred its surface — four for the wheels and one for the driver.

Inside his pumpkin seed Reid Railton had to arrange its machinery in a suitable manner. One approach would be to place the two Napiers in line, each driving its own axle, with the driver between them. However, this would have lengthened the wheelbase to an ungainly degree and increased the car's weight. In the latter respect Reid had to heed strictures from Fort Dunlop concerning the poundage that each of its tyres could bear.

In fact the issue of tyre capability was the first that Railton addressed when he began work on Q-5000, said Dunlop's David McDonald: "Strangely enough, Reid Railton had begun with the tyres when he designed Cobb's car. He went first to our research people who laid down very strict limits for the weight to be carried by each wheel. The total they specified for four wheels was, fortunately, in accord with the engines and other equipment the designer was planning to use. So he went ahead and designed the vehicle."



ABOVE John Cobb poses during the press launch of his new land-speed-record contender in April 1938

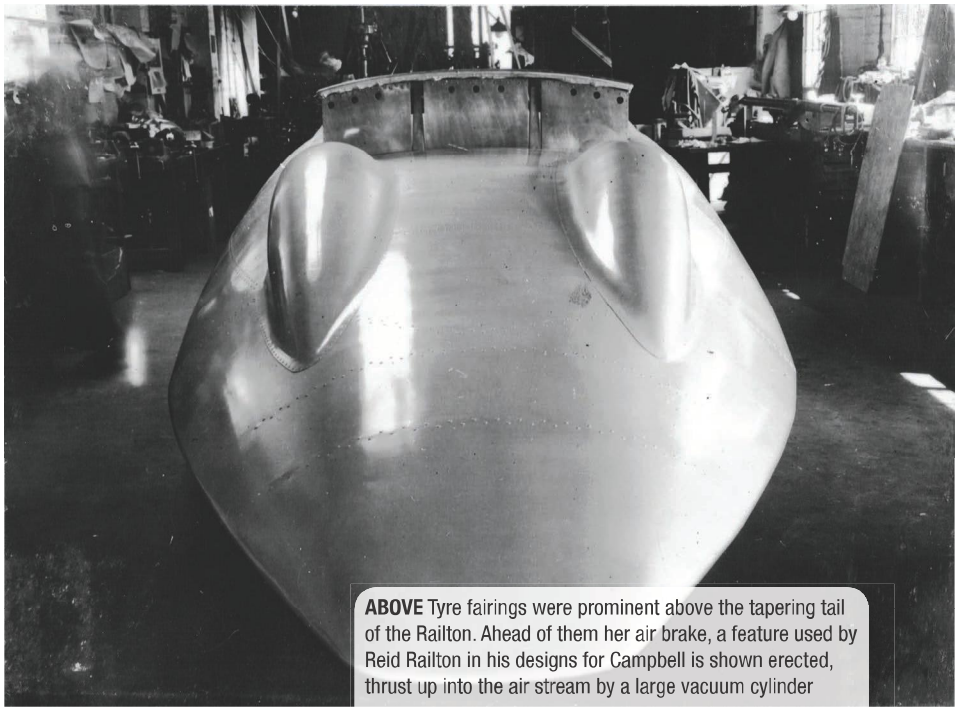
"In order to use four tyres only," said Railton, "the weight of the car dry, but with the body in position, had to be held to 7,000 pounds."

The actual layout was the result of multiple breakthroughs in Reid Railton's thinking — an esemplastic exercise of the first magnitude. Placing the two Napier Lions side by side might have worked; George Eyston did this with Rolls-Royce V-12s in his rival Thunderbolt. But the drive arrangements to all four wheels would have been a nightmare, heavy and complex.

Manipulating the elements in his mind and on paper, Railton juggled the

engines into their novel positions. One was slightly behind the other with both of them angled ten degrees to the right. The rearmost W-12, on the left side of the chassis, drove the front wheels while its sister on the right propelled the rear wheels. This arrangement left gaps along the flanks to accommodate tanks of oil, water/ice and petrol. It also had the advantage that the engines' crankshafts were rotating in opposite directions, their gyroscopic effects cancelling each other and enhancing the car's steady handling.

