BMW Drivers Club
New South Wales

A basic guide to Performance Driving:

(Written and compiled by Randall Lumbewe from reading, watching and listening to related videos and putting into practice both on track and day to day driving**)** July 2021

We will all have different thoughts of what constitutes "performance driving". Some consider it relating to only driving on a racetrack, or in a motorkhana, others might think of it as driving a performance vehicle, like a BMW M car or such like, on any road. But what about when you might be out for a weekend drive and you come across a road with a series of bends and switchbacks, advisory road signs showing 25km/h followed by 35 and 45km/h turns and a posted speed limit of (say) 80km/h as compared to freeway driving, even the boring Hume Highway Sydney/Melbourne?

Performance driving can be and arguably should be *whenever* you are driving. Why? Several reasons, because you might and ideally should know how to, you should be engaged in the whole process of driving, you can feel what the car is doing, where to look to predict the actions of other vehicles (where possible), your seating posture is correct, the mirrors are suitably adjusted so you know what is behind and beside your car, your braking, steering and acceleration is controlled and you are observing the rules.

But what really is performance driving about? Personal safety, safety of other road users, enjoyment, mastering the machine is all done by feeling what the car is doing and the vision, to control where the car is going. You are basically connecting the senses in your bottom and your eyes to control what your arms and feet are supposed to do.

However, let us talk about some of the ideas for performance driving on a racetrack, and then you might see benefit in translating these ideas to what you do in your driving daily.

By now you will hopefully have reviewed the You Tube **Incarnation** video *"Ten Tips to make you a better, faster smoother and safer driver"*, and after watching this you might even take some time to review it again, but to look and listen for other elements relating to Mark's performance driving. You might even go back to some of your favourite You Tube track car videos and watch and **listen** for some of the queues.

This guide to performance driving is provided to give new and relatively inexperienced participants (and maybe some experienced as well, as a refresher) help in the learning process and therefore being involved in motorsports at the club level with an increased level of knowledge and therefore an increased level of safety. Drivers will need to adapt these techniques detailed here slightly differently given the type of vehicle, power, FWD, RWD, braking capability, tyres, the vehicle's type of differential, suspension set up driver's reaction time and any electronic intervention, to mention just a few. This article has been prepared by its author with more than 50 years' driving experience, having completed many advanced driving courses from Peter Wherret, Ian Luff, BMW Driver Training not to mention having driven on three of the most challenging tracks, Mt Panorama, Spa de Francochamps and Nordschleife Nurburgring, to come away unscathed.

1. Seating / Posture / Steering

The seat position will control your comfort, and it should be as low as possible, but why? Getting low down nearer the car's centre of gravity is where you will feel the most of what the car is doing, so you can feel the lateral and longitudinal G-forces and the directional changes and be able to compare what you **feel** the car is doing as a result of your driving inputs of steering, braking and throttle.

The proximity to the steering wheel should be where the base of your hand (where the thumb meets the wrist) can sit on top of the steering wheel (and if necessary, adjust the steering column and seat position to help you achieve this) with a bend in the elbow, but why?

This may seem too close, however you do need to minimise the load on your shoulders and arms when steering, because remember, you should also be strapped in relatively tightly, so your body is not flopping around. There is a reason why performance cars have deep bucket seats.

The seating position also needs to enable you to reach the pedals comfortably so you have full reach to the clutch (if lucky enough to have one), so best that you have a slight bend at the knee when your foot is full on the brake (left and right feet if you can left foot brake – and if you can do this you probably know all of this anyway!)

When steering the vehicle, the technique is to have "soft hands". Do not use the steering wheel to brace yourself through a corner, hold the steering wheel lightly at the 3 & 9 o'clock positions. This is all that should be required for most racetracks. There is no need for push pull or shuffling your hands around the steering wheel. And should you need to brace yourself against the G-forces, use the "dead pedal" (to the left of the where there would be a clutch pedal). Most modern cars have one fitted.

2. Vision

Have you ever wondered why many vehicle head on collisions with a pole or a tree end up like these three images?

