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# A bright future

**THE** 2015 season has now well and truly arrived. Last month's Goodwood Member's Meeting provided a spectacular curtain raiser to the UK season, confirming the recently revived event's status as one of the best in the world. As I type, the Donnington Historic Festival is fast approaching in the Midlands, closely followed – in somewhat more exotic surroundings – by the Targa Tasmania, and of course the Mille Miglia.

Later on this summer, the SVRA's Brickyard Invitational returns to the hallowed ground of Indianapolis Motor Speedway after its triumphant debut in 2014. Closer to home, Chateau Impney in Worcestershire is set to echo to the sound of racing cars for the first time since 1967, while the Silverstone Classic (originally known as the Coys Historic Festival) celebrates its landmark 25th anniversary.

In short, historic motorsport is booming. Cars unseen for decades are coming out of the woodwork and there's an ever growing list of brilliantly run national and international level events.

We're also celebrating our own little milestone here at *Historic Racing Technology*. In theory, issue four marks the magazine's first birthday, although due to the various quirks of our publishing schedule we've actually ended up a couple of months ahead of ourselves.

Just occasionally the concept of modern engineering in or around historic cars still raises a few eyebrows. If you ever needed proof of how the two can sit side-by-side then look no further than the various articles we have on 3D printing and reverse engineering in this issue. Paul Foreman's Porsche Spyder replica, for example, used a digital scan of an original RS60 body to generate a CAD model followed by a CNC-cut buck, but the end result was built using traditional panel shaping techniques.

A year on, I'm proud to say the concept of *Historic Racing Technology* is more relevant than ever. HRT

**Chris Pickering**
**Editor**

NEWS

# Housing threat to Goodwood?

By **Andrew Charman**

**THE** future of Goodwood circuit, regarded by many as Britain's home of historic motorsport, could be under threat if a developer is allowed to build 300 homes within half a mile of the Sussex track.

That's the view of the Goodwood Estate, which manages both the circuit – home of top historic events the Revival and the Members' Meeting as well as a regular testing venue – and the hillclimb at Goodwood House on which is staged the annual Festival of Speed.

The Estate has formerly objected to a new proposal by Commercial Estates Group (CEG) to build homes around Madgwick Lane at Westhampnett, close to the circuit and airfield.

The new plan is a reduced version of an earlier proposal by CEG for 350 homes but the Goodwood Estate believes its future viability could be threatened by residents moving into the houses and then complaining about noise from the circuit, forcing the local council to issue noise abatement orders.

In a letter regarding the development Terence O'Rourke, Goodwood's planning advisor, emphasizes the employment that the Estate brings to the local area and describes the scheme as 'in the wrong location, poorly thought out and planned'.

He adds that the development would be 'harmful to the future economic, social and environmental interests of the district, and importantly to the setting of the Goodwood Estate.

'The proximity of the site to the motor circuit remains a concern and the reduction in numbers will still mean that there is a sizeable new population created, close to the motor circuit, that may complain regarding the noise,' the letter adds.

Goodwood, along with Rolls-Royce Motor Cars which has its factory adjacent to the circuit, has previously objected to proposals in the Chichester Local Plan which included strategic housing allocation on land in the vicinity. HRT

Goodwood Motor Circuit


**BELOW** Under threat? Goodwood believes that scenes such as this, at the 73rd Members' Meeting, could be lost if housing proposals go ahead


**ABOVE** Transatlantic BTCC battles will be recalled in the HRDC's races

# Races recall BTCC's pioneering years

By **Andrew Charman**

**THE** Historic Racing Drivers Club is planning to stage two races this season recalling what it describes as the pioneering years of Britain's premier saloon series, the British Touring Car Championship.

Dubbed 'The History of the BTCC 1958-1966' the two races will take place on 25th April at Silverstone as a support to the Britcar24 event, and at the Donington Park Historic Festival on 3rd May.

The races have resulted from a successful inaugural event to the format at last year's Donington Historic Festival, where the 36-car grid was over subscribed despite only being announced at five weeks' notice.

Pre-1960 cars will be drawn from the HRDC's 'Touring Greats' Series and entries already confirmed include ex-BTCC star Mike Jordan's rapid Austin A40 (emulating 1950s star Doc Shepherd's A40) and 1990 BTCC Champion Robb Gravett, sharing the drive with his son Bradley, in an HRDC Academy Austin A35 that recalls Graham Hill's 'Speedwell' entry.

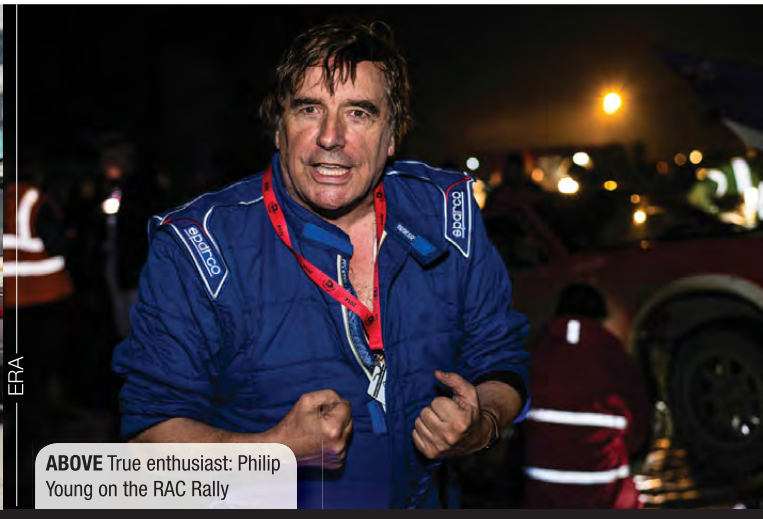
Later-era cars will are expected to revive the battles between Mustangs, Galaxies, Cortinas, Jaguars and Minis which marked out the BTCC as a perennial crowd-pleasing championship.

HRDC Race Director and *HRT* columnist Julius Thurgood is hopeful the format can be built into a full-blown HRDC series. "When I was approached by the organisers of the Donington Historic Festival in 2014 to come up with a twist on the historic touring car race format, I immediately proposed this homage to the early years of the BTCC, which after all created some of the most memorable touring car battles of all time," he said.

"Feedback after the race was so positive that I took the decision to run two races in 2015, with an ongoing view to building the format into a regular HRDC Series". HRT


**BELOW** Philip Young (standing by car) at the Thailand to Burma border crossing





**ABOVE** True enthusiast: Philip Young on the RAC Rally



# Rally stalwart dies after motorcycle crash

**HISTORIC** rallying is mourning the death of Philip Young, founder of the Endurance Rallying Association and the man behind the revival of the Peking to Paris Motor Challenge, described as one of the world's most epic motoring adventures.

Young died in hospital in Bangkok, Burma on 11th March following complications arising from a motorcycle accident suffered on the Road to Mandalay event in February. He was 67 years old.

In a statement paying tribute to its founder, the ERA described him as a "prolific ambassador of the historic rally movement" and "a larger-than-life character who pushed motorsport boundaries, organising marathon and endurance rallies all over the globe".

Young was a founder of the Historic Rally Car Register, and set a world record for driving from Cape Town to London in ten-and-a-half days. He was making achievements right up to his death, gaining permission for 70 rally crews to be the first to cross the land border from Thailand into Burma.

A memorial service celebrating Young's life is expected to be held in the near future and the Endurance Rallying Association has confirmed that its planned 2015 events will continue in his memory. HRT

# Historic hill climb returns

By **Chris Pickering**

**MOTORSPORT** returns to Chateau Impney on 11th-12th July, following an absence of nearly half a century. The picturesque Midlands venue hosted hill climbs from 1957 to 1967, with thousands of spectators lining the twisting 550 yard course.

The new event uses a significantly longer MSA-approved layout, which shares only its start straight with the original course. It's open to pre-1967 cars, with entry currently by invitation only. Cars and drivers will be selected on historical significance and connections to the original Chateau Impney events.

A diverse array of machinery has already been confirmed, ranging from a 1909 Lorraine De Dietrich to a collection of C and D-Type Jaguars. More than half the world's surviving ERAs are also due to take part in what is shaping up to be a very competitive event.

The organisers hope to attract 10,000 spectators across the weekend to the parkland setting. As well as a wealth of motorsport action, there will be a host of other attractions, including a concours d'elegance, a trading zone with over 100 dealer and trade stands and a major classic car auction, hosted by H&H Classics. HRT

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# FIA issues series updates

**SEVERAL** historic series run by the FIA have been affected by decisions approved by its World Motorsport Council, meeting in Geneva on 21st March.

To increase safety and entertainment in the Masters Historic Formula One series each car is to have its permitted tyre allocation doubled from four to eight.

Efforts to maintain the historical integrity of the Lurani Trophy for Formula Junior Cars have seen the banning of the use of data acquisition systems in the cars.

Meanwhile competitors struggling to fit modern seatbelt systems with five or six mounting points into historic cars may be permitted to use four-point systems following a change in the Appendix K regulations for cars competing in international historic competition. HRT


# Jim Clark tribute at Indianapolis

By **Chris Pickering**

**THE** Sportscar Vintage Racing Association (SVRA) is to honour Jim Clark at its annual Brickyard Invitational event at the Indianapolis Motor Speedway on 11th-14th June. The tribute marks 50 years since 'The Flying Scot' triumphed at the Indy 500 in the Lotus 38.

Clark's victory was the first for a mid-engined car and the first time since 1916 that a non-American had scooped the top spot. It came at the peak of his career, the same year he clinched his second Formula One World Drivers' Championship crown.

Details of the tribute had yet to be announced as HRT went to press, but it is set to include an array of Clark's Indy 500 cars, including the Lotus 29 in which he won Rookie of The Year in 1963, his 1965 winner and the Lotus Turbine car that he tested at Indianapolis in 1968, just weeks before his fatal crash at Hockenheim.

The Jim Clark tribute comes as part of a four-day festival of motorsport, with racing cars spanning over 100 years of competition taking to the track. Both the road and oval courses at Indianapolis will be in use, hosting 11 different classes, covering all manner of sports cars, touring cars and single seaters. HRT

# Clubmans gears up for golden anniversary

**THE** 50th anniversary of Clubmans formula racing will be celebrated in 2015 with separate events organised by the two clubs racing the cars today.

The formula was created in 1965 by Nick Syrett of the British Racing & Sports Car Club and the Clubman's Register, as a low-cost category for two-seater open-top front-engined sports cars.

Initially races were dominated by Colin Chapman's Lotus 7 and the ubiquitous U2 of Arthur Mallock, and the category then evolved into a reasonably technical slicks and wings formula, with Mallock cars remaining the constant factor for many years.

The HSCC Classic Clubmans will celebrate the anniversary at Snetterton on 13th-14th June as part of the Autosport 3-hour meeting. The Clubman's Register will have its own celebration and has also released anniversary merchandise.

The Register is also inviting all those involved in the category over the past half century to get involved in the celebrations – more information is at www.clubmans.org.uk HRT

# IN BRIEF

**THE** MSA has reminded competitors in historic rallying that only components of a type used in a car's original period of competition are permitted, after suggestions that dampers of a more recent type were allowed by the FIA's Appendix K regulations.

**THE** iconic central feature at the 2015 Goodwood Festival of Speed on 25th-28th June will honour Mazda and the Japanese brand's innovative motorsport achievements, and in particular the rotary-engined Mazda 787B that won the Le Mans 24-hours in 1991. The design of the Mazda-themed central sculpture on the lawn outside Goodwood House will be revealed closer to the event.

**ATL** has been announced as the fuel tank supplier for Jaguar's Lightweight E-Type continuation models. An FT3-spec bag tank will be supplied on all cars, set inside a period-correct aluminium tank made to the original pattern by RS Panels.

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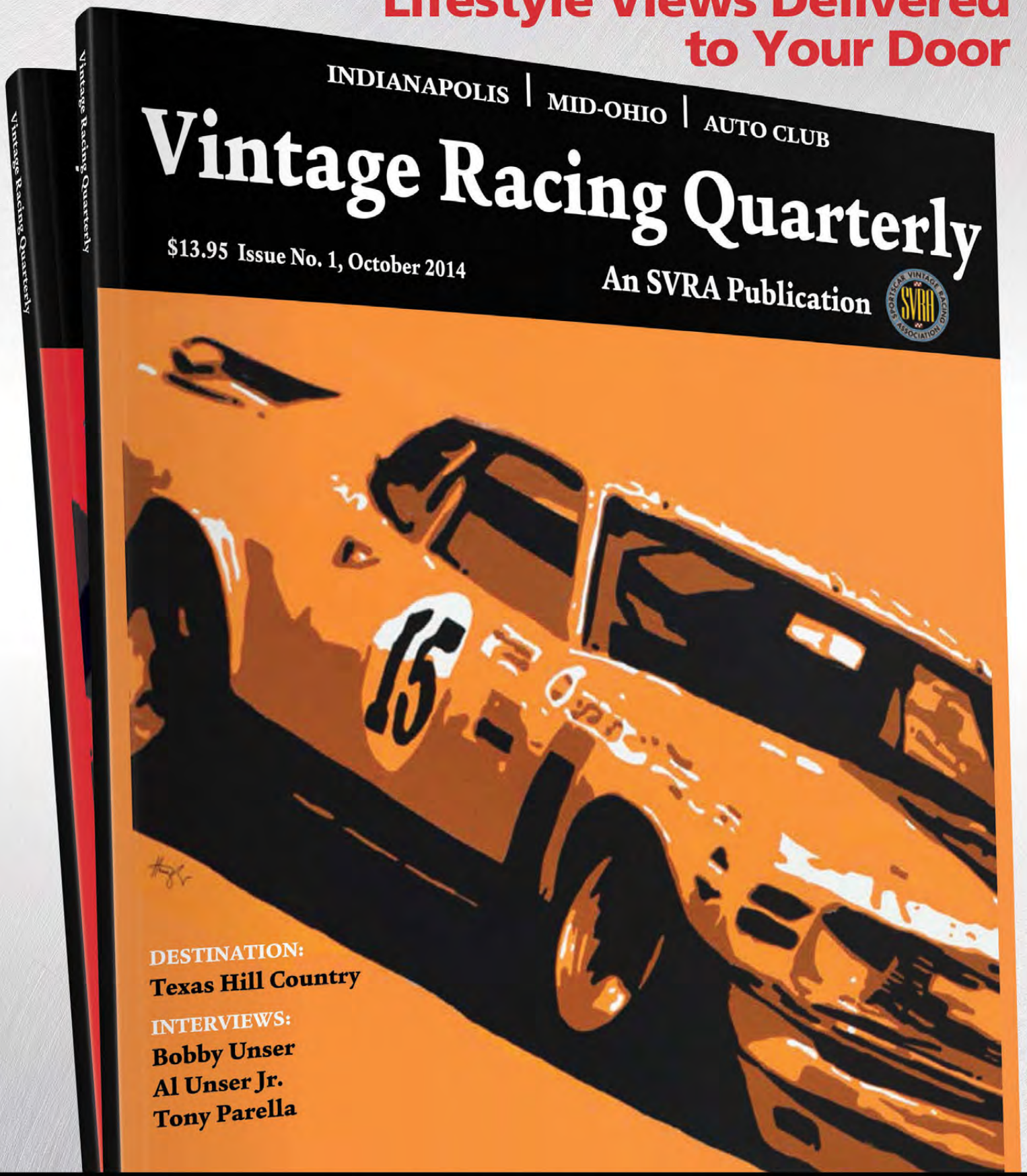



***Vintage Racing Quarterly*** celebrates the SVRA lifestyle at its best. ***VRQ*** offers quality photography and editorial about the cars, events and lifestyle of SVRA members and the sport of vintage racing in the US. It also delivers a unique look at the broad activities and interest of vintage racers: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

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

YouTube SVRA.com

# Back to The Future

With governing bodies getting wise to ever more extreme modifications, **Julius Thurgood** believes an eligibility clampdown is on the cards

**I**N the early 1980s, most historic touring cars were fairly standard bits of kit. From a performance standpoint, often armed with no more than a change of camshafts, some stiffer springs and a LSD, you could go racing on a small budget and, as long as the races were little more than 10-lappers, you had a good chance of finishing. Back then the car offering an obvious advantage was the Lotus Cortina Mk 1.

The Cortina was already a great package and when enhanced by the Lotus-derived Twin Cam Ford unit, which was gainfully employed in multiple applications – from sports cars to stock cars – it soon became a weapon of choice. Engine development was ongoing and, in the process, so came reliability.

As historic race formats evolved in favour of longer races – the Lotus Cortinas coped better than most due to the established development and so further endorsed its choice on the basis 'in order to win, first you must finish' – soon the grids were swamped with Lotus Cortinas and from there the race was on to 'develop or die'.

Within a decade, cylinder heads were re-cast, machining was to F1 tolerances and materials had no limit on expenditure. The Lotus Twin Cam's power output went from a 'period' 150 bhp to more than 180 bhp and yet – if your budget could stand it – the reliability was still there. Thus, for the preparers, it then soon became another race altogether; not for horsepower, but for handling.

As other makes and models caught up in the power and reliability stakes, cars started to adopt a stance altogether removed from that applied in-period and it is from here that 'development' has overtaken originality. Looking across any historic paddock nowadays there now seems to be an anomaly with historic race cars adopting oddly aligned wheels and adverse camber angles. When one references the cars that raced in period, it is clear that many of today's cars eschew period technology. Hidden development is now the norm; spring rates are progressive, ride heights incorporate 'zero droop', shock absorber technology encompasses properties never dreamed of in the 1960s. The list is endless as cutting edge technology is applied to problems that were basically inherent with old cars.

Such has the race for ultimate development come to pass that if we could load a Tardis with a competent historic driver in a 'modern' historic Lotus Cortina and whisk it back in time to a saloon car race in the sixties with the likes of Clark, Whitmore and Sears driving apparently the same equipment, I know that history would be re-written – and by some considerable margin.

I am all for reliability and competition in historic racing. They have to go hand-in-hand in order for the sport to survive. In our modern world, time is a precious commodity, therefore spoiling one's experience through unreliability of equipment is a factor that is now no longer acceptable. However re-inventing the wheel in an arena that pays homage to the past is a process that surely should not be condoned, although it appears to be at an epidemic level despite cars being required to conform to period homologation.

With such modern technology, however innovative, improperly applied to historic race cars, there is bound to be a backlash – and I firmly believe that draconian measures to counteract such practice are just around the corner. Ruling bodies and organisers are now aware that the specifications of historic cars are being changed after being awarded HTP (Historic Technical Passports) as there is presently little fear of being brought to task due to lax eligibility controls. That is hopefully soon to change. The onward issue is how to save the marriage between the advantages brought through modern technology and period values? Perhaps we need to go back to ensure the future. HRT


**ABOVE** Even the great Jim Clark would have struggled against a 'modern' Cortina

# A show of HANS

## Head and neck restraints are becoming mandatory in modern motorsport but, asks **Mark Hales**, are they the answer for historics?

**EARLIER** this year we learnt that the HANS device, which has been mandatory for a while in the upper levels of motorsport, will be required for all race drivers from 2016, with the exception of 'period defined' vehicles or historics where it will remain a recommendation. HANS is an acronym for Head and Neck Support and it is a strange carbon-fibre yoke, rather like a monkey on your shoulders, connected by webbing straps to your helmet and designed to prevent the head going forward in a sudden frontal impact.

Shortly before the new millennium, researchers in America charged with safety in NASCAR – where you are more likely to charge a concrete wall than anywhere else – discovered that fatalities in a great many such impacts were caused because the head (already the heaviest part of the body, plus the weight of a helmet) goes forward with such force that it breaks the vertebra at the top of the spine and severs the spinal cord. The driver appears otherwise completely uninjured but the internal consequences are catastrophic. This, I believe, is what happened to NASCAR ironman Dale Earnhardt in 2001.

Earnhardt might be alive today had he been wearing a HANS, but the logic is already compelling. The straps restrain the head while the yoke spreads the load down your chest. Now, NASCAR and Formula 1 and the rest of professional motorsport are a long way from the historic events which I hope will continue to occupy a few weekends in my year, but I do own a HANS device. I can't say I bought it willingly (they cost well over £500 and that was a few years ago) because the owner of the Crossle-BMW that I was sharing on a regular basis had decided it was a good idea and since the device works only when combined with the correct width of seat belts, I had no choice. We were also told as long ago as 2008 that HANS devices would soon be mandatory, but this is where it gets complicated.


**ABOVE** HANS devices are mandatory in modern F1

Some time ago, the FIA's Max Mosley asked former Lotus team manager Peter Wright to investigate the relevance of the HANS device for historic motorsport. Wright spent enough time in Formula 1 when it was dangerous to know a thing or two about the need for safety but following a wander round the paddock at that year's Monaco Historique event he reckoned that whilst a correctly fitted HANS device could never do any harm, he could find no reason to insist on them for drivers of historic cars.

The device is designed to defend against a 40 g shunt, and works in conjunction with a crashbox – like that mandated by the FIA for modern race cars – which absorbs something like 20 g in about 20 milliseconds and allows the HANS to protect the driver from the rest. It definitely works because drivers do walk away, and the carbonfibre tub is usually reusable. Wright was only stating the unpalatable, which is that nothing historic is likely to withstand a 40 g shunt.

### SIMPLE STEPS TO SAVE A DRIVER

Perhaps more important then, he said that there were so many other simple things that could be done to save a driver from needless injury without spoiling the car's originality – things which might not seem obvious until someone pointed them out. The suggestion was that a common sense briefing booklet – a sort of Safety Sense checklist like you get in aviation – be sent out with your licence, pointing out the obvious and the not so obvious. Small things I know, but I haven't seen one yet.

I'm not suggesting for a moment that we neglect safety because a car is old and already dangerous. I choose to wear my HANS device when I drive a Classic Clubmans car, crashbox or no crashbox, but it is my choice. And the FIA should be given much credit for improving safety in our sport. You can't however add safety when the technology can't accommodate it. A HANS device, the helmet with the attachments, and the correct seatbelts are a package which only works together with the car. So perhaps it's the less obvious things which merit closer scrutiny. HRT

# Forza Giulietta!

**Chris Pickering** discovers why a pint-sized historic tourer is capable of such giant-killing feats on the racetrack

**GLEAMING** under the midday sun, Geoff Gordon's Alfa Romeo Giulietta Ti brings a dash of Italian glamour to the small Hertfordshire industrial estate on which it resides. Tall yet comparatively narrow, there's a real delicacy to this pint-sized historic tourer. But don't let that fool you; behind all the elegance lies a heavyweight punch.

