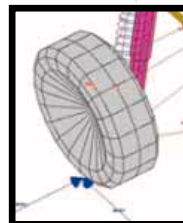


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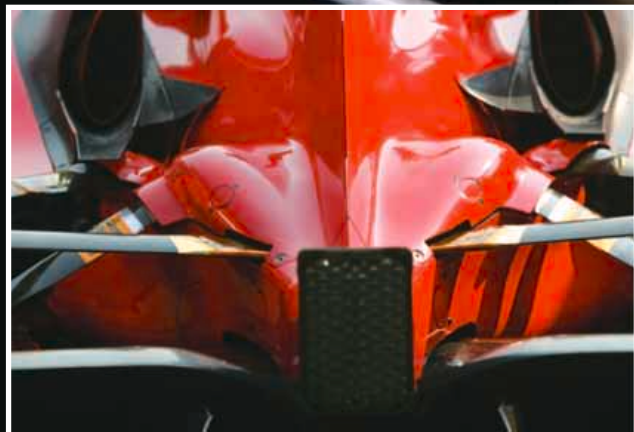
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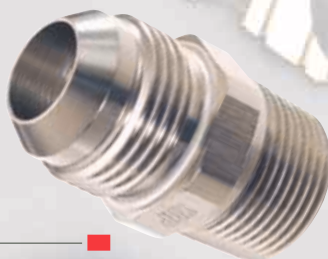
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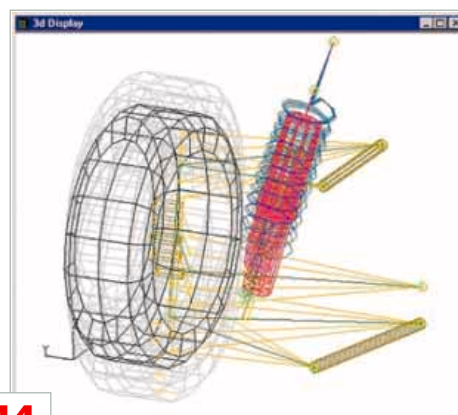
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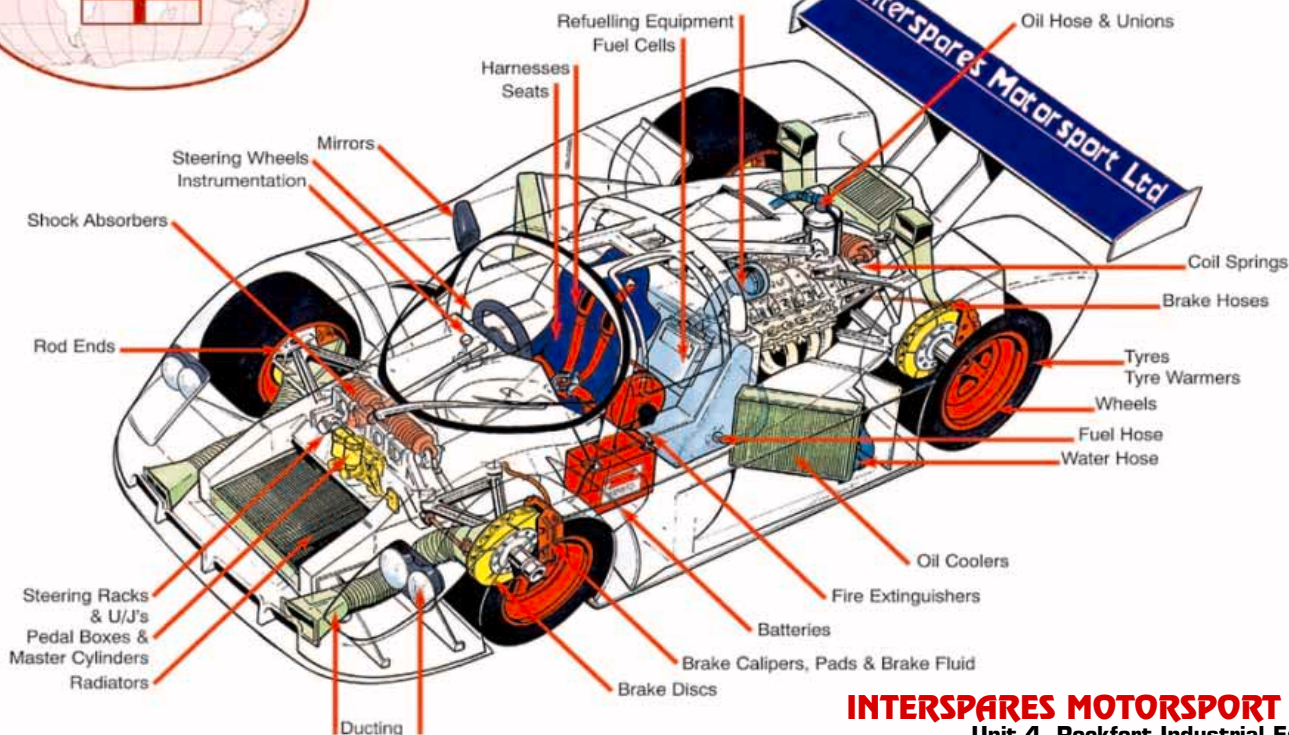
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Write Line

If it ain't broke, don't fix it, says the old adage and nowhere should that be heeded more than at BAR and Honda just now. From its formation BAR struggled to show the form its budget and expertise promised. Then, in 2001 Prodrive was brought in as a consultant with Dave Richards taking a high-profile position within the team and the rest, as they say, is history. The team galloping up the grid in 2004 to become the strongest challenger to Ferrari. A race win may have eluded the Brackley squad but Ferrari didn't leave many of those up for grabs. Just reward for the challenger's efforts were 10 podiums, second in the constructors' table and third in the drivers' standings. A year to be proud of and reason to be optimistic about the coming season.

Then, for whatever reason, when Honda increased its equity in the team the relationship with Prodrive was brought to a close. The official line is that Prodrive's work here is done and, with the key lessons learned, BAR can continue its progress to the top of Formula 1.

Talking to people within BAR, there is no doubt that some valuable lessons have been learned from its consultant partners. Before Prodrive became involved there was said to be a great deal of ability within each of the team's departments, but a lack of ability for those departments to work together. It seems that crucial among Prodrive's achievements was teaching the management skills that made BAR operate as a team in the way that is universal in successful competition.

Perhaps the new regime will proffer that now this skill is learned, it will stay with the team and Prodrive's work is done. And who is to say that is not the case, provided nothing interferes to change it. But there are to be changes to the team. New directors are about to be appointed to the board and a number of key personnel will be joining the 30 Honda engineers already based at Brackley. Either these new people are going to have to have a very strong acceptance of the status quo at BAR, or the newly appointed chief executive, Nick Fry will need to have a very strong hand on the tiller. As an ex-Prodrive employee he will have a good appreciation of how things must be handled, but he must be allowed to maintain that culture without interference. A management culture is a fragile thing and easily upset by influential individuals with misguided motives.

If one considers that at the Brazilian GP the Minardis qualified faster than the Ferraris in 2003, it is easy to see the rate of progress prevalent in Formula 1. Admittedly much of that has come from tyres in the last year, but the equation is so finely balanced that a competitive edge can disappear very quickly. Personally, I feel tampering with the formula that has brought such an improvement when success seems close at hand to be brave to the point of being foolhardy.

As for Prodrive, if I was Red Bull I would waste no time in beating a path to the former's Banbury headquarters in search of another course in how to achieve success in Formula 1.

“A MANAGEMENT CULTURE IS A FRAGILE THING AND EASILY UPSET”

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Charles Armstrong-Wilson



The International Journal
Racecar
engineering

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INTERCOM

IAN WAGSTAFF



The news that Honda is to build a new \$50 million wind tunnel at the BAR factory in Brackley focuses the attention on this critical part of any F1 team's armoury. Sauber, too, has a newly commissioned tunnel. The new facility at BAR will bring it up to date with Williams and add it to the list of teams such as Renault, Ferrari, McLaren and Williams that have more than one wind tunnel at their disposal. Ridge, the company working on the BAR tunnel, is also refurbishing Red Bull's former MoD tunnel that dates back to 1952. Only Minardi now remains without one.

The very concept of a wind tunnel goes back to the Wright Brothers, but it has only been the introduction of computer systems that have allowed matters in the tunnel to happen in a controlled manner. Today, they can be the most cost effective way to the front of the grid. Improvements in lap times can be gained in the wind tunnel at a fraction of the cost of achieving them through increased engine horsepower, particularly now wind tunnels offer the ability to carry out dynamic work.

A decade ago, around 2000 hours testing might be carried out during the year in a wind tunnel. Now, with three, eight-hour shifts, the total could be as much as 8000 hours, double that if two tunnels are in use. In order to run that length of time, teams now require enormous aerodynamic departments. The wind tunnel has become all-devouring.

An example of just how far a wind tunnel can influence thinking will be seen in this season's Formula 3 fields. Following the end of their joint venture, it was thought that both Dome and Lola would produce their own 2005 cars based on the Lola-Dome F106/03. However, once Lola started work in its own wind tunnel in Huntingdon the company found that it could greatly improve on what was already considered a competitive design. The result is that the new car will now be totally different to the old. Some of the design cues, particularly around the side pod, have been taken from Formula 1.

Wilbur Wright recalled that he and his brother reluctantly had to stop work on their 16ft x 16in x 6in wind tunnel prior to Christmas 1901, some two years before their historic flight. The reason? They had a bicycle business to run. How things have changed. Now it could be said that it's the wind tunnels that run the teams.

Toyota gives a power boost to Jordan



The Jordan F1 cars will be powered by Toyota engines for the 2005 season, new regulations favouring the Japanese manufacturing giant

Jordan has announced a one-year deal with Toyota that will see the team powered by 2005 specification Toyota RVX-05 engines on the grid for the 2005 season.

The future of Eddie Jordan's team had been in doubt following the announcement earlier in 2004 that Ford was to exit F1, putting Cosworth Racing – engine suppliers to both Jordan and Minardi – up for sale.

Toyota however stepped up, offering customer engines following the news that powerplants will have to last for two races next season. The deal has enabled Jordan to purchase a number of the 2005 specification engines at an affordable price.

Tsutomu Tomita, chairman of Toyota Motorsport GmbH and team principal of Panasonic Toyota Racing, admitted that the deal would probably not have

occurred had it not been for the new regulations brought in for next season. He added that he hopes Toyota power will be a strong asset for Jordan F1 after a few difficult seasons.

The agreement between Jordan and Toyota will not result in a re-branding of the Jordan team in 2005 and the Toyota name and logo will not be used in conjunction with those of Jordan Grand Prix next season.

Ferrari to start in re-vamped car

Ferrari has confirmed that it will start 2005 with a revised version of its 2004 car, to devote time to developing its 2005 chassis.

Ferrari has previously used this tactic of running the previous year's car for the early season racing with much success.

However, the wide-ranging changes to the 2005 technical regulations will require the team to carry out extensive modifications to adapt the 2004 chassis. The team aims to have its 2005 car on track by the end of February, with



Ferrari is using its tried and tested 'last year's car' tactic at the start of the 2005 season

the race debut scheduled for April.

The engine and gearbox however will be completely different from

those used on the 2004 chassis, which won 15 out of 18 races last season.

Racecar Engineering magazine now available in digital format

This month sees Racecar Engineering launched in a completely new format. From January, the magazine can be bought online as a digital publication, as well as in printed form. Designed to be compatible with the computer-driven environment of modern motorsport, the digital version of Racecar is downloaded as a file to be read by the innovative Zinio reader.

It appears on screen with exactly the same layout as the printed version. The pages can be turned by the click of a mouse and any story can be clicked to magnify it for reading. However, the digital magazine brings functionality not available in the traditional version, adding another dimension to the publication.

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Now you can subscribe and read Racecar Engineering every month on your own computer

through when running on a computer connected to the net. Also words or paragraphs in an issue can be bookmarked to return to later. The software even has its

own notelets that can be stuck to pages for recording thoughts or ideas. But perhaps most useful for Racecar readers is the ability to search the issue for key words.

This can be a valuable time saver when trying to remember where you saw that component or service you need right this minute.

The issue file sizes are small enough to store on the hard drive of any modern computer, allowing you to take your archive of Racecars around the world with you on your laptop. Not only can you catch up with your reading on planes and at airports but it also provides a valuable reference when solving problems at the track.

Readers can try it out for free by visiting www.racecar-engineering.com/digital and downloading the December issue. If it appeals, then either single copies of the current issue can be bought or a digital subscription taken out. The price of just £37.80 or \$70.00 a year is the same wherever you are in the world.

Plans for 2005 Corvette C6-R revealed

General Motors Corp. has released details of its 2005 sportscar contender, the Corvette C6-R, and the production Z06 upon which the C6-R is based. The two programmes – production and racing – are closely intertwined, resulting in the production Z06 now carrying a 7-litre engine, as was employed by the previous C5-R racecar. Most of the development work was as a result of the racing programme that made possible a 7-litre version of the Chevy small block V8. The new production car's cylinder heads are directly derived from the previous racecars and, according to Doug Duchardt, director of GM Racing, 'The C5-R head was the benchmark for the Z06 head.'

Three visible alterations have been

made by the designers following discussions with the team: a switch to a single air intake opening beneath the front bumper for better airflow to the engine, fixed headlights in place of pop-up units for reduced drag and a differently angled roofline for more downforce. Carried over from the last C5-R racers is a side impact-absorbing crush box mounted in the doors that cushions severe impacts. 'We had two

potentially fatal impacts – at Dallas and Miami – where the driver unbuckled and walked away because of this,' reported Fehan.

The C6-R's fuel cell has been redesigned without the long filler neck that splashed fuel into the cockpit in Earnhardt's dramatic full-tank crash, and instead the fuel fillers carry necks that protrude into the car to reach the fuel cell. The new car's rear suspension

mounts have also been revised to reduce the chance of them being driven into the fuel cell during a crash.

The new Z06 is constructed on an aluminium frame, in place of the base Corvette's steel frame which, along with a new magnesium engine cradle, trims weight from the car and should be helpful for the C6-R as well. The engine cradle bolts to the frame with steel bolts, isolated from the casting by aluminium washers to prevent galvanic action between the metals.

The Z06 engine is, for all practical purposes, a full race powerplant, featuring dry sump lubrication, titanium connecting rods and forged steel main bearing caps in an all-aluminium block that is deck plate bored and align honed.

Dan Carney



GM's new C6-R sportscar features exterior design changes and a 7-litre small block V8

Jokers in the pack

The Ford Puma, Fiat Punto and Peugeot 206 are to be given a new lease of life in the Junior World Rally Championship, thanks to a change in rules. Current JWRC regulations include restrictions on the possible development of cars: a move that is specifically intended to contain costs. One such restriction is the limit of a maximum of 10 amendments to a car's original specification over its life. In Super 1600 terms, these are known as 'jokers'. However, unusually – and no doubt as a means of prolonging their active life – the FIA is set to extend this rule for older Super 1600 cars, which will mean that a car homologated into Super 1600 over 36 months ago will be given the opportunity of a further three 'jokers' – and a longer racing life.

Registrations for the 2005 JWRC closed at the end of November 2004 and it was understood that fewer than 15 drivers had entered. In the championship's four-year history, this would be the lowest total ever, and high costs were being blamed.

The JWRC is a driver's championship, and the FIA does not permit manufacturers to run official teams; a ruling based on the feeling that if works teams were allowed, costs would be raised. The reality, however, is that although there is a price cap on Super 1600 cars for the series (Euro120,000 at present), this is difficult to control and that ceiling has been 'adjusted' by a number of manufacturers offering alternative performance-enhancing parts at higher costs.

There is a feeling among some manufacturers producing Super 1600 cars that official manufacturer teams should be allowed in the championship, and the debate was in full swing at press time.

Pace race steps up for showroom rally cars



The Subaru WRC is more powerful than its 2004 predecessor

With two consecutive Production World Rally Championship crowns under its belt, the Group N Subaru Impreza heads into 2005 in 'Spec C' guise.

Compared to 2004's STi version, this derivative has more power, revised differentials and lighter body panels. It

was expected that the minimum 2500 Spec C Imprezas required for homologation into Group N would be produced by December 2004 and that competition versions would be ready in time for the Swedish Rally in February; the first round of the 2005 PWRC.

There has been an escalation in the development of the road cars contesting the PWRC over recent years, and Subaru's only major rival in the series, Mitsubishi, will also have upgraded its Lancer Evo VIII MR ready for the 2005 season.

Even more Latin Lancer

Mitsubishi's Lancer WRC05 will appear at the season-opening 2005 Monte-Carlo Rally on Pirelli tyres – the first time ever for a works Mitsubishi rally car. A high proportion of engineers in Mitsubishi's, Rugby UK-based, world rally team are Italian; as is its boss, Mario Fornaris. The decision makes Mitsubishi the second manufacturer to make the switch from Michelin to Pirelli for the 2005 WRC, after Peugeot announced it was switching to the Italian rubber and, with Subaru, brings the number of teams running on Pirellis to three.

The Lancer WRC05 takes advantage of the FIA rule enabling an increase in body width by 30mm in 2005 for cars over 4000mm length. This necessitates redesigned front and rear wings, rear quarters and bumpers, together with longer suspension links and driveshafts. The chance has also been taken to develop



The WRC05 will be racing on new Italian rubber in line with much of its team personnel

stiffer uprights for dirt rallies.

More precise engine management, a new wastegate and anti-lag valves are aimed at bringing the engine closer to its limits, while an 'active' paddle gearshift and clutch system will be used for the first time. Taller gearbox ratios will be introduced from Rally New Zealand. Although

the team aims to have an active centre diff for the first time in Monte-Carlo, a debut in Mexico in March is considered most likely.

A decision on whether to use active front and rear diffs will be made in the first quarter of the year, based on development progress and the fact that such items will be banned in 2006.

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RML announces 2005 Le Mans prototype plans

RML has announced that it will enter the 2005 Le Mans Endurance Series and the 24 Heures du Mans with the MG Lola, backed by the AD Group. The existing MG EX257 is undergoing an upgrade programme and will enter the series in the LMP2 category. RML is working closely with MG and Lola to finalise the aerodynamic and safety upgrade package for the car.

Through MG's association with Engine Developments the car will be fitted with a Judd-developed, 3.4-litre, XV V8 engine. The car will run as an MG Lola and will be liveried similar to this year's LMP1 challenger. Team owner Mike Newton wants to focus on the prototypes in 2005 as a result of



The 2005 MG Lola will be an upgraded MG EX257, fitted with a Judd-developed, 3.4-litre V8 engine and running in the LMP2 category

the competitive performance of the cars in 2004, when the MG Lola EX257 ran to 5th place in the Le Mans

Endurance Series standings and recorded its endurance record at Le Mans, completing over 20 hours of the

24-hour race. In addition, the increased profile of the LMES championship added strength to his decision.

Audi raring to go

After Audi AG's successful DTM comeback, winning the drivers', manufacturers' and teams' championships, the team has increased its works involvement in the series. The new Audi A4, an entry of eight instead of six cars and a newly formed driver squad should allow for a solid defence during the 2005 season. As before, the two partner teams of Abt Sportsline and Joest Racing will assume responsibility for the race logistics. Based on the new Audi A4, the 2005 DTM car is being

developed at Audi Sport. With its prominent radiator grille and revised bodywork shape, the Audi A4 DTM 2005 will distinguish itself from the 2004 championship car and, in addition, will have a new engine configuration.

In total, four new A4 DTM cars will race alongside four 2004 season cars. In parallel to the works DTM entry, Audi Sport is developing a new prototype sportscar as a successor to the Audi R8 for 2006, which starts its sixth and final season in 2005.



Four of the highly successful 2004 Audi A4 DTM's will run alongside a new model in 2005

Live action arena



A chance to sample a variety of UK race series machinery made Race Car Live a success

The inaugural 'Race Car Live' event at Brands Hatch on December 4 2004 was deemed a success by Motor Sport Vision's Dr Jonathan Palmer.

Cars from a number of the UK's most popular circuit racing series attended the show, which aimed to offer a live action showcase for potential customers for the forthcoming 2005 season. To that end, MSA licence holders were afforded free entry and were given the opportunity to sample some of the circuit machinery on offer on the Brands Indy circuit, either from the passenger seat or (with

consultation) from behind the wheel.

There was plenty on show to tempt all budgets, ranging from Formula Ford to Kuhmo BMWs and classic Ferraris, right up to contemporary Formula 3 and even British GT cars. Entry level classes such as Global Lights and T-cars were also on show, as were the ever popular Radicals, although the exciting new V8 version was on static display only.

Exhibitors reported strong interest throughout the day and it is looking promising for a larger, two-day event in 2005.

Peter Knivett

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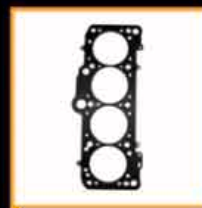
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Fuel for sport

VP Racing Fuels has signed MotorShack as a full line distributor for the UK. Based in Warwickshire, MotorShack will offer VP's complete range of racing fuels, synthetic oils, performance chemicals and accessories through its network of stockists and also online.

VP Racing has been manufacturing fuels for motorsports since 1975, currently producing more than 60 unique blends, which have fuelled champions in many racing categories

and classes — from drag racing, circle track and road racing to motocross and off-road racing. MotorShack is involved in various forms of motorsport and offers a trackside race fuel service at many racing events in the UK.

Sue Whyte, director of marketing for MotorShack, acknowledges that the company is looking forward to introducing VP's ranges to stockists and customers within the UK.

VP Racing fuels have been fuelling championship winning racecars for 30 years



Adrenaline boost for Woodward

Woodward Governor Company, independent designer, manufacturer and service provider of energy control solutions, has acquired the ionisation feedback and ignition specialist company, Adrenaline Research, to contribute to its combustion control strategy.

Combustion control is part of Woodward's systems integration strategy and, while it admits the acquisition is 'not material in terms of earnings impact', it will help customers reduce emissions and improve fuel efficiency. 'Our commitment to quality, service and cutting edge technology will be enhanced greatly,' said Ed VanDyne, Woodward's new director of advanced combustion controls.

Woodward will continue providing its 'SmartFire' products and technology, which are currently used in racing, dynamometer testing and automotive development around the world.

SmartFire technology delivers both a high-energy spark when needed and combustion feedback for knock and misfire detection. In the future, it is hoped this technology will allow 'in-cylinder combustion analysis' so engines can be tuned while running.

Shell strengthens relationship with ZF technology

Cooperation between Shell Global Lubricants and international supplier ZF, which specialises in driveline and chassis technology, is set to expand as a result of a meeting in November.

The two companies already have a strong history of collaboration on many successful motorsport projects and the meeting enabled both parties to further develop their strategic partnership and learn from each other.

Uwe Tribian, international key account manager at Shell Lubricants, commented: 'We were



Shell Global Lubricants fuelled the 2004 Ferraris to win the F1 constructors' championship

really able to learn about each other's businesses. We gained a far better understanding of ZF's

requirements and it learned about how Shell Lubricants can bring further benefits to its operations.'

Tata signs IT deal with Ferrari at Maranello

Tata Consultancy Services of India has signed a three-year deal to provide information technology to Ferrari. India's largest software service firm will provide engineering services for the development of the team's racecar for the 2005 season.

Engineers have already been working at Ferrari's headquarters in

Maranello, with core work being carried out on the engine. Vice president of Tata, Mr Chandrasekaran, said that the deal would help Tata raise its profile in Europe. The company is currently made up of 80 businesses spanning industries including hotels, truck manufacture, software, consumer products, chemicals and communications.



Tata Consultancy engineers have begun work at Ferrari's headquarters in Maranello, Italy

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Energetic debate

Once seen as no more than a marketing gimmick, there is now a major effort to make alternative fuels in motorsport relevant to the whole motor industry

BY CHARLES ARMSTRONG-WILSON



The EEMS report cites Team Nasamax, Taurus Sports and Mardi Gras Motorsport as trail blazing examples of how energy efficient motorsport can benefit road cars and racing

At the SAE Motorsport Engineering Conference at Dearborn in December, Chris Aylett acted as moderator on a panel discussing the relevance of energy efficient motorsport [EEMS]. Its aim was to help raise the profile of EEMS to the broader world of motorsport. It is Aylett and the MIA's conviction that in an increasingly energy conscious world, this association would have two-fold benefits. Firstly it will enhance the image of alternatives to petrol or gasoline giving them a more dynamic image and greater public acceptance. Secondly associating motorsport with green solutions will, they believe, improve its image which currently is widely regarded as being at odds with energy efficiency.

Aylett, is quick to point the inaccuracy of this perception citing the need for fuel efficiency to win not just endurance races but, these days, also Grands Prix. It is this phenomenon that has led to the publication of Energy Efficiency Motorsport by the MIA. The report, sub titled The role motorsport can play in the development of energy efficient automotive technologies, proposes the case for alternative fuels in motorsport and looks at strategies for encouraging their use. It is the result of research by the EEMS Project Team established in February 2004 to look at past activities and review strategic options for the future. The aim is to, 'encourage the automotive industry to view motorsport, not only

as a driving force for the development of its future energy efficient technologies, but also as an ideal marketing platform to promote low emission, fuel efficient vehicles,' according to the report.

In its pages it looks at three UK-based projects during 2004 that have attempted to explore the use of alternative fuels in motorsport. Team

panel of knowledgeable experts were asked to discuss the practicalities of alternative fuels and energy efficiency. On the panel were Dr Steve Bunkhall of the Motor Industry Research Association, Mike Endean founder of Xtrac and part owner of Nicholson McLaren Engines, Callum Lockie one of the Taurus Sports drivers at Le Mans in

proposals into realities and making alternative fuels more than just a fringe issue in motorsport.

To achieve this it has set a number of goals:

- It aims to persuade at least one UK championship to adopt a fuel flow formula which it believes will, 'allow considerable technical freedom for engineers to develop race winning, fuel

“WHILE AN IRL CAR HAS A DRAG COEFFICIENT ONLY SLIGHTLY BETTER THAN A BARN DOOR, MOTORSPORT IS ENERGY EFFICIENT WITHIN ITS OWN OBJECTIVES”

Nasamax launched a credible assault on the Le Mans Endurance Series running its sports prototype on Bioethanol all season. Taurus Sports bravely attempted Le Mans on a shoe-string budget with its Lola powered by Diesel. Also, Mardi Gras Motorsport competed in several rounds of the British Touring Car Championship powered by Liquid Petroleum Gas.

The report examines the fuel options and puts a case that was strong enough to win backing from the government. Its proposals were put before the UK's Motorsport Development Board, a body charged with investing £16 million of government funding to develop and enhance the UK motorsport industry.

It was against this backdrop that a

2004 and John McNeil of Team Nasamax. One thing they all had in common was a conviction that EEMS was not only possible but essential. Aylett pointed out that motorsport was the key to making green cars popular, citing examples like the Taurus Sports diesel Lola as demonstrating how it can work.

Meanwhile Endean tackled the public perception issue by pointing out that, while an IRL car has a drag coefficient only slightly better than a barn door, motorsport is energy efficient within its own objectives.

Generally response to the initiative from within the room was positive although on the whole they were preaching to a sympathetic audience. Having received its funding the EEMS Project Team is faced with turning its

efficient and environmentally friendly technologies.'

- OEMs from around the world working with UK companies to compete in championships based on EEMS concepts.
- Cars using different fuels and engine technologies racing against each other in the same championship.
- Gasoline no longer seen as the only fuel capable of delivering high performance and high efficiency.
- High performance Eco Record Breaking focussed on one or two annual events.

One attendee at the conference also proposed that Formula SAE should include an alternative fuels class suggesting that EEMS may well be the future of motorsport.

Race people



Nick Fry

● **Nick Fry** will replace Dave Richards as team principal at BAR. Fry has worked closely with Richards at the Northamptonshire based team, primarily as managing director of Prodrive Automotive Technology.

● Mercedes-Ilmor has appointed **Ola Kaellenius** as its new managing director. The move comes as DaimlerChrysler edges towards taking over the company completely.

● Tyre manufacturer Michelin has moved its F1 programme manager **Pascal Vasselon** away from the sporting side of the company. Vasselon will now work on road tyres for four-wheel drive cars in the USA.

● Group Lotus has employed **Kim Ogaard-Nielsen**, as its Chief Executive Officer.



Pascal Vasselon

Nielsen from Denmark has managerial experience from a variety of international industries and has co-founded the IT-based consulting and outsourcing business, IBIS Corporation, which primarily focusses on business process re-engineering and improvement through the application of web-based technology solutions.



Mark Gillan



Dietrich Mateschitz

● **Dietrich Mateschitz**, owner of the drinks firm Red Bull has bought the Jaguar Racing Team. The 60 year-old Austrian bought the team after it was put up for sale by Ford. **Mark Gillan**, Red Bull Racing's Head of Vehicle Performance, is to leave the team to pursue a career as a lecturer at the University of Surrey in the UK.

● Former TWR and Arrows boss **Tom Walkinshaw** has signed a deal to manage Australia's Holden Motorsport in 2005. Walkinshaw is a previous owner of the Holden Racing Team, and is a partner in Holden Special Vehicles, the company's performance road car offshoot.



Tom Walkinshaw

● **Don Rice**, who became ill after heart surgery, has died. Rice was the dynamic director of Clemson University in the USA driving the establishment's development. *Racecar Engineering* offers its sincere condolences to his family and friends.

● **Peter Knivett** has been awarded the Guild of Motoring Writers' Delphi Award for Automotive Technology Journalism. The award was based on three submitted features, one of which was an analysis piece on the 2.0-litre K-series engine used in the WSR MG BTCC cars, which appeared in RE V14N8. *Racecar Engineering* would like to congratulate Knivett on his award.

Send your company and personnel news direct to the *Racecar Engineering* team: tel +44(0)20 8726 8363, fax +44(0)20 8726 8399 or email racecar@ipcmedia.com

ON THE GAS...

RAY MALLOCK

Owner of Ray Mallock Limited

The Mallock family motorsport history started with Major Arthur Mallock, who was later joined by sons Richard and Ray, in the creation of a series of race-winning Mallock U2 cars. Ray Mallock has owned Ray Mallock Limited since 1984



How did you first get involved in motorsport?

Polishing the wheels of my dad's U2 and making the team cups of tea — I was drawn in from then. Firstly by racing professionally and then forming Mallock Atlantic Racing in 1979 which later developed into Ray Mallock Limited, in 1984.

What's the most interesting project you've ever worked on?

Our current Chevrolet World Touring Car

Championship programme where we have complete responsibility for car design, build, development, operations as well as engines and drivers. I enjoy working on the whole package as you can see all the developments.

Can you name your favourite racing car of all time?

Of the cars I have driven I would say that it was my Mk11 Mallock U2 which I won the Clubmans Championship with in 1971 and I am still winning in it this year. With regards

to cars I haven't driven then it would be the Lotus 49. It combined Colin Chapman's and Keith Duckworth's brilliance at a time when they were defining the future of F1 racecar engineering.

What achievements are you most proud of?

Building up RML into a successful and profitable Company that delivers success in every category we compete.

Who do you most admire in racecar engineering and why?

Patrick Head. I believe that he is a brilliant engineer, sportsman and businessman.

What tool/instrument could you not work without?

Without a doubt the calculator — it is all in the numbers!

What racing era/formula would you have liked to work in and why?

Can Am in the early 70s where the rules allowed engineers a great deal of scope which resulted in massive performance

improvements, almost week by week, culminating in the Chaparral Fan Cars.

What engineering innovation do you most admire?

The use of ground effects, we were all blissfully unaware of it for decades.

Is motorsport about engineering or entertainment?


It's a combination of both, but at the professional end, it is mostly about marketing.

What new technologies in motorsport are you most excited about?

Simulation Programmes. With the majority of formulae now restricting testing, it is possible to get a huge amount of analysis and feedback without even loading the truck.

Is there a future for high technology in motorsport?

There always will be. The rule makers are trying, quite rightly, very hard to reduce the need, whilst the engineers are trying even harder to find new ways of implementing new technologies.



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Picture this

LAT Photographic will be celebrating its 40th anniversary by displaying photographs from its world-renowned archives in the Historic Hall at Autosport International at the NEC, Birmingham from 13-14 January 2005. The display will include 1-metre high images along a 35m section of wall.

The new hall dedicated to historic motor racing and rallying is set to take pride of place at the world's greatest motorsport show and in association with Classic and Sportscar and MotorSport magazine. For many years Autosport International and Autosport Engineering has included historic cars and this will be the first time specific companies and historic car clubs will have their own dedicated hall in the show.

The archive, now boasting over 9 million images represents the history of the sport since 1895. LAT will be displaying images from the most evocative eras of motor racing, many seen for the very first time. LAT's photographers cover all major motorsport events world-wide from the Formula 1 World Championship to NASCAR, World Rally Championship to Le Mans.

Peter Higham, Director of LAT said, 'The launch of the Historic Hall gives us the perfect showcase for our unique archives, derived from influential magazines such as Autocar, and MotorSport, as well as Autosport. The images taken on glass negatives in the early years of the car capture the speed and personalities of a heroic age. We hope that this collection will add another dimension to the Historic Hall.'



Getting the drive to perform

Quafe Engineering has manufactured driveline components since 1965 and now specialises in both motorcycle and car transmissions: meet the team at the Autosport Engineering Show

The Autosport Engineering Show, taking place 13-14 January at the NEC in Birmingham, provides a great opportunity to meet companies and clients and those involved in the motorsport and engineering industries. One such company is Quafe Engineering, which has been an exhibitor at Autosport International and latterly AES for 12 years. Quafe Engineering designs, develops and manufactures driveline components for the competition markets worldwide and also has a commercial division that supplies leading manufacturers with on-board power for many utility companies. The company was set up by the late Rodney Quafe who first incorporated RT Quafe Engineering Ltd in 1965 at Charcott, near Tonbridge, Kent. The business started by carrying out sub-contract work for the motorcycle industry of AMC in South London. In the 1970s Quafe went on to gain exclusive contracts with Triumph Motorcycles and had various success with riders like Barry Sheen, Percy Tait and Paul Smart all winning with Quafe gears in their motorcycles. The company however now provides components for both motorcycle and car transmissions. In 1980 Quafe developed its 4x4 driveline system and later went on to develop its own GT car, for both road and racing. The business is now run by brother and sister Michael and Sharon Quafe

and the company currently employs 80 people worldwide. Seventy-five per cent of Quafe's products are manufactured in Kent and then distributed through various agents, its best-selling product being the Torque Biasing Differential. Quafe America however distributes to all of North America. In 2000 the Ford Motor Company fitted Quafe differentials as standard equipment to its limited edition RS Focus road car and Daimler Chrysler currently fits the Quafe ATB to its M12 GTO-3R. Quafe is now launching its own new trackday car named the Quafe R40. You can speak to the Quafe team about its new car or anything else at the Autosport Engineering Show, which Quafe believes is 'the best in the world and the only show to be seen at'. Make sure you are there too!

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The vacuum effect

Fancy doing something outrageous and totally pointless?
How about modifying your racecar to drive on a vertical wall or, even better, upside down on a ceiling!

I have a long history of promoting 'suction traction' for racecars. At Chevrolet R&D in 1968, I built and drove a prototype for the famous Chaparral 2J, which eventually got the principle banned forever in racing. Mine had a military tank cooling fan, which was belt-driven off the engine, and a plywood plenum with sliding skirts made out of plastic and nylon (for the complete story, see my book Chevrolet racing – 14 years of raucous silence!).

When word got around at GM that I was working on vacuum traction, I was told that someone at Pontiac had tried earlier to use the concept to help in drag strip launches. Apparently they had attached a vacuum box to the solid rear axle housing, although I never heard what they used to pump the air out. As the story goes, it was uncontrollable, sucking the axle down so hard that it flattened the

tyres, and locked the box to the pavement.

Eventually, as you may have read here already, I saw the error of my ways, and now promote just the opposite – zero aerodynamic downforce in racing. However, it's common for technology which is banned in racing to be highly developed and promoted in everyday passenger cars, like computer-controlled braking, traction control and stability control. And for the street, or exhibitions, anything still goes. Think 'drifting' for example.

Then, in another of my books, AUTO2010 – The car magazine from the future, I included a chapter about a fictional car with suction traction, that was designed to run on the walls of flood control channels and up the walls of buildings. This led to a project for Road & Track magazine where I →

“AS WITH ALL RADICAL INNOVATIONS, THERE WILL BE A LOT OF DEVELOPMENT PROBLEMS”



added an axle-driven fan and skirts to a go-kart, which then out-cornered an Indy car on the skidpad. Since durability wasn't a consideration, I just used long strips of Lexan, cantilevered out from the edges of the plywood, so that they were drawn down into contact with the pavement by the suction. They were good for maybe 20-30 laps before they wore through.

Subsequently, other racers built better versions for this 'Skidpad Challenge', raising the low-speed cornering power to almost

2gs. Their skirt seals also consisted of plastic strips sliding on the ground but, at speed over rough concrete, leakage was still fairly great. The skirts bounce and wear, with either too much or too little pressure holding them down, and they are easily broken off by sliding across pavement seams. Perhaps the best sliding-skirt material now is ultra-high molecular weight polyethylene, or UHMW. This has only a slightly higher sliding coefficient of friction than Teflon, and is far more wear resistant.

Recently a reader asked if I could offer some tips on how to do it. But there's really no justification for it, other than to prove it can be done, since it isn't allowed in racing. And it would rarely be useful on the street either – except perhaps in emergency braking – where it could shave many car lengths off your stopping distance (at least if it was always on, or it came on fast enough).

I don't have the time or facilities (or the need for sensationalism) any more but, if you have an appropriate vehicle – and the time and money – and you want the exposure, and you are nearby, I'll offer consultation and do a story on the results.

My first thought would be to modify one of those parking-lot sweepers that has a separate engine-driven vacuum fan mounted on the back of a pick-up truck, sucking rubbish up from a plenum underneath. It would be interesting to set it on wheel scales to see how much extra downforce it pulls as it is.

Otherwise, to start with, I'd suggest a more powerful vehicle, with rear-drive and front engine, so that the fan can be driven off front, off the nose of the crankshaft. If the fan doesn't fit behind the radiator, it could be mounted ahead of the bumper, and a shaft run under (or even through) the radiator, with a long, double-u-jointed shaft.

As for the fan – or air pump – the best compromise for maximum pressure drop and efficiency, and enough flow volume to allow for all the skirt leakage, seems to be an industrial centrifugal or 'squirrel-cage' blower. They generally

have nice, cast aluminum impellers, but their housings are crudely made out of sheet steel, and they're quite heavy. However, those can be easily reproduced in sheet aluminum.

The underside plenum should be hung from four suspension components, and not the body, so that it maintains a more constant clearance height with respect to the ground, and doesn't pull the chassis down. My first thought was to use a Corvette, but something like a Mustang has greater ground clearance and easier attachment points at the solid rear axle. The plenum roof has to be really stiff, because of the load created by just a few psi multiplied by 50-80 square feet. A carbon composite sandwich panel ought to be best.

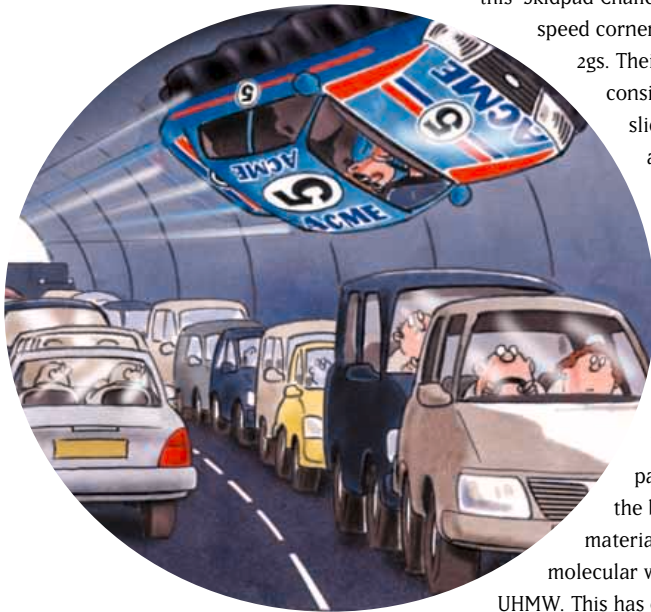
The real challenge is usually the flexible skirt seals. But I know from experience, it's not that hard to develop a sliding seal which has minimal contact pressure (and therefore sliding resistance and wear), and yet minimises the airflow leakage into the plenum. The worst case is at the leading edge, where added frontal air pressure and pavement irregularities impact it.

As with all radical innovations, there will be a lot of development problems. Especially if the car is to be run completely inverted, and not just on a vertical surface. Think about stunt aircraft as an example. Every fluid container has to be re-considered, including things like the fuel tank pick-ups, as well as engine oil settling in the cylinder heads. Fuel injection and a swinging fuel pick-up ought to help, but oiling problems are tough to solve. Although most engines can be run dry at low load for a minute or two without serious damage, a re-plumbed dry sump system might ensure the engine and vacuum pump don't suddenly seize and stop. And you will soon discover that dealing with all the vacuumed dirt is also a very real challenge...

In development, it might be fun to first set new traction records on the skidpad. Then it will be necessary to find appropriate locations for vertical and/or overhead driving, and ways to 'get it up'. But when you get to that point, refer to my fictional events in AUTO2010

Speaking of driving on walls... You want to think about something really bizarre? Consider all the speedways out there that are completely walled-in, from Indy to California Speedway. There must be some racing classification that doesn't specifically limit you to just four wheels. Suppose you mounted another two free-spinning wheels horizontally on the right side of the car? You could enter each turn at any speed you wanted, and just 'lean' against the wall all the way around. The gs would be limited only by the speed (therefore power) available, and the blackout tolerance of the driver's brain. Traction wouldn't be an issue, so any small (even solid) wheels that could take the load and RPMs would be adequate. I can't believe no one's tried it, or at least thought of it, already. Especially those guys who have a tendency to smack the wall anyhow.

RE



“MY FIRST THOUGHT WOULD BE TO MODIFY ONE OF THOSE PARKING-LOT SWEEPERS THAT HAS A SEPARATE ENGINE-DRIVEN VACUUM FAN MOUNTED ON THE BACK OF A PICK-UP TRUCK”



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In defence of scientists

I read Charles Armstrong-Wilson's November 2004 (V14N11) Write Line column with considerable interest and, while I generally agree that spacecraft projects should not be lead by scientists, the premise that these projects should rather be lead by engineers is equally flawed.

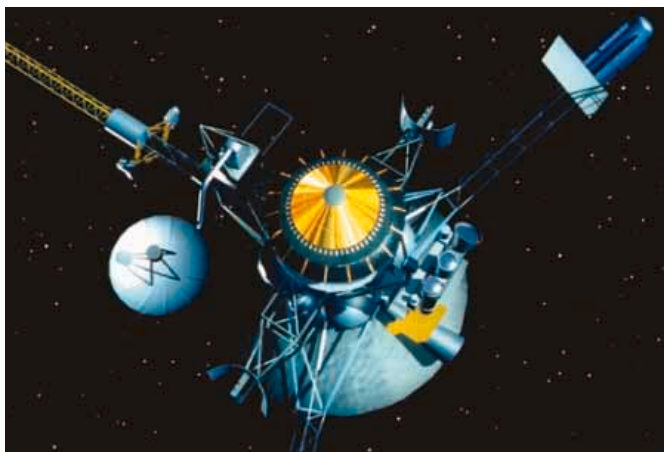
I am a practicing engineer in the business of building spacecraft, and I have witnessed first hand that not all engineers make good technical leaders. Far from it. The majority of engineers make poor project leaders, lacking the expertise, experience and manner of thought necessary to properly manage a team. Most are very good at component, assembly, or sub-system design and development, but fail when made responsible for the overall system. That said, the aerospace industry does have its share of Mike Gascoynes.

Most spacecraft are prototypes differing primarily in the payload they host, which is the part the scientists are most interested in. Consequently, experienced spacecraft engineers are good at those aspects of the spacecraft that scientists are not, and vice versa.

Motorsports is not immune from suffering the effects of differing engineering views of the project. Honda's earliest turbocharged engines had great power but lacked 'driveability'. The Can-Am Porsche 917-10 was similarly afflicted in its early incarnations. Only when the Williams personnel stepped

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Not all engineers will make great spacecraft designers say the scientists

across the engine-to-chassis interface and applied themselves to the engine did the team realise success. It is interesting to note that in winning F1 teams, the engine supplier is now integrally involved in chassis development.

While the top Formula 1 teams possess the aptitude, spacecraft are fundamentally a different engineering problem to a racecar, being unmanned and commanded remotely. The only view of their performance is through telemetry. They are deployed and never recovered for post mission analysis and their lifespan is very long. They must survive the vibrations of the launch event and operate in temperature extremes that make Formula 1's 'hostile environments' look very inviting. Such environments

would kill terrestrial electronics in a very short time. And their development budgets are small in comparison to all but Minardis.

The motorsports community undoubtedly has expertise obtained over many years, derived from building thousands of examples, that can be of benefit when applied to the manufacture of spacecraft. However, asserting that the motorsports industry could do or would have done a better job as the prime contractor in a spacecraft development effort is as naïve as stating that the major aerospace concerns could build a successful F1 car. Say, didn't Matra try that some time ago?

Rod Colen
Reston, Virginia, USA

Digital age

I have an enquiry about your new digital format. Will this service include versions of back issues published before the launch issue or is this going to be as far back as they will go?

Matthew Parker, by email

Unfortunately we can't generate issues retrospectively, so the December issue will be the first one available in digital format. However, from now on, subscribers will be able to create their own digital archive which is compact, portable and searchable. If, however, there are features from past issues you are particularly interested in, and which are no longer available from our back issues department, let us know and we may be able to generate an electronic version of just that feature — Ed

Back issue index

It would be very helpful if you had an index/table of contents for your back issues for sale. I saw one issue on your back issues page that mentioned kart design, but I have no idea what the scope of the article is or if it really would be of sufficient interest to warrant ordering the issue.

Bill Martin
California USA

Thank you for your suggestion which makes a lot of sense. We are continually developing our website and that could be a good future addition — Ed



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Taking the lead

The SAE held its biannual motorsport engineering conference among some prestigious company and the result was enthralling



Words | Charles Armstrong-Wilson

For 2004, the Society of Automotive Engineers' Motorsport Engineering Conference returned to its traditional home, Dearborn, Michigan, USA after visiting Indianapolis in 2002. And with the move it brought an array of big guns to speak to the assembled company. The theme of the conference was Change for Relevance and the keynote address on Tuesday morning was given by Max Mosley, president of the FIA.

He talked of facing the challenges presented by safety and also of rising costs and the pattern of boom and bust that it inevitably brings. Mosley observed that NASCAR had broken that pattern and went on to present four strategies to be applied to Formula 1, Touring cars, GT racing and World Rally respectively to control costs and ensure their stability in the future.

He then took his seat for the business panel alongside Tony George of Indianapolis Motor

Speedway, Tom Crompton of the NHRA, Mike Helton of NASCAR and Steve Johnson of the SCCA. What transpired from this session was, not so much the differences between these diverse arenas of motorsport, but the similarity in the challenges all five faced. One felt there

“[ROSS BRAWN] WAS BULLISH ABOUT A NEED FOR DIRECTION IN FORMULA 1 BY STATING THAT, ‘F1 SHOULD IDENTIFY WHAT ITS ATTRACTION IS’”

were contacts made between them that day that would be maintained to their mutual benefit for as long as they held office.

Brawn's method for success

However, for all the gravity they brought to the event and the relevance of their insight, most attendees were eagerly anticipating the meat of the conference with some hardcore engineering. Perhaps the biggest draw on this front over the three days was understandably Ross Brawn, the technical director who has presided over Ferrari's phenomenal success of recent seasons. Opening his presentation on the Keys to Ferrari's Formula 1 Racing Success he was bullish about a need for direction in Formula 1 by stating that, 'F1 should identify what its attraction is'. He asked whether budgets are controlled by the objective or the money available and said an F1 team needed to be able to do a respectable job



Left: (from the left) Paul Pfanner, Racer magazine; Duane Tiede, SAE; Steve Johnson, SCCA; Mike Helton, NASCAR; Max Mosley, FIA; Herb Fischel, Business of Motorsports; Tony George, Indianapolis Motors Speedway Corp and Tom Compton, NHRA. Above: award winners Klaus Böttcher, Bosch; Markus Krug, BMW Motorsport; Ross Brawn, Scuderia Ferrari and Doug Louth, Pratt & Miller Engineering. Below: the conference presented to a knowledgeable and appreciative audience



Doug Louth of Pratt & Miller Engineering, Markus Krug of BMW Motorsport and Klaus Böttcher of Bosch. Louth talked about the strides the team had made in conjunction with GM in vehicle dynamics optimisation on the Corvette C5R. He recounted the simulation techniques that had been employed and the contribution they had made to the car's competitiveness. Krug related the challenges of developing hand controls for Alex Zanardi's return to racing in an ETCC BMW and Böttcher gave an insight into the development of direct injection for the Audi R8 sportscar.