One of the first things that I was told when I started go karting, was to NOT look at an accident that will inevitably happen in front of you. Because that is where you will end up as well, despite the fact you will have the brakes locked up and the steering wheel frozen, whilst you are focused on your competitor crashing, only to then become part of the accident. This is called Target Fixation, meaning you become so focused on an object you inadvertently increase your risk of colliding with the object!

So, to avoid becoming part of someone else's accident and to best navigate your way through corners on a racetrack, is **look where you want to go**. But look well ahead and the only way to do this is to keep your eyes up and well ahead of where you are physically. Once you have turned the car into a corner there is little point in continuing to look at the corner you are turning through when you should

have least sighted the exit point to the turn as well as the following corner. Keep in mind there is a certain degree of muscle memory in track driving so once you have learnt the driving lines for the track, eyes up practice will become easier and you will get faster. How often have you been driving in laned traffic, in the right-hand lane and the car next to you (on the left) makes a 'last second' move to change lanes due to a parked vehicle in the left lane? You can guess where they were looking, perhaps at their bonnet decoration, or some other distraction.

3. **Smooth Operator:**

What is required of a driver, is to be the "smooth operator" when super sprinting on a racing track? Why is it so important? Remember, the idea of sitting low as practical and being able to "connect" senses between what you see (eyes) and what you feel (through your bum)?

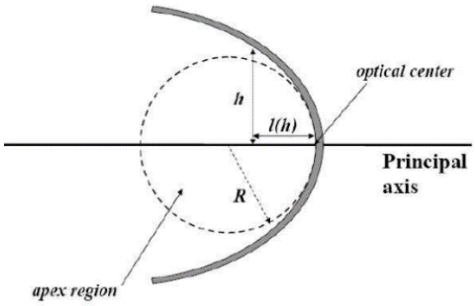
This is where this comes into play:

- Steering
  - You should have noticed the fast race car drivers e.g. F1, Supercars (V8s), the ones up front, are the ones who turn the steering wheel the least. And the science behind this is none other than Newtonian physics – 'actions and reactions'. The game is to try to cause the least amount of steering input to maintain the balance of the racing car when it is near or at the very limit of adhesion to the track and yet get the vehicle around the corner to the desired racing line. Smooth and controlled steering inputs will translate to reduced lap times because the vehicle is kept in balance so long as you consider the next two items.
- Braking
  - Braking is an input which is best done in a straight line since this is when the vehicle travelling at speed is still in a relative state of balance. And this supports the driving technique of slow-in and fast out of corners. Braking that upsets the vehicles balance during a corner, when the vehicle is at or near the limit of adhesion, will have probable unintended consequences and the consequences may differ depending on whether the vehicle is front, rear or all-wheel drive. Braking mid corner may be something which needs to be performed, being smooth with the application of the brakes can produce a better outcome. More on this later. Controlled braking can be used into a corner after the turn in, however this is performed at very much reduced braking pressure, and it is used to keep weight on the front wheels to help control the vehicle to turn-in to the corner. This is called trail braking and can be used to overcome either suspension set up issues, being front wheel drive or rear engine vehicles. Left foot braking can be used to help get the vehicle turned in to a corner in these circumstances.
- Throttle
  - Throttle control is another input which can upset the balance of the vehicle and in some instances, this can be an advantage to negotiating a corner.
  - Let us look at deceleration and when to do this and how the car may react. In a straight line (again) and under brakes is when the vehicle is relatively balanced, so no real issue with the deceleration, you turn the vehicle into the corner and then apply gentle (trailing) throttle to maintain mid corner speed, and if the tendency of the vehicle is to plough straight ahead (understeer – more on this later), the problem is that the vehicle entry speed to the corner is too high. Easing off the throttle in a controlled manner will create weight transfer to the front wheels which should increase the front steering wheels' grip and so the vehicle turns in. Being smooth in this action is important because if you decelerate too quickly, too much weight is transferred to the front, which removes weight from the rear of the vehicle and this creates another problem, called lift-off oversteer. (More on this later)
  - Acceleration is also very important to being smooth, together with being able to pick the ideal time to start to accelerate out of a corner. The smoothness of application of throttle from the exit of a corner can depend on the available power to weight ratio of the vehicle and timing of when to apply acceleration, and this is the easy bit, a bit, however, that many drivers get

