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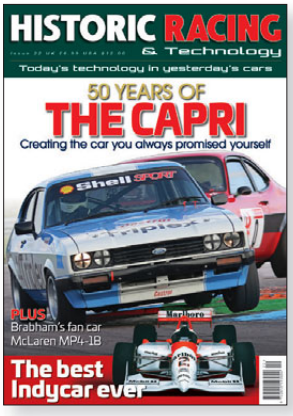
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# Is the historic racing bubble about to burst?

**WHILE** historic racing's popularity amongst the general public is on the increase, with many high-profile race meetings and events burgeoning in terms of spectator attendance, there are one or two ominous signs that the well could be beginning to run dry. By that I mean the owners and racers themselves are starting to kick against some of the high prices they are being charged in terms of race entry fees and so on.

It's always a fine balance between the organisers who want to extract as much as they can from all revenue sources, which is fair enough, and those who pay to compete, such as the drivers and owners.

The thing about historic racing is that there are a number of key wealthy people who will compete no matter what. But there are also many who have a finite limit on what they are prepared to spend on a weekend's racing, which can amount to five figure sums in some cases. Voting with their feet, they are either leaving the sport altogether or reverting to the usually less glamorous but better value for money club racing. The result is thinner grids in the 'professional' race series, of which there are many, or races being merged to compensate for the sparse grids.

Is there an answer to this? It would seem that lower race entry fees would be a step in the right direction, but the counter argument is that the cost of running race meetings is forever climbing, which needs to be passed on where possible. I gather some 'professional' race series are running at a serious loss. The question is therefore whether we have reached the peak of historic racing and whether it will now begin to revert to where it was 10 to 15 years ago?

At the same time, another important challenge is the ageing demographic that comprises historic racing. Not so much in terms of drivers and entrants, but in terms of engineers and mechanics who can fettle, repair and service the cars we love. We are simply not seeing enough youngsters coming into the industry. Motorsport engineering has been given a boost in recent years with different universities and colleges in many countries creating motorsport engineering courses. However, they focus as they should on today and tomorrow's technology and not so much on the engineering basics. There is the rare academy that tries to plug the gap when it comes to historic racing, and they do a great job, but there are not enough of them to fulfil the requirements.

It seems that historic racing confronts challenges on a variety of fronts. Not the least of them is that in the future it might face the charge of being a rich man's sport, perceived not as the saviour of the green world we seek, but as a threat to it.

So while the growing popularity of the sport is to be welcomed, the concerns of those providing the spectacle must not be overlooked. Without them, there *is* no sport. HRT

**William Kimberley**
**Editor**






**ABOVE** Thundersports cars are set to please crowds at this year's Silverstone Classic

# Thundersports added to Silverstone Classic bill

**THE** already-sizeable roster of races for the upcoming Silverstone Classic has been further bolstered with the confirmation that the Historic Sports Car Club's recently renamed Thundersports category will make another addition to the racecard at the celebration of historic racing.

The category will put on two spectacular shows over the weekend, with a single 25-minute Sprint Race on Saturday and a 40-minute Thundersports Endurance race on Sunday, which will feature a mandatory pit stop and optional driver change.

It is the fourth year that the Historic Sports Car Club-organised series is active in historic racing, but it marks the first time the category will appear on the Silverstone Classic bill. Thundersports comprises some of the most spectacular sports and GT cars active in historic racing, and features cars used in the World Endurance Championship, the FIA GT Championship and the FIA 2-Litre Sports Car Championship, as well as Can-Am racers from the category's heyday in the 1970s.

The first Thundersports race took place at Silverstone in May and saw a 30-car field headed by the DFV-powered Lola T282 of Leo Voyazides, the Chevron B26 of John Burton and the 8-litre Can-Am McLaren M8F of Dean Forward.

"We are thrilled to be adding two more great races to what's already a stand-out on-track programme at the Classic – perhaps our best ever," enthused Silverstone Classic CEO Nick Wigley. "The inclusion of these Thundersports cars will add yet another dimension to an incredible feast of motor sport history which ranges from the wonderful Bentleys that raced so heroically at Le Mans in the twenties right up to the recent eras of startling prototype sportscars. With so many truly wonderful cars from yesteryear all racing on track, this is going to be a very special Classic for all involved."

"We are very excited at the opportunity to take Thundersports to the Silverstone Classic alongside our existing races there for Historic Formula 2 and Classic Formula 3," added HSCC CEO Andy Dee-Crowne. "Increasing demand from competitors has made this race possible and we're planning to deliver a full, varied and spectacular field. I'm sure our regular contenders will be joined by some welcome newcomers to Thundersports." HRT

# HSCC see record Formula 3 entries at Silverstone Classic

**THE** Historic Sports Car Club (HSCC) will see a field of up to 50 Formula 3 cars from the 1970s and early 1980s for a pair of races at the Silverstone Classic this year.

Cars from the HSCC Classic Formula 3 Championship will be joined by similar cars from the French series to form a fantastic grid at the event, taking place between July 26-28th.

With 48 cars already entered, HSCC is expecting a grid of at least 50. Notable among the entries will be American racer, Joe Colasacco, in a rare Martini.

The HSCC Classic Formula 3 Championship is open to F3 cars built and raced from 1971 to 1983 and features many cars racing in original period liveries. These are the cars of drivers like Derek Warwick, Nigel Mansell, Martin Brundle, Nelson Piquet and Elio de Angelis. The 2019 season marks the 25th anniversary of the first HSCC race series for two-litre Formula 3 cars.

The F3 cars last raced at the Silverstone Classic in 2014, where there were 35 cars on the grid.

"We've been staggered with the response to the Classic F3 races at the Silverstone Classic," said HSCC chief executive, Andy Dee-Crowne. "It will be a spectacular grid of superbly-presented cars from the UK and France. When added to our sell-out Historic F2 grid, it gives the HSCC an outstanding position at the Silverstone Classic. I'm very proud that the HSCC has been chosen yet again as the race-organising club for the event." HRT




**LEFT** A record F3 grid is set to excite fans at the Silverstone Classic




**ABOVE** A 1937 Rolls-Royce was among the classics taking on the impressive Himalayan route

# Tough but successful inaugural Trans-Himalayan Adventure

**A** group of intrepid adventurers arrived in Kathmandu after an epic 5,540 km journey from Chengdu, China, organised by international rally expert Rally Round.

After 21-days, 15 cars ranging from a 1925 Bentley Super Sports to a 2014 Land Rover Defender and their crews became the first westerners to drive their own cars up and over the Himalayas in the inaugural Trans-Himalayan Adventure. From Chengdu, through the vastness of Tibet and into Nepal, the Trans-Himalayan Adventure was more of an expedition than a rally, with the terrain, altitude and elements providing the entrants with more competition than an added regularity could ever provide.

As well as crossing borders, seven of Asia's major rivers and umpteen mountain passes, the Trans-Himalayan Adventure also became the closest anyone has got to Everest base camp in their own vehicles including two Rolls-Royce, a 1937 Alvis 4.3, a 1965 Porsche 911, and a 1970 Mercedes 280SL Roadster. Crews also experienced high altitudes of up to 5600m and extreme temperatures, ranging from cold of -22 degrees Celsius to intense heat at 43 degrees.

The Spirit of the Rally was presented to two crews – Dominic and Rosie Collins in their 1959 Mk2 Jaguar and Rudi and Helga Friedrichs in a 2014 Land Rover Defender. While Dominic was an experienced rally goer, Rosie was a complete novice and had her first navigating lesson just weeks before the rally started in Chengdu. From a very nervous and fretful beginner, Rosie embraced the whole experience, even taking a stint behind the wheel. Despite numerous breakdowns, rough roads and even jumping out the car to run up a steep hill, Rosie smiled throughout and is now a fully-fledged rallyist.

Whenever there was a breakdown or steep ascent, Rudi Friedrichs and his Defender were always there to help the other crews. He towed six of the crews up the notorious 'Boulder Pass', gave roadside assistance when the sweeps were not around and even did a 120 km round-trip to fetch fuel for the Haslam's 1954 Jaguar XK120 when it punctured it's fuel tank.

The award for Against All Odds was also split between the 1937 Rolls Royce of Mark Robinson and Yvonne Fuller, who experienced numerous fuel issues in the heavy vehicle, as well as ending up stuck in a ditch, but never gave up and despite some very long days on the end of a tow rope, still drove across the finish line. They shared the award with Phillip and Yvonne Haslam in their 1954 Jaguar XK120.

Such was the success of the event, with exceptional feedback from the entrants and intense interest from those wishing to follow in their tyre tracks, a second is now in planning for May 2020. HRT

NEWS

# Bonhams takes up Bicester base

**BICESTER** Heritage has announced that Bonhams MPH is the latest specialist to open at the centre for historic motorsport businesses.

Pre-eminent auction house Bonhams, which hosts auctions at prestigious venues around the world, has chosen Bicester as its latest venue, and the site at which it will launch its new venture, Bonhams MPH. The offices of the auction house will be located in the recently refurbished RAF Guard House, located at the main gates to Bicester Heritage.

MPH is a separate entity within the wider Bonhams business, and will focus on the consignment and sale of modern and affordable classics. Four auctions a year will be held at Bicester, with the first taking place on Thursday 26 September. Before then, however, Bonhams MPH will have a presence at the inaugural Super Scramble event to be held at Bicester Heritage on Sunday 23rd of June, where the doors will be open to existing and new clients alike.

"We have long admired Bonhams' presence and performance in the classic car auction market and are absolutely delighted to welcome their new venture, Bonhams MPH, to Bicester Heritage," said Bicester Heritage chief executive, Dan Geoghegan. "The establishment of Bonhams MPH within 90 minutes of 50 percent of the UK population will offer the best skills and professionalism in the auction world to the largest possible audience."

Bonhams executive director and motoring group chairman, James Knight, added: "We identified Bicester Heritage as the stand-out location for our new operation and I am so pleased that Dan Geoghegan and the management team expressed the same appetite for Bonhams to take up residence. We cannot wait to develop Bonhams MPH. The potential is enormous." HRT




**ABOVE** Bonhams has set up a new entity at Bicester Heritage specialising in modern and affordable classics

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**BELOW** The Ferrari Museum in Maranello is celebrating the Scuderia's 90th anniversary with a special exhibition

# Ferrari Museum celebrates 90th anniversary of Scuderia Ferrari

**THE** Ferrari Museum in Maranello is celebrating the 90th anniversary of Scuderia Ferrari in an exhibition that will last until May next year.

Founded in Modena on 16 November 1929 by Enzo Ferrari, the team, which was first known as Società Anonima Scuderia Ferrari, initially entered Alfa Romeos. Its first event was the Mille Miglia in 1930 followed by the Targa Florio ad the Trieste-Opicina hillclimb where Tazio Nuvolari gave the marque its first ever win.

The cars featured in the "90 Years" exhibition include the Alfa Romeo 8C 2300 Spider, which became the very first car to sport the Prancing Horse as part of its livery at Le Mans in 1932 and last season's Formula 1 SF71H. In the exhibition, the timeframe separating these two cars is filled with a string of unforgettable single-seaters, the stars of hard-fought races, crushing defeats and historic victories alike. The Ferrari 500 F2, in which Alberto Ascari won two world titles in a row in 1952 and 1953, and the Ferrari D50 that Juan Manuel Fangio drove to take the fourth of his five world titles. Also featured is the Ferrari Dino 246 F1 that helped Mike Hawthorn beat Stirling Moss to the World Champion crown by a single point. The series continues with the Ferrari 156 F1 which gave John Surtees in 1963, the only man to be world champion on two and four wheels, his first win.

Also on show are the 1975 312 T with its revolutionary transverse gearbox which helped a young Niki Lauda to win his first World Championship, and the 312 T4 in which Jody Scheckter took the Drivers' title in 1979. There is also the Ferrari F2004, the car in which Michael Schumacher delivered 13 wins – including six consecutive ones – to take his final World Champion title in 2004 and the F2007 in which Kimi Räikkönen brought the Drivers' title back down to Maranello, after an epic race to win in Brazil, snatching the title by a single point.

The exhibition also pays homage to Ferrari victories in closed wheel racing. The 166 MM in the exhibition, for example, gave Ferrari its first win in the 24 Hours of Le Mans 70 years ago, followed by triumph in the 24 Hours of Spa and the Mille Miglia. The 275 P, on the other hand, dominated the 12 Hours of Sebring in 1964 before going on to win the Nürburgring 1000 km and the Le Mans 24 Hours.

The Maranello Museum is also staging a "Hypercars" exhibition dedicated to all the Ferraris that signalled landmark advances in the marque's technological evolution.

These cars are all limited series and the product of Enzo Ferrari's personal philosophy of aiming to make every new model the best car of its day. The result is that each new, more advanced addition is the embodiment of genuinely leading-edge research, setting the benchmark in the automobile world. This exhibition now offers visitors the opportunity to view just such examples of Ferrari technological excellence. The exhibition includes cars such as the 1984 GTO, the F40, the F50, the 2002 Enzo Ferrari and the LaFerrari.

Also at the exhibition is a static model of Ferrari P80/C, the latest product of Ferrari's One-Off programme which allows owners to create a truly unique version of an existing model, moulded around their personal wishes. Presented last April after four years of research and development, the P80/C is the only One-Off in Maranello history to be homologated solely for track use. Based on the Ferrari 488 GT3, it is a hugely sophisticated reworking of the concept behind the Sports Prototypes that has proved so successful in competition over the years.

The "90 Years" and "Hypercars" exhibitions are both running until May 2020. HRT




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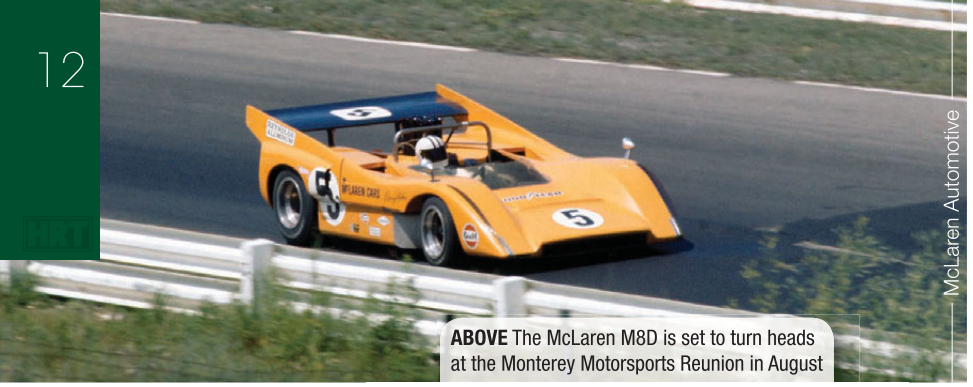


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**ABOVE** The McLaren M8D is set to turn heads at the Monterey Motorsports Reunion in August

NEWS

# ‘Batmobile’ to be piloted by Häkkinen at Laguna Seca

**SOME** 20 years after earning his second consecutive Formula 1 drivers’ championship, Mika Häkkinen will demonstrate his considerable driving talents behind the wheel of the 1970 McLaren M8D/3 “Batmobile” at the Rolex Monterey Motorsports Reunion, which takes place at WeatherTech Raceway Laguna Seca on August 15-18.

The “Batmobile” was campaigned by American racing legend Dan Gurney and British Formula One driver Peter Gethin during the 1970 Can-Am season, as teammates to Denny Hulme following the tragic loss of Bruce McLaren. Gurney drove it during the first three races of the season, winning twice from the pole position at Mosport and Mont-Tremblant, while Gethin raced the car seven times, scoring a victory at Road America along with two other podiums. The car was also used as a spare for Bruce McLaren Motor Racing drivers Peter Revson and Denny Hulme in 1971 before being raced by privateers from 1972-74

The vivid papaya-colored race car is powered by a roaring 7.6-litre Chevrolet engine, outputting some 670 bhp. The high strut-mounted rear wing of its predecessor – the M8B – had been banned by Can-Am, so the M8D’s rear wing was mounted low on fins, earning the car its “Batmobile” moniker.

The McLaren team dominated the 1970 season with nine wins in the 10-round championship. McLaren drivers Bruce McLaren, Denny Hulme and Peter Revson had won five straight Can-Am championships from 1967 to 1971.

This will mark the third consecutive year that Häkkinen, who had not previously driven at WeatherTech Raceway Laguna Seca, will make demonstration laps at Rolex Monterey Motorsports Reunion. He drove the 1974 McLaren M23 in 2017 and the 1995 McLaren F1 GTR in 2018.

“This track is fun, really enjoyable,” said Häkkinen. “The track goes up and down, and some of the corners have great camber. It looks tighter than it is from a distance, so you need a lot of guts to brake later and take the right line.”

Häkkinen will make spirited exhibition laps in the M8D/3 in the noon hour during the first three days of the four-day event. The Rolex Monterey Motorsports Reunion takes place August 15-18 and will also honour the 50th anniversary of the International Motor Sports Association (IMSA). HRT

# Monterey Motorsport Park becomes SVRA sponsor

**THE** Sportscar Vintage Racing Association (SVRA) has announced that Monterey Motorsport Park, a state-of-the-art condo-garage community, has become its latest premium brand sponsor. SVRA’s national platform through its schedule of racing weekends at all the top facilities across the US, and its extensive network of thousands of car owners and drivers, allows Monterey Motorsport Park to expand its reach in presenting its value proposition.




**ABOVE** The SVRA has announced that it will be sponsored by Monterey Motorsport Park

Units at Monterey Motorsport Park are designed to scale from one vehicle to a large collection of cars or motorcycles, and more if stacking systems are used. Any type of business or personal items can be included. Also, some garage-condos are suitable for boats and RVs.

“Where could you find a better cultural fit for an SVRA partner than Monterey Motorsports Park?” said SVRA CEO Tony Parella. “Monterey is easily one of the most revered capitals of American sports car racing. We are honoured to have this relationship and it is very appropriate in a year where we are excited to have WeatherTech Raceway Laguna Seca on our calendar.”

“Monterey Motorsport Park and SVRA share a tremendous passion for historic and collector cars and the people who own them,” said Ralph Borelli, chairman of the Borelli Investment Company and member of the facility’s development team. “We are excited to take our message to a broader audience and provide industry-leading garage-condo facilities and cater to the needs of discerning automobile enthusiasts.” HRT

# Aston Martin salutes Zagato centenary with limited edition models

**DURING** the Le Mans 24 Hours race in mid-June, Aston Martin revealed the track-only DB4 GT Zagato Continuation, a recreation of the 1960s race car of which just 19 were originally made. However, there is a catch. While the new Continuation model will cost in the region of £3.1m, it cannot be bought as a standalone vehicle, but as part of a two-car package costing in the region of £6m without tax or £7.2m with VAT. The other car is a 200 mph-plus DBS GT Zagato supercar which is based on Aston's latest DBS Superleggera that will be launched early next year.

Just 19 of each model will be made available as part of the Aston Martin DBZ Centenary Collection that is celebrating Italian styling house Zagato. First deliveries to customers will commence in quarter 3 2019, followed by the DBS GT Zagato in quarter 4 2020.

With around 4,500 hours going into every DB4 GT Zagato Continuation model at Aston Martin's Heritage Division headquarters in Newport Pagnell, each one is being constructed to the highest possible quality. They feature a blend of Sir David Brown-era old world craftsmanship and the sympathetic application of modern engineering advancements and performance enhancements.

A digital body buck, for example, was created to allow Aston Martin engineers to examine minute details of the Continuation cars. In contrast, hand-finished body panels of the new cars are each worked from flat sheets of 1.2 mm thick aluminium and representing hundreds of hours of world-class craftsmanship, are created using techniques that were commonplace almost 60 years ago.

Power comes from a 4.7-litre, straight-six engine producing "in excess of 390 horsepower" which is transmitted to the rear wheels through a four-speed manual transmission and limited-slip differential.

The car on show at Le Mans was finished in Rosso Maja red paint, the car's exterior colour matched to original masters created by Max Meyer & ICI, the paint suppliers for the original cars.

Inside, the car is trimmed in Obsidian Black leather, which covers the pads in the carbon fibre race seats, door cards, headliner and rear environment. Black Wilton carpets bound in Obsidian Black leather trim cover the floor, stitched in matching Obsidian Black thread.

Continuation specification instrumentation and interior equipment such as a full FIA-approved roll cage is standard, as are the Borrani silver painted wheels and polished lips.