Engine melt down

A lively discussion came out of the Engine and Drivetrain Panel session with ex-Cosworth and TWR engine man Geoff Goddard doing duty as moderator. Again the subject of effective cost reduction reared its head, a subject looming large in panel member Charlie Whiting's life at the moment as the FIA's F1 technical delegate. He pointed out how the one engine per weekend rule had already brought down costs as well as reducing engine failures during the race. Fellow panelist Ross Brawn elaborated on the challenges of achieving this and revealed that repeated heat cycling was causing problems on the forthcoming two-race engines.

Goddard added his thoughts on the proposed reduction to 2.4-litre V8s for Formula 1 engines pointing out that any assumption it will produce a corresponding reduction in power, 'doesn't take into account harmonic vibration of crankshafts.' In his view the resultant rise in revs will offset much of the power loss. He also dropped some tantalising figures into the conversation including 140 per cent volumetric efficiency on the best race engines and cylinder pressure monitoring technology measuring in one tenth of a degree steps at 19,000rpm.

From here on it was into the papers proper and the dilemma for attendees of which presentations to sit in on when there are up to four on the go at once. On this occasion the FIA's Hubert Gramling's paper on 'Testing of Car Launching by Nosecone Wheel Contact' coincided with Joseph Katz on 'Aerodynamics of Race-Car Lift-Off'. Surely frustrating for anyone with an interest in this field. Papers that had people talking included 'Spec Race Engine Preparation Techniques' in which Rudolf H Stanglmaier of Colorado State University proposed ways that extra performance could be extracted from controlled formula engines. After he closed, Geoff Goddard then added a few more suggestions of his own.

For those with any energy left, there was a lively historical session in the evening. Ex-Lotus man Peter Wright, now a technical consultant to the FIA and Racecar Engineering recalled →

for \$20 million. He also referred to the Concorde Agreement as a ball and chain.

His insight into Ferrari's competitive edge was even more enlightening. According to Brawn there are three main ingredients, budget, technology and people. He insists that the team's income only stems from sponsors and Ferrari's own marketing budget and claims no money comes from parent company Fiat. One ray of hope he gave other team principals, though, was that while Ferrari had enjoyed a period of growth, he said that it had now reached the limit and they are now looking at ways of getting greater value. Brawn put great store on the team's technical partnerships. In particular he said the team had lost its paranoia about working with other companies and he highlighted the relationship with Bridgestone that he described as now being, 'a totally open partnership' with a free transfer of information.

Crucially he explained how the team capitalises on its human resources by encouraging a 'no blame culture' within Maranello. 'If something goes wrong, there's a reason for it,' he observed and explained how during pit stops, perhaps one of the activities most vulnerable to human error in F1, Ferrari has three stages of failure. As he said, 'to err is human' and he closed with the team's motto TEAM standing for Together Everyone Achieves More.

Other speakers during this session included

“IN HIS VIEW THE RESULTANT RISE IN REVS WILL OFFSET MUCH OF THE POWER LOSS”



The range of subjects addressed was very broad and attendees were often presented with a dilemma over which presentations to sit in on when interesting subjects clashed

the changes in Formula 1 throughout his four decades of involvement. He was followed by Peter E Bryant on his career from a Lotus mechanic to CanAm racecar designer.

Crash-test dummies

Safety is always the easy option for a conference such as this, being one of the few areas of motorsport people are willing to talk openly about. So it is in the organisers interests to exert some restraint on the subject to prevent the event metamorphosing into a safety conference. In this the SAE was successful and focused most of the interest on a Safety Panel on the Tuesday morning.

John W Melvin of Tandelta highlighted the importance of crash data recorders in analysing accidents citing readings as high as 140G in a 60mph IRL accident. Shoulders and hips, he said, are the critical load paths to support the body without injury and pointed out the problem of using standard crash test dummies that are not designed with shoulders.

Gary Nelson of NASCAR triggered gasps around the room with his high-speed video shot inside a stock car pitched into a roll for research purposes. The crash-test dummy in the drivers seat moved in ways that most watching would never have imagined including its feet appearing

above the dash board.

Following an intensive first day, things settled a bit but did not slow down at all. The range was also undiminished. Daniel Metz' paper on Engineering of a Bonneville Land Speed Streamliner brought an enlightening counter-intuitive approach to racecar design. He

“CIRCUIT BOARDS CONTAINING A COPPER SANDWICH THAT ACTS AS A HEAT SINK”

advocated high polar moment of inertia, narrow track and a high mass in preference to drag inducing aerodynamic downforce.

Andreas Pechlaner of Infinition Technologies gave an insight into the challenges of creating a new electronic management unit for the Ferrari Formula 1 car. The biggest headache was heat build up in the unit generated in the chips and, because of the compact design, being unable to be dispersed. Infineon came up with circuit boards containing a copper sandwich that acts

as a heat sink conducting heat away from the critical components.

Thursday's vehicle panel was well attended and once again the question of where motorsport technology should be going was raised again. As Peter Wright put it, 'motorsport is facing an identity crisis,' and there was much deliberation on how much technology should be in a racecar. David R McLellan discussed the concept of 'dumbing down chassis' while Dr Wolfgang Ullrich of Audi was unequivocal in his assertion that racecars should be 100 per cent driven by the driver.

The last day finished with a very entertaining pair of presentations in another historical session. Geoff Goddard talked about his time at Cosworth and TWR relating tales of Indy engines that went faster as they reduced the boost and a very standard looking Ford panel van capable of 150mph – how else do you test an XJ220 engine in secret? Road and Track's technical editor Dennis J Simanaitis regaled the assembled company on the tortuous legal wranglings that associated the birth of the aircraft industry.

In a world of compulsive secrecy, the SAE conference is a rare fruit but one well worth catching for its insight and openness. Be there for 2006 wherever it is.

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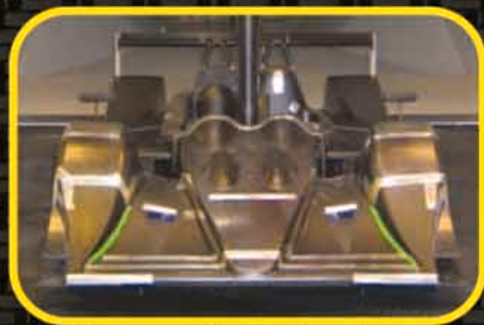
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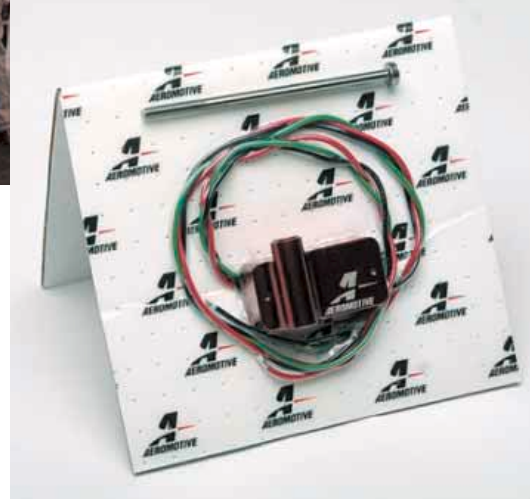
BOSCH



Special equipment

With an attendance figure expected to top 105,000 this year, the SEMA show is still growing, but is it the hot bed of technical innovation one might expect?

Words	Ian Wagstaff
Photos	Wagstaff/SEMA



Best performance product: Aeromotive carb float bowl sensor



New from Bosch: a purpose-made NASCAR racing alternator

It is true that the Las Vegas-based SEMA show concentrates on street performance parts and accessories. However, the fact that the Specialty Equipment Market Association (SEMA) has its own Motorsport Parts Manufacturers' Council, and that the MIA runs a mission to the event indicates its relevance to the racing industry, too.

It should also be pointed out that this year's show saw Jim Cozzie appointed SEMA Person of the Year. Cozzie is vice president of sales for B&M Racing & Performance Products, supplier of precision sport shifters and transmission coolers to the motorsport industry. Another relevant prize was that of the Best New Performance-Racing Product award which went to Aeromotive

for its carburettor float bowl sensor, with JSC Engineering and SCE Gaskets taking runner-up positions in this category.

Manufacturer debuts

The vehicle manufacturers take SEMA very seriously, and not just to show off their concept cars either. Pontiac announced that, following its success powering Daytona prototypes this year, it would be expanding its motorsports programme in 2005. Two production-based GTO cars are to join the Grand American Series mid-season. The company claims it will be the first to produce cars to meet the new GT regulations, the stock-bodied racers being based around its 6.0-litre LS2 small block V8 engine. Safety



Race parts for the street are big news now - Visteon showed its new, off-the-shelf 'Racing Radiators'



One of the success stories of 2004 was B&M Racing



Jim Cozzie, VP of B&M was SEMA's person of the year 2004



Ford announced its exciting new '05 competition programme



NASCAR Tech Institute chief Dennis Hendrix (centre)



New Pontiac GTO is set to join GrandAm series mid-2005

features developed in the Corvette C5-R and Cadillac CTS-V racing programmes are to be incorporated in the GTO, the intention being to eventually offer the car to private teams.

General Motors also announced that its Chevrolet brand is to broaden its Sport Compact drag racing programme with the introduction of the new Cobalt Phase 5 dragster. The demonstration vehicle at SEMA was designed to show racers how they can build their own front-wheel drive Cobalt dragsters using off-the-shelf GM and aftermarket parts.

Sport Compact drag racing was additionally in the news with the announcement by A&A Performance Motor Sports of New York of what was described as the first ever professional rear-wheel drive Dodge intended for this category. The car's Stratus body covers a Pro Stock tub chassis built by Unorthodox Chassis & Fabrication and a Chrysler 3.2-litre V6 running on methanol, with airflow provided by twin Garrett turbochargers. Also featured is a purpose-built, multi-speed, planetary-style transmission designed and built by the Californian company Pro-Trans.

Ford was the featured manufacturer this year and its 2005 Mustang the featured car. Dan Davis, director of Ford Racing Technology announced plans to continue its presence on the racetrack with a new performance parts and competition programme. A race version of the car was unveiled at the show, its colour scheme aping the orange and black livery of the legendary Parnelli Jones Boss 302 Trans Am cars. Ford Performance Parts is to offer everything from a 'body in white' for the DIY racecar builder up to a ready-to-race vehicle. The first offering from the competition programme is a road racing-spec Mustang powered by a 5.0-litre Cammer V8. For the drag racer, Ford is investigating the availability of a rolling, race-prepared chassis that can be built up using its performance parts catalogue.

Ford Racing also introduced two new screw-type supercharger 'swap' kits and announced that its crate engines are to be sold with a 12-month/12,000 mile limited warranty.

Where road meets track

For some, the fact that SEMA is where road meets track is seen as an opportunity. Cooper Tires, for example, used the event to point out to the USA that its tyres are to be used for the Ai GP series. Cosworth Racing may have been for sale at the time of the show but it reckoned its

stand to be busier than ever this year. Of particular interest was its new d-Power range of performance upgrades for the Ford Duratec engine. Another company once part of the Ford empire, Visteon, was leveraging the experience of C&R Racing, which fabricates radiators for NASCAR, to introduce a line of Racing Radiators that can be used for street use as well as racing. Hand-fabricated from die cut, aircraft quality, polished aluminium tanks and with engineered racing cores, these radiators come complete with attached electric cooling fans.

Re-inventing the wheel

First time visitor Paul Webb, autosport product specialist at Deutsch Industrial, pointed out that pure racing technology is still too complicated, and thus expensive, for the average SEMA customer. However, he also added how basic the PRI show was five years ago, predicting that 'a harness house with vision' might well take stand space at SEMA in a few years time

It might be a sign of the times in the USA, or it may be just coincidence, but virtually all the racecars on display at SEMA and at the adjacent AAPEX (Automotive Aftermarket Products Expo) were closed cockpit. The open wheeler racecars, from IRL to midjets, seemed to have disappeared

almost entirely from the show.

Demon Tweaks' John Minshaw also commented that there is no longer anything new to be found at these events. However, there were those among the first time visitors who disagreed and, with around 1100 products said to be have been premiered at the show this year, perhaps they were right — although even SEMA itself talks about re-inventing the wheel.

There was certainly new product if you looked carefully. Mechanix Wear, for example, unveiled a new racing mechanics glove, the Garage Camo. While this had more to do with graphics and less to do with innovation, the company also introduced a new lighted glove that features a 10,000 lumen light built into the index finger knuckle area of the design.

SEMA claims that, in terms of numbers through the door, 2004 was the most successful in the show's 38-year history with, at the time of writing, an attendance expected to top the 2003 figure of 105,000 industry professionals. According to Christopher Kersting, SEMA president and CEO, early analysis of the exhibition suggests 'a significant increase in buyer participation.'

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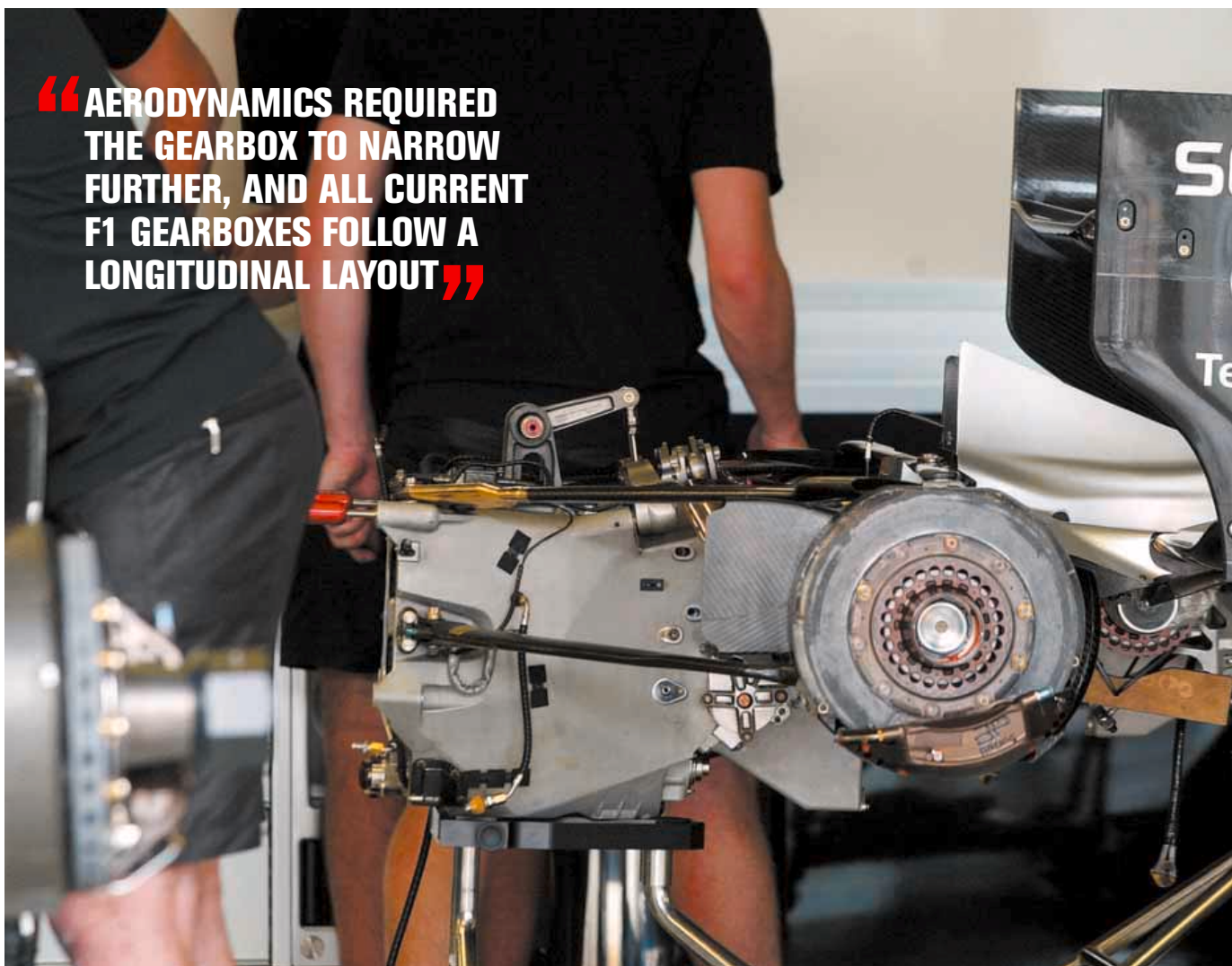
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F1 transmission trends

F1 gearbox developments over the past decade have been as spectacular as engine developments, only less talked about. Racecar looks at the latest trends

Words	Simon McBeath
Photos	Sutton Images; Xtrac

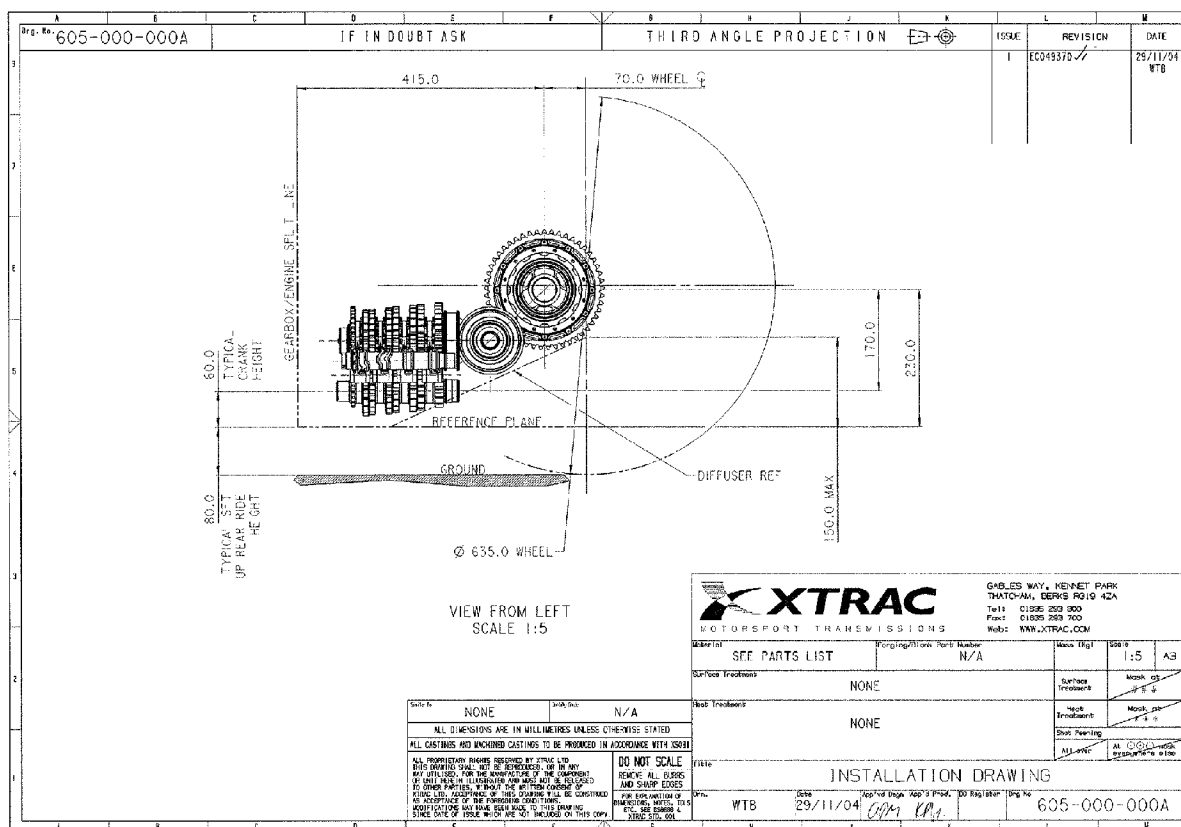
“AERODYNAMICS REQUIRED THE GEARBOX TO NARROW FURTHER, AND ALL CURRENT F1 GEARBOXES FOLLOW A LONGITUDINAL LAYOUT”



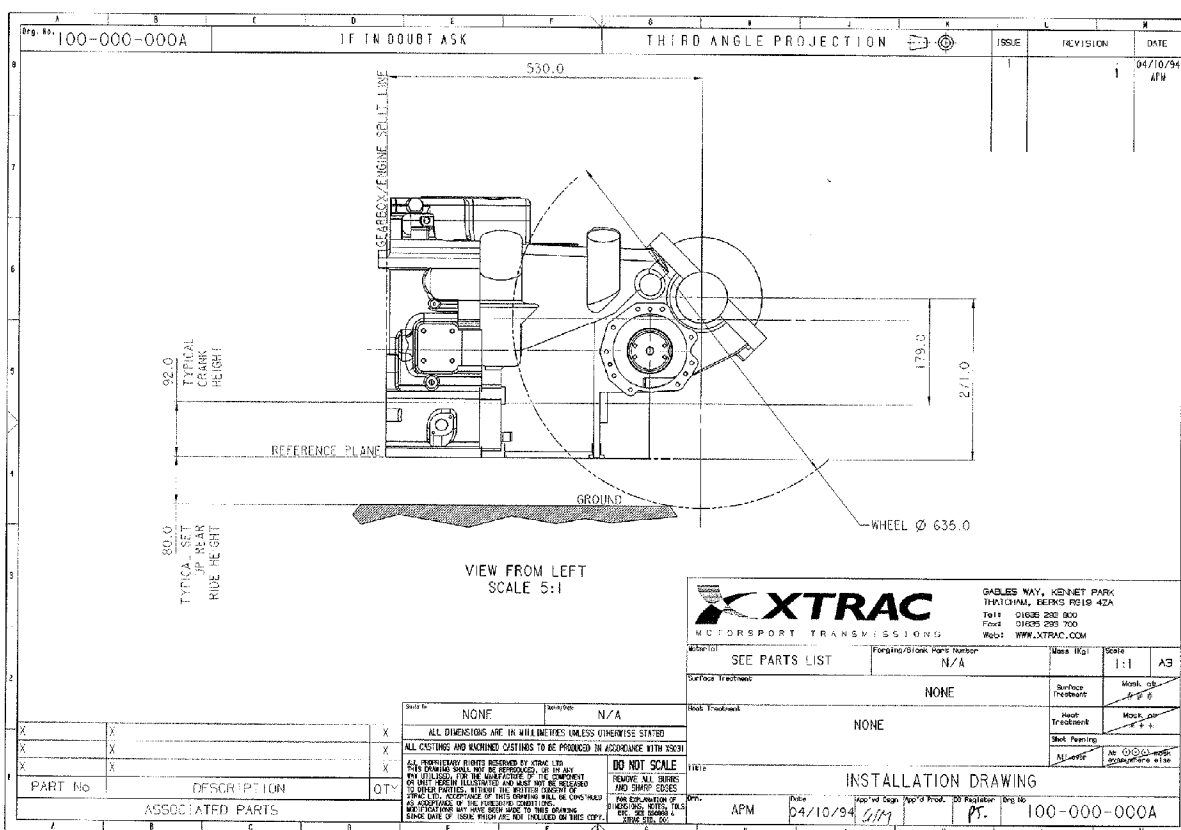
It has been said that the only time a gearbox gets noticed is when it breaks. This does a great disservice to the high-quality engineering that goes into modern racing transmissions, and especially so in Formula 1. Here, engine outputs have climbed back up to almost 1000bhp under the prevailing rules of 2004/05, and yet the gearboxes are smaller, lighter and more efficient than ever, contributing significantly to the cars' performance enhancement.

This progress has been driven by various factors, including: regulation changes; aerodynamics; the quest for weight saving and optimum weight distribution; better detail packaging; and more efficient operation. And the principal facilitators to progress include better materials, improved design and manufacturing technology and, let's not forget, good old-fashioned ingenuity.

To chart some milestones during the past decade or so we spoke to



Some constraints and typical dimensions on a 2004 F1 gearbox



Installation drawing of a 1995 F1 gearbox – the dimensions make an interesting comparison with current models

Adrian Moore at Xtrac Ltd, the renowned Berkshire, UK, racing transmission specialist that has been heavily involved in F1 since the late 1980s. After four years as a design engineer at Xtrac from 1992-96, Moore then spent a year at Ferrari, followed by two years at McLaren ('97 and '98, including design work on the '99 car), after which he returned to the Xtrac fold where he became technical director in 2002. With that history, there can be few people better placed to be our guide.

Layout and packaging

'Nowadays,' says Moore, 'the gearbox is just an inconvenience to the aerodynamics guys, and slightly less so for the suspension guys'. But the regulations also delineate the space the gearbox must occupy. The reference plane (the plane defining the minimum height for any component except the wheels and tyres) dictates the bottom of the gearbox. 'The distance from the reference plane to the engine →



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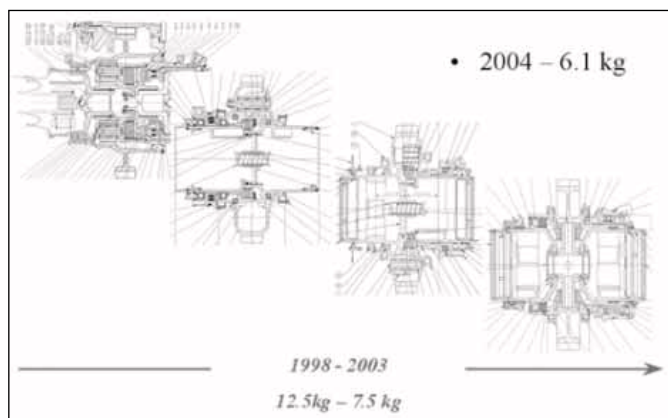


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Progressions in Formula 1 differential development between 1998 and 2004

crankshaft is critical. In the mid-'90s that was typically around 90mm. Now it is typically a bit less than 60mm. The 'box layout has had to change in response to this,' Moore continued: 'at the rear the diffuser delineates the space the gearbox occupies too, and since the suspension avoids the diffuser, and the suspension attaches to the 'box, this also defines the 'envelope' the 'box must fit. So the space is very confined. Of course aerodynamicists would prefer not to have a gearbox at all!'

The fundamental configuration of the gearbox has also changed considerably. In the early to mid-'90s there was a mix of transverse and longitudinal layouts – the former being wider but shorter. But post-1994 the 'stepped bottom' rule was invoked to reduce downforce levels by raising the minimum height of the outer sections of the floor. This meant that transverse layouts required drop gears to transfer drive to the wider-spaced internals above the step. The alternative was to use a longitudinal layout such as Xtrac's own F1 design of 1995. However, aerodynamics required the gearbox to narrow further, and all current F1 gearboxes follow a longitudinal layout.

The F1 layout locates the gear cluster ahead of the final drive, so ratio swaps can only be done by removing the 'box from the engine. But with simulations and track testing, ratio swaps in F1 (at race meetings at least) are now rare, so this in itself is only a minor inconvenience.

Clutch diameters, too, have shrunk in recent years. 'Around 1997 they were down to 4.5in (114.3mm),' recalled Adrian Moore, 'and now typically they're 4in (101.6mm). Recently with launch control disappearing and manual starts returning, although clutches have remained the same diameter to keep [rotational] inertia down, the number of plates has increased. This is because the driver is less efficient than an electronic control system using the clutch, and the start is where the clutch is given the hardest time.

'We have seen different clutch locations too,' continued Moore. 'For example, it could either be traditionally positioned on the engine, or in the 'box in an attempt to reduce stress on the engine crank and bearings. Either way it requires space, and this has usually been in the front of the gearbox. There have also been attempts to locate it at the rear, to improve weight distribution by moving the gear cluster forward, but this tends to be a slightly heavier solution because of the length of clutch shaft.'

Weighty issues

On the topic of weight, Adrian Moore reported that 'in 1995 several F1 teams adopted Xtrac's longitudinal transmission (its '95/'96 'box was the last entire F1 gearbox made by Xtrac). This weighed about 54kg including

the bellhousing (that contained the engine oil then), the hydraulic hoses and the suspension. In 1998 typical weights including the hydraulics and suspension were in the range 43-45kg, although engine oil tanks had been relocated in front of the engine, accounting for some of the weight saving. Currently a typical transmission weighs around 40kg or less, including the gear change system and the hydraulics and suspension. For comparison a typical sportscar gearbox weighs 70-80kg.'

Weight reductions have come from three areas: reduced dimensions, lighter casings and lighter internals. Dimensional changes were possible thanks in part to reductions in the size of internals, and this enabled reductions in overall dimensions of the casings. Adrian Moore's figures for the last decade show gearbox length – from the rear of the engine to the differential centreline – has reduced dramatically from around 500mm (19.7in) to around 400mm (15.7in). Clearly this factor alone has contributed

significantly to weight reductions.

But materials too have played a considerable role. Moore continued: 'in 1995 casings were usually made in RZ5 sand cast magnesium, weighing at least 14kg including the bellhousing. Nobody uses magnesium now, and current options include precision cast aluminium, investment cast aluminium or titanium, or carbon fibre reinforced plastic (CFRP) [as successfully employed by BAR in 2004, profiled in Racecar V14N9]. And Ferrari utilised fabricated titanium and even steel from the mid to late '90s.

'Precision sand casting can get the wall thickness down to 3mm typically, but investment casting can go much thinner. This enabled metallic casing weights to reduce to around 10-

11kg, but a carbon casing is probably around 8.5kg. John Barnard was influential on the use of these materials, and the '95 and '96 Ferraris used carbon bellhousing and suspension mounts on a fabricated titanium 'box.

'JB made everyone think about carbon casings but, interestingly, it hasn't usually been the front teams that have innovated, which says something about attitude to risk. It was the 1998 Stewart SF02 [under Alan Jenkins] that first ran with a carbon casing and, although they →

**“BY OPTIMISING
'SAFETY FACTORS'
IT HAS PROVEN
POSSIBLE TO
PUSH DESIGN
LIMITS WHILE
RETAINING
ASTONISHING
RELIABILITY”**

**CAD view of a 2003
F1 differential**



**Xtrac tests scale model
versions of all its gears to
failure on its 'foursquare
rig'. This has enabled it to
gain valuable information on
different materials and heat
treatments**



A 22:26 gear ratio set from the early 1990s, in carburised re-melted steel



Same gear ratio set, mid-1990s – by now around 2mm narrower in width



Same ratio again, but 2004 – lighter, smaller and with a new surface finish



Same gear ratio set once again, but this time a typical sportscar gear set

originally had manufacturing problems, they solved them successfully. JB's first carbon case ran in the Arrows A19 that same year. And it was Minardi that first ran an investment cast titanium casing in 1999.

'The main reason for abandoning aluminium and magnesium is that these metals do not have good mechanical properties, in particular stiffness at temperature. That is the big gain with carbon. Its specific stiffness is six times higher than that of magnesium at room temperature, and much better still at high temperature. And if the gearbox can run at higher temperature then the cooler can be smaller, offering an aerodynamic benefit. A secondary benefit is that aluminium and magnesium are essentially not repairable because of the heat treatment they require when they're originally manufactured. Titanium can be repaired, as can carbon.'

One of the larger internal assemblies is the differential, which has seen not only changes in operation principles in the last decade, but

“CURRENT F1 DOG RINGS ARE JEWEL-LIKE IN COMPARISON, LOOKING IMPOSSIBLY FRAGILE”

also substantial weight savings. Adrian Moore: 'Pre mid-'90s most teams used the plate-type 'Salisbury' limited slip differential, although there was some dabbling with hydraulic pump diffs. In the mid-'90s the viscous differential probably became universal, mostly made by Xtrac around 1996. Being speed sensitive made them good for reducing wheelspin, but they were far from optimum. Since then everyone has gone to hydraulically-controlled active differentials, and the rules are pretty free now, except there can be no torque biasing for a steer effect [as is allowed by the regulations in World Rally Cars, for example].'

On size and weight though there has been tremendous progress through improvements in design and manufacture. In the case of the diff this has enabled a 12.5kg item in 1998 to slim to less than half that at just over 6kg in 2004. Adrian Moore: 'in that time the basic functionality has stayed similar, but attention to detail has enabled the diff to be made much narrower especially. This allowed →

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Selector fork (199.6g) and dog ring (125.4g)



Selector fork (97.2g) and dog ring (115g)



Selector fork (104g) and dog ring (91.2g)

longer driveshafts, which have less angularity, and that's more efficient. In dimensional terms, since the mid-'90s the distance between the output joint faces has gone down from about 225mm to around 90mm now, which represents a big gain in aerodynamics and mass location.'

Improved design and manufacture

The improvements on the final drive and diff unit sound particularly impressive. The crown wheel gear is a heavy item, but by applying extensive knowledge of gear tooth design, and using leading edge technology, such as full form tooth grinding in manufacture, and inspection too, significant weight savings have been possible. And this same detailed approach has been applied to all the other gears in the transmission.

It's not all about computer-aided analysis tools either, although finite element analysis (FEA) is extensively used to better understand the loads each part must tolerate. Improvements in manufacturing technology also allow parts to be made to the shape and precision that analysis methods indicate. For example, one of the operations that has improved is the so-called 'hard machining' of heat-treated parts. Traditionally a part would be machined, then heat treated, then finally ground to shape and size. Now it is possible to carburise and then spark- or wire-erode, or even use milling or turning to machine a heat-treated part down to the optimum material thickness, allowing ever finer precision.

Modelling and materials

Xtrac also employs what it calls its 'foursquare rig', a piece of equipment analogous to a scale model wind tunnel, but instead the foursquare rig tests model gears. Pairs of very small gears are run to failure, and because they reach that point much sooner than full size versions it enables the study of certain gear characteristics to be rapidly accelerated. Using this rig Xtrac has gained valuable information on materials, heat treatments

and surface finishes, which has added to the company's database for application particularly to F1.

Xtrac has always manufactured loaded gears from in-house developed carburised vacuum re-melted steel – typically aerospace grade or better – which is ultrasonically tested to ensure its quality. A recent development is steel with increased core hardness for improved strength, enabling smaller, lighter gears to be made. One of the crucial qualities required of motorsport gearbox internals is what Adrian Moore refers to as 'impact resistance', or the ability to deal with shock loadings encountered when striking kerbs, enduring standing starts or from

accident impacts. Xtrac believes this requirement makes motorsport unique in the field of transmission technology, hence the attention to materials quality.

Nevertheless, by optimising 'safety factors' it has proven possible to push design limits while retaining astonishing reliability, leading to dimensional and weight reductions of many internal components. And changes of material or surface finish can be invoked to influence fatigue life and further 'tune' safety factors. Thus, for example, taller gear ratio sets can be made narrower and yet achieve the same safety factor as the short ratios, enabling

reductions in gear widths. A gear that was 14.5mm wide pre-1995 was reduced to 12.5mm during the late '90s. Remarkably, in 2005 that same ratio has been reduced to just 9mm!

Thus, although the layout of the gear cluster remains essentially unaltered since the mid-'90s, everything is smaller in detail, making a more compact, lighter package that remains reliable.

Evolving dogs

And it's not just gears that have been subjected to detail optimisation, as a glance at the selector forks and dog engagement rings shown at the top of this page reveals. In 1995 an example F1 selector fork and dog ring set weighed 324g (11.40z). Now those components weigh just 195g (6.90z) →

“IMPROVEMENTS IN MANUFACTURING TECHNOLOGY ALSO ALLOW PARTS TO BE MADE TO THE SHAPE AND PRECISION THAT ANALYSIS METHODS INDICATE”

and their performance has been continually improved along the way.

There have been evolutionary steps in dog ring design. In the early to mid-'90s the 'internal dog ring' appeared (another John Barnard invention), the dogs protruding inwards from the inner rim of the ring. This enabled significant narrowing of the rings, and a reduction in the overall length of the gear cluster. These rings were also slightly lighter than the earlier conventional type with the dogs on the ring face, but were not as robust or durable and hence carried an element of risk.

The next evolution incorporated a web between the internal dogs, these slimming down very slightly again. But current F1 dog rings are jewel-like in comparison, looking impossibly fragile.

Selector fork design has also benefited from detailed analysis – a current fork weighs 97.2g (3.42oz) compared to 199.6g (7.04oz) in the mid-'90s. The material is exactly the same in this case, but removal of redundant metal has reduced weight by over 50 per cent.

Miscellaneous modifications

There has been a raft of other changes in the past decade, too, some relating to performance and operation, others imposed by new regulations. Adrian Moore: 'Oil systems were pretty basic in the mid-'90s, with oil/air coolers sitting on the top of the 'box. Now, oil/water coolers are plumbed into the engine system with the cooler in the sidepod. In the early '90s there were simple oil pumps but, by the mid '90s, these became multiple stage scavenge systems. Now we're back to one or two-stage pumps, analysis enabling a better understanding on where to scavenge.'

'Oils have also improved, allowing higher temperature running which, combined with developments in casing and other materials and bearings, means we see much higher 'box temperatures now, again allowing for smaller coolers.

A couple of teams in the past have tried combining the engine and gearbox oil systems, but there's a compromise on the oil, filtration is more complex, and it's a difficult route to find a small benefit.'

Rear crash structures mandated in 1997 affected the width of the rear of the gearbox and its structural design. Wheel tether loads also have to be withstood now. And internally bearings have changed. 'Mid-'90s bearings came off the shelf from SKF, Timken etc.' recalled Moore. 'Plus there were a few 'specials'. Now there are specialist companies, including Xtrac, who design and make specific racing bearings. There have been two main design steps: first to angular contact bearings, then to ceramic hybrid bearings. Basically they allow smaller bearings with better load characteristics and the potential for higher temperature operation.'

Shift changes

Sequential shift gearboxes have been universal in F1 since around 1993, with 'assisted changes' on every car since 1995, and despite various evolutions the operation principles have remained similar. Adrian Moore revealed a little-known aspect of this development: 'John Barnard introduced the first semi-automatic shift [that raced in F1] on the 1989/'90 Ferrari so he didn't have to package a gear linkage! Then it was realised there was also a performance advantage...

'The mechanics and control systems for a semi-automatic shift require massive development,' continued Moore, 'plus great emphasis on manufacturing technology to produce, for example, the requisite dog tooth undercut, which has extremely tight tolerances. There have also been various types of actuator, such as the linear type driving a ratchet, or the proportional control rotary actuator. The ratchet type [as used on motorbikes] is probably more reliable, and doesn't need redundant sensors because it has an inherent mechanical failsafe mode.'

The future

There may be an impending revolution as pre-selector systems begin to appear. For example, twin-clutch systems already exist, although Adrian Moore declined to indicate if they have ever raced. 'There are a lot of control systems problems to solve, and they're mechanically complex and heavier' commented Moore. Racecar Engineering has already reported on the 'ZeroShift' system (V14N2), which offers minimal fluctuations in torque delivery as gear changes occur. No F1 teams had taken up this particular system at the time (February 2004), although the advantage that it, and well set up pre-selector systems, could offer is faster acceleration through minimally interrupted power delivery.

Not surprisingly Xtrac has its own development along these lines. Known in-house as the 'Post Box', or 'Post gear change de-selection gearbox' to give it its full title. Its principle of operation allows, for example, when driving in third gear, fourth gear to be selected without de-selecting third gear. The system reduces the time out of gear, as do the pre-selector systems mentioned above, but without the need for twin clutches or extra gear shafts. The system has been 'car tested though not raced' and is aimed at WRC and F1. Watch this space...

It may be a matter of interpretation as to what type of 'pre-selector' gearboxes meet current F1 rules, or, as Adrian Moore put it, 'their use requires liberal interpretation of the regulations – only Charlie Whiting

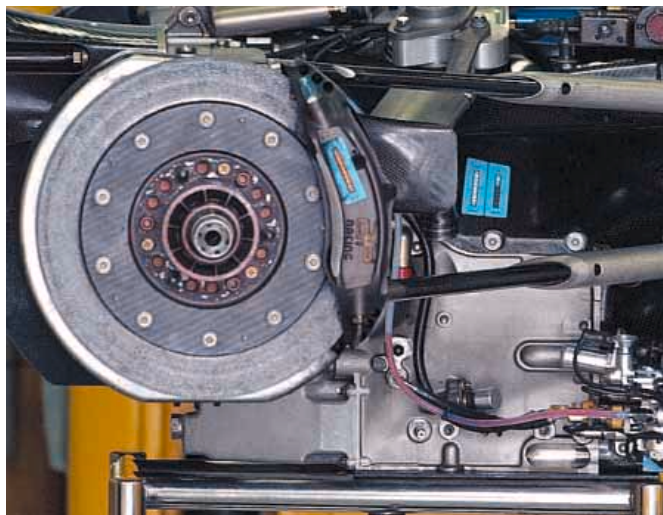
can tell you if they are legal or not!' The use of alternative gearbox principles might require similar 'clarifications'. For example, constantly variable transmission (CVT) has been deemed outside the regulations. Adrian Moore speculated on whether toroidal transmissions like the Torotrak and Perbury systems, which are also technically CVTs, might be a better technical solution than current operation principles. 'Perhaps,' he suggested, 'if they operated in a stepped fashion then they would not strictly

speaking be CVTs, although it appears that at the moment the regulations are being interpreted in such a way as to not allow even these solutions. They would certainly improve starts because they have a 'geared neutral', so there would be no clutch, hence there'd be no clutch slip...'

So, transmission developments have pretty much mirrored engine developments in Formula 1 – the current breed being smaller, lighter and more efficient than a decade ago. And clearly these developments have had an important influence on the cars' performance, too. It may also be that we're about to witness further performance enhancing gearbox developments in the very near future.

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Chassis analysis

Having produced outstanding handling road and racecars for 50 years, Lotus chassis technology is now available in a simple-to-use software package aimed at motorsport engineers

Words	Charles Clarke
Photos	Sutton Images

If you've ever had the opportunity to drive a Lotus, you understand what world-class ride and handling is all about. Lotus has always delivered an exhilarating driving experience, but it hasn't always been perfect. The original Lotus Elan was the best handling car there was at the time in the dry, but in the wet it was a nightmare. Most models have had their foibles over the years, but Lotus Engineering has continued to hone their chassis and suspension skills, aided and abetted by improving dynamics

knowledge and software. So much so that the current breed of Lotuses – the Elise IIR and the new Exige are, quite simply, superb driving cars.

Such is my affliction with the marque that I also had a Mk1 Elise, which was a real disappointment – not in the ride and handling department, but in the overall completeness of the project – which probably goes to prove that you shouldn't buy a Mk1 of anything. But six years on, all the annoying Mk1 wrinkles have been well and truly smoothed out – the build is

much better, the amenity is much improved, you still can't see much behind you, but hey, these cars are meant for going forwards (and sideways). The new, racier Exige is shod in standard trim with almost slick Yokohama tyres and the effect is nothing short of stunning – it's a true racecar for the road.

There is substantial aerodynamic downforce which, when coupled with the sticky tyres and significant mechanical grip from a highly tuned chassis and suspension system, makes the Exige

The Lotus Elise GT1 has proved its capability in the ALMS series



feel like it's on rails. Lotus kindly let me thrash one round its test track and you really have to be acting the hooligan to get it to step out, let alone do anything more dramatic.

The highly tuned chassis and suspension packages exhibited by these cars come from superior software tools and good old fashioned Lotus know-how. And the good news is that these are now available on the open market in the form of LSA (Lotus Engineering Suspension Analysis). This is the commercial version of some Lotus Engineering internal software that has been under development for 15 years.

The quality of this development has gone hand in hand with the quality of the physical development, which is there for all the world to see in the Elise IIIR and Exige. And just as you can buy the state-of-the-art in a physical sense, you can now buy it in a virtual sense, too.

Lotus know-how

LSA is the encapsulation of Lotus Engineering suspension know-how in software form. It provides an easy-to-use tool for the design and analysis of suspension geometry. Standard suspension types using individual default pre-filled templates provide fast creation of kinematic models, in either 2D or 3D modes. The template type defines how the suspension is connected to the vehicle.

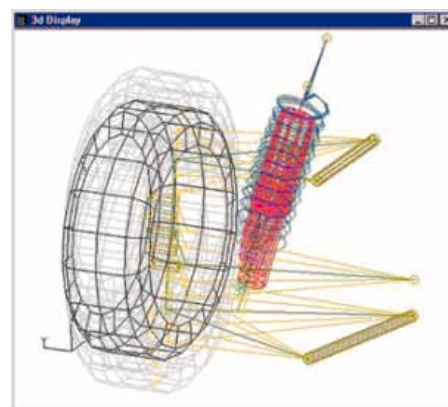
Templates include double wishbones,

“THE GREAT THING ABOUT THIS SOFTWARE IS THAT IT HAS THE CAPACITY TO SAVE YOU SO MUCH BASIC WORK”

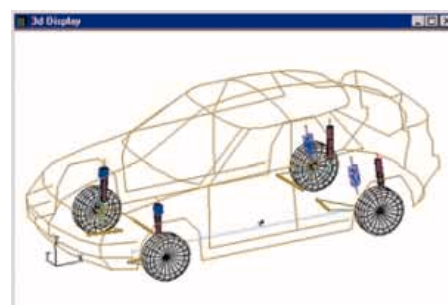
Macpherson struts, trailing arms, semi-trailing arms, pull rod and push rod damper actuation and 'A' and 'H'-frame configurations. You can also create and distribute your own specific templates and, even with no previous suspension design knowledge, you can be looking at something halfway decent in as little as 10 minutes.

Interestingly, steering type also includes steering box, which speaks volumes with regard to the origins of early versions of this software.

When you select particular templates you are presented with a wire frame representation of the suspension in a 3D environment. The graphical representation of the wheel is just that and, from a kinematic point of view, the tyre is assumed to be rigid. In terms of kinematics the contact of the tyre is a point not a patch. When you get into compliance modelling, forces can be



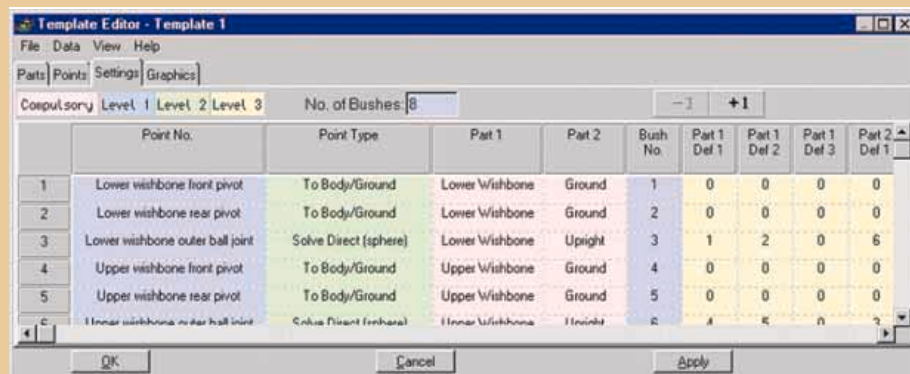
Standard templates include all common suspension types



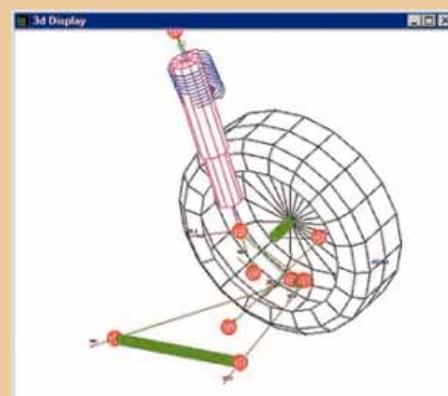
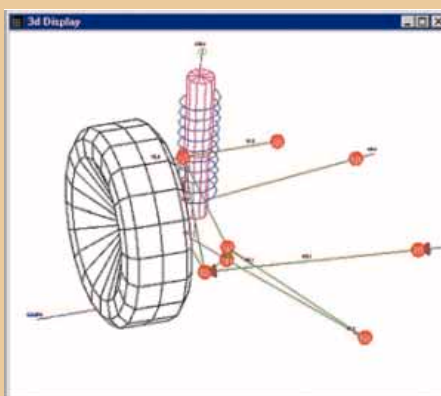
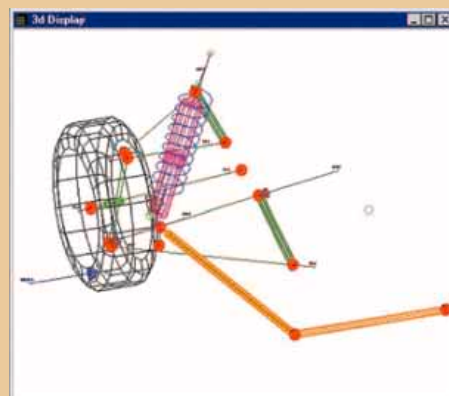
Here, a traditional Macpherson strut and trailing arm set-up

imposed at any points throughout geometry.

