PART THREE

Be a better driver

Part 3: Performance driving coach Neil Furber discusses cornering systems and explains the importance of vehicle dynamics

In my opinion, many drivers are over-confident driving in straight lines, yet under-confident in the bends. The bits in the middle (corner entry and exit) are where most of the problems occur. Since cornering is a major part of everyday driving in the UK, I think the subject is well worth a proper look; after all, it's in the twisty bits where the enthusiastic driver gains most pleasure, especially in a BMW!

From my extensive experience as a performance driving coach, I've discovered that the main fears for most people relate to 'the limit', how a car should be driven through a corner and a misunderstanding surrounding the ever-increasing safety systems which now form a standard part of modern cars, including BMWs.

WHAT'S THE LIMIT?

So, let's start with the least understood aspect, which is 'the limit'. This relates to the limit of a vehicle's adhesion on the road, and is governed by the ability of the tyres to grip the road surface. During enthusiastic driving, the limit may be reached by one tyre only, both tyres on a single axle, or any combination of the car's four tyres.

At a very basic level, the vehicle tyre is a deformable band that transmits all forces from the car to the ground, and vice-versa. Consequently, it's fair to say that the tyres, and more specifically their contact patches, are the most important components on a car. They enable the motion and dynamic control of the car, so are absolutely fundamental to both progress and safety.

As such, any tyre has its limit at the point where it exhibits a change from gripping the road surface, to reducing or letting go of that grip altogether. During driving, each of a car's four tyres is used differently, as the driver accelerates, brakes and steers.

ESSENTIAL SUPPORT

A car's weight is supported by its four tyres. When static, this is usually spread between a 50:50 and 60:40 front-to-rear split, but depends largely on the position of the engine. Generally, the side-to-side split is fairly even.

However, once a car starts being driven, its weight distribution will change both front-to-rear and side-to-side, so let's dig into weight transfer. The centre of gravity (C of G) is a theoretical point somewhere in the middle of the car, within the confines of the bodyshell. It's a combination of the masses and locations of all the components in the vehicle. The engine, gearbox, fuel tank and driver/passengers have the largest effect on its position.

A 50:50 car would have this point at midway between the front and rear wheels. But because this point is above the ground, the car's bodyshell moves relative to the wheels, during changes in speed and direction. Essentially, the bodyshell tries to carry on as it had been travelling, and will try to pivot about the tyre-to-road interface. This is most easily understood as body roll – a lateral tipping of the bodyshell towards the outside of the bend, during normal cornering.

During a corner, the bodyshell tries to move laterally sideways relative to the tyre contact patches, but is prevented from doing so by the grip the tyres exert on the Tarmac. As a consequence, the body rolls instead.

Weight transfer occurs for two reasons. Contrary to most understanding, the main reason is a jacking effect which tries to lift the side of the car nearest the inside of the bend, and load the outer side. This helps to explain why tall vehicles can actually roll over under heavy cornering. The higher the C of G, the stronger the jacking effect.

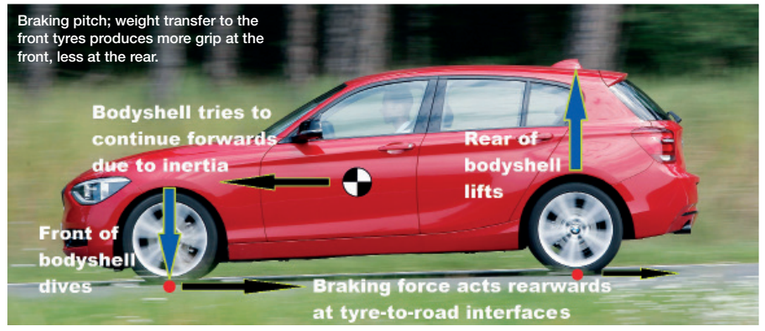
BODY ROLL

The second aspect is due to vehicles being fitted with compliant suspension systems. The on-board springing allows the body to roll to the side by a much greater angle than the flexing of the tyres alone. Therefore, the lateral position of the C of G moves closer to the outside of the bend. Imagine the driver getting out and moving to the passenger side and you'll get the idea. Both of these effects lead to the outer tyres supporting more of the car's weight during cornering, while the inner tyres support less. These effects are summarised in the 'Weight-transfer' panel.

So now we get to the interesting nugget. When adding more vertical load on to a tyre it will grip the road better, and its limit will increase. This will allow the tyre to work harder and do more than before. However, since the car's weight does not change during a corner (assuming nothing falls off!), while some tyres will gain load, others will inevitably lose it. It's the driver's ability to control this phenomenon that dictates how well the car will fare through

Body roll is a lateral tipping of the bodyshell towards the outside of the bend, during normal cornering.

The actual area of the tyre that's touching the road surface at any one time is known as the contact patch, and it's smaller than you might think.



Braking pitch; weight transfer to the front tyres produces more grip at the front, less at the rear.

the twisty bits.