very wrong. When to accelerate? Easy, **when you start the Unwind steering lock** – remember this, and put it into action, because if you accelerate too early on exiting a turn, generally it will result in the back of the vehicle stepping out, which is oversteer. Watch and **listen** to any video of fast cars with competent drivers, around, say the Nordschleife and LISTEN to when power is applied on exit of a turn. Acceleration too early on turn exit will result in some oversteer (when the rear of the car starts to "overtake the front") and of course this is a favourite fun driving technique for that noted UK journalist come driver, Chris Harris, but for super sprinting, the technique is slow.

4. Driving lines: the dry racing line

What is the apex of a corner? This of course has to do with the "Racing Line" and for the purposes of a dry track it goes like this:



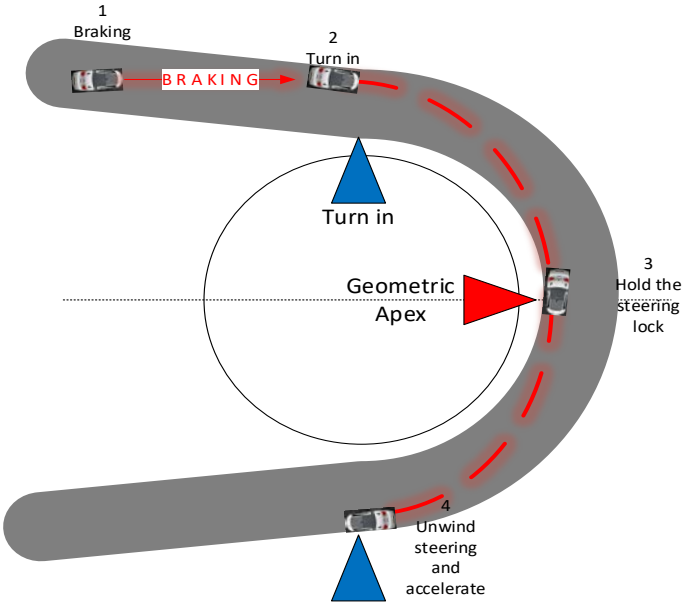
You may remember back to your high school days in mathematics when you would have learnt some geometry and there was probably this sort of diagram: The apex of the curve shown is considered the "optical centre".

Now, for some, you can finally get to apply geometry to real life, probably something you never thought was useful when at school.

By using the apex as shown to the left, it will ensure the widest approach and exit to a corner as illustrated and so the theory is you can execute the turn faster from entry to exit.