If you go for a shaded image display, the whole experience slows down, but in wire frame changes are instantaneous. The software →



Choosing a pre-set suspension template allows for fast creation of kinematic models, or you can create your own set-up



Shown here are three of the templates built into the programme that allow users to start work on analysis immediately. Template type defines how suspension is attached to the vehicle

“LSA IS THE ENCAPSULATION OF LOTUS ENGINEERING SUSPENSION KNOW-HOW IN SOFTWARE FORM”

List SDF

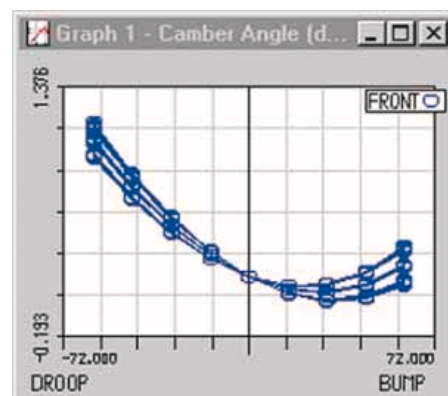
FRONT SUSPENSION - BUMP TRAVEL

TYPE 1: Steerable double wishbone - damper to lower wishbone

INCREMENTAL GEOMETRY VALUES

BUMP TRAVEL (mm)	CAMBER ANGLE (deg)	TOE ANGLE (deg)	CASTOR ANGLE (deg)	KINGPIN ANGLE (deg)	DAMPER RATIO	SPRING RATIO
0.00	0.0084	0.0004	0.1103	5.5638	1.424	1.247
5.00	-0.0656	-0.0033	0.0208	5.6378	1.423	1.246
10.00	-0.1455	-0.0074	-0.0677	5.7177	1.421	1.244
15.00	-0.2314	-0.0117	-0.1552	5.8036	1.419	1.242
20.00	-0.3233	-0.0162	-0.2416	5.8955	1.418	1.241
25.00	-0.4213	-0.0209	-0.3270	5.9935	1.416	1.239
30.00	-0.5254	-0.0257	-0.4113	6.0975	1.414	1.238
35.00	-0.6355	-0.0306	-0.4947	6.2076	1.412	1.236

All the significant kinematic suspension parameters are included in the package and can be altered incrementally



allows you to work on one corner of the suspension or two but generally most users prefer to concentrate on a single corner analysis at any one time.

The hard points are defined in a global (automotive) coordinate system, while bushes are orientated into a local coordinate system. The hard points of the template are just a list of coordinates. If you select 'change coordinates' you can modify the default values and the model changes. There is also a facility called 'joggle' which allows you to step through changes for particular coordinates – these changes can be sent to 'fine' or 'coarse'.

The suspension hard points coordinates can be picked on screen and edited to review changes to the suspension characteristics. Points can be moved interactively by on-screen dragging in 3D or by constraining the dragging along one or more axes. The beauty of this kind of manipulation is that the results are updated as you make the changes.

Where geometric relationships are fixed, points can be moved as a group, such that the dimensional relationship of an item such as a wishbone can be maintained. There is also a mode called 'tolerance analysis' where the effect of point tolerance on the calculated suspension derivatives can be evaluated and displayed through the same interactive environment. You simply select the point and specify the desired tolerance.

You can also do 'point limits', which is a way of putting a box round each point, so that if a particular motorsport regulation specifies that hard points should be within a certain envelope, you can define that envelope in the system. As you subsequently modify the suspension the system won't let you violate the pre-set regulations. If you wanted to know the effect of moving a point within a box on say, toe angle, if you select 'solve', 'point tolerance analysis' and select the point, you get the complete spread of toe and castor of moving the point within the box. So you can readily identify where you have

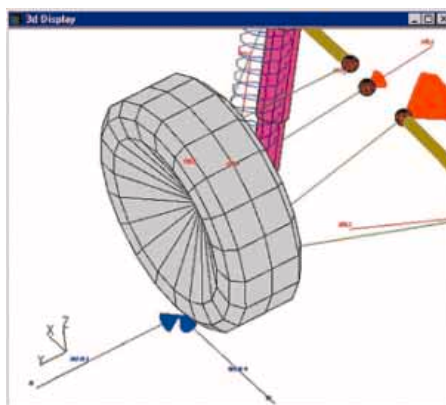
“RESULTS ARE PRESENTED AS A SERIES OF CURVES WHICH SHOW HOW THE SUSPENSION GEOMETRY CHANGES WITH THE VARIATION OF A PARTICULAR ELEMENT”

to move the point within the box to produce the desired results curve.

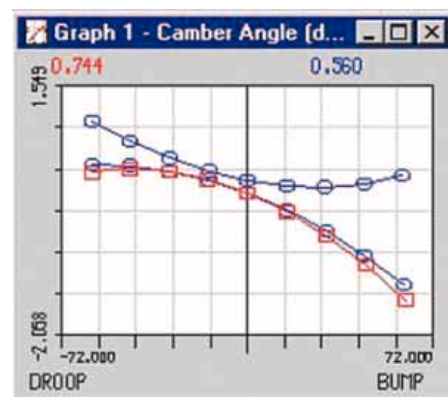
In some cases, particularly in motorsport, an existing part must be maintained. To do this it is possible to 'retain part lengths' so that when the hard point is moved the suspension is rebuilt, maintaining the geometry of the particular part.

Vehicle animation

It is also possible to put a body on the suspension so that if you were examining the (suspension) roll mode you could see the animations in the suspension as the vehicle is iterated through a roll sequence. And you can see things like the roll centre and centre of



External forces can also be applied to the suspension set-up



Any number of results curves can be open at once to help understand the consequences of each particular modification

gravity migration. Whilst the suspension is animating you can still make changes and see interactively the effect of the changes you are making on the animation.

All significant kinematic suspension parameters are included in the output, including camber and castor angles, toe, kingpin angle, spring and damper ratios, CofG and roll centre position, brake steer, track change, wheelbase change, percentage anti-squat, percentage anti-dive and percentage Ackermann. Results are displayed either graphically or numerically over specified bump, rebound, roll and steer articulations. External forces can be applied to the suspension, as well as suspension spring loads, anti-roll bar forces and the influence of steering rack coupling and compliance. Calculations are updated after each design change, together with graphical result displays, so you can see instantly the significance of changes. Results are presented as a series of curves which show how the suspension geometry changes with the variation of a particular element, and you can have as many curves open as you like to examine the consequences of particular modifications.

If you choose a particular characteristic, the graphics illustrates the directions of freedom and you can drag the geometry with your mouse in those directions to examine the changes. →

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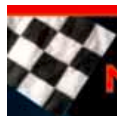


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“THE BENEFIT OF HAVING SUCH AN INTERACTIVE APPROACH IS THE ABILITY TO IDENTIFY TRENDS IN THE SUSPENSION RESPONSE VERY QUICKLY”

It is then possible to output graphs or numerical listings of the results, which can then be fed into other software. In the past, users used to write out wheel centre coordinates for people to do wheel envelope type work. Now it is possible to simply list out points so, if you wanted to know the coordinates at a certain position, you just request them. This data can then be cut and pasted into other applications.

Spline and articulation

While some users like to see results in terms of articulation, others may like to see the output in terms of splines, so there are options to put 'spline fits' to these data — instead of getting the numbers you get equations. Some other handling packages prefer to receive data in spline format.

You can also 'target set' with the graphs and specify the required response so that the output you receive as you animate the suspension and move the points is in relation to the target. You can't actually make a change to the graph and have it reflected in the geometry, but the target setting is sensitive enough to enable trends to be readily identified. To get a particular response you can do basic optimisation where you set up a number of runs with geometry varying incrementally until it converges to your desired result.

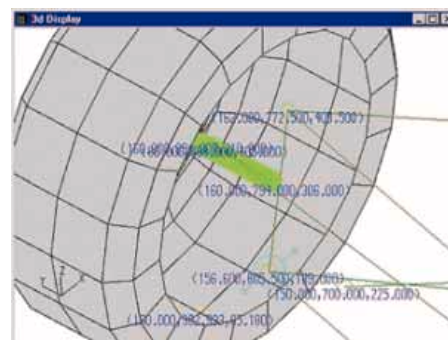
Factors such as spring forces and roll bars can be turned on and off and rack forces can be linked across the car. It even does 'exotic' roll

bars like blades. Basically, as long as you can represent it by mechanism with a stiffness it's possible to model virtually any kind of suspension system.

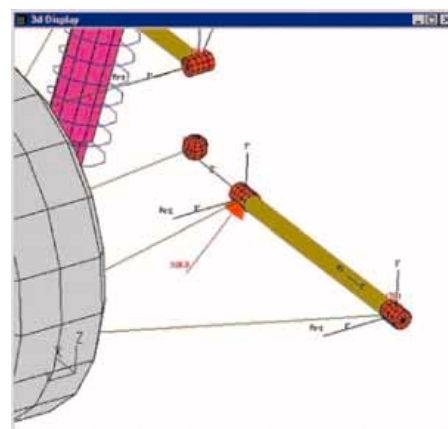
The benefit of having such an interactive approach is the ability to identify trends in the suspension response very quickly. One of the other main uses of the suspension analysis system at Lotus is to train new ride and handling engineers to give them a very quick insight into how changing suspension geometries influence the performance of the vehicle.

Compliance module

An optional module is available that allows you to add the stiffness properties of compliant bushes to calculate compliant displacements and bush forces. The software is deliberately structured like this because Lotus felt that many race teams would not be interested in compliance. However, if they are, it is possible to move around the geometry selecting the various bushes to be compliant and then changing the bush properties and orientations to reflect the actual situation. Just like the kinematics module, points can be picked up and dragged around and you can actually manipulate the bush axis to give you a more desirable response. This allows the axis of the bush to be altered and the mechanical reaction to that alteration examined. The rate, position and orientation of the bushes can easily be modified,



Individual points can be manipulated to give desired results



An optional module is available to allow the addition of compliant bushes and their displacement to be calculated

using the same interactive editing environment, to allow effects such as lateral force steer due to compliance to be included in the analysis.

The compliant deformation can be animated either throughout the suspension travel or as a scaled 'deformed geometry' sequence at a particular suspension position. You can also plot the distortion of the bush under the animation to examine whether a particular bush axis would shorten the life of the bush.



In addition to the defined suspension spring properties, external forces can be defined to review instantly the effects of compliance on suspension geometry and its derivatives. Instant graphical feedback is available with respect to how the system deforms, together with instantaneous numerical updates to the analysis. Any number of forces can be applied to any of the parts and the system recalculates when any of them are moved. It is even possible to apply 'sliders' to the properties of the bush to modify a parameter such as the stiffness of the bush. Moving a slider quickly tunes the suspension to give the required result.

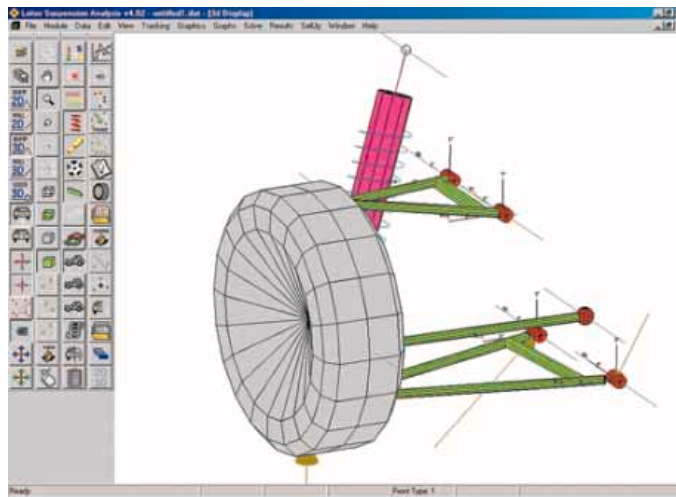
The great thing about this software is that it has the capacity to save you so much basic work – most common suspension configurations are pre-programmed and all you have to do is supply your dimensions and loads and the system is ready for your analysis.

LSA was originally developed at Lotus for its ride and handling engineers. These engineers have been responsible for the vehicle dynamics of many of the world's class-leading passenger cars, Lotus' ride and handling team was integral to the design and development of the LSA software and continues to use the package for in-house and client development projects. The PC-based software has been continually updated and refined to keep abreast of the latest trends in suspension configurations, design techniques and analysis requirements. The current software sits comfortably on an Intel P4 (or equivalent) PC with 512MB of RAM and a reasonable graphics card. The software footprint is small and you don't need any specific solvers for the kinematics and compliance modules as everything is contained in the code.

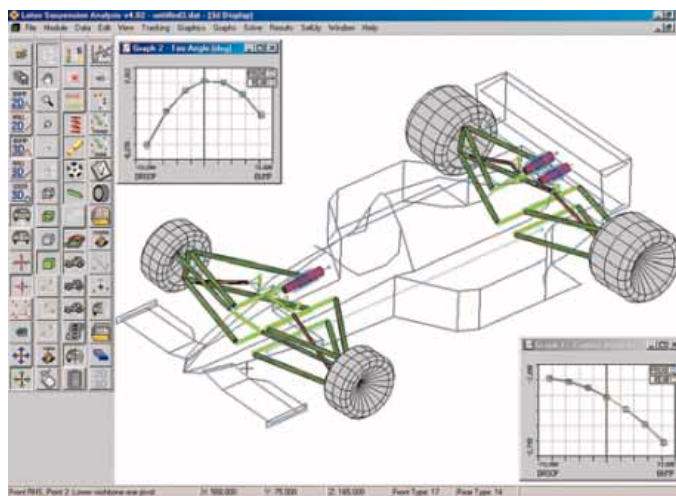
Handling module

The additional handling module available uses the MSC.Adams solver but is not promoted to the same degree as kinematics for that reason (it is generally seen as more beneficial to existing MSC.Adams users as a pre-processor to Adams). What it can do though is to import data from the Lotus Engineering Suspension Kinematics and Compliance Measurement System (SKCMS) or import data direct from the kinematics module. With a full vehicle suspension modelled in kinematics you can run a 'virtual compliance rig', which replicates what happens on the SKCMS rig. It is then possible to see the load cases being imposed and the lateral force tests. This in turn generates all the data needed for the handling module which models dynamically more tangible vehicle properties such as unsprung mass, track, tyre data etc.

The handling module is particularly suitable for manoeuvre/time based applications as it will produce simulations from one wheel bump to



This example shows the Lotus Elise suspension itself running on LSA



The software is suitable for all racecar types, and adding a body allows users to see animations in the suspension of a vehicle through a roll sequence

the next, road motions, steering motions, step changes, acceleration and braking type manoeuvres. The vehicle model is driven by splines, populated with kinematics data or data taken from the SKCMS rig.

The SKCMS rig provides accurate measured data of suspension and steering behaviour in response to applied quasi-static forces. These forces approximate those present at the tyre contact patch during cornering, braking or accelerating. Additional forces can be applied at the wheel centre if required. A typical full set of vehicle tests on the SKCMS takes approximately 16 hours to perform.

LSA's interface, with its unique 3D viewing and editing environment and its rapid computational speed, makes it ideal for use by either designers

or analysts at the concept design stage of a project. Common suspension layouts are pre-programmed into the software, whilst the user-definable template feature enables unique suspension configurations to be constructed. It is fully interactive and, once you have your configuration, you can make comprehensive 'what if' adjustments until you get the performance you're looking for.

Lotus Engineering is targeting LSA at suspension designers and analysts across a wide range of organisations from OEMs to small performance-engineering firms. Many top-flight professional and private motorsports teams are already interested in the software, but are currently reluctant to talk about it. However, several renowned academic institutions including: Cranfield's Motorsport Department; Kingston University, London; University LeMans, France and Kookmin University, Korea already have the software.

LSA is available through a range of flexible licensing options from Lotus Engineering Software (www.lesoft.co.uk), starting from as little as £350 per month up to a perpetual licence price of £8000 – small beer when you consider the wealth of development knowledge incorporated in this code.

“LOTUS' RIDE AND HANDLING TEAM WAS INTEGRAL TO THE DESIGN AND DEVELOPMENT OF THE LSA SOFTWARE”



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Magnesium

To many people, the F1 Technical Working Group's decision to prohibit the use of magnesium alloys in Formula 1 engines is difficult to understand. Clearly there were cost implications but more than that we do not really know. Magnesium is a low-density metal which is the sixth most abundant in the world and, in alloy form, would seem to be an ideal material for motorsport applications.

As with all pure metals, it is not particularly strong, but when alloyed with other materials, it comes into its own – a greater strength-to-weight ratio than aluminium alloys, good machinability and readily weldable.

Road car manufacturers are increasingly adopting magnesium alloys to save weight and reduce CO₂ emissions. For example, BMW's straight-six engine now has a magnesium/aluminium hybrid engine block, a magnesium bed-plate and a magnesium cam cover. DaimlerChrysler's new 7-G Tronic seven-speed

Abundant, versatile and increasingly common in road cars, why is magnesium's long history in motorsport being constrained?

Words	Dave Hancock
Photos	Hancock; Sutton Images

automatic gearbox (to be introduced across most of the Mercedes car range) has a magnesium casing. Looking at a smaller component, intake manifolds on an MG weigh 4.3kg in magnesium alloy. In aluminium alloy, they would weigh 9.3kg, while in plastics (polyamide) 6.2kg.

Motorsport wheels are almost entirely magnesium, and magnesium transmission components are used in series such as F1, WRC, DTM and LMES, as are magnesium hydraulic parts and steering components.

Sadly though, magnesium is a largely misunderstood metal, perhaps suffering from the reputation of older alloy technology. It is generally perceived to have poor high temperature performance and limited corrosion resistance. Yet magnesium alloys are now used in safety-critical applications in the aerospace industry – in helicopters and in military machinery, from jet fighters to amphibious craft. Clearly, we need to know more about magnesium and its alloys.

“AS WITH ALL PURE METALS, IT IS NOT PARTICULARLY STRONG, BUT WHEN ALLOYED WITH OTHER MATERIALS, IT COMES INTO ITS OWN”

opus

Magnesium, the lightest of the structural metals, was first discovered in 1808. Seawater contains 0.14 per cent magnesium and the element is abundant in minerals, carnallite, dolomite and magnesite. However, it was more than a century before a method of industrial production was developed. Nowadays, pure magnesium is mostly produced from Chinese dolomite rock, whilst most alloying takes place in the west. Around 400,000 tonnes of magnesium are produced per annum. Magnesium is also recyclable – a process that takes just five per cent of the energy required to obtain magnesium initially.

Despite being bought and sold a few times in its 68-year history, Magnesium Elektron is the world leader in magnesium wrought and casting alloys. Since 1996, UK-based Magnesium Elektron (often called MEL) is the centre of the Magnesium Division of the Luxfer Group – an international manufacturer of high performance

engineering materials including magnesium alloys, zirconium products, aluminium tube and high-pressure gas cylinders.

The Magnesium Division of the Luxfer Group is the largest producer of magnesium powders in the world (for use in the chemical, pharmaceutical and defence industries). A recent acquisition in North America means the group is now also the largest producer of magnesium wrought alloy products as well. Although Magnesium Elektron UK has some involvement in these markets, it specialises in magnesium casting alloys and wrought products, having developed more of these than any other company worldwide.

Wrought magnesium alloys – in sheet, sections, bar and billets – are quite popular in motorsport where tight turnaround times and low volumes often dictate machining an item from solid, rather than having it cast. Casting falls into two categories – die-casting in large volumes or sand casting in smaller quantities, the latter applying more to motorsport.

Rare earth metals

The oldest of the magnesium sand casting alloys are magnesium-aluminium-zinc alloys, dating from the 1930s. Those designated British Standard (BS) MAG 3 or the American Society for Testing Materials (ASTM) AZ91, contain around nine per cent aluminium, one per cent zinc and less than 0.5 per cent manganese, the remainder being magnesium. Since the 1980s, these have evolved into high purity alloys, AZ91D and AZ91E, with good corrosion resistance. They are inexpensive, but are only suited for low temperature applications and can be difficult to produce consistent results with.

From the late 1950s, Magnesium Elektron

developed and refined the process of producing magnesium alloys that contained zirconium and rare earth metals. The zirconium – which is present as about 0.6 to 0.7 per cent of the composition of the alloy – dramatically refines the grain structure and hence the strength and ductility. The additional introduction of rare earth metals makes the alloys easier to cast and improves their temperature capability. Despite the exotic name, rare earth metals are fairly abundant. They are found as oxides, hence the designation earth, from which the metals used to be difficult to extract – hence rare. Ion-exchange and solvent extraction processes are used today to quickly produce highly pure, low cost, rare earths. There are two blocks of rare earths – the lanthanide series and the actinide series, but there's no need to make this a chemistry lesson.

The original magnesium-zirconium-rare earth alloy, RZ5 or ZE41A, has been widely used in motorsport applications, such as transmission components, as well as similar applications in aerospace. This alloy has been around since the 1950s and is well known to foundries.

In the 1960s, silver was introduced to magnesium-zirconium-rare earth alloys at about 2.5 per cent to improve their capabilities at high temperatures. However, fluctuations in the price of silver have made these alloys less popular. There have also been magnesium alloys containing thorium but, as this is radioactive, they are no longer produced.

In terms of properties, the ultimate magnesium sand casting alloys are the Mg-Re-Zr alloys strengthened with yttrium – the WE family of alloys. Developed by Magnesium Elektron in the 1980s these WE alloys contain between four and six per cent yttrium, as



Motorsport wheels have traditionally been manufactured from magnesium to take advantage of its weight saving properties

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well as heavy rare earths, zinc and zirconium. They are commonly used in the aerospace industry due to their combination of low weight, high strength at high temperatures (UTS of 220MPa at 250degC) and extremely good corrosion resistance. Auxiliary drive gearbox casings for jet engines and stressed helicopter gearbox casings are good examples of aerospace applications. For motorsport, these alloys are also of interest, particularly in their wrought forms. Boasting similar or even better properties than WE castings, these alloys are perfect for Formula 1 engine components and ancillaries, such as cam covers, oil pump housings, sumps and end covers. Interestingly, the wrought WE alloys exhibit isotropic properties, meaning they are equally strong in the direction of extrusion as they are perpendicular to it. This is an extremely unusual trait for any material, and is being researched further by Magnesium Elektron and Manchester University.

“ANOTHER ADVANTAGE OF MAGNESIUM ALLOYS IS THAT THEY CAN BE MACHINED FASTER THAN ANY OTHER METAL”

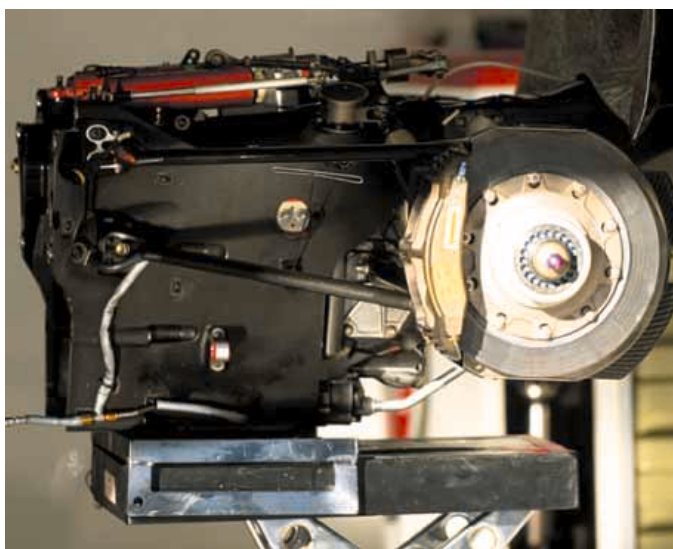
A special version is WE64, with six per cent yttrium and four per cent rare earth metals. This has higher tensile properties and hardness, but ductility is reduced. Nevertheless, Formula 1 teams have found its use attractive for (undisclosed) engine parts.

The latest development from Magnesium Elektron is Elektron 21 – a lightweight, high performance alloy for the motorsport and aerospace industries. The nominal percentage composition of Elektron 21 is 0.3 per cent zinc, 2.7 per cent neodymium, 1.3 per cent heavy rare earths (gadolinium based) as well as the usual 0.6 per cent zirconium grain refinement, with magnesium making up the balance. It has a fine-grained microstructure, is pressure tight and, because of the low oxidation characteristics, Elektron 21 has excellent castability.

Elektron 21 was developed to collectively improve on three of the most common magnesium alloys. AZ91E, although inexpensive, is temperature limited and produces parts with inconsistent properties. RZ5 (ZE41) has less corrosion resistance (although it can be surface treated) and is limited to around 140degC. The WE alloys, although achieving the best properties at the highest temperatures, are relatively expensive because they contain



WE magnesium alloys, strengthened with yttrium and containing zinc and zirconium have proved very popular with the aerospace industry, particularly in its wrought form, though cast magnesium alloys are still popular for items such as transmission casings



In 2002 F1 team BAR ran with a magnesium gearbox before switching briefly to aluminium and then going on to successfully develop a carbon fibre gearbox casing

yttrium. Yttrium is difficult to isolate as a pure metal, and its affinity to oxygen can lead to more casting defects, pushing up the overall component cost. With Elektron 21, Magnesium Elektron has tried to reduce the cost of magnesium components whilst maintaining their properties to as near to the WE alloys as possible. At ambient temperatures, Elektron 21 has a tensile strength of 280MPa, compared to 255MPa for WE43 and a lower figure again for AZ91. However, it is Elektron 21's elevated temperature performance that is most impressive as it nearly matches the more expensive WE43 (Elektron 21 is about 65 per cent of the cost of WE43).

In conclusion, magnesium alloys are very capable at high temperatures, and easily beat most aluminium alloys for tensile properties when operating at higher temperatures.

Corrosion resistance

To overcome the old perception of magnesium's poor corrosion performance, we must look at industry recognised ASTM B117 Salt Fog tests for the newer magnesium alloys. The WE alloys, as well as Elektron 21, perform in a very similar manner to aluminium alloys such as A356 or A357, and are around 10 times better than the old RZ5 (ZE41) alloys. To understand why, we look back at the aluminium-zinc-manganese →

alloys, such as AZ91. In the 1980s, it was discovered that if the contaminants in the alloy were kept below specific levels, this alloy would exhibit corrosion resistance on a par with aluminium alloys. Therefore, for the fourth and fifth iterations of this alloy family – AZ91D for die casting and AZ91E for sand casting – the iron, copper, nickel and silicon contaminant levels are maintained at extremely low levels, producing high purity versions with good corrosion resistance. The zirconium refined alloys, such as RZ5, the WE alloys and Elektron 21, make use of this contaminant reduction work, but it is the newer alloys' alternative strengthening elements that are less likely to form micro galvanic cells that further improve their corrosion resistance.

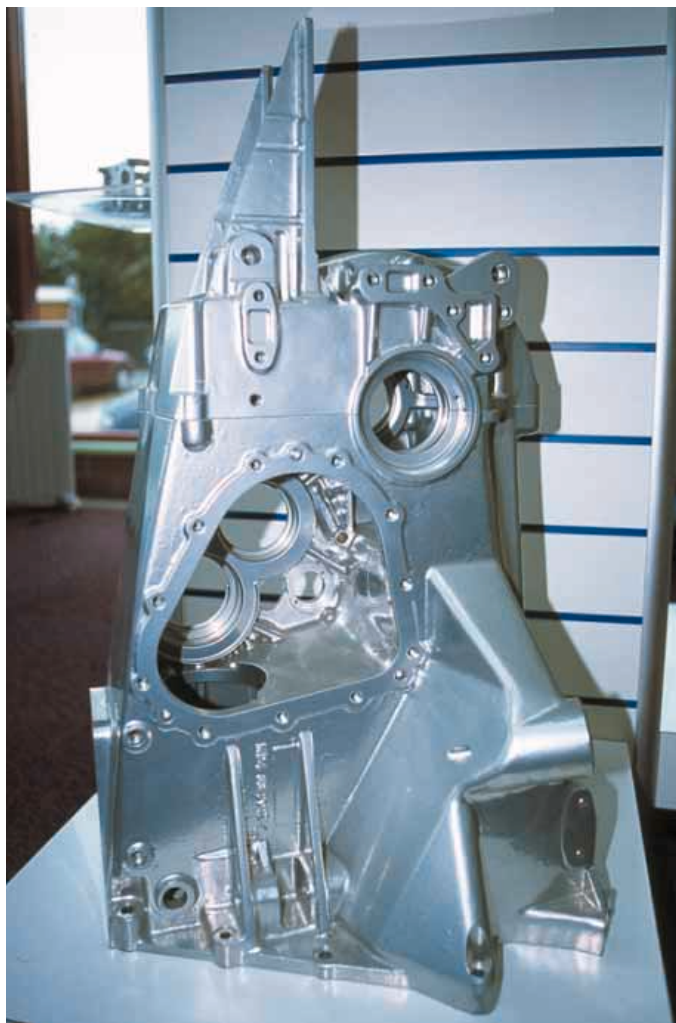
The magnesium alloys are all a shiny, silver grey colour and, just like aluminium, can be painted in any colour. To further enhance a magnesium component's corrosion resistance, several surface protection treatments are available. In motorsport, a chromate treatment followed by black paint seems traditional for the RZ5 castings, although this only actually offers a very poor surface protection, as it is easy to scratch. It would be better to use the improved properties of Elektron 21.

For protection against severe environments, such as helicopters on aircraft carriers, surface treatments based on an anodised layer are used. When sealed and painted, this can be used to protect magnesium in hostile environments for many years – which means it is commonplace on aerospace applications.

As with all magnesium alloys, Elektron 21 can be TIG-welded easily. The tensile strength of an undressed butt weld made by the argon arc process usually exceeds 90 per cent of that of the parent material in the un-annealed state. Post-weld heat-treatment to relieve residual stresses should follow unless the magnesium casting has to be heat treated at a higher temperature to meet the relevant specification for the parent metal.

Another advantage of magnesium alloys is that they can be machined faster than any other metal – up to 10 times faster than steel and twice as fast as aluminium. Indeed, machining magnesium is normally limited by the speed and power of the machine. It is normally machined dry and, if coolants are necessary, then a light mineral oil is used, rather than a water-based lubricant. After machining using a water-based lubricant, the storage of the resultant swarf is more difficult, due to the risk of reaction between the swarf and the water.

Magnesium components are almost impossible to ignite through the machining process, as magnesium must be heated to its melting point before it will burn. Magnesium swarf can be



Although still suffering from a reputation for poor corrosion resistance, several highly effective surface treatments are now readily available for magnesium components, such as chromate coating and anodising. Like aluminium, after treating, magnesium can be painted any colour

“MAGNESIUM IS ALSO RECYCLABLE – A PROCESS THAT TAKES JUST FIVE PER CENT OF THE ENERGY REQUIRED TO OBTAIN MAGNESIUM INITIALLY”



Magnesium is now finding favour amongst car manufacturers, here in BMW's straight six cam cover

ignited though, but the fast machining process should produce large chips that reduce this risk, as will good housekeeping. Cleaning machines regularly and correct storage of the swarf are

important aspects of machining magnesium.

So, forget your preconceptions and put magnesium alloys on your shopping list but make sure to check the regulations first...

RE

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Motorsports rules, goes the popular engineers' lament, have become so restrictive as to render racing no fun for the imaginative. In the US, however, a racing category exists that remains unfettered by the spec class-style regulations that have throttled innovation elsewhere.

D Sports Racer has existed on the fringe (some would say lunatic fringe) of amateur sportscar racing in the US for decades, a haven for backyard tinkers, self-styled engineers and other black sheep blazing their own trail.

'It is a great class for those people who think they are the next Colin Chapman or Adrian Reynard,' observed Bill Maisey, founder of the www.sportsracer.net website that cultivates Sports Racer discussions. 'There is considerable romance in building a better racecar.'

It is not a class for drivers who dream of promotion to a professional career, nor one for drivers who aim to match their talents against others in equivalent equipment. DSR drivers typically wanted to outsmart their competitors, spending the off-season studying the rulebook for any previously unexploited unfair advantage.

The result was sparse attendance and an even more scarce collection of finishers at the end. Victory was commonly awarded to the car that broke last, as these homebuilt specials expired on the track with alarming frequency.

Two-stroke engines were popular for their high power-to-weight ratio, but their ear-splitting din and unreliability attracted few converts. Rules permit two-stroke engines up to 850cc, four-stroke engines up to 1005cc, four-stroke engines with two valves per cylinder up to 1025cc, and automotive-sourced engines with a maximum of two valves per cylinder of 1305cc. Rotary engines of 450cc are also legal.



Carburetion is unrestricted, as is fuel injection. Forced induction is permitted, but only on vehicles whose engines displace less than 620cc and have four valves or fewer per cylinder. Chassis construction is similarly flexible, with steel tube frames and monocoque designs legal and competitive. The monocoque cars may be fabricated of sheet metal or carbon

fibre, but the SCCA requirement that carbon fibre cars carry FIA crash test approval has been an effective prohibition on its use.

Wheels and tyres are free, with a minimum wheel diameter of 10in, and the requirement that left and right sides be identical. Front and rear need not be the same size.

Such variety and flexibility naturally attracted

Radical SR4

Price:	\$59,000 with engine (£32,000)
Width:	64in (1630mm)
Length:	147in (3730mm)
Weight:	992lb (450kg)

Radical may have single-handedly re-invigorated the DSR class, but the company has largely re-focused its efforts on the heavier, more powerful C Sports Race category and on trackday cars. The US importer continues to supply the original Radical Prosport upon request, but competition from an abundance of the cars already sold and the fact the car is a little bit of a heavyweight for that class, makes new sales of Prosport cars scarce.

Instead the company is concentrating

on the new SR4 model, which targets CSR, but can be configured as a DSR for customers who want to race in that class, where there are typically more competitors. US sales coordinator Dan McBreen points out Radical's reputation for

quality and customer service as selling points for their cars. 'There is no other manufacturer that has sold more than a fraction of the approximately 500 DSR-type cars Radical has sold worldwide,' he said.

An obstacle to some customers who

The car that started the motorcycle-engined revolution: The Radical SR4, shown here in C Sports Racer trim, but available as a DSR, too



creative types, where seemingly everything is legal. That's not quite the case, as both turbine and steam engines are specifically prohibited, but nearly anything else goes.

Minimum weight for cars using a chain or belt drive system — typically those with engines taken from motorcycles or snowmobiles — is 900lbs, including the driver, so the challenge for DSR designers is achieving this weight. The practical challenge is to get the car and driver combination as close to that weight as possible. For cars not using chain or belt drive systems, commonly converted Formula Fords with an alternative engine replacing the Ford Kent, the minimum weight is 1000lbs, including the driver.

D Sports Racer has evolved dramatically in recent years — not because of new, restrictive rules, but due to the introduction of a number of professionally built racecars based on the latest high-performance sport motorcycle engine technology. The cars are fast, good looking, reliable and not prohibitively expensive.

The catalyst for the transformation of DSR was the arrival in the US in the late '90s of the Radical — a popular sports racer used in European spec series. The car was not optimal for DSR's rules, being much heavier than the minimum weight, but it was a reliable, well-engineered, easy to drive car, which stood in stark contrast to most cars competing in DSR at the time. The result was great success, which cultivated widespread interest.

While few of the tinkerers would embrace a turn-key racecar, a new group of drivers flooded into DSR, attracted by the Radical's Le Mans styling and its dependability.

'Radical was a huge step forward in the DSR field because, up until then, there was no purpose built machine for this class,' said Bob

“RADICAL'S POPULARITY DEMONSTRATED A MARKET FOR FACTORY-BUILT DSRs”

Schader, US importer of Speads racecars. 'A lot of the businessmen racers could look at those and say, "I'll order one, I know what I'm getting." A lot of people who weren't mechanically advantaged were suddenly able to race in this class because these cars were available through your local prep shop and you knew what you were getting. It wasn't a step off into the abyss.'

Radical's popularity with paying customers had another effect — it demonstrated a market for factory-built DSRs. Other constructors and would-be constructors could see that racers would pay good money for a properly designed DSR, and they set about developing such cars.

This wave of purpose-designed, factory-built DSRs began in 2001 with the Stohr, from Oregon, USA. Other recent arrivals include: Speads from South Africa; Maloy from New Mexico; traXstar Supercars Inc. from Calgary, Canada; and OMS from the UK.

'Now we are in a sort of space race,' said Pat Prince, owner of Prince Engineering, a race engineering and fabrication shop. 'It is a common evolutionary step. The first class to go through this race for the best constructor was back in the early Formula Vee days. Then, in the late '70s, Formula Ford went through the same evolution and now D Sports Racer is doing it. As each new, better, more expensive car comes out and shows well, more constructors say, "we can

do that," and develop a new car.'

All of these cars rely on salvaged motorcycle engines for power. In stock trim, 1000cc motorcycle engines can produce more than 160bhp at the rear wheels and, in race tune, they can produce over 180bhp. All of the engines make tremendous power, while spinning at RPM untouchable by any but exotic racing engines. Except for those engines built to the absolute limit, reliability is excellent, and availability of donor engines is good.

In addition to the nearly universal use of motorcycle powerplants, another constant among the cars available is the variability of their prices. With many cars constructed overseas, fluctuations in exchange rates and differences in the equipment specified make prices unpredictable, at best.

The challenge for the 2005 season could be adapting to rules changes with regard to the use of underbody ground effects tunnels. Such tunnels have always been believed to be illegal under the SCCA's ambiguously worded rules. But recent challenges to that understanding have some teams and constructors ready to field ground effects cars in 2005 (unless the rules are changed to prohibit them). At this point it is difficult to predict what the outcome will be.

'My view is we should let everyone hack up their cars and build tunnels and do them badly,' said Maisey. 'To do it right you would need a good Formula Atlantic car, but it would still be too heavy.'

Further predictions of escalating budgets may not come to pass, because it is an amateur series with no potential for its drivers graduating to professional series. 'It is still a bunch of guys with money playing with their toys,' Maisey said. 'This is not the top level of racing.'



considered going the turn-key Radical route, rather than cobbling together a Sports Racer from an old Formula Ford for example, was the price tag. 'Everybody talks about the cost to purchase,' said McBreen, 'but it has got to be the lowest cost, highest-performance car available in the world.'

Design highlights of the SR4 include an adjustable pedal box, which helps accommodate a wider variety of drivers, and optionally available headlights, tail lights and air jacks, which not only complete the Le Mans fantasy for owners, but make the car ready prepared for endurance racing.

■ www.radicalextremesportscars.com



Unlike the majority of Formula car-derived DSR designs, the Radical carries a two-seat cockpit. However, in the SR4, the left seat is too small to carry an adult passenger, so it is pretty much useless but forces an offset driving position

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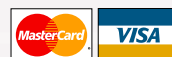


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STOHR D Sports Racer

Wheelbase: 96in (2438mm)

Overall Width: 65in (1651mm)

Weight: 775lb (352kg)

If Radical started the revolution, it was Stohr that capitalised on it by creating the first factory-built car designed specifically to dominate the class by taking full advantage of the rules. The result has been a couple of impressive victories at the SCCA Runoffs in races that have been dominated by Stohrs.

The Stohr DSR is based on managing director Lee Stohr's previous Formula Ford designs, with the necessary changes to make the car a Sports Racer. The biggest change is a switch from a purely tube steel frame to a semi-monocoque 4130 steel tube frame that includes a tub made of 1in thick carbon fibre composite panels in the cockpit area. 'I came up with a semi-monocoque design that is part steel tube and is part carbon and honeycomb,' Stohr said. 'It is designed to be repairable. We've had two guys who had big crashes and they've been fine and the cars were repaired. I think it is a lot better than just a steel tube frame. It is pretty much like a Formula Atlantic tub, but the carbon is not as thick.'

Because the SCCA requires FIA crash test certification for monocoque designs, the carbon tub is only a part of the car. 'It is a structural part of the centre of the chassis,' said Stohr. 'There is enough steel tube in there that that SCCA allowed me to homologate it as a steel tube frame.'

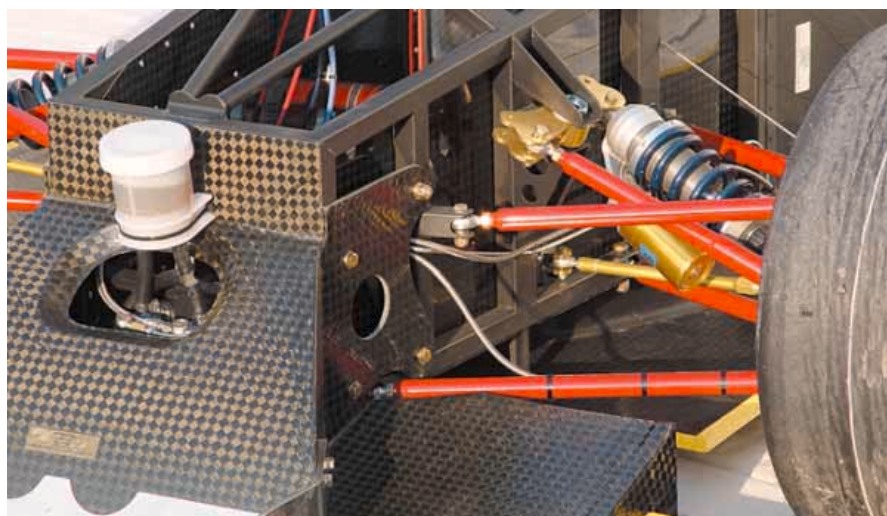
Another innovation is the front suspension which, rather than using a conventional pushrod acting on a bell crank to the damper, employs a 'double-acting' configuration. It is an outboard damper connected to a bell crank that has a conventional pushrod mounted on the opposite end. 'Both ends of the shock move, to increase the motion ratio, so you get twice the shock travel. I wanted a 1:1 motion ratio between the wheel and the shock. That is kind of hard to do with an outboard spring and shock because the angle isn't very good.'

Stohr's car initially used Penske dampers, but he has since switched to Ohlins, which is helping optimise the valving to suit the car. 'I'm working with Ohlins, on their seven-poster rig in North Carolina,' Stohr said, 'and they are trying to provide valving that gives maximum tyre grip.'

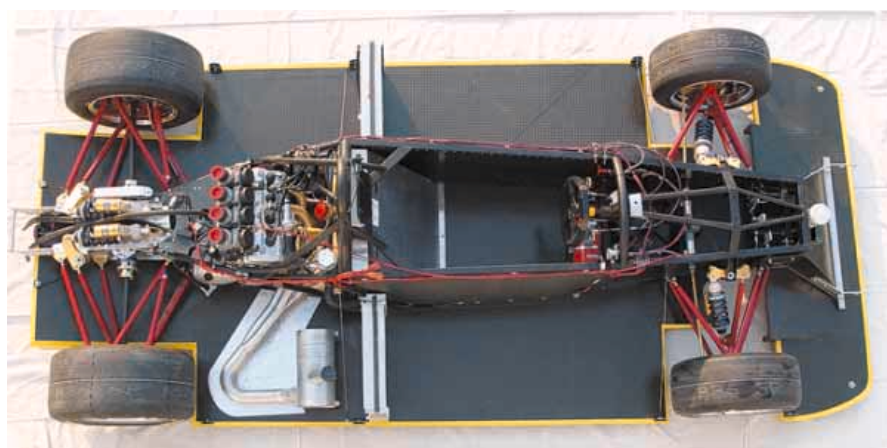
Another unconventional aspect of the Stohr's suspension is the absence of anti-roll bars, Stohr preferring to control roll with dampers and springs. This position defies



Lee Stohr with his semi-monocoque DSR which uses a part steel, part carbon fibre construction. Here with carbon body



The Stohr DSR has an unusual outboard damper/pushrod front suspension design to increase the dampers' motion ratio



Without bodywork, the formula car roots of the Stohr design are apparent. The paddle gear shifter is just visible here

conventional wisdom, but is supported by their success on track. 'My philosophy is that for any given engineering problem there are many pathways to the solution.'

Stohr has delivered 40 Sports Racers so far, of which 33 were in DSR configuration. One feature that lends a modern feel to the Stohr's operation

is a steering column-mounted paddle shifter that lets the driver change gears with both hands on the steering wheel. The shifter connects to the motorcycle transmission's shifter shaft via cables.

www.stohr.com



Speads RS-04A

Price:	\$35,000 rolling (\$19,000)
Length:	157in (3988mm)
Width:	64in (1626mm)
Height:	37in (940mm)
Weight:	812lb (368kg)

Speads is an anagram for the designer, John Sapsed's, last name. US importer Bob Schader found Sapsed selling motorcycle-powered formula cars in the UK, and convinced him to develop a Sports Racer derivative to target the US DSR market. The result is a car that scored a second place in its first appearance at the SCCA Runoffs, and which was on the pace of the winning Stohr for the entire week.

Such an impressive debut attracted significant attention, along with eight orders for cars at the time of writing. Like Stohr, the Speads' bodywork was obviously influenced by the Le Mans-winning Audis and, as with the Stohr,

copying the Audis' lines has produced a slick, low-drag package. That, combined with an engine producing nearly 200bhp (according to Schader) produced a car with visibly higher straightline speed at the SCCA Runoffs.

But Schader also points to sound fundamentals in the design. Offsetting the engine to the right serves the dual purpose of moving weight to the inside for the majority of corners at clockwise circuits, and permitting the Quaife limited slip differential to be mounted in the centre of the car, with equal length halfshafts.

Further, the Speads enjoys good mechanical grip in the corners, according to Schader. 'John Sapsed is a very talented designer, he is able to achieve cars with amazing mechanical grip,' he said. 'Right off the boat, they are easy to drive and confidence inspiring as they give the driver tons of feedback. If the back end starts to move out, it moves out gradually and it telegraphs that information to the driver.'

In most respects, the Speads is quite conventional, with pushrod suspension acting on bell cranks to inboard dampers and springs. The front pushrods do stand at a steeper angle than is typical, contributing to the nearly 1:1 motion ratios for the dampers.

The tube frame starts narrow at the front, widens all the way back to the roll hoop bulkhead behind the driver, and then tapers again at the rear. 'It is a tube frame that is fairly triangulated throughout,' said Schader. 'The frame would be a little different in the top rail's trapezoidal shape.'

The Speads is one of the lighter DSRs available, with a claimed minimum weight, without driver, of 802lbs. That weight is not typical though, warns Schader. 'That includes cutting bolts down. Plus it had titanium bits and was a hugely expensive car.'

■ www.racingconceptsllc.com



The Speads RS-04A DSR shows clear Audi Le Mans influences in its styling. However, thoughtful engineering and an offset engine design helps generate massive mechanical grip

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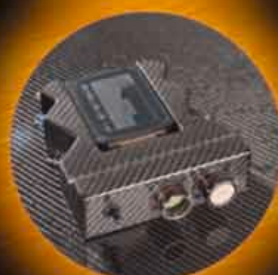
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traxStar tX-1

Price:	\$42,000 rolling (£23,000)
Length:	115in (2921mm)
Width:	60in (1524mm)
Height:	36in (914mm)
Weight:	750lbs (340kg)

Perhaps the most radical DSR proposed for series production is the Canadian traxStar tX-1. The car mounts its motorcycle powerplant alongside the driver for a lower polar moment of inertia. Designer and company founder Peter Derviller says he originally had the idea for the car upon the introduction of Honda's 1987 CBR1000 motorcycle, which produced then unthinkable amounts of power in a compact package.

'I had been a voice in the wilderness, saying these engines are great and they would make a super racecar powerplant. That was regarded as a strange idea until along came Radical.

'They sound great, they go great and if you don't tune them up too much they go forever. You can probably run it for a couple of seasons before it needs freshening. For the grassroots racer it is the ideal solution. It is lightweight, easy on tyres, easy to transport and easy to store — all in an affordable package.'

Derviller got his first prototype on track in 1990, followed by an improved version in 1994. Since then, he has worked to build the latest version, which arrived in 2002. 'From our point of view the hardest part wasn't designing the car, it was gathering the financial resources to build a platform that would show what the innovative parts could do. That's why it took us three cars to get to that stage. We feel like we've finally arrived at the point that we've proved the unique features of the car are a competitive advantage.'

Putting the engine beside the driver centralises the car's mass and makes it easier to make the car smaller, according to Derviller. 'That really gathers the mass of the car between the wheels. It makes it a very responsive platform, which really shows up on courses where you have tight, slow corners.'



The traxStar DSR carries its motorcycle powerplant beside the driver, offsetting the cockpit to the right side of the car

An additional benefit, however, was that moving the engine out from behind the cockpit leaves more space for the driver. 'We wanted to create a small car but one that had a full-length cockpit for a normal, American-size driver,' Derviller said. 'You can't recline somebody in a short wheelbase car without putting their legs ahead of the front wheels, which the rules won't let you do.' An adjustable pedal box helps drivers of different heights fit into the car.

Another benefit of moving the engine and transmission alongside the driver is that the suspension is left by itself at the rear of the car. 'It leaves the back of the car quite accessible, so you can get to the suspension. That was sort of a bonus that we found we had when we put the car together.'

