Advanced Circuit Driving Techniques

VBOX MOTORSPORT

Brain Power is the new horsepower

This guide is made up of articles written by pro racing drivers and instructors who use video and data to illustrate various circuit driving techniques, with tips on how to get the most out of yourself as well as your car.

Some may surprise you...

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Understand how to maximise the contact patch of a tyre by quickly removing the guess work surrounding vehicle set up.

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Advanced Circuit Driving Techniques

Article 15: The science of rapid race car optimisation using tyre temperature

Maximising the contact patch is the best way to get the most out of your tyre and ultimately improve lap-times. There are many variables which affect how your rubber is interacting with the track surface, such as camber, caster, toe-in, brake bias and tyre pressure. There are so many ways of changing the handing characteristics of a race car, so how can you go about this in a scientific way?

One answer is to use the wealth of information that the latest generation of tyre temperature sensors can give you. They read 16 independent values across the width of a tyre, allowing you to see exactly how hard your tyre is being worked, across its whole surface.

Optimising Camber

Under load, you want as much of the rubber contacting the track as possible. This normally means running negative camber so that when the car rolls during cornering, the tyre is as flat as possible in respect to the surface of the track. Therefore, during steady state cornering, the temperature across the tyre should be as uniform as possible.

Note that when you take a manual reading in the pits, you can only get an average overview of the temperature profile, so you can easily misinterpret the data, as tyres rapidly lose surface temperature in a straight line. Also, any negative camber will keep the inside of the tyre warmer than the outside, skewing the data.

In this example, I was driving a Chevron B8, and it had significant understeer on the exits of most corners. Taking a manual reading across the tyres throughout the season didn't indicate any particular camber problems.

We then fitted some tyre temperature sensors, and quickly saw that the front tyres were getting hot on the inside of the tyre, but only during the exit phase of the corner. You can see this in the tyre temperature graphic in the top right hand corner. The front left tyre is showing a marked temperature difference across the tyre of 23°C

Front left tyre showing steep temperature gradient of 23°C

By reducing the front camber, the temperature gradient became a lot less pronounced, and the grip at the front of the car was significantly more consistent and the understeer was significantly reduced. This gave us a benefit of 1.2s a lap around the Silverstone GP circuit:

After camber-change, front left showing temp gradient of only 9°C

As you can see in the second screenshot, there is still a small temperature difference of 9°C, so this tells us that the camber can still be reduced very slightly to get the temperature even across the tyre.

Normally, you wouldn't be able to adjust the camber to such a fine degree and feel any difference in the handling or spot a definitive improvement in lap-time, as you would have to make a much bigger change. However, by using the instantaneous temperature gradient during cornering, you can fine tune the camber with confidence, knowing that you are getting as close as possible to the optimum value, which wouldn't normally be possible using traditional methods.

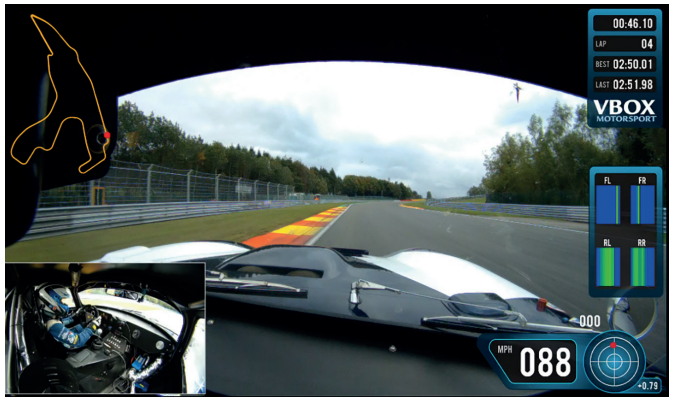
The benefit of this camber reduction wasn't only in helping the understeer, but it also gave better grip under braking as more of the tyre was in contact with the track, and less tyre wear on the inside of the tyre.

Optimising brake bias

To get the most out of your braking system, it is vital to fine tune the brake bias so you have an even distribution of load between the front and rear tyres. This is a tricky process to carry out and requires a degree of experience and understanding on the behalf of the driver. Even with the very best drivers, this is very much a trial and error process.

The more force you put through a tyre, the hotter it becomes. Therefore, you can see how hard the front tyres are working in relation to the rear by looking at their temperature during the braking phase.

Here is a good example where I was driving a Cobra Daytona at Spa, and braking down from 155 mph to 55mph at the end of the Kemmel Straight:

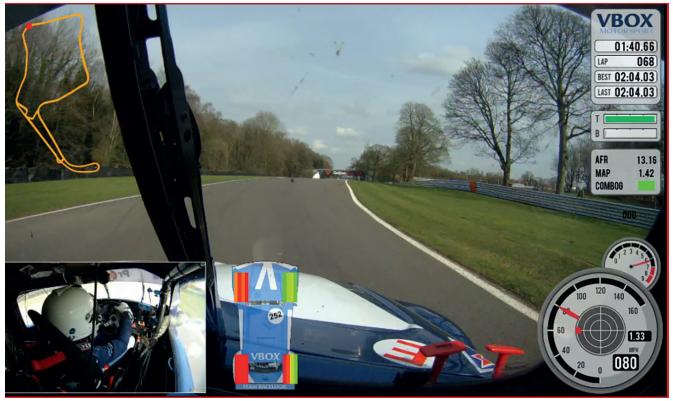


Too much rear bias leads to cold front tyres during turn in

You can see from this snapshot that the rear tyres have warmed up more than the front during the braking phase. This indicates that the bias is set slightly too much to the rear. By moving the brake bias forward, the braking performance could be improved.