Aston Martin Heritage has created a programme that will run for two years and take owners to eight of the world's best racetracks, including the spectacular Yas Marina circuit in Abu-Dhabi. Aston Martin Works will handle all the logistics and preparation of cars and ensure they run perfectly throughout each track session.

"The development and successful creation of this latest Continuation car is an achievement that should not be underestimated," said Andy Palmer, Aston Martin Lagonda president & group CEO. "Indeed, it could well be argued that we are making history with these new cars.

"Celebrating our brand's deep and enduring partnership with Zagato in this, their landmark year, by launching the DBZ Centenary Collection has been a mammoth undertaking and I'm personally extremely proud of the results in the shape of this new DB4 GT Zagato." HRT





**ABOVE & BELOW** Around 4,500 hours are involved in every DB4 GT Zagato Continuation model, created to celebrate the marque's ties with the Italian styling house

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**ABOVE** Nicolas Aubourg, Head of Performance & Simulation at the FIA chats to Richard Bardwell, Director at SHARC about their latest technology

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**ABOVE** Dialma Zinellia and DALLARA win Racecar Aerodynamicist of the Year, Integral Powertrain win Race Powertrain of the Year & Bcomp Ltd wins the Most Innovative New Motorsport Product of the Year

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# LIVING THE DREAM

With the Capri's golden anniversary celebrations in full swing, **Alan Stoddart** meets one of the marque's fans – a man who decided that just watching his favourite cars was no longer enough



**THE** car you always promised yourself was first unleashed on the British public in its Mark 1 guise 50 years ago. In 1969 Ford was seeking to bring some of the Mustang magic across the Atlantic with a stylish fastback coupe that, although built on standard Cortina underpinnings, captured the imagination and proved a hit on the British roads.

Where the Capri really caught the eye though was on the racetrack, whether as Group 1 touring car with very close ties to the road car, or the steroidal Zakspeed Group 5 machines. Devotion in this area remains strong, with lifelong fans of the Ford coupe still lavishing care on the cars and thrashing them around racetracks at historic racing events.

> **"It's actually faster now, as a homologated FIA car without any of the fancy bits on, than it was before"**

One such fanatic is Stuart Caie, who took the plunge and decided to build a racing Capri of his very own.

It started when a computer screensaver, an Escort RS2000 in that case, sparked a conversation with a colleague, who got Caie to come down to some classic touring car races. Before he knew it, Caie had found a donor car, a white 1.6-litre MkIII that, aside from a bit of welding, was in good shape, and had enlisted David Margalies, another Capri racer and owner of Lavant Garage in Chichester, to help convert it into a proper racer.

The first job was to convert the shell into that of a 3.0 S. That involved adding strengthening plates and lots of seam welding.

"The preparation of the shell took ages," Caie recalls. "You have to seam weld every single piece of the car. On top of that we were using a sun roofed car as the donor, so we had to change the roof, which meant drilling out all the spot welds. That was the most challenging piece of the shell actually, it took forever. We just tried to put as much strength into it as possible from the get-go."

This dedication was inspired by the original cars of CC Racing Developments – the famed Capri competition specialist which dominated the British Saloon Car Championship in the seventies with its Mk IIIs – which underwent extensive strengthening work themselves. The conversion of those original CC Racing cars started with a trimmed bodyshell and took about 550 man-hours to convert into a racer. Their shells were stripped down and had much of the standard CO2 welding replaced by nickel bronze welds to better stand up to a hard life on track. Other parts of the bodies such as mounting points and crossmembers were also reinforced to get them ready for races, while brackets were installed for the Safety Devices roll cage.

## PLAN FOR THE WORST

For Caie's car, however, an oversized SVG cage was chosen to protect the driver should the worst happen at a race meeting. "It is an overspecced cage, and actually it is a little bit heavy, but I'm a little bit heavy too," he grins. "It uses thicker tubing, and it is FIA compliant in Europe and all the rest of it, but it makes the car very rigid, and that was the focus: to get the strength and get it rigid. Everything else suspension-wise we could adjust around that when the car was up and running."

What Caie wasn't expecting, however, was the long lead times for parts. With many of the components being built to order, even things as simple as new




**ABOVE** Keeping the wheels on the ground is the preferred option – but not always possible

clocks for the interior slowed the build down as they required a three- or four-month wait because they were being built bespoke. These lead times then meant that the car would effectively fall out of the 'queue' at Lavant, which compounded the waiting. The result of all this is that the car took two or three times as long to build as expected.

At least choosing components to install in the car was relatively painless. When Caie first built the Capri, he did so to compete primarily in the Classic Touring Car Racing Club's Group 1 series. These races have more lenient technical regulations than the later FIA specification he would put the car into in order to be able to compete at a wider range of events. In the original specification, however, he was able to use the wisdom from his fellow racers and choose parts that were already well regarded, such as GAZ shocks, a four-speed straight-cut Quaife gearbox, a Rally Design anti-dive kit, Hispec Motorsport brakes with Mintex discs, Gartrac leaf springs, Revolution wheels, and Toyo tyres. He also decided to go with an AP Racing paddle clutch, which "takes quite a bit of getting used to" and a propshaft from Propshaft Services.

"They were all tried and tested parts that most people had recommended to us. They were also quite simple to get our hands on, which made it quite easy," adds Caie. "However, even the installation of some of these parts was unnecessarily difficult. Even if just one bit was slightly wrong, it meant it all had to be messed with or changed or adjusted or fettled or drilled out. It was like having a huge model kit where nothing was quite right."

Of course there was still one key component that was left to be decided upon. In period, many of the 3.0-litre V6s racing in the Group 1 series were made by Neil Brown, who was able to extract around 230 hp from the engine by 1979, some increase on the 138 hp that the Ford cars left the factory with. Even more impressively, after a refining of the rules in 1980 – to unlock a bit more power from the cars, which allowed the use of a bigger carburettor and more freedom when it came to the induction, among other things – Brown was routinely releasing around 255 hp at 7,000 rpm.

For Caie though, there was only one ▶




**ABOVE** The overspecced roll cage results from a decision to get as much strength into the car as possible from the very start

place to go for the engine in his car: Capri expert Ric Wood. "The engine was one of the few parts that was right straight out of the box," he says. "When it arrived, the engine was run in and it was fine straight away. For the V6 he really is the guy to go to. The engines are very fast.

"The only thing is that you do have to get used to them, because they really start to come in around 4,000 revs. That means you have got to keep your foot in it and rev the nuts out of it, but then they do pull like trains."

This engine relied on Ric Wood heads, single Weber 48 carburettors and a single pipe exhaust from Tony Law, on the recommendation of Wood.

In this specification the car was quite successful, and even won races in the CTCRC Group 1 series. However, the switch to a full period specification was required to get the necessary FIA papers for some of the other races in which Caie wanted to compete. This conversion was done by Colin Gibbons at CRG Automotive in Essex, and meant that the car not only had to be taken apart, and original or recreation parts to be sourced, but also some historical digging and discussing with the FIA's representative to ensure compliance and competitiveness.

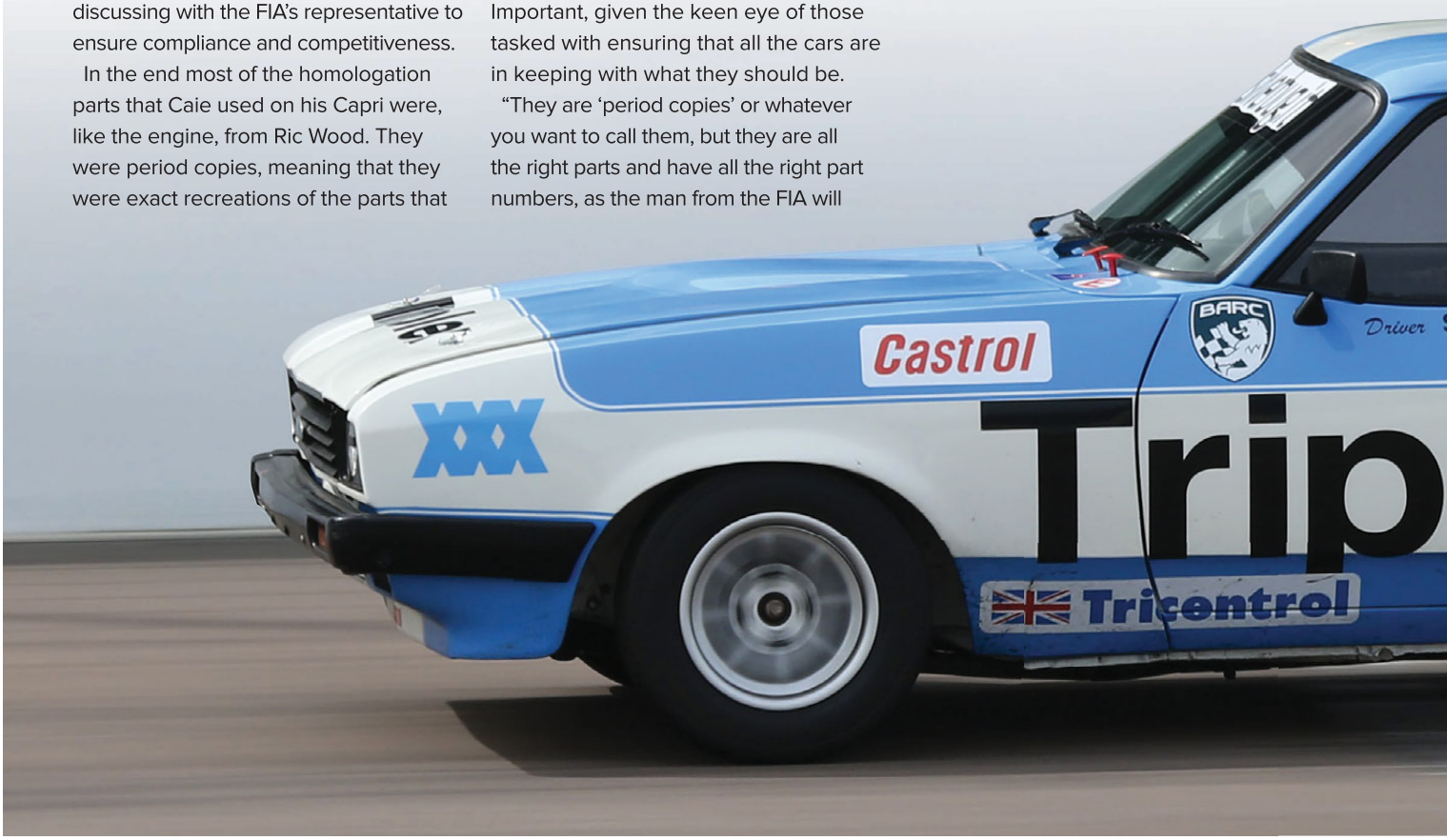
In the end most of the homologation parts that Caie used on his Capri were, like the engine, from Ric Wood. They were period copies, meaning that they were exact recreations of the parts that were used when the Group 1 Capris were originally trading paint on racetracks. These 'new originals' mean that there is a supply of parts readily available to ensure that Caie and his fellow racers are able to keep on competing without spending all their time trying to source incredibly rare components. As importantly, however, they also help to ensure that none of the competitors have an unfair advantage by using parts with more modern technology or manufactured to a higher specification. Important, given the keen eye of those tasked with ensuring that all the cars are in keeping with what they should be.

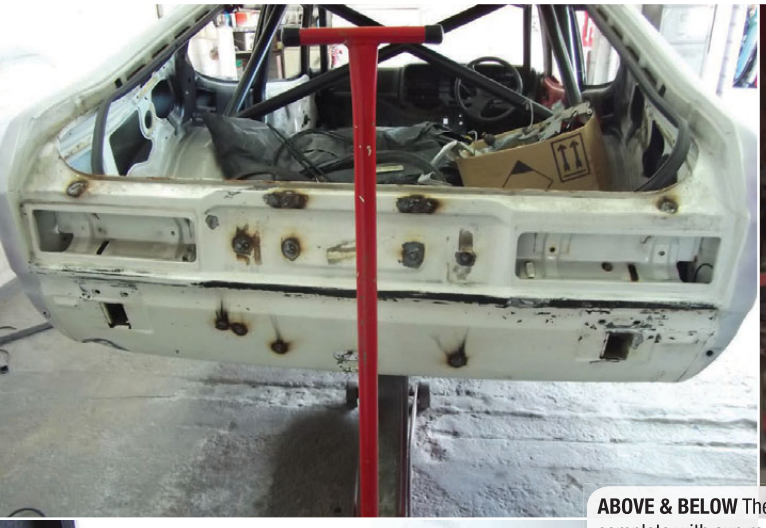
"They are 'period copies' or whatever you want to call them, but they are all the right parts and have all the right part numbers, as the man from the FIA will attest," Caie explains.

Unfortunately, the process was rather more involved than simply bolting on components with the numbers on, continues Caie.

"So for example, we had to modify the roll cage to get the papers. We had to move a brace between the two towers, which they [the FIA] said was structural. So that meant we also had to move the seatbelts. They are so picky.

"With anything, you really have to ▶







**ABOVE & BELOW** The donor car, complete with sun roof, is stripped down








**ABOVE** No, the name's not a mistake: ex-F1, touring car and Le Mans star Jochen Mass, a man who knows all about driving Capris, made a guest appearance in the car

show that it happened in period. So, for instance, if you find a car in a barn and it's got an aluminium dashboard, well it wasn't homologated with an ally dashboard, and even though that car was homologated in 1981, to be able to use it you really need a photograph of it at Brands Hatch, in the F1 support race, with Gerry Marshall there pointing at the dash. That should just about be enough!

"They really are that strict," he adds. "I had some photographs of the Gordon Spice cars that had aluminium radiators; you could see the car had ally radiators.

"The FIA man said, 'that's no good'. I asked 'why' and he explained that the photographs were taken at Spa, not at Brands Hatch or another English circuit.

"I said 'what!' He replied, 'Look I can see that. I know what you are saying and I agree with what you are saying, but the photo is not in England, so they could be under different regulations at the time. It doesn't count.'"

Despite the strictness of the regulations, however, Caie praises the FIA's representative for helping him navigate them, and ensuring that the process of bringing his Capri up to spec went smoothly. "We thought, 'that's it, we've done everything' and then we'd call the chap from the FIA, who was a very patient man and very helpful, but he wouldn't come and look at the car until we sent him photographs.

## PAINFUL PROCESS

"We sent him more and more photos and he wouldn't come and look at the car because he knew we'd not done it right.

"So we'd send him photographs and he'd tell us: 'That's not right, that's not right, that isn't right. Why have you done it like that? Who said to do it like that? They didn't do that in period. Did they do that in period? Where's the photograph?'

"So, it is quite a painful process, I have to say."

One of the reasons for the difficulty in assessing the legality of some of the Group 1 cars for events like the Gerry Marshall Trophy at the Goodwood Members Meeting is the aforementioned rule changes in 1981. This subtle rewriting of the Appendix J regulations has brought in ambiguity, with very small changes being put in writing. In 1981, for example, the induction section of the rules explicitly permits the removal of the 'filtering element on the condition that the original air filter box is retained', whereas the same section of the rules from 1975 makes no mention of such allowances. These details, compared with the scarcity of archival material about some of the rarer cars such ▶







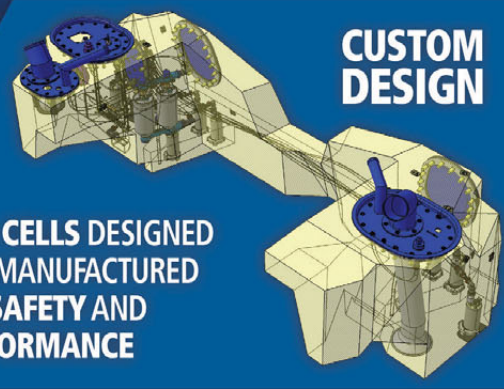


**ABOVE & BELOW** Preparation of the shell was a lengthy process

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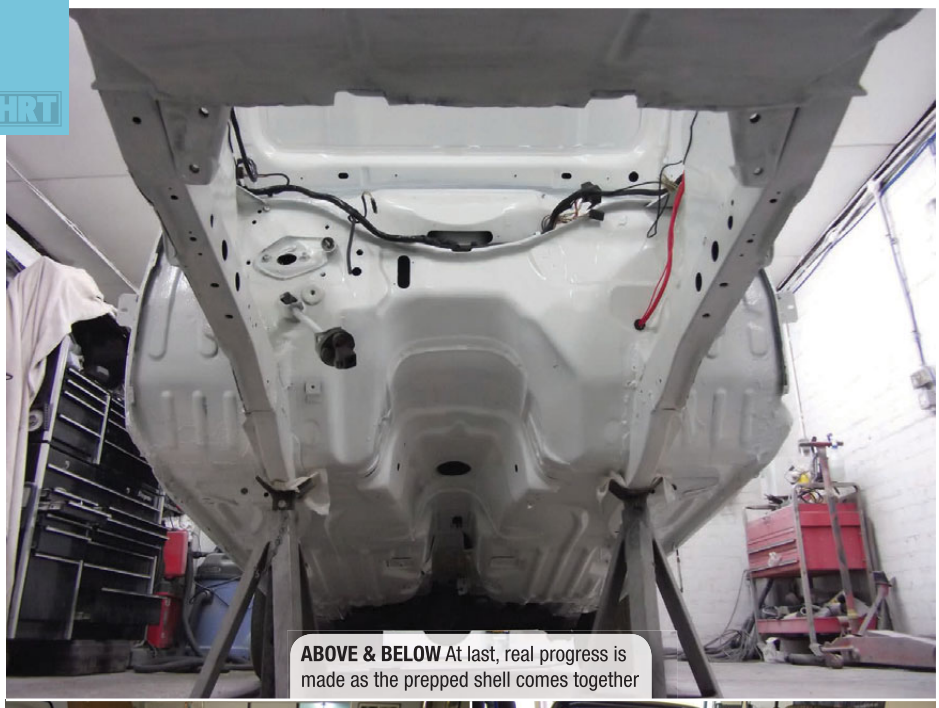
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**ABOVE & BELOW** At last, real progress is made as the prepped shell comes together

as the Audi 80s that compete, mean that the category can be, as Caie puts it, "a bit of a pain" for the FIA.

"In some instances, there are only a few cars that ran, and people didn't take a lot of photographs then. Of course, it was even rarer that they took photographs of the cockpit or of the engine bay or whatever, so if you're lucky you might find a picture of them going fast through Paddock, but the chance of finding a shot of what was in the passenger footwell?"

As well as dealing with the detail of the regulations, Caie also faced more humdrum, practical problems, that, like when building the car in the original specification, simply needed some finessing to overcome.

"One of the problems we had was getting the front legs and everything to fit," he recalls. "It was hard getting everything on the top mount to fit properly. You see I think of it as all standard stuff that's bespoke, so just small things like getting the bonnet to go back down properly could become a problem. Our shock towers were pointing too high up and the nuts were too long so they were sitting proud.

"That all sounds very simple but you have to take the leg off to fix it, so it just becomes a problem."

There are also other particulars mandated in the regulations that weren't necessarily problematic, but are simply another difficulty during the everyday running of the car. "There are other things like not being able to run helper springs on the front legs," he says. "So now when you lower the car down you are holding the spring in place while someone is doing the jack and trying not to trap your arm. They are called helper springs for a reason, but they see it as non-period so it's not allowed. But things like that are what makes it what it is."

As well as alterations to the car, the switchover to the FIA specification also required changes affecting the driver, with the tyres in particular representing something of a learning curve. Originally Caie had been running the car on Toyo or Nankang tyres, which he says are quite forgiving for several laps at least, allowing the driver to heavily lean on them without consequence. However, the switch to the Dunlop crossplies was something of a shock.

## "The car forces you to be brave"

"They are a bit hairy," he says. "You've got to get through the fear of it sliding that much. The car is moving around and it will go from one side to another, and you just have to hope that it stops!

"That is where you see the pro drivers at Goodwood really shine. They have no fear at all, and with it being a power circuit, they are just on the throttle all the time. The rest of us, on the other hand, are all going 'bloody hell' and trying not to crash!"

Far from crashing, however, the FIA-converted car was capable of far more than its predecessor. "What was funny though," he notes, "is that the Group 1 cars are essentially hotted-up road cars, as that was the original idea of the series, but the car is actually faster now, as a homologated FIA car, than it was before. It's faster without any of the fancy bits on.