The company has delivered two cars so far, and offers complete rolling chassis for \$42,000. Customers can install whichever motorcycle

engine they prefer, a flexibility provided by the engine's location, because there is plenty of space beside the driver.

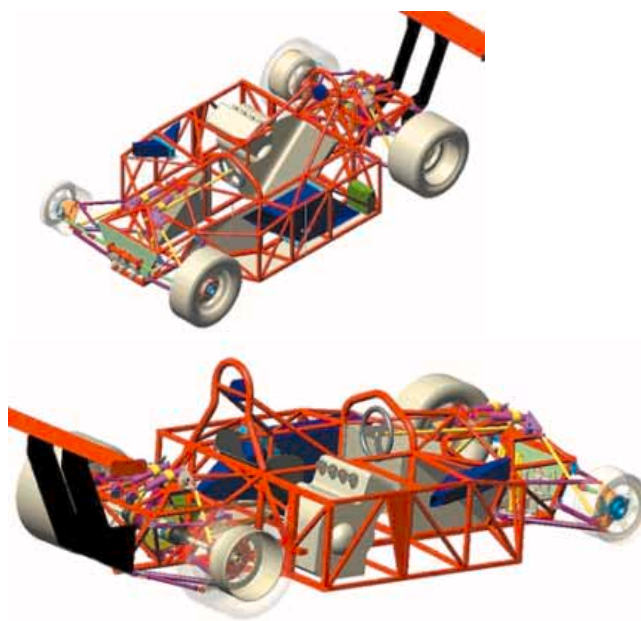
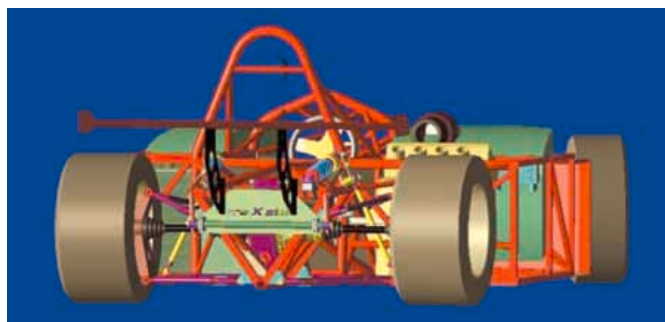
In a bid for parts affordability, the traxStar uses off-the-shelf TDC uprights, shared with older DSRs such as the Omnifab Cheetah and the Amac. 'We picked them because they are tried and true and they were available off the shelf,' Derviller said. 'They are the same left to right, they use Volkswagen Rabbit/Golf internals, they are adaptable to AP or Wilwood brakes and they work with radius rod and double wishbone type suspensions.'

Like Stohr, the traxStar car can run without anti-roll bars. 'At our last event we discarded the rear anti-roll bar and that worked out very well. As our spring rates increase, the need for anti-roll bars diminishes.'

www.traxstar.biz



CAD images of the traxStar design show the engine mounted alongside the driver in order to give a lower polar moment of inertia and more space in the cockpit



Maloy Racing DSR

Price:	\$44,500 rolling (£24000)
Length:	148.7in (3777mm)
Width:	67in (1702mm)
Height:	41.5in (1054mm)
Weight:	not available

While the designers of other D Sports Racers hope to convince potential customers that they have the know-how to design a successful racecar, the Maloy DSR designer has already established his credentials. Alan Mertens penned a DSR that follows convention in most areas.

The Maloy DSR's chassis looks much like an adapted formula car design, like the Stohr, but with some differences. The Maloy hangs the engine from mounts in the frame rather than using it as a stressed member, as the Stohr does. The car also uses traditional T-style anti-roll bars that may be set up for cockpit adjustability, according to general manager Don McCandless.

Durability and ease of repairs were kept in mind, so the engine sits where its oil pan doesn't hang down below the frame rails where it is susceptible to damage. 'If you run over a rumble strip it doesn't hole the oil pan,' he said.

The front floor has a replaceable splitter, simplifying repairs from off-course excursions, and the floor on newer cars has been narrowed in the rear so the car can accept wider rear tyres. The Maloy uses the same upright design at each corner, reducing the spares inventory dealers and teams need to stock. Those uprights use shims to adjust camber and have enough range of



Maloy frames are powder coated in bright yellow to aid crack detection after races and when repairing crash damage

adjustment to accommodate the high negative camber settings required by radial tyres, 'for those teams that want to run radials,' according to McCandless.

The downside of the car's durable design is that it is said to be heavier than its competitors. McCandless declined to cite a specific weight for the car, but pointed out that it is getting lighter. For example, switching from a balsa-core floor to a carbon fibre nomex honeycomb core floor saved 26lbs. Another 60lbs was cut from the bodywork with a switch from glass fibre to carbon fibre. Total reductions have been about 100lbs we were told.

The company has built six cars so far,

with a list price of \$44,500 as a roller, with Ohlins shocks and carbon fibre bodywork. 'With similar equipment, the Stohr is \$60,000,' McCandless claimed. To help spark interest in the car, which scored a third place finish at the 2004 SCCA Runoffs, Maloy is offering cars with stock Yamaha R1 engines installed for just \$45,000.

'The challenge for me is to do whatever it takes to get some cars on track,' he said. 'If you get behind the wheel, it is amazing how easy and fun it is to drive.'

www.maloyracing.com

RE



A Maloy DSR on the pre-grid at Mid-Ohio in the USA. Despite being a heavy design, the option of buying a complete car with a Yamaha R1 engine already fitted makes them a good proposition

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Aerobytes: Simon McBeath
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A question of balance

Once the domain of string and weights, chassis set-up is now a scientific art. We look at what's available to professional and clubman racers alike

Words

Ian Wagstaff

Martin Short of Rollcentre (which, along with Demon Tweaks, is responsible for the sale of Intercomp products in the UK) recalls how as a clubman racer in the late 1980s he was looking for ways to improve the performance of his car. He undertook an 'exploratory mission' to the PRI show in the days 'before people had discovered it.' The result was to be introduced to 'a bunch of companies, the most pivotal being Intercomp.'

In his search for that competitive edge, Short – who has gone on to become a serious LMES contender – had come across corner scales. Most people setting up their own chassis in those days used bars and string, a few may even have even brought into the equation a set of bathroom scales, but to Short this was something extra. And it was a product that 'people could not make themselves.'



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Good results can be achieved with affordable technology like these optical alignment gauges



Longacre Professional models offer auto levelling, noting the importance of consistency

Short also points out that, due to the specialist nature of the product, it is most likely to be manufactured in a country where racetracks, and therefore potential customers, abound. This would account for the predominance of US suppliers Intercomp and Longacre in this category.

Intercomp Company has been described as the world's largest manufacturer of portable weighing solutions, so its racecar products are just part of a portfolio that even includes aircraft scales. ISO 9001 accredited, the company has registered facilities in both the USA and UK. It supplies the official technical scales for a wide variety of sanctioning bodies and every NASCAR Nextel Cup, Busch Series and Craftsman Truck Series team is inspected at the track with the Intercomp scale system.

In May 2004 Intercomp moved to a new corporate headquarters and hi-tech facility in Minneapolis, while Longacre has just opened a new 51,000sq.ft manufacturing plant, close to the Evergreen Speedway in Monroe, Washington, USA — a convenient location for the testing of new products.

Precise weight distribution can have a major effect on a racecar's handling. Chris Turner, sales and marketing manager of Demon Tweaks points out that investment in set-up equipment can outweigh that put into a search for more power. Proper chassis set-up requires the weight balance be set correctly for the car, driver and track conditions — something that can only be achieved with a set of electronic scales.

A car should be race ready before the final scaling procedure is undertaken, and that means the castor should be adjusted, camber set, the rear end square and the toe checked. The fluid levels need to be topped off, tyre pressures set and ride heights adjusted. Whether the driver is in place is up to you, but driver weights vary so having them in the cockpit ensures the most repeatable results.

Intercomp offers a range of computer scales said to suit everyone from top professional teams to the clubman racer. At the top end is the Professional model. Like all offerings in the range this features 15 x 15 x 2in smooth, flat scale pads with a 1500lb capacity per pad. Other common features include half-inch display figures, a two-year warranty, 9v battery operation (most

scales are designed to work on a fully-charged battery, it being recommended to use this method to ensure a consistent supply of power) and certification to 0.1 per cent accuracy. The Professional model is almost twice the price of the entry level E-Z Weigh but has a 100 chassis set-up memory, centre of gravity calculator and user-selectable display modes. Other features it shares with the middle-of-the-range Quick Weigh are baseline set-up recall, printer and PC output and the ability to read any combination of left/right and front/rear weight and percentage display, including cross weight.

The Professional is what the name suggests, while the Quick Weigh, which has a 16 chassis set-up recall and is intended for the clubman racer

while the E-Z Weigh is said to be an introduction to the use of scale systems. Intercomp also introduced a Special Edition Scale Set to celebrate 25 years of business. Based on the Professional, it features specially engraved billet aluminium pads, a car cover and racecar management software. A scale cart — an aluminium trolley

that carries all four pads, cables and controller and has space for turn plates and other equipment is also included in the Intercomp line-up.

Longacre likewise offers a full range of computer scales starting with a Professional model with four corner weights that read left or right weight and percentage, front or rear weight and percentage, diagonal and total weight. An auto level electronically compensates for level differences between the workshop and the racetrack by holding baseline settings for recall.

Consistency is all-important when scaling and most workshop floors vary in height. If you are using a more basic set of scales it may be necessary to use shims to ensure that all four scale pads are level. Alternatively, use can be made of levelling trays. It is important to remember that scale pads also need to be maintained within the same plane. Raising one corner or opposing corners will affect the readings.

Longacre recommends a short cut to finding level ground when you get to the track paddock — a matter of four team members and two pieces of string. The person at the right front holds one end of the string, his opposite number at the left rear the other and vice versa for the other length, thus making a cross in the centre. Whether the top string is higher than the →

“INVESTMENT IN SET-UP EQUIPMENT CAN OUTWEIGH THAT PUT INTO A SEARCH FOR MORE POWER”



Longacre supplies all the hardware to store and transport its corner scales



Intercomp Professional series claims accuracy to 0.1 per cent and can store 100 pre-sets

bottom or whether it holds it down will indicate which pads need to be shimmed up. Using this process helps to ensure the weighing pads are placed in the same plane.

A Semi-Professional model is also available from Longacre but without centre of gravity, goal weight and customisable display. Further down its price range are Matrix Scales, with extra large corner weight displays, the Accuset model and the bottom of the range Intro model. Both Longacre and Intercomp also offer scales for karts.

The Longacre range of set-up equipment additionally includes scale set-up platforms, scale pad and roll off levellers, castor/camber and camber gauges and a chassis height checker. Interestingly, the company points out how the use of roll off-type trays is arbitrary, citing the fact that, in NASCAR, they have been used by such as Rusty Wallace and Dale Jarrett but not by Jeff Gordon or the late Dale Earnhardt. Likewise, Intercomp also has a variety of associated product including scale

It's no secret now that time spent on racecar set-up is as valuable as time spent in any other area of engineering. As well as accurate weight distribution, setting toe, camber and castor is vital to success on the track

ramps, levellers, corner weight scales, turn plates, laser pad levelling system and a variety of gauges in its line-up.

A third company offering equipment for chassis set-up is Dunlop. Both laser and optical alignment gauges are included in their product range, the latter said to require no special skills to operate. Also from Dunlop is a steering turntable with ramps — a useful piece of kit when measuring castor angles, kingpin inclination, toe-out on turns, and wheel lock and full lock angles. In addition the company offers a castor, camber and kingpin device — two instruments housed on one storage box — as well as a separate camber gauge.

Alignment

Toe settings have a major impact on directional stability, while castor angles improve straight-line stability. It is important to ensure that the castor is the same on both sides of the car to avoid the tendency to pull to one side. The correct camber can ensure that the tyres are working to maximum efficiency, although tuning camber angles has been described as a black art. Understanding of all three is obviously critical for the successful team.

ART (Advanced Racing Technologies) claims to be a world leader in totally portable laser and electronic alignment equipment. Its Triple Laser String II is claimed to be the only 3D portable wheel alignment and chassis inspection system available, and the only gauge to use the vehicle centre-line as reference. The entire battery-powered system weighs less than 23kg. Also available from the company is a laser toe/tracking gauge, laser and granite corner weight scale pad levelling system and various gauges, as well as laser toe plates and laser string, originally developed for CART technical inspection. Longacre's Jeff Butcher describes laser equipment as a 'nice luxury,' the alternative being to attach reference string between two simple jack stands.

Staatsburg, New York-based ART, which this year celebrated its tenth anniversary, supplies product for use by the CART technical inspection

team, as well as the majority of NASCAR teams.

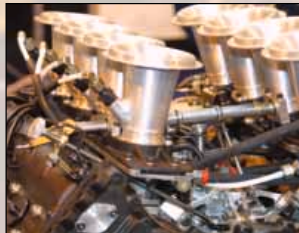
Other brands operating in this sector include: Precision Point (digital camber gauge, wheel alignment gauge and castor/camber gauge frame); Trak-Rite (alignment gauge); Smart (ride height gauge, castor/camber gauge, camber frame and castor/camber gauge frame); and ADA (castor/camber gauge and corner weight gauges).

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Webcon UK now has available turnkey quad-carburettor package for most popular American V8 engines, including Buick, Chevrolet, Dodge, Ford and Pontiac. Utilising a choice of Weber IDA, IDF or DCOE carburettors. Each kit comes fully assembled with carburettors, manifold, linkage and fuel rail, and is calibrated to match specific engine requirements.

Webcon claims a typical power increase over a single four barrel set-up to be in the



region of 60bhp.

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Safer re-fuelling

In response to demands for safer re-fuelling practices, UK-based Stäubli Motorsport has introduced a new, FIA-approved pit stop refuelling connector.

The SAF 45 is a single, coaxial, dry-break coupling that removes the need for separate filling and venting points. It requires only one operator to safely perform re-fuelling and, according to Stäubli, the five integrated security pins mean the mechanism is failsafe as

fuel will not flow unless the coupling is correctly engaged. Likewise, flow is stopped immediately if operator pressure is reduced.

Nozzles come with a polyurethane sleeve to withstand shocks and the system is designed for all gravity-feed fuel applications.

For more information call **+44 (0) 1952 292148**, email **connectors.uk@staubli.com**, or visit **www.staubli.com**



Pocket-sized pump

UK-based liquids handling specialists, Pump Engineering, has developed a new, pocket-sized, air-operated pump.

The Pageboy SFD15 self-priming diaphragm pump is ideally suited to use with aggressive or corrosive liquids such as solvents, strong acids and alkalis as the diaphragm is made from PTFE, with seals to suit individual applications. It comes in a choice of body materials including polypropylene, PTFE, stainless

steel and aluminium and has a maximum output of 3ltr/min with a maximum pressure of 6bar. As standard, the air supply required is 80-100psi and air consumption is approximately 0.5cfm, although a special version can be supplied for even lower air pressures.

The pump has only three moving parts, with a stress-free diaphragm that affords reliability and longer life by using a unique venturi system to create a vacuum behind the diaphragm that returns it on the discharge stroke.

The SFD15 is designed for vertical upward flow and comes with extended tie rod mounts.

For more information call **+44 (0) 1903 730900**, email **sales@pumpeng.co.uk**, or visit **www.pumpeng.co.uk**



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Compact doubles The stud(s)



UK-based Switchtec is offering a new twin-relay aimed at the automotive industry.

By incorporating two completely separate relays in one compact package, the Hongfa HFKA doubles up on functionality, while only

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The PCB relay has two sets of contacts, each able to switch currents up to 30A with a 25A motor load rating, yet measures just 15.4 x 14mm with a height of 13.5mm. The relay weighs 8g, is sealed to IP67 and is designed especially for use in automotive applications, having a functional shock resistance rating of 100m/s² and a destructive figure of 1000 m/s². Its resistance is 100Mohms and it has a maximum operation time of 10mS within a wide range of operating temperatures.

For more information call **+44 (0)1785 818600**, email switchtec@btinternet.com, or visit www.switchtec.co.uk

Now available in the UK through Co-ordSport is Automotive Racing Products' (ARP) range of bolts and fixings for Vauxhall 2.0-litre 16v XE-type engines.

The 8740 chrome moly steel main studs are heat treated to 200,000psi tensile strength and come with precision J rolled threads that are added after heat treating for maximum strength. Its range of conrod bolts are also manufactured from heat treated 8740 chrome moly steel and are available with a tensile strength of either 200,000 or 220,000psi.

For more information on UK availability contact Co-ordSport on **01384 216102** or contact



ARP direct in California on **+1 805 339 2200** or, for a full list of applications, try www.arp-bolts.com

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Heat preservation



Tyre Technology, has developed a means to insulate the heat in tyres, during quiet periods of a race meeting. The high frequency electromagnetic energy device is built into a racing car and creates a heat shield on the surface of the tyre, which stops heat from escaping.

According to the UK-based company the shield will retain approximately 90 per cent of the heat within a tyre whenever it is activated by the driver.

Developed in conjunction with Lancaster University, the Black

Frequency on-board tyre temperature management system is designed for formation laps, times behind the safety car or in very cold or wet conditions. On one side the device comprises a black carbon element with a pure gold reflector on the other. This is all encased in a strong quartz, and one is placed on each tyre.

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Low-heat light

Compressed air pneumatics and process control specialist, Thorite, has introduced two new LED inspection lamps under the COOLITE brand. The lamps' LCD elements generate little heat, enabling them to be safe in garages, workshops and factories. The 12volt model features 30 high intensity LED bulbs and is supplied with three metres of cable, cigarette-lighter plug and crocodile clip, whereas the 230V mains adaptor version has 60 bulbs and eight metres of cable. UK-based Thorite claims that both models are

shatterproof, water and oil resistant, with a long bulb life. The lights can be ordered online or from any of the company's regional sales and service centres. For more information call **+44 (0)1274 663471**, email **group@thorite.co.uk**, or visit **www.thorite.co.uk**.



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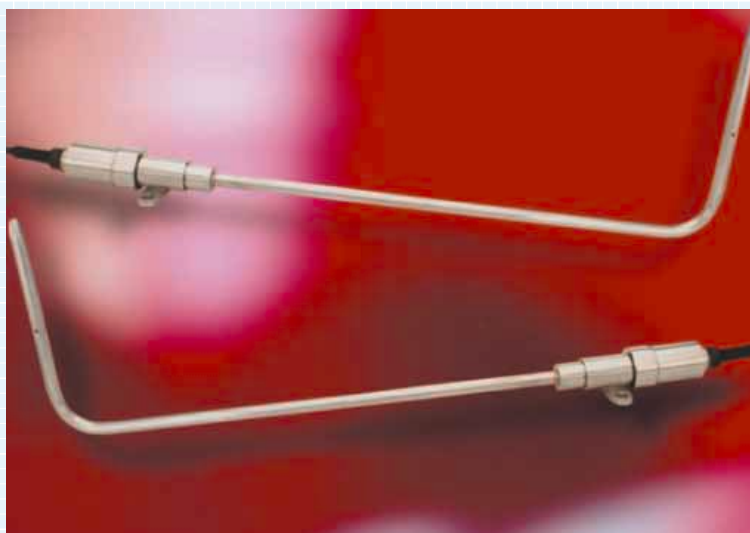


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UK-based Kulite Sensors has launched a pitot-probe assembly for modern racecar applications. The ET-10DC-312M provides an output for differential pressure applied via the pitot tube. An integral differential pressure transducer monitors the total and static pressures, calculating an output that can be used in computations to indicate airspeed. The product integrates the transducer directly with the pitot tube and removes the requirement for any additional piping to be used to connect the pitot tube to a remote transducer. The



assembly features an operating temperature range of -40 to 120degC, an insulation resistance of over 100MOhms at 50VDC, and a full-scale output of 4.5VDC. The rated

electrical excitation is 8 to 16VDC.

For more information call **+44 (0)1256 461646**, email **brianw@kulite.co.uk**, or visit **www.kulite.co.uk**

New products or services to tell us about?

We want to hear from you if your company is launching any new products suitable for the motorsport market at all levels.

Tell us about your new devices from connectors and pumps to engines and gearboxes. Just send in a press release, with an accompanying image and it could be featured within this Racegear section.

Send your product news to: **Racecar Engineering, Focus Network, Leon House, 233 High Street, Croydon, Surrey CR9 1HZ, UK** or email it to **racecar@ipcmedia.com**

Demon catalogue

UK-based Demon Tweaks Direct, provider of equipment and accessories for motorsport competitors, has published its new 2005 professional motorsport equipment catalogue.

The 404-page, full colour, mail order catalogue lists a huge range of products

available including, for 2005, two completely new product lines from Alpinestars and Sabelt.

Over 29 manufacturers' products are displayed within the catalogue including SIP (power tools), Impact Racing (US helmets), EZ-UP (portable shelters), VDO (gauges), SFS

(silicon hose) and Chicago Pacific (air tools). All products are available directly from the showroom in Wrexham, north Wales, by mail order or on line at **www.demon-tweaks.co.uk**.

For more information call **+44 (0) 1978 664466**, or email **enquiries@demon-tweaks.co.uk**



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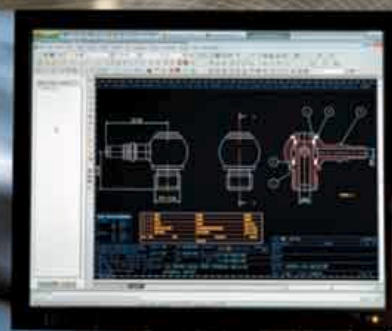
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Xtrac's family of gearboxes share the same architecture but with different torque capacities. The 407 touring car box offers torque handling of 300Nm

Value judgement

If you thought Xtrac's transmissions were out of your budget then the company's new range of in-line touring car and sportscar gearboxes are worth a close look

Words Charles Armstrong-Wilson

Over the last couple of decades, Xtrac has built an enviable reputation for the quality of its racing transmissions. During that time the company's components have been used by every Formula 1 team on the grid but consequently its products are widely regarded as the 'cost no object' option in racing. However, those with limited budget have tended to regard Xtrac transmissions as not cost effective. While durability and reliability that ensure low running costs and an absence of failures would be attractive qualities for a less well financed

car and sportscar applications.

All three six-speed transmissions use non-stressed L169 aluminium casings sealed with O-rings. The touring car casing comprises three parts. One houses the drop gears and joins to the customer's bell housing, another contains the gear selection system and gear box mounts while the rear casing houses the gear cluster and oil pump. The sportscar version has an additional intermediate casing creating more space for the larger cluster.

By designing the units with so many common components, Xtrac has been able to increase the size of manufacturing batches, thereby reducing unit costs of components. This strategy has produced savings that the company has passed on to its customers in the form of lower prices. Now many customers, who would otherwise have been unable to consider Xtrac, can reasonably consider incorporating the company's products into their budgets.

The touring car box, designated 407, weighs in at 31.5kg (69.4lb) and the gears come from Xtrac's standard 100 range with 12-12.5mm (0.47"-0.49") wide gears offering torque handling of 300Nm (221lb ft). Meanwhile the sportscar gearbox comes in two forms. The 427 uses Xtrac's 195 range of gears which at 17.5mm (0.69") wide handles 550Nm (406lb ft) of torque. The meatier 437 runs Xtrac's 126 range of gears which at 20.5mm (0.80") wide handle 800Nm (590lb ft) of torque. These units weigh 38.5kg (84.9lb) and 44.5kg (98.1lb) respectively.

Xtrac hopes these new transmissions, with their robust design and high standard of manufacture, will make the qualities associated with company's products available to a broader range of customers bringing both reliability and competitiveness.

RE

“THE GEARBOXES BRING XTRAC QUALITY AT A MORE MANAGEABLE PRICE”

team, the initial outlay on the box and selection of ratios has been perceived as prohibitive.

Now the company has addressed this with a range of in-line, sequential gearboxes that bring Xtrac quality at a more manageable price. Using its transverse touring car gearbox as a basis, the company has utilised this cluster design to produce a family of gearboxes that share the same architecture but with different torque capacities for touring

The 427 sportscar unit uses a range of gears which at 17.5mm wide is able to handle 550Nm of torque



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Web: www.sbdev.co.uk E-mail: sbdevmotorsport@btclick.com

Database

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Sections 7-8-9-10 list companies that supply services. Section 7 is devoted to Chassis Engineering Services, Section 8 to Engine / Transmission / Suspension Services. Section 9 to Testing Services. Section 10 to Non-Engineering Services

To get your company listed in the racecar database please contact Andy King - 0208 726 8329
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Costs listed below:

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1.1

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ICP/CITATION	USA (1) 413 267 0904 Small Fortune Racing, Monson, MA 01057, USA France (33) 1 47 49 15 66 1 Rue Pierre Cassin, 92500 Rueil Malmaison, Paris, France Tel 01353 861168 Fax 01353 861877 SHP Motorsport, Unit 7 Farraday Business Park, Littleport, Ely, Cambridgeshire CB6 1SE, England Australia (61) 396 822225 (61) 396 821199 (61) 396 900809 Email mrproot@tpg.com.au King Way House, 188-190 Kings Way, South Melbourne, Victoria 3205 Aus. USA (1) 317 872 3664 Fax (1) 317 872 3835
JADE	USA (1) 413 267 0904 Small Fortune Racing, Monson, MA 01057, USA France (33) 1 47 49 15 66 1 Rue Pierre Cassin, 92500 Rueil Malmaison, Paris, France Tel 01353 861168 Fax 01353 861877 SHP Motorsport, Unit 7 Farraday Business Park, Littleport, Ely, Cambridgeshire CB6 1SE, England Australia (61) 396 822225 (61) 396 821199 (61) 396 900809 Email mrproot@tpg.com.au King Way House, 188-190 Kings Way, South Melbourne, Victoria 3205 Aus. USA (1) 317 872 3664 Fax (1) 317 872 3835
JEDI	USA (1) 413 267 0904 Small Fortune Racing, Monson, MA 01057, USA France (33) 1 47 49 15 66 1 Rue Pierre Cassin, 92500 Rueil Malmaison, Paris, France Tel 01353 861168 Fax 01353 861877 SHP Motorsport, Unit 7 Farraday Business Park, Littleport, Ely, Cambridgeshire CB6 1SE, England Australia (61) 396 822225 (61) 396 821199 (61) 396 900809 Email mrproot@tpg.com.au King Way House, 188-190 Kings Way, South Melbourne, Victoria 3205 Aus. USA (1) 317 872 3664 Fax (1) 317 872 3835
KBS	USA (1) 413 267 0904 Small Fortune Racing, Monson, MA 01057, USA France (33) 1 47 49 15 66 1 Rue Pierre Cassin, 92500 Rueil Malmaison, Paris, France Tel 01353 861168 Fax 01353 861877 SHP Motorsport, Unit 7 Farraday Business Park, Littleport, Ely, Cambridgeshire CB6 1SE, England Australia (61) 396 822225 (61) 396 821199 (61) 396 900809 Email mrproot@tpg.com.au King Way House, 188-190 Kings Way, South Melbourne, Victoria 3205 Aus. USA (1) 317 872 3664 Fax (1) 317 872 3835
KUDZU	USA (1) 413 267 0904 Small Fortune Racing, Monson, MA 01057, USA France (33) 1 47 49 15 66 1 Rue Pierre Cassin, 92500 Rueil Malmaison, Paris, France Tel 01353 861168 Fax 01353 861877 SHP Motorsport, Unit 7 Farraday Business Park, Littleport, Ely, Cambridgeshire CB6 1SE, England Australia (61) 396 822225 (61) 396 821199 (61) 396 900809 Email mrproot@tpg.com.au King Way House, 188-190 Kings Way, South Melbourne, Victoria 3205 Aus. USA (1) 317 872 3664 Fax (1) 317 872 3835
LAZER	USA (1) 413 267 0904 Small Fortune Racing, Monson, MA 01057, USA France (33) 1 47 49 15 66 1 Rue Pierre Cassin, 92500 Rueil Malmaison, Paris, France Tel 01353 861168 Fax 01353 861877 SHP Motorsport, Unit 7 Farraday Business Park, Littleport, Ely, Cambridgeshire CB6 1SE, England Australia (61)

Database 2

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Lola Cars Inc, Suite B, 2801 Fortune Circle East,

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01524 844066

ROAD & STAGE M/SPORT France (33) 1 60 01 03 67

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ACTIVE ENG USA 001 714 637 1155

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EARS MOTORSPORTS 01625 433773

KS MOTORSPORT Germany (49) 2271 44905

OMP USA (i) 973 361 0508

MOMO USA 001 714 637 1155

LUKE 01323 844791

Total Restraint Systems 01722 326080

TRV SABELT 020 7736 2881

WILLANS 01264 810712

RUBBER & ELASTOMER COMPONENTS

BUTSER RUBBER LTD Tel: 01730 894034

2.2 Electrical Systems



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Fax 01606 737683

ALTERNATORS

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BRISE AUTO ELECTRICS Germany (49) 711 8111 USA (i) 312 865 5200

MM COMPETITION 01322 277622

TAG ELECTRONIC 08707 444666

01483 719643

CABLES

IS MOTORSPORT USA (i) 317 244 6643

PERFORMANCE WIRING SOLUTIONS +44 (0)1954 253620

SPEEDY CABLES 020 7226 9228

SPOT ON CONTROL 018 979 0682

TAG ELECTRONIC 01483 719643

TRIDENT RACING 01327 857822

CONTINENTAL USA (i) 513 459 8803

CONNECTORS

BERU FI SYSTEMS 01374 646200

DEUTSCH 01424 852721

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MAGNETI MARELLI Italy (39) 02 972 27570

MM COMPETITION 08707 444666

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SAKATA MOTORSPORT ELEC. INC. (714) 446 9473

SERVO & ELECTRONIC SALES LTD 01797 322500

SPECIALITY FASTENERS 01803 866877

RAYCHEM 01793 572217

TAG ELECTRONIC 01483 719643

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MM COMPETITION 08707 444666

PALLAS CONNECTIONS 01869 270553

PAD RACING NZ (64) 3 3386 2888

TAG ELECTRONIC 01483 719643

IGNITION SYSTEMS

BOSCH UK 01895 834466

SBD MOTORSPORT Germany (49) 711 8111 USA (i) 312 865 5200

EFI TECH 0208 391 0121

HELLA UK USA (i) 310 793 2505

LUMINATION 020 7403 4334

MAGNETI MARELLI Italy (39) 02 972 27570

MM COMPETITION 08707 444666

MOTEC UK 08700 109100

MOTEC (EUROPE) UK 08700 109100

MOTEC JAPAN Japan (81) 489 46 1734

MOTEC SYSTEMS USA USA (i) 714 897 6804

MSD IGNITION USA (i) 915 857 5200

PI RESEARCH 01954 253600

PIAA (UK) 01934 814812

STACK 01869 240404

TAG ELECTRONIC 01483 719643

THE STRAIN GAUGING CO 01256 320666

LIGHTS

HELLA 01295 272233

PRODRIVE 01295 254400

LOAD CELLS

NOVATECH MEASUREMENTS 01424 852 744

SPARKPLUGS

BERU 01295 272233

BOSCH Germany (49) 711 8111

CHAMPION AUTO UK 01895 834466 USA (i) 312 865 5200

KS MOTORSPORTS 0151 522 3000

MAGNETI MARELLI Germany (49) 2271 44905

MM COMPETITION Italy (39) 02 972 27570

NGK 08707 444666

Japan (81) 52 872 5937 UK 0208 202 2151

SPARKPLUG LEADS

MAGNETI MARELLI Italy (39) 02 972 27570

MM COMPETITION UK 08707 444666

TAG ELECTRONIC 01483 719643

WIRING HARNESSSES

A.N. MOTORSPORT DESIGN 01628 776320

COMPETITION DATA SYS USA (i) 716 631 2880

DC ELECTRONICS 01621 856451

SBD MOTORSPORT 0208 391 0121

EFI TECH USA (i) 310 793 2505

BERU FI SYSTEMS 01374 646200

MAGNETI MARELLI Italy (39) 02 972 27570

MM COMPETITION 08707 444666

MOTEC Australia (61) 3 9761 5050

MOTEC (EUROPE) UK 08700 109100

MOTEC JAPAN Japan (81) 489 46 1734

MOTEC SYSTEMS USA USA (i) 714 897 6804

PALLAS CONNECTIONS 01869 270553

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RAYCHEM 01793 572217



SAKATA MOTORSPORT ELEC. INC. Tel (714) 446 9473

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2.3 Controls

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SBD MOTORSPORT 0208 391 0121

HEWLAND ENG 01628 827600

JACK KNIGHT 01483 764326

PRODRIVE 01295 273355

QUAIFE ENGINEERING 01732 741144

RICARDO MIDLANDS TECHNICAL CENTRE 01926 319399

RINGS PAN (UK) 01234 342511

THE STRAIN GAUGING CO 01256 320666

STONE FOUNDRIES 020 8853 4648

HYDRAULIC VALVES

A.N. MOTORSPORT DESIGN 01628 776320

LEE PRODUCTS 01753 886664

MOOG CONTROLS 01684 296600

INSTRUMENTATION

ACTIVE SENSORS 01202 480620

CRANFIELD IMPACT CENTRE 01234 759044

LMI STACK USA 001 714 637 1155

LUMINATION 020 7403 4334

MAGNETI MARELLI Italy (39) 02 972 27570

MM COMPETITION 08707 444666

MOTEC Australia (61) 3 9761 5050

MOTEC (EUROPE) UK 08700 109100

MOTEC JAPAN Japan (81) 489 46 1734

MOTEC SYSTEMS USA USA (i) 714 897 6804

PENNY & GILES 01202 409409

PI RESEARCH 01954 253600

QINETIQ 08700 100942

SPA DESIGN 01827 288328

STACK 01869 240404

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01327 311018
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01926 472 471
01604 583344
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Wolverton Mill, Milton Keynes MK12 6LB
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Fax 01606 737683
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2.7 Brake Components

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BT BRAKE TECHNOLOGY

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Germany (49) 6003 82919
USA (i) 239 772 4261
01952 244321
USA (i) 803 222 2141
01280 843390

GKN SQUEEZEFORM
PERFORMANCE FRICTION

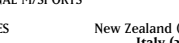
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08700 100942
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Italy (39) 039 587814
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QINETIQ
RACE BRAKES
TAR.OX
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DISCS
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AP RACING
ATE
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020 8654 8836
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CASTROL
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01793 512712
Malaysia (603) 245 2642
USA (i) 305 270 9433
USA (i) 973 305 3912
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CARBONE INDUSTRIE

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01274 854000
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USA (i) 803 222 2141
01280 843390
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USA (i) 805 388 1188

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AP RACING
TILTON
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KINESIS MOTORSPORT
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SPARCO

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TOYO
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Canada (i) 416 684 7418
01782 403284
France (33) 73 90 77 341
01933 411144
01582 633339
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BP
BURMAH
PETROCHEM CARLESS
CASTROL
CASTROL
CENTURY

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01793 51521
01372 380532
01793 512712
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01782 202521

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UK 0208 902 8820
01372 222000
01484 713201
08700 100942
01476 861995
Spain (34) 91 456 53 00
UK 0207 581 1933
UK 016 2881522
USA (i) 713 932 9954
USA (i) 305 771 1090
UK 01488 682655
USA (i) 919 480 0905
0207 719 3000
USA (i) 606 264 7222

Database 3 ENGINE & TRANSMISSION COMPONENTS

3.1 Engine Components

BEARINGS

BRITISH TIMKEN
CONNAUGHT
FASTENER FACTORY
RESB
QINETIQ
QUAIFE ENGINEERING
VANDERVELL
INTEGRAL POWERTRAIN
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0121 520 8271
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01732 353747
01888 538500
01908 278600
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KENT CAMS
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LUNATI
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01795 843802
USA (i) 619 422 1191
01689 857109
0208 391 0121
01449 677726
01885 400639
Australia (61) 3 9499 7433
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(33) 3207 46480
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01793 531321
01993 871000
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Germany (49) 21 91 9500
01793

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KINSLER USA (i) 810 362 1145
LINGENFELTER USA (i) 219 724 2552
SCHRICK Germany (49) 21 91 9500
SWINDON RACING ENGINES 01793 531321

LINEERS
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APPERLEY HONING 01242 525868
CROMARD 01902 451789
DITRON SLEEVES USA (i) 760 603 9895
GOITZE Germany (49) 217 4690
GKN SQUEEZEFORM 01952 244321
LAYSTALL ENG 01902 451789
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PISTONS
ACCRALITE PISTONS Tel 0121 525 6450
Fax 0121 553 5951
Accralite Piston Division, Spon Lane South,
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ARIAS FORGED PISTONS USA (i) 310 532 9737
BATTEN PERFORMANCE USA (i) 313 946 9850
CONNAUGHT 01795 84380
COSWORTH 01604 752444
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MALVERN RACING USA (i) 804 971 9668
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OMEGA PISTONS 0121 553 6788
PAD RACING New Zealand (64) 3 386 288
ROSS USA (i) 310 644 7779



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Email: sales@rosspiston.com
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WISECO PISTON USA (i) 216 951 6600
Canada 800 265 1029

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CORDS PISTON RING 0208 998 9923
FORD AUTO ENG USA (i) 805 2983785
GOITZE Germany (49) 221 217 4690
HI-TECH USA (i) 801 972 8766
TOTAL SEAL USA (i) 602 678 4977
TWR ENGINES 01993 871000

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Fax: (i) 661 295 5900
28128 West Livingston, Valencia CA 91355, USA
FERREA USA (i) 954 733 2505
GES VALVES LTD 01483 415444
QUINETO 08700 100942
MANLEY PERFORMANCE USA (i) 732 905 3366
RACING ENGINE VALVES USA (i) 954 732 6060
SCHRICK Germany (49) 21 91 9500
SUPERTECH PERFORMANCE USA (i) 408 448 2001
SWINDON RACING ENGINES 01793 531321
VALVE TECHNIC USA (i) 604 706541
XCELDTNE ENGINEERING USA (i) 336 472 8281

VALVE SEATS

ARROW PRECISION ENGINEERING LTD
Tel +44 (0) 1455 234200
Fax +44 (0) 1455 233545
Tel (i) 805 499 8885
Fax (i) 805 499 7810
2640 Lavery Ct, Unit C, Newbury Park, CA 91320, USA
SERDI 01895 232215
SWINDON RACING ENGINES 01793 531321

VALVESPRINGS

CONNAUGHT 01795 843802
DIAMOND USA (i) 313 792 6620
EDLBRICK USA (i) 213 781 2222
HERBERT TERRY & SONS 01527 64261
KENT CAMS 01303 248666
KURT KAUFFMANN Germany (49) 711 518300
MANLEY PERFORMANCE USA (i) 732 905 3366
PERFORMANCE SPRINGS 01253 716900
SCHMITTHELM Germany (49) 62 217060

VALVE SPRING RETAINERS

GES VALVES LTD 01483 415444

VALVE GUIDES

ARROW PRECISION ENGINEERING LTD
Tel +44 (0) 1455 234200
Fax +44 (0) 1455 233545
USA (i) 714 220 2227
01895 232215

KAITEN PRODUCTS
SERDI 01895 232215

3.2 Engine Ancillaries

AIR FILTERS



INDUCTION TECH GROUP Tel 02476 305386
Fax 02476 307999
Unit B, Quinn Close, Seven Stars Industrial Estate,
Whitley, Coventry CV3 4LH

K&N ENGINEERING USA 800 858 3333
K&N FILTERS (EUROPE) UK 01925 616050
KINSLER USA (i) 248 362 1145
PIPERCROSS 01604 671100

CARBURETTORS
BG FUEL SYSTEMS USA (i) 706 864 8544
CARBURETOR SHOP USA (i) 909 481 5816
SOLEX France (33) 14 729 7171
WEBER Italy (39) 51 417995
WEBCON 01932 787100

EXHAUST SYSTEMS

ACTIVE ENGINEERING USA (i) 714 637 1155
BURNS STAINLESS USA (i) 949 631 5120



GDS EXHAUSTS Tel: 01280 702510
Fax: 01280 702525
Email: sales@gds-exhausts.co.uk
Website: www.gds-exhausts.co.uk
Unit 8C Boundary Road, Brackley NN13 7ES
FLOWMASTER USA (i) 616 463 4113
JETEX EXHAUSTS 01789 298989
MARK ORTIZ USA (i) 715 835 3292
PIPER CAMS 01233 500200
SPECIALISED EXHAUST 0208 648 4786

FUEL FILTERS

AN MOTORSPORT DESIGN 01628 776320
CONNAUGHT 01795 843802
EARL'S PERFORMANCE Fax 01327 858221
Fax 01327 858473
Unit 17 Silverstone Circuit, Towcester,
Northamptonshire NN12 8TL, England
ED PINK RACING ENGINES USA 818 785 6740
EXACT ENGINEERING USA 818 785 6740
FHS MOTOR RACING 01803 866464
FLUID CONTROL PRODUCTS INC USA (i) 217 324 3737
FRAM EUROPE 01443 223000
KINSLER USA (i) 248 362 1145
LEE PRODUCTS 01753 886664
SPV RACING Australia (61) 2 791 9899
THINK AUTOMOTIVE 0208 568 1172
TJ FILTERS 01752 667675
WEBCON 01932 287100

FUEL INJECTION

AC ROCHSTER USA (i) 716 359 6361
ASNU Tel 0208 420 4494
BGC MOTORSPORT 0208 880 4205
BOSCH 01895 834466
Germany (49) 711 8111
USA (i) 312 865 5200
CONNAUGHT 01795 843802
SBD MOTORSPORT 0208 391 0121
FLUID CONTROL PRODUCTS Tel (i) 314 291 7223
GENESIS ELECTRONIC SYSTEMS 01635 582255
INDUCTION TECHNOLOGY 02476 305386
JENVEY DYNAMICS 01746 768810
JOHN WILCOX COMPETITION 01455 230576



KINSLER FUEL INJECTION Tel: USA (i) 248 362 1145
Fax: USA (i) 248 362 1032
Email: kinsler@kinsler.com
Website: www.kinsler.com

LINGENFELTER USA (i) 219 724 2552
MAGNETI MARELLI Italy (39) 2 618 351
MM COMPETITION SYSTEMS 08707 444666
MARREN USA (i) 203 732 4505
MILLINGTON 01746 789288
MOTEC Australia (61) 2 9761 5050
MOTEC (EUROPE) UK 08700 109100
MOTEC JAPAN USA (i) 814 897 6804
NIPPON DENSO Japan (81) 56 625 5511
UK 0208 591 7700
+44 (0)1954 253610
PECTEL CONTROL SYSTEMS (714) 446 9473
SAKATA MOTORSPORT ELEC. INC. USA (i) 805 967 9478
TWM INDUCTION

FUEL LINES

AEROQUIP USA (i) 419 238 1190
AN MOTORSPORT DESIGN 01628 776320



ATL Tel: USA (i) 201 835 1400
Fax: USA (i) 201 835 1962
Aero Tec Laboratories Inc, Spear Road Industrial Park,
Ramsey, NJ 07446-1221, USA

ATL

**Aero Tec Laboratories Ltd (Europe), 1 Patriot Drive,
Rooksley, Milton Keynes, MK3 8PU**

BROWN AND MILLER
CONNAUGHT
EXACT ENGINEERING
FAE MACHINE
FLEXOLITE
FUEL SAFE
GOODRIDGE CA
GOODRIDGE INDY
GOODRIDGE EAST



GOODRIDGE UK Tel 01392 369090
Fax 01392 447180
Exeter Airport Business Park, Exeter, EX5 2UP
HENRY'S ENG USA (i) 410 535 3142
JLS MOTORSPORT Tel 0121 525 7733



KRONTEC MASCHINENBAU GmbH
Fitting & Hose Systems
Pommernstraße 33 93073 Neutraubling
Tel: 09401 5253-0
Fax: 09401 5253-10

KS MOTORSPORTS Germany (49) 2271 44905
PRONAL'S France (33) 320 99 75 10
SPECIALTY FASTNERS 01803 866371
SPV RACING Australia (61) 2 791 9899
THINK AUTOMOTIVE 0208 568 1172
FLEXOLITE 01684 891898
GOODRIDGE 01392 369090
PRONAL'S France 33 3 20 997510
RACETECH 01327 359912
WELDON RACING PUMPS USA (i) 216 232 2282



XRP INC Tel: USA (i) 562 861 4765
FAX USA (i) 562 861 5503
5630 Imperial Highway, South Gate, CA 90280, USA

FUEL VALVES

AN MOTORSPORT DESIGN 01628 776320
ATL USA (i) 201 825 1400
EXACT ENG USA 01908 351700
KINSLER 01803 866464
PRONAL'S USA (i) 248 362 1145
SPECIALTY FASTNERS France 33 3 20 997510
01803 866371

HOSES & HOSE-ENDS

AEROQUIP USA (i) 419 238 1190
AN MOTORSPORT DESIGN 01628 776320



BROWN AND MILLER

UK Tel: 01753 553610
Fax: 01753 577477
Unit 7-7A, Langley House, Middle Green Trading Estate,
Langley, SL3 6DF USA Tel: 704 793 4319
Fax: 704 793 4321
4005 Dearborn Place NW, Concord, NC 28027

DELPHI BRAKES SYSTEMS

01908 47472
USA (i) 310 609 1602
EXACT ENG 01803 866464
FASTENER FACTORY 01327 311018
FHS MOTOR RACING 01753 570863
FLUID CONTROL PRODUCTS INC USA (i) 217 324 3737
Fax (i) 217 324 3717
01392 369090
GOODRIDGE UK USA (i) 310 533 1924
GOODRIDGE CA USA (i) 317 244 1000
GOODRIDGE INDY USA (i) 704 662 9095
HCL FASTENERS 01282 411992
HENRY'S ENG USA (i) 410 435 3142
JLS MOTORSPORT 0121 525 7733
KINSLER USA (i) 248 362 1145
SAMCO SPORT 01443 238484



SFS PERFORMANCE

Tel: 01582 418870
Fax: 01582 422777
Website: www.sfsperformance.co.uk
Unit E Kingsway Industrial Estate, Kingsway
Luton LU1 2LP
01803 866371
0208 530 6664
0208 568 1172
01932 355277
USA (i) 562 861 4765

INTERCOOLERS

AH FABRICATIONS 01432 354704
FLUID CONTROL PRODUCTS INC USA (i) 217 324 3737
Fax (i) 217 324 3717
PACE PRODUCTS 01440 760960
SERCK MARSTON 0208 965 2151
SFS PERFORMANCE 01582 412 697

OIL COOLERS

AEROQUIP USA (i) 419 238 1190
CV PRODUCTS USA (i) 910 883 4096
DOCKING & CO 01372 857164
EARL'S USA (i) 310 609 1602
EXACT ENGINEERING 01803 866464
FAE MACHINE USA (i) 317 243 3092
FLUID CONTROL PRODUCTS INC USA (i) 217 324 3737
Fax (i) 217 324 3717
GOODRIDGE UK 01392 369090
GOODRIDGE CA USA (i) 310 533 1924
GOODRIDGE INDY USA (i) 317 244 1000
GOODRIDGE EAST USA (i) 704 662 9095
LAMINOVA Sweden (46) 85 907 4045
PROCAMP 0121 350 3258
SERCK MARSTON France (33) 14 790 6512
020 8965 2151
SETRAB Sweden (46) 40 158060
SPECIALTY FASTNERS 01803 866371
SPV RACING Australia (61) 2 791 9899
THINK AUTOMOTIVE 020 8568 1172
TREVOR MORRIS ENG 01547 530289

OIL FILTERS

AN MOTORSPORT DESIGN 01628 776320
COSWORTH 01604 752444
EARL'S USA (i) 310 534 1390
ED PINK ENGINES USA (i) 310 609 1602
EXACT ENGINEERING USA 818 785 6740
FLEXIBLE HOSE 01803 866464
FRAM FILTERS 01553 570863
KINSLER 01443 223000
USA (i) 248 362 1145

OIL PUMPS

ED PINK RACING ENGINES USA 818 785 6740
KENT CAMS 01303 248666
PACE PRODUCTS 0440 760960
SPV RACING 01628 526754
SWINDON RACING ENGINES Australia (61) 2 791 9899
TITAN MOTORSPORT 01793 531321
01480 474402

OIL SEALS

RACE-TEC NAK 02380 246986
PIONEER WESTON (WYKO) 0161 703 2011

OIL SUMPS

AH FABRICATIONS 01432 354704
A.R.E DRY SUMP SYSTEMS USA: (i) 916 987 7629
www.drysump.com
01795 843802

JENVEY DYNAMICS 01746 768810
MILDON USA (i) 818 407 1211
PACE PRODUCTS 01440 760960
STONE FOUNDRIES 0208 853 4648
SWINDON RACING ENGINES 01793 531321
TAN MOTORSPORT 01480 474402
TREVOR MORRIS ENG 01547 530289