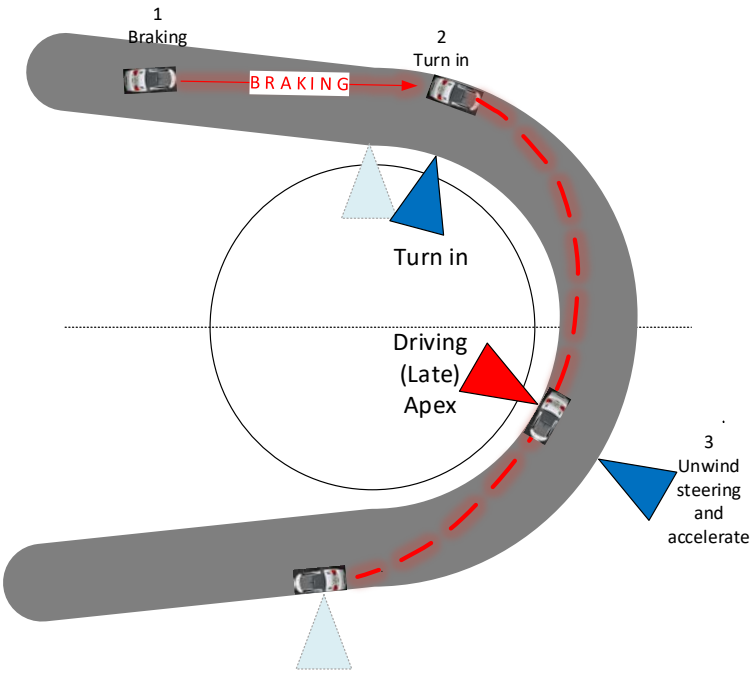
Applying your geometry to your motorsports, take the example 1, of turn 15 (after Corporate Hill) to Sydney Motorsport Park (SMPS) where you could use the geometric centre of the turn (Red cone) as the apex. Once the vehicle is turned in and if you were to do this with just the one steering motion (being smooth), you can hold the line to the apex, right through to the turn's exit point (the lower blue cone). This ensures you use all of the track, from entry to exit, increasing the radius of the vehicle's turn, so you should be able to go faster through the turn, yes? The answer is generally, no.

Example 1: Turn 15 SMPS
(using the geometric Apex)



You may well have heard the term “late apex” and it is physically not related to the geometric apex at all. The reason is illustrated here in example 2, again representing Turn 15 of SMPS.

Example 2: Turn 15 SMPS
using the Late Apex



Note the turn-in point is later than in example 1, the Apex is relatively late in the corner (after the geometric centre). But look where you can start to unwind steering lock, just after the apex of the turn. And therefore, you can accelerate (smoothly) at this point, and this translates to more speed approaching turn 16. **Remember, accelerate smoothly out of a turn <u>AFTER</u> you start to unwind steering lock. By the way this is not to suggest that you should not apply some (constant) throttle input to maintain mid-corner speed if it is a long turn.**

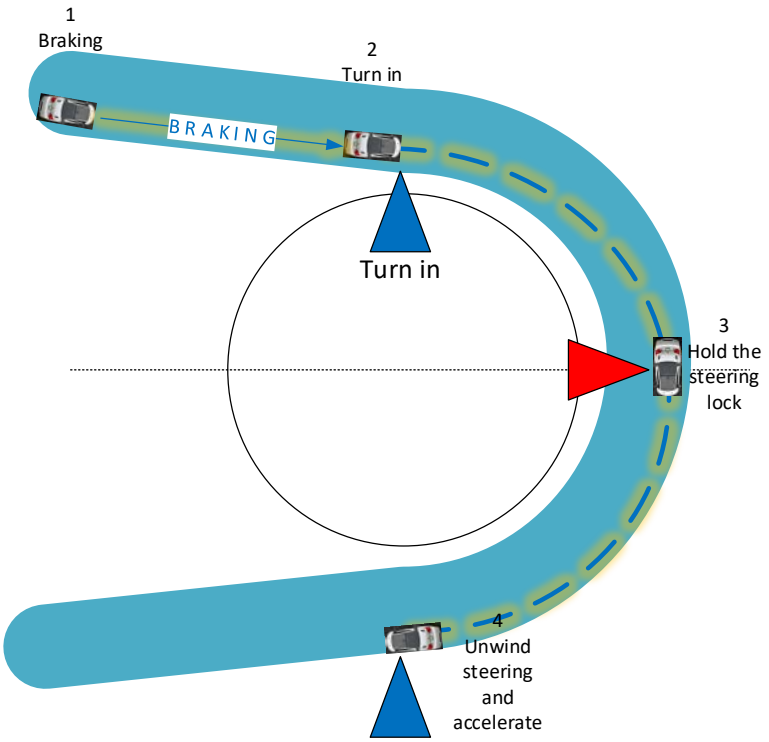
At the turn-in point (first dark blue cone) you should be already looking at the exit point (second light blue cone) and beyond. See the next image for SMPS layout

Sydney Motorsport Park Track Layout:

5. The wet racing line:

The dry racing line obviously leaves a build-up of rubber embedded into the bitumen, and when the rubber mixes with water it creates a surface that is a lot slipperier than normal. The wet driving line should therefore be quite different to the dry line and Examples 3a and 3b below, illustrate two possibilities. Of course, you can choose to take the normal dry racing line, but your cornering speed will be less because of reduced traction.