"I was at Brands Hatch at Easter and I





**ABOVE** The V6 engine was good straight out of the box

was half a second faster than I was before. I was laughing, explaining it away by saying it is because the brakes don't work, so you can't use them as much, but I do think there is some truth in that. I've gone from four-pot callipers that stop you dead in your tracks to something that is... vague to say the least.

"You get braver. The car forces you to be brave."

Despite this improvement in laptime, Caie reckons there are still a few ways for the car to be able to perform even better in upcoming races. One of the first things to address is taking more weight out. Currently, it weighs 1,175 kg with him in it, some 40 kg heavier than the 1,135 kg allowed by the rules, so there is lots of potential for improvements on that front. Caie says that although he is not willing to compromise on safety, this overspecced cage might have to go, given that its removal offers such an "easy win".

There are other things to work on too. There are many tips to go faster to be found in the paddock at race meetings, with even pro drivers who used to race the Capris in period able to share hard-earned pearls of wisdom.

"One of the people I spoke to was Graham Scarborough, who ran Capris in period," says Caie. "You just have to listen to these people.

"I looked at his cars and how he set them up, because he's done the same thing for 30 years. When I looked at his car in the paddock, I noticed that there are small spacers in the back, so his rear wheel was just a little bit further out to get a slightly wider track.

"I thought 'oh bollocks, I should have done that', so he's chatting to me and I'm trying to sneak looks at his car!

"Another thing he said to me is that they always run the cars soft, and actually take the anti-roll bars off. It makes sense because if you look at the old footage there is plenty of body roll. In their view, you have to keep the wheels on the ground, because if they are on the ground they have traction, so it doesn't matter where you are, the car can throw you about anywhere, but it's always better to keep the wheels on the ground."

Aside from the car and the setup though, the last part of the puzzle is Caie himself.

"I just need a bit more time behind the wheel," he admits. "I just need a bit more time in this spec and we'll be up there!" HRT




**ABOVE** Scrapping at Goodwood. A weight reduction campaign probably offers the next performance gain

# That 'What have I done?' moment!

**Chris Pickering** follows the at times daunting restoration of a car from a British sports car marque known for its giant-killing performances

**YOU'D** be forgiven for not being overly familiar with Turner Sports Cars. This quintessentially British manufacturer was founded in 1951. Its small, affordable sports cars put in a number of giant-slaying performances, upstaging the likes of Lotus, Jaguar and Aston Martin along the way, before the company quietly faded out of existence in 1966. Since then, Turners have continued to compete on both sides of the Atlantic and they now offer one of the most affordable routes into historic GT racing.

The car that you see here is a 1962 Turner Sports Mk2. It's owned by Jamie Mason, director of Road and Competition Engineering Ltd, who bought it – almost by accident – in 2015.

"One of our customers has a Turner that he races in the HSCC Historic Road Sports series. He knew I liked the car and he'd heard of a Mk2 that was for sale via the Turner Register, so he rang to ask if it would be of interest. A few days later I ended up coming back with it on a trailer," he recalls.

Mason's plan was always to use the car for the Road Sports series, but he decided he would essentially build it to FIA spec following the original homologation form. That meant that the fundamentals would already be in



place if he ever chose to take the step up to international-level competition. First, however, there was the small matter of building the car and getting a race licence.

"My first thought was, 'What have I done?'" he jokes. "When I got the car back, I knew I'd have to strip it to a bare chassis and decide what was useable and what wasn't."

His approach was to keep everything and essentially sort the components into two piles. Parts that were obviously re-usable were set aside, whereas parts that would require more work were treated on a case-by-case basis, largely depending on the availability of new items.

> **"The first time I drove it, I did the first four flying laps in one gear"**

"Virtually everything on the Turner comes from a well-known donor," comments Mason. "The problem is, they never quite seem to fit. It always turns out that Turner cut something down or put a notch in to provide clearance somewhere. The steering rack, for instance, comes from a Triumph Herald, but you have to cut the rack and the casing down to get it to fit, just as the factory would have done originally."

## SOLID BACKBONE

The backbone chassis consists of a pair of 3-inch steel tubes with outriggers to take the seats and a set of pylons for the suspension top mounts. It's similar in design to a Cobra chassis and it's described in a period brochure as 'an extremely rigid frame', although we suspect that would be something of a relative term these days.

Upon arrival, the chassis tubes on Mason's car were found to be quite heavily corroded in places. He's managed to retain the original backbone tubes, but the outriggers had virtually dissolved, so these were swiftly replaced with new items. New engine mounts were also welded in and the chassis was then hand painted. The ▶




**LEFT** Recent results suggest the Turner still has giant-slaying potential

Peter French - Flying Tigers Photography



**ABOVE** The original backbone chassis tubes were retained but new outriggers and engine mounts were required




**ABOVE** It's possible to have a complete, driveable rolling chassis without the body sat on it

Peter French - Flying Tigers Photography

only part of the fabrication that Mason didn't carry out himself was the roll cage, which came from Lee Adams at CageCraft in Daventry.

The FIA homologation papers for the car served as a starting point for the project. Mason sat the chassis on wooden blocks at the allotted ride height of five inches and started building it from there. First to go on was the back axle and suspension linkage. The axle itself is a BMC A-Series item, but Turner used a bespoke torsion bar configuration, in place of the normal leaf springs. On the Mk2, it's essentially a five-link setup, with a pair of trailing arms picking up the torsion bars to form the lower links, while the upper links are straightforward tubes, with a Panhard rod to provide lateral location.

The front suspension is a double wishbone setup, taken straight from a Triumph Herald, with coil springs and telescopic dampers (both off-the-shelf items from AVO). Similarly, the disc brakes on the front are from the early Herald. The callipers are no longer available, so Mason stripped the originals, had them sandblasted and re-plated then rebuilt them with a new set of seals and pistons. Solid, non-vented discs are mandated by the FIA (again taken straight from the production Herald) while the only solution for the brake pads these days is to buy a later Herald design from Mintex and cut around 6 mm off each side. Meanwhile, Midget drums are used on the back with standard Girling brake shoes.

"It is possible to get linings manufactured with a more modern friction material, but for the smaller sports cars nobody really bothers," notes Mason. "The rear end on these cars is so light that the brakes on the back don't do a great deal, especially with the crossplies."

## PRE-CROSSFLOW ENGINE

Under the bonnet, there's a pre-crossflow engine from a Ford Cortina, bored out to around 1,550 cc. The block and heads are standard production items, although there's the obligatory forged crank along with Accralite piston



and rods from Burton Power. Similarly, there's now an uprated camshaft and modern valve springs to cope with the increased engine speeds. As per the original homologation, the Turner uses tubular inlet and exhaust manifolds with Weber 45 DCOEs.

Mason, whose background lies in engine building, says this was the most enjoyable part of the project for him: "I'd never actually worked on a pre-crossflow before, so it was interesting to take one apart and see how simple everything is. For instance, the oil pump is on the outside of the engine with just three bolts to hold it on. Everything is very accessible and very straightforward."

That said, it wasn't all plain sailing. The engine was heavily corroded and virtually seized up when it arrived, meaning that the original pistons had ▶



**ABOVE** Mason found working on the pre-crossflow engine one of the most enjoyable parts of the project




**ABOVE** The car makes up for lost ground through the corners

Peter French - Flying Tigers Photography

to be driven out with a club hammer. After that, the oil galleries were drilled and tapped to accept removable plugs. Next, the block was acid dipped and sent for a re-bore. The cylinder head was also acid dipped and crack tested, before Mason moved on to the porting.

"I wanted to increase the total air flow to match the high-lift cam," he says. "The valve sizes are stipulated in the homologation papers, so the first step was to open the ports out to something suitable for those and get a nice smooth finish. From there, it was a similar process of matching the intake manifold diameter to the carburettors. It's always a balance between getting the flow at high rpm, but not opening them out so much that you get a giant flat spot lower down."

Having never raced before, Mason was particularly keen to ensure that the engine would be tractable, with a broad spread of torque. "The first time I ever drove it properly was in qualifying for the Silverstone GP round of the Road Sports championship and I did the first three or four flying laps in one gear. Even after that I only usually used two, because it would pull from about 4,000 rpm up to 7,000 rpm," he says.

That generous torque curve partly comes down to fine-tuning the cam timing to control the dynamic compression. Too much compression will result in too much cylinder pressure, followed by detonation. Instead the plan was to play things relatively safe on the static compression ratio and then alter the camshaft timing to control the point when the mixture is trapped.

"Setting the static compression ratio comes down to previous experience," says Mason. "We have to run the engines on super unleaded pump fuel, so you can't run too much compression. We were aiming for something relatively mild in the region of 10:1 or 11:1. It would have been about 8.3:1 as ▶

**"Virtually every part comes from a well-known donor, but they never quite seem to fit!"**









**ABOVE & BELOW** The car was pieced together in stages

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**ABOVE** The double wishbone front suspension setup is taken straight from a Triumph Herald, with coil springs and telescopic dampers

standard, but with the forged pistons you can run at higher temperatures. After that it was basically a trial and error process on the dyno to see what gave us the flattest torque curve."

One unexpected issue has been keeping the engine quiet enough to meet the noise tests. Being a pre-crossflow, the exhaust and induction are both on the same side. With a side box on it only just crept through the 105 dB limit, so a second box was added underneath the boot floor to try and separate out the induction and exhaust noise on different sides of the car. It's now down to the mid 90s, which allows the road-legal Turner to be taken on public trackdays for testing.

The Ford 2000E gearbox is identical to that fitted to the Cortinas of the period. Even the ratios remain standard, so all Mason had to do was strip the original unit apart, clean it up and reassemble it with new bearings.

By this point, the car was beginning to come together. "You can have a complete, driveable rolling chassis without the body sat on it, so that's what we did," comments Mason. "The tub [for the cockpit] drops on and then the body comes after that, so you can build it in stages."

## ON TRACK

Mason kept coming back to the car in between his work commitments throughout 2015 and 2016. By the start of the 2017 season, both car and driver were finally ready to race, making their debut at the second round of the Road Sports championship that year on the Silverstone Grand Prix circuit.

"Apart from the ARDS test that was the first time I'd ever driven around Silverstone. It was a bit nerve-wracking initially, with a damp track and the car ▶



**ABOVE** The Ford 2000E gearbox is identical to that fitted to the Cortinas of the period

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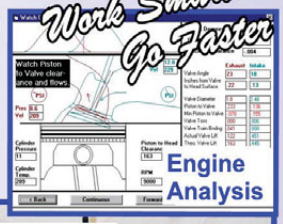


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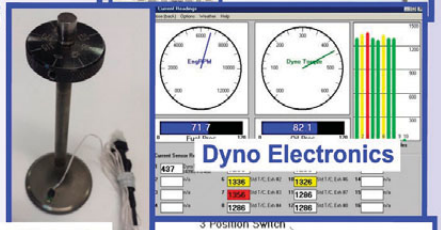
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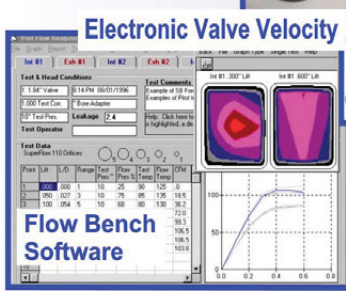
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Peter French - Flying Tigers Photography

**ABOVE & BELOW** The Turner still carries excess weight compared to its homologation trim from the sixties, but is becoming more competitive




> **"One of the most affordable routes into historic GT racing"**

only running a very basic baseline setup. I ended up second-to-last in qualifying," he recalls. Things were to go slightly better in the race, with Mason ending up 19th out of 22 finishers.

In between a busy work schedule, the next few months were spent away from the track, making alterations to the car after its first competitive outing. Then a friend at the Equipe GTS championship phoned up and mentioned that a group of Turner owners were trying to put a team together for the series' three-hour relay race. The Nankang radial tyres that the car had used for Road Sports were quickly swapped for a set of the Equip GTS series' Dunlop Historic crossplies. Eventually the Turner squad had to drop out, but Mason ended up teaming up with a fellow competitor in an MG Midget and the two of them took turns to complete the entire 180 minutes, finishing 23rd.

The 2018 season proved to be another mixed bag, with a fairly substantial 'off' at Brands Hatch requiring new front bodywork and repairs to the rear end. Later in the season the car returned, only to retire with alternator failure. For 2019, however, things seem to be looking up. Mason finished first in class and 11th overall at the opening round of the Equip Pre '63 series at Silverstone in March and he was running first in class and fifth overall in the second round at Brands Hatch before mechanical gremlins intervened.

Despite these teething troubles, the Turner is going well, we're told: "Down the straights it doesn't stand a chance against cars like the Austin Healey 3000, but through the corners – given it only weighs so little and it's on the same size tyre – I can recover a lot of that ground. At the moment, the car weighs 610 kg, but the homologation weight from the sixties is right down at 10 cwt (508 kg). If you put a good driver in it, I reckon it would match the big Healeys over the course of a lap."

That's borne out by the car's recent results, which have seen it finish ahead of a host of more expensive machinery, such as Austin Healey 100Ms, Lotus Elites and MGBs. It's proof that the Turner's giant-killing credentials are still alive and well. HRT




Peter French - Flying Tigers Photography

**ABOVE** The cylinder head being tested on the flow bench



Peter French - Flying Tigers Photography

**ABOVE** The engine on the dyno. The focus has been on ensuring driveability

# THE BEST INDYCAR EVER

**Andy Swift** examines the meticulous, and poignant, restoration of an Indycar revered for one of the most dominant seasons ever in motorsport history

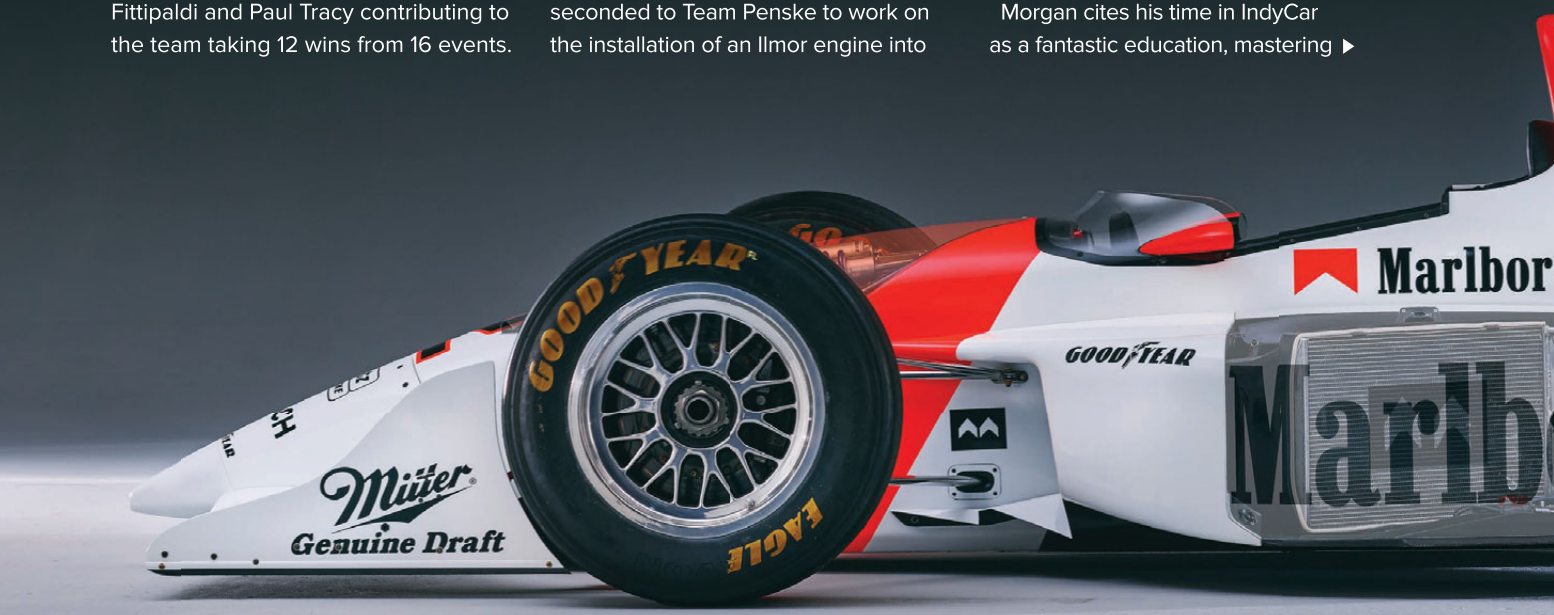
IN 1994, Team Penske won the Indianapolis 500. The most storied team in American racing history winning the country's blue ribband event might not be unusual, but that year victor Al Unser Jr's Penske PC-23 was propelled by one of the most celebrated racing engines of the modern era: Ilmor's top secret and phenomenally powerful 265E – the pushrod motor.

That showcase win at Indy was the seasonal highlight but it came at the mid-point of Team Penske's most dominant ever season. Unser swept to the title with team-mates Emerson Fittipaldi and Paul Tracy contributing to the team taking 12 wins from 16 events. While the 265E might have stolen the headlines, the PC-23 it powered remains a seminal IndyCar design from the era before American open-wheeled racing was split asunder with the formation of the Indy Racing League.

Patrick Morgan is the fortunate owner of PC-23 chassis #8, purchased from former Penske team manager Chuck Sprague in 2011. Morgan's connections to this era are deep: his late father, Paul, was founder of Ilmor and the younger Morgan began his engineering career as a junior trackside race engineer in IndyCar in 1997; by 1998 he was seconded to Team Penske to work on the installation of an Ilmor engine into an ex-Dario Franchitti Reynard as part of a benchmarking exercise. The PC-23 is particularly special to Morgan as its motors ran with Ilmor logos on the cam covers before Mercedes-Benz funding led to rebranding for 1995's PC-24.

As a teenager, Patrick had helped run his father's old warbirds, including a P-51D Mustang. This background in precision engineering offers some insight into his clinical and painstaking work at Dawn Treader Performance Engineering, which specialises in the restoration and preparation of high-end racing cars (and occasionally motorcycles).

Morgan cites his time in IndyCar as a fantastic education, mastering ▶






**ABOVE & BELOW** Beneath the skin of perhaps the most dominant car in IndyCar/ChampCar history




**ABOVE** Sensational in period, the PC-23 is no less stunning in its latest incarnation

the complex demands of street circuits, road courses, short ovals and superspeedways; this at a time when there was competition between manufacturers of chassis, engines and tyres. During his work with Ilmor in the States, he oversaw a pole position and win in the Indy 500 – achievements he ranks as the most significant of his career.

All that said, he still found himself taking a deep breath when his PC-23 landed at Dawn Treader in 2012. While he is at pains to confirm that there was no misrepresentation through the sale of the car, finding a tidemark 1.5" high in the bottom of the tub confirmed that #8 had clearly spent some time outside in the rain once its racing career was over.

The strip-down took three engineers two weeks. The small team sketched and photographed every possible detail and installation. Each restoration at Dawn Treader takes its own bay, with #8 occupying its spot for four years of painstaking work. Morgan found himself as much historian as engineer at this stage of the project. He spent days at a time locked in his office poring over notes and photos.

Team Penske maintains a fastidious record of each chassis's history and Morgan's strong connections with the outfit made the research of #8's 1994 season relatively straightforward. It had been raced by Emerson Fittipaldi as well as used extensively for testing, during which time it was driven by the late Greg Moore. Thereafter, it passed to Bettenhausen, for whom it is believed to have been raced by Stefan Johansson, though its precise race history is unknown. What is clear, though, is that it was used – and heavily crashed – by Gary Bettenhausen during the 1996 U.S. 500, with filler repairs to the sidepod entry visible once stripped down.

## ENGINE RARITY

Chassis #8 arrived as a partially complete car. Its recent life had been spent as a showcar, so it was back in iconic Team Penske Marlboro livery, rather than that of Bettenhausen. A correct Ilmor 265D engine was present – actually quite a rarity as most were upgraded in period – but it was only loosely fitted with rough transit mounts, rather than as a fully plumbed installation. There was no real spares package, no heat exchangers, the wrong exhaust system, the fuel cell was shot and a chunk of the wiring loom was missing. Fortunately, the team at Dawn Treader did, however, inherit a 20-page operations manual and, most critically, a parts list. This Morgan cites as being the most useful document of the restoration as it enabled the team to piece together the awkward little bits which had been lost when the car was gutted after its U.S. 500 smash.