OIL TANKS

BS ENGINEERING 01908 618080
GARTRAC 01288 682263
GOMM METAL DEVELOPMENTS (483) 764876
KS MOTORSPORT Germany (49) 2271 44905
MIDAS METALCRAFT 01933 355512
PACE PRODUCTS 01440 760960
THINK AUTOMOTIVE 020 8568 1172

RUBBER & ELASTOMERIC COMPONENTS

BUTSER RUBBER LTD Tel: 01730 894034

STARTER MOTORS

ARK RACING 01785 715234
EARL'S USA (i) 310 609 1602
RTRAC Germany (49) 9725 5075
STARTLINE UK LTD 01933 665752

THROTTLE BODIES

JENVEY DYNAMICS 01746 768810
KINSLER USA (i) 248 362 1145
LINGENFELTER USA (i) 219 724 2552
LUMINATION 0207 493 4334
SWINDON RACING ENGINES 01793 531321
TWM INDUCTION USA (i) 805 967 9478

THROTTLE VALVES

JENVEY DYNAMICS 01746 768810
KINSLER USA (i) 248 362 1145
LUMINATION 0207 493 4334
TREVOR MORRIS ENG 01547 530289
TWM INDUCTION USA (i) 805 967 9478

TURBOCHARGERS

GARRETT AUTOMOTIVE 01695 22391
HOLSET ENG 01484 422244
INTERPRO ENGINEERING 01454 412777
QUINETO 08700 100942
TURBO TECHNICS 01604 764005

WATER COOLERS

AH FABRICATIONS 01432 354704
DOCKING & CO 01327 857164
DENSO MARSTON 01274 582266
NIPPON DENSO Japan (81) 56 625 5511
UK 0208 591 7700
PACE PRODUCTS 01440 760960
SERCK MARSTON 0208 965 2151

WATER INJECTION

ERL 01273 581007

WATER PUMPS

DAVIES, CRAIG Australia (61) 39 499 7433
ED PINK RACING ENGINES USA 818 785 6740
EDELBRICK USA (i) 213 781 2222
TREVOR MORRIS ENG 01547 530289

Proflex UK Ltd



Sole UK Sales & Service

Thorn Street Garage, Thorn Street, Clitheroe BB7 2LJ

phone: 01200 442345 fax: 01200 443050

01606 737 500
info@redlinemotorsport.co.uk

Specialised Motorsport Components



3.3 Engine Electronics

COMPUTER SUPPLIERS

ACES 01206 395324
ADVANCED AUTOMOTIVE 01753 642019
COMPETITION DATA USA (i) 716 631 2880
FUELINICS Australia (61) 88363 2199
PAD RACING New Zealand (64) 3 3386 288
PERFORMANCE TRENDS USA (i) 248 473 9230
RACELOGIC 01280 823803

DATA-ACQUISITION

ACTIVE SENSORS Tel 01202 480620
Fax 0120 2480664
ADVANCED AUTOMOTIVE 01753 642019
B&G RACING USA (i) 602 274 2537
BOSCH 01895 834466
Germany (49) 711 8111
USA (i) 312 865 5200
USA (i) 716 631 2880
USA 800 870 8383
01905 796090
USA (i) 313 761 1545
Germany (49) 721 944550
0208 463 9222
01908 261655
DIGICON ENGINEERING Canada (i) 604 984 9437
FOREFRONT USA (i) 404 448 9550



INTERCOMP USA Tel (i) 763 476 2531
Fax (i) 763 476 2613
14465 23rd Avenue N, Minneapolis, MN 55447, USA
ISAAC INSTRUMENTS INC. Tel: (450) 658 7520
Fax: (450) 658 3322
Email: isaac@isaac.ca
Website www.isaac.ca
25 Robert, Chamby, Quebec, Canada J3L 1S2
USA (i) 425 485 0620
01953 608000
08707 444666
Australia (61) 3 9761 5050
UK 08700 191900
Japan (81) 480 46 1734
MOTEC SYSTEMS USA USA (i) 714 897 6804
MOTEC USA (i) 804 973 1399
MOTOR SPORT ELEC Australia (61) 7 3290 1309
MOTORSPORTS INTERFACE 01327 310111
MTS Powertrain Tech Tel 01932 351517
Fax 01932 351517
7 Glen Court, Canada Road, Blythelee, Surrey KT14 7JL
NIPPON DENSO Japan (81) 56 625 6951
PENETAL CONTROL SYSTEMS +44 (0)1954 253600
PENNY & GILES 01202 409400
PERFORMANCE TRENDS USA (i) 248 473 9230
PI RESEARCH 01954 253600
POLY LOGIC 01462 621066
QINETIQ 08700 100942
QUANTUM SUSPENSION 01243 885058
RACE DATA ENGINEERING USA (i) 714 449 1445
SAKATA MOTORSPORT ELEC. INC. (714) 446 9473
STACK Tel 01865 240404
Fax 01865 245500
email: sales@stackitd.com

Wedgewood Road, Bicester Oxfordshire, OX26 4JL
STEVE BUNKHALL 01223 303025
VARIOHM 01327 351004

ENGINE MANAGEMENT SYSTEMS

ADVANCED AUTOMOTIVE 01753 642019
ASNU 0208 420 4494
BOSCH 01895 834466
Germany (49) 711 8111
USA (i) 312 865 5200
01795 834466
CONNAUGHT 0208 463 9229
DATAPARES 0208 391 0121
SBD MOTORSPORT 01455 230576
JOHN WILCOX 08707 444666
MM COMPETITION



MOTEC PTY LTD Aus Tel: 613 9761 5050
Aus Fax: 613 9761 5051
Japan +81 489 461 734
121 Merringdale Drive
Croydon South Victoria Australia
UK: +44 8700 19100
USA: +1 714 895 7001
PECTEL CONTROL SYSTEMS +44 (0)1954 253600
PRECISION RACE SERVICES USA (i) 248 844 1060
SAKATA MOTORSPORT ELEC. INC. (714) 446 9473
STACK 01869 240404
SUPERCHIPS 01280 816781
TERRY SHEPHERD TUNING 01695 574454
WALBRO ENGINE MANAGEMENT USA (i) 989 874 7091
ZYTEK SYSTEMS 0121 323 2323

ENGINE SENSORS

ACTIVE SENSORS Tel 01202 480620
Fax 01202 480664
Unit 12, Wilverley Rd, Christchurch, Dorset, BH23 3RU England
AVL DEUTSCHLAND (49) 6134 7179-0
GmbH Germany
DATAPARES 0208 463 9229
ENTRAN 01923 893 999
KISTLER INSTRUMENTS 01420 544477



KULITE SENSORS Tel 01256 461646
Kulite House, Stroudley Road, Basinstoke, RG24 8UG, England

MAGCANICA INC USA 858 454 8950
PAD RACING New Zealand (64) 3 3386 288
THE STRAIN GAUGING CO 01256 320666
VARIOHM 01327 351004

REV-LIMITERS

LUCAS ELECTRICAL 0121 536 5050
LUMINATION 020 7403 4344
MM COMPETITION 08707 444666

3.4 Transmission Components

CLUTCHES

ALCON Tel +44 (0) 1827 723700
Fax +44 (0) 1827 723701
Email info@alcon.co.uk
www.alcon.co.uk
Apollo, Tamworth, Staffordshire B79 7TN



ALCON

AP RACING

FICHTEL & SACHS (0)24 7663 9595
GOODRIDGE Fax (0) 24 7663 9599
LOLA Wheler Road, Coventry, CV3 4LB
0208 654 8835
01392 369090
Tel 01480 451301
Fax 01480 456722
QUARTER MASTER USA (i) 847 540 8999
Fax (i) 847 540 0526
510 Telser Road, Lake Zurich, IL 60047, USA
UK 01926 812136
Germany (49) 9725 5075



SUPER CLUTCH

RTRAC Germany (49) 9725 5075



SACHS RACE ENGINEERING GmbH Tel +49 9721-984300
Fax +49 9721-984399
Email service.srea@sachs.de
Website www.sachs-race-engineering.de
Ernst-Sachs-Strasse 62, 97424 Schweinfurt, Germany
SACHS BOGE UK 01788 822353
TILTON ENGINEERING USA (i) 805 688 2353
Fax (i) 805 688 2745
25 Easy Street, Buellton, CA 93427 USA
Fax (i) 805 388 4938
USA (i) 805 388 1188
416 Calle San Pablo, Camarillo, CA 93012, USA

COMPLETE TRANSMISSIONS



RICARDO MIDLANDS TECHNICAL CENTRE Tel: 01926 319399
Fax: 01926 319352
Email: rasimmonds@mtc.ricardo.com
Website: www.ricardo.com
Southam Road, Radford Semele,
Leamington Spa CV31 1FQ

CWP'S

DAVID BROWN 01484 422180
DTS USA (i) 313 778 0540
JCM TRANSAXLES USA (i) 303 695 6093
MARK BAILEY RACING 01380 850303
XTRAC LTD 01635 293800

DIFFERENTIALS

AJEC INDUSTRIES 01242 222739
GEARACE LIMITED 01869 277563
GKN AXLES 0207 930 2424
HEWLAND ENG 01628 827600
JCM TRANSAXLES USA (i) 303 695 6093
MARK BAILEY RACING 01380 850303
QUAIFE ENGINEERING 01732 741144
RICARDO 01273 455611
RICARDO MIDLANDS TECHNICAL CENTRE 01926 319399
TOM'S DIFFERENTIALS USA (i) 310 634 8431
TRAN-X GEARS LTD 02476 659061
XTRAC LTD 01635 293800
ZEXEL-GLEASON USA (i) 716 464 5000

DRIVESHAFTS



CTG Tel: +44 (0)1295 220130
Fax: +44 (0)1295 220138
Email: motorsport@ctgid.co.uk
www.ctgid.co.uk
Thorpe Park, Thorpe Way, Banbury, Oxfordshire
OX16 4SU United Kingdom



GKN MOTOR SPORT

Tel 0121 313 1661
Fax 0121 313 2074
Unit 5, Kingsbury Business Park,
Kingsbury Road, Minworth, Sutton Coldfield,
Birmingham B76 9DL, England

METALORE USA (i) 310 643 0360
PANKL 0043 3862 33999
TEX RACING USA (i) 910 428 9522
TRAN-X GEARS LTD 02476 659061

GEARS



B&M 001 818 882 6422
www.bmrracing.com
Chatsworth CA 93711 USA
02476 462328
USA (i) 916 933 1080
01484 422180
01869 277563
01628 827600
USA (i) 303 695 6093
Ger (49) 6074 47 663
01380 850303
0043 3862 33999
USA (i) 910 428 9522
01926 319399
RICARDO MIDLANDS TECHNICAL CENTRE 02476 659061
TRAN-X GEARS LTD 01635 293800
XTRAC LTD

UNIVERSAL JOINTS

FLAMING RIVER USA (i) 440 826 4488
GEARACE LIMITED 01869 277563

Database 4

FACTORY EQUIPMENT

4.1 Factory Hardware

AIR LINES & FITTINGS

A.N. MOTORSPORT DESIGN 01628 776320
EARL'S UK 01327 892211
EXACT ENGINEERING 01803 866464
Fhs Motor Racing Ltd 01753 513080
GOODRIDGE UK 01392 369090
GOODRIDGE CA USA (i) 310 533 1924
GOODRIDGE INDY USA (i) 317 244 1000
GOODRIDGE EAST USA (i) 704 662 9095
INGERSOLL RAND 01204 690690
JLS MOTORSPORT 0121 525 7733
KRONTEC Germany (49) 9401 703062
REGEN 01908 612602
ROTOSET Sweden 46 8532 55890
THINK AUTOMOTIVE 0208 568 1172

AIR TOOLS

DESOUTTER AUTOMOTIVE 0208 205 4884



DINO PAOLI S.R.L.

Tel: +390 522 300828
Fax: +390 522 304864
email: info@dinopaoli.com
Website: www.dinopaoli.com
Via Guido Dorso, 542100, Reggio Emilia, Italy

FACOM

INGERSOLL RAND 01204 690690
JLS MOTORSPORT 0121 525 7733

CNC MACHINING CENTRES

ABSOLUTE MACHINE TOOL USA (i) 440 324 5133
BOSTON DIGITAL USA (i) 508 473 4561
BRIDGEPORT MACHINE USA (i) 248 299 1750
DEREK ROBINSON 0116 266 2222
DEWCO USA (i) 765 962 7201
MACHINERY SALES USA (i) 510 490 4000
MAKINO USA (i) 800 552 3288
MEDDINGS MACHINES 01752 893277
MILLS ENGINEERING 01603 745531
MILLSITE ENGINEERING USA (i) 304 273 3533
RGS PERFORMANCE USA (i) 716 434 2599
RMT MECHATRONICS 01565 050411
SERDI 01895 232215
SOUTHWESTERN IND USA (i) 310 608 4422
SPA AEROFOLDS LTD 01827 260026
T&S USA (i) 940 668 1002
TOYODA EUROPE 02476 547200

CRACK DETECTION

ABS PRODUCTS USA (i) 714 671 0728
DCM TECH USA (i) 800 533 5339
KRAUTKRAMER BRANSON USA (i) 717 242 0327

CRYOGENIC TEMPERING

FROZEN SOLID 01449 674914

DUST EXTRACTION EQUIP

DENCER 01789 470198

DYNAMOMETERS: CHASSIS

FROUDE CONSOLE 01905 856800
International Dynamometers LTD/Dynapack
USA 001 559 292 3800 New Zealand 64 4587 0484
LAND & SEA USA (i) 603 329 5645
KISTLER Instruments Ltd 01420 544477
ROTOSET Sweden (46) 8 532 55890
SUPERFLOW USA (i) 800 471 7701
Belgium 3215 216300
UNICO (UK) LTD 01908 260000

DYNAMOMETERS: DAMPER

BEHRENS SPEED CENTER USA (i) 914 651 7389
CZECH MATE USA (i) 800 819 7223
DYNAMIC SUSPENSIONS Can (i) 905 470 8778
UK 01842 755744
USA (i) 520 624 3907
ND TECH SHOCK DYNOS UK 02476 697192
SCHMITT EUROPE 01827 260026
SPA DESIGN USA (i) 317 271 7941
SPA TECHNIQUE Germany (49) 7252 84258
TAT

DYNAMOMETERS: ENGINE

AVL Germany (49) 61 34 71 790
D&P TECHNOLOGY 01932 351516
DYNAMIC TEST SYSTEMS 01842 755744
ENGINE & DYNAMOMETER 01708 857108
FROUDE CONSOLE 01905 856800
J&M AUTOMOTIVE USA (i) 508 966 2531
LAND & SEA USA (i) 603 329 5645
LOTUS ENGINEERING 01953 608000
MOTORSPORTS INTERFACE 01788 890412
TAT Germany (49) 7252 84258

DYNAMOMETER INSTRUMENTATION

AQUIRED DATA SYSTEMS USA (i) 810 566 0131
DEPAC DYNO SYSTEMS USA (i) 315 339 1265
DYNOLAB USA (i) 206 243 8877
FROUDE CONSOLE 01905 856800
LAND & SEA USA (i) 603 329 5645
KISTLER Instruments Ltd 01420 544477
PERFORMANCE TRENDS USA (i) 248 473 9230
QUADRANT SCIENTIFIC USA (i) 303 666 8414
ROEHRIG ENGINEERING USA (i) 336 431 1827
SUPERFLOW USA (i) 800 471 7701
Belgium 3215 216300
TAT Germany (49) 7252 84258

ENGINE BALANCING EQUIP

ABS PRODUCTS USA (i) 714 671 0728
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5.1 Pits Equipment

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SMR COMPONENTS USA (i) 708 949 9100

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REDLINE MOTORSPORT Tel 01606 737500
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CONTINENTAL SPORT USA (i) 513 459 8888
ME MOTORSPORT 01884 253070
MOTEC Australia (61) 3 9761 5050
MOTEC (EUROPE) UK 08700 119100
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MOTEC SYSTEMS USA USA (i) 714 897 6804
MST SPORTS TIMING 01684 573479
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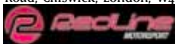
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6.1 Driver's Equipment

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DESIGN AND ANALYSIS



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AZTEK 01509 261299
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LOTUS ENGINEERING 01953 608000
LYNX MOTORS 01424 851277
MACDONALD RACE ENG 0208 889 1633
MATRIX ENGINEERING USA (1) 888 249 0013
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MICRO CRAFT USA (1) 909 947 1843
MIKE TAYLOR DEVELOPMENTS 01609 780123
MIRKO RACING USA (1) 408 776 0073
POLSON 01440 820371
PREMIER AEROSPACE 01332 850515
QinetiQ 08700 100942
RACEPREP 3001 01903 734499
RBS 01788 543094
RETRO TRACK & AIR UK 01453 545360
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Tel 01933 402440
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SPA AEROFOLDS LTD 01827 260026
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VIN MALKIE RACING 01505 777395

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ASTEC 01332 875451
BENTLEY CHEMICAL TRADING 01562 51521
BUTSER RUBBER 01730 804034
CML GROUP 0151 647 5531
COMPOSITE DESIGN USA (1) 727 539 0605
COMPOSITE WINGS 01953 885478
CROSBY GRP 01327 857042
CROMPTON TECH GROUP 01295 220130
CTG '44 01295 220130
G.FORCE COMPOSITES 01243 544192
GRUFFITHS ENGINEERING 01582 600629
JANUS TECHNOLOGY 01753 869996
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PROTECH COMPOSITES LTD Tel: +44(0) 1420 471 000
Fax: +44 (0) 1420 487 047
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STARTLINE UK LTD 01933 665752
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AOLUS TECHNOLOGY USA (1) 970 472 1288
ENABLING TECHNOLOGIES LTD 01983 550483
COSINE TECHNOLOGY 01706 378851
CRANFIELD UNIVERSITY 01234 754152
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DEREK BENNETT ENGINEERING 01565 777395
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DRIVETRAIN & SUSPENSION ENGINEERING SERVICES

8.1 Engine Services

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ALDON 01384 572553
ANDY ROUSE ENGINEERING 02476 635182
AUTOKRAFT 0121 777 2083
AZTEK 01509 261299
BJ MOTOR ENGINEERS 0161 748 8663
BR MOTORSPORT 01926 451545
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SBD MOTORSPORT 0208 391 0121
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DBR Motorsport Tel 0161 627 489 Fax 0161 627 489
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DTM POWER 01865 407726
DUNNELL ENGINES 01449 677726
EARS MOTORSPORT 01625 433773
EDS 01708 857108
ELABORAZIONE COLASUNO 0207 738 8331
ENGINE DATA ANALYSIS 01977 516622
ENGINE SHOP 01280 804999 USA (1) 888 767 8840
FISCHER ENGINEERING 01676 523256
FORWARD ENGINEERING 01474 534779
GEMINI ENGINEERING 01480 861599
GEOFF RICHARDSON ENGINEERING 01646 621814
GF BECK MOTORSPORT PREPARATION 01491 875554
GOLDFLOW 01327 300422
GOODMAN RACING ENGINES 01621 856956
GRAHAM HATHAWAY RACING 01793 771802
GRIFFIN MOTORSPORT 01642 818188
HARBERS PERFORMANCE 01202 556566
HARTWELL USA (1) 714 545 2755
HAUS OF PERFORMANCE 01474 872888
HT RACING 01543 414666
IRMSCHER 01923 816277
IVAN DUTTON 01722 321833
JANSPEED MOTORSPORT Greece 003 019 52 761
J MATTIS ENGINETECH 01455 230576
JOHN WILCOX COMPETITION ENG 01933 411993
JONDEL 01303 874082
KENT AUTO DEVELOPMENTS Germany (49) 221 171025
KREMER RACING France (33) 14 582 4400
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LINGENFELTER 01327 858 006
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MATRIX ENGINEERING 01608 685155
MAXSYM ENGINE TECH 01283 518184
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MILLINGTON 01509 239700
MINERVA MOTORSPORT 01634 682577
MINISTER RACING ENGINES USA (1) 408 776 0073
MIRKO RACING (49) 263680394
MIS M/SPORTTECHNIK GERMANY 01621 854029
MOUNTUNE RACE ENGINES 01775 730532
NEIL BROWN ENGINEERING 01541 301936
PHIL JONES ENGINE DEV 01564 824869
PHIL MARKS ENGINE DEV USA (1) 812 546 4220
PRICE MOTORSPORT 015 9491903
PRIMA RACING 01295 273355
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QUICKSILVER RACE USA (1) 01599 41337
RACE ENGINE DEVELOPMENTS USA (1) 760 630 4590
RACE ENGINE DEVELOPMENT 01925 636950
RACESPEC 01242 245640
RACE TECHNIQUES USA (1) 714 779 8677
RACING BENT Germany (49) 761 16373
RANDLER 01524 844066
ROAD & STAGE MOTORSPORT 01453 750864
ROADSPEED PERFORMANCE (33) 3 86 66 00 08
RPM FRANCE 01416 759 9309
SCARBOROUGH Canada (1) 466 759 9309
SEARLE 0208 305 2250
STEVE CARBONE RACING USA (1) 918 835 6596
SWAYMAR 01932 868377
SWINDON RACING ENGINES 01793 53321
TECNO 01268 764047
TERRY SHEPHERD TUNING 01605 574454
THINK AUTOMOTIVE Tel 0208 568 1172
Fax 0208 847 5338
Email matt@thinkauto.co.uk
292 Worton Road, Isleworth, Middlesex, TW7 6EL
THUNDERBIRD RACING INT LTD 01623 622848
VAN DYNE ENGINEERING USA (1) 714 847 4417
WARRIOR 01825 764833
ZYTEK ENGINEERING 01332 48974
ZEUS MOTORSPORT ENGINEERING LIMITED
Tel 01604 878101 Fax 01604 878111
The Racing Stables, Blisworth Hill Farm,
Stoke Road, Blisworth, Northants NN7 3DB

8.2 Engine Services

REBUILDS

ANDREASON RACING 01300 348499
ANEX SYSTEMS 01869 345038
BTR PREPARATIONS 01977 522348
EARS MOTORSPORT 01625 433773
GTC COMPETITION 01483 272151
HAUS OF PERFORMANCE USA (1) 714 545 2755



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Fax 01628 829200
Waltham Road, Maidenhead, Berks, SL6 1JR
JACK KNIGHT 01483 764326
JP RACE CENTRE 01327 858151
KREMSPEID EQUIPMENT INC. USA 0184 724 4086
MARK BAILEY RACING 01380 850130
MATRIX ENGINEERING USA (1) 888 249 0013
ME MOTORSPORTS 01884 253070
QUAIFEE ENGINEERING Tel 01732 741444
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www.quaifee.co.uk
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AZTEC 01509 261099
BEAUFORT RESTORATION 01795 830288
DAVID POTTER CONSULTING 0033(0)494 339090
BRADY FABRICATIONS 01869 252750
CRANFIELD UNIVERSITY 01234 754152
DON FOSTER France (33) 470 580308
EARS MOTORSPORT 01625 433773
GEOSCAN (G.I.L. Design) 01235 790508
LOLA Tel 01480 453101
Fax 01480 456722
USA (i) 714 545 2755

HAUS OF PERFORMANCE 01454 412777
INTERPO ENGINEERING 01953 608000
MARDI GRAS MOTORSPORT 01327 858006
MARK ORTIZ USA (i) 704 933 8876
PILBEAM RACING DESIGNS 01778 424838
PODIUM DESIGNS 07000 763 486
Tel 0933 402440
Fax 01933 676519
Ray Mallock LTD (RML) www.rmlmallock.co.uk

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FUSPENSION TECHNOLOGY 01327 858558



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Website: www.shockbox.co.uk
Email: ghj@compuserve.com
67 Blackthorn Road, Attleborough, Norfolk, NR17 1YJ UK
THE STRAIN GAUGING CO 01256 320666
UNIVERSITY OF HERTFORDSHIRE 01707 284270

ENGINEERING SERVICES

RACING INDUSTRY TECHNICAL SERVICES USA (i) 248 645 1724

8.4 Metal Services

BEAD & SAND BLASTING

BEST-IT-ALL USA (i) 800 353 2612
CAMCOAT PERFORMANCE COATINGS 01925 445090
COMPAIR AUTOPOWER 01494 465000
HANKCO MOTORSPORT 01753 522779
MACDONALD RACE ENG 0208 889 1633
SWAYMAR CASTING 01932 868377
AEROMET 01795 415000
GM DESIGN 017 985 9964
GRIFFITHS ENGINEERING 01582 600629
HILLGARD Sweden (46) 300 60590
JENVEY DYNAMICS 01746 768810
KENT AEROSPACE CASTINGS 01795 476333
PANKL Austria (43) 3862 512500
QUAIFE ENGINEERING 01732 741144
QDF COMPONENTS 01322 760260
QUARTERMASTER USA (i) 847 540 8909
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www.QinetiQ.com
Cody Technology Park, Ively Road, Farnborough,
Hampshire, GU14 0LX
01384 482222

ZEUS ALUMINIUM

COATINGS
CAMCOAT PERFORMANCE COATINGS 01925 445093



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E-mail: motorsport@ctgtd.co.uk
www.ctgtd.co.uk
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OX16 4SU United Kingdom

LURO COTE USA (i) 909 885 3223
KENT MOTORSPORT CASTINGS 01795 662288
POETION 01452 300500
POLYMER DYNAMICS USA (i) 713 694 3206
QINETIQ 08700 100942
SWAIN TECH USA (i) 716 889 2786
WALLWARK HEAT TREATMENT 0161 797911



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www.zircotec.co.uk
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Didcot, Oxfordshire OX11 0QJ United Kingdom

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ARMORALL PRODUCTS 01799 513130
CML GROUP 0151 647 5531
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HEPWORTH INTERNATIONAL 01484 71720
JENVEY DYNAMICS 01746 768810
KENT AEROSPACE CASTINGS 01795 476333
QUAIFE ENGINEERING 01732 741144
QINETIQ 08700 100942

RICHARD BARRETT MOULDS USA 353 282 9842
ZEUS ALUMINIUM PRODUCTS 01384 482222

FOUNDRIES

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BA HARRISON 0116 2769351
GM DESIGN 017 985 9964



FINECAST 01903 765821
H GRIFFITHS ENGINEERING 01582 600629
JENVEY DYNAMICS 01746 768810
KENT AEROSPACE CASTINGS 01795 476333
KENT MOTORSPORT CASTINGS 01795 662288
QUALCAST 01322 760260
UK RACING CASTINGS 01227 750877

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AUTOSPRINT 01675 464857
AVONBAR 01932 840058
BEAUFORT RESTORATION 01795 830288
JENVEY DYNAMICS 01746 768810
PANKL Austria (43) 3862 512500
QUANTUM HEAT TREATMENT 01908 624242
TECVAC 01954 233700
ZEUS MOTORSPORT 01604 878101

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ACTIVE ENGINEERING USA (i) 714 637 1155
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ATHENA MANUFACTURING LP USA (i) 512 928 2693
AVONBAR 01932 840058
AZTEC 01509 261099
BEAUFORT RESTORATION 01795 830288
CML GROUP 0151 647 5531
COLEMAN MACHINE USA (i) 906 863 8945
DATUM ENGINEERING 01246 383032
FORMULA FABRICATIONS 01953 605490
DONCASTERS LTD 01322 864900
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Fax Germany (49) 9401 5253-10
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LANGSTONE ENGINEERING LTD 02392 452430
LINGENFELTER USA (i) 219 724 2552
LOTUS ENGINEERING 01953 608000
MACDONALD RACE ENG 0208 889 1633
MASON ENGINEERING USA (i) 805 527 6624
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PREMIER FUEL SYSTEMS 01332 850515
QUAIFE ENGINEERING 01732 741144
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TITAN MOTORSPORTS 015474 289
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METAL MATRIX COMPOSITES

BP METAL COMPOSITES 01252 37



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www.motorsport-cranfield.ac.uk
Motorsport Group, Cranfield University,
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ADVANCED METALS INTERNAT 01923 210250
AIRCOT METALS LTD 0188 973 0509
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CML GROUP 0151 647 5531

COAST FABRICATION USA (i) 714 842 2603
DATUM ENGINEERING 02476 383032
DONCASTERS LTD 01322 864900
PANKL Austria (43) 3 8625 12500
QINETIQ 08700 100942
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Fax 0121 784 8054
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Keys House, Granby Avenue, Garretts Green,
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TUBE FORMING

CONTRACT MFG & ASM USA (i) 920 720 4225
MALVERN AIRCRAFT 01684 892600
SPA AEROFOLLS LTD 01827 260026

8.5 Race Preparation

CHASSIS

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AMS 01831 501363
AMT MOTORSPORT 01444 483477
ANEX SYSTEMS 01869 345038
AUTOMECH 0161 775 1851
AVONBAR 01932 840058
BARWELL MOTORSPORT 0208 397 4411
BR MOTORSPORT 01926 451545
BRM MOTORSPORT 01327 858055
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FOXCRIFT ENGINEERING 01264 810101
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K2 RACE ENGINEERING 01825 766728
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MARTIN MOTORSPORT 01227 852746
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Tel 0151 8919533
07000 763486
08700 100942

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RACE TEC DESIGN & ENGINEERING 01816 871292
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TT AUTOMOTIVE RACING 0147 485 3456
VIN MALKIE 01565 777395
ZAKSPEED Germany (49) 2636 87923

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TESTING SERVICES

9.1 Chassis Testing

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THE STRAIN GAUGING CO 01256 320666
TORQUE FAST CALIBRATION 01782 744212
UNIVERSITY OF HERTFORDSHIRE 01707 284270

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KISTLER INSTRUMENTS LTD 01420 544477
MIRA LTD 0247 635 5000
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CCA DATA SYSTEMS 01525 378938
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GENESIS ELECTRONIC SYSTEMS 01923 893 9999
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0208 427 8822
0247 635 5000
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08700 100942
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Sweden (46) 85 325 5890
01256 320666

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BRUNO HANSON Denmark (45) 65 99 1616
CARBURRETOR CENTRE 0208 340 5057
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CRANFIELD INSTITUTE 01908 694134
DERBY AUTO ACCESSORIES 01327 674933
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ELABORAZIONE COLASUNO 0207 735 8331
FGR 01885 400639
FROUDE CONSOLE 01905 856800
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JANSPED MOTORSPORT 01722 321833
MACHTECH 01923 269788
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MIRA LTD 0247 635 5000
MOTORSKOPE 01609 780155
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PERFORMANCE CENTRE 0161 761 1177
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ROADSPEED PERFORMANCE 016 00 10 367
SARDOU France (33) 16 00 10 367
SCHENK 01869 32111
SOUTHAMPTON UNIVERSITY 01703 585044
TIM STILES RACING 01278 453036
TIPTON GARAGE 01404 812091

STRESS ANALYSIS

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LOLA Tel 01480 451301
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WELD TESTING



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email candbaero_indy@email.msn.com
6200 Leas Trail, Indianapolis, IN 46268, USA

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AIOLAS ENG Canada (i) 416 674 3017
CRANFIELD INSTITUTE 01908 694134
CRANFIELD UNIVERSITY 01234 754152
DOME CARS LTD Japan (81) 75 744 3131
IMPERIAL COLLEGE LONDON 0207 589 5111
LANGLEY FULL-SCALE MARCH USA (i) 757 766 2266
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MIRA LTD 0247 635 5000
OHIO STATE UNIVERSITY USA (i) 614 292 5491
RMCS (CRANFIELD) 01933 785359
QINETIQ 08700 100942
SARDOU SA France (33) 16 00 10 367
UNIVERSITY OF MARYLAND USA(01) 301 405 6861
WESTLAND HELICOPTERS 01935 702190

WIND TUNNEL MODELS

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CAPITAL PATTERNS 0208 777 9276
COMPOSITE DESIGN USA (i) 727 539 0605
DOME CARS LTD Japan (81) 75 744 3131
MARTIN FELDWDICK 01603 712611
MICRO CRAFT USA (i) 909 947 1843
MIRA LTD 0247 635 5000
SARDOU SA France (33) 16 00 10 367
THE STRAIN GAUGING CO 01256 320666

9.2 Engine Testing

COMBUSTION ANALYSIS

AM TEST SYSTEMS 01253 780780
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Rear spoilers

The benefits of rear spoilers are legend, but the mechanisms are not so well known. CFD reveals all...

The usual texts are pretty much in agreement on what we can expect to gain and lose when fitting a rear spoiler onto a saloon/sedan-based racecar, not surprising considering how much work has been done on the effects of varying spoiler length and angle. The benefit of looking at the topic with CFD, though, is that changes to pressures and airflows can be visualised in ways that help us understand so much better what's actually going on.

Advantage CFD once again used the full size virtual model of a NASCAR racer that regular readers will have seen in the past few issues to evaluate the effects of changing spoiler angle and length. Figures 1 and 2 show the racecar model, and the geometry of the spoiler device tested (which for simplicity was modelled as an infinitely thin flat plate).

Figures 3 and 4 summarise the results in graphical form, with dimensionless coefficients multiplied by frontal area plotted versus spoiler angle, which is the aspect this column will focus on. Positive $C_L A$ values represent total downforce, while negative $C_L A$ values represent lift. Let's draw the obvious conclusions before proceeding: there is an increase in downforce when a rear spoiler is added (this is felt at the rear, there is actually a slight decrease in front downforce) and there is a more or less linear increase in downforce with increasing spoiler angle.

The downforce gain seems to be tailing off at the steepest angle and longest length, though at shorter lengths the gains with increasing angle are still linear. In general, steeper angles lead to greater drag. For any given length, increasing spoiler angle also increases efficiency ($C_L A / C_D A$).

There's no doubting the value of a simple rear spoiler on this type of generic production car shape then – substantial and perhaps surprisingly efficient gains in lift reduction/downforce creation are apparent. Indeed, a shallow (20 degree) spoiler as long as 60mm is capable of actually reducing the car's drag while reducing rear lift or creating modest downforce, and although it's likely that seeking maximum downforce will be the aim in many cases, clearly there are options to balance downforce and drag here, rules permitting of course. Note that different body shapes are likely to produce different results and therefore would ideally need individual evaluation.

Figure 5 shows the changes in static pressures (Delta C_p) that occur around the car with the fitment of the steepest (and longest) spoiler. →

Figure 1: NASCAR model with rear spoiler variants



Figure 2: spoiler length and angle definitions:
 H = length, θ = angle

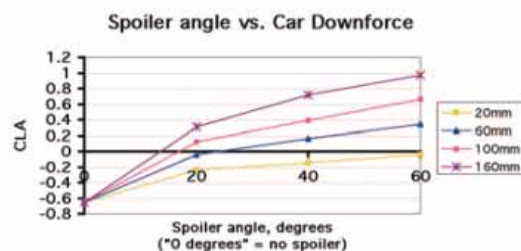
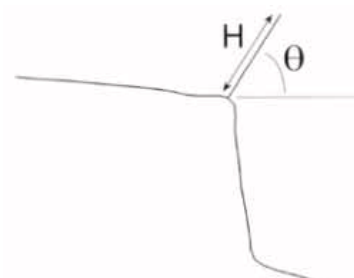


Figure 3: effect of spoiler angle on non-dimensional total downforce (0 = no spoiler)

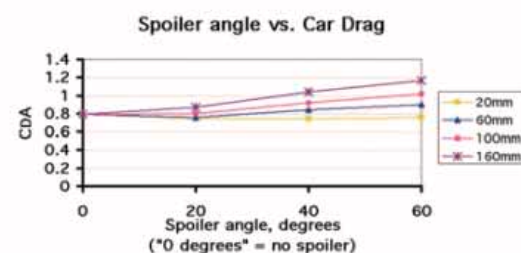


Figure 4: effect of differences in spoiler angle on non-dimensional car drag

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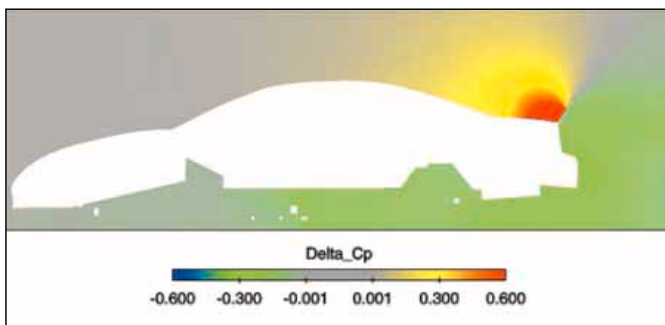


Figure 5: the effect of the addition of a 60-degree, 160mm rear spoiler on static pressure

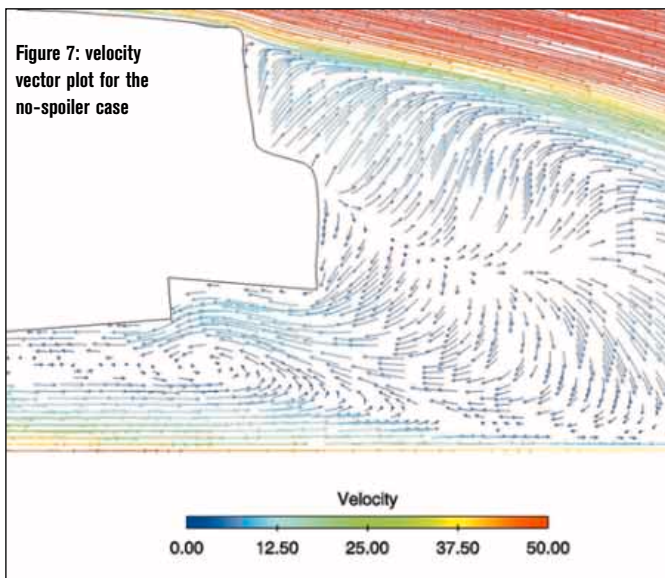


Figure 7: velocity vector plot for the no-spoiler case

Red and yellow indicate increases in local pressure, while green indicates reductions. Clearly there is a substantial increase in pressure over the rear deck of the car, extending quite a long way forward, which contributes to lift reduction/downforce generation. It is also clear that the pressure behind the car has reduced, which contributes to the increased drag in this configuration. And there is also a notable reduction in pressure beneath the car, which further contributes to downforce generation. So now let's delve a little deeper into the mechanisms themselves.

The change over the rear deck is relatively simple to explain. Adding a spoiler has slowed the airflow over the rear deck and, at steeper spoiler angles, has probably caused the flow to separate from the shallow angle rear screen, both of which have contributed to the increases in static pressure in this region. The airflow direction is also altered, the spoiler deflecting the flow upward, indicative of momentum transfer from the airflow to the car.

Behind the car the situation is more complex. Adding a spoiler increases the size of the car's wake and the low total pressure region behind the car. Increasing the spoiler angle leads to further increases in wake size and the low total pressure region. And it is the losses in total pressure that are significant here, more than any changes to air velocity. Returning briefly to Bernoulli's Equation explains the significance of this:

$$P_s + \frac{1}{2}\rho v^2 + \text{losses} = C$$

Where P_s = static pressure and $\frac{1}{2}\rho v^2$ = dynamic pressure.

The losses are large and cause the static pressure to reduce. Any reductions in dynamic pressure as the result of decreases in flow velocity, which in a more ordered flow regime would cause increases in static pressure, are outweighed by the losses.

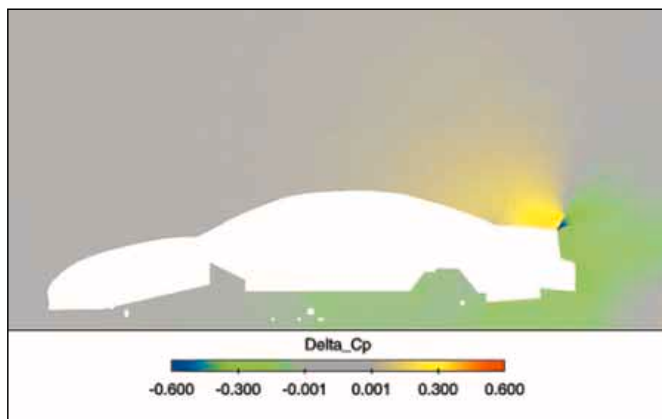


Figure 6: the effect on static pressure of increasing spoiler angle from 20 to 60 degrees

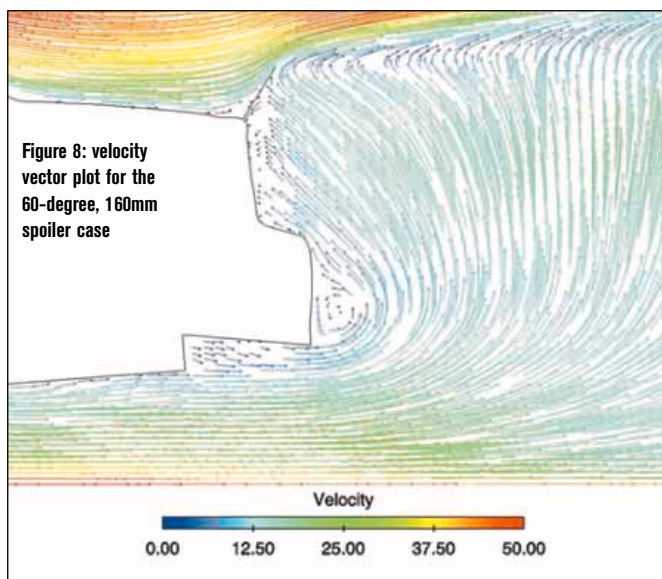


Figure 8: velocity vector plot for the 60-degree, 160mm spoiler case

Beneath the car a different situation prevails. The reduced static pressure region behind the car promotes an increase in mass flow under the car, air flowing happily into a low-pressure region. This has caused an increase in dynamic pressure and, in turn, a drop in static pressure under the rear of the car in classic Bernoulli style. However, although this adds to the generation of downforce, a drawback of this is that the increased mass flow that interferes with the pipes and chassis rails beneath the car also adds to the increase in drag already caused by the pressure differentials across the spoiler itself, and around the car as a whole. Increasing spoiler angle amplifies all these effects, and figure 6 shows the change in static pressures (delta Cp) that occur when the longest spoiler is increased from 20 to 60 degrees inclination.

The change to the pattern of airflow behind the car from the baseline, no spoiler case to the steepest, longest spoiler case is profound, as figures 7 and 8 illustrate. Colour-coded velocity vectors show in figure 7 that with no spoiler the airflow coming off the rear deck is fast and downward directed towards the rear, but the flow immediately behind the car is very slow and completely disordered. Contrast that to figure 8 with the steep, long spoiler, and not only has the flow over the rear deck been slowed and re-directed, but now the flow in the wake shows no recirculation under the car, and overall is pulled strongly upwards by the presence of the spoiler. The flow emerging from under the rear is also clearly smoother and faster.

■ Next month we'll ponder the mechanisms involved with different spoiler lengths in more detail, and also examine how a short spoiler reduces drag.

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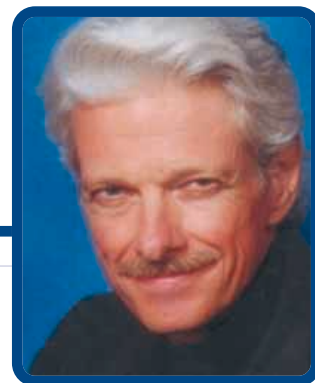


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Explaining load transfer in cornering



Use of the term weight transfer can confuse this issue. Load transfer causes an increase in force and a decrease in coefficient of friction



Could you explain in more detail the effects of load transfer under braking?

A In the Forum column of the October 2004 issue was a letter from a physicist, responding to an earlier article on the theory of cornering line and trail braking by Erik Zapletal (V14N8). Erik had correctly noted that forward load transfer (weight transfer, in customary vernacular) tends to improve the lateral acceleration capability of the front wheels, at the expense of the rear ones. The physicist took issue with this, and pointed out that adding weight to a wheel pair reduces lateral acceleration capability, because due to the phenomenon we call tyre

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load sensitivity, the coefficient of friction diminishes as we add load. Zapletal replied that this is true, but load sensitivity is a minor effect. He also noted that other factors enter into this, including aerodynamics, brake bias and camber changes.

So who is correct? Well both are, partly, but I shall endeavour to explain the matter a little better. (I should perhaps mention here that Zapletal is a sharp guy and it was he who first pointed out my error on brake caliper location – see below. Hopefully, I am returning a favour and shedding some light here, not being a pain).

This question illustrates perfectly why I prefer to speak of load transfer rather than weight transfer. The effects of forward load transfer under braking are quite distinct from the effect we get if we move mass forward in the car. Moving mass forward in the car adds understeer. Forward load transfer in braking adds oversteer. Both effects can be said to relate to tyre load sensitivity.

When we move mass forward in the car, we increase both the normal (vertical or perpendicular to the road) force on the front tyres and the centrifugal (inertial) force the tyres must overcome to produce any given lateral acceleration. Consequently, the front end's lateral accelera- ➔

tion capability depends not on whether the force capability of the tyres increases, but on whether it increases at the same rate as the normal (and centrifugal) force. The ratio of the tyre's force capability to the normal force is the coefficient of friction. This diminishes with increasing normal force so, in any situation where we add weight to the front end, the lateral acceleration capability diminishes.

When we brake, however, most of the load increase on the front wheels does not come from mass moving forward on the wheelbase, although a small amount of such motion does usually occur. The increase in front wheel loading comes primarily from the forward pitch couple which inevitably results from the tyres exerting a rearward force at ground level, and the car's inertia exerting an equal and opposite forward force above ground level. To prevent the car from somersaulting, the front tyres exert an increased support force against the ground, and there is a correspond-

ing decrease in support force at the rear, creating an equal and opposite anti-pitch couple. Because the centre of mass has not moved appreciably on the wheelbase, the front wheels are not required to overcome an increased centrifugal force per unit of centripetal acceleration in proportion to their increased normal force. The normal force increases, while centrifugal inertia force for a given car-lateral (centripetal) acceleration remains largely unchanged. Consequently, lateral acceleration capability for the front wheel pair increases.

In both cases, the normal force increases and the coefficient of friction decreases. But in the former case, the centrifugal force per unit of acceleration increases with the normal force, whereas in the latter it does not.

The latter case may be said to be similar to what happens when we add aerodynamic downforce. We add significant normal force, or load, without adding significant mass.

RE

ERRATA AND ADDENDA

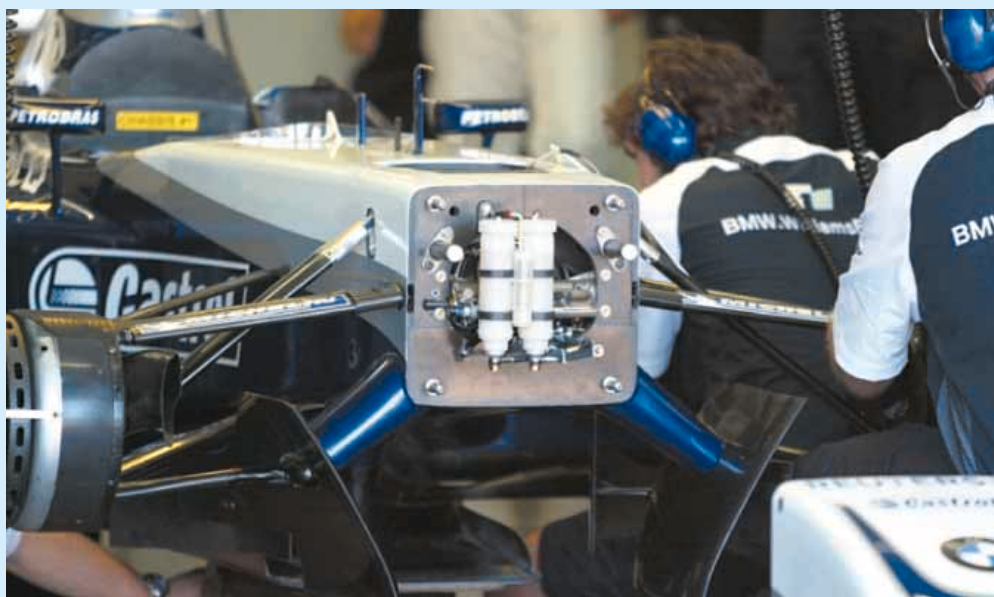
Thank you to readers who have pointed out some detail discrepancies in recent columns in Racecar Engineering, which are drawn from my newsletter.

In the April newsletter I originally stated that for least bearing loads with an outboard brake, the caliper should be somewhere in the upper rear quadrant of the disc. Shortly after sending out that issue, I sent out a correction saying that should be the lower rear quadrant. This correction was supposed to be incorporated when the material was published in the magazine, but unfortunately the original version was what ran (July 2004 issue). So a correction is in order on this point, for those who read my column in the magazine.

In my October 2004 column, drawn from the June 2004 newsletter, there was some disagreement between what I said about the Williams Formula 1 suspension and the second picture that ran in the magazine, showing the suspension from above and behind. I had said the forward portion of the upper wishbone was not aligned with the tie rod, whereas in the picture it appears to be aligned. Some readers have understandably called this to my attention.