Wind the clock back to last summer and it was this car, in the hands of Emanuele Pirro, that found itself locked in an epic three-way tussle for the lead of the St Mary's Trophy race at Goodwood with Anthony Reid's Mk1 Jaguar and the Austin A40 of Andrew Jordan. Snapping at the heels of the 3.8-litre Jag, the two smaller cars looked like terriers attempting to bring down a wildebeest.

Although it was Wildebeest that won on this occasion, the diminutive Alfa led the race for a time before going on to finish second.

It's fair to say there would be easier ways of getting onto the Goodwood podium, but this giant-slaying performance is exactly the sort of thing that Gordon had in mind when he began working on the project. The labour was carried out at nearby Raceworks Motorsport, but Gordon – a former engineer and founder of silicone hose manufacturer Samco – was very much hands-on throughout.

"Geoff [Gordon] is just down the road from us and we started off discussing our ideas in the pub," recalls Raceworks director Mike Purse. "Beating the bigger

cars was always a real driving force for us. Everybody loves to see the underdog doing well and we put a lot of work into making the car competitive."

Closer inspection reveals just how much time and effort has been invested. The attention to detail is simply staggering, even by the standards of a professionally prepared car. The underfloor and the interior have been polished to the same mirror-like finish as the rest of the body, thanks to a crystal-based paint protection serum.

Inside, a period steering wheel has been discretely mated to a quick release boss, while the switches have been moved to a touring car-style electrical panel on the floor next to the driver's seat. For events like Goodwood there's a lightweight trim set, complete with rear bench seat, that fills the otherwise spartan interior. Similarly, the bumpers – often absent from racing cars – are in fact fibreglass items, moulded from the originals and complete right down to the replica rivets. There's even a set of leather luggage straps securing the boot.

## SHELL PREP

It's a similar story with the mechanical preparation. Originally acquired as part of a package with a second ready-to-race example, the current Giulietta was little more than a bare shell when it arrived, but it was deemed to have the better structure of the two. So, after a season, the decision was taken to sell the complete car and concentrate on preparing the spare shell.

"We wanted to start from scratch and build the car exactly the way we wanted it," comments Purse. "We sent the shell off to be acid dipped and when it came back we realised it wasn't quite as nice as we first thought. At that point we discovered just how difficult it is to get panels for these cars. The chassis legs were good, but all the floors had to be re-done and we also replaced sections of the rear three-quarter panels and the sills. Some bits were taken from an earlier car and re-shaped to fit, but the others we had to fabricate in-house."

The original spot welds on the underside of the monocoque have been replaced with stitch welds to improve strength and rigidity. Raceworks stopped short of fully seam welding the shell, however; Purse isn't a fan of the technique, pointing out that any cracks that develop later on can propagate down the full length of the joint.

Running under the more liberal FIA Appendix J regulations, the extent of the modifications is greater than it would be for an Appendix K car, such as those found in the U2TC. And perhaps the most fundamental change is the adoption of a Watt's linkage on the rear end. ▶

**"Beating the bigger cars was always a real driving force for us. Everybody loves an underdog"**


All photos: Chris Teagles


Jeff Bloxham

**ABOVE** The diminutive Giulietta leads the 3.8-litre Jaguar of Anthony Reid at Goodwood

As standard, the Giulietta's live axle was located by an A-frame link above and a pair of radius rods running forward onto the chassis (a bit like the setup on some U2TC Lotus Cortinas, but upside down). This method has its drawbacks, both in terms of axle location and roll centre position, so Purse and his colleagues began looking at alternatives.

"The A-frame looked like it was made out of scaffolding tube and the ball joint on it was about six inches across," he recalls. "It was just big and heavy, it wasn't really controlling the rear axle the way we wanted it to. I found a Watt's linkage kit sold for more recent Alfas in the States. When I phoned up, the guy said, 'It'll never fit under a Giulietta, I've had a look under the back and there's no way'."

Undeterred, he persevered: "I decided we'd order one and find out. It wasn't easy [but] a lot of cutting and shutting later we've got the roll centre right down and the installation works really well."

The radius rods are essentially unchanged, with the exception of stitch welds to beef up the forward mounting points on the chassis legs and a series of lightening holes drilled in the rear mounts on the axle. Where it starts to get interesting is the Watt's linkage. Viewed from the front this is basically an elongated Z-shape, with the outboard mounting points picking up on a pair of fabricated steel pylons. These are welded to the chassis legs, with a length of square section tube grafted onto the floor between them to provide extra strength. There's also some additional triangulation for the lower mount (on the right-hand side of the 'Z'). "Without this extra structure you'd be relying on the chassis legs, which are quite flimsy, so you'd get a lot of deflection," notes Purse.

The Watt's linkage is a common mod in the category, with a number of A35s and the like concealing similar setups, but it wasn't straightforward, he explains: "The rear end took quite a lot of thought. People were telling us there wouldn't be enough space for a Watt's linkage, and that was with the standard fuel tank. We were also a little concerned about eligibility initially, but when we looked closer it seemed to be the thing to do. Whether it's a Panhard rod or a Watt's linkage, everyone appears to be trying to improve the rear axle location."

At the front, the double wishbone suspension layout remains essentially ▶

**ABOVE** No component was safe from the Raceworks drill

**BELOW** The Watt's linkage is a triumph of packaging

unchanged, albeit with the addition of yet more lightening holes in the spring pans. Launched in 1954, the Giulietta's use of coilover suspension units front and rear was quite radical for its day and that layout is retained on Gordon's car, with externally adjustable Koni racing dampers all-round, valved to Raceworks' own specifications. These days the car also runs anti-roll bars on both ends, with a particularly chunky-looking item on the front.

## BRAKE FROM TRADITION

The rear brakes have also succumbed to the Raceworks drill, with holes dotting the back plates to provide cooling as well as weight reduction. The original aluminium drums are still used on the rear, with standard Alfa shoes re-lined with new friction material by Questmead. At the front, however, a relatively dainty pair of single caliper discs has been added from elsewhere in Alfa Romeo's period parts bin.

Inside the standard differential casing lives a plate-type limited slip differential, built by Italian transmission specialist Bacci Romano and set up by Raceworks. "That little unit there makes such a difference to the handling. We've played with the ramp angles and preloads to get it to behave just the way we want it," notes Purse.

The tyres are L-section Dunlop radials. The larger M-section tyres are allowed for the car's occasional U2TC outings, but fitting them would have required flared wheel arches, which was deemed out of character with the Giulietta's elegant aesthetic.

During the development, Raceworks commissioned Nigel Rees at Global Sports Development to run a full computerised analysis, which helped to guide the suspension setup and kinematics. It meant the team could run a full lap simulation before the car had even turned a wheel, evaluating things like damper curves and spring rates.

"The computer simulation is a really useful tool. It allows us to generate a setup sheet before we go testing and it means we have an idea in our head of what we're aiming for," says Purse. "Of course, that assumes perfect track conditions and a perfect driver. In reality, there's no such thing as either, so you've got to aim as close as you can and make the car as driveable as you can."

Ultimately, though, nothing beats track time for setup purposes. And while Gordon is an accomplished racer in his own right, the team relished having a five-times Le Mans winner racing with them at Goodwood.

"We all felt the pressure to a certain extent when Emanuele [Pirro] drove the car for the first time in qualifying, but you cherish feedback from guys like that," says Purse. "He got on with the car right from the start, but he came back with a few suggestions. Fortunately, the car responds very well to changes – you can make very subtle alterations like you would with a purpose-built racing car."

## ENGINE

Alfa Romeos of this era are known for their sweet-revving four-cylinder twin-cam engines. This particular example was prepared by Dave Ashford of Alfa experts Brunswick Motorsport, and it's fair to say it's a little bit special.

"We didn't want to buy the same engines that everyone else was buying," recalls Purse. "Over a beer with Dave and Geoff we decided we could do better than that. And we have. The car isn't a million miles off GTA twin plug power now really."

With a plan starting to come together, the search began for a donor engine. A suitable candidate was eventually found at the bottom of somebody's garden, where apparently it had resided for some time. Ashford promptly took the castings to Cambridge-based Aquablast UK, which used a wet-blasting process to restore them to pristine condition.

Under the HRDC Touring Greats ▶

**ABOVE** The spartan interior is beautifully finished

regulations, it's possible to increase the engine capacity by up to 25 per cent, so the first job was to enlarge the little 1290 cc twin-cam to around 1.6 litres. Another fundamental change was the switch to twin 45 DCOES in place of the original downdraft carburettor. Meanwhile, on the opposite side of the engine bay there's now a very neat four-to-one tubular exhaust system, designed to carefully calculated tuned lengths.

The team has tried three different exhaust configurations, Purse explains: "All three were side-exit: a straight-through pipe for weight saving; a single silencer system; and a twin silencer system. Without the silencer the car was painfully loud. Out on the track it was okay, but it was unbelievably loud in the pits even compared to the Lola T70s we run. The twin silencer is the exhaust we use most often due to noise restrictions, but the single silencer system sounds lovely."

The exact details of the engine are being kept quiet, but Ashford hints at something quite radical at work. "It's based on ideas I've had for a long time, but we needed a customer who had the faith to go ahead and try it," he says.

Much of the work focused on gas flow and the shape of the combustion chambers. The pistons started life at JE Pistons, but they were machined in-house to a carefully-designed specification, which is understood to be a key part of the concept.

Ashford was also keen to keep windage and frictional losses down to a bare minimum. "The crankshaft spins round like a propeller, whipping up air and oil," he says. "To counteract that we use windage trays to separate the air and the oil. We've also worked very carefully to get the whole thing balanced. We took as much weight out of the components as possible and concentrated on getting them working together."

Alfas of this age can be susceptible to head gasket issues and the problem tends to lie with the cylinder liners. To combat this, Ashford lapped the liners into the block with a very fine cutting paste to take off any high spots.

## INSTALLATION

The engine bay of the Giulietta is hardly expansive and yet the tiny four-cylinder looks almost lost. What really strikes you is how low it sits – I initially assumed it had been lowered, but it turns out the mounting position is standard, barring a slight tilt to clear the twin carbs.

Things are a bit tighter underneath, however, where the cooling fins have been machined down to accommodate a larger sump, taken from a 1970s


**ABOVE** The Brunswick Motorsport-developed twin cam sits low in the engine bay


**ABOVE** Performance was helped by the fact that the team had run a full lap simulation before the car had even turned a wheel

Alfetta. The radiator is also an enlarged item ("the biggest we could fit without looking conspicuous," notes Purse) and it's now twinned with an external oil cooler.

The gearbox is a five-speed unit, fitted with a close-ratio Bacci gear set originally developed for the GTA. Due to the Giulietta's 15-inch wheels the final drive ratio has been shortened somewhat, while the gear selection is now by means of a floor-mounted lever in place of the 1950s column shift.

A modified GTA pedal box has now been grafted on, made possible by a rather complicated assortment of levers and pushrods. This was principally done to tidy up the pedal box, but it also allows the use of a bias bar and has the added bonus of reducing the centre of gravity.

It's a trend you see right across the car – just about everything has been lightened, lowered or both. The fuel tank, for example, is now a modern bag tank encased in aluminium and slung under the boot floor. This is more than adequate for the 25-minute HRDC rounds, but for longer events such as U2TC races (where the car competes in the invitation class) an additional foam-filled tank is used, which piggybacks onto the main unit with a feeder pipe running between the two. It unbolts in a matter of minutes with a blanking plate to seal the filler of the main tank, Purse explains: "We looked at having a secondary pump to shift one to the other, but it just came down to simplicity in the end. Gravity can't fail."

## UNFINISHED BUSINESS

Alfas may have a reputation for fiery Latin temperaments, but Purse says the Giulietta has proved a relatively easy car to run, "mainly because we built it," he jokes. And certainly the attention to detail bears that out. The loom, for example, is a bespoke item from DC Electronics, built with the same MiL-spec connectors you'd find in a high end modern car.

The Goodwood outing last year proved just how potent the little Alfa can be, but Raceworks reckons there's more to come. Having been through two iterations of the engine so far, Ashford believes there are still incremental gains to come from friction reduction. And you can be sure the team will be on the lookout for any refinements to the chassis.

This year, the St Mary's Trophy alternates to the later 1960s touring cars. While the Giulietta overlaps the two eras, the feeling is it would struggle against the likes of the Alfa Romeo GTAs and Lotus Cortinas.

In 2016, however, it's likely the 1950s touring cars will be back and Gordon hopes to return with them. If that happens, the big boys better watch out. Next time the terrier might just come away victorious. HRT

# The name's Bond...

## Meet a striking Formula Junior machine that, as **Chris Pickering** reports, was feared to be lost forever

**THINK** about it for a second. Given the freedom to choose virtually any car for historic racing, what would you pick? A Jaguar D-Type, perhaps? Maybe a Maserati Birdcage or a pre-war ERA?

That's the rather enviable dilemma that faced entrepreneur Jon Goddard-Watts a few years ago. Sat at the kitchen table of Andrew Tart's Worcestershire home, the pair were discussing a list of cars that Tart's engineering company could potentially run on his behalf. But what he really wanted, Goddard-Watts explained, was his old Bond Formula Junior car back.

If you've not heard of the Bond Formula Junior before you wouldn't be alone. Only one car was actually completed in-period and it ran briefly in 1961 with Goddard-Watts – then Lawrence Bond's business partner – as the works driver.

This striking-looking machine was unique for other reasons too. At first glance you might think it was four-wheel drive, given the driveshafts that protrude from its pointed snout. But Bond was a passionate believer in front-wheel drive and the Formula Junior, like most of his automotive projects, uses this layout.

While it was one of very few cars in the category to do so, it was by no means unique in Bond's own repertoire. The diminutive Berkeley sports cars he designed had achieved considerable competition success with front-wheel drive, despite their tiny engines, which started from as little as 322 cc. Prior to that, Bond had also built a series of front-wheel drive 500 cc Formula 3 machines that he raced as early as 1947.

The Formula Junior was intended as a more serious commercial proposition, but unfortunately it came out at a similar time to the Lotus 18. While other racing car constructors routinely plundered the big manufacturers' parts bins, Bond was a stickler for making his own components. And that cost money. Next to the mid-engined grand prix-inspired Lotus, the cigar-shaped Bond looked not only old fashioned but also rather expensive. Not a single one was sold and the company closed down the following year after a distinctly patchy season of racing.

The car eventually passed to Chris Featherstone, subsequently a single-seater racer of some repute, who campaigned it on and off in Monoposto events. Unfortunately a big accident at Mallory Park in 1964 forced the car into storage and for years it appeared the only Bond Formula Junior machine had been lost in the mists of time.

After a bit of digging by Andrew Tart, however, it turned out this wasn't the case. The works car had survived. And what's more, there was the basis of a second example out there too.

"It didn't take us long to locate Jon's old car through the Formula Junior Historic Racing Association and after a few years we persuaded Chris [Featherstone] to sell it to us," recalls Tart.

The Bond had been rebuilt in the late nineties and, while it had been something of a labour of love, the work had not been entirely successful. "When

**BELOW** The Bond was notable for its innovative monocoque construction, the inner aluminium structure of which is exposed here

**ABOVE** The fibreglass being laid up on the second car

we first got the car it was theoretically ready to go," Tart explains. "So much so, I couldn't resist taking it for a quick drive – completely illegally – down the road. I was absolutely staggered at the steering. It was totally uncontrollable as far as I was concerned."

A quick inspection of the car confirmed a substantial amount of attention was required and it went straight into the workshops at Andrew Tart Motor Engineering (ATME).

Along with the unusual drivetrain layout, the Bond was notable in its day for a highly innovative monocoque construction. Like the Berkleys, it uses a fibreglass outer skin on top of a bonded and riveted aluminium structure. It resembles an aircraft fuselage, with a pair of sill members running the full length of the car, connected by a set of aluminium bulkheads that carry things like the engine mounts and suspension pick up points. This made the car extremely rigid yet very light – the sales brochures put its weight at just 360 kg (790 lb) when launched.

"You have to bear in mind that Lawrie Bond was working on this car in 1959, so he had a monocoque single-seater racing car well before Chapman did with the Lotus 25. And in fact he was building a monocoque sports car in the Berkley well before Chapman did the Elite too," says Tart. "All the manufacturers were looking at one another, so it's very possible that the Bond cars planted a seed in Chapman's mind."

## STRAIGHT TALKING

It's at this point that the second car enters the equation. Following the smash at Mallory Park, the rear was cut off the spare tub and grafted onto the damaged car. Unfortunately it wasn't entirely square. "You could line yourself up with the spine of the headrest and see the curvature in the body," notes Tart.

With this in mind, he set about rebuilding the monocoque with his colleagues at ATME. They began by chopping off the back of the tub and making a new panel. The rear section of the shell was then carefully re-aligned and bonded back in to leave a completely seamless zigzag-shaped join; the only clue to its existence is a neat line of rivets on the aluminium structure within.

They also took the opportunity to add some extra layers of fibreglass to the inside of the tub. Again, these are completely undetectable from the outside, but help to provide a little extra crash protection, should it ever be needed. The flipside to this is that the car now tips the scales at around 410 kg.

At the rear, the Bond uses a swing axle, which consists of two large tubular A-frames pivoting very nearly on the centreline of the car. These had been modified at some point, so Tart set about making a new pair, using a set of original drawings that had come with the car. It wasn't entirely clear how they would have been mounted originally, but there's no evidence of rose joints having been used in-period, so ATME has gone with 1960s-style metalastic bushes.

On the front, the car uses double wishbones with purpose-built cast aluminium uprights and bespoke cast iron trunions. Originally the coil-over damper units would have come from the rear end of a motorcycle, but these are now provided by Gaz with ATME's own valving set up by Sean Pickering of SP Suspension.

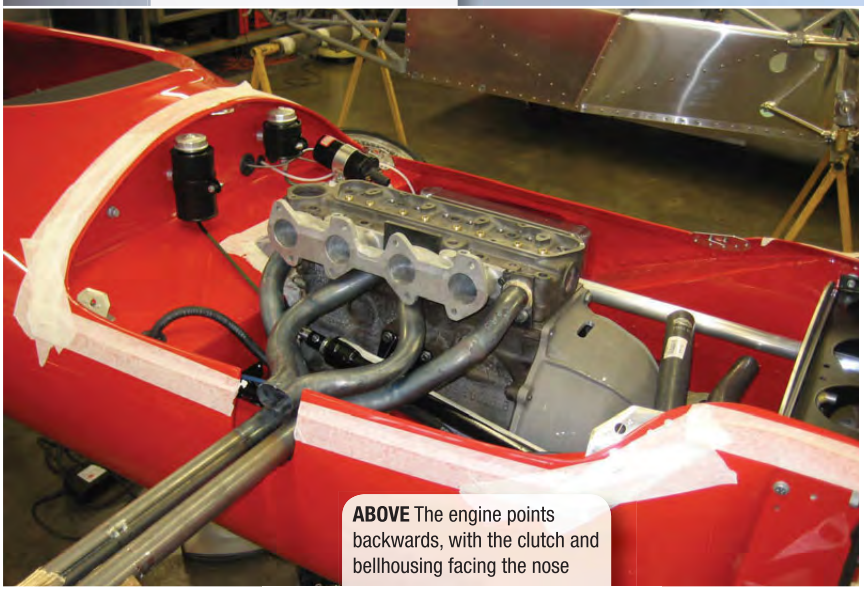
Bond's extensive use of bespoke parts ▶

**ABOVE** Could the Bond's construction have been a catalyst for some of Colin Chapman's ideas?

led to a few headaches. The brake drums, for example, are cast items that form the centre of the wheel, with the rim bolted on directly via a series of tapped holes. Fortunately the tooling (patterns) for these were included in the spares package that came from Chris Featherstone, so ATME approached Foley Patterns to oversee the production of a new batch, working with local foundry JJ Siddons. Meanwhile, Laranca Engineering, run by successful historic racer Richard Shaw, provided the final machining.

This local talent pool was to prove useful for the uprights too. Although original items were used in the rebuild, these were known to be something of a weak point in the design and ATME has since commissioned a batch of spares, using a somewhat tougher alloy cast with the original patterns.

**ABOVE** The original pinion has been remade with a spark eroded spline



**ABOVE** The engine points backwards, with the clutch and bellhousing facing the nose

## ENGINE AND TRANSMISSION

Thanks to the Bond's longitudinally-mounted engine and front-wheel drive layout, the transmission is an ingenious mixture of the oddball and the conventional. Perhaps not surprisingly, it broadly resembles a normal front-engined, rear-wheel drive installation that's been turned through 180 degrees. The engine now points backwards in the chassis, with the clutch and bellhousing facing the nose.

In-period a modified Ford Zephyr gearbox would have been used, although these days a Lotus Elan gearbox of the same series takes its place. This runs in-line with the engine and, in place of a propshaft; a standard Ford pinion has been grafted directly onto a shortened gearbox output shaft to drive the differential.

The original pinion was held on to the main shaft by a single dowel, so all the torque went through a single 5 mm pin. "I have now remade it with a spark eroded spline, done to an unbelievably close tolerance by Brand Engineering in Birmingham who also did the splines on the driveshafts," notes Tart.

Bond designed his own differential casing, which holds the crown wheel on the other side of the pinion to give four forward gears and one reverse (as opposed to the four reverse gears that would result from simply turning the standard differential around). In doing so, he created a do-it-yourself-transaxle, which Tart believes was a step up from the Renault items used in Lotuses of the same period.

> **"The transmission is an ingenious mixture of the oddball and the conventional"**

Very little is known about the original engine, other than the fact it came from Cosworth. During the car's Monoposto career it was swapped for a different lump, which was swapped back to Formula Junior spec in the late nineties. Tart, however, wanted to build a new engine when the car came into his care.

The Ford Anglia 105E-based unit features an Arrow crank and rods mated to a custom-made steel flywheel. Piper Cams developed a bespoke camshaft for the Bond, designed to produce a less peaky torque curve, which reduces the risk of spinning the front wheels. ("We did initially go a bit too soft on the cam; we've gone wilder and wilder since, but it's nowhere near as extreme as a normal Formula Junior cam," notes Tart.) ▶

**ABOVE** Jon Goddard-Watts (left) and Andrew Tart inspect the original car

The cylinder head was gas-flowed in-house and it breathes through a pair of Weber 40DCOE carburettors. The exhaust manifold is another ATME item, sand bent as it would have been in-period. Aldon Automotive was used to set up the finished engine on its rolling road, to good effect.