With the car back to a bare tub, the team was able to start stripping the paintwork. It found four coats of paint, 5 mm thick, which peeled off in huge plies, as Morgan explains: "Stripping the paint removed 8 kg of weight – it was so thick the panels didn't fit together properly. We photographed the removal. It was history in front of us and revealed the U.S. 500 damage, verifying that part of the car's career."

With the car's specification having varied significantly during its contemporary career, a decision had to be made on precisely how to rebuild it. Morgan settled on Fittipaldi's road course configuration from Cleveland 1994. He already had the correct sidepods and




**ABOVE** The PC-23 is particularly special to Morgan because '94 was the only IndyCar season that Ilmor ran an engine under its own name

floor; by sheer good fortune he was also able to obtain Johansson's front wing from Laguna Seca in 1995. While the car would be more difficult to run in oval configuration, Morgan admits that the decision to opt for Emmo's road course configuration was driven by its striking aesthetics and that priceless link to a Formula 1 and IndyCar legend.

The dismantlement was photographed extensively but Morgan is also a firm believer in taking detailed notes. Sketches and annotations therefore recorded many unseen aspects of the car, including sundry assemblies, bolt locations, toe link settings, gear ratios and the like. In 2011 while negotiating the purchase of #8, Dawn Treader was charged with running Penske's own PC-23 at the Goodwood Festival of Speed. Morgan took that opportunity to explore a finished example.

He believes the carbon fibre work was the biggest headache on the project – quite an accolade considering the complexity of the restoration. The full spine of the car was sent to MCT in Daventry, where significant quantities of fibreglass repairs made themselves evident. All the bodywork was re-skinned in carbon fibre inside and out, with the heat shielding stripped and replaced; the process took a full three months. This has left the panels 0.2 mm thicker but the compromise is deemed more acceptable than manufacturing whole new panels.

Morgan is clear, though, that the Penske bodywork – produced in period at its manufacturing facility at Poole in the UK – was way ahead of its contemporary competition. All the restored parts fit perfectly and he smiles when remembering how tight the shutlines were when the car was first reassembled; the neat turbo inlet scoop ▶




**ABOVE** The underwing is removed as the car is gradually dismantled ready for the rebuild

was particularly satisfying.

The brake ducts had been designed in several parts, enabling the size to be altered easily. The extraordinary depth of Penske's engineering is demonstrated with a feed pipe to the inboard side of the calliper featuring its own cooling passage. These were found to have been crushed, so new parts were produced.

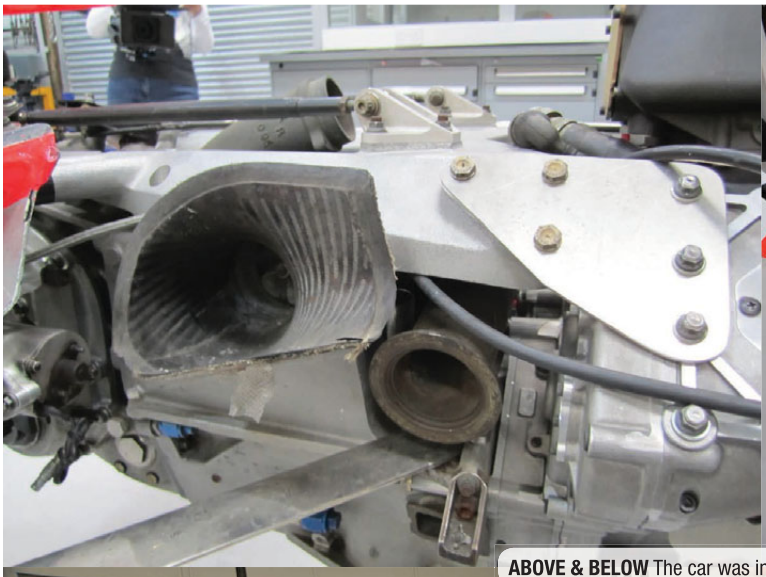
Morgan retains contact with Barry Sweetland, who ran Penske's composites shop during the constructor's IndyCar glory days. He arranged for a batch of period inspection stickers to be made up and attached to the new brake duct cooling passages, which Sweetland inspected. Satisfied that they were to Penske standard, he physically signed-off the parts, exactly as he would have done in 1994. It's a vivid demonstration of the commitment pledged in the name of authenticity on the build.

The tub required painting very early during the restoration, before any of the mechanical installation could take place, because it was exposed in several areas. This was undertaken by Classic Sport Engineering – Dawn Treader's next door neighbours. Morgan nominates the red as being particularly difficult to get right as it requires a mist coat to achieve the right colour. Mercifully the crisp red lines of the Marlboro chevrons lined up cleanly when the bodywork was sited. From there, the team had to be especially careful to protect the finished livery from damage. "That's why I don't wear my wedding ring at work!" Morgan quips.

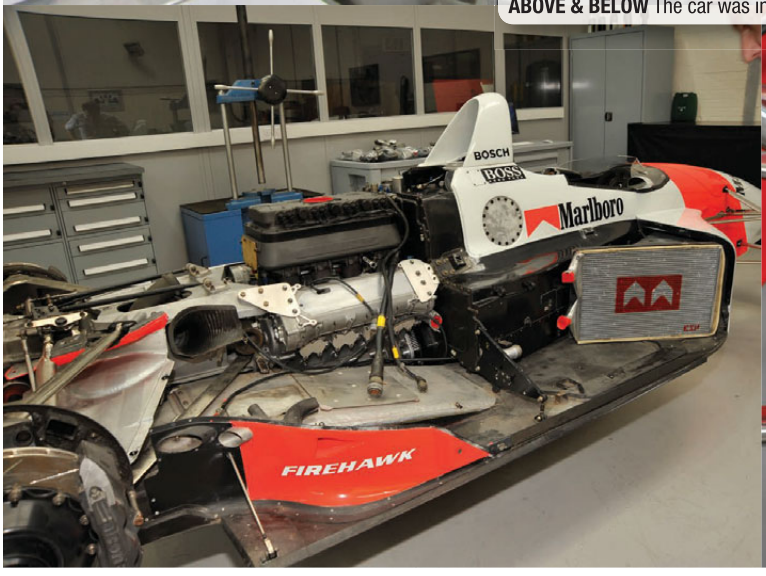
#8's bare, polished wishbones were chrome-plated for its life as a showcar. The chrome can cause hydrogen embrittlement in the welds, with the webs rusting from the inside out, so the decision was taken to manufacture new parts to the original design. These were fabricated by Ady Matthews at Historic Fabrication, who created Penske's wishbones in period. Matthews also reproduced the complicated heat shielding for the exhausts, including the replication of embossed Penske logos.

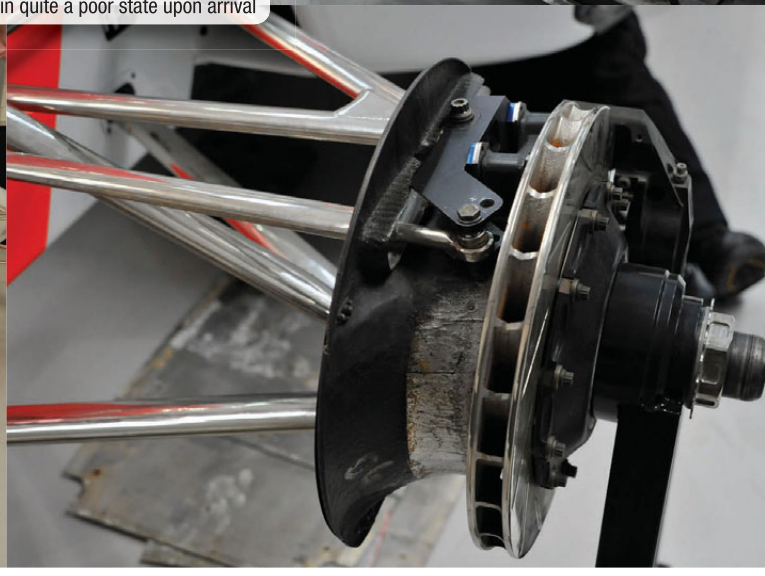
> **"The Penske bodywork was way ahead of its contemporary competition"**

The finishing visual touch was the wheels. Having dulled over time, they benefited from many hours of elbow grease to bring them up to a Penske ▶





**ABOVE & BELOW** The car was in quite a poor state upon arrival



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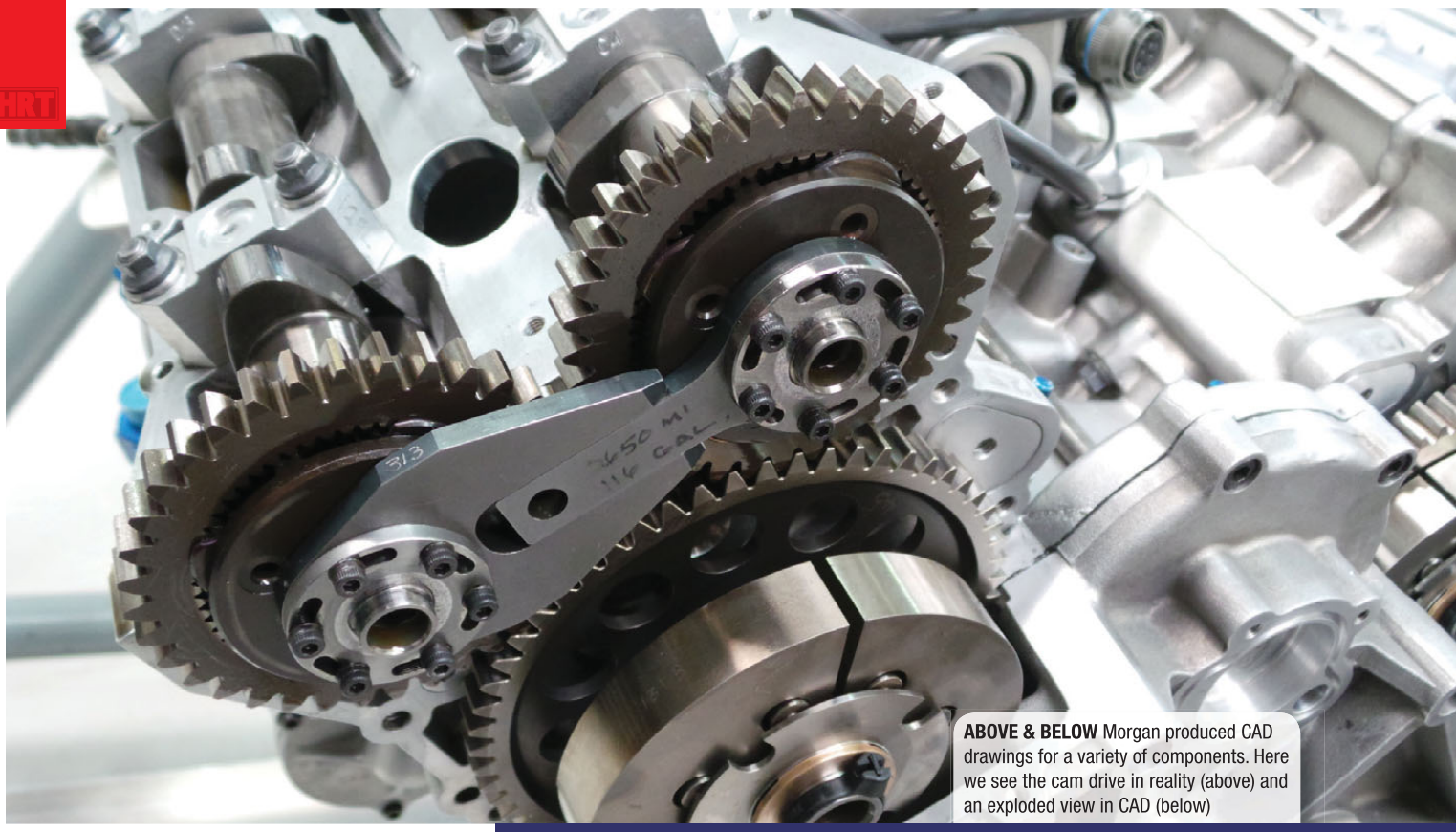


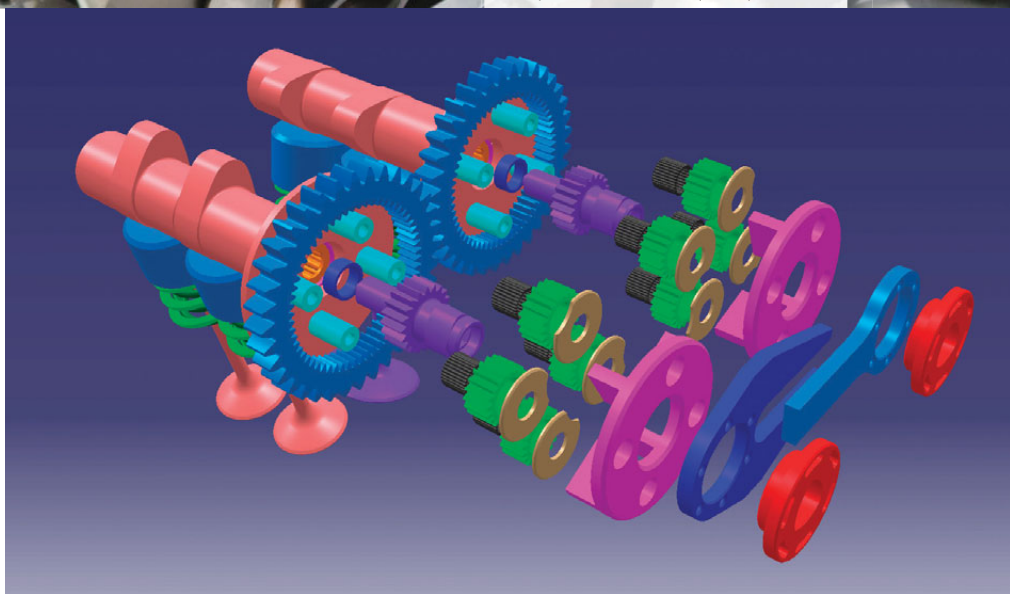

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**ABOVE & BELOW** Morgan produced CAD drawings for a variety of components. Here we see the cam drive in reality (above) and an exploded view in CAD (below)

standard of sheen.

Dawn Treader undertook all the engine work in-house. The 265D had completed dyno time only since its last rebuild but the team carefully stripped it, crack testing all the parts and replacing springs, seals, ball races and the like. Water had been left in the pump and fur was evident in the sump, so those were replaced with new parts. The existing turbo was rusty and finding a like-for-like replacement took a full year.

The inherited radiators were recommissioned and, remarkably, the missing heat exchangers for the engine and gearbox oil were located in Australia – presumably left there after a race at Surfer's Paradise. Morgan was able to obtain a pallet's worth of crucial parts for the build from the Antipodes and they passed pressure testing once cleaned up.

The pipe runs for the cooling system were especially painful due to a number of compound radii, requiring considerable trial and error. The 20-page user manual couldn't help much with the systems installation, which required extreme care: as Morgan points out, it was a pipe failure which caused Rick Mears' horror smash at the Indy 500 in 1992. Mears has described how the second pirouette executed during that accident was a moment that came to mind when making the decision to retire from driving. Thereafter, Penske employed neat clamps over the Wiggins clips on the water pipes to prevent a repeat.

In spite of the challenges, Morgan describes the engine rebuild as "straightforward but not simple".

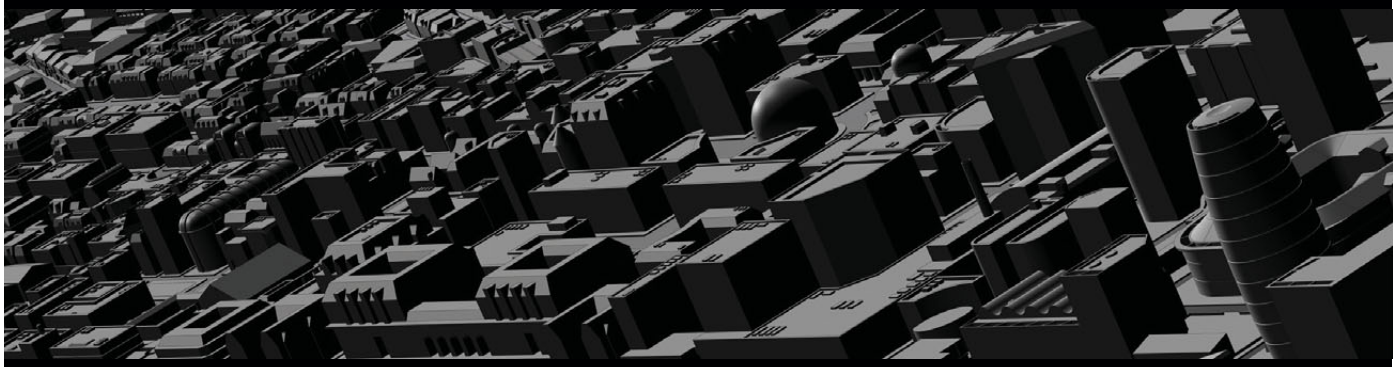
That said, these are awkward machines to run, being fuelled by methanol rather than petrol. Morgan explains that they are certainly harder work than a Formula 1 engine of the same period: "Methanol has a voracious appetite for O-rings and seals. The injectors must be flushed daily with petrol, with all methanol removed from the fuel cell at the same time. Exposure to methanol can quickly cause the cup on the fuel rail to degrade."

In order to start, the water temperature must be at least 40 deg and the fuel collector flooded, meaning the car needs to be carrying over 100 litres of fuel. Just starting the motor will use four to five litres of fuel, which makes it hard work at demonstration-type events like the Goodwood Festival of Speed. The oil is pre-warmed by a heat pad – a neat solution carrying nearly no weight penalty.

The exhausts get enormously hot and a cold towel is thrown over the engine ▶

# TRINITY

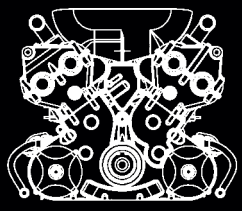
The new techno-thriller by Patrick Morgan with David Kidger

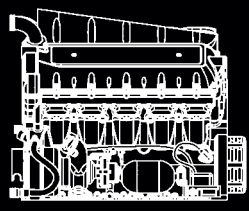


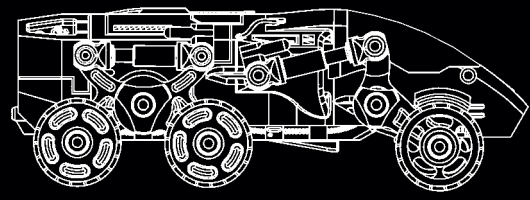
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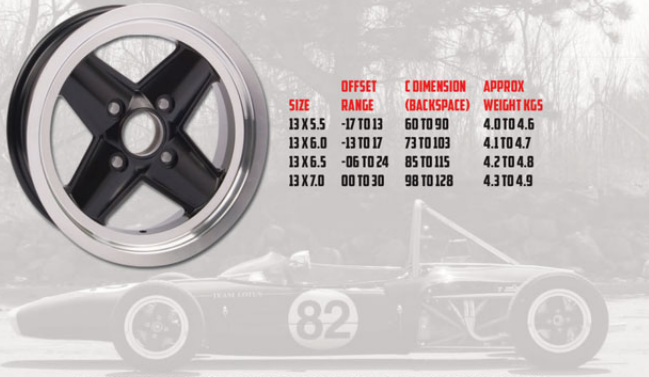


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**ABOVE** Unser Jr's Indy 500 victory with the top secret pushrod engine was the seasonal highlight, but beyond that win the PC-23 itself redefined US single-seater racing

cover after every run to stop the paint blistering. This also helps minimise fuel vaporisation which can drastically increase pressure in the plenum, preventing the injectors from opening and hence the engine from starting altogether.

Morgan also mentions that dramatic burn-out starts are encouraged from the drivers of these cars – even during demonstration runs. Period footage of pitstops will show all the drivers leaving big 'elevens' as they rejoin. This practice prevents wind-up of the driveshafts – rather counter-intuitively, it's kinder for the car, especially when using superspeedway gear ratios with 110 mph potential in first gear.