The picture in question was chosen by the magazine, not supplied by me. I based my comments on other pictures, which I did not have in electronic format. If anybody is to be faulted here, I am. Anyway, it appears there have been two versions of the suspension. In the version shown in the magazine, the bump steer and aerodynamics appear good, but the camber control properties appear poor. In the version I was looking at when I wrote the text, the control arm appears to have been levelled out by moving the forward pick-up point down a bit, without the steering rack being lowered to match.

Without inside knowledge of the team's internal affairs, I am of course speculating as best I can from partial evidence. The best explanatory theory I can devise is this: the original version had the wishbone and the tie rod as shown in the October column's illustration.



The original image of the Williams F1 suspension referred to by Mark Ortiz, showing the lower forward pick-ups for the control arms

Perhaps the camber control was consciously compromised to get the nose higher and aid airflow underneath it, which was also partially the object of the tusk nose design. To get the nose up, the driver's feet had to go up. That forced the steering rack, the pedals, and everything else to go up. The wishbone then had to agree with the steering, to prevent bump steer and get good airflow over the tie rod and wishbone.

When it was found that the car lacked front grip, and other fixes didn't cure the problem, the team tried moving the wishbone pick-ups down. Moving them down a little on the existing tub was feasible, but moving the steering rack was tougher. So as a temporary experiment – and hopefully a temporary solution – the team decided to accept some bump steer and rely on driver skill to deal with that, and see if improved camber control would help the grip.

Raising the upper ball joints and outer tie rod ends was not an option, because the wheel rim was in the way. Lowering the rack was not an option either, because the driver's feet (or maybe other elements of the car) were in the way. So the team made the only modification they could under the circumstances.

I also noticed in the October issue that as of the Hungarian GP the team abandoned the tusk nose, although the tub has not been re-done. I understand they are trying an entirely new approach for 2005.

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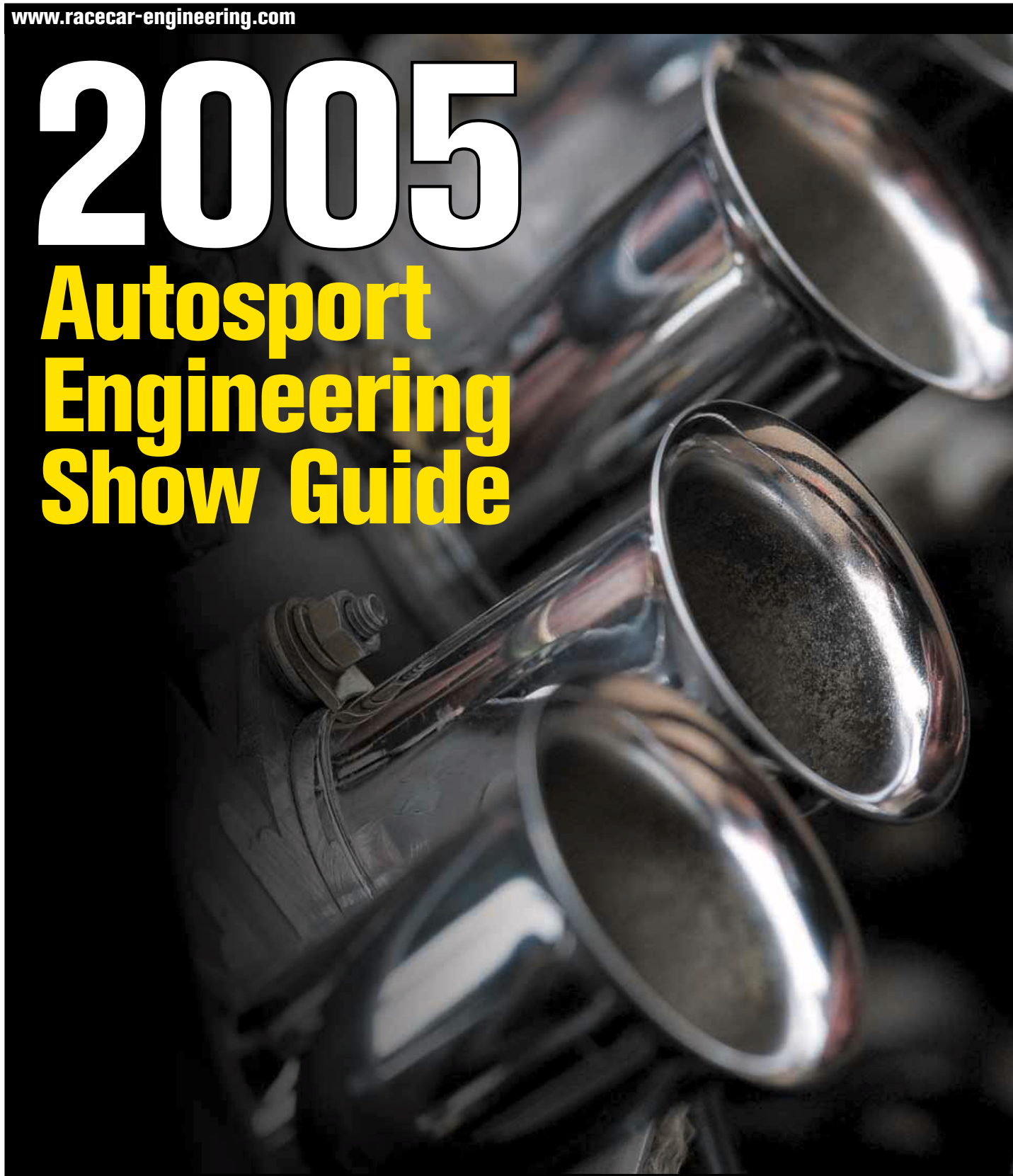
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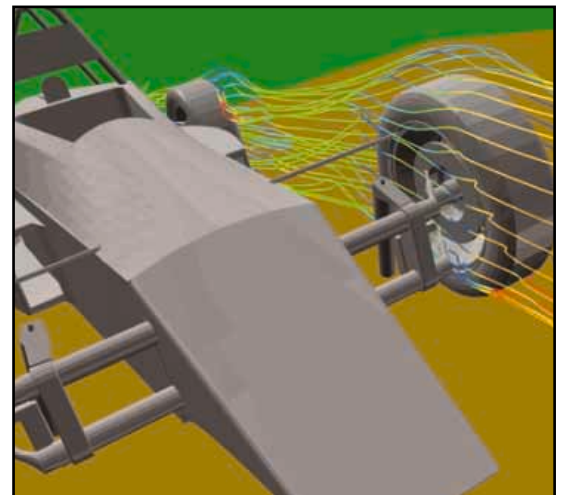
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At the forefront of composites technology for over 25 years, ACG is well established as the world's leading supplier of composites technology and materials to the motor racing industry. It offers an unparalleled one-stop supply of tooling and structural materials, combined with in-house manufacturing, design, prototyping and R&D facilities, as well as introductory and advanced laminating training packages. ACG is a global leader in composite material innovation, with technical and manufacturing facilities in both Europe and the USA. ACG is the manufacturer of ZPREG BPS240, a rapid advanced composite body panel system using carbon or e-glass materials. This variable temperature-curing system offers substantial reductions in tooling, prototype and production part manufacture costs, with 'A' class compatible surface finishes. Advanced Composites – the centre of composites technology.

Advanced Fuel Systems E371

Saxon House, Station Road
Newport, Essex CB11 3PL, UK
T: +44 (0)1799 541 955
F: +44 (0)1799 541 983
mailbox@advancedfuelsystems.co.uk
www.advancedfuelsystems.co.uk

FIA-approved fuel cell manufacturer Advanced Fuel Systems has enjoyed a successful year after winning the MIA's Award for Technology & Innovation at last year's show. It has continued to develop its innovative monolithically constructed bag tanks – the advanced construction of these bespoke safety fuel tanks offers improved levels of durability, fit and weight reduction. Advanced Fuel Systems also manufactures a comprehensive range of quick refuelling valves for endurance race cars and a broad range of fuel system components required by the designers of high performance vehicles.

• Reps on stand: Jonathan Tubbs, Patrick Dyer

AN Motorsport Design E81

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T: +44 (0)1628 776 320
F: +44 (0)1628 782 039
jgibbon@anmotorsportdesign.co.uk

AN Motorsport Design is a specialist in total system design and the supply of fluid and pneumatic systems, as well as the authorised motorsport distributor of Titeflex, FR-Hitemp, Novintec, Stanley Aviation and CTG.

It supplies hoses, bespoke special fittings, quick release dry break and quick connect clearbone couplings and high-pressure composite accumulators and bottles, together with Novintec filters, PRV and NRV valves, Gamah Pipe camps and rigid pipe assemblies, high-quality machining and Lasergold, the all-surface plating technology.

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• Rep on stand: Laura Shipley

Andream Ltd E415

Unit 3-4, Griston Road
Watton, Thetford, Norfolk IP25 6DL, UK
T: +44 (0)1953 885 775
F: +44 (0)1953 884 176

AP Racing E161

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Coventry CV3 4LB, UK
T: +44 (0)24 7663 9595
F: +44 (0)24 7663 9559
sales@apracings.com
www.apracings.com

AP Racing is a world leader in the design and manufacture of brake and clutch systems for motorsport, performance road and motorcycle applications. The current brake range includes two-, four-, six and eight-piston callipers, discs, master cylinders, pedal boxes and Formula Big Brake kits. The clutch range features its 2004 world championship winning 97mm F1 clutch, from the state-of-the-art carbon clutch range, together with Formula Clutch kits and more conventional sintered and cerametallic race, rally and clutch ranges.

Aquarius Metals Ltd E162

18-22 Birch Road east
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Birmingham B6 7DB, UK
T: +44 (0)121 328 7700
F: +44 (0)121 328 8381
info@aquariusmetals.com
www.aquariusmetals.net

Aquarius Metals is the UK's specialist automotive metals supplier. Established in 1981 it has built up a wealth of experience in serving the automotive market. Aquarius Metals is part of the metalweb group, and has branches in London, Manchester, Oxford and Birmingham. It offers high-quality material cut to customers' requirements, with a fast response and nationwide delivery service, aiming to provide 100% on-time delivery of high-quality products both for day-to-day requirements and long-term contracts. The company holds extensive stocks of aluminium in all alloys and forms including plate, bar, sheet and extrusions.

• Rep on stand: Lee Shaw

Arrow Precision Engineering E146

12 Barleyfield
Hinckley Fields Industrial Estate
Hinckley LE10 1YE, UK
T: +44 (0)1455 234 200
F: +44 (0)1455 233 545
Enquiries@arrowprecision.com
www.arrowprecision.com

Arrow Precision has earned a worldwide reputation for the design and manufacture of connecting rods and cam followers with a quality and strength unrivalled in performance racing. It also produces fly-wheels, valve guides, spring retainers and

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shims. Arrow Precision has been privileged to manufacture for many of the top names in motorsport and would be privileged to work for you. From custom to production, from vintage to Le Mans, you need Arrow at the heart of your engines.

ASP (Auto Sport Parts) E293

Lagosweb 57-59
Delft 2622CZ, Netherlands
T: +33 115 257 4766
F: +33 115 257 4768
Info@autosportparts.nl
www.autosportparts.nl

ASP is introducing Chicken Hawk Tyre warmers on the European market. These use new technology to heat the tyres – instead of heating via a wiring system, a conductive material distributes the heat evenly into the surface of the tyre. In addition, each blanket can be equipped with a digital control box for individual operation. Also on show is the Powerflo Fuel Rig which is built to FIA specification or for use on Le Mans series. These are two new items out of a range of other products that ASP has on offer.

• Rep on stand: Geert Rienstra

Atec Autotechnic Ltd E220

Unit 4 West End Farm, West End,
Silverstone, Northants NN12 8UY, UK
T: +44 (0)1327 858 855
F: +44 (0)1327 858 866
atecltd@btconnect.com
www.atecautotechnic.co.uk

Atec will be showing a range of hardlines, hoses and fittings, all of which are produced in house. The company has CNC tube bending capabilities

and can offer a fast turnaround on machined parts. It prides itself on the quality of both its service and its products.

• Reps on stand: Gunter Lambert, Kieron Griffiths, Jody Bowman

ATEX Ltd E92

4 Thames Park, Lester Way
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F: +44 (0)1491 839 466
contactuk@atex-f1.com
www.atexf1.com

Atex, incorporated in both France and the UK, designs and manufactures solid state sensors for the autosport industry. It has developed its own breed of F1 racing sensors, making it the most innovative company in the race Instrumentation Industry. Atex is working personally with most of the F1 teams, helping it to achieve the highest sensor supply volume to the sport. Specialising in acceleration, load and pressure sensing, as well as strain gauging, Atex products can be found in the most difficult and demanding environments, most often in the high vibration and extreme temperatures that are involved in autosport applications.

• Reps on stand: Dominique d'Antonio, Peter Copping

ATI Titanium International E270

Keys House, Granby Avenue
Garrets Green, Birmingham B33 0SP, UK
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ATL Racing Fuel Cells E313

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F: +44 (0)1908 351 750
kmolloy@atltd.com
www.atltd.com

ATL Racing Fuel Cells specialises in the design and manufacture of FIA-approved safety fuel cell bladder tanks, and is proud to be the chosen supplier to every current Formula 1, F3000 and World Rally car. ATL has also developed water, brake reservoir and oil bladder cells for use in motorsport. It also manufactures and supplies to NASA, military, marine, aviation, automobile (road cars), motorbike (race and road), petrochem and other mainstream industries.

• Reps on stand: Steve White, Kevin Molloy, Phil Keyworth

Aurok E61

Hermitage Farm
Colemore, Alton, Hants GU34 3PU, UK
T: +44 (0)1420 588 191
F: +44 (0)1420 588 190
admin@aurok.com
www.aurok.com

Aurok is the UK distributor for the world-renowned Ohlins Car Damper Products. On display will be a range of the selection and also the new TTX Damper which has taken the American market by storm, as well as finishing first and second at the 2004 Bathurst Touring Car Classic. Aurok and its agents are able to provide design, development, build and service for the complete Ohlins range.

Aurok is also able to provide set up, race team and engineering services for all forms of motorsport.

• Reps on stand: Dave Phillips, Toby Phillips, Jim Packham, Peter Karr, Bengt Ohlsson

Autocar Electrical Equipment Co Ltd E208

49-51 Tiverton Street
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• Reps on stand: Cameron Campbell, Steve Pearce

Automotive Racing Products E225

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ARP is a leading manufacturer of specialised threaded fasteners, engineered primarily for engines used in motorsport. Producing high-strength fasteners from a wide variety of austenitic and martensitic alloys and Titanium, ARP offers both off-the-shelf and custom-made parts. With a wide range of advanced production, inspection and testing facilities on site, all manufacturing processes, including cold heading, heat treating and black oxide finishing are carried out in-house. The year of 2004 marked another successful racing season for ARP, with customers' engines winning races in Formula 1, CART, NASCAR, IRL and NHRA, to name but a few. The expanding range of fasteners for European and Japanese engines will be on display, together with a new selection of metric fasteners for 2005.

Autosport Electronics Ltd E201

Unit 4, Keytec 7 Business Park
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Worcestershire WR10 2TA, UK
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F: +44 (0)1386 561001
paul.whiting@autosportelectronics.com

Automotive Manufacturers' Racing Association Limited (AMRA) E365

The Nook, 27 Top Side
Grenoside, Sheffield S35 8RD, UK
T: +44 (0)114 246 4878
F: +44 (0)114 246 4858

AMRA was founded in 1951 and has become the real voice of the motorsport manufacturing industry with strong and respected links to the sport's major governing bodies. Members of AMRA form the core elite of the manufacturing industry that provide vital components and technical support to the world of motorsport, helping to keep the UK at the forefront of world technology. For more information on the Association's activities, visit the AMRA stand at Autosport Engineering.

• Rep on stand: A Barnes

Auto Trim Systems E166

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T: +44 (0)116 266 4112
F: +44 (0)116 261 0652
peter@auto-trim.co.uk
www.auto-trim.co.uk

Auto Trim Systems designs and manufactures protective covers for the motorsport industry for both cars and ancillary equipment. All products are manufactured from the latest materials for a stylish and personalised finish. In addition to protective covers, the company also manufactures pit lane canopies and banners, security screens and heat insulation covers. Its experienced staff can provide advice and recommendations to meet any budget. Auto Trim Systems is also the appointed distributor for Recaro seats.

• Rep on stand: Peter Swann

Balzers Ltd E136

Bradbourne Drive
Tilbrook, Milton Keynes MK7 8AT, UK
T: +44 (0)1908 377 277
components.uk@balzers.com
www.balzers.co.uk

Balzers is a world leader in friction and wear reduction coating applied to engineering components. This year, Balzers is pleased to announce the launch of new additions to its family of carbon-based coatings. BALINIT DLC STAR is a modified DLC coating with enhanced load-bearing capacity and BALINIT DLC-R has an enhanced running-in performance. These design concepts can be combined in BALINIT DLC-R Star. The enhanced load-bearing capacity can also be added to BALINIT C coating. These coatings are used in high performance engines and gearboxes to produce benefits of increased lifetimes, increased efficiency, reduced lubrication needs and smaller, lighter components using less expensive materials.

• Reps on stand: Manfred Berger, Takashi Kanamori, Jeff Bulmer, Andy Bloyce

BAR Group/Advantage CFD E142

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cfd@advantage-cfd.co.uk

Baty International E195

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T: +44 (0)1444 235621
F: +44 (0)1444 246985
sales@baty.co.uk
www.baty.co.uk

New from Baty is the 3D Venture Multi-sensing vision CMM range. Available as manual or CNC, the Venture now features 0.5 micron resolution and programmable white LED lighting for surface and profile illumination. Other standard features include an on-screen focus meter for manual Z axis measurement and auto-focus for CNC systems. Also available in 2D format for profile projectors, Baty's new software can scan profiles and best fit to a dxf file and report specific dimensions in a drawing format. A 40-page guide to metrology solutions is available from the Baty stand.

BBS Motorsport and Engineering GmbH E217

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F: +49 7836 521290
info@bbs-ag.com

Beringer Brake Systems

ZA, 42940 Chatelneuf, France
T: +33 4 77 76 82 95
F: +33 4 77 76 80 09
contact@beringer.fr
www.beringer.fr

Product listing: motorbikes and race car bucking system pressure limiter; master cylinder; brake designer and CNC machined callipers. Beringer has developed the Aerotec patented system of chrome-plated guides for brake pads which greatly reduces hysteresis of the caliper. The company works for motorbikes, car motorsport and light planes.

• Rep on stand: G Beringer

BERU F1 Systems Ltd E226

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Raid, Moto GP, CART and IRL. Beru F1 Systems offers a technologically advanced design and production facility that can respond quickly to a full range of their electrical needs. It manufactures, delivers and supports complete harness systems and electronic measurement systems to any customer location. Beru F1 Systems is the only company able to offer composite design and manufacture of all components relating to the wiring harness systems that it designs and produces giving total project control. It also supplies non-related composite parts to several major manufacturers. Beru F1 Systems continually invests extensively in R&D to develop new systems that the marketplace demands, including the now renowned tyre pressure system and the bespoke load cell product range.

BG Developments **E233**

Unit 9 West Court, Buntsford Park Rd
Bromsgrove B60 3DX, UK
T: +44 (0)1527 873 716
F: +44 (0)1527 575 403
Info@bgdevelopments.co.uk

BG Developments is a well-established brake and clutch specialist and has been involved with competition braking systems for almost 40 years. It has a large range of high-performance and competition brake kits available and is able to produce one-off kits for virtually any application.

BG Developments ranks as the largest UK AP Racing agent, carrying substantial stock of discs, calipers and accessories, together with a full range of racing and special tuning clutches. It also stocks a large range of brake pads including Performance Friction, Mintex, Ferodo, Pagid and EBC.

Blanc Aero Technologies **E262**

Le Jouquet, 22190 Plerin, France
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F: +33 2 96 68 33 45
www.lisi-group.com
[www.lisi-automotive.com]

As part of Lisi Aerospace, Blanc Aero Technologies is a leader in the manufacture of fasteners and assembly components for the racing and sports car industry. Blanc Aero Technologies supplies most of the leading teams, among them the Formula 1 and WRC World champions. All racing series can take advantage of its extensive experience in the manufacture of racing fasteners. Blanc Aero Technologies integrates the complete manufacturing, and through equipment investments and implementation of automatic manufacturing processes, it offers cost effective process with just-in-time deliveries.

• Rep on stand: Didier Godin

Blum Novotest Ltd **E151**

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BOS Engineering **E168**

Bowers Metrology Group **E75**

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julie.nuttall@bowers.co.uk

Braithwaite Rebuild **E111**

Braithwaite Machines
Bridlington YO16 6HH, UK

Braye Precision Ltd **E355**

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Brembo SPA **E86**

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F: +39 35 605273
laura-zuccali@brembo.it

Brown and Miller Racing Solutions Ltd **E340**

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T: +44 (0)1753 553 610
F: +44 (0)1753 577 477
paul.knight@bmrsuk.com
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Located in both the UK and USA, Brown and Miller Racing Solutions has over 40 years' experience in hose and fitting production. It uses this expertise to offer you new designs tailored to suit your particular application. Take advantage of its lightweight range of smooth bore and convoluted PTFE hose systems in various materials and braids in sizes #2 through to #20. It offers standard and custom-manufactured designs including forged and block fittings in numerous materials as well as one-piece swept elbows in standard and custom angles.

• Reps on stand: Paul Knight, Barry Miller

Butser Rubber Ltd **E160**

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Butserrubber@btinternet.com
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Butser Rubber specialises in custom-made rubber mouldings and high-quality components and is an ISO9001:2000 certified company. Currently supplying demanding markets including Formula 1, motorsport, maritime, aerospace, medical and defence, it is always looking to expand into new areas. Butser Rubber manufactures any product from one-off prototypes to volume production. Development and technical consultancy is available, together with assistance in design. Its range includes rubber-to-metal bondings, gaskets, extrusion and mouldings.

• Reps on stand: Nigel Easton, Nicky Easton, Mark Byrne, Robin Easton, Edward Easton, Charles Easton

C&B Consultants Aerodynamics Ltd **E359**

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mike.clark@candbconsultants.com
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C&B Consultants specialise in aerodynamic programs, model making and full size carbon composites. It has carried out major aerodynamic



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programmes in CART, IRL, LMP, GT and high performance road cars, the most significant being five years for Honda in the CART series, and currently the Superfund Formula car. Its ability to follow the whole process through (design, pattern making, mould making, component manufacture to final assembly) is epitomised by its manufacturing of carbon wiring loom junction boxes and range of wind tunnel model wheels. The C&B equipment inventory includes CNC machine tools, composite ovens and 1.5 meter diameter autoclave.

• **Reps on stand:** Michael Clark, Adam Dugdale

Chambon **E120**

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42042 Saint Etienne, France
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F: +33 4 77 74 33 58
sales@chambon.com
www.doverpmi.com

PMI, a subsidiary of Dover Corporation, is an international group of premier companies in the motorsport industry including JE Pistons, Wiseco Piston, Carillo Industries (all in the USA), Vertex Pistons (Italy), Perfect Bore Ltd (UK) and Chambon Crankshafts (France). The group currently designs and manufactures internal engine components including pistons, connecting rods, cylinder liners and crankshafts for the automotive and power sports markets worldwide.

• **Reps on stand:** Nicholas Chambon, Bob Burggy, Marl Otway, Ian Graham, Jim Zoretich

Co-ordSport Ltd **E19**

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T: +44 (0)1384 216 102

F: +44 (0)1384 216 109

sales@coordsport.com

www.coordsport.com

Co-ordSport is a wholesaler of branded tuning parts and equipment, especially for Japanese performance models. Co-ordSport is distributor for Cosco, ARP fasteners, Fidanza, Oliver and Ross pistons. Main dealers for HKS, EGR or fitters, Yokohama Motorsport tyres and much more.

• **Reps on stand:** Philip Smith, Tessa Cope

Corus Engineering Steels **E26**

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Rotherham S60 1DW, UK
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philip.barker@corusgroup.com
www.corusgroup.com

Corus Engineering Steels offers autosport component manufacturers and end users: specialist VAR or ESR remelted and standard automotive steel bars; multi metal stockholding services; materials technical support service; and supply chain experience. The stand personnel will be available to discuss the development of improved steels and material supply routes for engine, transmission and driveline, steering and suspension components.

• **Reps on stand:** Chris Dale, Steve Bacon

Cosworth Racing **E7**

St James Mill Road
Northampton NN5 5RA, UK
T: +44 (0)1604 598 654

F: +44 (0)1604 598 656

With experience spanning more than four decades, Cosworth Racing is a world leader in design, development and manufacture of ultra-high performance engines for racing, rally and road car applications. Cosworth Racing provides powerplant technology and design solutions for premier teams in Formula 1, the world Rally championships, CART (USA), GP motorbike racing and Sportscars, as well as racing engine technology transfer to the premier automotive group of Ford Motor Company.

Coventry Prototype Panels **E240**

Wheler Road, Seven Stars Industrial Estate
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F: +44 (0)24 7630 8090
vstephens@covproto.com
www.covproto.com
[www.superform-aluminium.com]

For 2005 CPP is sharing a stand with its strategic partner, Superform Aluminium. They will be exhibiting a pair of high performance, all-aluminium racecars, demonstrating the specialist capabilities of the two companies in development and production of body, chassis and lightweight components. The pair will comprise a Spyker supercar, featuring full aluminium chassis and body, manufactured entirely by CPP, and a Morgan GT racecar, prepared for the 2005 season and featuring superformed aluminium body panels. The two companies are also collaborating on the development of magnesium race parts and will have demonstration samples on the stand.

• **Reps on stand:** V Stephens, L Betieridge, D Wesh, B O'Toole

Craftsman Tools Ltd **E207**

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F: +44 (0)1242 604059
sales@cotswold-machinery-sales.co.uk

Cranfield University Motorsport Group **E266**

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motorsport@cranfield.ac.uk
www.motorsport.cranfield.ac.uk

Cranfield University provides research, consultancy, testing, education and recruitment. Facilities include the Cranfield Impact Centre, wind tunnels, vehicle dynamics and brake rigs, competition vehicles, advanced materials, coatings, composites, computing, engine manufacturing, microsystems, nanotechnology, precision engineering, structures and welding laboratories. Postgraduates from Cranfield's MSc Motorsport Engineering and Management course often go on to motorsport careers with companies such as Williams F1 (which provides scholarships), BAR, McLaren Racing, Jaguar Racing, Jordan GP, M-Sport, Prodrive, Xtrac, Alcon, RML, Pirelli, G-Force and EM Motorsport. Prodrive backs the Group Design Project and the BRDC is a major supporter of the Cranfield Masters programme. Cranfield is a member of both AMRA and the MIA.

• **Reps on stand:** Jeff Alcock, John Nixon

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motorsport@stone-foundries-united.com
www.stone-foundries-limited.com

Manufacturers of high integrity aluminium and magnesium sand castings to the autosport industry.

• Reps on stand: Paul Evans, Chris Powley

CRP Technology E112

Via Cesare della Chiesa 150/B
Modena 41100, Italy
T: +39 059 821135
F: +39 059 822071
icevolini@crptechnology.com

CTG Ltd E248

Thorpe Park, Thorpe Way
Banbury, Oxfordshire OX16 4SU, UK
T: +44 (0)1295 220 130
F: +44 (0)1295 220 138
motorsport@ctg ltd.co.uk
www.TORQline.com
www.ctg ltd.com

CTG has several exciting developments to show at the 2005 exhibition. It will be demonstrating the TORQline range of advanced composite driveline products, including a range of aftermarket automotive propshafts, new race propshafts and TORQdisc Flexible Disc Couplings, together with a new addition to the TORQline portfolio, its range of

optimised lightweight metallic propshaft solutions. CTG will also show its ever-developing range of advanced composite hydraulic accumulators and pressure vessels. Several other highly innovative composite motorsport products will also be on display, as well as CTG's superb keronite ceramic coating for aluminium and motorsport magnesium components.

• Reps on stand: Mike Dewhirst, Dinesh Sathianathan

Custom Crank & Engineering Co Ltd E348

Sunbeam Works, Moore Street South
Wolverhampton WV2 3JN, UK
T: +44 (0)1902 422 144
F: +44 (0)1902 422 133
Info@customcrank.co.uk
www.customcrank.co.uk

Custom Crank specialises in the manufacture of high-quality crankshafts machined from castings, forgings or solid billet (EN 40B) for a wide range of automotive, motorsport and industrial applications. The company is 150 9001-2000 registered and all its manufacturing processes conform to this standard at every stage of manufacture.

• Reps on stand: Mark Rigg, Sally de Sanaha

Cutting Edge Solutions E421

5 Thorney Leys Business Park
Witney, Oxfordshire OX28 4GE, UK
T: +44 (0)1993 849 500
F: +44 (0)1993 849 600

Since its formation, Cutting Edge Solutions has become the UK's premier Solid Edge reseller. Solid

edge is a windows based world beating CAD system from UGS. By a method of business that includes an open, honest and no-nonsense approach and regular customer update events, Cutting Edge Solutions now support more companies for Solid Edge than any other. In autosport our customers range from single component suppliers to full racecar designers and based in Oxfordshire we offer local support and expertise to the industry. On display will be Solid Edge version 11 with complimentary applications ranging from Analysis through to Product Data Management. Also on display will be customer examples, illustrating how Solid Edge has improved design and productivity within their business.

Datron Technology Ltd E130

6 Potters Lane, Kiln Farm
Milton Keynes, Bucks MK11 3HE, UK
T: +44 (0)1908 261655
F: +44 (0)1908 260108
jgrist@datrontechnology.co.uk

DC Electronics E83

Unit 1 Quayside Industrial Park, Bates Rd
Maldon, Essex CM9 5FA, UK
T: +44 (0)1621 856 451
F: +44 (0)1621 842 237
sales@wiringlooms.com
www.wiringlooms.com

In addition to being a leading manufacturer of electrical systems in the motorsport industry, DC Electronics has developed a unique electronic power steering system – test the system yourself on its stand. The company can provide engine management and data acquisition hardware for

most of the leading motorsport manufacturers, as well as advising on and supplying control panels, LED lights, switches, circuit breakers and sensors. Visit DC Electronics not just for your wiring loom but for your complete electrical system.

• Reps on stand: David Cunliffe, Sandra Cunliffe, Dion Scholte, Simon Astle

DCM Products Ltd E17

Bayton Rd, Exhall, Coventry CV7 9EL, UK
T: +44 (0)24 7636 1601
F: +44 (0)24 7636 7914
high@dc.co.uk
www.precisionpoint.co.uk

DCM Products Ltd will be exhibiting and demonstrating its popular Precision Point PPL40 Laser Wheel Alignment Gauge and DCG2000 Digital Camber Gauge. The PPL40 Alignment gauge is probably the quickest and easiest wheel alignment gauge available in the market today. It gives accurate results, is battery operated and ideal for use either in the workshop or at trackside. The DCG2000 Camber Gauge has a large, clear digital display, a hold and backlight facility and an alternate zero mode to compensate for the un-level floors. Both units are available through nationwide distributors and worldwide agents.

• Reps on stand: Hugh Wadsworth, Paul Williams

Delcam plc E49

Talbot Way
Small Heath, Birmingham B10 0JH, UK
T: +44 (0)121 766 5544
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www.delcam.com

Delcam is the world's leading supplier of CAD/CAM systems developed specifically for the design, manufacture and inspection of complex shapes. Such systems are essential for the development of many components in the motorsport industry, ranging from engine assemblies through to aerodynamic body panels, and for the manufacture of all types of tooling. Delcam's Power Solution software enables companies to maximise their profitability by increasing productivity, improving quality and reducing lead times. It is used in over 60 countries worldwide by more than 9,000 organisations, ranging from large multi-nationals to small toolmakers.

DATAS (Data Analysis Tools and Simulation) E79

The Old Chapel, Norfolk IP21 4XP, UK
T: +44 (0)1603 506 526
F: +44 (0)1603 504 907
info@datas-ltd.com
www.dats-ltd.com

DATAS was formed by vehicle dynamicist Steffen Kosuch and F1 designer Chris Murphy in 1999, primarily to develop and distribute their main award-winning product, RaceSim vehicle simulation software. After extensive development and validation testing, RaceSim is now available in Version 2.6.x, with levels ranging from Dallara F3 up to full dynamic transient Expert. Recent DATAS developments include pit stop strategy module, vehicle optimisation module and a direct import/export link to Mitchell WinGeo kinematic software.

Delwest Engineering E197

28128 W Livingston Avenue
Valencia, CA 91355, USA
T: +1 661 295 5700
F: +1 661 295 8300

Zi Les Vernes, 1852 Roche, Switzerland
T: +41 21 967 21 21
F: +41 21 967 21 27
info@delwestusa.com
www.delwestusa.com

Delwest USA has its headquarters in Valencia, California, and operates an additional engineering design and manufacturing facility in Roche, Switzerland. The company's titanium valves and lightweight valvetrain components lead the market in a diverse range of professional racing series, including Formula 1, Le Mans, NASCAR Nextel Cup, Busch and Craftsman Truck, IMSA, IRL, HNHRA and IHRA drag racing, and a number of additional US open wheel series, including the United States Auto Club (USAC), Champion Racing Association (CRA), and World of Outlaws (WoO) sprint cars.

Deutsch Ltd E230

2 Stainer Rd, Castleham Industrial Estate
St Leonards On Sea
East Sussex TN38 9RP, UK
T: +44 (0)1424 852 722
F: +44 (0)1424 855 979
p.webb@deustch.co.uk
www.deutschltd.co.uk

Another busy year at Deutsch autosport as it starts production of the next generation of autosport electrical connectors. As teams push the space

envelope barriers still further, Deutsch introduced a high density range, starting with the ASU with five contacts, during 2004. These are specially designed for racing with the next generations of smaller, lighter wire, and introduce new technologies in contact retention inside the connector. This will be followed by a 6 Way version of the ASL (size 6) connector in early 2005, followed by a suite of larger shell sizes during '05 and '06. At the other end of the scale, the new heavy-duty product is proving very popular for battery, alternator and starter motor applications and further variants are expected during 2005.

• Rep on stand: Paul Web

Doug Kiddie Engineering (DKE) E176

Enterprise House, Leicester Road
Sapcote, Leicestershire LE9 4JF, UK
T: +44 (0)1455 273 738
F: +44 (0)1455 274 435
dkecrankshafts@aol.com
www.dkecrankshafts.com

DKE manufactures performance crankshafts, to order, for the automotive sector, specialising in R&D, race and tuning projects.

• Reps on stand: Tim Moss, Somon Osman, David Whitbread

DMS Technologies E30

Belbins Business Park, Cuperham Lane
Romsey, Hampshire SO51 7JF, UK
T: +44 (0)1794 525 400
F: +44 (0)1794 525 450
info@dmstech.co.uk
www.dmstech.co.uk

Visit the DMS stand to see its Varley Red Top range of race and rally batteries, which offer 30% better engine start performance than any other AGM/dry cell batteries. Red Top are the original racing batteries – they require no topping up, and can be installed in any orientation while providing the best power-to-weight ratio. The Red Flash 650 grid start power pack will also be on display – ideal for workshop and pits use.

• Reps on stand: Paul Edwards, Heather Munroe, Kelvin Charles

Docking & Co Ltd E214

Unit 15, Silverstone Circuit
Silverstone, Northants NN12 8TL, UK
T: +44 (0)1327 857 164
F: +44 (0)1327 858 011
www.dockingengineering.com

In 1984 Docking Engineering was formed to develop a range of aluminium cooling products for motorsport and special vehicle use. From the beginning its products were successful and have played their part in winning the world Sportscar and World Rally Championship, as well as the world's classic races: the Le Mans 24 hour, Daytona, the Indy 500 and the gruelling Paris to Dakar rally. The company offers a full range of services from core block supply to full system design and manufacture. By using its own products or those of its technical partners Docking & Co is able to offer the most efficient cooling products available.

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www.donfoster-racing.fr

Design and engineering of fabricated parts (upright, wishbones).

• Reps on stand: Christian Gigot, Michel Costa

DP Seals E118

Unit 6, Dawkins Rd
Hamworthy, Poole, Dorset BH15 4JY, UK
T: +44 (0)1202 674 671
F: +44 (0)1202 665 581
sales@dpseals.com
www.dpseals.com

Manufacturers of custom precision rubber seals. If rubber seals, gaskets or moulding play a vital role in what you produce, DP Seals can play a major part in your future. The company specialises in providing expert advice on materials and performance to help ensure your products meet specification. Working hand in hand with your design engineers it can develop prototypes and manufacture everything from simple O-rings to complex metal bounded products – all to the highest standards of quality and precision and with its own cam-linked CNC tool room, DP Seals can shorten your time to market.

• Reps on stand: A Piper, D Piper, P Hendes

Drill Service (Horley) Ltd E31

Albert Rd, Horley, Surrey RH6 7HR, UK
T: +44 (0)1293 774 911
F: +44 (0)1293 820 463
sales@drill-service.co.uk
www.drill-service.co.uk

On show will be samples from the large Drill Service range of drills, reamers and milling cutters, especially tools relating to areas of motorport industries, showing the company's long-term involvement and commitment to its customers. Particular emphasis will be placed on its ability to supply special tools, especially reamers on quick deliveries. Tools supplied in carbide, cobalt and HSS, with coatings where necessary. Drill Service can work from customer drawings and advise on the right tool for the job when required. Its stand will be staffed with willing personnel ready to listen to your requests and hopefully provide you with answers.

• Reps on stand: Georgie Worsley, Stuart Lawson, Rick Dival

Dr Schrick GmbH E51

Dreherstr 3-5, 42899 Remscheid, Germany
T: +49 2191 9500
F: +49 2191 950 115
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• Reps on stand: Thomas Heitmann, Stefan Wolf, Joerg Reitz

Druck Ltd E67

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F: +44 (0)1162 317246
tony.cuttill@ge.com

DTA E229

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Salford, Manchester M50 2GN, UK
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The complete range of engine management systems, dashboards and throttle bodies will be available to view. Technically aware staff will be able to explain their use and functionality – ask any question and they can answer it.

• Reps on stand: Allan Warburton, Steve Greenald

DVT Corporation E73

MWB Business Exchange
4th Floor, Exchange House
494 Midsummer Boulevard
Milton Keynes MK9 2EA, UK
T: +44 (0)1908 255 773
F: +44 (0)1908 255 700
ian.tatton@dvtensors.com
www.dvtensors.com

DVT Corporation will present the world's first public demonstration of vision-enabled robotics. Developed with KUKA Automation + Robotics, the technology, which embeds machine vision within the robotics controller, is causing quite a stir. As sensors become part of the robot itself, this system shows how an emerging generation can work faster still, make autonomous decisions based on sensory feedback, reduce or eliminate the need for line fixtures and even be operated by untrained personnel, using its two-tier GUI. By being able to interact directly with its own vision system (effectively giving the robot a pair of eyes) the robot can change programmes to respond to what it sees.

• Rep on stand: Simon Beveridge

Earls Performance Products Ltd E215

Unit 17, Silverstone Circuit
Silverstone, Northants NN12 8TL, UK
T: +44 (0)1327 858 221
F: +44 (0)1327 855 473
martyn.pott@earls.co.uk

East Penn Manufacturing Co E205

Lyon Station, PA 19536, USA
T: +1 610 682 6361
F: +1 610 682 4781
eastpenn@eastpenn-deka.com
www.eastpenn-deka.com

Since 1946 East Penn has been producing high-quality batteries for industrial, automotive, commercial, marine, stationary and specialty markets. A progressive company committed to the future, East Penn operates the largest single site facility in the industry. For racing applications, East Penn presents Deka Power Sport's battery range. The Deka Power Sport AGM batteries are completely spill and leak proof. The absorbed glass mat (AGM) technology increases performance, versatility, strength (vibrations and impact and durability). Deka Power Sport's battery range has already an impressive file of references among European racers (manufacturers/teams) and is

distributed and serviced by a team of enthusiast dealers committed to satisfy with excellent racers' needs.

• Reps on stand: Bob Patterson, Davide Gaudino, Sergio Sironi, Damiano Lo Giudice, Jessica Mortara

Eibach UK E126

Swannington Rd, Broughton Astley
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sales@eibach.co.uk
www.eibach.com

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• Reps on stand: Ralph Eibach, Dan White, Julian Gill, Rob Hodgson

Elite Design and Manufacturing E177

Gear Works, Salem Street
Eturia, Stoke on Trent ST1 5PR, UK
T: +44 (0)1782 280 136
F: +44 (0)1782 269 913
sue.bloor@netcts.net
www.eliteracingtransmissions.com

Elite Design and Manufacturing, specialists in race engineering and racing gearboxes, will be launching its brand new in-line six-speed sequential gearbox, specifically designed for front engine rear wheel drive cars, with higher torque capacity (300lb/ft) to withstand the vehicles of rallying. Elite will also be displaying its various other in-line/transaxle gearboxes, along with its other racing products and services, which include diffs, drive shafts, gears etc. Elite is a company that can offer anything from a complete rebuild, through to a full design and manufacture of a bespoke gearbox.

• Reps on stand: Mark Bloor, David Fenton, Paul Williams

Elmdon Metals E419

Unit 39, Elmdon Trading Estate
Bickenhill Lane, Birmingham B37 7HE, UK
T: +44 (0)121 781 0999
F: +44 (0)121 781 0909
elmet@0800dial.com

Eltro (GB) Ltd E44

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Southwood Business Park
Farnborough, Hampshire GU14 0NR, UK
T: +44 (0)1252 523 000
F: +44 (0)1252 522 338
jeremy@eltro.co.uk
www.eltro.co.uk

Eltro operates an advanced surface engineering facility for pulsed plasma nitriding using its patented Eltropuls process. The company offers a sub-contracting service for plasma nitriding, nitrocarburising, oxy-black finishing and hard coating, and also provides sales and support for customers wishing to purchase equipment and do surface treatments in house.

• Reps on stand: Jeremy Cockrem

EM Motorsport E100

John Eccles House, Oxford Science Park
Oxford OX4 4GP, UK
T: +44 (0)1865 338336

F: +44 (0)1865 338100
ian.stone@emmotorsport.com

EMW Law E238

Seckloe House, 101 North 13th Street
Milton Keynes MK9 3NX, UK
T: +44 (0)1908 399 600
F: +44 (0)1908 236 038
robertc@emwlaw.com

Engine Parts UK E228

Units 14-17, Thurrock Commercial Park
Purfleet Industrial Estate
South Ockendon, Essex RM15 4YA, UK

Enpar Special Alloys Ltd E150

Station Rd
Ecclesfield, Sheffield S35 9YR, UK
T: +44 (0)114 219 4094
F: +44 (0)114 219 1140
mwright@frithrixson.com
www.frithrixson.com

Enpar Special Alloys is a wholly owned subsidiary of Frith Rixsons plc and a world leader in the production and distribution of high technology alloys, supported by continued research and development. It specialises in nickel-cobalt-titanium alloys in various parts of the car, particularly engine suspension parts, general chassis and drive train construction, roll cage tubing and exhaust systems. The range consists of Inconel 625 - 'LCF' - 718-725-617; Nimonic 75-80-90 C623-PE11 - AK33 and titanium CP-6AL.

• Reps on stand: Mike Wright, James Ashmore, Keith Roden

EPM E101

20 Victoria Road
Draycott, Derby DE72 3PS, UK
T: +44 (0)1332 875 451
F: +44 (0)1332 877 415
info@epmtechnology.com

ETA Circuit Breakers Ltd E163

6 Telford Close, Aylesbury
Buckinghamshire HP19 8DG, UK
T: +44 (0)1296 420 336
F: +44 (0)1296 488 497
info@e-t-a.co.uk
www.e-t-a.com

ETA will show its competition-proven circuit breaker range, which is designed to avoid the inconvenience of blown fuses and provide superior protection for vehicle wiring harnesses and related components on all types of race and rally cars. Among the products on display will be its heavy-duty circuit breakers for all high current applications and battery isolation switches with remote control.

• Reps on the stand: Kathryn Clamp, Steve Lett, and Albert Pipe

ETS Racing Fuel & Lubes E209

3 Rue de Tronquet, BP 198
Mont Saint Aignan, Cedex 76136, France
T: +33 2 32 82 77 12
F: +33 2 32 82 77 95
Jerome.duche@ets-p.com

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Autosport Engineering
Stand E106 The Racing Car Show

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Telephone: (+44) 1233 500 200 Fax: (+44) 1233 500 300

engines or gear boxes.

• Rep on stand: Dr B Philippon

Evans and Price Ltd E288

Silica Road, Amington Industrial Estate
Tamworth, Staffs B77 4DT, UK
T: +44 (0)1827 544 72
F: +44 (0)1827 609 06

Farnden Engineering E343

Bayton Road, Exhall, Coventry CV7 9EG, UK
T: +44 (0)24 7636 6910
F: +44 (0)24 7664 4698

Faro UK E377

The Techno Centre
Coventry University Technology Park
Puma Way, Coventry CV1 2TT, UK
T: 0800 917 6167
F: 07623 6150
uk@faroeng.co.uk
www.faroeng.co.uk

Faro UK is the global leader of portable 3D measurement solutions consisting of products that can measure from a few inches up to 70 metres, at the point of manufacture. The FaroArm is a highly accurate portable measurement arm designed for engineering, manufacturing and controlling dimensional quality by anyone in production. The FaroLaser ScanArm is a simple addition to a FaroArm, creating the world's first fully integrated non-contact line scanner for rapid 3D inspection or reverse engineering. The latest award-winning product is the Faro Gage, the world's first personal CMM that allows 3D measurements to be taken by machinists with

tolerances up to 5µm.

• Rep on stand: David Homewood

Farrington Instruments Ltd E63

Unit 9 Oriel Court, Omega park
Alton, Hampshire GU34 2YT, UK
T: +44 (0)1420 541 591
F: +44 (0)1420 587 212
andrew.schryver@farringtoninstruments.co.uk
www.laptimer.com

Farrington will be showing the latest versions of its lap timer products including models with data logging and a performance indicator. Also on show will be the SWIS10 Steering Wheel Instrument System which provides a comprehensive set of timing and gauge instruments, housed in an enclosure integrated with a racing steering wheel. These systems are available with a range of data logging options. The new RCA50 racing quartz tachometer with a tell-tale hand will also be shown. A special version will be available that closely resembles the chronometric tachometers used on many historic race cars.

• Reps on stand: Andrew Schryver, Andrew Parrott

Federal Mogul Special Products E306

Corso Inghilterra 2
Mondivi, CN 12084, Italy
T: +39 174 560519
F: +39 174 552248
cristina.rocce@ev.fmo.com

Ferrea Racing Component E224

2600 NW 55th Court, Suite #238

Fort Lauderdale FL 33309, USA

T: +1 954 733 2506

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ferrea@ferrea.com

www.ferrea.com

Engine valve train components for racing cars, motorcycle and boats. Products are titanium, super alloy and steel alloy valves retainers, valve guides, valve springs, valve seat locators lifters, wrist pins, cylinder head gaskets.

• Reps on stand: Oscar A Romano, Zeke Urrutia, Jon Verburg

FGP Sensors & Instrumentation E200

(c/o NetSensors Ltd)
5 Pipers Court, Berkshire Drive
Thatcham, Berkshire RG19 4ER, UK
T: +44 (0)1635 292 713
F: +44 (0)1635 866 144
peter@netsensors.co.uk
www.fgpsensors.com

FGP Sensors will be launching a new series of ruggedised single and triaxial accelerometers for vehicle dynamics measurements in high vibration applications. Also new is a series of ultra-miniature pressure/temperature sensors for high temperature applications. Other products on show include a wide range of sensors to measure force, pressure, acceleration and torque on vehicle and test bench applications. With over 25 years of continuous experience in applying sensors to demanding applications, FGP offers not only a standard line of sensors but also fully bespoke solutions to your measurement and logging requirements.

• Reps on stand: Peter Trevor, Catherine Money

Fine-Line Developments Ltd E187

36 Burners Lane, Kiln Farm
Milton Keynes, Bucks MK11 3HB, UK
T: +44 (0)1908 564 096
F: +44 (0)1908 565 408
colin.bradshaw@finelinedev.com
www.finelinedev.com

Fine Line Development is an established Mechanical Engineering design business, effecting component design, manufacturing tooling, jigs, fixtures and special purpose manufacturing machinery, serving large corporate plc's and multinational organisations. All general design undertaken as design only or design and build projects.


• Reps on stand: Colin Bradshaw, Ian Williams

Flex Metrology E321


Unit 2, Homefarm, Luton Hoo estate
Luton LU1 3TD, UK
T: +44 (0)870 143 3008
F: +44 (0)870 143 3016
sales@flexmetrology.co.uk

Forsberg Services Ltd E133

1b Waterview Way
White Cross, Lancaster LA1 4XS, UK
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Stand E229 The Racing Car Show

DTAfast is a fully configurable dashboard display able to receive all engine data and sensor readings directly from the serial port of the DTA P8Pro race engine ECU with just a simple serial port link - no need for extra sensors.