## TESTING TIMES

With precious little time before the start of the season, the front suspension was left more or less as it was for the first test at Mallory Park. The results were not wholly encouraging.

"It drove just as badly as it had when I took it down the road," recalls Tart. "I came in after three laps and Chris, our chief mechanic, thought I was still trying to warm the tyres up by swerving down the straights! After that we packed up and went home."

The car was due to make its debut that weekend, so the team found themselves in a race to locate the problem. It was eventually traced to an issue with the geometry of the steering arms and the track rods, which resulted in flex in the linkages and a very odd non-linear motion ratio. A quick modification to eliminate this had a transformative effect on the handling, but the Bond's fortunes were yet to fully recover.

Mallory Park seems to have fateful implications for the little Formula Junior. On the first outing, Tart spun on an oil spill laid down by one of the other cars. This caused him to slide over the kerbs, breaking one of the rear swing arms, just as Featherstone had done in the crash that ended the car's Monoposto career 40 years earlier. Cue another suspension rebuild, this time with a somewhat reinforced set of swing arms.

Tart describes those first few events as a steep learning curve, but gradually things started coming together. "We began developing the car and learning what it needs," he says. "The main thing is that you have to run very soft suspension at the front and keep it fairly stiff at the back to provide traction. That's completely the opposite of what you'd do with a rear-wheel drive car and we also played with springs and dampers a lot.

"I wanted quite a radical damper setting so I re-valved them myself and sent them off to Shaun Pickering to test. We have a lot of bump and very little rebound on the front, and lots of rebound and very little bump on the rear. It comes down to weight distribution: I want to get it on three wheels. We have to run an open diff, so it's all about traction, and since we got rid of the rebound on the front it just digs in and drags you round."

It may be an unusual configuration for a single-seater, but Tart reckons anyone used to setting up conventional front-wheel drive machinery would feel at home with the Bond. "There's nothing particularly unusual in the geometry; we have about 4.5 degrees of castor and about 1.5 degrees of static camber front and rear with just a little bit of toe-in," he says. "We would very much like more castor, but to do that would mean changing the crossmember, which would take the car away from its original spec."

The results are certainly effective. Tart has had great success in the car, including scooping the FIA's Lurani Trophy outright in 2013 and picking up several class titles in the Millers Oils Historic Formula Junior Championship. So what's it like to drive? "I just grab

**BELOW** You might not know the car well, but that driver looks familiar! Barrie 'Whizzo' Williams at the wheel

hold of it and cope with it," he says. "It power understeers, so if you go into a corner too fast and try and recover on the throttle the front end will just wash out. Equally, it oversteers like a pig if you lift off at the wrong time, so you have to think carefully about what you're doing. It's clearly not as quick as the conventional car, which is a combination of my driving and the car, but it is surprisingly good, it absolutely loves big corners. I can gain yards on the other cars on the fast right-handers out the back of the Brands Hatch Grand Prix circuit, for example. On the tighter bends you just light the front tyres up if you're not careful."


**ABOVE** With Bond 2 now up and running, the two cars make a formidable team

## TAKE 2

While the debut season was all about getting the first car up and running, Tart and Goddard-Watts had always harboured plans to complete the second example. Dubbed Bond 2, it uses the front half of the spare factory tub (the rear portion of which is now found on Bond 1) mated to a new back end.

In order to accommodate Tart's slightly oversize frame the footwell has been lengthened on the second car, but otherwise its structure is identical to the first. The original package also included the all-important transaxle casing, a more or less complete set of suspension components and a steering box, plus numerous other odds and sods. This means it is recognised as an original car by the Formula Junior Historic Association and now competes as part of a two-car team run by ATME.

Bond 1 was driven by Gill Duffy in 2013. Since then ex-Formula 2 racer Mike Walker has been the regular driver, with Barrie Williams, Alex Morton and Formula Junior stalwart Duncan Rabagliati also pitching in. Tart, meanwhile, tends to drive the second car.

Together, in their matching paintwork, the two Bonds make a formidable team. As in-period, there are faster Formula Junior cars out there, but the innovative fibreglass monocoque machines now put in a strong, reliable performance. And most importantly, it gets these cars back out on the circuit where they belong. HRT


**ABOVE** Andrew Tart on his way to the first ever win for the Formula Junior Bond

# Thinking outside the 'box

Lotus's pioneering sequential gearbox was conceptually brilliant but dogged with problems when it first appeared. **Paul Fearnley** meets a convert to the cause

**VASTLY** experienced racer Philip Walker's heart sank when the Historic Grand Prix Cars Association politely but firmly advised him in 1996 that it would prefer his 1959 Formula 1 Lotus 16 to use its original transmission. The replacement H-pattern, four-speed dog 'box made by a previous owner and fitted to the car when Walker bought it in 1993 was "agricultural but getting the job done". To swap this for the infamous 'Queerbox' seemed an "expensive inconvenience". For none other than legendary motorsport engineer Keith Duckworth reckoned it unfit for purpose and left Lotus to found Cosworth because of it.

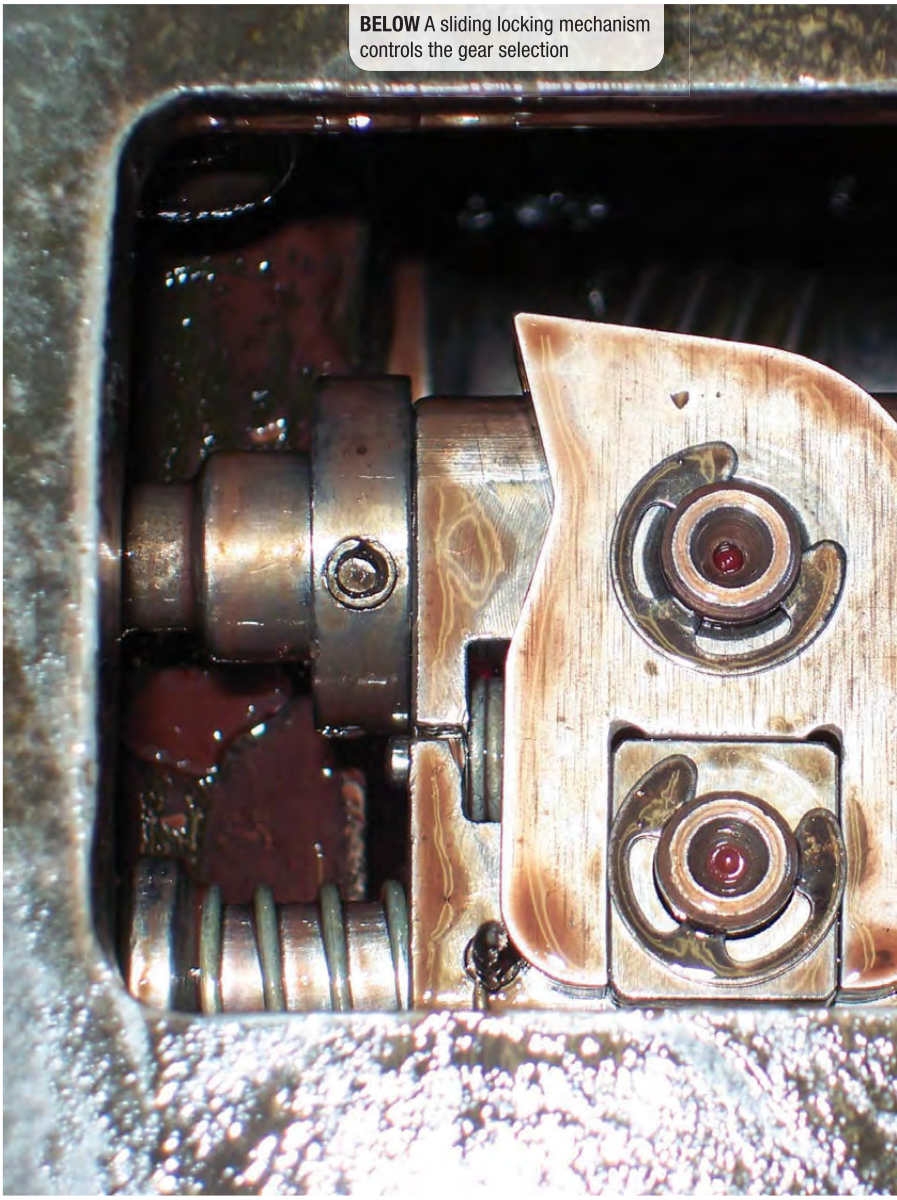
> "It's a gearbox. It's not black magic"

Like several of Colin Chapman's brainwaves, this five-speed, all-indirect, sequential-shift transaxle was deemed brilliant in conception and theoretically superior, being light (80 lb dry weight), compact and low-line. But it was also accused of being under-specced and thus found wanting in practice. Poor lubrication, chewed gears, disorientated and disaffected drivers: the list of cons for this 'box of tricks was long.

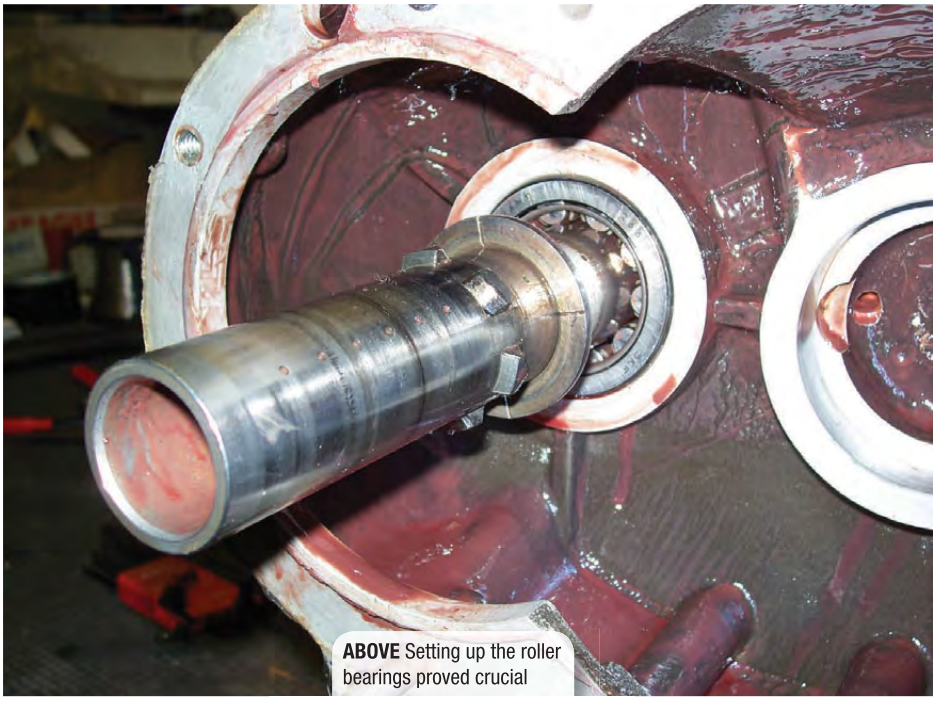
But Walker, who was in possession of the original casing and its internals, acquiesced and commissioned the car's preparers at that time, Retro Track & Air of Dursley, Gloucestershire, to make three identical versions. The process took more than a year and wasn't cheap, plus mistakes were made and breakages resulted – but the disbeliever is now a devotee.

"I'm glad I did it," he says. "It's transformed the car for the better. It's not a quick-shift like a modern sequential – you have to be deliberate and positive with it – but it's as fast, if not faster, than a dog 'box. First to second is a bit slow as you pass through neutral but the other changes are click-click-click. The ZF in my 1965 Ford GT40 is lazy in comparison.

"We didn't re-engineer it bar strengthening the magnesium casing in thin and weak areas, and it uses precisely its original principle, yet we've done more than a dozen races this season and had no trouble. The gearbox reached 180 degrees C at



**BELOW** A sliding locking mechanism controls the gear selection



**ABOVE** Setting up the roller bearings proved crucial

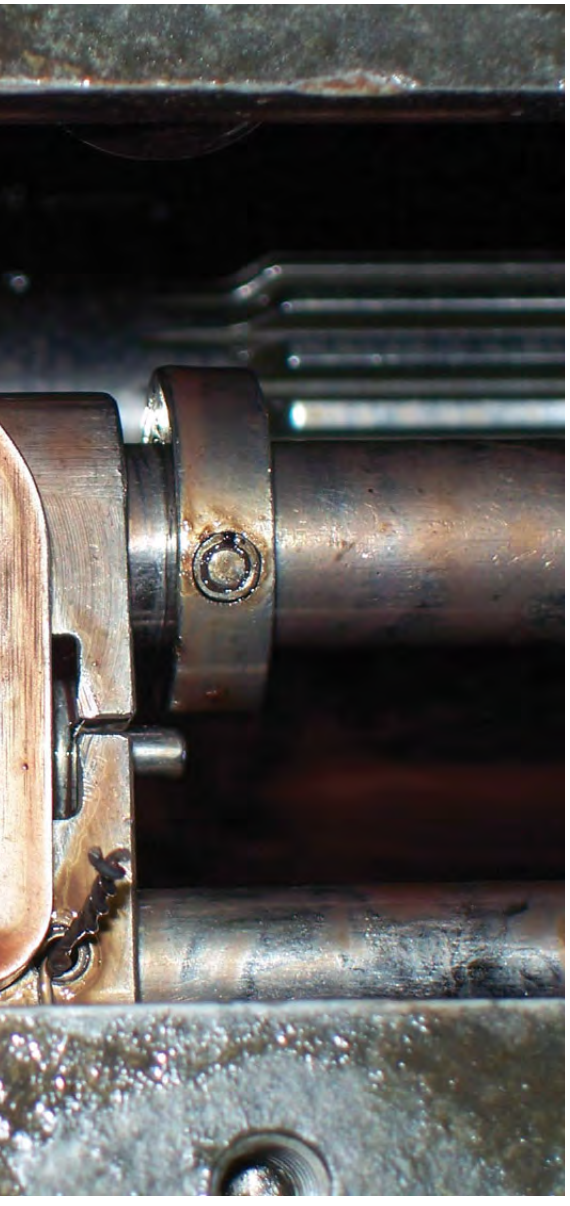
Portimao in Portugal recently; it should have seized – but didn't. From it being almost the only thing we talked about when discussing set-up, it's reached the stage where we hardly discuss it."

Chapman had wanted a bespoke item rather than a badly packaged road car casting adapted to 'accept' racing internals. He also wanted a wide choice of ratios: the 22 gears supplied by ZF of Friedrichshafen provided him with 18.

"But we tend to be a bit lazy with them," admits Walker. "Often we gear the car to the fastest circuit on the calendar and leave it, relying instead on the torque of the 2.5-litre engine."

It sounds simplicity itself. How was this transformation achieved?

It's true that the Lotus today contests only sprint races – it has won more than 60 since 1993 – but Walker is convinced that it could complete a two-hour Grand Prix, something often beyond it in period, in its current form. It's true, too, that Walker is likely more mechanically sympathetic than an impatient professional grabbing gears while not fretting about footing the bill; they wanted it to work there and then, not 20 years hence.



Time has been the big difference. Walker and his one-man army have been able to finesse and refine at their relative leisure. Fifty-five years ago Team Lotus was racing internationally in F1, Formula 2 and with sports cars and GTs, while newly restructured Lotus Cars Ltd was readying its groundbreaking fibreglass monocoque Elite road car and also moving to a new factory to build it in numbers. External pressures as well as internal stresses queered the Queerbox's patch. And its (maddeningly catchy) nickname, which pre-dated Duckworth's 1957 journey of discovery from Imperial College to Lotus's 'Fine Limits Engineering Shop' – a shed in the yard at Tottenham Lane! – has stuck.

But a few thou here and there have made a big difference too. Mechanic Steve Slyfield was swiftly briefed of its gearbox's fabled shortcomings when he assumed preparation of the Lotus in 2003. This engineer with experience of missile guidance systems and ejector seats, plus complex Wilson pre-selector gearboxes in pre-war ERAs and racing Rileys, preferred to see for himself, however, and to make his own mind up.

"Everybody told me it was dodgy," he says. "But nobody could really tell me why. It's only a gearbox. It's not black magic. You just need to get your head around it."

## BOX OF TRICKS

Designed in 1956 by consultants Richard Ansdale and Harry Mundy, both ex-BRM, the Lotus Sequential Gearbox began life in the company's first single-seater, the F2 Type 12, and its sports-racing cousin, the 15. Its selection method shunned the dog-ring-and-fork norm in favour of a sliding locking mechanism that travelled through the hollow centres of the gears. Panhard used a similar layout at the end of the 19th century, as did Ferdinand Porsche's advanced but unraced four-wheel-drive GP Cisitalia 360 of the late 1940s, albeit with synchromesh. Chapman's take on the principle, of course, pushed the technology to – and beyond – its limit: five gears in a space just 81 mm long.

Within the bore of each are six equally spaced but alternately staggered splines. These mesh in turn with the external counterparts of a fixed gear on a selector sleeve. Supported at each end by open roller bearings, and accepting drive from the input shaft via internal splines, the sleeve is controlled by a left-hand lever that the driver, once on the move, pushes for up and pulls for ▶

**ABOVE** Walker's car had previously been converted to an H-pattern 'box

down; first is selected from a standstill by pulling. The original iteration of the gearbox saw the lever return, via spring-loaded detent, to the same position after each change, but a pawl-and-ratchet positive-stop mechanism – one of Duckworth's modifications for 1958 – was applied after drivers complained of losing track of which gear they were in. Now the lever progressively migrates approximately four inches along a linear, gate-less guide.

"Parts were sticking and jamming because they didn't have the right clearances and tolerances," says Slyfield. "We had trouble with the roller bearings: their housings were too tight. That squashed the bearings, which in turn gripped the shuttle. We removed another three-thou from the housing and now it's fine.

"The ratchets that control the positive-stop must be bang-on, too. If they're out of sync with the indents that tell the shuttle where to stop, they overcompensate and want to return to the gear that you've just come from.

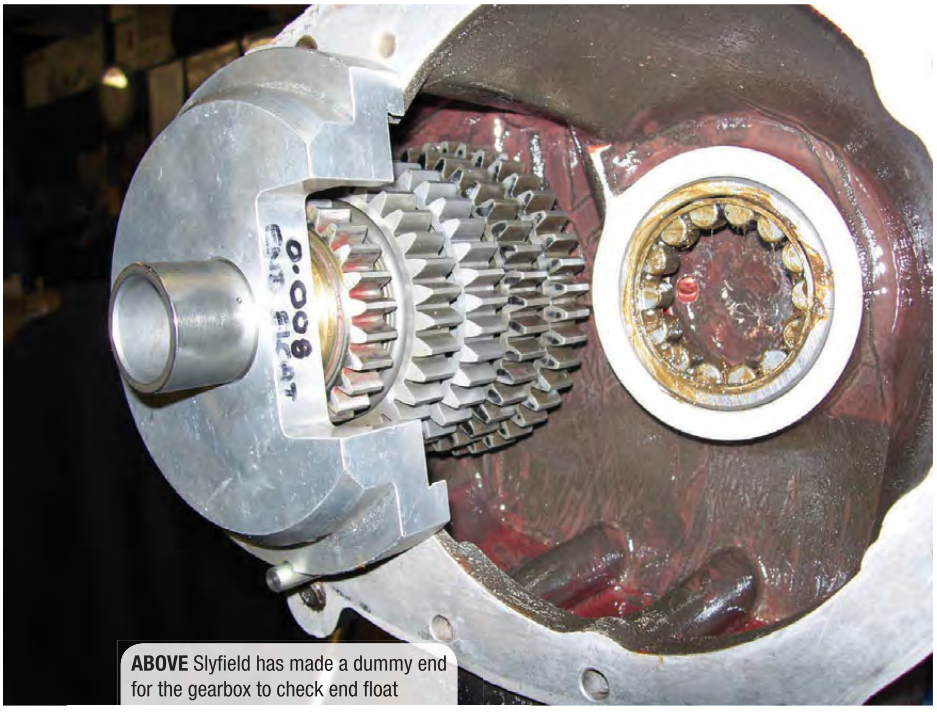
"The biggest tolerance issue, however, are the shuttle's teeth. There are no dogs, just bronze spacers [creating neutrals], and the spacing has to be spot-on. You need 10-thou of end-float across the gear pack. Any less and it will seize. I've made a dummy end for the gearbox so that I'm able to check with a feeler gauge before assembly."

> **"There are five gears in a space just 81 mm long"**

A big step forward, done by somebody else, was reducing the width of the gears, Slyfield explains. Now narrower by 2 mm, they pick up the next gear more easily: "Even so, we change the shuttle after every seven hours of use. When Philip says its changing gear beautifully is the time to act. By then it looks pretty tired, with its edges knocked off, and it's too loose. Miss a gear and it's hard to get it back into gear. There's no synchromesh, the gearbox is running all the time in freewheel, and so the only thing to do is match the revs to the wheel speed and bang it in. That's when things get damaged. But stories of selecting two gears at once are rubbish. The gear on the selector sleeve is too narrow [9.5 mm] for that to happen."

Another Duckworth mod has also been modified. His method has been retained – he cured the spiral bevel (in place of the original hypoid) differential's lubrication problem by inserting 'tinware' shields and a jet directing cooled oil – but its medium has changed. Team Lotus used engine oil within the gearbox to obviate the weight of a separate tank and cooler.

"We still have no gearbox oil tank," says Slyfield. "But we just use the 1.5 litres in the diff, circulated by a mechanical pump driven, as per the original, from the nose of the gearbox; it also recycles the gearbox oil. I asked a lab to recommend the best oil, but there are different materials involved – bronze, mag-alloy – plus a limited-slip diff and high pressures, so they couldn't find one to suit. They could've engineered one but we would've had to buy something like 10,000 litres! So I had to find something else: Red Line 75/250 Heavy Shockproof Gear Oil. The cheaper, thinner stuff used




**ABOVE** Slyfield has made a dummy end for the gearbox to check end float

when I first worked on the car wasn't up to it. Now, even when the 'box gets theoretically too hot, oil sticks to the gears and lubricates. We are, though, considering fitting a cooler. The oil is too thick for a conventional type, so probably we'll use some form of tube arrangement in the air stream."