**ABOVE** Some of the work involved, such as these brake calliper pistons, dragged Morgan well outside of his comfort zone

> **"Harder work than a Formula 1 engine of the same period"**

## EXPLOSIVE DEVELOPMENT

The mid-1990s was a period of explosive development in the electronics field. Formula 1, DTM and IndyCar were at the vanguard of a movement which brought about traction control, ABS, moveable ballast, active suspension and advanced data logging. Dawn Treader has previously undertaken a three-year restoration of a 1994 Mercedes-Benz C-Class DTM car from the fearsome Class One era, providing 100% functionality with absolute originality. Achieving this level of engineering integrity is the only way the team will approach a major project – and that applied to the PC-23.

Chassis #8 retains all its original electronics, with Morgan claiming that a move to something like a MoTeC ECU would have been functionally feasible for a naturally aspirated engine but hugely involved for the 3D mapping required by a turbocharged unit. He also cautions against the use of lambda sensors, which were never used in race conditions in period due to the risk of broken tips getting sucked into the turbine.

Morgan retains some contemporary Ilmor notes for the electronics, but much of the work has required consultation with former team members and a good deal of trial and error. The PC-23 was also considerably more complex than its immediate predecessor, the PC-22, which ran without electronic boost control and a pitlane speed limiter.

The electronics system was largely complete with the main ECU, spark box, Pi data logger including digital dash, and the MRC for shift-without-lift, boost controller and pitlane speed limiter. Unfortunately the wiring was incomplete, though the car did retain its chassis loom and the forward loom on top of the cockpit which handles dash input, wheel speed, brake temperatures and the like.

A new right-hand side loom needed to be made from scratch for the ECU and spark box, along with the left-hand side interface. The provenance of the existing wiring is unknown as the car served time as a test bed and may have received some 1995 upgrades as a result. Due to the sheer volume of work on the car, Dawn Treader did sub-let some of the electronics work to Ray Mallock Limited, so it became something of a team effort.

Morgan describes the Delco 4 hardware as bulletproof, with the systems themselves being excellent, but communication is the most awkward aspect of dealing with 25-year-old electronics. He habitually buys old laptops off eBay – because of their propensity to fail – and finally managed ▶

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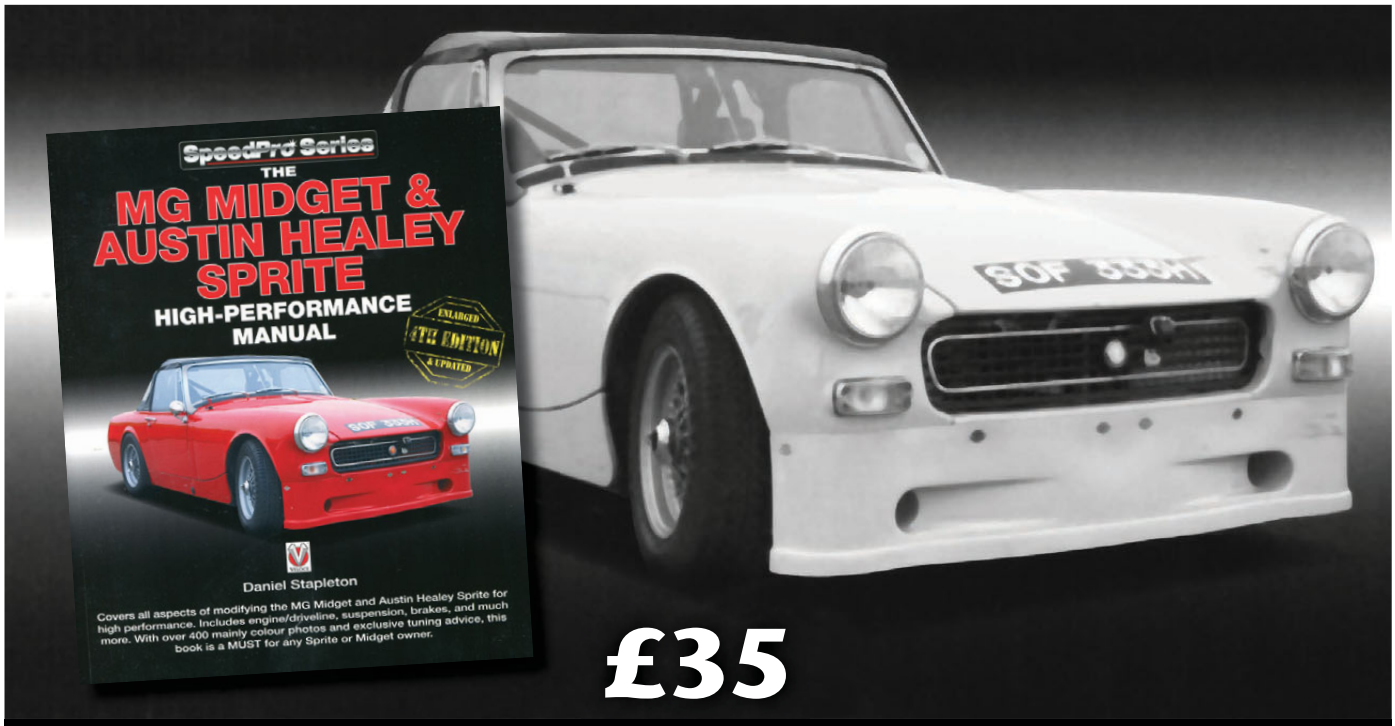
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**ABOVE** Dawn Treader undertook all the engine work in-house

to get an old computer to talk to the ECU after two months of endeavour. The baud rate between the laptop and the ECU is selected by the manufacturers from one to 15,500, giving an enormous number of potential permutations. Fortunately only a handful of rates were commonly used, limiting the number of options that had to be explored, though Dawn Treader inherited no existing data with the car.

Adding further complication was a lack of information for the data logger required to operate the dash. Three files are required in order to make the dash work: each of those has 30 software levels. They must be entered in the correct sequence or the system won't start.

## ELECTRONIC BOOST CONTROL

The boost system on the PC-23 is unusual and 1994 was the first year Penske employed an electronic boost control system. Being inherently conservative, Roger Penske insisted that the car should also have a mechanical system as a back-up courtesy of a lock-out valve. "Figuring it all out was a challenge," laments Morgan, "but fortunately Tony Matthews had a photo of the cockpit which showed the controller above the driver's left knee."

While the relentless work to get the electronic systems talking to one another sounds painful, Morgan is positive about the process: "It's not creative and I do find the design-side work more satisfying, but it is rewarding in its own way."

Morgan also found himself treading new ground by designing brake parts for the first time. There was no ABS system on the PC-23 – a rare nod to simplicity – but the mechanical parts needed an overhaul. "We inherited four calliper housings in reasonable condition with a mix of worn pistons. You can't afford to take any shortcuts with uprights or brakes and, with no spares available, I set about designing new parts for manufacture," he explains. ▶




**BELOW** The fit and finish of the body was, and is, sensational

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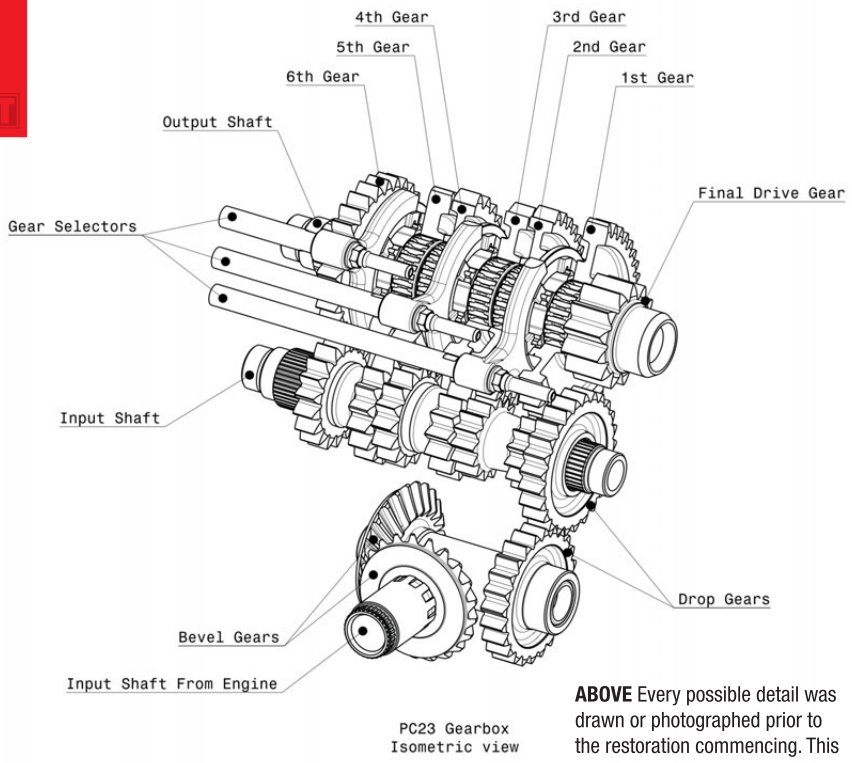
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**ABOVE** Every possible detail was drawn or photographed prior to the restoration commencing. This is the PC-23's gearbox

The new pistons presented a design challenge, with the angled inner face of the seal groove proving extremely hard to measure. The machining was done by a local independent specialist in titanium, with a titanium nitride coating. In spite of the concern, the pistons operated exactly as intended.

These small replacement parts often became hugely time-consuming to accurately measure and draw. Morgan produced CAD drawings for a variety of supplementary parts such as studs, bearings, pushrod turnbuckles and the fuel system banjo. Whether they were created in-house or out-sourced, spares have been made for all these items to prevent the cost of re-tooling for additional small batch runs. Naturally, all drawings are retained for record purposes, even in-house manufactured parts.

Despite the many hours spent designing in CAD, Morgan was unwilling to compromise on the authenticity of the project by using 3D printing. "I prefer to use period machining: the guide patterns are different when they're printed and I insisted on programming the machines to match the patterns used in 1994," he confirms. That said, he is experimenting with 3D printing on other projects but didn't feel it was right for the PC-23.

Across the rest of the car, there were detailed assemblies and systems to strip, clean and reassemble such as the steering rack, air jacks and master cut-off switch. The air jack system includes a dump valve located behind the driver's back. The driveshafts are asymmetrical, a legacy of the single turbo arrangement which means that exhaust gases vent over the driveshafts on one side only,




**ABOVE & BELOW** Four years of painstaking work went into the restoration project



**ABOVE** The 'Mono Bump' third spring system, which enabled lower ride height to be run, was one of the secrets of the car's phenomenal performance out of corners

requiring different materials for each.

The original Penske dampers were refurbished by SPA. The suspension system is unusual in featuring a monobump third spring which allowed the cars to run a lower ride height. This gave the benefit of more effective ground effects and, combined with an Xtrac viscous differential which was unique to Penske, terrific traction. The PC-23's ability to haul itself out of corners supposedly raised the eyebrows of a number of paddock observers at the time, including Nigel Mansell who speculated that it must have been running a form of traction control.

> **"A project executed to a notably high standard, even within an industry which prides itself on excellence"**

The result of all this endeavour across every millimetre is a PC-23 restored, in so far as is practicable, to exactly the specification and standard executed by Penske and Ilmor in 1994. The presentation, detail, authenticity and integrity are without peer, though Morgan jokes that it's almost impossible to over-restore a Penske, such is the level of contemporary preparation.

It is clear that this project has been executed to a notably high standard, even within an industry which prides itself on excellence. It is a deeply personal project for Patrick Morgan but unusual in that the owner of the car is an engineer well-versed in the challenges and complexities of running these remarkable and vastly potent cars. It is unlikely any other potential custodian of #8 would – or indeed could – have gone to such extreme lengths to preserve its legacy.

Morgan expresses some regret that he hasn't enjoyed a greater number of opportunities to drive his most treasured possession. One rather gets the impression, though, that simply owning a totemic icon, not only of the IndyCar world but also his own family history, is fulfilment enough. HRT




**BELOW** At long last, Patrick Morgan finally gets to sit behind the wheel of the car that his father helped make famous

# BACK TO THE FRONT

The car that famously won from the back of the grid at Detroit in 1982 has returned to winning ways. **Alan Stoddart** talks to the man now calling the shots in John Watson's cockpit




Jeff Bloxham

**I**N 1982, the tight, unforgiving streets of Detroit played host to a spectacular race. Between disrupted pre-race practice sessions, the threat of rain during qualifying, and a mid-race red flag and restart, the stage was set for a truly dramatic finale. This climax came in the form of John Watson and the McLaren MP4-1B that he expertly threaded through the tight American turns.

Starting from 17th on the grid, Watson battled through the pack, eventually making it to fifth position and closing on his team-mate Niki Lauda, Eddie Cheever in the Ligier JS17B and the Ferrari 126C2 of Didier Pironi. Amazingly, where Lauda and Cheever had been held up by Pironi, Watson was able to almost immediately scythe through the group, rising three places in a single lap.

This left him second only to Keke Rosberg in the Williams FW08. Rosberg had been ahead at the mid-race restart, so had a sizeable time advantage. Fortunately for Watson however, the Williams also had started to develop gearbox and fuelling problems, allowing him to make his final pass, and steal the victory.

This drama once again proved that the MP4-1B was a race-winning car. It was a point that was emphatically re-emphasised in May 2019, when, in the hands of new owner Steve Hartley, the car once again took victory, but this time on the asphalt of Brands Hatch in the ▶



**LEFT & INSET** Thirty-seven years on from its finest moment in Detroit (inset), Hartley's MP4-1B was again victorious, coming out on top in a thrilling FIA Masters Historic Formula 1 Championship race at Brands Hatch

**"You can see where, if Arrows spent one hundred grand building a car, McLaren spent two hundred. It's the detail"**



**ABOVE** The MP4-1B relies on ground-effects to generate its downforce. It is a direction to which F1 may well return with its next rules package

Masters Historic Formula One series.

When Hartley first got the car, it was in reasonable condition, especially for a racing car, but there was still some work that needed completing before it was ready to be taken out and thrashed around on track. One of the first things to do was to take the Cosworth DFY engine out and completely overhaul it. This work was done at TMax Engines, by an expert who specialises in the DFV, and its upgraded versions such as the DFY.

Hartley says that he could have taken the engine back to Cosworth, but while the company that did originally make the engine still makes parts, he feels the smaller independent specialists such as TMax may actually hold an advantage.

"The small one-man bands have actually developed the engine further




Photos: Jeff Bloxham

**ABOVE & BELOW** Such is the abundance of grip available with the McLaren, compared to the Arrows A4 that he raced (below), Hartley is having to relearn circuits he has been driving for years

> **"Setting it up is an art in itself"**

even than Cosworth, because they are still doing development work on them while Cosworth stopped after they weren't used anymore. It's really the privateers that make them work," he explains. "Although I can't tell you exactly what they do.

"It's an intellectual property-type thing to the specialists: they don't really tell you what goes on. Instead they just say 'the heads are wrong' and if you ask why they'll just tell you the 'gasflow isn't right' or the 'size of the valves is wrong', or that they don't like the pistons that are in it.

"It goes a bit like that. I can't tell you what they do in terms of the degrees of inlet timing, or exhaust timing or ignition timing, for example, because that is their speciality, it's what they do. Some might run a lightened rod, while some might use a heavier rod, some might use cast iron liners, while others might use Nikasil aluminium liners. They don't tell you because if they did, then the competition might find out."

To this end, adds Hartley, they don't even give the full results of the dyno tests. "Without doing the proper conversion factors for things like ambient pressure and moisture and things, then it can dramatically affect the outcome. So only they have the full picture."

On top of this, he continues, the other big concern for the specialist, and one of the reasons such highly strung engines must be overhauled at all is to protect them.

"What they are most concerned about is if the thing blows up on the dyno and they have to pay for it. You are probably looking at a 60-grand bill if it all goes wrong, so they tend to know what they are doing and only take it to 9,000 or 9,500 rpm. There they know what power they are looking for and if it isn't quite there then they do some tweaking, but that is a bit of a black art."

## UNDERSTANDING THE AERO

Aside from the physical rejuvenation of the car, the majority of the workload focused on understanding the complex aerodynamics of the racer, and working out exactly how to set up the McLaren so Hartley could best take advantage of its ground-effect concept. To perfect the setup, GSD RaceDyn was enlisted. Working with this specialist, Computational Fluid Dynamics (CFD) was used to understand the car's aerodynamics. CFD is a computer software system which could be likened to a digital wind tunnel. Hartley also took the car to an airstrip where it was festooned with potentiometers and laser ▶





**ABOVE** McLaren changed the face of Formula 1 forever with the composite tub, produced by aerospace expert Hercules

ride height gauges and was then run at various speeds up and down the runway. Testing in this way provided an effective substitute for a wind tunnel, and allowed the aerodynamic characteristics of the racer to be better understood.

All of the collected data could then be analysed by GSD RaceDyn, which was able to advise on the most effective setups and to ensure that the ground effects were able to work in harmony with the rest of the car's aero and perform properly.

## RAISED SKIRTS

"You need to know how much the wing and how much the undertray are working, and then to calculate out what springs you need to bring the car down, because the car needs to come down very quickly. So, you are relying on the main wing to push the car down and then the underbody starts to perform but you need to calculate that out," Hartley explains. "In 1982, the cars ran with hinged skirts in permanent contact with the ground, but current regulations don't permit that. We are forced to run with the skirts clear of the ground, which reduces downforce, but we have managed to claw a lot of it back.

"We learnt quite a bit about the wings at the front and at the rear, and how they don't always work like conventional wings because you have got the aerodynamics taking place under the car. This set up work was all-important, it was critical. Many of the amateurs and people who mess with racing cars don't understand, so yes, you can put a lot of wing on it and make the cars stick to the ground, but that creates a lot of drag."

"You have to understand the mechanical grip side of things too," Hartley continues, "or you will just end up with the car set inherently wrongly. So setting it up, when your shock absorbers have five or six settings bump and five or six settings in rebound, and you have as many springs as you want to put on the car, setting it up is an art in itself."