Each engine propelled the Q-car through its own drive train, from transmission through to final-drive gears and thence to a pair of road wheels. The only interconnections were throttle controls and transmission shifters. Co-ordination of engine speeds was by means of the roadway on which the vehicle ran; no other linkage between the power units was in effect. Nor was there any doubt about what roadway would be used. Campbell's success in 1935 had marked Bonneville as by far the best venue for a Land Speed Record challenge.



ABOVE Tyre fairings were prominent above the tapering tail of the Railton. Ahead of them her air brake, a feature used by Reid Railton in his designs for Campbell is shown erected, thrust up into the air stream by a large vacuum cylinder

EDITOR'S NOTE:

John Cobb broke the Land Speed Record three times in this car, in 1938 (353.30 mph/568.58 km/h), 1939 (369.74 mph/594.97 km/h) and 1947 (394.196 mph/634.398 km/h).

On 15 September, 1938, he became the first driver to exceed 350 mph (560 km/h) but the record stood for just one day as it was recaptured by George Eyston the following day in Thunderbolt. On 23 August, 1939, Cobb re-took the record and was the last piston-engined car to hold the 'fastest-ever title' at that speed.

In 1947, Cobb set a new record in the renamed Railton Mobil Special following sponsorship from the oil company. Although it was below 400 mph, he achieved 403.135 mph/648.781 km/h) on one of the timed runs, the first car to have beaten that barrier. HRT

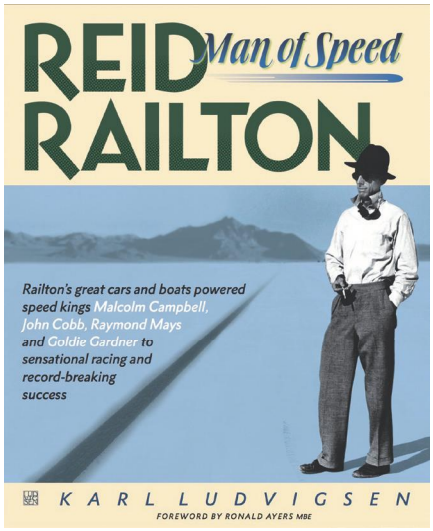
Photo: Charles Taylor



ABOVE At the roll-out of the Railton a contrast with an Austin Seven was amusing. At the centre, John Cobb is speaking with Reid Railton , almost hidden but with hat and cigarette visible. The car has an open-top conning tower that saw brief use during early testing

Reid Railton

Man of Speed
Karl Ludvigsen
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ISBN 978-1-910505-25-0
2 volumes/848 pages
£150.00/$220.00



OVER the last few years since reviewing books for *Historic Racing Technology*, we have received into the office some truly magnificent books. We may live in the digital age but we are blessed with book publishers who persevere and produce some of the best quality books ever seen.

The latest to arrive, though, literally takes your breath away on all levels. Karl Ludvigsen, the American author who lives in the UK, is unquestionably one of the finest automotive historians ever. The quality of his research and writing are nothing short of brilliant. Whatever he turns his attention to you know he will deliver.

His latest tour de force, and I don't use that phrase lightly, is a 2-volume biography on Reid Railton whom Ron Ayers, chief aerodynamicist of the Bloodhound SSC record car, claims is the best automobile designer of any generation. I would also add the word engineer.

Furthermore, EVRO Publishing has done Ludvigsen's work proud. The book itself reeks of quality in terms of production, layout and design. It's a book you just have to read even though it's heavy on the arms.

As no doubt you will have noticed, we have included a very short extract preceding this review, but it's only the smallest of hors d'oeuvres and can only give the merest hint of what lies between the four covers.

