HISTORIC RACING Technology

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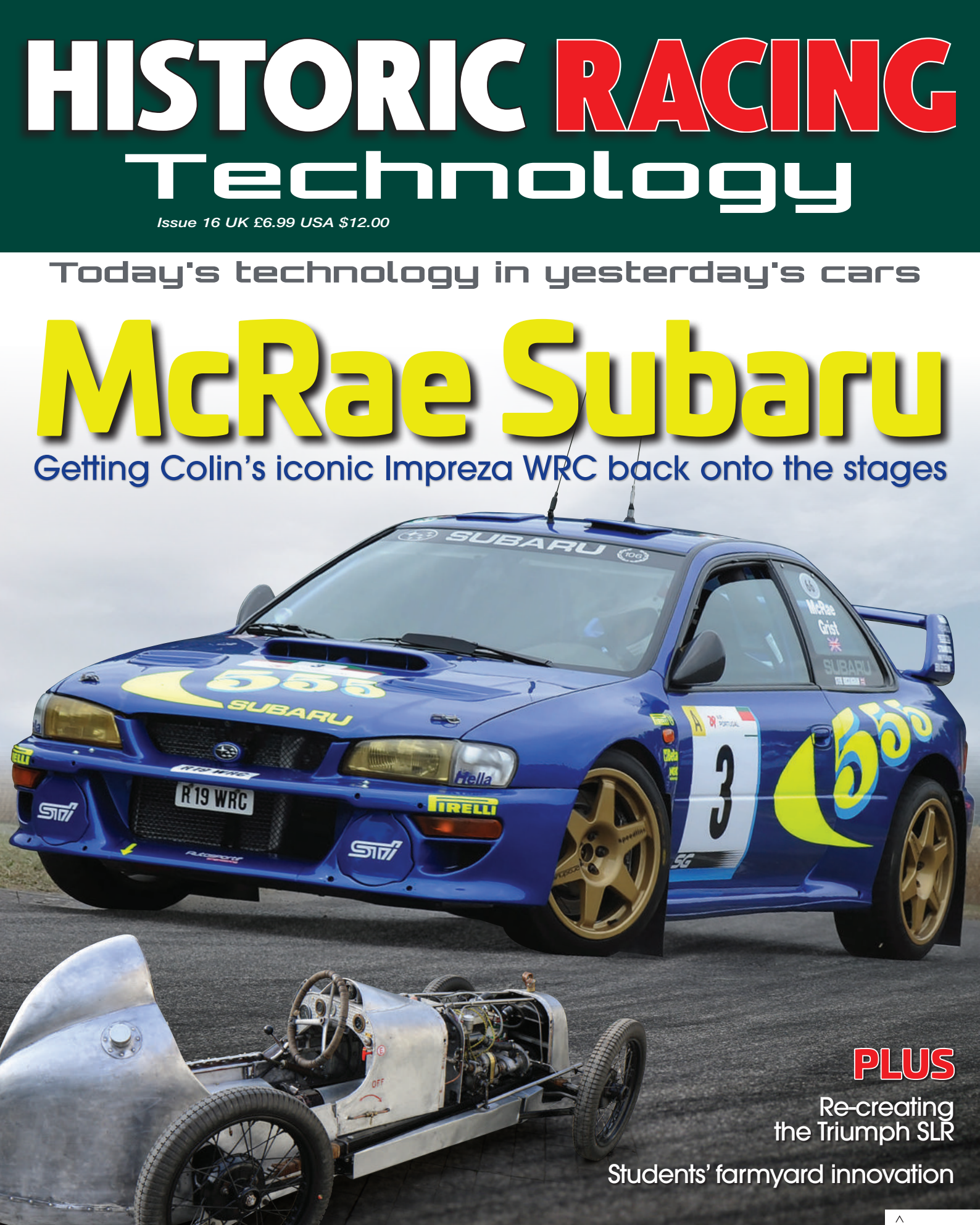

PLUS

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Students' farmyard innovation