Let's work our way through a corner. Before the corner, you are driving at a steady speed in a straight line. The car's bodyshell will be level and, for the sake of simplicity, we'll assume that all four tyres are evenly loaded, each supporting 25% of the car's total weight.

As the corner approaches, you start applying the brakes, which causes the bodyshell to pitch forward (nose-down), and the weight distribution gets altered. The front tyres may be supporting 60% of the total weight between them, while the loading on the rears will have reduced to 40%. This is why front brakes are always bigger and more powerful than those at the rear – they can work the front tyres harder due to the increased limit induced through braking.

GRIP VARIATION

The important thing to appreciate, once the braking phase begins, is that the rear tyres will become less capable than they were because the forwards weight transfer will have reduced their limits.

Turning the steering wheel to enter the corner may be OK, but if the rear tyres are already near their limits, the rear of the car could start to break free, leading to a spin – the famous oversteer. In fact, you'll find the car more stable if you gently release the brake pedal, and reapply a very small amount of throttle (just enough to maintain the new speed), before turning-in to the bend.

By adopting this technique you will be allowing the car to settle back into a level position before it has to start rolling laterally during the cornering phase. Consequently, the tyres will now be supporting an even share of the car's weight, front-to-rear.

With overall speed reduced and the bodyshell back level following the initial braking phase, a smooth steer to turn-in to the bend will induce lateral weight transfer, causing the bodyshell to roll towards the outside. Maintaining a steady throttle position will keep the car's speed and front-to-rear weight distribution steady. This is balanced cornering and is the safest, most effective use of the available grip.

As the end of the corner approaches, it's time to think about the exit. It's often tempting to floor the throttle and surge up the next straight, but the exit is just as important as the entry. Excess power, or applying too much, too quickly, can overload the driven tyres (usually the rear ones on a BMW) and lead to a loss of grip.

MAXIMUM SAFETY

For the maximum safety, it may be best to wait until the car is out of the corner, and steering lock has been fully unwound, before accelerating. In practice, though, engine power can be progressively applied as the steering is unwound during the corner exit phase, but it's important that there's an exchange from one to the other.

If you squeeze open the throttle pedal too rapidly relative to unwinding the steering, the driven tyres may be overloaded (through a combination of both cornering and acceleration), and their grip limit will be exceeded. Starting to unwind the steering first, then following with an exchange to gently increasing throttle, will maximise progress out of the bend without overdoing the stress on the driven tyres.

The most common issue I see with road drivers during cornering is a lack of planning. The general series of events unfolds as follows. The driver approaches the corner and starts to brake, but this is usually too late. As the bend starts and steering adjustment is required, the driver is still braking as they aren't yet at a comfortable speed. By the time the speed is suitable, the car is at least halfway into the bend.

The driver then releases the brake and is finally ready to start thinking about the exit. However, they haven't yet reapplied the throttle pedal and their speed is still reducing. Not quite on the straight, they

The black and white symbol shows a typical centre of gravity location for the car – this is where the car's momentum can be considered to act.

A common concern for many drivers is the 'limit' of their car and its tyres, and what happens if they push beyond it.

IMPROVE YOUR DRIVING

DRIVE 7TENTHS offers a range of performance driver training courses both on-road and on-track. There will be more information in the following articles but if this article has piqued your interest you can always get in touch with Neil through the DRIVE 7TENTHS website – **drive7tenths.com** – to ask questions or discuss driver training options

As for modern safety systems, they aren't magic and they don't operate as often as most drivers seem to think

finally decide to accelerate, often too hard to try and make up for lost time and speed.

In most cases with this kind of scenario, drivers are lucky and don't get punished for their poor technique. Thankfully, a combination of decent available grip and modern safety systems typically saves the day by preventing a skid.

CORNERING PROBLEMS

Problems are often triggered by drivers wanting to drive 'fast', and feeling that a fast entry is the way to do it. Unfortunately, for many, it's simply that their vision is focused too close to the end of their bonnet, so the corner is seen too late. My article last month dealt with vision and planning in more detail but, clearly, by looking further ahead up the road, the corner can be seen much earlier.

Using the Visual Link Cascade referred to last month, the radius of the bend and the surface, visibility and specific hazards can be considered much in advance, enabling the driver to choose a suitable speed and gear. The most important thing is to plan and start the braking phase sufficiently early to ensure that it's fully finished before turning the steering wheel.

By adopting this approach, not only is the car's balance achieved as described earlier, but the driver's mind is no longer stressed and cluttered. So, instead of focusing on braking as the corner is developing, the driver has a clear mind at entry to focus on position and exit. With the latter, the car will be better balanced (and therefore further from a skid), the minimum speed will be higher and the exit acceleration both smoother and earlier. This is obviously safer but also more efficient.