Not only that, but by putting more energy into the front tyres, they would warmer before the crucial corner entry phase. In fact, with too much rear bias, the front tyres were cooling down on the long Kemmel straight and not coming up to temperature until the exit of the corner. Without this data, you wouldn't think that you can reduce corner entry understeer by moving the brake bias forward..!

On a different car, we have also seen too much rear bias overheating the rear tyres on the entry into a fast corner, which then leads to oversteer later on in the corner as the rear tyres have become too hot:



Too much rear bias overheats the rear tyres, causing late corner oversteer

Optimising tyre pressures

The best tyre pressure is one that enables an even contact patch for the rubber on the track surface. Too much pressure makes the tyre balloon and too little makes it collapse in the middle.

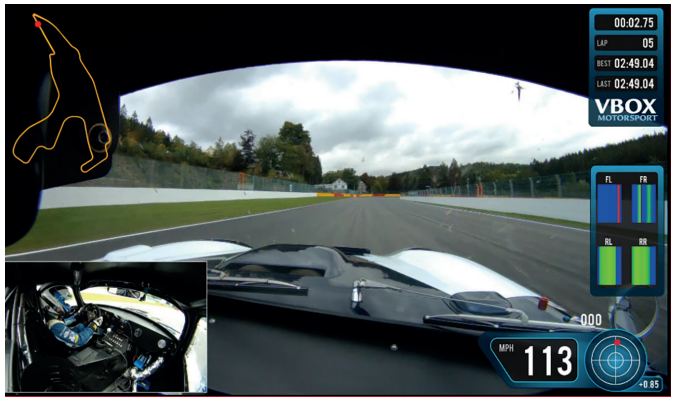
By using tyre temperatures, you can see this happening in real-time. If the centre of the tyre is colder than the rest, then the pressure is too low, and if the centre of the tyre is hotter, then the pressure is too high.

In the following example, the front right tyre is showing signs that it is over-inflated, you can see the hottest part of the tyre is in the middle:

Front right tyre hotter in the middle

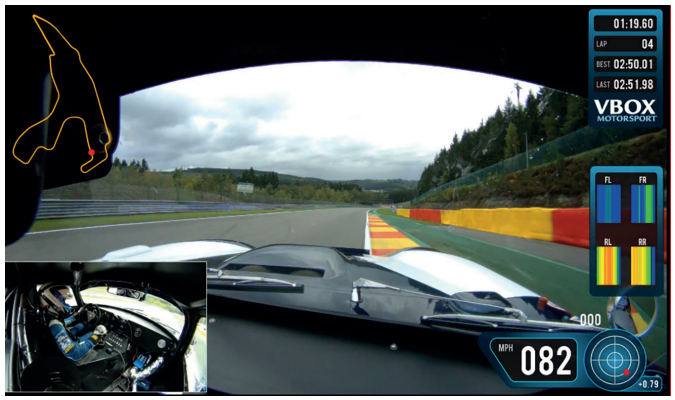
This allows you to finely tune the pressure of each tyre to maintain the best possible contact patch. This then works the tyre more evenly, and the long term tyre wear will be reduced.

Here is another example, where the front right tyre is under-inflated and there is an obvious cold patch in the middle:

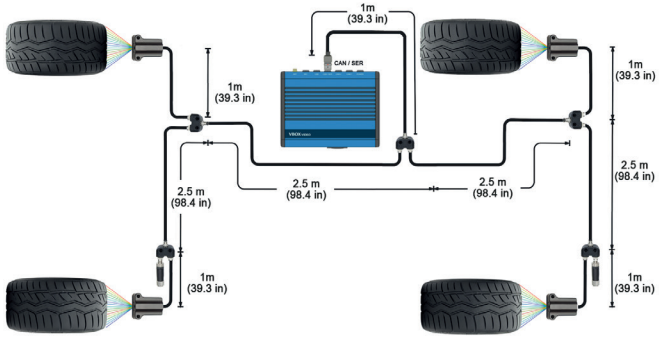


Front right tyre colder in the middle

Another example where the left rear is over-inflated:



Left rear tyre hotter in the middle



Conclusion

As you can see from some real world examples, real science can be applied to the process of optimising camber, brake bias and tyre pressures. Previously this would involve a lot more testing and is very dependent on the feedback from the driver, which can be difficult to determine in a short test session.

Live Streaming

If you want to speed the setup process up even further, then you can Live Stream this video back to the pits, so the engineers can see what is happening to each tyre, and be ready to make adjustments the moment the car comes back into the pits. In this way, the car's setup can be perfected with objective measurements in a very quick time frame.

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VBOX VIDEO HD2
two cameras and High Definition video capture

VIDEO VBOX PRO
with two cameras and predictive lap timing display

VIDEO VBOX LITE
with two cameras and predictive lap timing display

All the video and data in these articles were recorded using a **VBOX MOTORSPORT VIDEO DATA-LOGGER** as pictured above. The screenshots have been taken from **CIRCUIT TOOLS**, intuitive analysis software that comes included with every **VBOX MOTORSPORT** product.

VBOX VIDEO HD2 and the **VIDEO VBOX** range incorporate a GPS engine and synchronised video recorder with customisable graphic overlay, designed and manufactured in the UK by **RACELOGIC**.

Anyone can work through the examples in these chapters using **CIRCUIT TOOLS** and the files available that accompany them. Download the software from the **VBOX MOTORSPORT** website.

Lots more information about **RACELOGIC'S** motorsport products and where to buy them is available from vboxmotorsport.co.uk

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