None of the above, however, deals with Duckworth's main bone of contention: overall size. He calculated that increasing the width of each equal-width gear by a tenth of an inch would have made it easier for the internal splines to locate the selector while reducing the wear and radiusing of gears to a more acceptable level.

## LEGACY

Originally designed for a 1.5-litre, the gearbox was now absorbing torque from a 2.2 (and later a 2.5) Coventry Climax. But Chapman had neither the money and time nor inclination to commission a larger casing from ZF.

He and Duckworth were destined to graunch. With strong personalities and very different MOs, their future relationship, though successful, rarely got beyond grudging admiration. Some project or other was going to drive them apart and onto parallel paths. It just happened to be the Queerbox.

That's not to say that both didn't have a valid point. The Queerbox was an area of weakness – even though Moss won the 1960 Monaco GP with one in his Rob (not Philip!) Walker-run rear-engined Type 18. Chapman admitted as much when he dropped it for 1961 'in favour' initially of a ZF that was relatively heavy, big and slow-of-change and unable to provide fast, indeed any, swaps of gear ratios. Moss had switched to a Colotti before 1960 was out.

But Chapman refused to let go of the idea – and was right to do so. Though his F1 Getrag 'Son of Queerbox' of 1977 – gears were selected in Goggomobil fashion by balls forced through holes in the shaft and into grooves in the internal bore of the driven gear – also proved problematic, sequential gearboxes have become the norm in competition. Today's feature a selector drum/barrel rather than a sleeve, with a peg or lever engaging with a machined pathway, and are operated by electronics, hydraulics or pneumatics controlled by microprocessors accurate to milliseconds and devised and often overseen by teams staffed by hundreds.

Though it's been a far from seamless process, it was the Queerbox that let the dogs out., when what was needed was a fraction more give and take – aka tolerance – and understanding. It's taken more than half a century, but finally the Queerbox has received the patient care its quirky character demanded. HRT

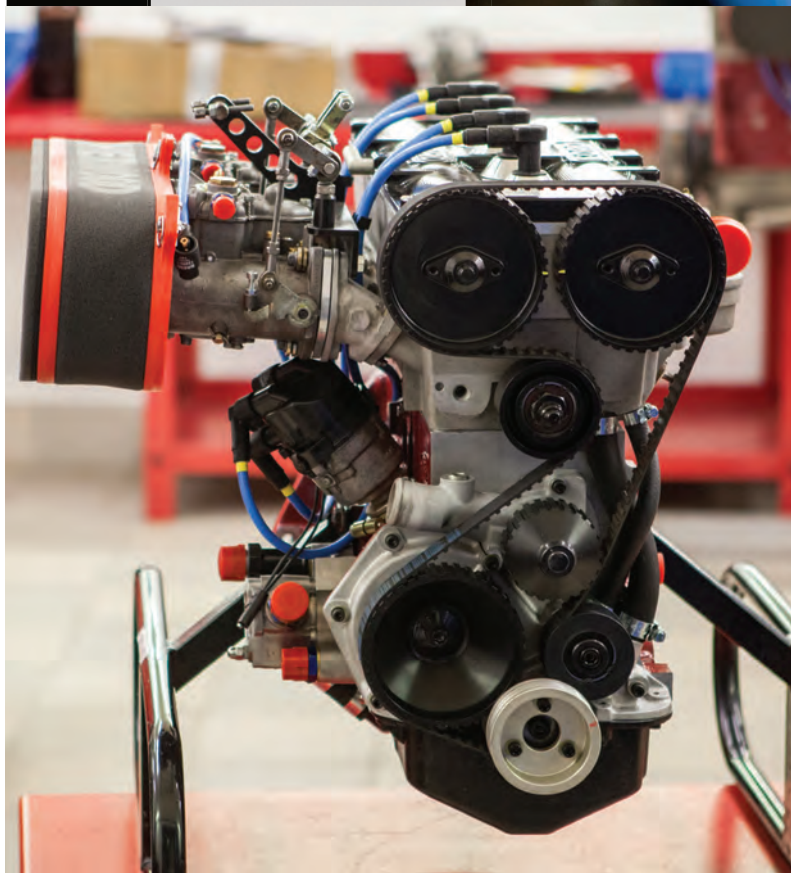
**ABOVE** The transmission oil is circulated using an external pump

**ABOVE** Walker says the modifications to the gearbox have transformed his Lotus 16 for the better

# FAMILY AFFAIR

**The Cosworth BD family has powered everything from rally cars to top end single-seaters. John Simister takes a look at these ubiquitous powerplants**

**ABOVE & BELOW** The BD-series has proved versatile and successful



**IF** you're competing with a Cosworth BD-series engine today, it will most likely be a BDG. And it most likely won't have been built by Cosworth, nor even contain any Cosworth parts. It will be a replica, made to the Cosworth design but resembling the hammer that is all original apart from its new head and its new handle.

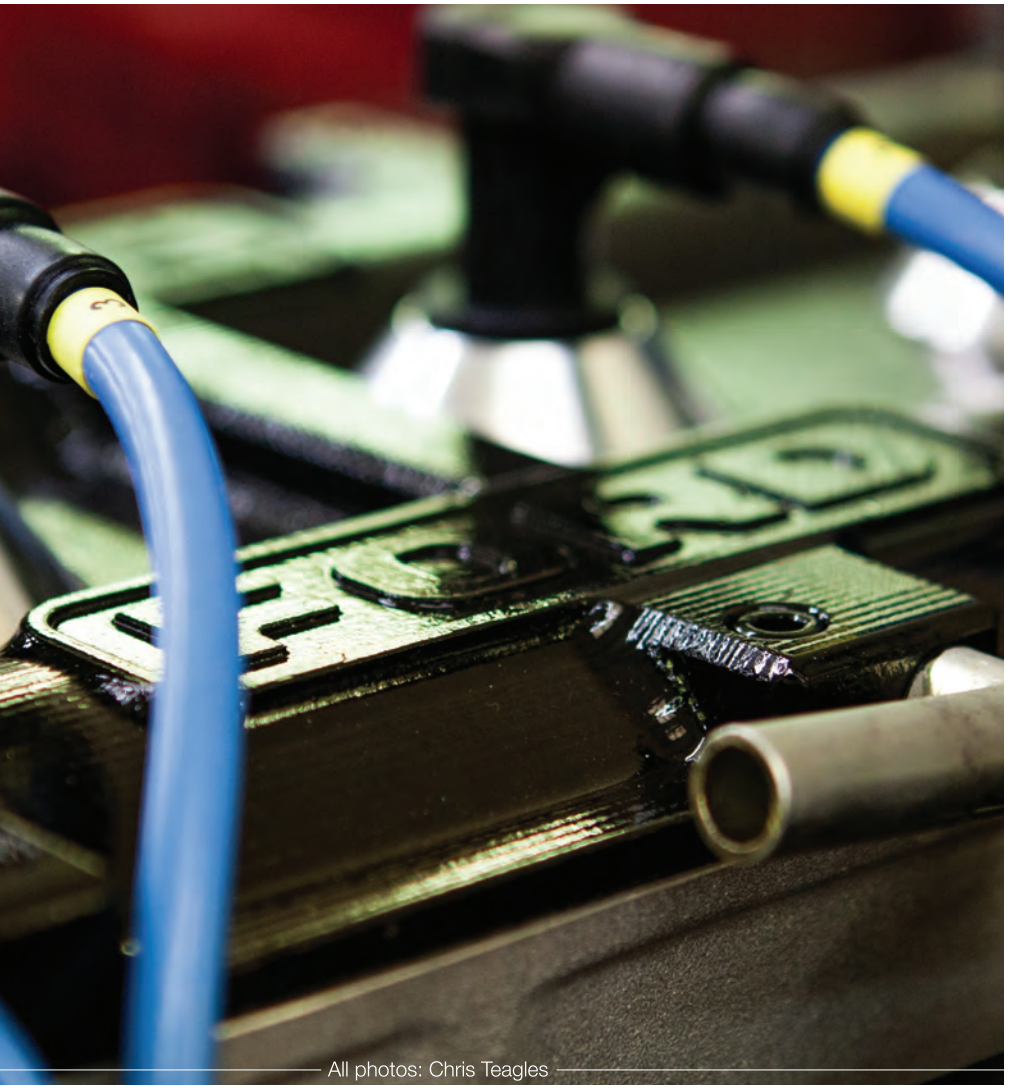
This, of course, is normal in the world of historic motorsport when we're dealing with relatively rare engines used to the limits of their ability. And as long as the new engine remains true to the design and philosophy of the original, no-one minds much. You could say that all you've done is give your engine such a thorough overhaul that every part had been replaced.

The Cosworth BD-series – the initials denote the toothed-belt drive to the camshafts – was a staple of motorsport from the late 1960s to the early 1980s, used in rallying, Group Six racing and even Formula Two, and it remains popular today in historics. There is a whole family of BDs, with many variations to suit many different branches of motorsport over the design's production career from 1969 to the mid-1980s, including a road-going BDR for Caterham sports cars.

It began life as the BDA, its belt-driven overhead camshafts actuating 16 valves set in a cylinder head which sat atop an iron Ford Kent-family block, maintaining the Ford link that suited its first application, powering the Escort RS1600 in a gentle 115 bhp state of tune. The camshafts and bucket tappets operated in a hefty housing as broad as the cylinder head beneath. Its nominal 'official' capacity then was 1,601 cc, to put it in the over-1600 class, although in reality it had a 1,599 cc displacement; by the time it had evolved into the BDG, the most common variant, the block had changed to aluminium and it had grown to 1,975 cc.

## MEET THE NEW BOSS

"It was a very common engine, the one to have," says Terry Dolphin, who has been building BD-Series for years at his engineering shop in Southend, Essex. "The ones now in use will soon be all-new, but there are still original ones

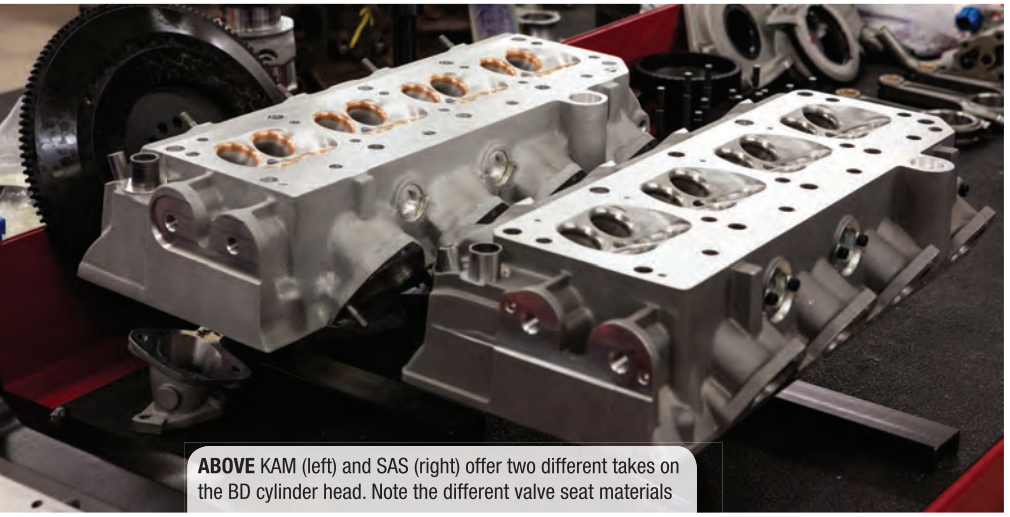


All photos: Chris Teagles

about. I did one recently, but we had to throw the head away. The cam carrier had worn away so there was 40 thou endfloat on the cams. It was dead. And that engine was already on a new block."

Dolphin knows all the weak points. "This is an engine that will rev and rev," he says, "but if you use all those revs it will break a valve if they're not changed regularly. The engine needs a strip and rebuild every 1,000 miles if it's used competitively, revving to 9,500 rpm. If just used on the road, though, it might do 40,000 miles before a rebuild. I'll fit bigger tappet buckets if the rules allow it, to make the valves' acceleration and deceleration more gentle."

John Fyda of Dundee-based Agra Engineering has also had many years of experience in BD engines. "We used to have problems with the head gaskets until there was a new laminated design. It's an old engine now, but we still build them. It was an exceptional engine but it depended on revs to make it go and its life expectancy wasn't great. You could be revving it hard, you'd go over a big jump in your rally car and suddenly you'd over-rev it."



**ABOVE** KAM (left) and SAS (right) offer two different takes on the BD cylinder head. Note the different valve seat materials

> **"An exceptional engine, but it depends on revs to make it go"**

Alan Sherwood, who runs Sherwood Engines with his son Paul, is even more steeped in Cosworth BDs. Nowadays he probably builds more than anyone else, including complete new units from kits supplied by KAM Developments, although they still look after an original 1974 unit for an Irish customer. KAM has the cylinder heads cast by Creasey Castings, and they make an interesting comparison with heads from SAS, which Sherwood also uses. SAS has them cast at Grainger and Worrall.

Two interpretations exist, then, of Cosworth's original cylinder head. Why are they different? Which is more accurate? Does it matter? "Both are much better castings than the original," says Paul Sherwood. "The casting boxes are better and so is the quality of the aluminium. Which one we use really depends on what the customer wants."

The differences are found in the subtle shapes of various lugs and in the design of core plugs. The port shapes differ, too, more binocular-shaped, as original, in the SAS head, more opened-out, as often modified back in the day, in the KAM head. And then there's the material for the valve seats, a beryllium alloy for KAM, hardened steel – reckoned better able to cope with poorer fuels – for SAS. The choice is yours.

As for cylinder blocks, new ones are available in both cast iron and aluminium. The aluminium blocks can have press-fit iron cylinder liners, or the pistons can reciprocate directly in aluminium bores with a Nikasil ▶

coating; either is period-correct. The liners can be rebored when needed, and the aluminium bores can be re-coated with Nikasil should it ever be necessary. The 0.005 inch thick coating is extremely hard-wearing but Dolphin describes how it's not quite indestructible: "The turbocharged BDTs, as used in the Ford RS200, used to detonate which picked off the Nikasil. And then it would eat itself."

The blocks, be they iron or aluminium, reveal engineering archaeology about their ancestry. The design was originally intended for a pushrod engine, so earlier overhead-camshaft conversions of a Ford unit – the Lotus Twin-Cam, for example – retained not only the machined holes in the block for cam followers and pushrods but also the camshaft, used as a jackshaft to drive the oil pump and distributor as per the original design. But BD-series blocks typically have just a series of small, unmachined, blind holes where the tappet bores would have been, and a short jackshaft ending at what was the centre camshaft bearing. Why have added friction and inertia if it's not needed?


**ABOVE & BELOW** Sherwood Engines relies on its Superflow engine dyno

## TRIAL BY TRIBOLOGY

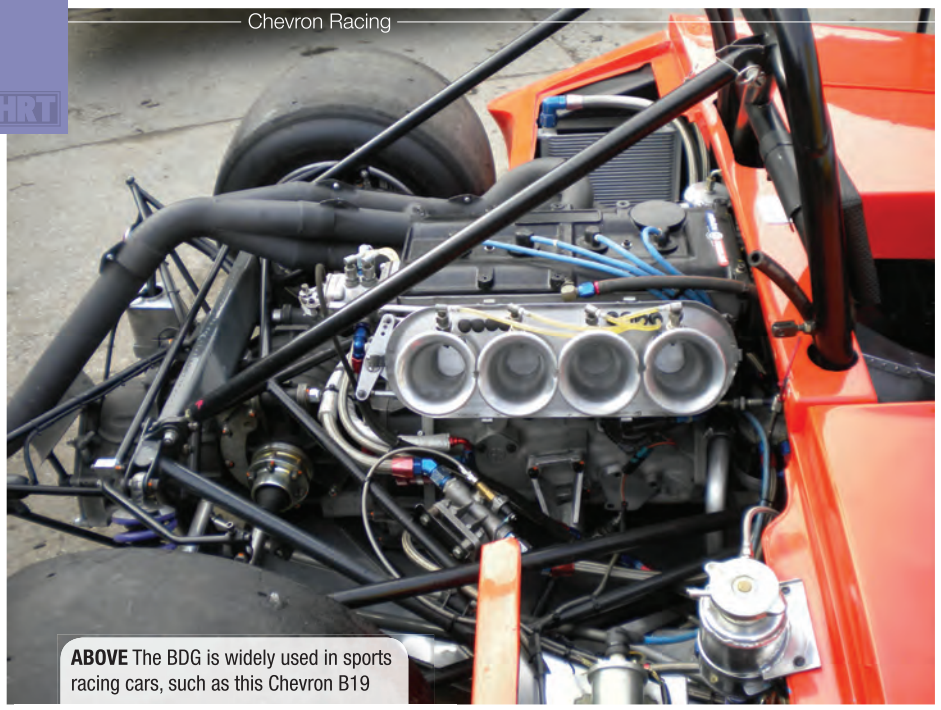
All BD engines have a dry-sump lubrication system, the shallow sump itself nowadays a cast item because the pressed ones are no longer made and have become scarce. The oil pump's dimensions are mandated by homologated specifications, but, says Paul Sherwood, "it's a bit small, and it struggles to keep the oil pressure up after a rally stage. So we run tolerances as tight as we can".

Alan Sherwood, freshly arrived after collecting another complete BDG kit from KAM, adds: "It's a particular problem with the aluminium blocks and their differential expansion relative to the steel main bearing caps. We use Millers 10W/60 synthetic oil to keep the pressure up." Another aid to healthy pressure is using a large oil filter with neither a sludge trap nor a non-return valve, so there's as little resistance to flow as possible. The Sherwoods favour a Wix item here.

Sherwood senior started the business having worked with Fords for most of his working life. Sherwood Engines, like Dolphin's operation, can build competition-ready examples of all Ford four-cylinder units and a lot more besides, with Pinto units, Cosworth YBs and Lotus Twin-Cams much in evidence alongside the BD Cosworths and the occasional Vauxhall 'Red Top' interloper. Alan Sherwood is particularly proud of his Superflow SF-902 engine dynamometer with its water brake: "It's the most user-friendly dyno in existence," he says. It measures and corrects for air pressure and humidity, which Sherwood checks against data from two weather stations either side of the workshop near Ely, Cambridgeshire to ensure repeatability and historic comparison.

While I was there, a 2-litre BDG engine which had been fitted with a new pair of Weber 48DCOE carburettors, to replace worn-out examples, was being fine-tuned on the dyno. The test runs capped the revs at 9,250 rpm, on the way to which the engine's power peaked at 260 bhp between 8,400 and 8,500 rpm with a 180 lb ft torque peak. That is a good example of what can be expected on carburettors, but there is potential for more if the engine is used in a competition class not defined by FIA rules.

How is this achieved? A higher compression ratio, slipper pistons, wilder camshaft profiles and forensic attention to detail in the build process, plus Lucas fuel injection, have combined to make an engine generate as much as 294 bhp at 9,400 rpm on the Sherwood dynamometer. But even the carb-fed ▶




**ABOVE** The BDG is widely used in sports racing cars, such as this Chevron B19

260 bhp is a useful jump over the 245 bhp the original Cosworth-built engines typically produced, and care, attention, new processes and materials, and decades of experience are the factors that have made the difference.

"The engines can run in higher state of tune now but still be reliable," says Paul Sherwood. "For example, the quality of the cylinder head studs is better, the head gaskets, from Cometic, are better, and the new castings are much better. And Alan is always trying to come up with better specs and packages." This has to be done without altering fundamentals such as the valve angles and the basic port shapes, so it's all about incremental knowledge. Sherwood Engines employs a cylinder-head expert who used to work for Brian Hart, whose 420R Formula 2 and 415T Formula 1 engines had their roots in the BDG, and all his work is done painstakingly by hand with every combustion chamber volume accurately checked by burette.

## INTERNALS

Deeper down in a Sherwood-built engine, the crankshaft is likely to be a new billet item. If it has seen some use, it will be crack-tested. Great attention is paid to parameters such as the clearance of the valve stems in their guides, and Sherwood uses bronze inserts in the Lucas injection-pump shuttle to overcome past problems with seizure. Many small parts are machined on Sherwood's site; Paul Sherwood shows me a particularly beautifully-made water pump impeller.

Sherwood Engines' suppliers include many well-known names in the motor sport world. Camshafts come from Kent Cams, either in Cosworth profiles or modern alternatives. Exhaust manifolds are by Tony Law if mild steel, Simpson Race Exhausts if stainless, with pipe diameters and lengths to suit the engine's intended use. Pistons are by CP Carillo or JE, shell bearings come from Mahle. Sparking plugs are NGK, fired by a Lumenition electronic ignition system which Alan Sherwood describes as "very reliable". And some seals are still available from Ford.

> "Brian Hart's Formula 1 engines had their roots in the BDG"

**ABOVE** BDs thrive on revs, so good quality reciprocating components are a must

As well as building the engines, Sherwood Engines aims to go out to the customer once the engine is installed to check on everything before firing it up. This will involve an appraisal of wiring, hose diameter, cooling system adequacy, anything which is vital to a new engine's health. That way, the company can be sure where the responsibilities lie should a fault manifest itself. The engines are also run before despatch, something that Terry Dolphin also insists upon.

Sherwood Engines and Dolphin are also on common ground as far as the cost of a newly-minted BDG is concerned. Depending on specification, a complete engine can be yours for between £20,000 and £25,000. If that sounds a lot, an hour watching how meticulously these masters build them soon reveals how your outlay is spent. And if you want your Escort rally car to be fully period-authentic, there's no alternative to a really good Cosworth BDA or BDG. As Dolphin says, "There's nothing better than hearing a BD coming through the forest."

# ONE-MAKE WONDER

## Historic racing isn't all paid drivers and stratospheric budgets. **Andy Swift** goes behind the scenes with the HRDC Academy

**IT SEEMS** hard to believe, but a one-make race series for dinky saloon cars may just be the most exciting new initiative in the historic racing world. The Historic Racing Drivers' Club's A35 Academy is intended to offer an affordable – and, crucially, fun – route into the rarefied world of historic racing.