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The **GDash** is available complete with wiring loom and button plate directly from DTA and its extensive worldwide dealer network @ **£850 + VAT**



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Forsberg Services supplies dynamics measurement and navigation components to system integrators; and is the European dealer for NovAtel GPS equipment. The company has developed several new products to provide enhanced connectivity from any of the NovAtel GPS engines. The FSLPak has many features including RS-232, RS-422, RS-485, USB, external oscillator connection, variable 1PPS and Ethernet connection. The company also provides tools that assess vehicle performance and variations in driver technique. NovAtel is pleased to introduce SPAN (Synchronised Position Attitude Navigation) Technology, a next generation positioning system that combines GPS and inertial capabilities for uninterrupted operation and highly accurate position and attitude measurements.

Froude Consine **E192**

Blackpole Road, Worcester WR3 8YB, UK
T: +44 (0)1905 856 800
F: +44 (0)1905 856 811
sales@froude.fki-et.com
www.fki-et.com/fr

Froude Consine manufactures a wide range of engine testing systems for motor and motorcycle racing markets. All of its solutions – from bespoke installations to standard dynamometer equipment – focus on delivering value to its customers. Whether your requirements are for a 20,000rpm/750kw fully automated test system or low cost, power dyno the company is confident that it can deliver and service its systems to your highest expectations. In addition it can offer a full test system and dynamometer overhaul and repair service through its dedicated customer services support team.

• **Reps on stand:** Simon Ruffley, Keith Stokes

Gearfox Ltd **E45**

Charter House, 106 Baker Street
Marylebone, London W1U 6TW, UK
T: +44 (0)20 7486 1970/1862
F: +44 (0)20 7935 3268
dan.sargent@gearfox.co.uk
www.gearfox.co.uk

From gearbox design, prototype and build, Gearfox complements programs through quality component sourcing, developing the best lubricants, specialist coolants and additives. Gearfox is the technical, logistical and marketing partner for a wide range of products and services associated with the automobile, aeronautical, marine and industrial sectors. Gearfox works with class leading partners in engineering disciplines across the world. Our in-depth experience ranges from drivetrain development to full automotive refinement programmes. Gearfox is experienced in working from concept, through prototype stages to development and application.

Gieffe SRL **E205**

Via San Giuliano, 39A
Castelceriolo (AL) 15040, Italy
T: +39 0131 216 505
David.gaudino@gieffesrl.it

GKN Motorsport **E254**

Unit 5, Kingsbury Road, Business Park
Minworth, Sutton Coldfield B76 9DL, UK
T: +44 (0)121 313 6253
F: +44 (0)121 313 2075
r.tyler@gkndriveline.co.uk

Bespoke driveshaft and propshaft solutions, from design through to manufacture backed by years of

technical development and innovation. GKN Motorsport can offer services to beginners and world champions alike.

Glebe Engineering Ltd **E246**

Edensor Works, Greendock Street
Longton, Stoke on Trent ST3 2NA, UK
T: +44 (0)1782 599 161
F: +44 (0)1782 324 410
nick.cresswell@glebe.co.uk
www.glebe.co.uk

Glebe supplies precision components to: Williams F1, McLaren International, Renault F1, Red Bull Racing and Lola Cars, while Glebe Transmissions produces gearboxes and gearkits for the clubman race and rally market. The new six-speed sequential has been very successful in the hands of McRae protégé Kris Meeke, winning his class on the McRae stages rally.

• **Reps on stand:** Nick Cresswell, Tom Cresswell, Jan Cresswell, Wayne Aurose

Goodridge **E164**

Exeter Airport Business Park
Exeter, Devon EX5 2UP, UK
T: +44 (0)1392 369 090
F: +44 (0)1392 441 780

The world's leading manufacturers of lightweight fluid transfer systems. Supplying all disciplines of motorsport including F1, Champ Cars, NASCAR, training car and WRC teams. Substantial investment within our engineering facility allows Goodridge to provide rapid turnaround of milling, turning and tube bending. A constantly expanding product portfolio keeps Goodridge strides ahead. Worldwide distributors of Staubli and Wiggins

couplings.

Gosnay's Engineering Company **E396**

Eastern Avenue, Mawney Road Junction
Romford, Essex RM7 7NS, UK
T: +44 (0)1708 740 668
F: +44 (0)1708 733 266
sales@gosnays.co.uk
www.gosnays.co.uk

Established in 1935 Gosnay's has been serving the local motor trade and competition engine builders continuously for over 70 years. Its workshops are equipped with the latest machines for cylinder boring and resleeving, diamond honing, con rod reconditioning, valve seat recutting and inserting as well as white metallising of main bearing and con rods for vintage engines. Gosnay's is distributor for JE Pistons, Darton Sleeves, Carillo Con Rods, K-Line Bronze Guide Liners and Goodson Workshop Equipment, as well as federal Mogul Engine parts, Mahle Pistons, Karl Schmidt Pistons and Bearings.

• **Reps on stand:** Adrian Wilkes, Chris Holmes

Griffin Thermal products **E300**

100 Hurricane Creek Road
Piedmont SC 29673, USA
T: +1 864 845 5000
F: +1 864 845 5001
sales@griffinad.com
www.griffinad.com

High performance aluminium heat exchangers, including radiators, oil coolers and intercoolers.

• **Reps on stand:** Buddy Griffin, Brian Griffin, Jackie Griffin



Autosport Engineering
Stand E301 The Racing Car Show

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Ole Buhl Racing Ltd.
Roughwood House
Highwood, Nr Ringwood
Hampshire, BH24 3LE
England

sales@efitechnology.co.uk
Tel: +44 (0) 1425 478822
Fax: +44 (0) 1425 478866

Grip Tyre Softener E82

Unit 10 Midland Business Centre
Midland Rd, Higham Ferrers,
Northants NN10 8DN, UK
T: +44 (0)1933 312 735
F: +44 (0)1933 317 171
info@griptyresoftener.com
www.griptyresoftener.com

Grip Tyre Softener was developed over a decade ago when engine performance and horsepower levels were advancing faster than tyres could keep up with and many felt that they needed more grip. The results of treated tyres are dramatic. Not only are new tyres made softer and stickier, but old, previously discarded tyres are given a whole new lease of life, enabling the more budget conscious racer to get the very last out of their sets. Wet weather tyres also benefit greatly from being treated, again with impressive results.

• Rep on stand: G Hauser

G&S Valves E43

Alder Works, Catteshall Lane
Godalming, Surrey GU7 1JS, UK
T: +44 (0)1483 415 444
F: +44 (0)1483 426 891
gsvalves@aol.com
www.gsvalves.co.uk

G&S Valves, founded in 1946 specialises in manufacturing a wide range of valves, from one-off prototypes for engine development, up to ongoing scheduled contracts for larger companies. It has received approved supplier status from many of the major OEM and high performance manufacturers. G&S Valves works very closely with the motorsport industry to design and manufacture valves and

spring retainers for new and existing projects, as well as older style vintage car and bike engines.

Haas Automation E324

Bradgate House, 13 Unthank Road
Norwich NR2 2PA, UK
T: +44 (0)1603 760539
F: +44 (0)1603 760542
mchedgey@haas.co.uk

Hamlin RPD E395

Bunkers Hill Farm, Welsh Road
Offchurch, Leamington Spa CV33 9BE, UK
T: +44 (0)1926 614147
F: +44 (0)1926 612899

Hawk Performance E48

920 Lake Road, Medina, Ohio 44256, USA
T: +1 330 721 1225
F: +1 917 464 8227
bberentz@wellmanproducts.com
www.hawkperformance.com

High-performance street and dedicated motorsports disc brake pads. Hawk Performance is a leading provider of high-quality motorsports and performance street disc brake pads with a worldwide distribution.

• Reps on stand: Bruce Berentz, John Slagle

HB Bearings E167

Riverside Works, Honley, Holmfirth
Huddersfield, West Yorkshire HD9 6PQ, UK
T: +44 (0)1484 665 116
F: +44 (0)1484 662 619
motorsport@b-bearings.com
www.hb-bearings.com

HB Bearings Motorsport Division will be exhibiting examples of its special bearings and slim-line bearings for use in applications including Formula 1, Rally and Performance cars. Types can be ball, roller, thrust, angular contact or even combination. The design can incorporate special flanges, threaded locations, completely no standard sizes, bearings also supplied with ceramic components if required. Cages for bearings can be to customer specification with high specification materials. HB Bearings works very closely with its customers on development and improvement in this very demanding environment. It is also able to supply quantities from as little as one off without prohibitive cost penalties up to batches of around 1,000 or more, depending upon size and complexity.

• Reps on stand: Graham Hirst, Frank Roebuck, Michael Hales

Heidenhain (GB) Ltd E198

200 London Road
Burgess Hill, West Sussex RH15 9RD, UK
T: +44 (0)1444 247711
F: +44 (0)1444 870024
sales@heidenhain.co.uk
www.heidenhain.co.uk

Heidenhain will be showing products that dramatically aid production in manufacturing engineering and component inspection. These will include; Heidenhain TNC CNC controls, used widely on the milling machine and lathes; CNC machine probes which dramatically reduce component set up times; digital readouts that can be fitted to all forms of manual machine tools; and gauging systems, used widely to measure cam and

crankshafts, as well as general component measurement.

• Reps on stand: Keith McGowan, Phillip Lodge

Hone All Precision Limited E186

Unit 1, Frenchs Avenue
Dunstable, Bedfordshire LU6 1BH, UK
T: +44 (0)1582 477 721
F: +44 (0)1582 477 728
sales@hone-all.co.uk
www.hone-all.co.uk

Hone-All Precision provides a wide variety of industries with a complete service to meet and exceed its manufacturing needs – from sourcing raw materials to producing finish machined components. At the Hone-All stand you will see a variety of components, all machined from solid by skilled engineers and on the company premises. This exhibition of single source manufacturing will demonstrate that supply chains and costs can be reduced while quality and traceability is increased by using a company that can handle the whole job – from start to perfect finish.

• Reps on stand: Andrea Rodney, Colin Rodney, Ted Barchard

Horn UK E346

32 New Street
Ringwood, Hampshire BH24 3AD, UK
T: +44 (0)1425 481 880
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info@phorn.co.uk
www.phorn.co.uk

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SHOCK ABSORBER DYNAMOMETERS



>CLUBMAN 04

This machine is designed to bring features of higher end machines to racers with limited budgets. The standard windows based software supplied with this machine enables the user to access data of both velocity and displacement. The machine is an economy evolution of the wide range of capabilities available with SPA Dynamometers.



>BTP 4000

The SPA BTP4000 is the latest in a line of successful Dynamometers which runs all software options. This new level Bench Top Portable has all the features of our world leading BTP2000 but now with a 4" stroke option, and with further updated features it offers the Race Engineer an unrivalled degree of accuracy and flexibility, in its' class, in Shock Absorber Data Acquisition



>PSD 04

This advanced Dynamometer from SPA is specially designed both for the experienced Engineer and for anyone utilising the many benefits to be gained, by owning a Dynamometer for the first time. The standard software package with the PSD 04 has a range of graphical analysis allowing simple measurement of Velocity and Displacement. A wide range of upgrade options are available

Autosport Engineering
Stand E289 The Racing Car Show

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Fax: +44 (0)1827 300151
Email: sales@spa-uk.co.uk

SPA Technique
1209 Indy Way, Indianapolis
IN 46214, USA
Tel: (317) 271 7941
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e-mail: patrick@spatechnique.com
website: www.spatechnique.com

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SUCCESS BY DESIGN...

tools to the Formula 1 and motorsport industry. On display will be the latest range of cutting tools for the manufacture of automotive components, these will include proven solutions for the production of piston ring grooves, brake callipers, injection systems, turbo charges and cylinder head port machining. Horn UK will also be displaying its new broaching technology for CNL machine tools, allowing keyways to be produced during the machine cycle.

• Reps on stand: Alan Whailey, Tony Byrne

Hyperco Suspension Components E169

European Distribution, Nimbus Motorsport
30 Main Street, Wetwang, Driffield
East Yorkshire YO25 9XJ, UK
T: +44 (0)1377 236 170
F: +44 (0)1377 236 175
sales@nimbusmotorsport.com
www.nimbusmotorsport.com

Hyperco is the supplier of high performance suspension components for all levels of the motor racing industry. The Hyperco product line includes suspension coils (Hypercoils), the innovative hydraulic load centring spring perches and composite leaf springs. Hyperco specialises in the development and optimisation of these products for the motor racing industry. The reps attending the show will bring technical expertise direct to the racing professionals and can discuss specific design.

• Reps on stand: Kelly Falls, Richard Pare, Steve Clark

Igus (UK) Ltd E222

79-83 Tenter Road
Moulton Park, Northampton NN3 6AX, UK
T: +44 (0)1604 490 000
F: +44 (0)1604 490 010
www.igus.co.uk

Igus (UK) specialises in the design and development of plain bearings for a wide range of automotive applications, with the aim of delivering an end to lubrication, longer service life and less cost. Iglidur polymer bearings are used in windshield wipers, steering systems, foot pedals, hinges, seats and chassis. The company also manufactures Iglubal ball socket joints and spherical bearings, and Drylin linear slides. Low profile Drylin is suitable for use as a simple telescopic assembly guide for central armrests, drawers, cup holders, pull-out load compartment floors and seat systems.

• Reps on stand: Dave Spence, automotive product manager

Impact Finishers E109

ISPC Surface Preparation Limited
Unit 5, Sandy Lane Business Park
Sandy Lane, Coventry CV1 4DQ, UK
T: +44 (0)24 7625 8811
F: +44 (0)24 7625 8822
chris.pallot@surfacepreparation.com

Whatever the application, Impact Finishers will provide precise, dependable proven and rapid solutions to your component fatigue problems. Based on over 35 years of hands-on experience and using state of the art techniques and equipment, Impact Finishers operates to the

highest international automotive, aerospace, defence and construction engineering industry quality standard. Carefully selected to ensure the most efficient, cost effective and safe result, its portfolio of peening processes covers all fatigue enhancement regimes for: aeroengine, airframe and undercarriage components; automotive gears and transmission parts; high performance motorsport engine and suspension components; high volume parts; on-site structural steelwork; aeroengine, airframe and undercarriage components; automotive gears and transmission parts; and remove on-site structural steel work.

• Reps on stand: Chris Pallot, Christian Tyroll, Tony Grammauro

Incotest E98

Holmer Road, Hereford
Herefordshire HR4 9SL, UK
T: +44 (0)1432 382249
F: +44 (0)1432 353545
niall.dodds@incotest.co.uk

Induction Technology Group E193

Unit B Quinn Close
Seven Stars Industrial Estate
Whitley, Coventry CV3 4LH, UK
T: +44 (0)24 7630 5386
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Induction Technology Group (ITG) supplies the most lightweight high-performance/technology air filters available anywhere in the world. Whatever level or type of motorsport, choose from a huge range or order a bespoke filter exactly to your requirements. ITG is also able to optimise a filter

specification exactly to your particular needs, from off-road to racetrack – even different stages on a rally. Air intake design service and four sizes of carbon air box/filter combination available

• Reps on stand: Stephanie Hutton, David Lea, Andrew Jackson,

Industrial Tooling Corporation E46

Cyber House, 1 Kepler
Lichfield Road Industrial Estate
Tamworth, Staffs B79 7XE, UK
T: +44 (0)1827 304 500
F: +44 (0)1827 304 501
sales@itc-ltd.co.uk
www.itc-ltd.co.uk

ITC will be showing the full range of Cyber series solid carbide end mills. These tools are signed and manufactured in the UK with the express intention of reducing the manufacturing costs of manufacturers and sub-contractors. The range includes long length, short length of cut tools for high speed machining of aluminium, and reduced shank tools for increased flexibility. Special carbide tooling will also feature on the stand, along with tools from Metal Removal (USA) and Hanita (Israel). Air Turbine Technology tools, renowned for their quietness and lack of vibration (avoiding 'white finger'), will also be on display.

• Reps on stand: Paul Ensor, Gary Bambrick, Peter Graves, Roy Talbot, Richard Poole

Intersparses Motorsport Ltd E20

Unit 4, Rockfort Industrial Estate
Wallingford, Oxon OX10 9DA, UK
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THE SECOND INTERNATIONAL HISTORIC MOTORSPORT SHOW 2005

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The 2005 event is expanding to 20,000 square metres in five Halls, including the new International Hall. Last year we attracted 16,000 enthusiasts, competitors and newcomers to the Show.

FEATURES AT THE SHOW

- 5 main halls with 600 stands, themed as Race/Speed; Rallying, Trials, Oval/Short Circuit and Nostalgia Dragsters; International Exhibitors; Memorabilia/Art/Models and Motorsport Autojumble.
- Over 200 competition cars on display
- 75 Race, Speed, Rally, Trials and other Event/Series Organisers - 25 showcased on Speed Street
- 200 Car Preparation, Engineering and Accessory Companies
- New International Hall for Continental Race and Rally Organisers
- Rally Hall - Feature Stands with famous cars and drivers from the Golden Age of Rallying
- Motorsport memorabilia, art and models hall - 120 stands
- Historic Motorsport Autojumble - 150 stands
- H&H Classic Auctions: Sale of classic and competition cars, plus memorabilia
- Virtual Competition Car Showroom - Find the car you want!
- Annual Historic Motorsport Awards Charity Dinner



LIVE EVENTS IN THE PARK

- Rally Supercar Special Stage Demonstration
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TICKET HOTLINE 08450 70 68 70

In advance Adults £12.50 Two Days £22.00
Children under 16 FREE

SHOW OPENING TIMES

Friday and Saturday 9.30am - 5.30pm Sunday 9.30am - 4.30pm

On the day - Adults £15.00 Two days £25.00

www.historicmotorsportshow.com

* Transaction fee - 50p per booking. Car Parking £3.00

F: +44 (0)1491 827 469
export@intrnsport.com

Export suppliers specialising in motorsport and performance parts. Interspaces Motorsport offers a single source for the vast range of products associated with circuit racing, rallying and performance road cars. Formed in 1971 to meet a worldwide demand for racecar parts, Interspaces now deals with many of the top overseas stockists, manufacturers and teams. Interspaces distributes from a wide range of suppliers and its stand should be an essential one for an overseas visitor requiring a fast and efficient export parts service.

Isoclima (UK) Ltd E134

Alfred Court, Saxon Business Park
Hanbury Road, Stoke Priory
Bromsgrove, Worcs B60 4AD, UK
T: +44 (0)1527 577 955
F: +44 (0)1527 577 988
info@isoclima.co.uk
www.finind.com

Isoclima produces curved or flat heater windscreens/backlights/side windows in either lightweight laminated glass (including thermally toughened) or composite materials, heated or coated to the relevant ECE 43 R or FIA standards. Glazings offer significant weight-saving and higher impact resistance. Micro wire heating, anti-fog coating for de-misting in race conditions and anti-IR coating can be incorporated into them. Isoclima also manufactures prototype and low-volume glazings.

Jacquemin Tuning E165

233 Avenue de la Republique
59110 La Madeleine, France
T: +33 3 20 74 64 80
F: +33 3 20 74 64 89
jmjacquemin@nordnet.fr
www.jacquemintuning.com

As well as being a specialist for Citroen, Peugeot and Renault parts, Jacquemin Tuning also imports parts for all types of cars and motorcycles, from Bugatti and Coventry Climax to Mitsubishi, Subaru and Ford. Its connections and suppliers are not only in Europe, but also in North and South America. The company is the SAENZ European importer, as well as French importer for Kent Cams, JE Pistons, ARP, Cool It, Samco, TWM, MPI and HKS, and distributor for Revotec, EBC, Mintex, ITG, Lumenition and Magnecor, among others. It also supplies injection and turbo diesel performance kits.

James Lister & Sons Ltd E71

Union Street, West Bromwich
West Midlands B70 6DG, UK
T: +44 (0)121 525 5800
F: +44 (0)121 525 4833
mikeaston@lister.co.uk
www.lister.co.uk/motorsport

JLS Motorsport is the UK's leading manufacturer and supplier of inboard airjack systems. It provides high and low pressure systems with special length and stroke airjacks to suit most applications. To complement the JLS range of brake hose and couplings it will be exhibiting XRP products for fuel and oil applications. On display will be a selection of high performance control and brake bias cables which are built to customers' specifications. The Setrab Pro-line range of oil coolers, along with the Venoir Sports silicone hose, will also be exhibited.

• Reps on stand: Mike Aston, Andy Berry

Jenvey Dynamics Ltd E362

Building 2, Stanmore Industrial Estate
Bridgnorth, Shropshire WV15 5HP, UK
T: +44 (0)1746 768 810
F: +44 (0)1746 768 363
sales@jenvey.co.uk
www.jenvey.co.uk

Jenvey Dynamics designs, makes and supplies throttle bodies, manifolds, air horns, air boxes/filters and most other parts for induction systems. They stock a range of systems for popular race and performance engines as well as providing a design, prototype and make service for more specialised and production needs.

Kaiten Performance Products E324

4431 Corporate Center Drive, Unit 131
Los Alamitos, California 90720, USA
T: +1 714 220 2227
F: +1 714 220 2819
sales@kaitenproducts.com
www.kaitenproducts.com

Manufacture of forged and billet flywheels, forged and billet connecting rods, valve binders and transmissions gears.

Kasto Ltd E373

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Hedge End, Southampton SO30 2FZ, UK
T: +44 (0)1489 772 882
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sales@kasto.uk.com
www.kasto.uk.com

The Kasto product range features: sawing machines, high performance bandsaws for sawing difficult materials like titanium, inconel, stainless, MMC plus all standard ferrous and non ferrous materials; high performance circular sawing machines up to 150mm; bar storage solutions, semi auto and fully automotive material handling integrated systems; and consumables, carbide and bimetal blades, and coolants.

• Reps on stand: Ernst Wagner, Terry Ashton

Kayaba E424

2548, Dota Kani-shi, Gifu 5090298, Japan
T: 0081 574 265 460
F: 0081 574 271 576

Kitagawa Europe Ltd E378

Unit 2 Dolphin Industrial estate
Southampton Road
Salisbury, Wiltshire SP1 2NB, UK
T: +44 (0)1722 421 155
F: +44 (0)1722 421 071
enquiries@kitagawaeurope.com
www.kitagawaeurope.com

Kitagawa Europe offers total production solutions with its range of specialist work holding products, which include: Kitagawa chucks, cylinders and rotary indexing tables; specialised work holding solutions; Chick work holding system - the ultimate work holding solutions for CNC machining centres; the Darex range of precision cutting tool sharpeners; Cooljet high pressure coolant systems which slash cycle times and increase tool life; IEMCA short and long magazine and multi spindle; Absolent oil mist, oil smoke and dust filtration; and leave fixturing - simple, quick, affordable, quality fixturing. Many other solutions are available and

are all backed by Kitagawa's excellent warranty and service.

• Reps on stand: John McNally, Seamus Miley

Koni BV E141

PO Box 1014, 3260 AA Oud Beyerland
The Netherlands
T: +31 40 261 9155
F: +31 40261 8523

Kronos Engineering Solution E411

Callamore Cottage, The Ruffitt
Little Dean, Glos GL14 3LB, UK
T: +44 (0)1594 827 332

Krontec GmbH Fitting & Hose Systems E260

Pommernstr 33
Neutraubling 930073, Germany
T: +49 9401 5253 22
F: +49 9401 5253 10
g.gschneidinger@krontec.de
www.krontec.de

Krontec Fitting & Hose Systems has a long experience as a manufacturer of high-quality machining parts, fluid transfer, pneumatic and hydraulic systems and also as a dealer for motorsport equipment. It supplies in all industrial sectors, including motorsport, automotive, aircraft and machining industry. Krontec designs and manufactures a wide range of flexible Teflon and rubber hoses for low, medium or high pressure applications. All fluid systems with standard or special fittings are pressure tested and 100% peer-reviewed. Another branch is the manufacturing of bespoke parts – the 3D software allows it to transfer dates from the customers. High-quality parts will be produced on CNC turning and 3D milling centers. The company has a wide range of materials, including aluminium (7075), stainless steel (cres 304) and titanium (grade 5) in its stock. Since 1999 Krontec has been cooperating with Staubli and is the worldwide distributor of its racing quick disconnect coupling products. In its range it carries low- and high-pressure couplings in aluminium and titanium.

• Reps on stand: Mr Jobst, Mr Weik

Kulite Sensors Ltd E18

Kulite House, Stroudley Rd
Kingsland Business Park
Basingstoke, Hants RG24 8UG, UK
T: +44 (0)1256 461 646
F: +44 (0)1256 479 510
Sales@kulite.co.uk
www.kulite.com

Kulite produces a range of pressure transducers for the extreme environmental conditions encountered in competition vehicles. Small yet rugged, Kulite sensors possess high signal outputs, combined with impressive repeatability and infinite resolution, combined with a high temperature capability. On show will be a varied range of miniature motorsport transducers, including a combined pressure and temperature sensor with an 8mm mounting thread. Of particular interest is a new pitot probe device with an integrated pressure sensor, providing a high level output signal relating to a differential pressure of typically 80 millibar, without the need for extra pipe work.

• Reps on stand: Steve Bancroft, Brian Waterworth

Langley Wind Tunnel E194

PO Box 65309, Langley Airforce Base
Virginia, USA 23665-5309
T: +1 757 766 2266
F: +1 757 766 3105

Langstone Engineering Ltd E218

Units 1 & 2 Beaver Industrial Estate
Southmoor Lane
Havant, Hants PO9 1JW, UK
T: +44 (0)23 9245 2430
F: +44 (0)23 9245 2440
langstone@engineering-ltd.fsnet.co.uk

Langstone Engineering is based in modern, well-equipped premises and supplies tool making and precision engineering services, as well as prototype engineering and component manufacture for F1, motorsports and other industries, receiving high standards of engineering. Langstone Engineering uses its engineering experience and tool-making expertise to assist its customers to design and develop new tooling and prototypes in order to meet their precise specification requirements. As a toolmaker and specialist precision engineer, it offers a full hands-on fast-track supply service with a full CAD/CAM suite manufacturing from customer electronic files via its CAM system, specialising in three-, four- and five-axis 3D CNC milling and turning. Accredited to BS EN ISO 9001:2000, supported by CMM Technology.

Lee Products E352

3 High Street
Chalfont St Peter, Gerrards Cross
Buckinghamshire SL9 9QE, UK
T: +44 (0)1753 886 664
F: +44 (0)1753 889 588
sales@leeproducts.co.uk
www.leeproducts.co.uk

Lee Products will be exhibiting its range of miniature hydraulic components such as Lee plugs, restrictors, nozzles, check valves, relief valves, shuttle valves, solenoid valves, filter screens and flow controls. as well as custom-designed lubrication and scavenge pumps.

• Reps on the stand: Mike Stott, Lloyd Bailey, Tom Barron, Roger Brooks

Lemo E24

12 North Street, Worthing BN11 1DU, UK
T: +44 (0)1903 234 543
F: +44 (0)1903 206 231
uk.office.services@lemo.com

On show at Autosport 2005 will be the range of Lemo ruggedised connectors used in many autosport applications. The F series range continues to develop in line with the demands of the autosport industry. Features such as the ruggedised construction, waterproofing, high vibration resistance and a high number of contact variations, including LV and Fibre Optic contacts, provide a connector suitable for most designers requirements. The FF series connector, probably the smallest ruggedised connector available, allows designers to benefit not only from a light weight design but also from considerable space savings.

• Reps on stand: Gillian James

Lincoln Electric (UK) Ltd E37

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infouk@lincolnelectric.nl
www.lincolnelectric.co.uk

Lincoln Electric is world's largest manufacturer of welding equipment and consumables. In the US we provide equipment and trackside support for many of the Nascar and Cart teams. With this experience Lincoln has developed products specifically for the autosports market. Just some of those on show will be a 200 amp AC/DC Tig welder, a plasma cutter and a 160 amp DC Tig welder. All are trackside tested and work from a 13 amp supply.

Link Electro Systems Ltd E35

1 Bridle Path Road
Heathcote Valley, Christchurch
New Zealand
T: +64 3 34 888 54
F: +64 3 34 361 95
sales@link-electro.co.nz
www.link-electro.co.nz

Link Engine Management is a range of plug-in and wire-in management systems. These systems are sold around the world and are renowned for their ease of use while being amongst the most powerful systems available. Our laptop tuning software PCLink is fast and intuitive to use allowing the tuner to get the desired result quickly yet provides the detail required for precision tuning. PCLink and instruction manuals are available from our website. We are here to meet with our dealers and extend this network. Look for our new G3 based systems that we are showcasing at this show.

• Rep on stand: Phillip Royds

Louviers Auto Development E211

Route National 15
27400 Heudebouville, France
T: +33 232 40 47 50
F: +33 232 25 25 10
ladsarl@wanadoo.fr

Engine; engine parts - valves, springs, cam follows, piston etc; engine management system; dashboard; documentation.

• Reps on stand: Christian Dieux, Didier Fourien

Mahtechs E55

Via per Spilamberto 4/AB
41051 Castelnovo Rangone
Modena, Italy
T: +39 59 533 2067
F: +39 59 533 2068
marco.gestri@mahtechs.com

Martins Rubber

30-31 Orchard Place
Southampton SO14 3PE, UK
T: +44 (0)23 8022 6330
F: +44 (0)23 8063 1577

Martins Rubber is a family-run business established in 1865, specialising in manufacturing and supplying rubber and polyurethane foam products, gaskets, extrusions, matting and hydraulic & pneumatic seals. At the cutting edge of technology, we provide products which consistently meet the required high quality standards of our customers including those in the autosport industry. The company has been supplying World Championship winning organisations across the motorsport sector for many years including those in the acknowledged pinnacle of competition, Formula 1.

Masiero Antonio SPA E357

Via Tubertini 10, 40054 Budrio, Italy
T: +39 059 533 2067
F: +36 059 533 2068
marco.gewstri@mahtechs.com

Materials and Engineering Research Institute E96

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F: +44 (0)114 225 3501
n.farmilo@shu.ac.uk
www.materials.shu.ac.uk

The Materials and Engineering Research Institute (MERI) is a world class support centre to industry in materials technology, specialising in the research, development and analysis of materials and products. MERI strengths include: paint development with interests on coatings containing nanotechnology and smart coatings for corrosion sensitive structure; corrosion science and engineering, including anti-corrosion performance of coating systems, corrosion fatigue and atmospheric corrosion; surface engineering, hard corrosion resistant and low-friction coatings which are characterised by extremely reliable properties and outstanding adhesion performance; advanced polymers, composites and surfaces, innovative spectroscopy, microscopy and analysis; materials modelling which involves developing new stimulation methods and techniques.

• Reps on stand: Nick Farmilo, Simon Robinson, Michael Orgill, Darren Swinson

Maxsym Engine Technology Ltd E58

Unit 5 Brailes Industrial Estate
Lower Brailes, Banbury
Oxon OX15 5JW, UK
T: +44 (0)1608 685 155
F: +44 (0)1608 685 156
info@maxsym.com
www.maxsym.com

Maxsym is exhibiting the GP500 and GP600 racing engines, aimed at applications including small single seater racecars; superkarts; motorcycles and ATVs. These in-line twins deliver ultra smooth, high performance in a super-light, super-compact package. Different specifications cover a range of power outputs between 70bhp and 110bhp, delivered in a compact package weighing 30-37.5kg. Options include six-speed transmission and dry clutch or fixed reduction gear; and intake ports oriented to the front or rear. Engines are for sale to individuals, race teams and vehicle OEMs - first deliveries in March 2005. In addition, expressions of interest are invited from importers and distributors.

• Reps on stand: Patrick Walker, Guy Heathcote

McLaren Electronic Systems Ltd McLaren Technology Centre E251

Chertsey Road
Woking, Surrey GU21 4YH, UK
T: +44 (0)1483 261 400
F: +44 (0)1483 261 402
sales@mcclarenelectronics.com
www.mcclarenelectronics.com

McLaren Electronic systems will be showcasing its extensive range of motorsport components at Autosport 2005. The parts are all made specially

for racing and are small, tough and affordable. Brand new products for the Autosport show include the TAG-400 engine control unit (for motorbikes and cars up to eight cylinders) and the KN-5 motorsport fuel injector. There will also be other sensors, injectors, ignition coils and alternators on display. Formally known as TAG Electronic Systems, the company supplies complete systems and components to Formula 1, Le Mans, WRC, IRL, MotoGP and other racing categories.

• Reps on stand: Bob McDonald, Clive Hill

Metal Improvement Company E227

Hambridge Lane
Newbury, Berkshire RG14 5TU, UK
T: +44 (0)1635 279 600
F: +44 (0)1635 279 601
jeremy_allen@metalimprovement.com

Metal Improvement Company is the world leader in sub-contract controlled shot peening, laser peening, super finishing combating fatigue, fretting, galling and pitting problems in engineering components. It also provides sub-contract coating application to provide protection and enhanced lubricity. There are six facilities in the UK providing these quality services to all engineering metals/alloys.

Micrometric Ltd E76

Doddington Road, Lincoln LN6 3RX, UK
T: +44 (0)1522 509 999
F: +44 (0)1522 501 901
enquiries@micrometric.co.uk
www.micrometric.co.uk

Laser manufacturing service Micrometric provides a sub-contract laser profiling, laser machining, laser welding and laser engraving service to the competition automotive sector including F1, rally, touring and high-performance race car applications. Parts can be manufactured in flat and tubular form, in a range of competition automotive materials. The laser activity is supported by a wire EDM and conventional CNC milling capability. Parts can be produced directly from patterns and templates via our scanning service, thus eliminating the need for drawings.

• Reps on stand: Phil Weston, Tony Lister, Alastair Lloyd

Micron Workholding Ltd E149

Nene Road, Bicton Industrial Park
Kimbolton, Cambs PE28 0LF, UK
T: +44 (0)1480 861 321
F: +44 (0)1480 861 515
sales@microloc.com
www.microloc.com

The Microloc workholding system is a versatile clamping system to hold round, square or irregular shaped work pieces in fixed, known datum positions on CNG milling machines. Micron also designs and manufactures fixtures for automotive industry precision sub-contract machining.

• Reps on stand: Matthew Jenness, John Luther

MMC Hardmetal E310

Mitsubishi House, Galena Close
Amington Heights, Tamworth
Staffs B77 4AS, UK
T: +44 (0)1827 312312
F: +44 (0)1827 312314

Mountney Ltd E29

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andy.williamson@mountneyttd.com

MoTeC Europe Ltd E13

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T: +44 (0)8700 119 100
F: +44 (0)8700 111 922
sales@moteurope.co.uk
www.moteurope.co.uk

MoTeC Europe is a supplier of advanced electronic systems for all forms of motorsport, from vehicle manufacturers and works teams through to club competitors. MoTeC combines innovative product designs with an outstanding software package and worldwide technical support. Products include the ADL (Advanced Dash Logger) and the M800, M600, M400, M4, M48 engine management systems, OEM and aftermarket sensors, lambda meters and wiring looms.

Moton Suspension Technology Ltd E191

Neutonenlaan 68, 5405 NH
The Netherlands
T: +31 413 259 838
F: +31 413 259 892
info@motonsuspension.com

MTCE/Dynamic Suspension E21

20 Fison Way
Thetford, Norfolk IP24 1HU, UK
T: +44 (0)1842 755 744
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MTCE Ltd (Dynamic Suspension) is a world leader in the supply of specialized high technology automotive suspension dampers, damper dynamometers and suspension testing equipment and services, for both the Motorsport and general automotive industries. What makes MTCE unique amongst suspension providers is the totality of the service offered. No other company offers a single source for vehicle suspension development, trackside support, bespoke damper design and manufacture, and a 4 or 6 post rig for complete suspension analysis.

MTS E159


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F-42500 Le Chambon-Feugerolles, France
T: +33 4 77 61 06 24
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mpchambon@mts-sa.com
www.mts-sa.com

MTS Camshafts specialises in prototyping for racing applications and supplies the automotive industry with small to medium production runs. The cam grinding section features CBN grinding as well as concave cam profile grinding down to 50mm radius in prototyping or production mode. MTS's manufacturing capacity includes a full heat treatment facility in-house for complete manufacturing process control, and lower delivery time. A continuous investment policy generates an impressive CNC machine population averaging a mere two and a half years, for optimal accuracy and productivity. MTS is an ISO 9001/2000 company.

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Stand E84 The Racing Car Show

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HRI, US Rep. for NASCAR
Phone: +1-770-867-7704
Email: gtwilliams@mindspring.com

Mike Knowles US Rep. for DRAG
Phone: +1-706-265-8765
Email: lgracing@axcess.net

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MTS Systems Ltd E212

Brook House, Somerfield Road
Cirencester, Glos GL7 1TW, UK
T: +44 (0)1285 648 800
F: +44 (0)1285 658 052

MTS Systems Ltd will be displaying a high-power, ultra low-inertia permanent magnet dynamometer developed for Formula 1 gearbox and engine testing. This 'virtual engine', designed and built by MTS, reproduces the power, torque, and speed of a Formula 1 V10 engine and allows engineers to develop new powertrain systems and control strategies under laboratory condition. Speeds of up to 22,000rpm are possible with this dynamometer with available power of 850kW. Extremely fast transient torque capability allows the simulation of real time ignition cut and throttle blips, such as gear changes and traction control usage, during events. MTS is also the world's leading supplier of Rolling Road and Model Motion Systems for aerodynamic development of race vehicles in the wind tunnel, as well as systems for the development and testing of a wide variety of motorsport and passenger vehicle components.

Muffett Gears E317

Ashdown House, Lamberts Rd
North Farm Industrial Estate
Tunbridge Wells, Kent TN2 3EH, UK
T: +44 (0)1892 532 900
F: +44 (0)1982 542 117
sales@muffett.co.uk
www.muffett.co.uk

Following last year's successful launch, Muffett Gears will again be exhibiting the TSR300 range of differential units designed for use in motorcycles engined applications. In addition to the TSR300 range of differential units, Muffett Gears is also able to manufacture gear sets, including dog rings, drive shafts, pulleys, racks and general machining used in motorsport applications.

• Reps on stand: Tony Smith, Neil Rodemark

NCMT E375

Summer Road
Thames Ditton KT7 0QJ, UK
T: +44 (0)20 8398 4277
F: +44 (0)20 8398 3631
daveburley@ncmt.co.uk

Newman Cams E84

Farnborough Way
Farnborough, Kent BR6 7DH, UK
T: +44 (0)1689 857109
F: +44 (0)1689 855498
info@newman-cams.com

Newton Equipment Ltd E97

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Barking, Essex IG11 8DY, UK
T: +44 (0)20 8594 7990
F: +44 (0)20 8594 7989
info@newton-equipment.com

www.newton-equipment.com

Newton Equipment will be showing its large range of Aero and Classic filler caps. There will be some exciting additions at the show.

• Reps on stand: Michael Byrne, Lee Baxter

Nicholson McLaren Engines Ltd E290

12 Ivanhoe Road
Hogwood Lane Industrial Estate
Finchampstead, Berkshire RG40 4QQ, UK
T: +44 (0)1889 738 017
F: +44 (0)1889 738 033
tony_hewitt@n-mclaren.co.uk

Nikken Kosakusho E386

Precision House
Barbot Hall Industrial Estate
Rotherham S61 4RL, UK
T: +44 (0)1709 366 306

Incorporated in 1989, Nikken Kosakusho (UK) Ltd is a subsidiary of Nikken Works Ltd, Japan. Operating from the 'Euro Centre', Nikken UK's principal activities are the import, distribution and supply of the entire Nikken product range, which encompasses CNC Rotary and Tilting Tables, N/C Tooling Systems and Measuring Devices. Our quality products and services are used by engineers around the world including those involved in aerospace and F1 Motor Racing.

• Reps on stand: Alistair Bowmar, Steve Maddy, Russell Paling, Bill Fox, Steve Eckersall, Gary Williamson, Duncan Crossland

Northbridge Motorsport E78

Unit 16, Viking Road
Wigston, Leicester LE18 2BL, UK
T: +44 (0)116 257 2934
F: +44 (0)116 257 2932
sales@northbridgemotorsport.com
www.northbridgemotorsport.com

Northbridge Motorsport designs and manufactures high performance bolts and studs. All operations are completed in house, including heat treatment, inspection and test. These parts are made in all critical materials including high strength titanium and multiphase alloys.

Norton Motor Sports Ltd E189

34 Burners Lane, Kiln Farm
Milton Keynes, Bucks MK11 3HB, UK
T: +44 (0)1908 561 444
F: +44 (0)1908 307 519
peter@nortonmotorsport.co.uk

Norton Motor Sports is an engineering company dedicated to serving the engineering industry in the manufacture of high-quality machined parts to individual customer requirements, under the ISO 9001:2000 Quality Assurance System, for motorsport, aerospace and IT industries. The company has a highly skilled workforce and is well equipped for the manufacture of the most complicated parts in the latest materials. It also manufactures steel and carbide tooling for the can making and powder compaction industries. Norton Motor Sports has developed finish machining of hardened tool steels by the 'Hard Machining' process (milling and turning) up to a hardness of 64rc. It covers all machining disciplines from CNC milling, CNC turning, wire erosion, spark erosion, universal and surface grinding to bench polishing and assembly, as well as a well-equipped QA department.

Oldings MCR Ltd E210

Rosscliffe Road
Ellesmere Port, Cheshire CH65 3AS, UK
T: +44 (0)151 355 0261
F: +44 (0)151 356 4423
enquiries@oldingsmcr.co.uk

Oldings MCR is Cheshire based. It manufactures and supplies blast cleaning and degreasing equipment for every aspect of industry all over the world. As a specialist manufacturer, it has been requested by many companies to develop automatic machines, custom built for their own use. Over the years this has increased, and now all users can benefit from its experience and automate their cleaning process from its standard automatic range.

Ole Buhl Racing E301

Roughwood House, Highwood
Nr Ringwood, Hampshire BH24 3LE, UK
T: +44 (0)1425 478 822
F: +44 (0)1425 478 866
sales@efitechnology.co.uk

Okavko Steel Ltd E286

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Wednesbury
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• Rep on stand: Graham Butler

Pace Products (Anglia) Ltd E360

Unit 1, Homefield Road
Haverhill, Suffolk CB9 8QP, UK
T: +44 (0)1440 760 960
F: +44 (0)1440 708 787
sales@paceproducts.co.uk
www.paceproducts.co.uk

Pace offers a range of remote mounted oil pumps second to none. From single stage scavenge/pressure pumps, to complete dry sump kits (including our 'easy clean' oil tanks). The company designs and manufactures one-off oil pumps to customer specifications. It is the UK's leading manufacturer and supplier of lightweight, high performance, alloy water radiators in straight, curved and tapered form for cars, motorcycles, karts, aircraft and tanks. Pace manufactures and supplies a wide range of lightweight, high-efficiency alloy intercooler and charge coolers. One-offs and batch work are a speciality. Both radiator and intercooler cores can be manufactured in-house, to specific requirements.

• Rep on stand: Neil Patterson

Pathrace E175

45 Boulton Road
Reading, Berkshire RG2 0NH, UK
T: +44 (0)118 975 6084
F: +44 (0)118 975 6143
sreynolds@pathtrace.com

Pays De La Innovation Centratlantic IRC E94

6 Boulevard des Pâturaux
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France
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F: +33 2 28 +44 (0)1 90 31
g.duchene@pdlinnov.com
www.pdlinnov.com

Pays de la Loire Innovation is a partner of the Centr'Atlantic IRC. As a member of the IRC Automotive Thematic Group, it has decided to attend Autosport Engineering with three companies, all specializing in embedded systems for cars, will share the same stand. Visit Alsims for dashboards and embedded electronics; CénoSYS for data acquisition equipment and telemetry; and SOJADIS for equipment for disabled people and CAN Bus interface. All are members of a regional group working on electronics for cars and special vehicles.

• Reps on stand: Pays de la Loire Innovation – Gérard Duchene; Alsims – Jean-Paul Monnin, Cyril Jousselein; CénoSYS – Valérie Pelhate, Dominique Vovard; SOJADIS – Adeline Humeau, Jean-Marie Humeau, Joël Malville, Guillaume Perrain

PDJ Vibro Ltd E287

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Water Eaton Industrial Estate
Bletchley, Buckinghamshire MK2 3BB, UK
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• Reps on stand: Paul Hurley, David Hurley, John Hurley

Penny & Giles Controls Ltd E247

15 Airfield Rd
Christchurch, Dorset BH23 3TG, UK
T: +44 (0)1202 409 409
sales@pennyandgiles.com
www.pennyandgiles.com

On show for the first time will be the new MLS130 sealed linear position sensor, offering a fully waterproof sensor for suspension, steering and throttle data acquisition applications. The new sensor joins the highly successful SLS130 and SLS190 models, and the popular SRS280 sealed rotary sensor, allowing Penny & Giles to offer a 'one stop shop' for all autosport customers' position sensing needs. Penny & Giles rugged position sensing technology is widely used in racing classes including NASCAR, Formula 1, Formula 3, Formula

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www.performancefriction.com

Performance Friction Brakes is the leading manufacturer of motorsport braking products in the racing world, with brake pads, discs and callipers used by teams in every major category. Contact Performance Friction UK office today to learn the secret so many teams have already discovered.

Performance Racing Industry E137

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T: +1 949 499 5413
F: +1 949 499 9521
francis@performanceracing.com
www.performanceracing.com

Performance Racing Industry (PRI) produces a trade show and publishes a trade magazine for the 'hardcore' racing industry. The 18th annual PRI Trade show in Orlando, Florida, USA, December 1-3 2005, will be the world's largest hardcore racing show where racing business people come from around the world to do business face-to-face and to see the next generation of technology: 1,400 exhibitors; 3,700 booths; more than 45,000 international buyers! The PRI magazine enters its

19th year of publishing monthly in the interest of the development of the global racing market. With over 26,000 trade only subscribers (distributors, retailers, engine builders, racing teams etc) the PRI magazine is the absolute reference and the place where manufacturers advertise to set up their distribution channels to the US racing market place. The PRI organisation is the hub of the dynamic racing market and the direct access to volume buyers of racing products. In other words: 'The gateway to the racing market'.

• Rep on stand: Francisque Savinien

Piper Cams E106

2 St Johns Court, Ashford Business Park
Ashford, Kent TN24 0SJ, UK
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Piper Cams offers a unique service to the automotive and motorsport industries. Constant re-investment has resulted in a full CAD/CAM design service linked to a complete CNC machine shop including four-axis machining centres lathes and a Landis 3L grinding machine. Because the company offers in-house design and valve train analysis services it can often reduce lead times both on production and problem solving. Full heat treatment services and super finishing are also available.

Pi Research E258

Brookfield Motorsport Centre
Twentypence Road
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An integrated package of racecar electronics and software for every level of competition. For data logging, control systems and data analysis software to wiring harnesses and instrumentation, Pi Research is a one-stop-shop for all your performance electronic requirements. Extending its tradition for innovation, Pi Research will be unveiling a completely new data acquisition product for use in professional motorsport, which eliminates preconceptions of size and weight for on-car electronics.

• Reps on stand: Simon Holloway, Roland Meister

Pistal Racing SRI E304

Via Nicola Sardi 82
14030 Rocchetta Tanaro (AT), Italy
T: +39 141 644 816
F: +39 141 644 970
info@pistalracing.it
www.pistalracing.it

Pistal Racing is able now to produce forged steel pistons for new generation diesel engines, to add at its well-known aluminium alloy forging. The forging process, heat treatment and the special steel used, launch a new era in the racing field. The high pressure possible in the new generation diesel engines is no longer limited by the piston. The accurate machining and special geometry have made it possible to reduce drastically the clearance between piston and cylinder, blow by and oil consumption.

Plastic Parts Centre E25

Unit 12 Old Forge Trading Estate

Dudley Rd, Lye, Stourbridge DY9 8EL, UK
T: +44 (0)1384 424 248
F: +44 (0)1384 424 348
sales@plastic-parts.co.uk

Plastic Parts Centre will be exhibiting its full range of plastic protection and cable management components. Free catalogue, free samples (on plastic parts), no minimum order quantities, trade counter, national branch network. New for 2005 its sister company, Alexander Industrial Supplies, will be exhibiting its range of work wear. Visit the stand and collect your free catalogue from both Plastic Parts Centre and Alexander Industrial Supplies.

• Reps on stand: Bev Bradley, Julie Hay, Barry Dhillon

Poggipolini Group E272

S. Lazzaro De Savena - Bolohna
40068, Italy
T: +39 051 625 6090
F: +39 051 625 7084
info@poggipolini.it
www.poggipolini.it

Fasteners - fittings (titanium, aluminium); special parts (titanium, aluminium, superalloy); heat treatments with vacuum technology; coatings; rapid prototyping.