Winning in the McLaren MP4-1B represents something of a step up ▶




**ABOVE** Independent engine experts have developed the engine further than even Cosworth did in-period

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# Gordon Murray
# ONE FORMULA
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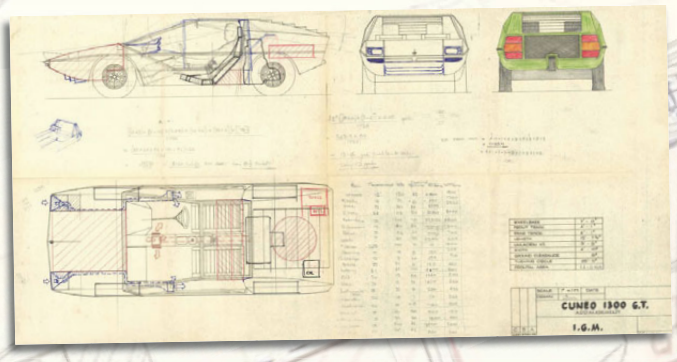



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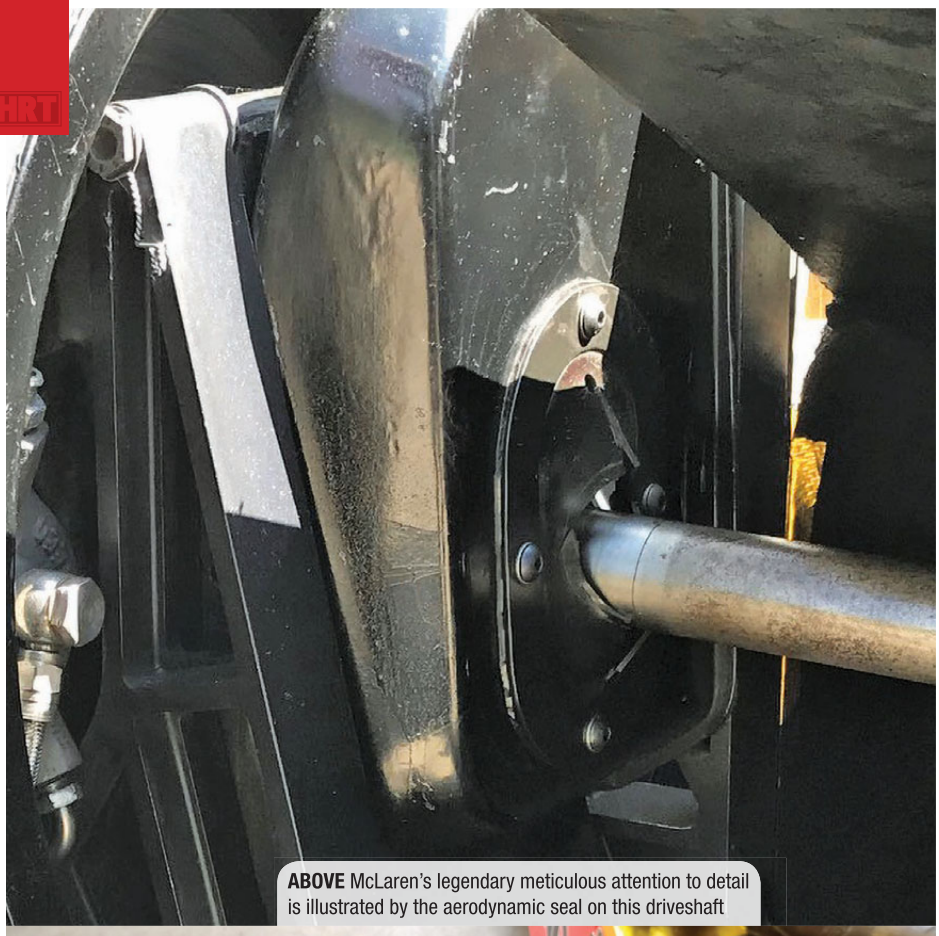

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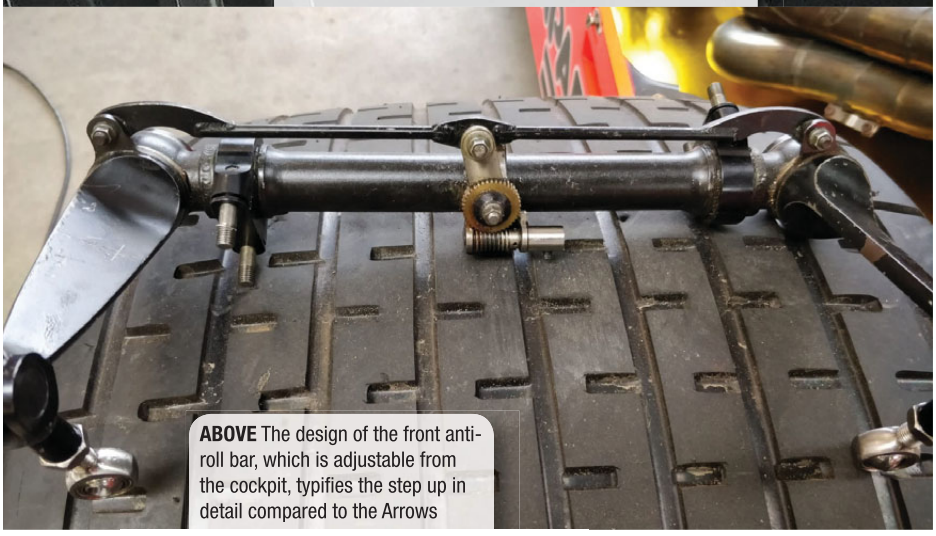
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**ABOVE** McLaren's legendary meticulous attention to detail is illustrated by the aerodynamic seal on this driveshaft



**ABOVE** The design of the front anti-roll bar, which is adjustable from the cockpit, typifies the step up in detail compared to the Arrows

for Hartley, who has raced with some success in the Masters F1 series for some time in an Arrows A4, winning the FIA Championship in 2014. Having made the switch to a front-running car though, he is able to see all of the small engineering details that raise the car above his past flyer.

## BIG DIFFERENCE

"There is a big difference," he explains. "I think you can see where, if Arrows spent one hundred grand building a car, McLaren spent two hundred. It's the detail.

"The Arrows was a decent car and when it was set up properly with the ground effects and with the skirts, it was a bloody good car, and on occasion beat the Williams and others. But you can see why it wasn't a front-running car all the time.

"When you look at it and you look at how it is put together, you can see the difference. One of the classic examples is the mechanism that runs the front anti-roll bar. I mean, mine didn't have a remote front anti-roll bar that you can adjust in the cockpit, but the McLaren has a rear one and a front one. It's all in how they designed it and how they built it.

"There are all sorts of things when you pull it apart, where you can see that McLaren has gone the extra mile."

There are other things too. To get the aerodynamics working as efficiently as possible, McLaren made the underwing as big as possible. To do this not only were the pumps on the engine moved to improve the packaging, but far smaller details were also considered. For example, where the air comes out of the tunnel, which is where the bottom wishbone and the driveshaft is, the driveshaft has even got a specially shaped grommet around it to stop air being disturbed where it comes out the gearbox.



"That sort of thing just sets it apart," he admits.

"There is another thing called a nappy," continues Hartley. "It's a carbon fibre bit, and it wraps under the gearbox, so when the air comes down the centre of the tub, all the engine and all the gearbox is smooth, but you have to take the nappy off to get to the gearbox.

"When I bought the car the nappy wasn't there. The guy that ran it before said you don't really need the nappy, and that all it does is crack if you get the trolley jack on it.

"But you do need it! McLaren designed it and put it on the car for a reason. You can't work out what specific difference it does make, it's probably only two or three per cent, but if it is three per cent there, and four per cent somewhere else, and another three per cent somewhere else... all the little bits and pieces add up, and that's when you have a good car."

## "THE CAR'S FASTER THAN I AM!"

All of these individual elements compound, and it means that for Hartley in the driver's seat, the difference between the MP4-1B and the A4 is stark. The contrast is so great that he is even having to relearn tracks that he has raced on for many years. "So when I was turning into bends at Brands Hatch, for example, I was driving it as I would the Arrows and I just realised there was much, much more grip, and I could have turned in much faster.

"But when you have been driving a car for 10 years, it is hard to get it out your head with the braking points and the speed that the Arrows would go round.

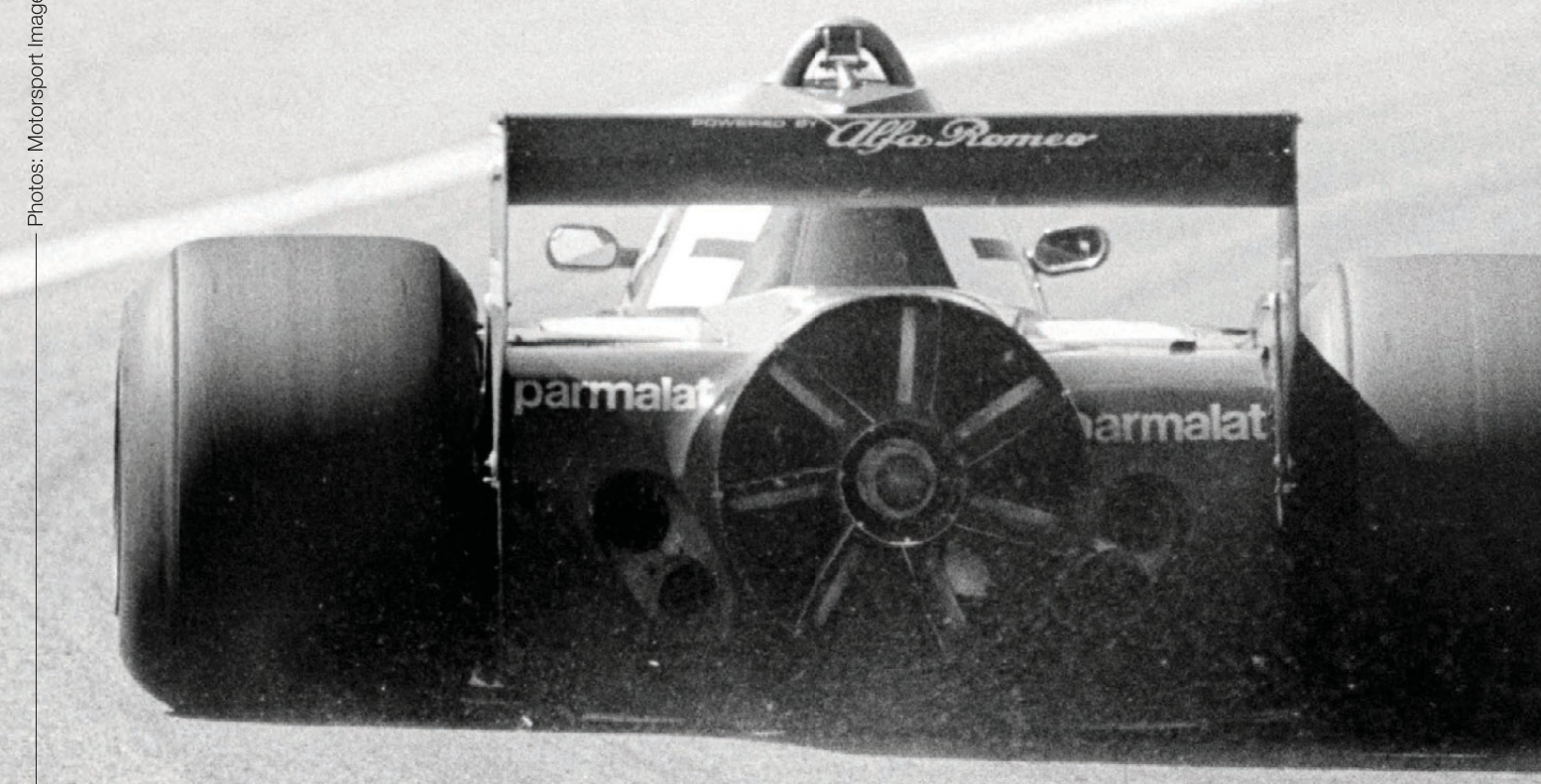
"So at this moment in time the car is definitely faster than I am."

And of course, as well as the thoughtful engineering, and the on-track performance, there is also one final detail that makes the car special compared to his old Arrows: "It's a bloody McLaren!" HRT




**ABOVE** Hartley only had to come from fourth to secure victory at Brands, where Watson had battled back from 17th at Detroit in the car's heyday

# WHEN THE **** REALLY DID HIT THE FAN...




Photos: Motorsport Images

In an extract from his new book, **Gordon Murray** reveals the inside story behind one of the most controversial cars in Formula 1 history

**LOOKING** back at Gordon Murray OBE's incredible body of work in the retrospective book, *One Formula – 50 Years of Car Design*, published by Porter Press, it is hard to imagine that the designer of such legendary cars as the McLaren MP4-4, the Brabham BT49 and the McLaren F1 doing anything else. This portfolio of work could have looked very different, however, were it not for a fortuitous (for Murray, at least) misunderstanding, which helped him get his first job in motorsport's top tier.

As Murray recalls in the book, he was attending an interview for a position at Alan Mann Racing in Fairoaks, when one of the designers in the office mentioned that the Brabham F1 team, which was based just up the road, also had a position available.

"I thought, Formula 1 – my God. I hadn't even dared to think about Formula 1. I was looking at road car companies. Anyway, I walked to Brabham – it was a long way – and knocked on the door. I said, 'I believe you're looking for somebody.' They said, 'Oh, yeah. Come in.'

"Ron Tauranac interviewed me for 15 minutes. He wasn't interested at all in any of my academic qualifications or prizes or anything like that. He was just interested in the fact that I'd designed and built my own car and engine. He picked up something on the desk and said, 'How would you make that? Explain how you'd make that with a lathe, and what chuck you'd use.'

"Then he said, 'You've got the job.' That's how I got the job at Brabham."

As Gordon departed through the waiting room, he passed the guy who had an appointment for an interview for the job he had just been given! For Murray, it was a very happy misunderstanding. On such quirks are lives changed.

## INSPIRED CREATION

This 'quirk' not only changed Murray's life, but it also led to the creation of one of F1's most inspired designs, the Brabham BT46B. The fan car.

In 1977, the Lotus 78 introduced the

**BELOW** To meet the letter of the law, more than 50 percent of the fan's flow was employed for cooling purposes. The rest, unashamedly, was to suck the car down

ground-effect phenomenon to Formula 1. However, due to the car's unreliability and a few driver errors, the 78 was initially inconsistent and far from dominant. As a result, the opposition did not take it too seriously. With the dawn of 1978, it was all change. In the hands of Mario Andretti and Ronnie Peterson, Lotus 78s won two of the first three races and the successor 79 announced itself with a win in Belgium, a one-two in Spain and France, and victories in Germany, Austria and Holland, finishing the year on 86 points to Ferrari's 58 in second position.

"The 46B was absolutely born out of necessity. After all this pain with Alfa Romeo [engines] through the early bad years, we suddenly had a car in the 46 that could win races again. Bernie [Ecclestone] and I and the drivers were just patting ourselves on the back, and reckoning we could have a pretty good season that year, and Colin Chapman came along with ground effect and the venturi cars.

"In the beginning, I am not sure even they knew quite what they had. They were still experimenting with big changes and sections, and skirts and stuff. But everybody could see they had masses of downforce with not much drag.

"Of course, for anybody with a DFV or a V12, it was easy because you just copied what Lotus did. But we had a flat-12 engine and the cylinder head stuck out into where the venturi should be. Just where the slope from the throat of the venturi coming up into the diffuser should be, the cylinder head sort of poked out into that. I said to Bernie that we had just realised what Chapman and Lotus had got and we couldn't have it. Bernie said, 'Why?'

"Of course, I explained to him why and he said, 'Well, what are we going to do?' and I said, 'We are going to lose the Championship, basically.' We had just got this car that's really competitive with the Alfa flat-12 and we've had it.

"I put my thinking cap on and the first idea I came up with was a twin-monocoque car. I've got a drawing of it somewhere. I did the first monocoque up to the back of the driver and then it stopped right behind the driver – no fuel tank. By then, most of the fuel was carried behind the driver. Because the engine moved from behind the fuel to behind the driver, that put the cylinder heads in the low part of the venturi so they could stick above the sidepods and not interfere.

"Then I had a second little monocoque, which was bolted onto the back of the engine and held the fuel and that had a hole through it and the input shaft into the gearbox ran through that. Then on the back of that, I bolted the gearbox. ▶

> **"We were so fast. Bernie didn't want to piss everybody off completely, so he made the drivers qualify on full tanks"**




**ABOVE** *One Formula – 50 Years of Car Design*, printed by Porter Press, charts the exploits of one of the sport's true superstar designers

# GORDON MURRAY **Brabham fan car**



**ABOVE** Murray being quizzed at the launch

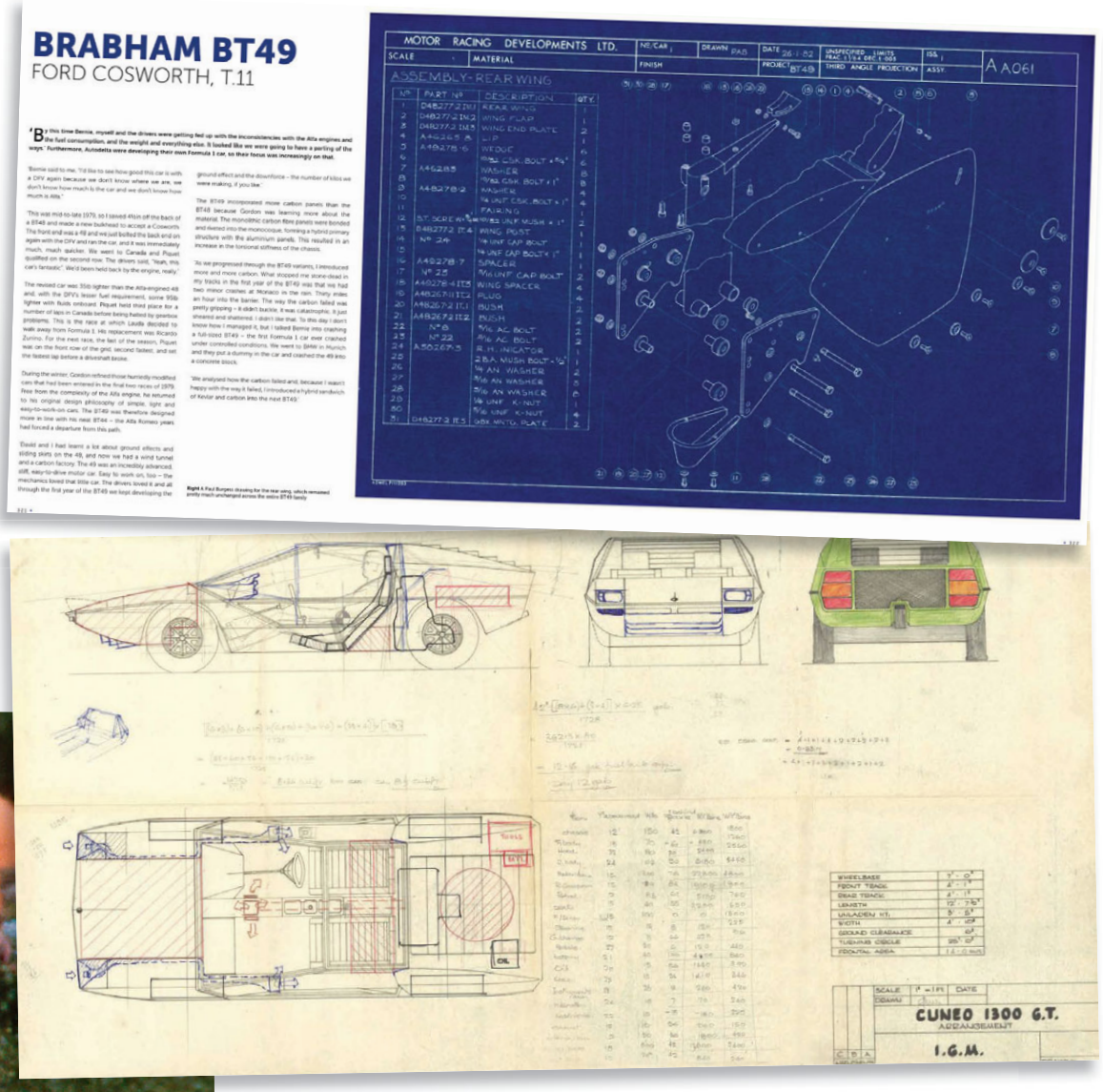
So I had a quill shaft running through the second monocoque and that meant that the flat part of the engine was right where it didn't affect the aerodynamics and the fuel cell was where the sides started to sweep up. I thought, well, that wouldn't take long to build. We would only lose a race and I will have those running. That will be our 46B and we'll be back winning races again.

"However, when I did the calculations, it added about 20-25 kilos with the extra driveshaft and all the bolt flanges and bulkheads. And it was a compromise on torsional rigidity and engine access. Changing engines was going to be a nightmare. So I thought, it's not going to work at all.

"I read the regulations again and Article 3.7 on aerodynamic devices said, 'Anything that's primary function is to have an aerodynamic influence on the car must always remain stationary and be fixed relative to the sprung mass of the car'. I spoke to a lawyer friend and said, 'What does primary function mean?' and he said, 'Well, how many functions are there?' I said, 'Two'. So he said, 'The primary function is the one that has more than half the influence.'

"So if we could get skirts to seal like the Lotus ones and have a cooling fan

**BELOW** The BT46B won its only Grand Prix, in Sweden in the hands of Niki Lauda. The drivers had qualified with a full fuel load in order not to reveal the car's phenomenal performance to rivals before the race




**RIGHT** From some of Murray's earliest inspirations (below), through to his title-winning machines (above), the book offers a fascinating insight into one of the sport's most turbulent and exciting periods



that uses more than 50 percent of its flow to cool the car and the rest to suck the car down...

"Chaparral had previously used fans, but that was a completely different situation with separate, independent engines driving the fans, and no restrictive aero regulations, so their design just wouldn't work for us.

"A lot of stuff has been written that says we tried to hide the fact that it was sucking the car down. We didn't. We always said, 'It sucks the car down, but that's not its primary function. Its primary function is cooling.'

"We got a fan guy involved, because I knew nothing about fan design, absolutely zero on what pitch and size you needed. His name was David Cox. He did all the calculations and designs for the size of the blade and the diffuser behind the blade to recover the pressure.

"Then I thought, OK, but this is in the middle of a racing season. How do you solve all the problems? So we wrote them all down, between David North and myself. One of the first problems was, how do you drive the fan? It turned out that David Cox's calculations showed we needed a fan about 18in. First you've got to find one. Then how do you drive that, off the engine or the gearbox with all that inertia, and get round things like gear changes and starts?