The series is the brainchild of serial race organiser, old car locater, Goodwood Revival advisor and HRT columnist, Julius Thurgood. Thurgood has a long history with cars of this era, having driven them since the early 1980s. This led to the creation of Top Hat which organised long-distance races for a variety of saloon and GT races, with the emphasis on competitor camaraderie. Thurgood cites the arrival of corporate sponsorship and hospitality as his signal to withdraw and Top Hat was subsumed by the Masters organisation during the last decade.

Fast-forward several years and Thurgood found himself being approached by a number of competitors looking for somewhere to race pre-1960 saloon cars. This era of car now carries a very significant following, with fierce – and often hilarious – annual tussles in the St Mary's Trophy at the Goodwood Revival. The result is the Historic Racing Driver's Club, which caters for a number of classes at the more prosaic end of the historic spectrum. The emphasis remains firmly on the competitors, mechanics and supporters and not on corporate hospitality.

Buoyed by the remarkable success of the all-Mini races for the St Mary's Trophy at the 2009 Revival, Thurgood identified that perhaps historic one-make racing offered the opportunity for a truly level competitive playing field at very low cost. It then became a question of which car to pick, but as Thurgood asserts, "The Austin A35 was an obvious choice because it is such an iconic and loveable model, with a character of its own – it evokes a sense of fun." The HRDC A35 Academy was born.

Thurgood developed a partnership with Moto Build, creator of the wild Speedwell A35s which terrorise Mk1 Jaguars and the like at Goodwood. The Academy car has been developed by Moto Build owner Darryl Davis to provide a safe, fun and affordable entry into historic motor racing using a tried and tested selection of components from a reliable supply chain. He reckons a race-ready car needn't cost more than fifteen thousand pounds and, even better, the would-be competitor can carry out much of the work him or herself.

An Academy car can be built up from any A30 or A35, though the A35 is preferable as its transmission tunnel more easily accommodates the standard 1275 gearbox. Both Thurgood and Davis are unequivocal that a barn find represents a false economy, though building a rusty old A35 into an Academy racer is still


**ABOVE** The Academy A35 offers a safe, affordable and fun entry to historic racing


**ABOVE** Chris Rea is among those who have given the Academy car the thumbs-up

possible. As Davis maintains, "buy the best car you can because the difference in price between a wreck and a very good car will buy very little restoration on the rusty car." He also confirms that every Academy build to date has involved a ground-up restoration to the highest standards. Evidently, even for the cost-conscious racer, preparation and appearance really matters.

With a tidy, rust-free runner on the drive, the build can begin and it's fully intended that the enthusiastic and patient amateur should be capable of carrying out the work at home. Davis elaborates on the option of self-build: "Any competent mechanic could easily build the car: the more complex operations, such as the pedal box, do come with fitting instructions, and no special tools are required to build any part of the car, so while it may be time consuming it is not that difficult." So, are you feeling brave?

## STEP ONE

The first job is to strip the car back to a bare shell. Depending upon the amount of remedial work required, the owner may choose to sand blast or acid dip before carrying out any necessary repairs. It's at this stage that a solid base car will make the build quicker, easier and – perhaps most importantly – cheaper than the more romantic notion of bringing a barn find back to life. Davis advises that the arches will need to be gently rolled to accommodate the broader Academy-specification wheels before painting is considered.

At this stage, the owner might wish to consider fibreglass panels, which are available off the shelf from Moto Build. These are limited to the bonnet, boot and wings. The final stage before hitting the paint shop is a trial fit for the roll cage, with the mounting blocks for the legs left in place.

This being the gentleman's end of the sport, a degree of propriety is expected in terms of paint finish. While no colours are expressly prohibited, competitors are requested to wear a period-style hue. Additionally, HRDC guidance states that all cars must have an Old English white roof, front grille and side 'moustache'. The white roof finishes on the join line on the scuttle panel just in front of the wipers. No lairy Kawasaki green or day-glo pinks in the A35 Academy, thank you.

From there, it's a case of carefully building the car back up using the HRDC ▶




kit of parts, substituting for the originals where applicable. Davis recommends using new rubbers for the windows as they tend not to leak so badly. The side windows must still wind down but they can be made from 4 mm Perspex for safety, as can the rear screen. A laminated windscreen is mandatory. Inside, a fully trimmed interior must remain, with rear and passenger seats in place. These may be new items but must be trimmed to replicate the originals. Headlining is not required, but the same standard of paint finish on display externally is to be maintained internally.

Safety has been a key driver throughout the development of the Academy kit. As well as the revised fenestration and rugged roll cage on the inside, an FIA, MSA-approved competition seat is a requirement, complete with full racing harness. The original fuel tank is replaced with a six gallon alloy tank, protected by a firewall in the boot. Finally, the mandatory battery master switch enables quick electrical isolation in the event of any incident.

Propulsion is provided by an Austin A-series unit prepared and sealed by Classic and Modern Engine Services in Bracknell. In this form, the venerable A-series is pumping out a safe 85 bhp, compared to the 125 bhp of the Speedwell 'hot rods'.

The engine ancillaries comprise Moto Build's so-called 'Kit A' and include the inlet manifold and SU HIF44 carburettor, which Davis confirms is more reliable and easier to set up than the HS6 the team originally tried. Also in the kit bag are an aluminium radiator and fan, oil cooler kit comprising cooler, pump and braided hoses, distributor, engine mounts, breather tanks, exhaust manifold, competition air filter and intake kit, throttle cable and pedal, and alternator.

This is a comprehensive and carefully-selected pack, designed to provide the right blend of performance, reliability and price. Everything is capable of being fitted either by an expert preparer or the enthusiastic amateur, though Davis admits that the full build from bare shell to finished race car would take in the order of 200 man hours. There's no better way to bond with your new purchase, though, than to comprehensively strip and rebuild it ready for competition.

The various kits can be bought progressively or at once – to suit the owner's pocket and storage allowances. Kit B is the transmission and includes a 1275 A-series gearbox prepared to race standard and requirements. Bearings, synchro rings and seals are all uprated, while the kit also includes a competition gear level, slave cylinder and related pipework. Competition halfshafts and a rebuilt prop shaft complete the kit. Ratios are fixed to keep the field close and costs down.

Kits C and D comprise front and rear suspension componentry respectively. While the arrangement of front coil springs and dampers with rear leaf springs is carried over from the base road car, the suspension receives perhaps the most modernisation of any aspect of the Academy build. Davis compares today's set-up to how A35s raced in period: "We now use brand new lever arm shock absorbers that we have ▶

**ABOVE & BELOW** A number of kits have been developed to aid the build process, much of which can be completed by the competitors themselves


**ABOVE** The A35s look similar to those that terrorised the post-war race circuits but, beneath the skin, they take advantage of modern materials and know-how where possible

stripped and checked for consistency before upgrading the damping. In the old days, people would have just put heavier oil in the old shocks, the spring rates are much higher now than before, as is the anti-roll bar and mountings."

This set-up is evidently more sophisticated than that employed by the amateur saloon pedallers of the 1950s. Academy cars also run polyurethane and nylatron bushes in the suspension wherever possible. In spite of being more cleverly suspended, the Academy cars must run on treaded Dunlop L-section tyres. Davis is quick to point out that these tyres develop less grip than a standard road tyre so keeping progress smooth is imperative.

The final significant mechanical kit is Kit E, comprising everything within the braking system. This includes the front discs and callipers, rear drums and shoes, master and slave cylinders, hoses, pipes, and pedal arrangement. The brake set-up has been refined during the development phase, as Davis explains: "We increased the bore size of the brake master cylinder as it shortened pedal travel and gave greater confidence in stopping the cars." Small changes to add confidence for new drivers can make a big difference.

The finishing touches are the alloy fuel tank and a set of evocative Minilite wheels to set off that gentle, period paintjob. The final car looks really very similar to the A35s which terrorised the race circuits of Britain during the post-war period. Despite appearances, there is still much under the bonnet which takes advantage of modern materials and know-how. ARP engine bolts, multi-layer cylinder head gaskets, electronic ignition, and superior pistons and bearings may not make a massive contribution to the Academy A35's moderate 85 bhp output but they add a welcome layer of reliability to the package.

## SIMPLE SETUP

This is very much a series designed to allow the best drivers to flourish – Thurgood has been careful not to create an environment which might be in danger of becoming an arms race. "Attention to detail is paramount in obtaining the best from an HRDC Academy car," he comments. "That's a given. But foremost, this is a drivers' series."

In spite of this laudable attitude, there must still be some scope to make changes to suspension geometry, I suggest. "It's very simple" says Thurgood, "tyre pressures are free!" That significantly reduces the number of potential entries on the famous racing driver's list of excuses. Thurgood has nevertheless employed the services of old pal and former F1 racer Rupert Keegan to help with the development of the car to get it right as quickly as possible.

Keegan shared the first Academy A35 with journalist David Lillywhite throughout the 2014 season and his informed input proved invaluable, Thurgood explains, "Rupert is one of the very few ex-F1 drivers who does not run a huge ego. He still loves racing and he has raced in my series since I started promoting races. He is a consummate set-up man. His feedback is extraordinary and his input to the project was invaluable in making the right decisions on the set-up of the Academy car."

The Academy A35 remains a robust and simple car, with the kudos of having been developed by a former grand prix driver. As well as the HRDC's own events, including two driver mini-endurance races, the car is an easy entry into classic sprints and hillclimbs. For those drivers wishing to progress, Moto Build will provide all the necessary kit to upgrade to full Speedwell specification – perfect for baiting those big Jags.

The concept is quickly gaining traction and Thurgood estimates up to eight A35 Academy cars will be out during 2015. The HRDC has created an historic race series with perhaps fewer barriers to entry than any which have come before. Conceptually, there may remain a few purists who need convincing of the merits of a one-make (and effectively single car) race series. The low cost, high fun and genuine driver-orientated meritocracy may yet convince them – and let's not forget that the Junior Car Club was organising one-make races at Brooklands between the wars! There's never been a better time or place to kick off that historic racing career. HRT

# TO PROTECT AND SERVE

Coatings and surface treatments can provide protection and performance benefits. **Chris Pickering** and **William Kimberley** investigate the options

**CHOOSING** materials can be a frustrating process. The mechanical properties required at one point on a component can be very localised and quite contradictory to those elsewhere. For instance, hardness and smoothness may be paramount on the outer surface of a part, but the dense materials that provide these qualities may be too heavy for the component as a whole.

Applying a thin coating of additional material solves this problem, allowing you to achieve seemingly impossible combinations of properties. The same applies to surface treatments such as carburising, nitriding and superfinishing, which can dramatically transform the localised characteristics of the material.

Some might question the ethics of using modern coatings and surface finishing techniques to engineer a performance advantage on an historic car, but it's an increasingly common practice. They can also help to safeguard original components by providing corrosion resistance and thermal protection to materials that would otherwise be exposed to the elements.

One of the unique factors of historic motorsport is that the components can come from the unlikeliest of sources. Although the idealised 'barn find' is perhaps a less common occurrence than some would like to make out, it's not unknown for a car to be dragged out of hibernation with years of accumulated muck and corrosion. In such cases, techniques like vapour blasting and acid dipping can restore the underlying metal to pristine condition.

## ZIRCOTEC

F1-inspired thermal barrier coatings may seem a bit extreme on cars that never benefitted from such technology in-period, but the fact is they are often needed. While blistered paintwork or a few hastily improvised additional cooling vents might have been considered an acceptable solution in-period the idea of taking a pair of tin snips to, say, a 250 GTO these days would bring tears to the eyes of most enthusiasts. And that's assuming it has no more heat to dissipate. In many cases, modern fuels burn hotter than their period counterparts, while advances in components have led to higher engine speeds.

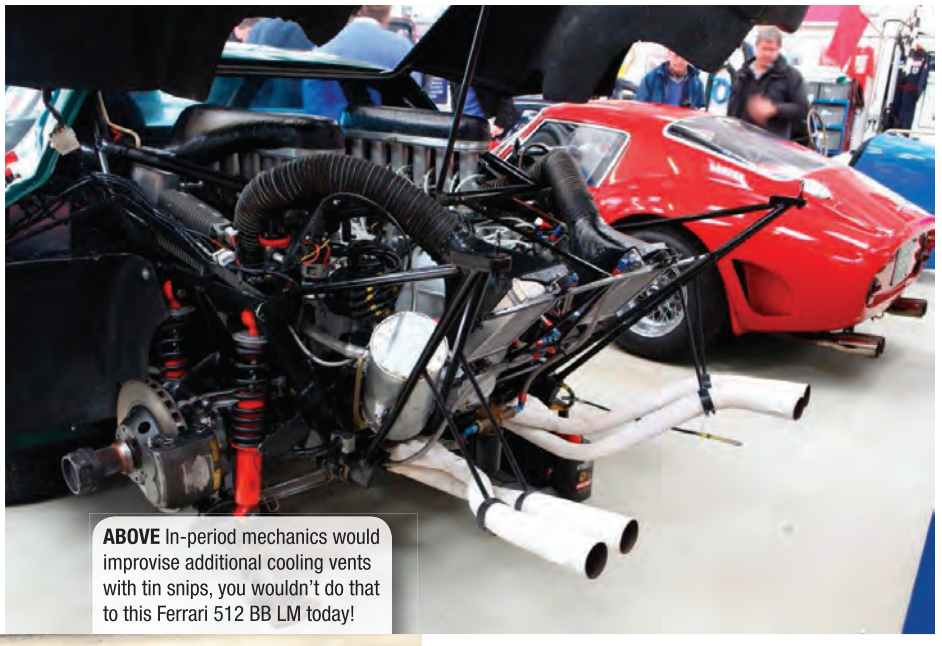
Zircotec's ceramic thermal barrier coatings effectively fall into three different categories, explains the company's managing director, Terry Graham: "Performance White offers our highest level of protection, but the white finish is slightly absorbent, it will show oily fingerprint marks. The next grade is our Performance Colours range, which uses the same underlying coating with a coloured top coat that seals the pores in the coating. That's basically for aesthetics – it has virtually no impact on the thermal performance and it comes in 14 different colours. A lot of people go for blacks or greys

**BELOW** An Abarth exhaust system treated with Zircotec's Performance White coating

[which resemble period exhaust paint]. Finally, the Primary Colours range is a low cost option for applications where the level of performance is not quite as critical."

Ultimately, it's always best to stop heat transfer at the source (i.e. the exhaust) because this is where the greatest temperature reductions can be achieved. But where that's not possible the next best thing is to protect the components around it.

During the blown diffuser era, Zircotec developed a spray-on thermal barrier for composite surfaces, designed to withstand the onslaught of exhaust gases. While blown diffusers are not generally a factor in historic racing (last of the Group C cars aside...)



**ABOVE** In-period mechanics would improvise additional cooling vents with tin snips, you wouldn't do that to this Ferrari 512 BB LM today!

there are plenty of areas where a coating capable of being sprayed directly onto fibreglass bodywork could be of use.

The thermal protection performance is similar to that of the company's ZircoFlex stick-on foil, but the coating is a fit and forget treatment that should last for the life of the panel and can potentially blend in with the original surface.

"Until now it's not something we've really promoted in historics, but it is a growing market," says Graham.

The spray process is much the same as that used on exhausts with a few tweaks to the plasma system and the raw materials; the ceramic coating material is melted at very high temperatures and propelled towards the component at around twice the speed of sound. There, the molten droplets flatten, cool and quickly solidify to weld themselves in place.

"People find it slightly odd that we're using a plasma spray process for fibreglass where we heat the surface to 10,000 deg C and shoot particles at it at twice the speed of sound. It sounds terrifying, but the particles are tiny so the actual amount of heat transferred is very small. The component condenses and solidifies very quickly with only very localised melting - the particles are effectively welded on." ▶


**ABOVE** Peter Carter's Phantom P79 serves as a rolling test bed for Camcoat

## CAMCOAT

Anodising is one of the oldest forms of coating, but traditional sulphuric anodising has limited applications and is principally carried out for aesthetic reasons. Hard anodising, meanwhile, improves strength and wear resistance, but it comes with a number of challenges. For a start, the part's external dimensions grow as the process is applied and it can't be coloured.

There is, however, another option in the form of the DiamonDyze ceramic anodising process. Originally developed by Canadian firm Hupe Manufacturing in conjunction with US coatings specialist Tech Line, it's now been brought to Europe as a sub-division of Camcoat Performance Coatings

Its creators claim that DiamonDyze offers the best of both worlds. Wear resistance is said to equal or better to that of hard anodising with virtually no change in dimensions and a wide range of colour options. Like all anodising, it relies on oxidising the surface of the aluminium, but the DiamonDyze process also deposits a ceramic material onto it, giving a hard-wearing surface with very low friction. Crucially, however, the oxide layer grows into the metal rather than sitting on the surface.

"With traditional hard anodising, if you put a 30 micron layer on, 15 microns will grow into the metal and 15 microns will grow outwards, so with something like a piston you'd end up with a 30 micron increase in diameter," explains Camcoat and DiamonDyze managing director, Peter Carter. "With ceramic anodising you maybe add 3 microns at the most, so the parts can be used straight away."

At first glance, the equipment used to apply DiamonDyze coating looks no different to a regular anodising line. An electrical current is passed through an electrolytic solution with the aluminium part forming the positive electrode. The current releases hydrogen at the negative electrode (the cathode) and – more importantly – oxygen at the anode, forming an oxide layer.

"We've had tests done which have shown a 12 per cent improvement in wear resistance over traditional hard anodising," says Carter. "Hardness is perhaps fractionally less, but it's very close, you're still talking 400 Vickers. The main thing, though, is surface finish. Aluminium is typically something like 2.8 Ra but DiamonDyze takes that down to around 1.7, so it's a very dense, hard, slippery surface. It's fantastic for things like pistons."

Camcoat's existing range continues to grow with polymer and ceramic coatings for applications including thermal insulation, heat dissipation, corrosion protection, wear resistance and lubrication. These all rely on the same basic spray/bake process, where the coating is sprayed on before being oven cured. Things like brake coatings are applied at 150 deg C so they can be used on virtually any material, while some of the exhaust coatings go on at up to 450 deg C. As a rule of thumb, the higher the curing temperature the greater the protection available from the finished surface.

The company's exhaust coatings provide protection at up to 1,000 deg C and have seen service on a large number of historic cars. "We've coated hundreds of cars with our Black Satin exhaust coating," says Carter. "One of the advantages – particularly when you get to valuable cars with original exhaust systems is that we coat the inside. That prevents any corrosion, which gives it virtually unlimited life."

Camcoat also offers a thermal dispersant – also developed by Tech Line – called TLTD. This helps to dissipate heat from metal surfaces anything up to 20 per cent more effectively than the uncoated surface. "We're finding it helps with big drum brakes and for that matter the callipers on disk brake cars," says Carter.

Another interesting application is the use of the clear LTC coating for long term crack testing on tubular chasssis. Carter uses this on his own car, a Phantom P79, along with a host of other Camcoat products. "That's our test bed," he comments. ▶

**BELOW** Pistons treated with a variety of Camcoat's products, including DiamonDyze, ceramic crown coatings and thermal dispersants

## AQUABLAST

Cleanliness is next to godliness, or so the saying goes, which is good news for the father and son team of Jonathan and Aaron Wright. Their business is to restore the shine to parts that have long since seen better days. If this sounds like a glorified valet service, then think again, because what Wright senior and junior do is more than just adding a buff to a sheen. "We understand that impeccably clean, well prepared surfaces are fundamental to any mechanical, engineering or preparation process," says Wright senior.

While Jonathan took an apprenticeship in the aircraft industry, Wright junior earned his engineering spurs working for Lister Engineering in Cambridge, renowned for the world famous Lister Jaguar, as an apprentice. Both are also keen racers, Jonathan even been given a big write up in *Autosport* magazine in 2009 for taking the Golden Helmet award for being Britain's most successful driver, notching up 27 wins and 26 pole positions in the 34 races he entered that year, more wins than anyone else in the country. Aaron is an up and coming motorcycle racer, currently developing a Triumph 675R.

"What started out as a sideline business specialising in bikes and classic cars, mainly to do our own parts, but as the word of what we do has spread, so has demand for our services," says Jonathan. By referring to Aqua Blast UK (Cambridge) as a sideline business, Wright's main business is Industrial Site Services (Cambridge), a high-end engineering and machine shop that provides parts and services to the aviation industry.

Jonathan is at pains to point out that the aqua blasting, which is also known as vapour blasting – a process that utilises 100/150 micron glass media suspended in a high-pressure water system – is not a performance enhancer, but one that degreases and cleans. As he describes it: "It's completely non-aggressive so there's never any danger of sensitive items like valve seats or gasket faces, for example, being scratched. What it does is sympathetically bring components and parts back to as new, producing a satin finish which can be handled without picking up finger marks and gently peens the surface so can help reduce porosity in castings and it's very easy to keep clean."

Aqua/vapour blasting, which is suitable for aluminium, bronze, magnesium, titanium, brass and copper, is ideal for a wide range of both bike and car components such as engine and gearbox casings, cylinder heads, blocks, carburettors and crankcases.

In addition to this service, the Wrights also offer a welding service, which has proved beneficial to the majority of their customers, Jonathan saying that something like 70 per cent of the parts brought in for aqua/vapour blasting are broken and need to be welded together. In some case, they even have to fabricate new parts that are then welded in: "This is an important service we offer and having an in-house welding service has proved really beneficial."

Asked what has been one of the most challenging jobs they have had to tackle in the 18 months since the company has been trading, Jonathan refers to a one-off stainless steel exhaust system fabricated for a Honda CBX 1100 Turbo which had to wrap around a Spondon frame. Other recent items include repairs to an engine case with missing parts for a Honda CBR900, a Yahama DT400's head and barrel and modifications to the inlet manifold of a classic racing Mini.

The way things are going, a conundrum facing Wright père et fils over the next few years could be managing a role reversal, because at this rate, the aqua/vapour sideline could well be the tail that begins to wag the dog. ▶


**BELOW** Alfa Romeo Giulietta cam covers before and after Aquablast

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## SANDWELL UK

Sandwell UK has been in business for almost 20 years, during which time it has built up a reputation for its specialist surface engineering solutions and its expertise in shot peening technologies. While managing director Liz Taylor looks after the business end, it's technical director and fellow co-founder Colin McGrory, who has a background in metallurgy and a 21-year career in Formula 1 including stints at Arrows, Stewart Ford and Jaguar, who is the driving force behind the company's technical advancement.