'RUBBER DUCK' READY TO FLY

Austin Seven restoration examined

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Encouraging young engineers

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

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

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

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

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

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

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

William Kimberley
Editor

A lesson in engineering

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

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

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

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

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

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

BATTERY EXPERIMENT

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

Jeff Bloxham

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

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

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

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

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

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

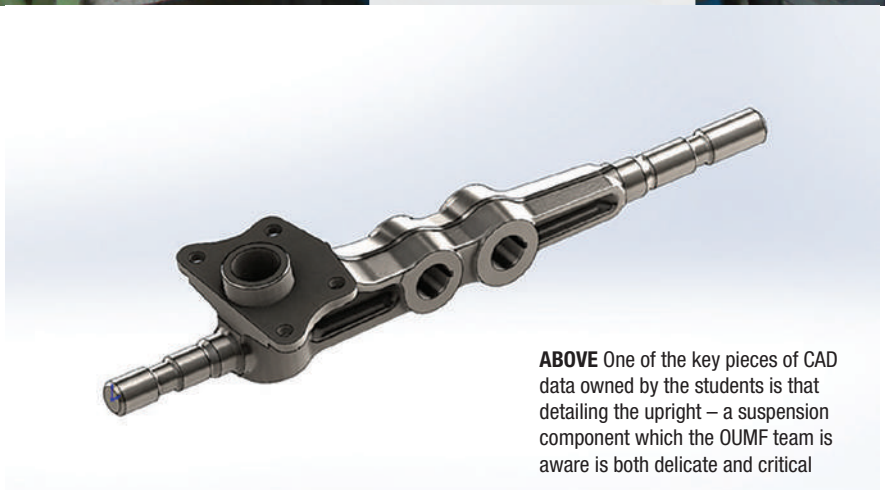
REVELATION

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

The solution, he says, is Lenton ▶

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

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

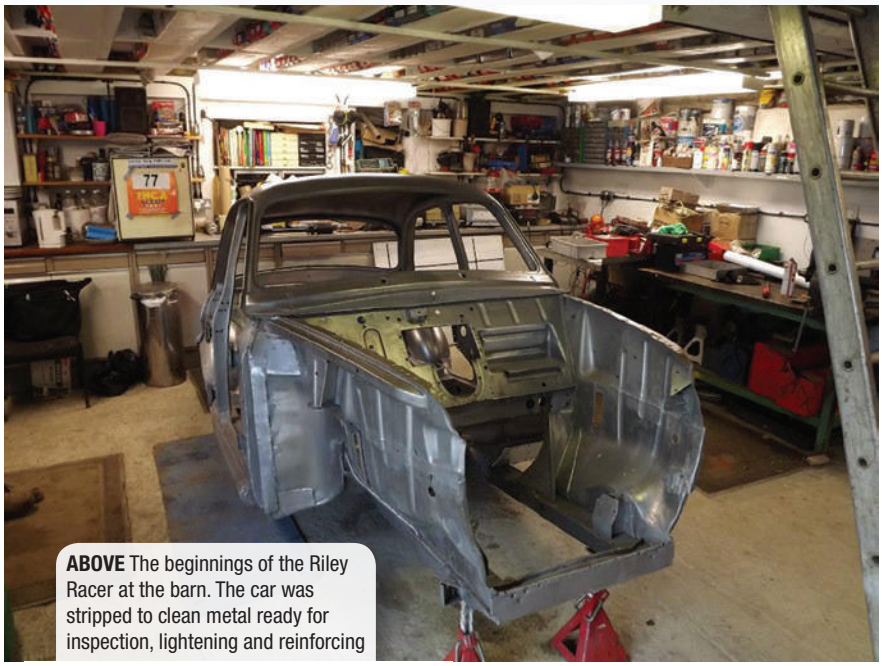


ABOVE One of the key pieces of CAD data owned by the students is that detailing the upright – a suspension component which the OUMF team is aware is both delicate and critical

AWKWARD INCLINATION

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

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



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

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

DIMINISHING RETURNS

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

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

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

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

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

STAGGERING SCRUTINY

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

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

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

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

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

BIG SURPRISE

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

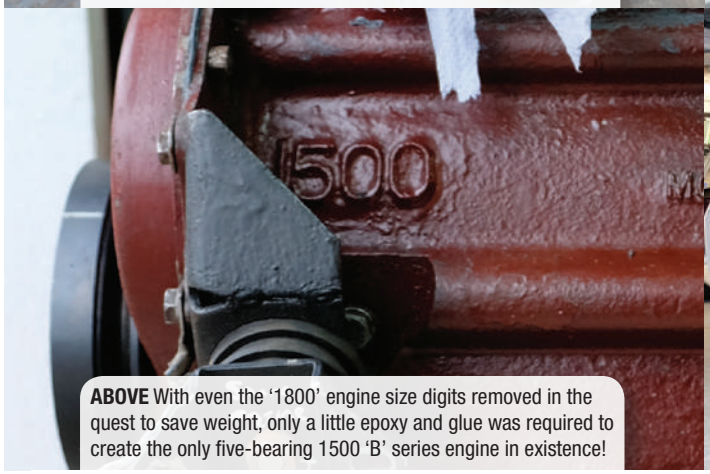
"So that was it, and assembly was put on hold. Nick uses nearby Gosnays Engineering and asked them to help to line bore the block to suit because it was just picking up. It came as a great surprise to us all that the varied torques and tolerances between fixings and bearings from different manufacturers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

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

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

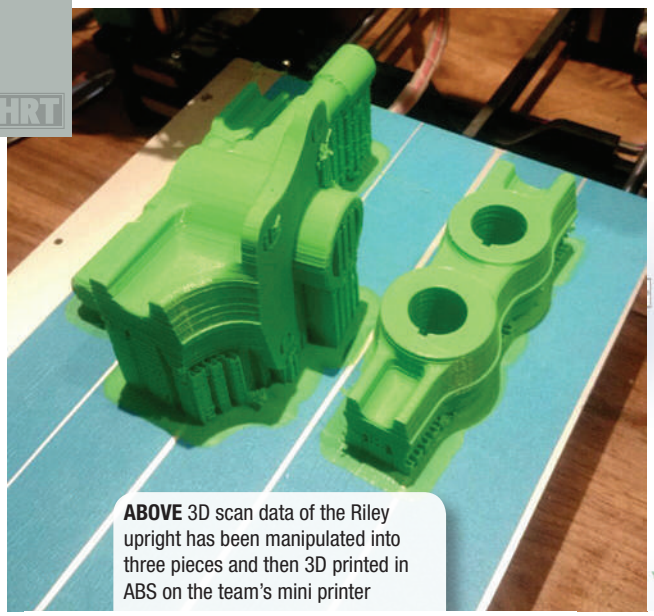
ABOVE The team went so far as to slice up an engine to identify where problems may originate or advantages be gained