"Then there was starting inertia. You've got an 18in fan that's standing still, the guy's got the clutch in, engine's revving at 10,000, light goes green, you take your foot off, then you've got to wind up that much inertia in a matter of a second. It was geared up to 7,900 revs. So, the Alfa had 11,000 or 12,000, but the fan was doing 7,900 – that's the gear ratio I used so the fan wouldn't explode. And also to control the tip speed, which couldn't go supersonic.

"I thought, that's never going to work. The quill shaft that's driving the fan is just going to twist itself round and snap ▶




**BELOW** A succession of catastrophic fan failures had been experienced in the weeks leading up to the car's maiden appearance

because you'll never go from a static fan to 8,000 revs in half a second. I mean, it's just not going to happen.

"I designed a torque-limiting clutch, which was a little clutch with springs and screws. It enabled you to adjust the torque so that with the drag on the fan at maximum speed, the clutch was engaged, but when the driver slipped his foot off the main clutch, that clutch would slip and slowly speed up the fan, just for the start of the race. It would slip until it got to the right torque and then it would grip, and the fan would be running. So that was clutch number two.

"Gear changing on a straight-cut gearbox without synchromesh is really




**ABOVE** A well-positioned dustbin lid was used to keep prying camera lenses away from the fan

an art, with double de-clutching and blipping the throttle, and getting the inertia of the slowing-down gear and the speeding-up gear matched so you can change with a dog change. I know how difficult that is when you go to bigger-weight gears on, for example, a Le Mans car. The gear change is far worse because of the inertia and the gears. Now I'm adding an 18in fan to the output shaft, the poor driver's never going to be able to match the gears.

"We did a third clutch, which was a sprag clutch, a one-directional clutch. As soon as the driver put his foot on the main car clutch and took the torque out of the shaft, this sprag clutch would freewheel and de-couple the fan inertia from the main shafts of the gearbox, de-couple that completely, and then when he banged his foot off the clutch again the sprag clutch would catch and the fan would be re-engaged. You took the inertia out of the drive. So that was three clutches.

"We weren't trying to pretend it didn't suck the car down, but when the guys were just revving the car up in the pits, it was going up and down on the springs by about two inches. It was sucking itself down and springing up, and Bernie said, 'That's going to aggravate people.'

**"All the books and magazines said that the car was banned. It was never banned"**

## FOURTH CLUTCH

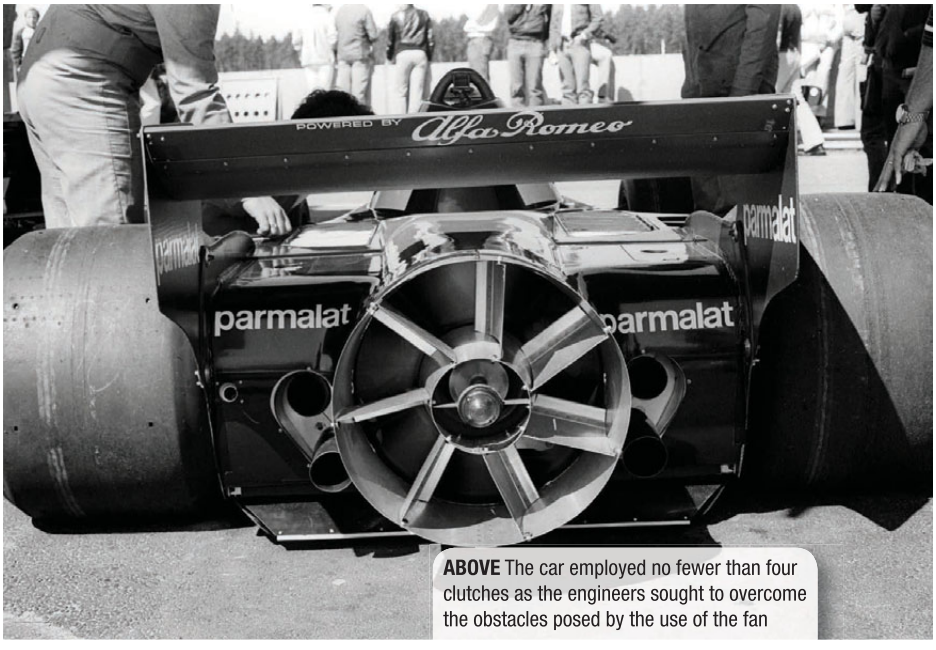
"So I did a fourth clutch, a mechanical dog clutch with a lever that stuck out of the bodywork and that was just a dog engagement clutch. I said to the guys, 'When you want to warm up the car, you just push that forward and that will de-couple the fan.' So the fan stayed still while you were warming up the car. When the car was warm, you'd pull that back and go out to practice, and you've got the fan on again. Those were some of the problems.

"The biggest problem by a mile was sealing the skirts. We'd had a lot of experience with the side skirts and we just used flexible skirts with a little stainless-steel leaf spring that we could tune. We could tune how hard it pushed into the ground because if you had too much spring on the skirts the sacrificial wearing strip would wear out before the end of the race, and you'd had it, basically. If you had it too loose, the suction from the fan working on the inside of the skirt would lift them up and you would lose the seal. So, we just tuned and practised with these at Brands Hatch and Balocco in Italy.

"The rear one came down across the back of the car. We tuned the leaf spring and those were all proportional to the suction from the fan at maximum revs, so it was easy to tune. The front skirt was a different issue because it went across the front of the car like a dam, just behind the nose. With the front skirt, you have the suction on the back of the skirt like all the others from the fan. At maximum fan revs, there will be a certain amount of suction trying to lift the skirt up. So, you tune the stainless-steel leaf springs. Fine. But what you've also got, as the car goes faster, is dynamic pressure on the front. One is car-speed dependent and the other is engine-speed dependent. You can never match them. In testing, we just kept either lifting skirts or wearing out skirts; we could never get it right. And it was different on different lengths of straights, different car speeds, different fan speeds... It lasted two or three laps and the thing would either lift up or wear out.

"I think it was David North who came up with an idea, and then we worked on it together. We came up with two balloon sail cloths, tadpole-shaped things – bags behind the skirts – and my wife stitched them on a sewing machine at home. Then we punched a series of about one-inch holes in the skirt facing the dynamic pressure. These bags could blow up and change shape, and there were two of them: one behind the other. They had holes punched in them but at different places, so the suction on the back of the skirt was constant but, as the car dynamic pressure got more, it started lifting the skirt, which opened the hole to the first bag, which blew up and put pressure on the skirt. When it got to be even again, it opened a hole to the second bag, which blew up and put pressure on, and it modulated itself. That was finished the week before the race and it worked. We were brilliant by this time, David and I together, because of bouncing ideas off each other.

"There were more than a hundred drawings to do in a couple of months. The original fan blades were glass reinforced nylon mouldings, as was the two-part fan hub that locked the blade roots at the desired pitch angle. During ▶




**ABOVE** The car employed no fewer than four clutches as the engineers sought to overcome the obstacles posed by the use of the fan

the first test, we had a catastrophic fan failure and tried different materials, which appeared to work. But with just weeks to go, we had another fan-blade failure, so I had them cast in magnesium, which made them significantly heavier. With just one week to go before Sweden, we had another catastrophic fan hub failure. I had just enough time to machine two hubs from solid aluminium and the final assembly went off to Sweden untested!

"Bernie loved the fan car because it was going to piss everybody off. When we were testing, it was very different for the drivers but they eventually got it. I kept saying to Niki and John [Watson] that, with regard to the entry speed into the corner, forget what you know. It's just to do with engine revs, so you have to go in using a much lower gear than you would normally and at higher engine revs. Don't brake; you can go in much faster.

"But the only problem was that they wouldn't know if they had damaged the skirt. They could go into a corner 30 mph too fast and then have no suction and go flying straight on. So, David went down to a scrap yard and got an altimeter out of an old aeroplane. We had a pitot tube on the front, which you can see in all the photographs, which measured the static pressure. All an altimeter does to read the altitude is measure static pressure and local pressure, and it uses the pressure differential to calculate the height. So that's what we did. We had this altimeter tie-wrapped in the cockpit, right in front of the driver, with a green zone and a red zone. We said, 'Forget the numbers; that's nothing to do with it. If you're coming in to a corner, the needle has to be in the green zone. If it's in the red zone, you've lost suction. Slow down.'

"People were photographing the fan blades, so the mechanics found a dustbin lid, which fitted perfectly! We were so fast, Bernie didn't want to piss everybody off completely so he made the drivers qualify on full tanks."

In spite of this, Watson shared the front row with pole man Andretti in a Lotus 79. Lauda was third fastest, with the other 79 of Peterson for company. "Of course, the rest is history. We won the race."

## ONE-RACE WONDER

That amazing victory in Sweden was the BT46B's one and only race but, as Gordon puts it, "the one thing that's been completely misreported in all the books and magazines is that the car was banned. It was never banned.

"I have still got the letter from the CSI, the ruling technical body in those days. After the race they came and sealed the car, sealed the fan, put the cars in the truck and sealed the truck, came to Chessington. I had explained already to the scrutineers that more than 50 percent went through the radiator and the rest of it sucked the car down; I wasn't trying to hide it. So they came to the factory with an anemometer and they got us to go up through the revs – 5,000, 6,000 – and then measured the air through the fan and the air through the radiator. They got more than 55 percent of the air going through the radiator and wrote me a letter that said, 'It's absolutely legal. You can run it until the end of the year, but then we will close the loophole.'

"It was Bernie that came to me and asked me to withdraw the car because he was being put under massive pressure from Chapman and Tyrrell and the other constructors. Bernie was just getting powerful in Formula 1, and they said, 'If you carry on racing that car, that's the end of the Formula One Constructors Association. You can forget





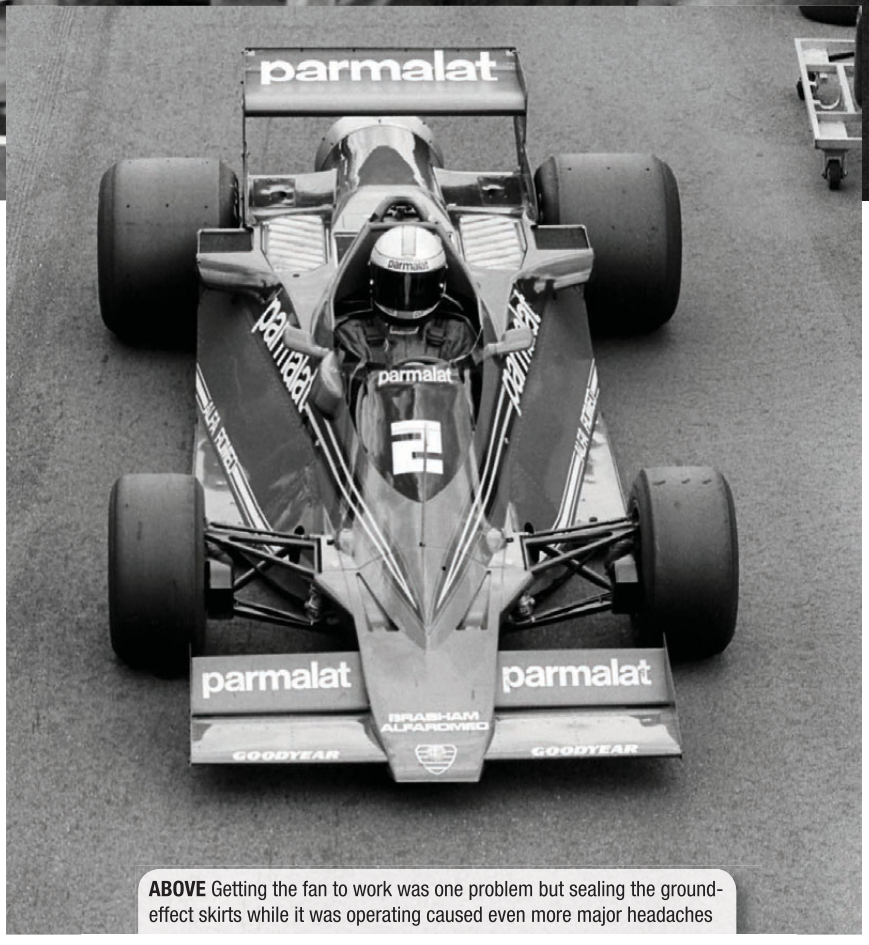

**ABOVE** The fan car went wheel-to-wheel with ground-effect pioneer Lotus in Sweden, but there was only going to be one winner in this contest

**ABOVE** Knowing that his title plans were about to be blown away by the fan car, Colin Chapman (centre, flanked by Ecclestone and Murray) used his clout with the other constructors to pressure Brabham into withdrawing its controversial creation

it; we are walking away from it.'

"It was all led by Chapman. We would have won every race and he could see his Championship flying out of the window. He got Andretti to go round and tell the other drivers the thing was throwing stones out. It never threw stones out; the fan efflux was 55 mph. It was never throwing dust or stones anywhere. Chapman told Andretti to go round saying it was dangerous, it should be banned. When he didn't win that argument, he got the constructors together and said, 'If they don't take that thing off the road, we'll just ban them from the Constructors' Association.' So, Bernie came to me and asked me to scrap the car.

"He was looking at the bigger picture, for sure, otherwise he would have just said, 'We're going to win the Championship.'" HRT




**ABOVE** Getting the fan to work was one problem but sealing the ground-effect skirts while it was operating caused even more major headaches

# ‘ANY TIME, ANY PLACE, ANYWHERE...’

From a competition history spanning 15 years, ranging from the World Sportscar Championship through to Thundersports, you would never guess that only six Chevron B31s were ever built. **Hal Ridge** visits a distinctive Martini-liveried version that is still going strong

**CONCEIVED** by Chevron Cars founder Derek Bennett in 1975 to compete in both European sportscar races and the World Sportscar Championship, a few examples of the Chevron B31 still race today.

A mere half-dozen B31 chassis were born from the Lancastrian outfit’s workshops. An evolution of the B26 produced by the late Bennett’s squad, they featured a number of revisions. But, as is so often the case with period competition machinery being used in the present day, extra adaptations have been made to enable further use.

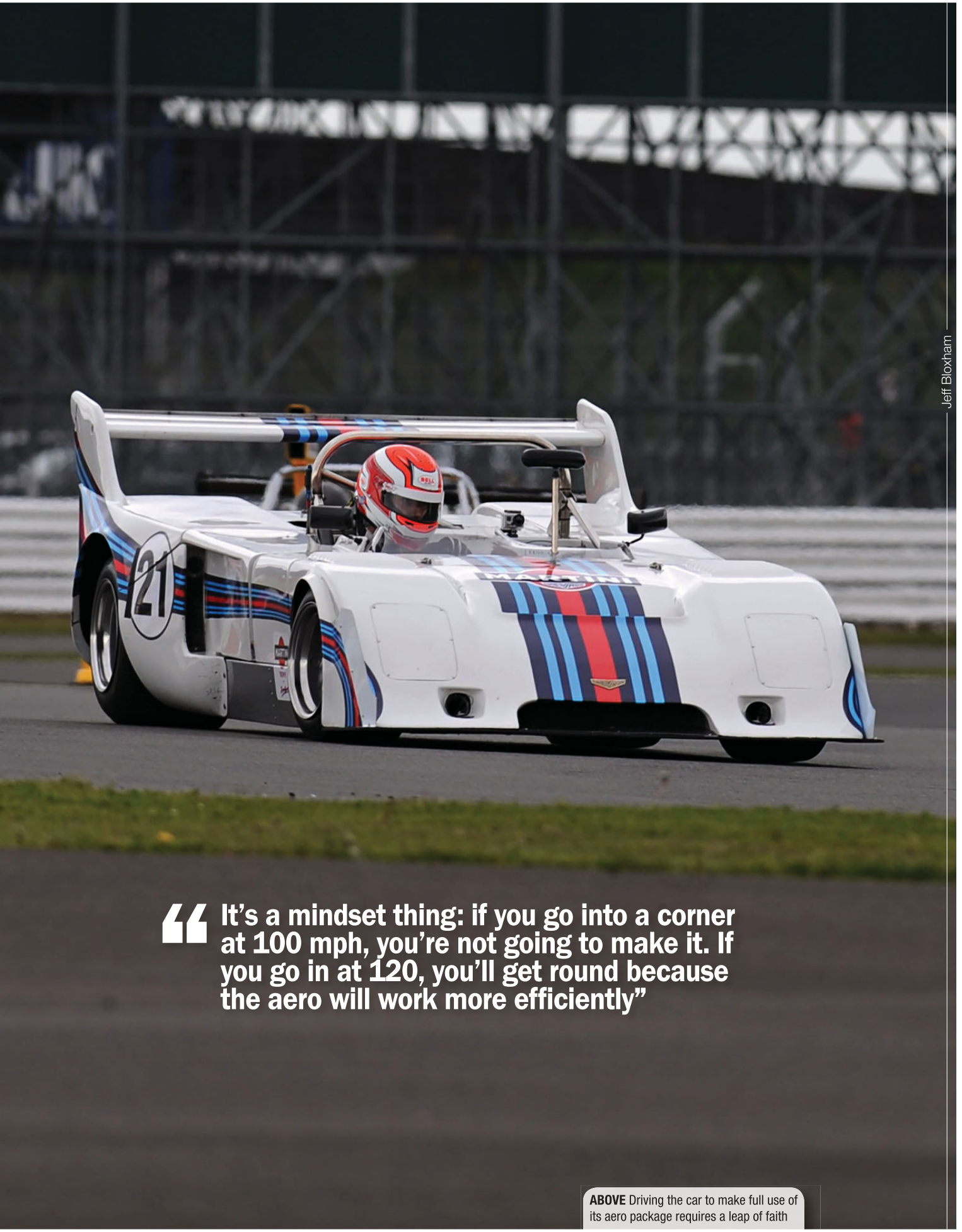
James Dodd, the driver of this example, experienced possibly the most alarming type of development possible for an aero-dependent car while racing at Oulton Park, one of Bennett’s original local circuits.

“I was going down the pit straight at Oulton. I was about to turn into the first corner, had a glance in the mirror and thought, ‘That doesn’t look right’,” he recalls. “The original honeycomb rear wing had snapped, so I drove a little gingerly for the rest of the lap. We had to get a new aluminium one made.

“The front splitter we make out of plywood and change after each meeting because it gets chomped away. It would benefit from having a proper composite one, like some of them did in period. What we do on the SuperTourer (Honda Accord) we run is ▶




**ABOVE** A new aluminium rear wing has replaced the original honeycomb item




Jeff Bloxham

**“It’s a mindset thing: if you go into a corner at 100 mph, you’re not going to make it. If you go in at 120, you’ll get round because the aero will work more efficiently”**

**ABOVE** Driving the car to make full use of its aero package requires a leap of faith

have plywood under a carbon splitter, which makes it stronger: you can just replace the ply after so many meetings and the splitter stays as it is."

The B31, one of the final models Bennett produced with his Chevron firm before his passing in a hang-gliding accident in 1978, features slightly re-designed composite bodywork compared to its predecessor. It is wrapped around the same aluminium monocoque chassis, and uses double-wishbone suspension. The front double A-arm, complete with GAZ Shocks coilover dampers and an anti-roll bar, picks up off a tubular frame and is joined by a rack and pinion steering rack, mounted above the location of the car's Varley Red Top racing battery. The rear arrangement is mounted to the Hewland gearbox with single top arms, twin lower trailing arms and another anti-roll bar.

That setup, combined with the aforementioned aero package and wide [9" wide front, 12" rear], soft Avon tyres makes for a potent collaboration of mechanical and aerodynamic grip.

"This is a very aero-heavy car," Dodd explains. "When I first drove it, I got behind someone and had no grip at all. As soon as you get behind someone, you have to be quite a lot quicker to get past them, otherwise you're kind of stuck in this two-second gap that you can't close because of the aero."