Another key person is engineering manager Paul Neil who joined the company in its early years. Regarded as a source of knowledge for all of Sandwell's activities, and in particular its resident expert on specialist coatings, he undertakes a variety of projects for the company's research and development and is currently involved in increasing Sandwell's level of process automation.

While its coatings and superfinishing technologies are a vital part of the business, shot peening is a growing part, the company commissioning another multi-axis shot peening machine in mid March.

"Shot peening basically induces a compressive layer on the component's surface," explains Neil. "After having been machined where you get tooling dragging across the surface which puts the whole surface in tension, or when it cools down after having been welded, there's shrinkage causing tension in the surface and that tension is trying to pull itself apart. Assuming there are no material defects then a crack will almost always propagate from the surface. This means that any force that's strong enough to make a crack has not only got to overcome the normal yield strength of the material, but also overcome the additional compressive stress that we've put into the surface."

Superfinishing is a process that refines the surface and is most applicable for reducing the friction in a gearbox. "After shot peening small dimples are usually left on the gear's surface so what superfinishing does it to bring back the contactable surface area while maintaining the dimples on the surface to retain the lubricants. The end result is that both friction and heat are reduced in the gearbox."

On the coatings side of the business, Sandwell UK offers two – Kephos and Xylan. The former is a single or dual coat phosphate paint system that affords good resistance to chemical attack and is especially suited to environments where brake fluid and similar oils are present. "One of the main advantages is that due to its coating thickness of 10µm it is possible to crack test without the need for coating removal," says Neil. "It's available in any colour the customer wants as long as it's black and it's ideal for weight limited applications, suspension components, axle rods, engine frames and fasteners."

The Xylan coating comes in a variety of grades, all offering different properties. The two used by Sandwell UK are 1010, a low friction coating that's said to offer excellent chemical resistance and the greatest operating temperature of any fluoropolymer coating; and 1070, a low friction coating that provides high corrosion resistance, even at high temperatures.

"The Xylan coatings are a little bit more high-tech than the Kephos," says Neil. "It's a PTFE coating that has various different uses, mainly as a release agent or for friction coefficients. It can be used as a decorative finish or the low friction version on the internals of a scavenge pump, throttle slide, piston skirts and superchargers." HRT

**ABOVE** A Xylan coated subframe for a rally car

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Chris Teagles

# Lords of the rings

**Incremental changes to piston and ring technology can add up to a big benefit. Chris Pickering talks to one of the leading experts in the field**

**ABOVE** A Coventry Climax piston produced by Omega

**THEY** say it's the little details in life that matter. And that certainly seems to hold true when it comes to pistons. You'd struggle to measure some of the subtle changes in geometry that Omega Pistons applies to its historic racing parts, let alone pick them out with the naked eye. But they're there.

The same goes for the advances in heat treatments and manufacturing techniques that help the piston to stand up to the rigours of competition. Outwardly there's very little to distinguish the new parts from their period counterparts; it's the small differences that add up to a significant improvement.

Founded in 1972, Omega is able to draw on a wealth of experience, not least that of managing director Fred Hadley, who has been with the company since the start. These days, however, the facilities have grown to include state of the art 3D modelling software and an extensive CNC machining suite.

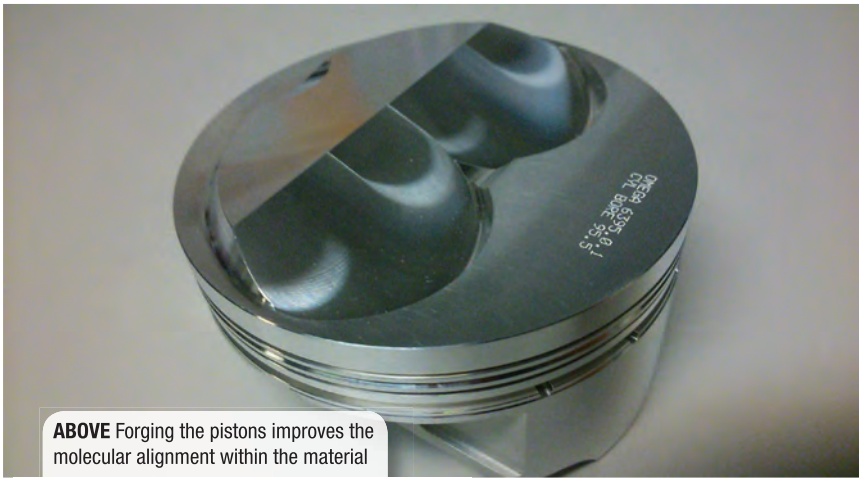
The recent surge in interest in historic racing has seen the order books swelling, with something like 50 per cent of the business now devoted to classic and vintage pistons. "Historic racing is a big part of what we do, both for cars and bikes," explains general manager, Andy Baker. "Some of the designs are completely new to us, whereas in other instances we're dusting off original tooling that was used in the '70s or '80s."

Where required, Omega can put a modern twist on these designs, such as up-to-date ring technology and skirt profiles, he explains: "In the past all the ovality and the barrelling was put on manually, but now we have two very sophisticated CNC machines. That means we can tailor the profiles far more to suit individual engines."

Designing the skirt profile can be a deceptively complex job. Two pistons which have the same clearance on paper can have very different thermal expansion characteristics in practice.

It comes down to a mixture of cold hard science and engineering intuition, says Baker: "If you take the 2-litre Ford Pinto engine, for example, we know a huge proportion of the engines now being raced have actually come out of the scrap yard. Prior to being dug out they were sat in the scrap yard with three inches of water in the bottom with half an inch of sediment, so the bottom of that block is going to get hotter than the top and it's going to get hotter than it would have done when it was new 40 years ago. We're only talking tenths of a thou, but [with CNC machining] we can change the profile very easily to suit that characteristic."

Omega tends to use a high strength aluminium alloy called 2618A, which is a derivative of the Rolls Royce RR58 material that can trace its origins back to the Merlin



**ABOVE** Forging the pistons improves the molecular alignment within the material

engine. Advances in heat treatment and ageing have led to significant improvements to the material since it first made the leap to motorsport in the 1950s, however. Unusually, both are carried out on site. For some applications Omega also uses coatings, although with so many historic blocks made from cast iron the benefits are not always as dramatic as they can be in modern engines.

Originally, most historic pistons would have been cast. Omega does still produce high-grade castings from LM13 aluminium alloy in its on-site foundry, but these days they only account for a small part of the business. Likewise, some pistons – usually one-offs or prototypes – are machined from billet. Most, however, are forged.

It all begins with aerospace-grade alloy bar received in 'F condition', which has been extruded repeatedly to generate a very dense grain structure. Forging the pistons improves the molecular alignment within the material, leading to an exceptionally strong part, which is then heat treated (again in-house) to a variation of 'T6 condition'.

## RINGS OUTLAST ENGINE

One of the main areas for development is the ring pack and the associated grooves, Baker explains: "We can get rings now which are 1 mm wide nitrided steel that will last longer than the engine. Back in the '70s steel rings just weren't available. The old cast iron rings used to wear a lot quicker so they had to be thicker and you might have had a 1.75 mm ring in its place, causing far more friction."

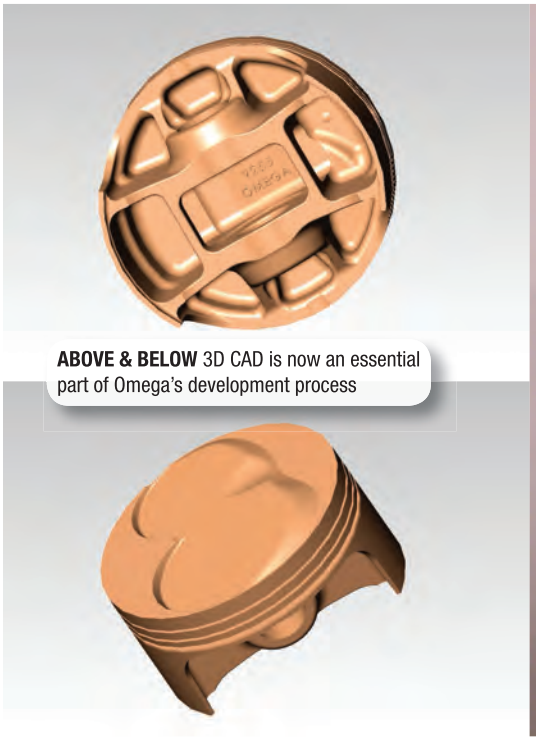
Older rings are typically far more susceptible to thermal collapse , so they run much higher static tension to give the right characteristics at working temperature. This means there are significant friction benefits to running a modern ring pack.

"Recently we did an old Aston Martin that represented the very best technology in its day, but looking at the ring pack today you wonder how it even ran," he says. "The tension was so high I struggled to push it in with my fingers and the radial depth and height were huge. A modern piston for this engine would still have to have the same deck height and dome height to achieve the right compression ratio, plus the same valve cut-outs etc, but with a modern ring pack and better profile you've got a lot less friction."

It's a similar story with gudgeon pins. On a lot of old engines the gudgeon pins span virtually the whole width of the piston, with buttons on the end to retain them. Thanks to better materials, improved fasteners and modern machining techniques it's now safe to use a circlip. In some instances this means 20 mm can be removed from the length of the pin. Even if the regulations don't permit any changes to the external dimensions, there are still advantages to be gained from tricks such as enlarging the internal diameter. It's not unknown to shave 40 or 50 g off the weight of the original pins, Baker explains. And don't forget, that's per cylinder, right at the business end of the reciprocating assembly.

There's also a trend at the moment for engine builders to fit much longer conrods to their engines. This allows the compression height to be reduced, with much smaller skirts, to reduce the length. The overall stroke remains the same, but the reduced weight of the piston this allows more than compensates for the longer conrod.

"We are the only specialist piston manufacturer in the UK which can take care of forging, heat treatment and the production of gudgeon pins and piston rings under one roof," concludes Baker. "And because this is all done in-house we can spend a lot of time refining the details." HRT



**ABOVE & BELOW** 3D CAD is now an essential part of Omega's development process

**ABOVE** A cross-braced piston for a Volvo B230

# MODS TO ROCKERS

## Engineer and motorcycle racer **Peter Hindley** turns to a 21st century solution to fix a unique 1930s powerplant

**I NEVER** really liked British bikes. Brought up on a diet of Spanish and Italian trials bikes, with a slightly unhealthy fetish for Kawasaki triples on the road, I never really came into contact with them. Most of my mates had Japanese four stroke multis, or delicious early nineties GP replica two-strokes. No one I knew had anything British or old, apart from my mate's dad who owned a dog-eared square four Ariel (which constantly dripped oil and never moved).

All that changed a couple of years ago when my good friend Mike Botting offered me the chance to ride an AJS R10 that had been ridden in the 1931 Senior TT by George Rowley. What a fantastic experience! I relished the challenge of riding something completely different. So much more mechanical understanding of the machine is required to make smooth progress, it gives you a real appreciation of the 80 mph + TT laps the likes of George were posting back in the day.

And then it broke. The exhaust rocker arm snapped clean in two. Naturally I offered to source a new one to replace it, it seemed only common courtesy as Mike had been good enough to let me ride the bike. And that's when the problems started.

Being an ex-works bike (only three were made) the unique-to-bike rockers were not exactly prolific. Nothing even remotely close seemed to be adaptable or could be modified to work.

"It's okay, I'll just make one."

I regretted the statement almost as soon as it left my lips. The part was a swine. Clearly machined from solid steel by a highly skilled individual some 82 years ago, this hand made part was worn smooth with time and had no flat faces or obvious datums to work from. The part would require multiple fixtures making simply to hold it before the many hours of machining could commence. 'This could get really expensive,' I thought to myself.

CNC machining is a term which is often bandied around at times like this, but the machine still needs a program to be written, and the part still needs to be held securely in order to be machined. CNC manufacture for one-offs rarely stacks up; producing the part as a casting is another option, but patterns are expensive and foundries can be reluctant to deal in very small volumes.

But is there another way? Rapid-prototyping has been with us for some 20 years now, and the process is gradually gaining traction. The basic concept is that a part can be drawn in 3D CAD and then simply 'printed' from a variety of plastics in what looks like a giant microwave. Part strength and accuracy are very good nowadays, comparable in fact to an injection moulded part. The plastic part can then be used for prototyping or even as a finished usable part.

Plastic parts have other uses too, they can be used as patterns for sand casting. Last year I produced a magneto-drive housing for a 2 3/4 hp Sunbeam using this process. The casting was first drawn using 3D CAD before adding a two per cent shrinkage allowance, and then 'printed' in plastic to produce the pattern. The aluminium casting was then produced using traditional sand casting techniques. The advantage over traditional pattern making technology was cost and speed.


Alfred Noakes

**ABOVE** Mike Botting's AJS R10 is now back on the track

### LASER SINTERING

As far as our rocker was concerned, an aluminium casting would probably not be man-enough, and as I can't melt steel at home, another option was needed. As luck would have it, the University of Wolverhampton has an EOS EOSINT M 280 laser sintering machine which can again print parts, but directly in steel (or Inconel, stainless steel, aluminium etc.) This process uses a 400W laser to fuse powdered material


**ABOVE** George Rowley streaks through Parliament Square in Ramsey during the Senior TT

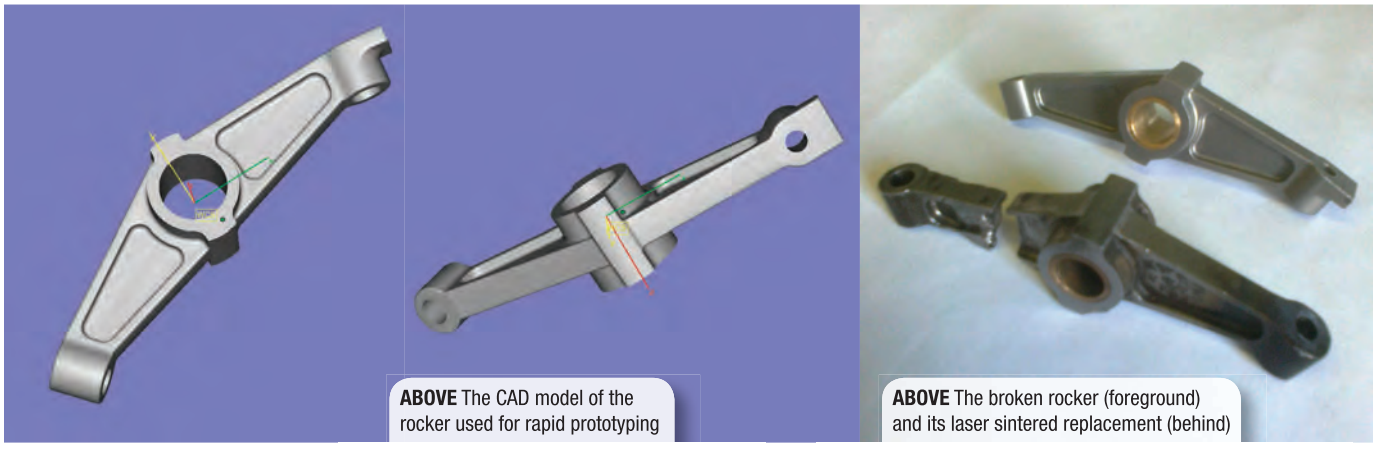
together to form the part. Mechanical properties are excellent: dependent upon the chosen material, yields of up to 1800 Mpa are achievable and accuracy of ± 0.004" commonplace. The part can also be post machined (reamed, tapped, welded etc.) as would any normal steel or aluminium part.

These processes, however, are not the all-encompassing solution to everything. Rules apply, and traditional production methods may be more applicable to that replica engine you are planning on making.

With either plastic or direct metal parts, the major factor controlling cost is the volume of material used, complexity is irrelevant as far as the machine is concerned. A $10cm^3$ cube would cost the same as $10cm^3$ replica of St. Basil's Cathedral. Small intricate parts currently make sense; large featureless parts don't. The rockers shown here cost £370 each, which is cost effective when compared with a machined or cast steel part given that only two are needed. Had the shape been a little kinder, or more parts required, then traditional machining may have won out.

Speaking of shapes, it is worth bearing in mind that there are no limits to what you can produce using these processes. The engineer has traditionally been constrained by 'am I milling it or turning it, can it be held, can I get it out of the mould' questions. Now you can drill round corners, make fully enclosed hollow sections or even print parts within parts. Formula 1 roll hoops, wafer thin skin with an internal spider's web of support material, are being made. Cylinder heads for Moto3 are currently being printed, and port shape is no longer decided by a compromise between gas flow and machineability, but purely ideal gas flow. The only limit is your imagination.

This process worked well for us on this part, but the technology is still very young. Today, it is possible to print an entire functioning motorcycle using these processes, but the cost would be horrific. In 10 years' time, however, direct metal printing will be far more commonplace and cost effective than it is today, and making unobtainable bits for old cars and bikes will be far simpler. Surely that will be of benefit to us all? HRT



**ABOVE** The CAD model of the rocker used for rapid prototyping

**ABOVE** The broken rocker (foreground) and its laser sintered replacement (behind)

**BELOW** The small but perfectly formed Amilcar C6

# ALL MOD CONS

**Chris Pickering** investigates the cutting edge modern techniques being used to replicate a programme of modernisation first carried out on this Amilcar C6 in the 1930s

**LIKE** people, cars of a certain age all come with a story to tell. As the years go by, they build up a patchwork of different experiences which cumulatively shape their personality.

The small but perfectly formed Amilcar C6 Voiturette you see here is a case in point. While it may have been stunning to behold, and deceptively potent thanks to a race-derived 1,100 cc twin overhead cam supercharged straight six, the C6 was never big on creature comforts when it left the factory.

Following a spell as a racing car at Brooklands and Shelsley Walsh, this 1927 example was sold to an enterprising Russian engineer, sometime around 1933. He set about tailoring the car to his own specification, which included such luxuries as a remote gear linkage and an electric starter motor.

At some point in the intervening three quarters of a century the gearbox extension was removed, but the current owner has decided to reinstate it as part of a major restoration. With the original assembly long since lost, all that remained was a single black and white photograph from which to resurrect it.

The job fell to KW Special Projects, a high-tech engineering and manufacturing firm based in the heart of the UK's Motorsport Valley. And what really sets this project apart are the techniques employed in its execution.

The process began with setting up the existing gearbox cover in the KWSP workshops and then scanning to create a 'cloud point' data model of the casting, including all of the mechanical interfaces.

"Using SolidWorks Pro CAD software, we converted the scan data into useful CAD files that gave us the mechanical interfaces and geometry to begin designing the new cover," explains KWSP managing director, Kieron Salter. "Because the original castings were manufactured from handmade patterns, there are not many exact features within the cover that can be predicted, so the scan data had to provide a very accurate representation of the original.

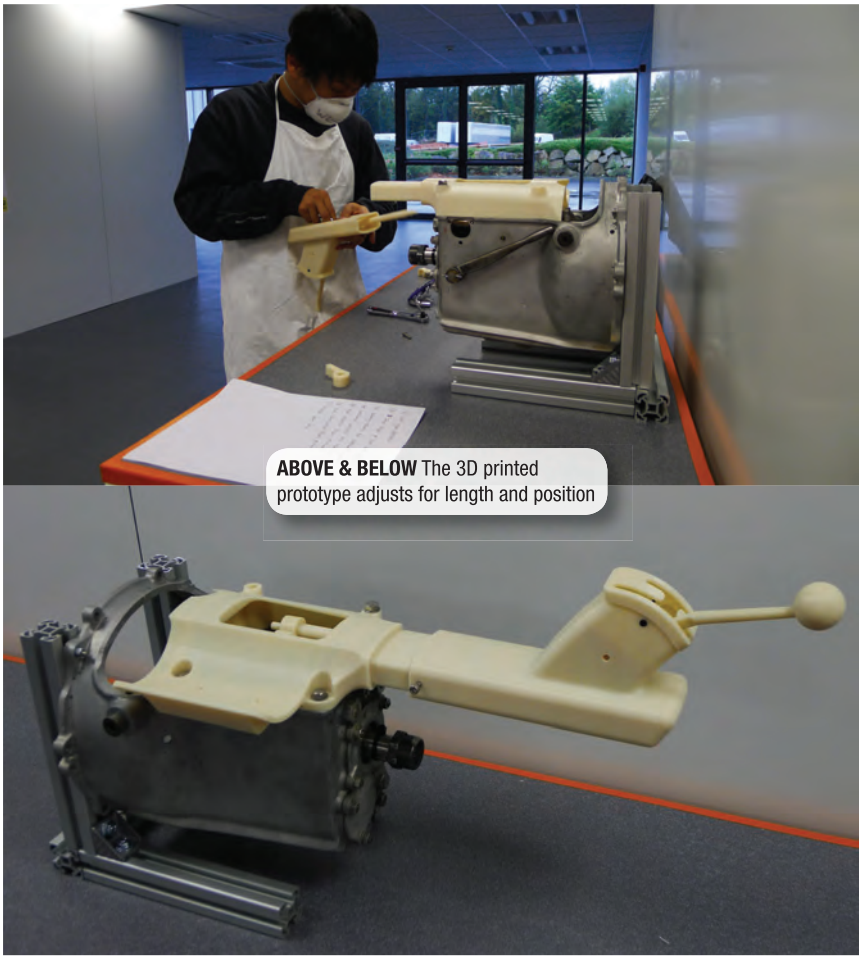
"Also, the new position of the gearshift via the remote linkage was not easy to predict, so we not only had to reverse engineer the casing, but also its installation in the car and the hard objects such as the dash bulkhead in order to get the positioning correct. We also needed to design a linkage mechanism that could allow a simple retrofit to the existing gearbox mechanism that would be stiff, reliable and give good feel and feedback to the shifter."

The ergonomics of the C6 cockpit are best described as cosy. It is a tiny, lightweight car that provides very little

room to manoeuvre once you've got a driver and passenger onboard. For that reason, it was felt necessary to build a prototype of the casing and mechanism to validate the ergonomic success of the new design.

KWSP looked into three different types of extension, evaluating each for performance, cost and manufacturability, before settling on a dual rod linear mechanism.

With the concept agreed upon, the engineers set about designing the new extension, based on the hard points from the CAD model. This too was drawn up in SolidWorks before the CAD data was fed into KWSP's Stratasys FDM 3D printer to create a fully functioning prototype in ABS plastic.