Example 3a: Turn 15 SMPS wet racing line

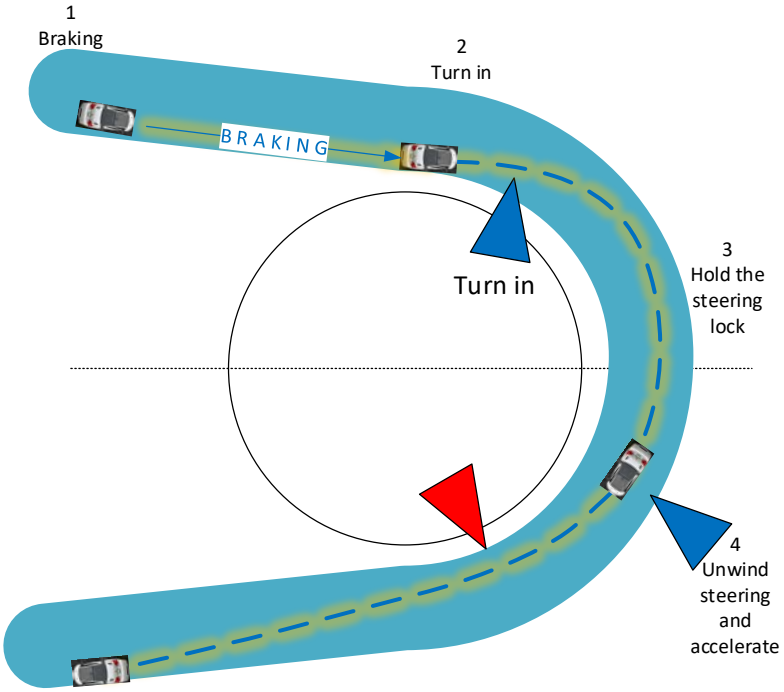


All common sense yeah? A recent experience flag marshalling, indicated to me that many participating in super sprinting did not know the difference between wet and dry lines and it was clear to me that there was a big difference in the stability of the vehicles entering Turn 14 of SMPS, let alone the exit. No doubt those taking the dry line when the track was wet, possibly had more "fun" and more adrenalin pumped but were slower in the process.

Also refer to the subject of braking and where it is best to do this in the wet.

Example 3b is arguably the quicker wet line by **not** only keeping away as much as possible from the dry line but being able to accelerate (smooth input) earlier on the exit of the turn.

Example 3b: Turn 15 SMPS wet racing line



Avoid excessive amounts of acceleration to avoid wheel spin, which is loss of traction. It may even be better to use a higher gear.

What line to choose will entirely depend on the track conditions at the time and will be best experimenting and from what you feel the car is doing when executing the turn.

Again, also refer to the subject of braking and you shall see that the area in which is it suggested to do the braking, is off the dry braking line. Compare the two sets of examples for both wet and dry lines and note the braking lines suggested.

6. And on the subject of braking:

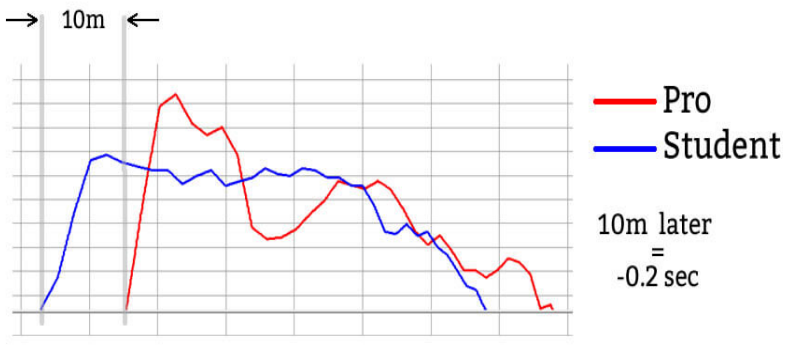
Where to do it?