SAFETY SYSTEM MYTHS

As for modern safety systems, they aren't magic and they don't operate as often as most drivers seem to think. In my professional capacity, I've experimented with many different systems across multiple brands. Some systems are proactive but the majority are reactive.

A proactive system will prevent the driver from introducing an issue, while a reactive one will attempt to limit or control a developing, driver-induced issue. The simplest way to illustrate this is to consider a traction control system.

Proactive traction control will limit the amount of engine power available, no matter how far the throttle pedal is pressed. The comfort mode in an M4 feels like this. Although it may be possible to spin the wheels in certain situations, the maximum

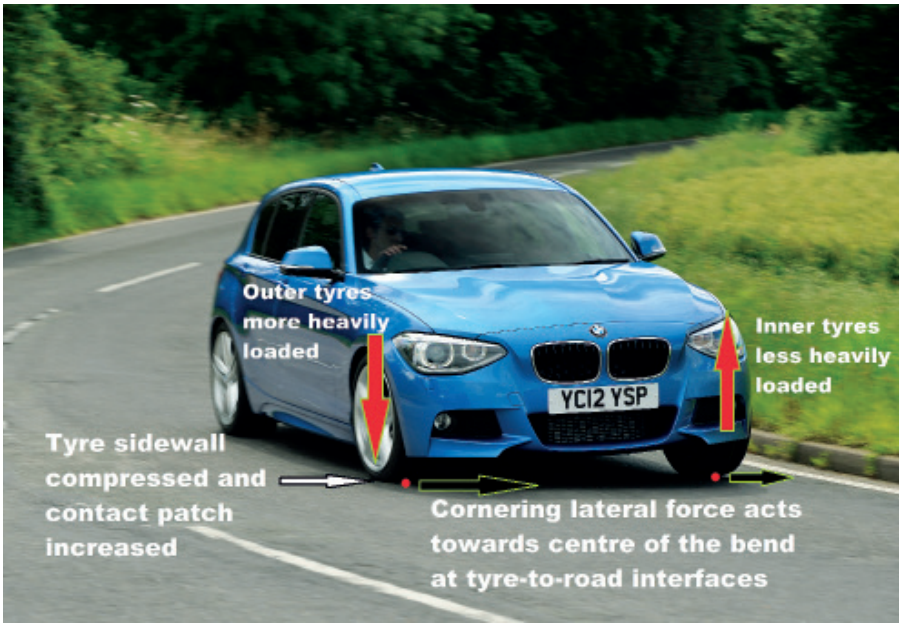
In most cases with this kind of scenario, drivers are lucky and don't get punished for their poor technique

WEIGHT TRANSFER

During braking, the bodyshell will pitch forwards and the front tyres will be loaded more heavily.

During acceleration, the bodyshell will pitch rearwards, and the rear tyres will be loaded more heavily.

Cornering produces lateral roll of the bodyshell towards the outside of the corner – it will roll left in a right-hand bend and vice-versa. The outer tyres will be loaded more heavily.



Lateral weight transfer is a combination of jacking effect and a lateral movement of the centre of gravity.

power is reduced and it feels like the computer is holding the engine back.

In contrast, a reactive system will sense and attempt to limit wheel-spin as the wheel speed sensors measure an excess in driven wheel speed. This will usually cut the throttle input electronically and, in some cases, apply the brake to reduce the wheel speed to below a trigger threshold.

Stability control systems are an extension of the traction control system, and also make use of the braking system. They limit excess engine power and brake individual wheels to both skew (steer) the car and slow it down to help the driver regain control. Again, some systems are reactive and wait for a trigger threshold, while others are proactive and won't allow the car to be driven above a certain proportion of the tyre limits.

Most importantly, if the car is being driven both sensibly and correctly, the safety systems should not be required, and reactive systems should never be triggered. This can apply both during commuting in urban traffic and at speed on a circuit. A very skilled driver can keep a car just below its limit of grip, and still set a much faster lap time than a less-skilled driver over-driving the same car on the same circuit with many of the reactive safety systems triggering regularly. An interesting consequence of the latter is much-increased temperature and wear of brakes and tyres.

The cornering system described in this article represents a nice, stable platform for most cornering. Of course, there are exceptions and developments for specific requirements. Next month I shall be moving on to explain heel and toe, rev-matching techniques, as well as gear selection. ●

VISUAL LINK CASCADE FOR CORNERING

Approaching the bend, the driver can position the car laterally, analyse the radius and whether the bend has good visibility or is quite blind. This leads to a choice of appropriate speed and gear selection.

Before committing to the bend, there may be an opportunity to look across the hedgerow or through some trees to gain extra information about the exit. Is there a large vehicle coming the other way or a horse-rider's helmet bobbing along in front? Is there mud on the road or obvious potholes to be concerned about?

Is there a camber or gradient that will affect weight transfer and vehicle dynamics? Does the speed need further adjustment before balancing the car for the corner?

Many drivers are unsure of what Sport modes, DTC and ABS systems actually do.