Dodd sits low inside the monocoque ▶



**BELOW** The aero package can leave the car in no-man's land, unable to pass, when other traffic is encountered




**BELOW** The plywood front splitter suffers so much that it gets changed after each event

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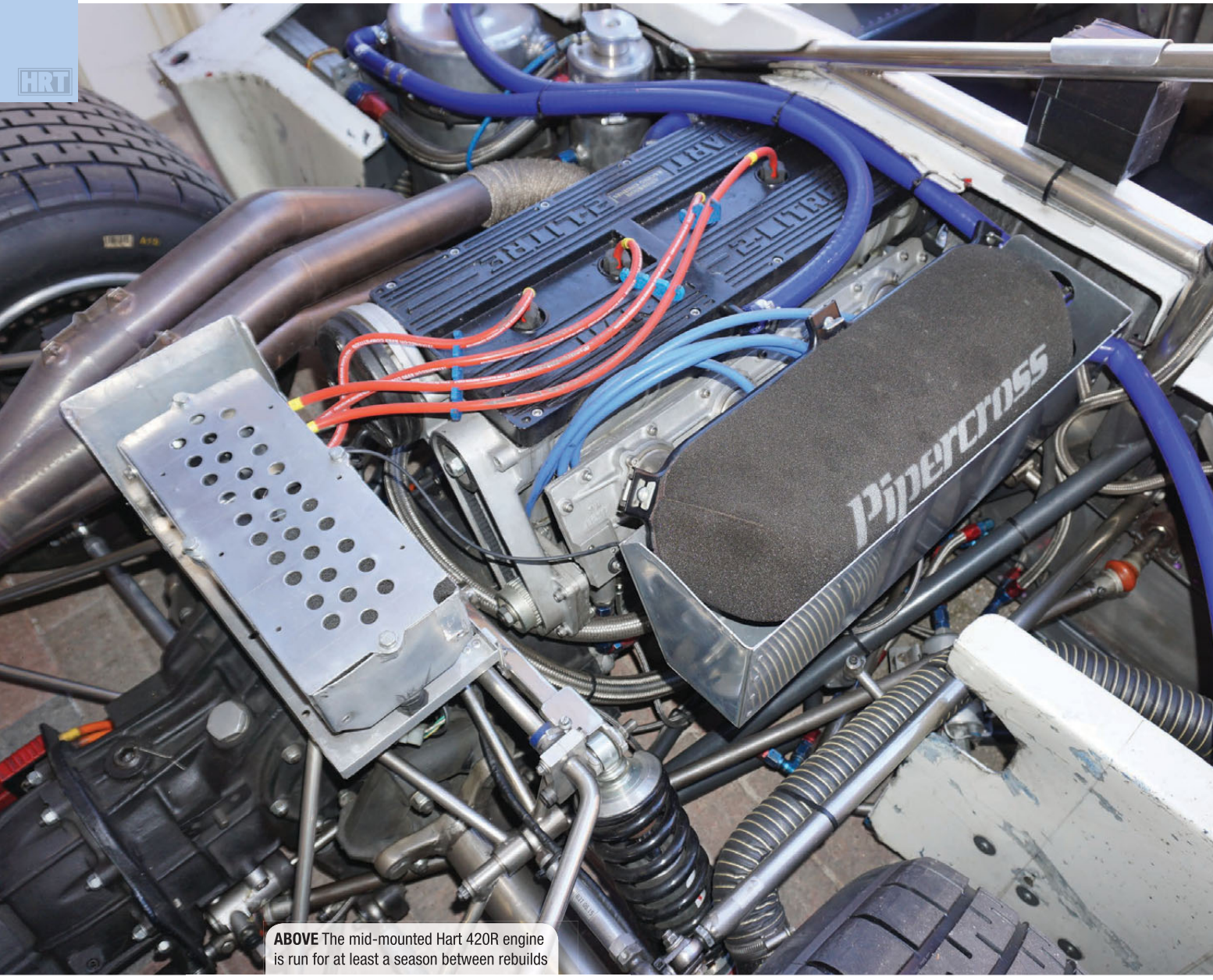

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**ABOVE** The mid-mounted Hart 420R engine is run for at least a season between rebuilds

chassis, behind a Momo steering wheel, in front of a mixture of Armtech (rev gauge) and RaceTech (oil and water temperature) gauges. “It’s the original Chevron seat as well, and it’s not very comfy!” he laughs. “Other owners have put their own seats in them, but I’ve just got bits of padding trying to make it comfier. You just get chucked around a lot if you’re not tucked in.”

## STOPPING POWER

The dampers themselves were replaced within the last five years for new items, constructed in the same way as the original units. Attached to the suspension via cast steel uprights are as-period floating ventilated 280 mm steel brake discs, with four-pot callipers all round, more than effective for stopping the 580 kg machine.

> **“The SuperTourers are very quick, but this is over 10 seconds a lap quicker”**

Shrouding those brakes are the 13” three-piece wheels [9” wide front, 12” rear], connected to the six-speed h-pattern Hewland FG400 dog-engagement transmission at the rear by tube shafts with a universal joint at one end and a Cush drive at the other.

“We get to 160 mph at Silverstone easily with the right gearing, and it would go faster too,” he notes. “We change the gearing for every track. We have a good dozen gear sets, but we only alter it a bit, mainly changing the top gear to get the odd corner to work better for us. You could run it without changing the gears but it’s pretty straightforward to do with the gearbox in the car. Not as simple as on the SuperTourer, but pretty simple. We do everything in-house, but the engine and gearbox go away for anything major.”

The mid-mounted engine, the same Hart 420R motor that was fitted in period, is built by tuner Frank Anderson. A naturally-aspirated, two-litre, four-cylinder 16-valve direct overhead cam (DOHC) unit with mechanical fuel injection and a slide throttle system, the engine produces around 290 horsepower at 9,500 rpm. That makes for a power-to-weight ratio of 0.5 horsepower per kilogram. Water cooling is facilitated by a front-mounted ▶

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**ABOVE LEFT & RIGHT** The suspension picks up off a tubular frame at the front and is mounted to the Hewland gearbox at the rear

> **"I was about to turn into the corner, had a glance in the mirror and thought, 'That doesn't look right'"**

radiator, with a mix of aluminium and Samco silicone hoses sending the water the length of the car to the engine. A Pipercross sausage air filter sits in front of the four inlets, with the four-branch exhaust elegantly curving over the gearbox and out of the rear bodywork.

Where this B31 is most different from how it was created in 1975, however, is in the engine management. "It's just a modernised system but you only have to touch it: just turn the ignition on and off you go," says Dodd of the updated DTAfast ECU and two-dimensional single coil mapped ignition setup.

"The only thing is starting from cold – it's a bit of a procedure to start it. You can't just press a button and fire it up; someone has to spray [Sunoco 102 octane] fuel into the injectors to get it to go because it's a mechanical fuel system. That's a bit unnerving sometimes, but we use different [spark] plugs to start it too.

## ENGINE LIFE

"Frank does a very good job with the engine. We tend to run it for a season, maybe two if there's not too many races. We don't really have a kilometre clock on it, we just get it checked at the end of the season and if the engine builder thinks it's okay for another season, we do that. We only rev it to between 9,000 and 9,500 rpm, to try and help its lifespan. It will go to 10,000 (rpm) but just to help with its reliability and to make it last a bit longer, we peg it back."

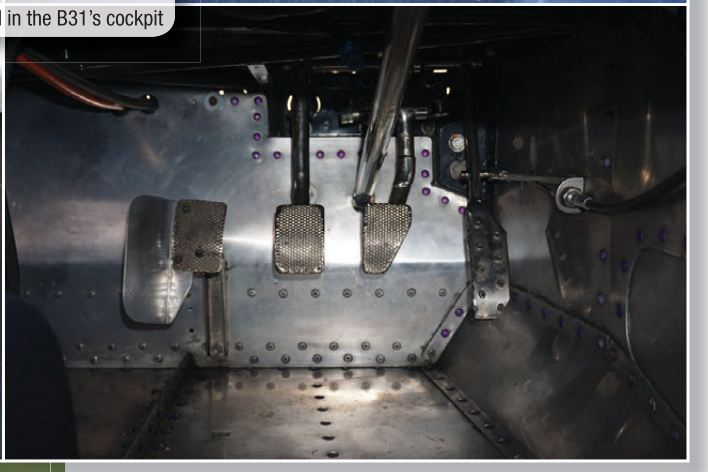
Other adaptions for present day use include the implementation of the latest carbon Lifeline fire extinguisher system, and braided fuel lines, but the fuel tank remains as original, although is











**ABOVE & BELOW** There's not much comfort to be found in the B31's cockpit




Jeff Bloxham

**ABOVE** The B31 is more fun to drive than even a Super Touring car

checked for fatigue on a regular basis.

A championship winner in modern day historic SuperTouring competition, versatile driver Dodd says the B31 is the most fun car he has competed in.

"You jump out of it and get the most amazing smile on your face. It's probably the fastest car I've driven. The SuperTourers are very quick, but this is over 10 seconds a lap quicker," he grins. "Anyone could drive it; it's actually easy to drive and at a reasonable pace too, but it's the last little bit which is more difficult.

## RIGHT MINDSET

"The car understeers because of the massive amount of rear end grip. So you just drive it until it understeers really, that's it basically. But, I'm not really allowed to drive it actually much anymore. My wife and mum have said it's too fast. With the SuperTourer you're inside a tank: it's designed like a NASCAR from the ground up. It's a safety cell – it's not a normal Honda Accord, that's a proper race car. But if I could choose to drive one it would be the Chevron, it's a lot more fun.

"It's a mindset thing: if you go into a corner at 100 mph, you're not going to make it. If you go in at 120, you'll get round it because the aero will work more efficiently for you. It's having belief in the car. Obviously the F1 boys are used to it, but for me it's still amazing." HRT






**LEFT & ABOVE** Deconstructed Ferrari at Design Museum exhibition (left). Salvator Mundi (above)

# LESSONS OF 'THE LAST LEONARDO'

There are, says **Alan Stoddart**, striking parallels between the fate of a record-breaking painting and the spectacular 'barn finds' that are the Holy Grail for historic racecar enthusiasts

**ALMOST** as long as there have been cars, there have been those that have argued that these thunderous, temperamental beasts transcend transportation sport. There are those that argue that these characterful constructions, toiled on by visionary designers and uncompromising engineers, should be elevated in our esteem to the rarefied strata reserved for the masterpieces of artists such as Turner, Monet and Miro.

These feelings have blossomed and the awed admiration of some of motorcardom's most beloved shapes has spilled out of the grandstands and garages, and into galleries. Whether at the Victoria & Albert Museum's upcoming exhibition celebrating the design of the car, or the Driven by Design exhibition at Düsseldorf's Kunstpalast which took place last year.

With this welcome transition, and some of motoring's finest moments now taking a place in the art world, people in the motoring industry must wonder if there are any aspects of the art world that have moved in the opposite direction, particularly given one of its recent scintillating stories.

The Salvator Mundi is a painting attributed to Leonardo da Vinci. It made the world sit up and take note in 2017, when the work of art, which was auctioned for less than $10,000 in 2005, was sent on a world tour before being sold for a record-breaking price. When the hammer went down, the painting, billed as 'the last Leonardo', changed hands for $450,000,000. This 4,499,900 per cent increase in price may be a rather extreme example, but anyone flicking through the classifieds hoping to find an old Jag to take racing will be familiar with the principle.

The far more interesting part of the story, however, is the reason for this shocking increase. When the painting was sold in 2005, before it was thought to be anything special, it was, rather like many of the 'barn finds' in the motoring world: a mess. It had been heavily overpainted, it was dark and gloomy and looked like a copy.

It was then sent for restoration, where the overpainting was removed, significant damage was fixed and parts of the painting were essentially re-done. During and after the restoration, experts were brought in to confirm the painting's attribution ahead of a major show at The National Gallery. It was subsequently authenticated as a da Vinci original, allowing it to go on public display and to begin its meteoric increase in price.

However, there are still questions about its authenticity. One of the experts brought in to authenticate the painting, Dr Carmen Bambach, only this month told *The Guardian* that her view was that it was actually painted by the Italian master's assistant, Giovanni Antonio Boltraffio, with da Vinci only responsible for "small retouchings".

This multiple-painters theory is common among doubters of the work's provenance, with many suggesting numerous artists and restorers, from the 1500s to the present day, all left their mark. This makes the question of the Salvator Mundi's actual creator difficult to answer with certainty.

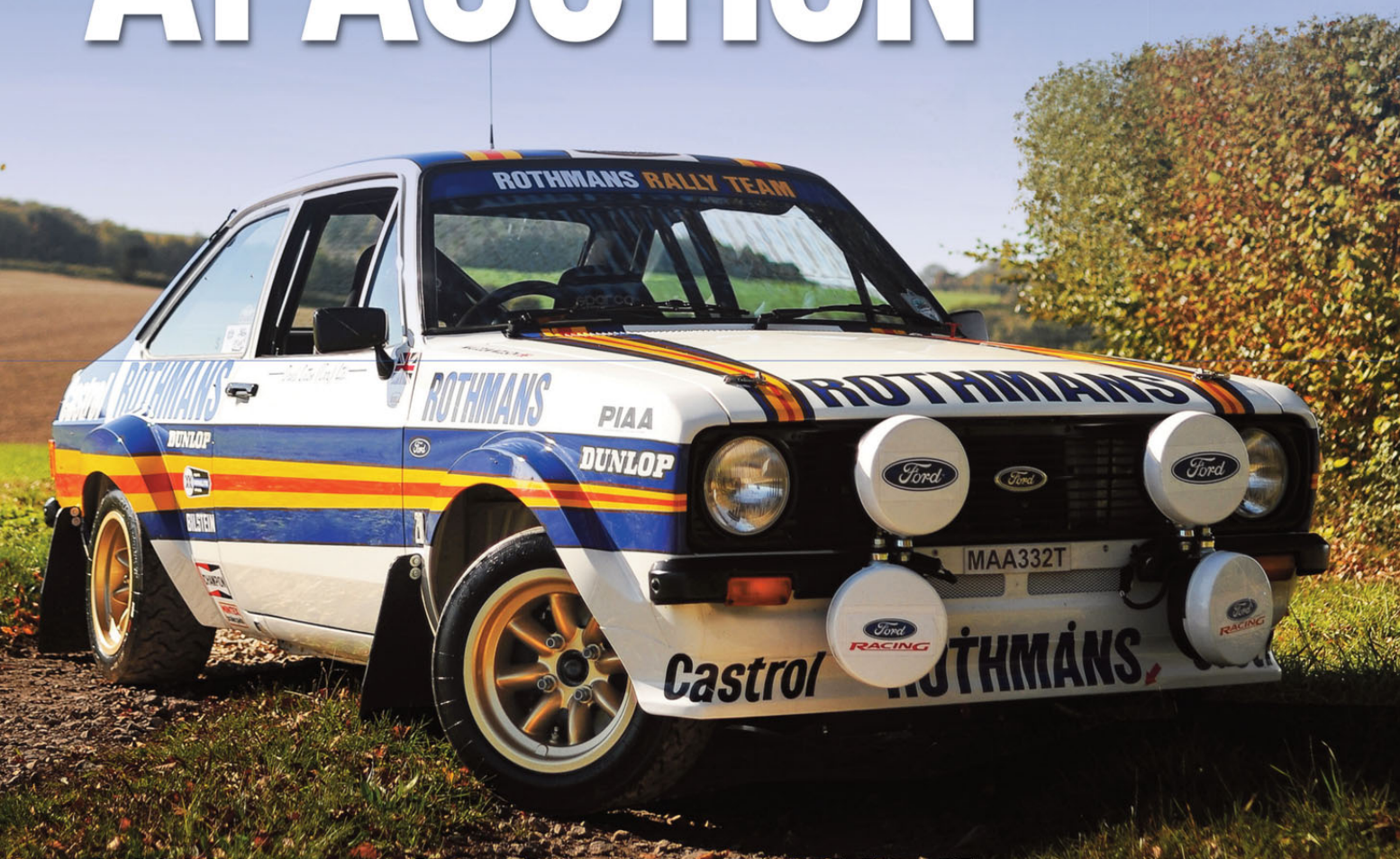
As values of pieces of four-wheeled art skyrocket, similar debates about the history of cars and their often-replaced and upgraded components are bound to proliferate, with more and more experts set to weigh in and build and destroy values in an instant. Speculators take note.

The truly saddening part of the Salvator Mundi's tale, however, and the one which must stand as a warning to those in the car world, is that the continued debate surrounding the painting has meant that instead of being displayed in a brand new gallery in Abu Dhabi for all to see, as was planned, it is thought to be hidden away in a Swiss vault.

A sorry state for a fascinating piece. HRT

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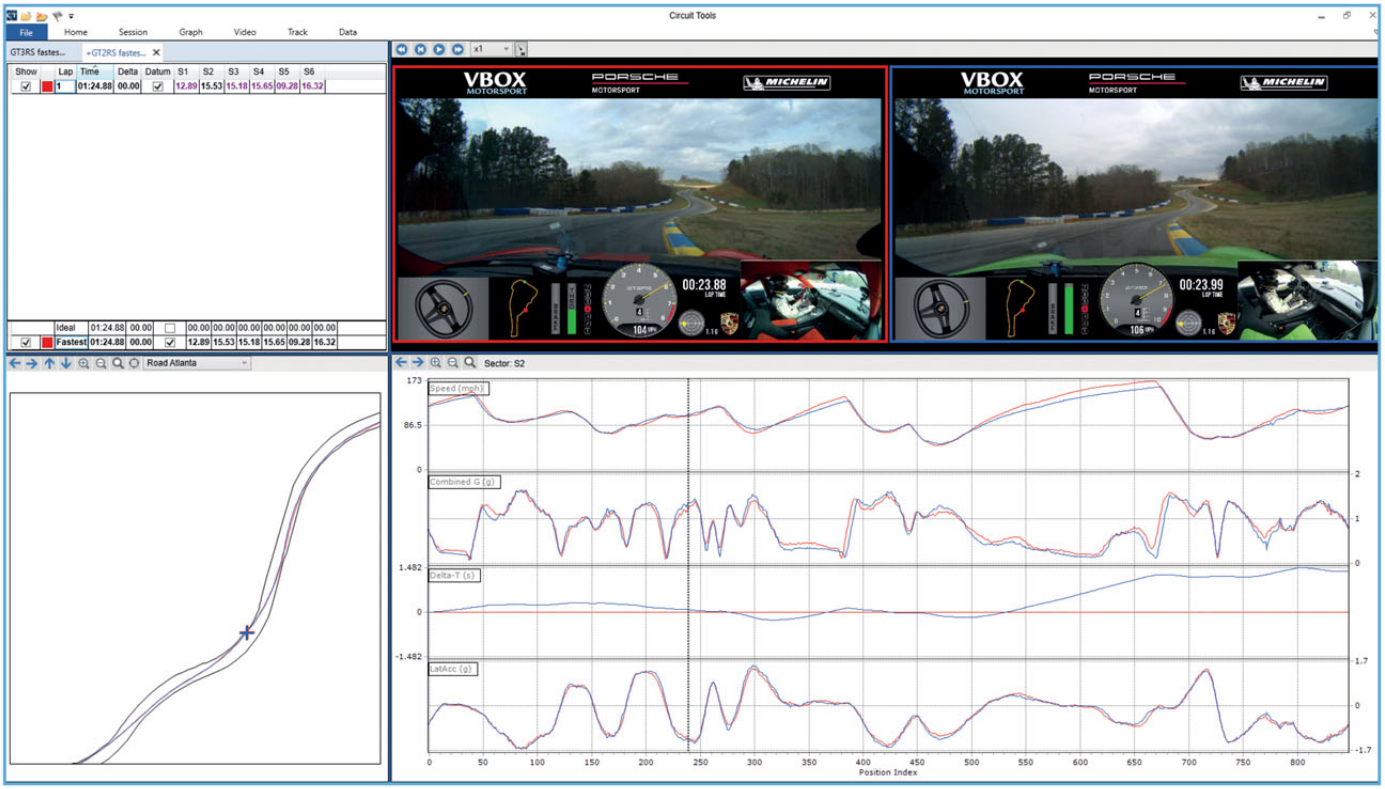
## The Quickest Way To Go Faster

"In my experience, drivers benefit most from reviewing 'intelligent' video which has information overlaid on it.

With **VBOX**, this video is automatically synchronized with data, able to be compared side by side to a GPS position, allowing drivers to quickly and expediently coach themselves, towards better performance in less time."

Peter Krause, Professional Racing Coach, Virginia International Raceway.




Professional racing drivers share their experience on advanced circuit driving techniques in our FREE eBook:
vboxmotorsport.co.uk/ebook

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