• Reps on stand: S Poggipolini, R Quadrigli, S Stoppoloni

Pollard & Co Ltd E204

St Saviours Road, Leicester LE5 4HP, UK
T: +44 (0)116 276 7534
F: +44 (0)116 274 1547
sfinn@pollardfredk.com
www.pollardfredk.com

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SFS Performance is one of the world's leading hose manufacturing companies for Motorsport applications.

We cater for the ultra-high specification and time-sensitive demands of race teams which enables us to provide unique services and bespoke products with low tooling costs for our customers.

One of our greatest assets is our ability to offer bespoke hoses, designed to meet your exact requirements, with low-cost tooling, and rapid turn-around from conception through to production.

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Our products have been proven at the highest levels of racing, and are used by some of the most prestigious teams and manufacturers including:

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E: sales@sfsperformance.co.uk

W: www.sfsperformance.co.uk

Unit E, Kingsway Industrial Estate, Kingsway, Luton, Beds LU1 1LP UK



For further details please call or email us, or visit our website: www.sfsperformance.co.uk

Autosport Engineering
Stand E184 The Racing Car Show

Pollard is the sole UK distributor for the extensive range of Mori Seki CNL machine tools, supported by its in-house fixture design and manufacturing facilities, which strengthens its ability to completely integrate a full turn key engineering solution.

• Rep on stand: Steve Finn

Power Torque Engineering Ltd E108

Herald Way, Binley, Coventry CV3 2RQ, UK
T: +44 (0)24 7663 5757
T: +44 (0)24 7663 5878
sales@powertorqueracing.co.uk
www.powertorqueracing.co.uk

Power Torque supplies Ford engines to low volume vehicle manufacturers, race engine tuners and individuals for road or track use. On show will be a selection of the power units available from a range covering 1.2 litres to 8.0 litres capacity. It also offers a range of transmissions and components to complement the engines. Current clients include Morgan, Noble, Raceline, Dunnell, BJP services and many more. Visit the stand to discuss your individual requirements.

• Reps on stand: Jon Townley, Salv Sacco

Precision Micro Ltd E265

PO Box 162, 30 Curzon Street
Birmingham B4 7XD, UK
T: +44 (0)121 380 0100
F: +44 (0)121 359 3313
info@precisionmicro.com
www.precisionmicro.com

Precision Micro produces stress and burr free, two-

and three-dimensional, precision metal components, including gaskets, shims, and electronic screening cans/enclosures from its extensive range of stock material and thicknesses. With low-cost tooling, samples and prototypes are provided in days, rather than weeks, at minimal cost, giving designers ultimate flexibility to modify designs without substantial cost/time penalties. The company is also able to offer production quantities of precision components using its large etching capacity, high speed presses or its in-house laser facility.

Premier Fuel Systems E366

Willow Industrial Park
Castle Donnington, Derby DE74 2NP, UK
T: +44 (0)1332 850 515
F: +44 (0)1332 850 749
www.premier-fuel-systems.com

Premier Fuel Systems will this year reach the milestone of 25 years as a specialist manufacturer of safety fuel cells and bladders. All cells are manufactured to FIA specifications, from FT3 to FT5, or USAC and are fully vulcanised. Premier can design cells and bladders to meet any customer request, or manufacture direct from a customer drawing. Premier manufactures the complete cell, including all metal fittings, rubber mouldings, and where required, protector blankets. In addition to cells and bladders, Premier is also manufacturer of dry-break and sealed loop refuelling systems via single or double point valve actuation. The company also supplies every component which is required to make up an entire fuel system from filler to engine. Technologies include flexible safety fuel cells and bladders; self sealing fuel cells for

protected vehicles; tig welding and precision fabrication; CNC machining; and 3D CAD/CAM/CMM. Premier is keen to expand its market in self-sealing fuel cells for the protected vehicle market. Tests have shown the Premier cell to be the fastest sealing on the market. Premier also welcomes further opportunities to collaborate with customers who require a low-emission (EMI-spec) safety fuel bladder.

Pronal E216

ZI de Roubaix-Est
BP 18, 59115 Leers, France
T: +33 3 20 99 7500
F: +33 3 20 99 75 20

Pronal manufactures FIA. accredited FT3, FT3.5 and FT5/1999 flexible tanks for all types of racing car. The company is also offering a range of standard fuel cells, with or without carbon protection boxes. Manufacturing techniques mean that Pronal can design all kinds of autoclave polymerised (carbon and kevlar) composite parts, including flexible tanks protection boxes, cover carter engine, floor closing panel, fender, under body panel, door panel, dash board panel, wheel rims etc.

• Reps on stand: Gregory Langlais

Protex fasteners Ltd E32

Arrow Road, Redditch B98 8PA, UK
T: +44 (0)1527 63231
F: +44 (0)1527 66770
Sales@protex.com
www.protex.com

Protex manufactures and sells the world's largest single range of over-centre type fasteners.

Products include quick action toggle-type fasteners and draw latches, catchbolts, prolatches, flush latches, bandclamps and case fittings. Most Protex products are available in stainless steel and zinc-plated steel. All products are available direct from stock at Protex and there is no minimum order value.

• Reps on stand: Adrian Symond, Howard Cooke

Quarter Master Industries E47

510 Telser Road
Lake Zurich, Illinois 60047, USA
T: +1 847 540 8999
F: +1 847 540 0526
aborodin@quartermasterusa.com

Racecar Engineering E364

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Croydon, Surrey CR9 1HZ, UK
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Fax: +44 (0)20 8726 8399
Email: racecar@ipcmedia.com
www.racecar-engineering.com

The world's leading motorsport technology magazine, Racecar Engineering keeps readers in touch with the cutting edge of developments in the sport. It analyses championship winners and reports on new racecars as they are unveiled. It also examines motorsport practice and theory, challenging accepted wisdom and forcing the boundaries of understanding. Racecar publishes monthly and to take out a subscription visit its pavilion on the central aisle of Autosport Engineering or see page 70 of this issue.

New Pi Research products for 2005 include..... Vids 2..... Toolbox V4..... Lightweight Logger Box..... Lightweight Junction Box.....

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Visit
Pi Research on
Stand nos. E258 &
E259 at Autosport
Engineering

Raceparts UK Ltd E156

Unit 3 Rockfort Industrial Estate
Wallingford, Oxon OX10 9DA, UK
T: +44 (0)1491 822 000
F: +44 (0)1491 822 009
sales@racparts.co.uk
www.raceparts.co.uk
www.raceparts-direct.com

Race Tech Magazine E221

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F: +44 (0)20 8446 2191
skimberley@racetechmag.com
www.racetechmag.com

Motorsport Engineering publications, concentrating on powertrain, drivetrain, electronics, software, data acquisition and testing. Race Engine Technology is the world's only publication devoted to high-performance powertrain engineering. As such, it is a unique and invaluable reference for all working in the field. This new quarterly journal includes in-depth engine and transmission profiles and interviews with leading performance powertrain engineers. Race Tech is a highly focused magazine addressing all those involved in the motorsport industry whether race car engineer or racing enthusiast, professional driver or club racer, team manager or circuit owner. The depth and quality of Race Tech magazine means that it is read by the people directly involved in business, design, preparation and racing competition cars.

• Reps on stand: Soheila Kimberley

RCS Ringspann UK Ltd E41

3 Napier Road, Bedford MK41 0QS, UK

T: +44 (0)1234 342 511
F: +44 (0)1234 217 322
grisley@ringspann.co.uk
www.rcscables.com

RCS, specialist cable division of Ringspann UK, will be giving a taste of the expertise available to every customer, from the individual motorsport competitor to the manufacturer of high performance road and race cars. Any control cable application can be covered from shifter systems, gearshift, throttle or anti rollbar, whether a one-off prototype or production requirement. A wealth of experience in cable and controls allows it to offer a bespoke service to assure you the best solution. On show will be its latest exciting application integrating the Ricardo Ford GT transmission and RCS control cables.

• Rep on stand: Gordon Risley

R & D Motorsport Ltd E33

1 Baird Close, Drayton Fields
Daventry, Northants NN11 5RY, UK
T: +44 (0)1327 872855
F: +44 (0)1327 872855
sales@rdtransmissions.co.uk

Redline Synthetic Oil E319

Market Overton Industrial Estate
Rutland LE15 7PP, UK
T: +44 (0)1572 768 311
F: +44 (0)1572 768 249

Redline Synthetic Oil corporation is a world leader in lubricant and fuel system chemistry. Used in Formula 1, F3000, ChampsCars, Gts, NASCAR, Touring cars, on road, off road, 2 wheels, 4 wheels, watercraft and aircraft: the same leading edge

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Renishaw E38

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F: +44 (0)1453 524102
ben.spokes@renishaw.com

Ricardo UK Ltd E328

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West Sussex BN45 5FG, UK
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F: +44 (0)1273 464 124
motorsport@ricardo.com
www.ricardo.com

Ricardo Motorsport offers specialist engineering products, designs, consulting and software in the following areas: design and manufacture of bespoke race-car transmissions; a large range of off-the-shelf transmissions for motorsport; complete engine design and development; Le Mans Ricardo-Judd race diesel engine; simulation tools for engine performance; engineer build and dyno facilities; engine mapping and calibration; complete intake and exhaust system design and manufacture; control and electronic systems; and vehicle dynamics and chassis technology.

• Reps on stand: Iain Wight, Mark Barge, Dave Morrison, Rob Simmonds, Steve Sapsford, Mick Strong, Ian Holden

Richard Grant Mouldings Ltd E381

Unit K4/K5 Cherrycourt Way
Leighton Buzzard, Beds LU7 4UH, UK
T: +44 (0)1525 853 888
F: +44 (0)1525 383 229
Linda@rgmouldings.com
www.rgmstyling.com

Manufactured automotive styling products and components for civil aircraft seating.

• Reps on stand: Richard Grant, David Foster

Roehrig Engineering Inc E263

633 McWay Drive
High Point NC 27263, USA
T: +1 336 431 1827

Rosler UK E93

Unity Grove, School Lane
Knowsley Business Park
Prescot, Merseyside L34 9GT, UK
T: +44 (0)151 482 0444
F: +44 (0)151 482 4400
rosler@rosleruk.com
www.rosleruk.com

Rosler is one of the world's largest producers of abrasive surface finishing equipment, with a build programme that includes shot blast, wet blast, shot peening, vibratory and high energy and cleaning and de-greasing equipment. Many high tech industries use Rosler machines and processes, with motorsport in particular benefiting from them. Super polishing, cleaning and peening of engine and transmission compartments is now a large part of Roslers involvement in motorsport, with its unique Keramo process producing surface finishes



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Autosport Engineering
Stand E224 The Racing Car Show

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on cam shafts and gears that are able to demonstrate significant performance improvements and reliability.

• **Reps on stand:** Colin Thompson, Colin Spellacy, Paul Rawlinson, Phil Evans

Rotronics E11

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74800 La Roche sur Foron, France
T: +33 4 50 030 859
F: +33 4 50 030 597
Info@rotronics.com
www.rotronics.com

Rotronics specialises in rolling road test beds and dynamometers for the automotive and motorcycle sectors. Developed for high level competition, Rotronics products are available to all professional service engineers at affordable prices. Rotronics designs, manufactures and sells electronic and mechanical equipment and software, and offers complete engine test cells and rolling road test beds to inertia and brake test beds and teaching cells. It also offers upgrading of old test cells and caters for all data acquisition needs for the internal combustion engine. The exclusive distributor for Rotronics products in the United Kingdom and Ireland is Overmarsh Engineering.

RSP Technology BV E405

Metaalpark 2, Delfzijl, 9936 BV
The Netherlands
T: +31 596 632 300
F: +31 596 632 678

RSP Technology produces aluminium as strong as titanium, by using its unique rapid solidification process of metal spinning. The most complex

aluminium alloys are produced with cooling speeds of over 1 million degrees celsius per second which results in a material with a very fine, homogenous microstructure. This provides the fundamental base for the superior and advanced characteristics of RSP materials, offering the ultimate solution for a variety of high end applications in the racing industry. A number of race component manufacturers are among the pioneers applying RSP technology just where it belongs: high performance/high quality components such as RSP racing pistons.

RT Quaife Engineering Ltd E154

Vestry Road
Otford, Sevenoaks, Kent TN14 5EL, UK
T: +44 (0)1732 741 144
F: +44 (0)1732 741 555
info@quaife.co.uk
www.quaife.co.uk

RT Quaife has designed and developed drive line components for all types of motorsport and commercial use through the main manufacturers for the past 40 years. On display at the stand this year will be engine driven compressor units for use in service vehicles, plus many five- and six-speed complete gear boxes which are H pattern and sequential. It also has different types of gear kits ranging from historical to modern day, as well as half shafts and sub kits and the gear torque bias differentials, which at the moment are being supplied to all of the three major manufacturers, Ford, Chrysler and GM.

• **Reps on stand:** Michael Quaife, Jon Parker, Paul Doble

Questmead Ltd E367

2 Red Lane, Rochdale OL11 5RZ, UK
T: +44 (0)8707 450 584
F: +44 (0)8707 450 585
sales@questmead.co.uk
www.questmead.co.uk

Questmead is a leading supplier of brake and clutch components to the race and rally markets. Specialising in friction, Questmead stocks the largest range of Mintex friction anywhere. To complement this, the full range of Pagid and SBS friction products (of which Questmead is the UK importer) are also stocked. As AP Racing's main distributor the company can supply all products, many of them off the shelf. PIAA lighting, NGK spark plugs and Silkolene racing oils complete its portfolio. From early 2005 it will have in stock bespoke classic and historic race and rally brake pads, with the ability to manufacture any pad to sample.

• **Reps on stand:** Alan, John, Jason

Saint Gobain Performance Plastic NW/SA E171

Engineered components
Heiveldeken 22, 2550 Kontich, Belgium
T: +32 3 458 28 28
F: +32 3 458 26 69
infoproducts.kontich@sgppl.com
www.plastics.saint-gobain.com
www.rulon-meldin.com
• **Contact:** Steve Armstrong, Sales Manager
UK, Seals; Ash Chand, Sales manager UK,
Polymer Products

High performance PTFE or metal seals; OmniSeals (spring energised PTFE seals); OmniLip, Dynalip

(HP PTFE rotary lip seals) and Omnilflex; HP polymer components; Rulon (PTFE based material); Meldin (PI based materials); Fluoroloy, such as gears, piston rings, and bearing.

Scandinavian Brake Systems E231

Kuopiovej 11
DK-5700 Svendborg, Denmark
T: +45 63 21 15 15
F: +45 63 21 15 95
sbs@sbs.dk
www.sbs.dk

Protouring and heavy duty ceramic compound for street cars, SUVs, light trucks and for light track use. A large number of applications are approved according to ECE R90. Protrack - endurance: carbon ceramic compound for race use at top level. The full range of features includes: the unique NRS retention system to ensure superior mechanical contact between back plate and friction material; DEST surface treatment to ensure degassing of the friction material; and UCT technology to give a uniform mixing of the friction material.

• **Reps on stand:** Peter Diekhoner, Jesper Tonnesen

SDW Light fabrications Ltd E148

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Banbury, Oxfordshire OX16 4SX, UK
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to the motorsport industry. Established for over a decade, the company draws on experience from Formula 1, World Rally, Touring Car and GTs to produce quality fabricated components in a full range of materials. With its in-house coordinates measuring machine, combined with a modest hourly rate, you can be assured work is constructed to the highest quality and within budget. The new transfluid Mandrel pipe bending machine which has a capacity to bend from 19mm (3/4") to 76mm (3") diameter, including square sections, enables SDW to fabricate exhaust systems, manifolds, roll cages – any pipe bending requirements.

• Reps on stand: Paula Whitehead, Steve Whitehead

Securon (Amersham) Ltd E311

Winchmore Hill

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securon@securon.co.uk

www.securon.co.uk

Securon was founded during 1973 and has grown to be Britain's leading independent manufacturer of seatbelts and motorsport harnesses.

All products are designed and manufactured at two sites in Amersham. Securon has metal pressing and plastic injection moulding facilities, supported by excellent quality control, independently certified to ISO9001:2000. On the stand this year will be a range of motorsport race-rally harnesses with both a new improved lightweight buckle and lightweight adjuster. Alongside, will be Securon's E-approved harness with retractor and a selection of coloured

seatbelts.

• Reps on stand: Richard Wills, Sandrine Etienne

Sescoi UK Ltd E369

Wellington House, Starley Way

Birmingham International Park

Solihull, West Midlands B37 7HE, UK

T: +44 (0)121 781 7234

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info@secoi.co.uk

www.secoi.com

Sescoi UK is a wholly owned subsidiary of SESCOI International, a privately owned French company with other subsidiary offices in Germany, Spain, USA, Japan and India. SESCOI will be exhibiting WorkNC, its automatic CAM/CAD milling solution, including the new and revolutionary intelligent five-axis option. SESCOI will also be demonstrating WorkPLAN, its integrated management solution for custom manufacturers. WorkPLAN is an efficient and practical tool that gives your company the financial and competitive edge. SESCOI, the software expert in your industry, specialises in developing engineering software solutions that are easy to use, reliable and will give a rapid return on investment.

Setrab AB E65

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SE-216 10 Malmö, Sweden

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F: +46 40 155287

info@setrab.se

www.setrab.com

Setrab will show its latest range of technically

advanced motorsport coolers. The range is called Proline and it features oil coolers with an adapter system. The range has both low and high pressure coolers as well as water coolers, oil cooler and cooling packs with an electric fan. Setrab will also introduce its new range of high performance intercoolers for the motorsport market.

SFS Performance E184

Unit E, Kingsway Industrial Estate

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F: +44 (0)1582 412277

sales@sfsperformance.co.uk

www.sfsperformance.com

SFS Performance is one of the world's leading silicone hose manufacturing companies, dedicated to motorsport and fastroad applications. Its concentration on catering for the ultra-high specification and time-sensitive demands of teams enables it to provide unique and bespoke products and services for its customers. Its products have been proven at the highest levels of motorsport, including F1, WRC, NASCAR and BTCC. Its standard range of motorsport products should enable you to plumb in any configuration. Direct replacement hose-kits are available for after-market use. Bespoke hoses, tailored exactly to your application, can be manufactured.

Skegness Springs Ltd E12

Hassall Road

Skegness, Lincolnshire PE25 3TB, UK

T: +44 (0)1754 764 792

F: +44 (0)1754 610 584

Skegness Springs is a family-run business,

specialising in the design and manufacture of high performance springs. Its clients include motorsports teams, the aeronautical industry and the medical sector – all highly demanding industries that expect, and receive, a high level of specialist knowledge and uncompromising production standards. As bespoke manufacturers, no standard range is kept in stock. All forms of compression, extension and torsion springs, wire shapes and flat pressings are made to order from a range of standard and specialist materials.

• Reps on stand: David Johnson, Russell Matthews, Pete Turner

SKF UK Ltd E323

Sundon Park Rd, Luton, Beds LU3 3BL, UK

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F: +44 (0)1582 504 203

rob.jekinson@skf.com

www.skf.com

SKF is the world's largest producer of rolling element bearings, SKF Racing develops and supplies products, services and expertise in the area of rolling element bearings and related components used in all racing applications. Examples of its bespoke racing products will be on display, as well as information relating to its analytical capabilities and services. SKF racing will be on hand to answer bearing related questions.

• Reps on stand: Rob Jenkinson, Paolo Andolfi, Ian Peverill

Société Fonderie Usseil E393

ZI de la Petite Borde

BP48, 19202 Usseil, France

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360° OF SIMPLY THE BEST

The Lifeline ZERO 360 gas system represents a major step forward in motorsport safety. The system is filled with 2.25kg of FE36 gaseous fire extinguishant, distributing 1.5kg to the engine and 0.75kg to the cockpit through six nozzles. By using remote compression technology a constant discharge is achievable in any orientation. The ZERO 360 is significantly smaller and lighter than traditional FIA approved foam systems but despite its size the ZERO 360 system packs a mighty punch and is produced using only the finest components both in its construction and installation kit.

A new member of the 360 family is the 2.0kg Hand Held which contains the same highly efficient ZERO 360 gaseous extinguishant and is designed specifically for the rigours of motorsport. This extinguisher will discharge in any orientation allowing for far greater fire fighting ability.



lifeline
Fire & Safety Systems Ltd

Lifeline Fire & Safety Systems Ltd Burnsall Road Coventry CV5 6BU UK

Tel +44 24 7671 2999 Fax +44 24 7671 2998 www.lifeline-fire.co.uk

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Solution F E273

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www.solutionf.com

Solution F has been manufacturing racing cars since 1984. Fully independent and autonomous, the company offers a complete service from design to race. Elements of its expertise include: race engine engineering, chassis engineering and dyno and track tests; using motorsport experience for the benefit of the industry, ref Renault Sport Technologies, Peugeot Sport, Nissan Rallye raid team.

SPA Design Ltd E289

Common Barn, Tamworth Road
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Staffs WS14 9PX, UK
T: +44 (0)1827 300 150
F: +44 (0)1827 300 151
sales@spa-uk.co.uk
www.spa-uk.co.uk

Manufacturer of fire suppression systems, electronic instruments, alpha steering wheels, steering quick release assemblies, and mirrors. Sole European distributor for Penske Racing Systems. The SPA group also has manufacturing facilities for fabrication and composite work and manufactures a comprehensive range of shock

dynameters.

• Reps on stand: Ian Maple, Steve Hawkins

Specialty Fasteners and Components Ltd E320

Unit D Seymour Wharf, Steamer Quay Rd
Totnes, Devon TQ13 7FE, UK
T: +44 (0)1803 868 677
F: +44 (0)1803 868 678
graham@specialty-fasteners.co.uk
www.specialty-fasteners.co.uk

Specialty Fasteners is an ISO9002 approved company that has been a supplier of engineering solutions to fastening problems since 1991. Today it enjoys an enviable reputation for quality, technical knowledge and service. SFC designs and manufactures a range of push turn fasteners and captive screws, and also acts as a technical distributor for the Fairchild Fasteners Group – whose products include Livelock panel fasteners, Keensert thread inserts, Camloc 1/4 turn fasteners and latches and Rosan Fluid Boss adaptors. Other products include quick release pins, Barry Controls shock and vibration mounts, Hydraflow flexible fluid couplings and Spiralock thread locking systems.

• Reps on stand: Graham Leo, Peter Boote

Staubli Motorsport E1

Stafford Park 17
Telford, Shropshire TF3 3DG, UK
T: +44 (0)1952 292 148
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connectors.uk@staubli.com
www.staubli.com

There is a quick release connector in Staubli's range for all motorsport applications; from brake

and clutch systems, coolants and lubricants to fuel lines and compressed nitrogen/air circuits. Each connector is flush faced, dry break and made to the highest quality and performance standards expected from Staubli. The complete range is now available on next-day delivery. Staubli's international network is able to provide support wherever in the world it is required. New on the stand are the CCB 02 – a very compact, lightweight connector for bleeding brakes and hydraulics – and the SAF 45 fast fuel fill venting connector, specifically designed for endurance racing cars and bikes.

• Rep on stand: Peter Webster

Swindon Racing Engines E180

Crampton Road, Greenbridge Estate
Swindon, Wiltshire SN3 3JJ, UK
T: +44 (0)1793 531 321
F: +44 (0)1793 528 484
info@swindon-engines.com
www.swindon-engines.com

Swindon Racing Engines designs, develops and manufactures racing engines for the automotive industry, with 34 years' experience and winning in Formula 1, Formula 3000, Formula 3, Touring Car, World sportscars and World Rally Cars. Consistent investment in technology and the company's impressive facilities have kept it at the leading edge of performance engine development. It has the in-house capacity to manufacture billet crankshafts and five-axis CNC cylinder head port-flow machining using the latest developed CAD CAM software will be demonstrated at the show.

• Reps on stand: Gary Dunn, Eric Pasture, Sean O'Rafferty

Subcon Drilling Ltd E326

Unit 3 Langley Wharf, Railway terrace
Kings Langley, Herts WD4 8JE, UK
T: +44 (0)1923 270 370
F: +44 (0)1923 270 375
subcondrilling@aol.com
www.subcondrilling.com

Subcon Drilling specialises in providing a first-class service in gundrilling, honing and superfinishing to F1, motorsport, and various other hi-tech industries. A positive approach and an emphasis on quality has underpinned all of its operations and helped facilitate its recent BS EN ISO 9001:2000 accreditation and membership to the MIA. The company was established four years ago and although a young and growing business, its management has a combined total of over 30 years' experience in gundrilling and honing. Subcon can comfortably undertake a broad spectrum of jobs from the simplest to the most complex. Flexibility is a key attribute, so one-off jobs as well as whole production runs can be easily catered for.

Summit Precision Engineering Ltd E351

Vulcan Road, Lode Lane Industrial Estate
Solihull, West Midlands B91 2JY, UK
enquiries@summit-precision.co.uk
www.summit-precision.co.uk

Summit Precision Engineering, an ISO9001:2000 and AS9100 approved company, manufactures precision machined components and assemblies for the motorsport, aerospace, defence and medical industries, and is well equipped to handle the quality requirements and short lead times expected



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E-Mail: r.tyler@gkndriveline.co.uk

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in these most demanding markets. Its production facilities, featuring the latest in CAD/CAM technology, and its established network of suppliers for materials and processes, enable it to offer a cost-effective 'one stop shop' for all of your requirements, from one off prototypes to batches of many thousands.

• **Reps on stand:** Andrew Dowler, Managing Director; Steve Batsford, Technical Sales Director

Tecno 2 E372

Walkers Garage, South Otterington
Northalletrun, North Yorkshire DL7 9HT, UK
T: +44 (0)1609 777 221
F: +44 (0)1709 778 067
john@techno2.co.uk

TEG Sport/Modena Engineering E158

Sand Lane
Warton, Carnforth, Lancs LA5 9NJ, UK
T: +44 (0)1524 733 837
F: +44 (0)1524 733 837
admin@tegssport.co.uk
www.tegssport.co.uk

Modena Dfag Gear Kits, transmission components
• **Reps on stand:** Stuart Newby, Frank Capo

Tennant Metall & Technologie GmbH E178

Castroperstrasse 137, 44628 Herne, Germany
T: +49 2323 18429
F: +49 2323 18427
post@tennant-metall.de

www.tennant-metall.de

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• **Reps on stand:** B Tennant and D Sildatke

Think Automotive E57

292 Worton Road
Isleworth, Middlesex TW7 6EL, UK
T: +44 (0)20 8568 1172
F: +44 (0)20 8847 5338
info@thinkauto.com
www.thinkauto.com

The company is a leading supplier to the automotive and racecar industry, and has been for nearly 40 years. It manufactures and distributes the Mocal range of oil coolers and associated hoses and hardware. To complement this it is distributor for Aeroquip, Krontec, Speedflow, ProGold and Moquip, giving it a range of hoses and fittings second to none. Think Automotive also distributes fuel filler caps from Newton Equipment and Enots, along with a whole range of products to provide the complete solution to all your automotive 'plumbing' needs. So whether it is for brake, fuel, oil or coolant requirements, remember to think Think.

• **Reps on stand:** Derek Heath, Matthew Potter

Tilton Engineering E190

25 Easy Street, Buelton CA 93427, USA
T: +1 805 688 2353
F: +1 805 688 2745
sales@tiltonracing.com
www.tiltonracing.com

Tilton Engineering, manufactures racing and high performance driveline components and in-cockpit controls, which will be on display. Driveline components include racing clutches (carbon and metallic), flywheels, bellhousings, concentric slave cylinders and competitive driveline systems. For 2005, Tilton is introducing many new brake system controls, including an advanced pivot-type balance bar/master cylinder system that will be available separately or as part of a new firewall-mount pedal box. In addition, Tilton will be displaying its range of high torque Super Starters.

• **Reps on stand:** Kirk Skaufel, Jason Wahl

TMD Friction UK Ltd E344

PO Box 18, Hunsworth Lane, Cleckheaton
West Yorkshire BD19 3YJ, UK
T: +44 (0)1274 854 000
F: +44 (0)1274 854 021
marketing@mintex.co.uk
www.mintextracing.com
www.mintex.co.uk

TMD Friction is exhibiting Mintex racing and fast road brake pads, brake discs and brake fluid, which have had another highly successful year. New this year is Mintex 'F6' compound for high temperature, medium friction, applications - the latest addition to the race winning 'F' compound family.

• **Reps on stand:** Terry Armstead, Allan MacKenzie

Total Restraint Systems Ltd E116

Unit 4, Hurricane Close
Old Sarum, Salisbury SP4 6LG, UK

T: +44 (0)1722 323 004
F: +44 (0)1722 334 437
post@totalrestraint.com
www.totalrestraint.com

TRS manufactures an extensive range of premium specification FIA- and SFI-approved competition harnesses, including the unique Magnum Ultralight. These are supplemented by a high quality selection of motorsport products including window nets, helmet hammocks, load restraints and hold-down straps. Other driver aids include carbon-fibre roof vents, navigators footwell, aluminised sun shade and Bergo Tiles: a portable flooring for workshop, pit and paddock use. TRS is also sole UK distributor for James Performance Suspension alongside Supersport, Delta Mics, eKtor and PLS performance road products.

• **Rep on stand:** Harley Morgrette

Total Seal Piston Ring Company E303

22642 N.15th Avenue
Phoenix AZ 85027, USA
T: +1 623 587 7400
F: +1 623 587 7600

Trackcar Design and Development Ltd E276/316

Unit 6, Leen Court
Boughton Industrial Estate
Ollerton, Nottinghamshire NG22 9ZD, UK
T: +44 (0)1623 836 683
F: +44 (0)1623 861 642
tim.blake@trackcar-dd.com
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W: www.motorsport.cranfield.ac.uk

Autosport Engineering
Stand E266 The Racing Car Show

Cranfield
UNIVERSITY

and rally cars. Performance transmissions and differentials: six-speed sequential in line and trans-axle transmissions; and sequential Evo transmission and full paddle shift steering wheel systems. Race and rally car manufacture: Toyota Altezza Rs200 GT car-520bhp, 950kg, Trackcar six speed, composite body, sequential paddle shift; Formula Ford GG01 – designed for Zetek series, new for 2005, full works supported team, available as Kent option; Ford Ka DOM – four-wheel drive, Cosworth engine, Trackcar six-speed sequential Evo transmission. Composites: interior and exterior panel design and manufacture. Engine development: full race engine programs, Dyno development, engine mapping.

• Reps on stand: Tim Blake, George Rytton, Dave Plant, Steve Willis

Tran-X E314

A.S.E Building, Brandon Road
Binley, Coventry CV3 2AH, UK
T: +44 (0)24 7665 9061
F: +44 (0)24 7645 9077
sales@tran-x.com
www.tran-x.com

Tran-x has been at the height of British motorsport for over two decades. Its reliable and durable retail range is often the unsung hero of many spectacular motorsport performance. As part of the Autosport Engineering group it has achieved a level of excellence, unrivalled in its field. With Tran-x failure is not an option. Please come and see its product for yourself and chat to its experienced team.

• Reps on stand: Dan Jones, Phil Wright

Trident Racing Supplies E342

Unit 31, Silverstone Circuit
Towcester, Northants NN12 8TN, UK
T: +44 (0)1327 857822
F: +44 (0)1327 858096
sales@tridentracing.co.uk
www.tridentracing.co.uk

Trident racing supplies will be exhibiting a wide range of fasteners, including NAS, AN and Unbrako and a wide range of hardware. The Trident Pedal box will also be shown.

• Rep on stand: Bill Bray

TTD Ltd E64

Davis House
Lodge Causeway Trading Estate
Bristol BS16 3JB, UK
T: +44 (0)117 965 9999
F: +44 (0)117 965 4724
ttdsales@ttd.org.uk
www.ttd.org.uk

TTD supplies quality parts to the automotive aftermarket. It specialises in distributing Dayco belt products, UFI filters, Raicam brake and Euro flex silicone hoses. The company's customers include MOD, Ferrari UK, 450 Motor Factors and motorsport/race markets and it exports to Europe, USA, Asia and Australia. The main TTD product for this show is its range of turbo and coolant hoses – Euro flex.

• Reps on stand: Callum Goodland, John Goodland

TTE International

Hogerwerf 15

Roosendaal 4704RV, The Netherlands

T: 0031 165 521 361

F: 0031 165 521 366

Tungsten Alloys E219

Unit C2, The Poplars Business Park
Poplar Way, Catliffe
Rotherham S60 5RL, UK
T: +44 (0)1709 363 633
F: +44 (0)1709 838 089
info@tungsten-alloys.co.uk
www.tungsten-alloys.co.uk

Tungsten Alloys (TAL) manufactures and supplies finished to drawing and blank tungsten alloy components in various specifications of tungsten materials, drawing on over 35 years of manufacturing experience. TAL services the performance racing industry with balance weights (static and dynamic), ballast, heavy skids, and other tungsten products where high density (65% greater than lead), quality and prompt service are priorities. Other engineering applications are in defence, aerospace (military and civil), tooling and radiation shielding. Showing will be examples of tungsten alloy ballast, skids, crank weights (dynamic and static), plus other dense products.

• Reps on stand: Chris Smith, David Richardson, Craig Wilkes

United Springs E394

Mandale Park, Norman Road
Rochdale OL11 4HP, UK
T: +44 (0)1706 644 551
F: +44 (0)1706 630 516
sales@united-springs.co.uk
www.united-springs.co.uk

United Springs has been manufacturing since 1821 and has implemented many changes in technology, particularly machinery and materials. It has kept pace with these advancements to maintain a position as a market leading precision springs manufacturer of the highest quality. Technological advancement coupled with a powerful customer orientation enable it to deliver results when repeatability and precision are critical. United Springs offers a full and confidential design service including prototypes to 'prove' the client's concept. Its unique point is that it can offer a broad and diverse range of products – springs, wireforms, flat springs and pressings.

• Reps on stand: Steve Grundy

Universal Race Technology E280

Unit G5/6, Beeding Close
Southern Close Industrial Estate
Bognor Regis, West Sussex PO22 9TS, UK
T: +44 (0)1243 842373
F: +44 (0)1243 842374
info@urtltd.co.uk
www.urt-composites.com

Universal Race Technology (URT) offers a diverse range of services from design to manufacture of composite components. It will be showing examples of components and assemblies manufactured from composite materials, from the smallest single part through to full-size racecars. URT is able to produce one-off and mass production items to the keenest of deadlines. It has rapidly developed a firm customer base on a direct and subcontract basis, producing high-quality components for motor racing, aerospace and commercial clients. From patterns through to final

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Stand E367 The Racing Car Show

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Autosport Engineering
Stand No. E176 The Racing Car Show



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Website: www.dkecrankshafts.com Email: dkecrankshafts@aol.com

installation URT tailors its services to any customer's needs.

• Reps on stand: Paul Walters, Matt Cox, Kevin Emmett, Lee Patterson, Nigel Taw

Universal Turbos E202

Universal House
Crow Arch Lane Industrial Estate
Crow Arch Lane, Ringwood
Hants BH24 3EF, UK
T: +44 (0)1425 471 421
F: +44 (0)1425 470 773
mail@universal-turbos.com
www.universal-turbos.com

Universal Turbos is the UK's premier supplier of Hybrid Performance Turbochargers. It is an authorised parts and service centre for Honeywell Turbo Technologies and Turbonetics and carries a full range of stock exchange turbochargers for all makes and applications.

Variohm Eurosensors Ltd E68

Williams Baerns
Tiffield Rd
Towcester, Northants NN12 6HP, UK
T: +44 (0)1327 351 004
F: +44 (0)1327 353 564
sales@variohm.com
www.variohm.com

Variohm Eurosensors is a specialist supplier of sensors - its range of rotary and linear sensors and pressure transducers is proven in many different autosport applications. It uses both contacting and non-contacting technologies, allowing the sensors to see high vibration, shock and temperature levels, surviving time and time again. Displayed on the Variohm stand will be the company's range of position, pressure, vibration accelerometers, force, torque, load and temperature sensors. Variohm is also able to offer custom-designed sensors to meet your exact requirements. Its team of technical sales engineers has many years' experience and is able to solve the toughest of applications.

Vibra Technics Automotive Ltd E157

90 Cavendish Road
Knighton Fields, Leicester LE2 7PH, UK
T: +44 (0)116 283 5053
F: +44 (0)116 244 0017
mailbox@vibra-technics.co.uk
www.vibra-technics.co.uk

Vibra Technics will be exhibiting a range of its own design engines and gearbox mountings for high performance cars including the VW Golf range, Escort and Sierra Cosworths, Focus and some Peugeot and Citroen applications. Also on the stand will be some of the suspension bushes it has developed for competition and fast road use. It will be offering its engine mount system design services to the smaller companies involved in car construction who may not be able to afford to have anti-vibration and system design engineered in the engine mounting area.

• Reps on the stand: John Wright, Hannah Bentley, Roger Lott, Martin Tyman, Mark Wright

Vision Engineering Ltd E385

Monument House, Monument Way West
Woking, Surrey GU21 5EN, UK
T: +44 (0)1483 248 300
F: +44 (0)1483 248 301
generalinfo@visionseng.com
www.visioneng.com

Vision Engineering designs and manufactures inspection microscopes and three-axis non-contact measurement equipment, from simple stereo viewers to fully automated measuring solutions. Their optical design allows operators to work effectively for longer, ensuring the highest quality standards are maintained. Systems are used in a variety of motorsport inspection and measurement applications, where ease of use and accuracy allow for fast, effective inspection. Established in 1958, the company has delivered more than 300,000 systems to a worldwide customer base.

• Reps on stand: Richard Nagel, Peter Williams

Wallwork/Tecvac Ltd E170

Lord Street, Bury, Lancs BL9 0RE, UK
T: +44 (0)161 797 9111
F: +44 (0)161 763 1861
sales@wallworhht.com
www.wallworhht.com

Wallwork/Tecvac operates a high-quality, comprehensive one-stop shop heat treatment and hard coating service from centres in Manchester, Birmingham and Cambridge. Launching at this year's show will be Tecvac's Autosport division, consisting of the latest low-friction, high-hardness coatings. This new process will bring a leading edge to Tecvac customers, giving them a significant improvement in component life in extreme conditions. This will be backed up with the Tecvac express turnaround service (24 hours), 15 years' experience in the industry and a free transport service across most of the UK.

• Reps on stand: Simeon Collins, Howard Maher, Mike Morris, Tony Gibbs, Andy Hiron

WDS E406

Richardshaw Road
Grangefield Industrial Estate
Pudsey, West Yorkshire LS28 6LE, UK
T: +44 (0)845 606 6677
F: +44 (0)845 601 1173
pheselton@wdsitd.co.uk
www.wdsitd.co.uk

WDS manufactures and distributes in excess of 19,000 engineered components with over 96% available ex-stock - a selection of over £2.5m. These include quick release pins, hoist rings, toggle clamps, Mitee-Bite clamps, ball lock Marlo broaches, MicroLoc workholding, Spencer Franklin hydraulic workholding to name just a few. Visit the stand for full details.

• Reps on stand: Peter Heselton, Chris Putman

Welwyn Tool Co Ltd E392

4 South Mundells
Welwyn Garden City, Herts AL7 1EH, UK
T: +44 (0)1707 331 111
F: +44 (0)1707 372 175
tools@welwyntool.co.uk
www.welwyntool.co.uk/tools

Welwyn tool, a major supplier of quality production tools for industry will be showing and demonstrating a wide range of electronic assembly hand tools including the latest soldering stations from Weller, and new from Saltus, electronic torque wrenches with aerial transmission systems. Also from Meister, a range of production line electronically controlled hot air tools, and hot air for gear box testing, plastic welding and for SMD rework.

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stand E118

Wenzel UK Ltd E390

2/3 Grove Industrial Estate
Gloucester Road
Patchway, Bristol BS34 5BB, UK
T: +44 (0)117 969 5551
F: +44 (0)117 969 5552
info@wenzel-cmm.com
www.wenzel-cmm.com

Wenzel, one of the world's largest CMM builders, will show its smartCMM which can operate at high speed and accuracy in shop-floor conditions. The smartCMM was conceived for the industries like autosport which demand fast answers and precision measurement of complex mechanical parts. The smartCMM uses linear guides, bellows and a thermally stable mechanical structure using granite and carbon fibre to minimise effects of temperature change. The monitor and keyboard, used to launch measuring programs via Wenzel's Metromec software 'Quick Selection Table' are mounted on an ergonomically positioned shelf at the side of the machine.

• Reps on stand: Graeme Webb, Andy Woodward

Whitley Brooks Engineering E349

Herald Way, Binley, Coventry CV3 2NY, UK
T: +44 (0)24 7645 5938
F: +44 (0)24 7663 6950
joe.Reynolds@whiteleybrooks.co.uk
www.whiteleybrooks.co.uk

Established in 1965 by Ken Whiteley and Stan Brooks, Whiteley Brooks Engineering has always maintained a commitment to producing high-quality machined parts. Specialising in CNC machining, with extensive experience in supplying the motorsports industry, it has developed an understanding of the unique nature of supplying this sector. Employing a highly skilled workforce, Whiteley Brooks is justifiably proud of its ability to satisfy the delivery and quality demands required by customers in this demanding industry. It has a full inspection facility, including two CMM machines and offline CNC programming with the ability to accept solid models from most industry standard systems.

William C Mitchell Software E268

125 East Plaza Drive, Suite 117
 Mooresville NC 28115, USA
T: +1 704 660 0330
F: +1 704 663 0085
bill@mitchellsoftware.com
www.mitchellsoftware.com

The Racing by the Numbers programmes are intended for engineers, experienced crew members, and newcomers to the sport. Over the last 20 years, the programmes have been successfully used by Formula 1, Indy Car, Formula Atlantic, Winston Cup, SCCA club racers, short track oval, autocross and Formula SAE teams. Users have included professional engineers and design teams. The mission of William C Mitchell Software is to provide world-class programs at an affordable price. The latest product is the Driving Simulator program that explores different lines through a turn, as described by Racecar Engineering.

• Rep on stand: Bill Mitchell

WNT (UK) Ltd E407

Sheffield Airport Business Park
Europa Link, Sheffield S9 1XU, UK

T: 0800 0732073
F: 0800 0732074
glenn.stanton@wntuk.com
www.wntuk.com

'total tooling = quality x service'

WNT is dedicated to the metal cutting industry, supplying an extensive full range tooling program consisting of top quality products. In addition to the internationally renowned Ceratizit range for its own company network, WNT is able, thanks to its co-operation with selected European brand manufacturers, to provide a total tooling solution covering everything from the pull stud to the cutting edge. The WNT technical sales engineers are apprentice-trained, time-served engineers who can provide application oriented technical advice in order to select the right cutting tool for the job.

• Reps on stand: Glenn Stanton, Adrian Fitts

Wixroyd E401

Dunley Hill Court, Ranmore
Dorking, Surrey RH5 6SX, UK
T: +44 (0)1483 286 677
F: +44 (0)1483 286 678
info@wixroyd.com
www.wixroyd.com

Wixroyd will be showing its industry-leading Zero Point system, for achieving quick fixture change in seconds with five-micron repeatability. With a wide scope of experience in Wixroyd Zero Point solutions in motorsport and sub-contracting, a visit to the Wixroyd stand is a must.

A wide range of workholding and design elements will also be exhibited, with free catalogue and CAD available.

Woodward Machine Corporation E174

PO Box 4479, Casper WY 82604, USA
T: +1 307 472 0550
F: +1 307 235 1551
tech@woodwardsteering.com

Woodward Machine Corporation manufactures power rack and pinion steering systems, featuring field-interchangeable valve internals. This enables the feel of the steering to be closely fitted to a car's characteristics, as well as to the preference of an individual driver. Woodward's newest lightweight power rack is designed for the international market. It can be furnished left-handed, right-handed, or centred, for front or rear steer, and in custom lengths, with a rapid delivery time. Other Woodward products include collapsible safety steering columns, quick-release steering wheel hubs, splined steering shaft kits, needle-bearing steering u-joints, and one-piece swaged tubular tie rods and suspension links.

XAP Electronics E273

Le Mercure - Bot A
1740 ave du Maréchal Juin
(note address change)
30000 Nîmes, France
T: +33 4 66 02 94 94
F: +33 4 66 02 94 90
hardy@xap.fr
www.xap.fr

XAP Electronics designs and manufactures motorsport electronics products. Its products range from electronics battery switch, dashboard integrated in the steering wheel, dashboards, data logging system, sensors, wiring looms. The products it designs and manufactures are optimised to withstand the hard conditions of

motorsport. Its engineering department designs embedded electronic systems including complex hardware and software.

• Rep on stand: François Hardy

Xceldyne Technologies LLC E124

37 High Tech Boulevard
Thomasville NC 27360, USA
Tech Support/Sales 888.481.2310
T: +44 (0)1 336 475 0201
F: +44 (0)1 336 475 3772
contact@xceldyne.com
www.Xceldyne.com

Xceldyne Technologies has partnered CV Products to design, manufacture and distribute a complete line of technologically advanced titanium valves and valvetrain components to engine builders and racers in virtually any market, at any level – from professional to grassroots. Housed in a recently completed world-class manufacturing facility, Xceldyne features technologically advanced manufacturing capabilities, proprietary material coating technologies, patented reciprocating mass reduction techniques, state-of-the-art quality control with 100% certified inspection and a dedicated technical sales/support team. Xceldyne has successfully earned the business of some of the most demanding clients worldwide, including Formula 1, NASCAR, CART, Indy Car, NHRA and more.

Xtrac Ltd E223

Gables Way, Kennet Park
Thatcham, Berkshire RG19 4ZA, UK
T: +44 (0)1635 293 800
F: +44 (0)1635 293 700

Xtrac is the world's premier supplier of motorsport transmissions, offering a complete design, manufacture and analysis service for all the top formulas. The vast majority of teams in Formula 1, WRC, IRL, DTM, sports cars and touring cars use Xtrac transmissions, differentials, engine gears, driveline and steering components. In addition to its new 407/427/437 range of touring and sports car in line gearboxes, which are suitable for both petrol and diesel applications, Xtrac will also be exhibiting the 395 sports car transmission, 386 Grand Am transmissions, 416 ETCC transmission, 426 (Diesel) ETCC transmission and the GTS longitudinal transmission, plus the 247 Limited Slip Differential.

• Reps on stand: Robin Price, Cliff Hawkins, Peter Digby

Zeus Holdings Ltd E284

Sunrise Business Park, Wallaston
Stourbridge, West Midlands DY8 4ZZ, UK
T: +44 (0)1384 446 400
F: +44 (0)1384 446 446
sales@zeuscastings.com
www.zeuscastings.com

Suppliers of aluminium precision sand castings specifically for the motorsport and automotive industry, specialising in the manufacture of thin walled, originally accurate, complex cylinder heads, block and ancillary castings for all forms of motorsport applications including Formula 1, NASCA, IRL, Le Mans, DTM and others. A complete service including full CAD/CAM facilities, on site pattern making, casting simulation, latest state-of-the-art foundry facilities (including dedicated foundry for motorsport) from last component to fully machined parts.

ZF Sachs Race Engineering GmbH E294

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F: +49 9721 98 4299
Service.sre@zf.com
www.sachs-race-engineering.de

ZF Sachs Race Engineering develops, constructs, produces and sells shock absorbers and clutches for use in racing vehicles and performance enhanced series vehicles. As a subsidiary of the world's largest shock absorber and clutch manufacturer, ZF Sachs AG established itself as a legally independent business unit (GmbH) in 1998 and has been expanding continuously since then, now counting over 78 employees. 'Our goal for our involvement in motorsports is to increase the Sachs brand awareness in international markets and to strengthen the image of our organisation through success in motorsports', stated General Manager Olaf Schwaier. 'At the same time, and together with our partners, we aim to raise the technical standards in motorsports and to keep testing and improving our products for the extreme demands in competitive motorsports.'

Zircotec E353

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Zircotec offers a wide selection of coating services to protect components against the effects of heat, wear, abrasion and oxidation. These coatings enable our customers to optimise material performance in a range of demanding technical and clinical applications. Zircotec coating solutions are used by leading manufacturers in the telecommunication, automotive, power generation and orthopaedic markets – for components where quality of performance is vital. The Thermohold range of multi-layered coating systems is designed to reduce the flow and transfer of heat and provide thermal management by a number of options. Variants of the coating system can be applied to metals, carbon fibre composite and laser sintered nylon components. They can be used to contain heat within hot components or to protect sensitive components from heat. Zircotec coatings have been developed and proven over many years and the company offers a rapid turnaround service.

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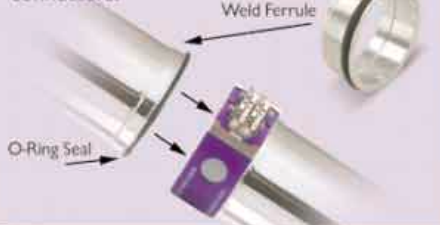
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