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

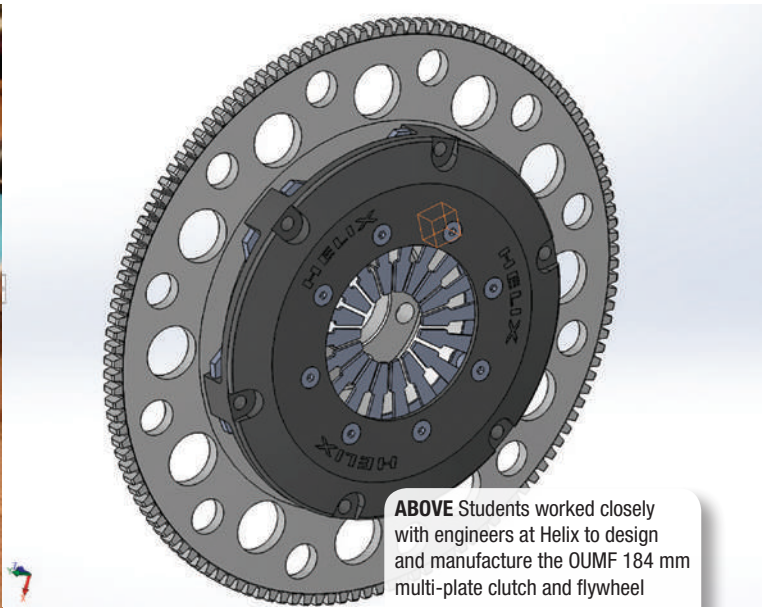


ABOVE With even the '1800' engine size digits removed in the quest to save weight, only a little epoxy and glue was required to create the only five-bearing 1500 'B' series engine in existence!

ABOVE The team pictured with the stripped Riley Rally



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



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

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

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

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

MODERN TECHNOLOGY BENEFITS

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

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

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

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

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

DATA LOGGING CLUES

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

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

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

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

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

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

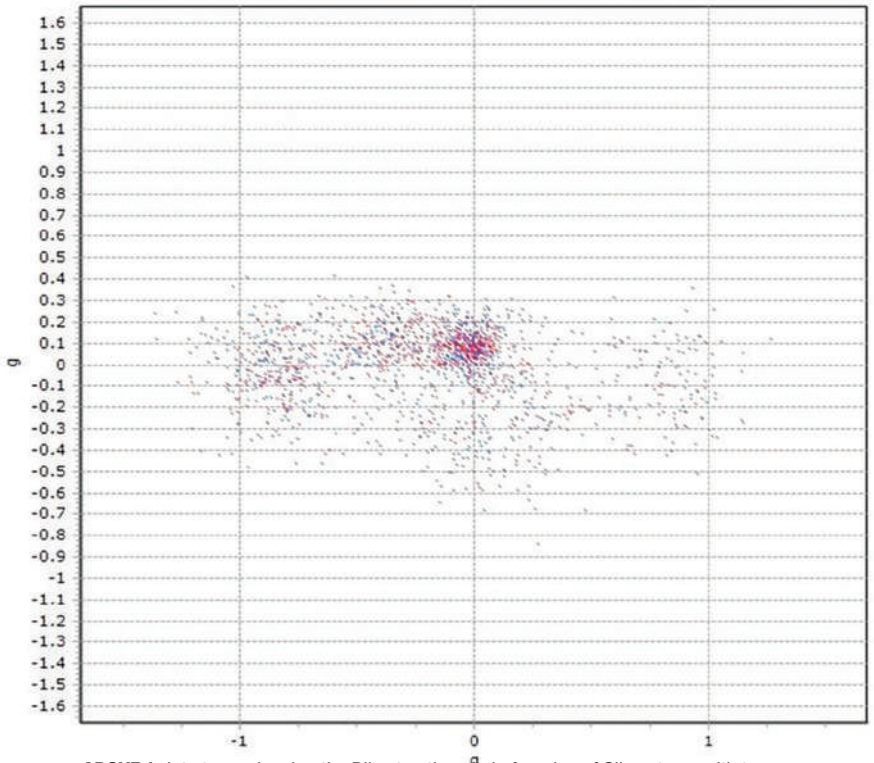
"Most advice about what oil you should run in 'B' series engines is a good classic 20/50," says Boston. "No way! When the team were given a tour of Fuchs' headquarters in Stoke, followed by a comprehensive lecture, it was explained to them why this is simply not the case anymore. They have worked with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

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

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

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

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



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

ROLE MODELS

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

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

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

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