What is also inspirational about this book(s) is the subject himself. Without this publication, it is quite possible that Reid Railton would have slipped from view and what he achieved lost and his name forgotten. Ludvigsen has firmly brought him back and placed him on the pedestal where he belongs.

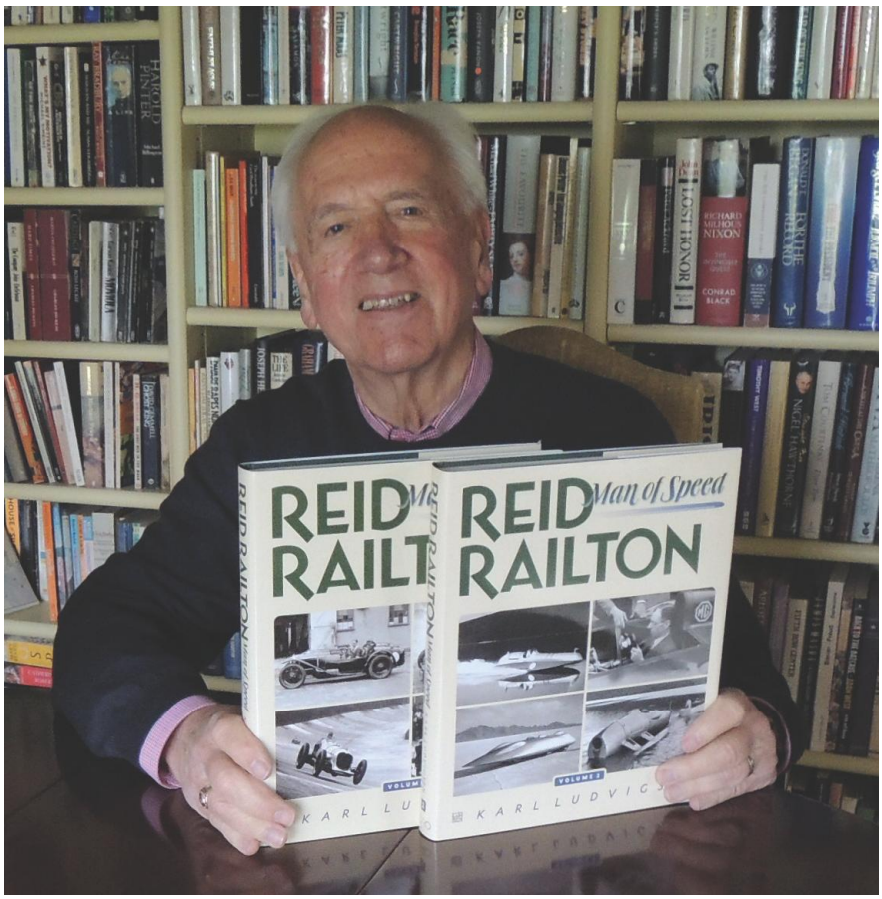
There is just so much to read in this book that it's almost unfair to single out anecdotes. There's the Railton car itself, which a *Motor Sport* review of the time praises to the hilt, but as Ayers points out in his Foreword, it's his design of world land speed record cars for which he is best remembered.

However, he was involved in other projects. One was the record breaking MG EX 135, and if you think removing the steering wheel is a relatively modern phenomenon, think again, because there is a picture of Railton sitting in the car with a removable steering wheel in his hands.

I also love the introduction to this chapter, which I think applies today more than ever. "It is primarily the human appeal of the sporting element in racing that provides the incentive for development work. The harassed executive, worn out with the endless worries of his ordinary routine, turns with relief and genuine keenness to the consideration of his racing programme" - Reid Railton.

I think those words should be imprinted on the foreheads of some people who run some contemporary racing programmes and championships.

I have probably been gushing too much about the book, and I appreciate it is expensive, but I do urge those of you who not only like motoring history but also appreciate fine research and writing, along with superior production values to buy it as you will be very well rewarded. Just think of it as filling up your car with fuel two or three times and the sting of the price will be reduced. HRT





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