**ABOVE & BELOW** The 3D printed prototype adjusts for length and position

## DIGITAL WORLD

The ABS prototype was designed to adjust for length and position, allowing the ergonomics to be assessed. In total – from the creation of CAD data through to prototype manufacture – the process took less than 24 hours.

"The reverse engineered ABS model was not only vital in the design process, it acted to validate the casting pattern, thus saving time and cost by avoiding expensive redesign or rework," comments Salter. "All the data we collected remains in the digital world, so it is highly repeatable and multi-functional."

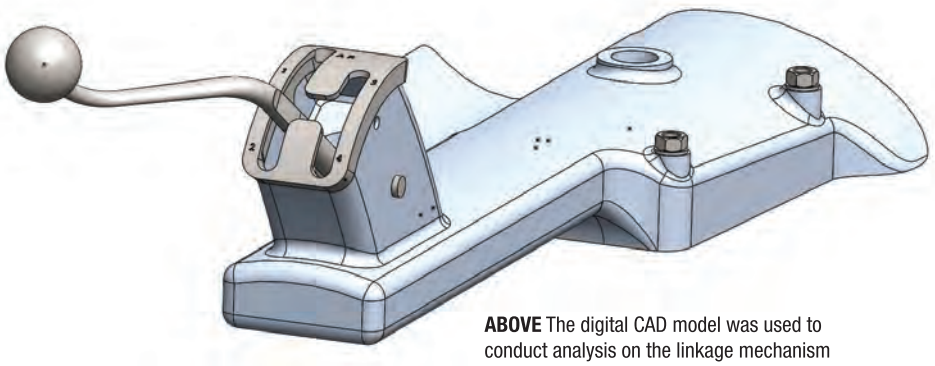
KWSP used the same digital CAD model to conduct finite element and kinematic analysis on the linkage mechanism, the ABS plastic model and the final aluminium casting. State of the art CAD rendering tools also meant it was possible to create photo realistic images of the new parts for the owner, based overseas, to review and sign-off prior to manufacture. "This saved us a huge amount of time and gave our customer confidence in the final design," he notes.

From there, Salter worked with a specialist foundry to cast the new casing in aluminium. The end result is indistinguishable from the original, but the process involved has been very different.

Using 3D CAD data provided by KWSP, the foundry was able to 3D print the sand moulds direct from CAD. This eliminates the need for a traditional pattern, saving time and money when it comes to a one-off project. Because you no longer have to extract a solid pattern from the sand core, it also simplifies the geometry of the casting, eliminating the need to worry about tricky draft angles and undercuts. Nonetheless, the CAD model used for the mould still has to be designed to promote the flow of molten metal through the structure and it has to be designed with additional material in any areas where sacrificial material will be machined away.

We caught up with Salter just as the casting had been completed and the casing was being sent through to heat treatment. Such has been the success of the rapid manufacturing techniques that the company even considered extending these to the H-pattern gate and the gear lever. In the end these were machined from solid, but it demonstrates the potential that exists within additive manufacturing.

As the restoration work nears completion, the C6 is gradually returning to its prime, complete with the remanufactured gearbox extension. It's another new chapter in a story that will hopefully run for many more years. HRT



**ABOVE** The digital CAD model was used to conduct analysis on the linkage mechanism


**ABOVE** Neil Fender heroically taking on the rain

# QUALITY NOT QUANTITY

The choice in lubricants for the historic racer is large and growing, but as **William Kimberley** discovers, there's more to it than just choosing one on price

**PENRITE** is an Australian oil company that has been in the vintage, veteran and classic car market in Europe for around 30 years. It offers a broad range of products that includes gear additives and coolants, plus brake, suspension and steering fluids. It also carries over a dozen veteran, vintage and classic low-detergent engine oils for vehicles from the Edwardian era through to the 1950s and high detergent oils where better filtration is available for more modern cars.

Martin Gough, Penrite Oils' general manager in the UK, is proud of the fact that Penrite has been active in Europe and the UK for over a quarter of a century, during which time it has studiously built up its name and reputation.

"People make weird and wonderful assumptions about the classic car market, believing that it's like the rest of the automotive market, but it's not," he says. "Where you find people hunting around for the best bargains in oils when it comes to modern cars, in the classic car market they're looking for something to protect an investment more than anything else. For example, a common complaint on older cars is low oil pressure, so we've moved customers from 20W-50 to 20W-60. Another common complaint is the need to change oil for winter, so we've included rust prevention and additives within the original products to save them that oil change."

Gough stresses the fact that it is quality rather than quantity as far as Penrite is concerned and understanding the specific concerns of its customers. "Everything is keyed in to high zinc so in general our classic oils have around 16ppm zinc or ZDDP (Dialkyl DithioPhosphate).

"We could make a cheaper oil but we only use Group II base oils which are defined as being more than 90 per cent saturates, less than 0.03 per cent sulphur and with a viscosity index of 80 to 120. Since all the hydrocarbon molecules of these oils are saturated, Group II base oils have better antioxidation properties. They also have a clearer colour and cost more in comparison to Group I base oils."

Group I base oils are solvent-refined, which is a simpler refining process and so are the cheapest base oils on the market. They are classified as less than 90 per cent saturates, greater than 0.03 per cent sulphur and with a viscosity-index range of 80 to 120.

"While someone buying the oil would not understand the full processing, they would see it in the performance for sure," says Gough. "Our products look water white to the eye, some thinking that there's something wrong with it; but with base oils, the clearer, the better."

Penrite also has a wide range of gear oils that includes the traditional sulphur phosphorous products as well as EDP, a non-sulphur phosphorous product that will not tarnish or pit yellow metals and is also based on zinc technology. "It's really very suitable for things like gearboxes and differentials that have brass and bronze bushings that would otherwise be susceptible to being attacked by sulphur phosphate that does happen at a certain temperature," he says. HRT

# Shifting expectations

**Chris Pickering** looks at the new partnership bringing decades of experience to Hewland's classic gearboxes

**ABOVE** Hewland Classic provides servicing and spare parts for all of Hewland's historic gearboxes

**EVER** since Mike Hewland set up a small engineering firm bearing his name in 1957 the brand has been synonymous with racing gearboxes. The Berkshire company's big break came with Volkswagen-based Formula Junior units in the early sixties, but it rapidly went on to supply teams in everything from Formula 1 to Can-Am.

These days the factory has its work cut out catering to an ever expanding range of modern products, so last year Pontefract-based PDS Racing was brought in to oversee the classic range. This decision led to the creation of a separate company, Hewland Classic, which now looks after the parts and servicing for all the H-pattern gearboxes.

"PDS has been a Hewland sales and service agent for 35 years," explains Peter Smith, managing director of PDS Racing and Hewland Classic. "It got to the stage where we were manufacturing historic parts on behalf of the factory because they couldn't keep up with demand. When Hewland restructured a few years ago the decision was taken to split the product range into the modern sequentials and the pre-1990 H-gate boxes, which covers everything up to Group C. Thankfully the Hewland board decided we were the most suitable candidates to take on the classic work."

It means for the first time the full range of classic gearbox components is available to the original patterns and sizes. Gear cutting is still handled by the factory, but parts like casings, washers and spacers are taken care of by Hewland Classic. The new parts are all fully interchangeable with their period counterparts, but they benefit from modern quality control and tolerancing.

"With modern manufacturing techniques you can work to much closer tolerances," explains Smith. "The materials are alloyed much better and you have far greater control over heat treatment, so a component made to the same specification now is stronger than it was in the sixties.

"Gear cutting was always a bit of an art. You have standardised cutters and you're running on fixed shaft centres, so for a given diametric pitch there's only a certain tooth count you can get on the two gears. To get the intermediate gears you had to apply manual corrections to the gear cutting and that's where the black art came in. It could vary from batch-to-batch, so an early gear might not run with a later gear. Nowadays they get dedicated gear cutters made to those corrected factors, so any gear can mesh with any other gear."

The advent of CNC-controlled furnaces has seen much more repeatable heat treatment, while modern vacuum re-melt steels tend to be a lot cleaner and more consistent than their period counterparts. Advances in gearbox lubricants have also had a massive effect on durability.

Despite these improvements there's still enough call for replacement parts to keep the order books full at Hewland Classic, and the company can even supply brand new gearboxes if required. "Our primary function is to supply parts to keep the existing Hewland gearboxes running," says Smith, "but if someone has a requirement for a complete gearbox we can assemble one from those parts." HRT

**LEFT** Hewland's Formula Junior gearboxes are still well supported

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# It's optical, but no illusion

Optical scanning has become an essential tool for reverse engineering. **Chris Pickering** looks at the work done by one of the leading specialists in the field

**ABOVE & BELOW** The scan in progress

**CHANCE** encounters don't come much more fortuitous. Porsche enthusiast Paul Foreman had been looking for an RS60 Spyder to use as the basis for a recreation for some time. And there, sat in the paddock of the Le Mans Classic, was the exact variant he was looking for.

Tantalisingly, the car even bore a UK registration, he recalls: "I wasn't aware of any cars in the UK, so I looked up the owner's name on the entrants list and Googled him, and it came up with a London telephone number."

The car's owner was historic racer Dietrich Hatlapa. When Foreman rang the number – to his great relief – it connected. But only just. It transpired Hatlapa was moving on to pursue a new business interest and the phone number was due to be disconnected that afternoon.

"He was very open to the idea of having the car scanned," says Foreman. "He races the car and I explained that he would be given a copy of all the data, in case it ever sustained any damage."

At this point Foreman approached Worcestershire-based Central Scanning to take a 3D scan of the Porsche's bodyshell. A deal was struck, and before long he was in a van with Central Scanning's managing director Nick Godfrey, bound for the private museum in Germany where the car is housed.

"It was a two-day affair. The car was in a workshop having some work done on

## A world of possibilities

**ALTHOUGH 3D** scanning lends itself to large surfaces like body panels, just about anything can be scanned. Castings such as uprights are also commonly captured using this technique, particularly when the owner plans to remanufacture them from solid billet, as is quite common with one-offs.

One of the more ingenious uses was to scan the interior volume of a car in order to design a bespoke roll cage in CAD. "We put markers around the interior and used the hand scanners for that," comments Central Scanning's managing director Nick Godfrey. "We've done a similar thing underneath cars for exhaust routing and even inside vans for interior conversions!"

Central Scanning uses a variety of optical and laser scanners. The exact choice of equipment depends on the size of the car, the accuracy required and the environment in which it is going to be scanned. The company has a secure, air-conditioned site in the UK where scanning can take place, although the team can travel elsewhere using portable scanners.

The whole process can be carried out on a completely non-contact basis, although using a spray-on dulling powder (removed after the scan) can help to speed things up.

"A lot of it comes down to whether we can put any powder on the car," says Godfrey. "If the surface is very shiny we sometimes apply a dulling spray, but some customers prefer us not to touch the car at all, in which case we have to do everything with lasers."

Up to 250 individual scans can be involved, depending on the complexity of the project. Once captured, the raw data is processed to an STL file, which consists of a high-resolution triangular mesh. The data is then aligned to generate a flat datum plane, either manually or automatically depending on the exact technique employed. At that point Central Scanning can begin taking a series of digital sections to generate a buck.

"Before we go into that level of detail we will speak with whoever is going to build the body and find out exactly where they want the sections," comments Godfrey. "Areas of high curvature tend to need more sections, so from that we can decide where the sections go and start designing the buck."

Throughout the process, Central Scanning works with the customer and the coachbuilder to determine whether

**ABOVE** The completed car owes its existence to advances in 3D scanning

**ABOVE** The data was harnessed to create a classic 'egg crate' body buck to guide panel shaping

the engine when we arrived so it wasn't on display and we were able to get to all sides," he recalls.

Scanning a car requires a reasonable amount of space and the workshop was not much bigger than a double garage, which presented something of a challenge. "It was pretty tight on the sides," comments Godfrey. "Ideally we need a couple of metres around the car to get the best quality data, although we do specialist equipment that can operate in tighter confines."

While the scan was taking place, Foreman went over the car in forensic detail, gathering measurements of the chassis and producing templates of features like the grille and the rear vents. He also took hundreds of photos, documenting every conceivable angle.

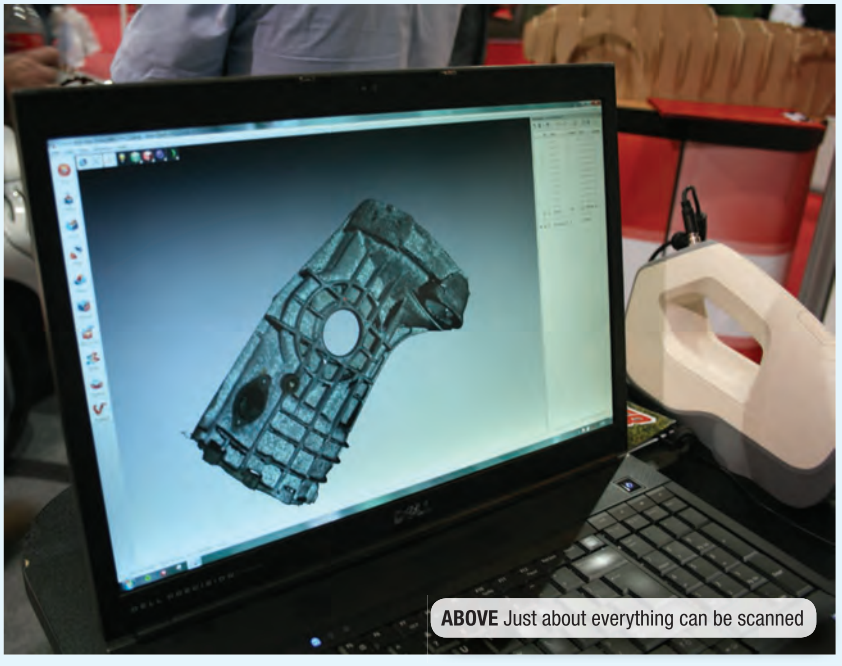
Once back in England, Godfrey and his colleagues began processing the scanned data to create a 3D CAD model of the car. Working in conjunction with a coachbuilder they then sliced the CAD model at varying intervals to generate a series of two-dimensional sections. These were then sent to an external company for CNC routing to produce a classic 'egg crate' body buck to be used as a guide for the panel shaping.

The project has taken a number of years to complete, but Foreman's Spyder replica is up and running. What's more the car is up for sale and he now plans to build four more as part of a limited production run. Details are available from Central Scanning. HRT

they should retain any the original body's quirks and idiosyncrasies or 'correct' them to give perfect symmetry.

"On one car we did recently the customer wanted the front end reprofiled by mirroring one side onto both halves of the car," says Godfrey. "In another instance, a customer wanted the front of one car transferred onto the body of another."

Operating in the digital world, it's also possible to replace missing features. In another example, the team was approached by a Jaguar XJR-15 LM owner whose car was missing its roof-mounted air intake. They scanned the car and then used historical images to model a new scoop in CAD, before 3D prototyping a half-scale model of the revised roof, which was presented to the owner for sign-off. HRT



**ABOVE** Just about everything can be scanned

# Beyond imagination

## Hethel in Norfolk is world renowned for one particular reason, Lotus Cars, but it's not the only game in town as **William Kimberley** found out

**WHEN** Mike Lucas started out modifying an injection pump for his racing BMW over 20 years ago, little did he realise that he was walking down the slippery slope of motorsport that would eventually claim his soul. Having a fine career ahead of him as a powertrain engineer at Caterpillar, specialising in diesel exhaust emissions, such was his handiwork in refurbishing fuel pumps that what was once a hobby led to him leaving his well paid job and forming Lucas Development to commercialise his activities.

"That was six years ago. It was a bit of a gamble because I was unsure if there was even a market for pumps and how many I could expect to make, calibrate and sell within a year; it's been a very high investment for five years. I might not be making as much money relative to working for Caterpillar, but it's a lot more interesting," he says with a chuckle.

Basically, there are two prongs to the business – one producing a complementary range of slide throttles for engines, the other reconditioning fuel pumps, specifically Kugelfischer for four or six-cylinder engines. Mind you, reconditioning is the wrong word because what he does in some cases is reverse engineer the original product, and then manufacture a new one using 3D technology. On the stand at Race Retro, for example, was an original pump manufactured in Munich from 1972 and alongside it a Lucas Development pump from Norfolk in 2013.

### GLIMPSE OF THE FUTURE

Lucas is adamant that the Kugelfischer pump is the future. Forget carburettors and Lucas injection, he says, they're the past. He gives the example of the Mk2 Escort: "In the last 12 months we've seen a high demand come from the rallying fraternity. Six of the 25 Boreham-built Escorts were homologated with Kugelfischer pumps and now everyone wants one so it's now Kugelfischer and our implementation of it using the calibration techniques that we've developed. It's a better solution and something that I think the historic race boys will soon discover and will want."

Injection pump calibration is really the speciality; a 'drive-by-wire' injection pump is used to generate bespoke engine fuel metering cams: "We manage stepper motor position, at target engine speeds, throttle positions and air/fuel ratio, in order to generate an engine calibration.

"Stepper position translates to fuel quantity, or delivery; this would be pulse width on an EFI system. Using the coordinate data that generates, a correct and bespoke three-dimensional fuel metering cam can be designed using CAD software and surface modelling techniques; this is then cut on a CNC milling machine. This cam is then indexed within the injection pump, generating improvements in engine power, torque and transient response. The whole calibration process significantly undercuts original factory


**ABOVE** Later versions of the Lancia 037 used Kugelfischer fuel injection

calibration timescales and offers greater accuracy. We have full authority over the engine fuel quantity demand."

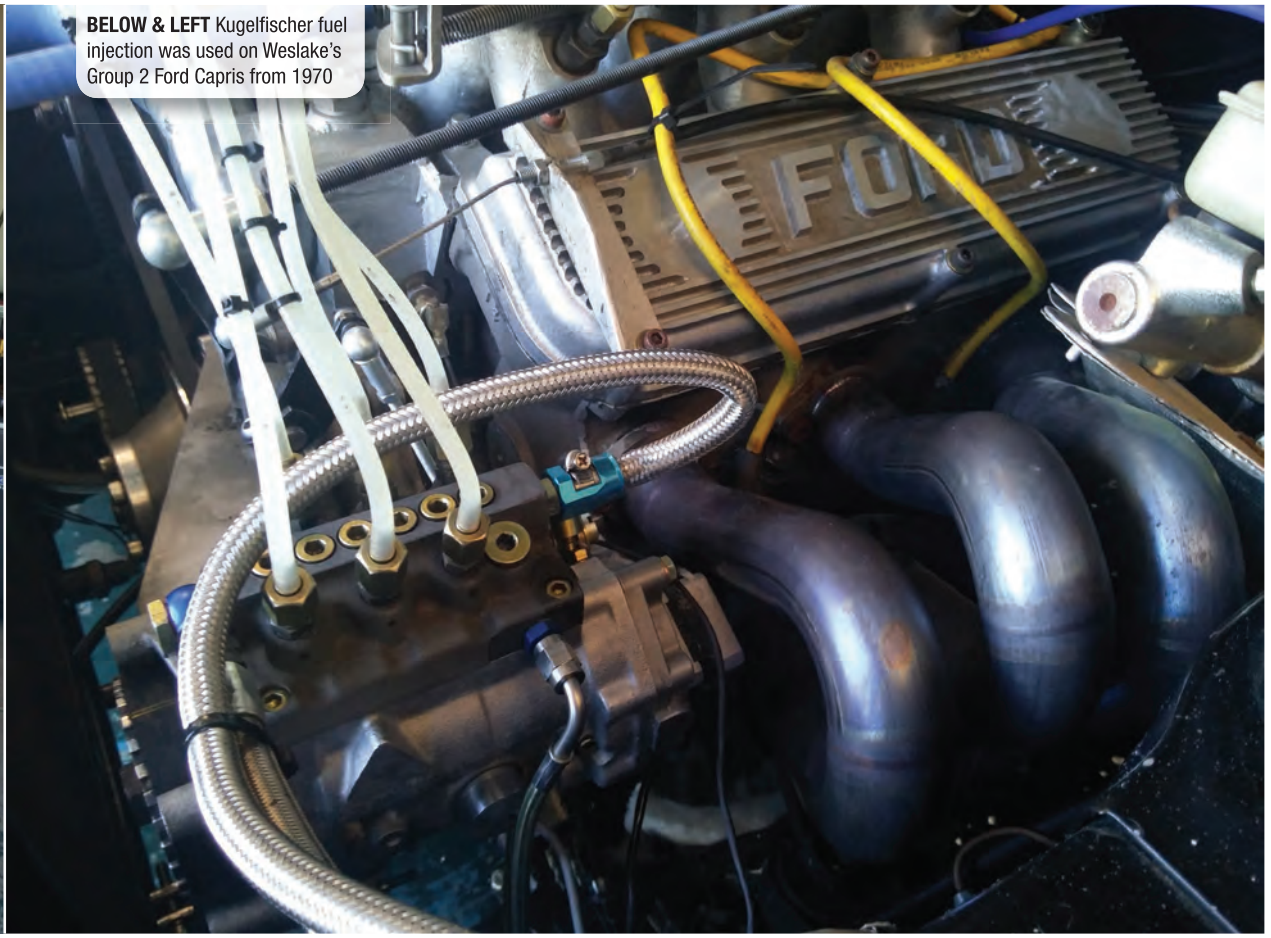
An interesting sideline has grown out of all the bespoke software and hardware that has been developed to drive the calibration pump. "One of the things that the industry struggles with is measuring throttle position, so we've designed a unique throttle position sensor which is inductive, in other words, non contact; this has been built into our pump. This isn't just cutting edge in the historic motorsport world but for the automotive industry as a whole."

The way it's been developed is that it fits into a specially designed architecture within the injection pump housing. There has been interest in this component alone from the industry.

Taking things a step further, the software, which can include a full engine management system, has Bluetooth connection with an android phone. This allows GPS co-ordinates to be tracked at the same time as engine management system data. Thus it tells the driver everything he needs to know such as fuel consumption, engine speed, throttle position, air/fuel ratio and so on while also telling him exactly where he is on the planet. "Furthermore," says Lucas, "you can probably drive from Land's End to John o'Groats and back again, a distance of just under 1,700 miles, without filling up the phone's memory logging at 100 Hz."

It is a worthy footnote that multiple skills have been required to support the whole project. "This is where Norfolk really scores," says Lucas. "There really is a wealth of engineering expertise here, at or within just a few miles of Hethel. Specialists in the fields of design, electronics, fabrication and precision manufacturing, to name but a few, a fantastic and supportive network to draw upon, many of these business are a consequence of Lotus Cars' location."

What started out as a leap of faith into what was then an unknown market looks as if it could have been a clever, farsighted choice. Who knows, maybe in a few years, he could be paying himself more than he would have earned had he remained in the mainstream automotive industry while still having a more interesting time. HRT



**BELOW & LEFT** Kugelfischer fuel injection was used on Weslake's Group 2 Ford Capris from 1970

**ABOVE** Simpson works closely with engine builders

# FEELING THE PULSE

**William Kimberley** discovers a company that is at the forefront of bespoke exhaust systems but likes to keep its light under a bushel

To many, the exhaust pipe is just an expensive add-on, a tube that vents the exhaust fumes away from the engine. Not sure what job it does, but convention dictates that cars have them. To those in the know, though, especially in motorsport, they are a finely tuned instrument that helps the engine maximise its torque and/or power output.

For Matt Simpson, managing director of Simspon Race Exhausts, it's a way of life. When he talks about pulses, tuning and scavenging all in one sentence, then it becomes obvious that he's more than a Kwik-Fit exhaust jockey.

In fact, the company he created in 2003 came about as he was helping his father in his racing activities, but it wasn't just a case that he happened into the technology as he had undergone an apprenticeship with Goodfabs, the renowned company that supplies customers in Formula 1, NASCAR, IndyCar and cars in many other top end series. He also had a spell at SS Tube Technology, another well known specialist company, so his grounding was second to none.

Initially, though, it was just a case of helping out dad, but it wasn't long before his handiwork was getting noticed by others in the paddock and what started out as a trickle of requests quickly became an avalanche or orders. It was at this time that he made the decision to commit his total time to Simpson Race Exhausts. "Things took off from there and I've never looked back," he says.

He takes pride in the fact that everything is bespoke and stainless. He would never consider going mainstream: "It's all TIG welded and gas purged, equal length headers as the exhausts need to be equal in length as an exhaust is obviously a pulse. We tune the extractor manifolds to help the scavenging of the exhaust gases by delivering a pulse of negative pressure just before the exhaust valve closes."

To ensure that the exhaust is as highly tuned as possible means that he works closely with the engine builders. "Obviously different engine builders have different cam profiles, cam timing and so on and they would also have done a great deal of expensive dyno work, so there's so much there to be had," he says. "This means that if someone comes in with whatever car it may be, we'll always ask who built the engine and whether there's an exhaust spec for it. We'll then call them and build to the exhaust spec. If there isn't one to build to, we know roughly where they need to be and so will build some adjustability into the exhaust system if we can so that it can go to a hub dyno rolling road where the primary and secondary lengths can be adjusted in situ to move the power band around to where it is wanted."

With the Ford Escort being raced, rallied and hillclimbed so extensively, it is an important market for Simpson Race Exhausts, the company providing off-the-shelf items. "We work closely with a number of engine builders such as Roy Millington, Smith & Jones Engineering and a few of the other major engine builders," he says.

However, for the private customer who might call into Simpson Race Exhausts, the usual timeframe is a week. "We normally book a customer in on a Saturday morning as it saves him or her from having to take a day off work, then we work so that the car can be picked up the following Saturday."

The company has a healthy export market with customers in Australia, New Zealand and the US as well as in Europe and Africa. "These tend to be for our off-the-shelf items but we do sell components, such as flanges, collectors and silencers as well, so if anyone does want to do a home build or has a fabricator close by, they can do their own one using our parts."

However, Simpson says he is not looking for distributors abroad as he wants to keep things close to home. "We do have overseas customers who buy in bulk, "he says, "and I'm worried that if we get too big then the quality factor might suffer and that would harm our reputation." HRT

# Tread where you trust

**Chris Pickering** learns why, when some drivers agitate for modern tyres, Dunlop's historic race range accurately replicates the performance levels of the era

**THERE** aren't many companies that can boast a competition history stretching back 126 years. Dunlop, however, can trace its winning streak to 18th May 1889 when cyclist Willie Hulme crossed the line at the Queen's College sports race in Belfast. Hulme was not a well-known racer and his win was thanks, in part, to an invention that would revolutionise transport: the pneumatic tyre. A little over 13 years later, Dunlop would pull off the same thing on four wheels when Marcel Renault snatched victory on the epic Paris to Vienna race of 1902. The rest, as they say, is history.

The value of this heritage is not lost on Dunlop, which is one of very few large tyre manufacturers to produce a dedicated historic motorsport range.

"A lot of car manufacturers run an historic fleet with road or racecars from their golden era and it's important for us to do the same," says James Bailey, Dunlop's public relations and communications director. "We use historic racing to promote our heritage, but I think we also have a sense of duty."

The full heritage range caters for everything from pre-war roadsters to 1980s touring cars, although Dunlop is best known in historic circles for making tyres for the cars of the 1950s and 1960s. Virtually all British sports car teams of that era used the company's CR65 range, as did a great number of saloon car racers, and it has become almost the default choice for such machinery in modern historic events.

With its distinctive serpentine tread pattern, the CR65 is something of an icon itself. It was designed from the


**BELOW** The distinctive serpentine tread pattern of the versatile CR65


Chris Pickering

**ABOVE** Dunlop remains a force to be reckoned with in historic racing

> **“Using period-spec tyres puts the right level of energy through the suspension, brakes and bodyshell”**

outset for racing where the aim was to create a versatile tyre that would combine some degree of wet weather performance with a tread pattern that would not ‘chunk’ through excessive heat build up generated by the increasingly powerful and aerodynamically efficient cars of the day. This, don’t forget, was before the advent of slick tyres, and the CR65’s characteristic fine groove tread pattern gave a high contact area, offering excellent dry performance with limited block movement.

## INCREDIBLE STRAIN

Six decades after its introduction, the CR65 is still in production, and Dunlop goes to great lengths to keep the performance and specification as close to the original tyre as possible.

“We are proud of the fact that our historic race tyre range accurately replicates the performance levels needed for cars of the era,” says Bailey. “It would be easy to find performance gains by bolting on a set of modern trackday tyres, but in most historic championships this is not allowed. More to the point, the grip and braking ability of modern tyres would place incredible strain on the suspension. Before long you’d be twisting the chassis and breaking components so the cars would effectively have to become modern silhouette racers. Using period-spec tyres, on the other hand, puts the right level of energy through the suspension, the brakes and the bodyshell.

“Some drivers have lobbied for more modern tyres, in particular when it comes to improved wet weather performance,” he concedes. “We’ve listened to that, but there is also a counter argument that says the obvious way to improve wet weather performance would be to use a softer compound, which would most likely result in a faster dry weather tyre too. While there are historic events that have the infrastructure to mark tyres during scrutineering and control what gets used over the weekend, the vast majority do not. We will carry on listening, but we’ve researched this across a lot of different championships and the feedback was to keep the tyres as they are.”

That’s not to say the tyres haven’t changed at all. New environmental regulations and the fact that some of the original materials are no longer available mean the composition of the CR65s has seen a few evolutionary steps over the years, but only through necessity. Each time the tyres have had to be partially re-engineered to ensure that their grip, wear and breakaway characteristics match those of the originals.

The last big shift came in 2009 when the extender oil in the styrene butadiene polymer was changed to a low-aromatic content type as a result of EU legislation. “Removing the aromatic oils represented a big investment for us with the CR65,” says Bailey. “When it comes to modern road tyres you’re constantly introducing upgraded models and always pushing forward on the technology, so it’s easy to plan for changes and incorporate that into the production. With historic tyres the intension is to keep them in their original specification and you don’t really plan to do any updates, so it’s a big commitment.”

Another challenge came two years ago when production had to be moved to a new site. Dunlop’s historic racing tyres are largely made by hand, using the same moulds and presses that were employed in-period. “Incorporating this into a modern manufacturing environment is not easy, but we’ve managed to do it,” says Bailey.

Although technology has moved on a great deal, one of the benefits of using period-spec tyres is their longevity. It wasn’t unusual to see top teams doing several races on the same set of tyres in the sixties and the same applies to those using CR65s today.

Historic racer and HRT columnist Mark Hales is a fan. “They’re all-but indestructible,” he says. “You can abuse them to almost any extent and they don’t go off or fall to pieces. That is a fantastic support system for amateurs in old cars. You can also use them several times without penalty. I have fetched some out of the back of the truck and discovered they were no slower than the ones we bought last time out. That takes out a huge expense which modern motorsport has to cope with.”

Dunlop’s historic racing tyres are supplied by the company’s specialist motorsport department, so the teams at events such as the Le Mans Classic or Goodwood Revival receive cutting edge trackside support, just like those at contemporary events. And it’s backed up by a century and a quarter of competition expertise that all began with one man on a bike. HRT

# CCK Straight Cut Gear Kits

**CCK HISTORIC** is one of the best known names in historic race preparation, thanks in no small part to the Sussex firm's regular Goodwood outings. But what's less well known is that it also produces a range of bespoke gearbox components, and indeed complete gearboxes.

The range includes a straight-cut close ratio gear set for the 1275 MG Midget gearbox. Manufactured by Quaife and sold exclusively through CCK Historic, it fits the standard gearbox casing found on the MG Midget and the Healey Sprite, as well as cars like the Austin A40 and A35.

A similar straight cut kit is available for the Volvo M40 gearbox, complete with needle roller bearings for the mainshaft gears. The kit uses the standard mainshaft, but it's only suitable for later gearboxes fitted with the larger 18.3 mm countershaft. If that's not enough, CCK Historic will supply a complete gearbox built around an original Volvo casing.

# Super B


**LITHIUM** ion batteries provide a tempting option for historic racing. Not only do they weigh substantially less than traditional lead acid alternatives, they also offer a very stable discharge, which makes life easier for engineers and mechanics.

Super B's new SC casing has been specifically designed to replicate the dimensions of a traditional lead acid battery, so there's no need to modify the vehicle. The company says the lithium ion units also tend to last three to four times longer than a traditional battery, making them a much more cost effective ownership prospect over their lifespan. This is backed up by a two year warranty for competition use.

# Cortina Pads

**THERE'S** a good chance you've already experienced CL Brakes, even if you weren't aware of it. The French brand (formerly known as Carbone Lorraine) is used on everything from passenger trains to airliners, but more recently it has been making significant inroads in the historic racing market.

The latest addition is a range of pads for the Lotus Cortina's P14 caliper, developed in conjunction with AH Racing. They come in two variants, with the RC6 compound recommended for sprint races, while the RC6E is aimed at longer distance events.

One of the main priorities in the design was longevity. AH Racing says the aim was to create a pad that would provide consistent pedal feel and performance across a 3-day U2TC race weekend. The Tamworth-based company is something of a Cortina specialist and produces a number of its own products for the iconic tin top, including rear shoes and brake cylinders.

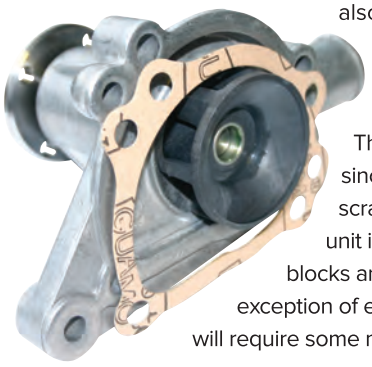
# Go-Race Quick Release

**MANY** cars have quick release steering wheels, but they can sometimes be far from quick to reattach. The new Self-Aligning Quick Release Steering Hub from Go-Race Engineering aims to solve that, with a clever mechanism that eliminates the need to line up splines.

Using the Go-Race system you simply pull back on the locking collar, slide the hub onto the steering column boss and spin the wheel until the quick release unit automatically locks in the correct position. Conforming to FIA specifications, the new hub is available in a range of sizes in both weld-on and bolt-on fitments. Despite its added functionality, the Self-Aligning Quick Release Steering Hub is still very light, with the weld-on Formula 3 model tipping the scales at just 215g.

# Mini Water Pump

**MINI SPARES** has introduced a reproduction of the Rover Airtex high capacity water pump for use on classic Minis. Featuring a larger PPS impeller, which provides a greater flow rate, it reduces weight on the bearing loading and has a triple lip seal giving better flow control across the rev range. It's also about 130g lighter than the original and uses the rolled edge gasket facing developed by Rover for better sealing.



The original been unavailable since the Rover tooling was scrapped, but this reproduction unit is a direct fit for all 1,275 cc blocks and all small bore blocks, with the exception of early 850/997cc engines, which will require some modification.

# Rawles Motorsport

**RESTORATION** specialist Rawles Motorsport offers a rolling road service, with a 2,000 hp Mustang MD 1750 eddy current dynamometer. Using state of the art Powerdyne software, the rolling road is suitable for both steady state testing and acceleration runs. It can measure road speeds of up to 250 mph and it's big enough to accommodate larger classics such as American muscle cars.

# Magnetic Sump Plugs

**BURTON POWER** is now stocking the Gold Plug range of magnetic sump plugs. These high quality plugs are constructed from a 303 stainless steel body that houses a strong, high temperature, N45SH neodymium magnet, designed to collect any ferrous swarf or wear particles missed by the oil filter

Fitments are available for a range of Ford and Ford-derived engines including the Cosworth YB, the Essex V6 and the Crossflow.


# Intercomp Wireless Scales

**INTERCOMP** Racing has launched a new wireless weighing system. The SW656 iRaceWeigh Scale System combines four 15" x 15" x 2.5" (381 x 381 x 64 mm) Wireless RFX billet scale pads with the newly updated iRaceWeigh Module, which works with various Android and iOS devices.

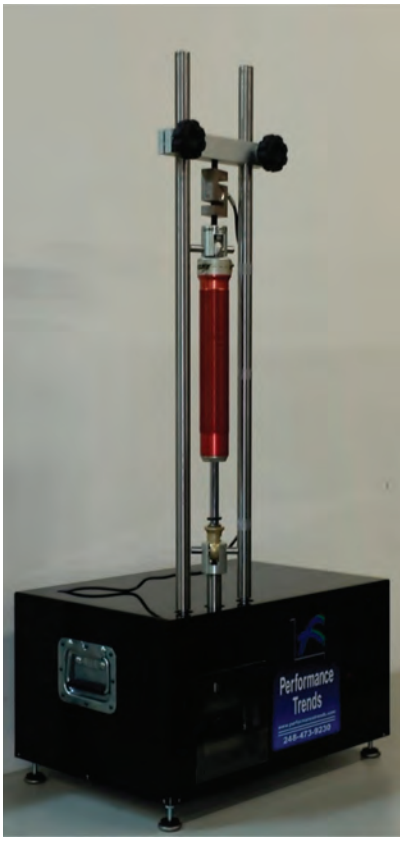
The iRaceWeigh App is available for free on iTunes and Google Play, and can be downloaded to as many devices as desired. It allows you to view and record live scale data over a secure link, as well providing a wireless setup facility.

The package comes with a two year warranty and even includes batteries. Intercomp says that customers can be up and running in minutes, requiring nothing more than a compatible smartphone or tablet to get started.

# Performance Trends

**THE NEW** Shock Dyno from Performance Trends is designed to provide an affordable entry into the market. By using advanced electronics and software, its makers say they have been able to use a more affordable motor and the controller without compromising on accuracy or durability

As standard, a 1.5 hp 110V AC motor (suitable for trailers and portable generators) is used, but a 220V option is also available. The stroke can be set to 1, 2 or 3" (25 to 76 mm) with speeds of up to 20 inches per second.



# A little piece of Le Mans history


**William Kimberley** takes a look at a rather special Porsche that will be coming up for sale in May

**SUCH** is the relentless progression of motorsport technology that few top-flight racing cars are competitive for more than a single season. One notable exception from Formula 1 is the Lotus 72, which won two Drivers' and three Constructors' Championships between 1970 and 1973, but even this praiseworthy achievement cannot begin to compare with that of the Porsche 962. Introduced towards the end of 1984, this remarkable machine was still winning races at international level 10 years later. By then the Porsche 962 had won Le Mans three times (on the last occasion badged as a Dauer); the World Sportscar Championship twice; the IMSA GT Championship every year between 1985 and 1988; the Interserie Championship from 1987 to 1992; and the All Japan Sportscar Championship between 1985 and 1989.

The Porsche 962 was a development of the preceding Type 956 and like the latter was intended for both IMSA GTP racing in the US and Group C competition in Europe. An aluminium monocoque chassis was used, braced by a steel roll cage, while the engine was an air-cooled flat six. Always turbocharged, the latter varied in capacity according to the prevailing regulations and would later be redesigned to incorporate water cooling. One of the reasons that the Porsche 962 remained competitive for so long was the fact that it underwent extensive development by private teams.

The example featured here – chassis number 962-155 – must today be unique in that it was sold by the factory with a 3.2 litre works engine to its first owner in 1990 who has retained the car until today in private ownership. Campaigned by Obermaier Racing and finished in Primagaz livery, the car's first outing was 18 August, 1991 at the Nürburgring where it finished a creditable fourth and then again later that year at Zeltweg in the second round of the Interseries championship. However, its moment of glory was to come a couple of years later when it was raced at Le Mans on 20/21 June.

Sporting race number 21 and driven by Jürgen Oppermann, Loris Kessel and Otto Altenbach, it qualified ninth on the grid but it very nearly didn't start the race. Having no sponsor for the event, the privateer owner decided that he would decorate the car with the logo and colour scheme of 'Les 24H du Mans', the official organisers' livery. However, this created havoc with the ACO (Automobile Club de l'Ouest), the race organisers, who would not let the car start in this livery in spite of the excellent qualifying time and grid position. With the owner refusing to change the livery it came to a stand-off but the ACO finally relented and allowed the car to start. It turned out to be the right decision because in a race dominated by the works Peugeots, which claimed the three podium places at the end of the race, and three works Toyotas, which took the next three places, the privateer Porsche finished a very creditable seventh. This Porsche 962 was to be the only car to ever race at Le Mans in this 'official' livery.

With a short but successful race history, continuous maintenance – the estimated engine life between rebuilds being 60 hours but having been run for a mere 11-12 since the last one, it is estimated to be 'on the button' for another close on 50 hours until the next full service – and in private ownership since delivery 25 years ago by the factory, it surely represents a unique opportunity to acquire a part of Le Mans history at the Bonhams sale which takes place on 24 May at the Spa Francorchamps race track during the 'Spa Classic'.

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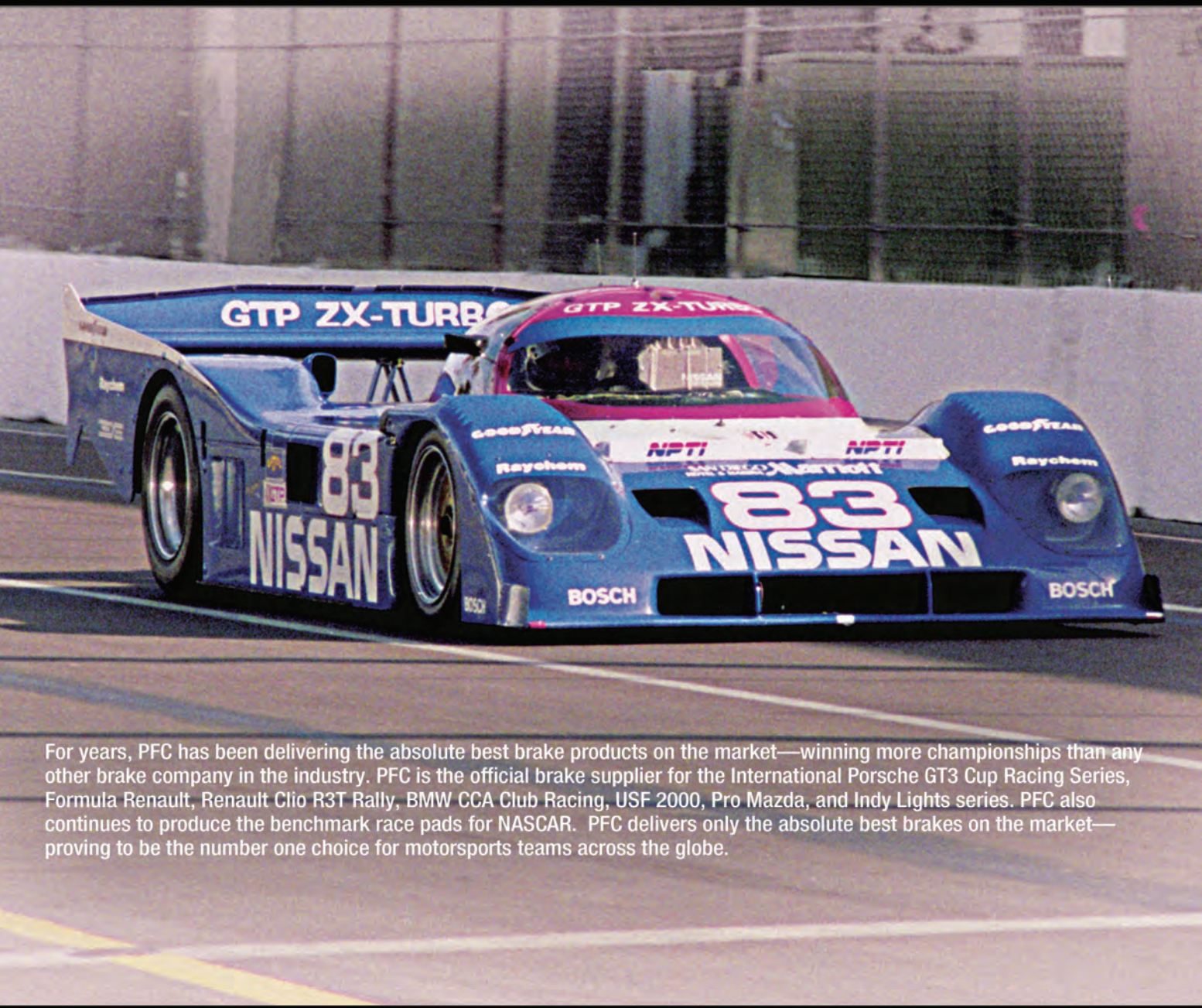


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