Braking is a lot about driver perception. How the driver perceives the vehicle's braking capability against what the driver sees. The braking capability can be determined by the tyres, the brake balance set up of the car (to ensure all four wheels can provide maximum braking without any of the four wheels losing adhesion) brake pads, brake temperature and the ability of the brake rotors to dissipate the heat. The brake pedal pressure is important so the driver can feel a level of consistency with the take-up point of the brakes relative to the brake pedal input. To a large extent, this can be determined by the type of brake fluid (needs to be fresh and have a high boiling point) and if the physical brake lines that carry the brake fluid to the brake callipers are sufficiently stiff so they do not expand under brake pressure (use of steel braided brake lines are a real benefit here).

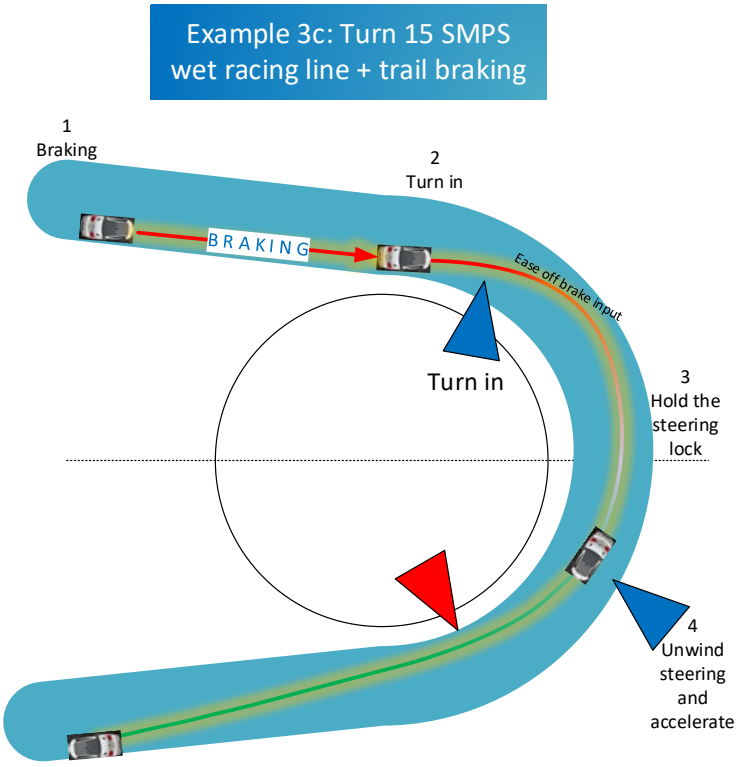
We must assume that the vehicle brakes are properly maintained here, but bear in mind drivers can make up more time in improved brakes than by adding extra kilowatts of power to the engine. This is to say, an upgrade to the brakes can yield a better outcome to lap times than some engine modification.

A Braking "rule of thumb": if the wheels are locked up due to too much brake pressure, the steering has no effect! See the image to the right and note the direction of the front wheels. This 323i rally car entered the corned with brakes locked up and the inevitable "off" occurred. (Do you know where the term "rule of thumb" came from? Check it out on Google.)

Braking is best done in a straight line to ensure the vehicle will maintain balance. It will be up to the driver's perception of where the initial braking point to a corner is going to be. Example: driving into turn 15 at SMPS, the driver has chosen the braking point, stabs the brake pedal only to find there is the need to release brake pressure well before the turn-in point (say 10 to 15 metres) then reapply the brakes just prior to turn-in. Two braking applications is one too many in this instance. The next lap's braking point needs to be moved forward to the turn-in point. The typical brake pressure map provided above, shows the difference in braking between what a Pro driver does compared to a student. Note there was a second brake input here too, from the Pro!



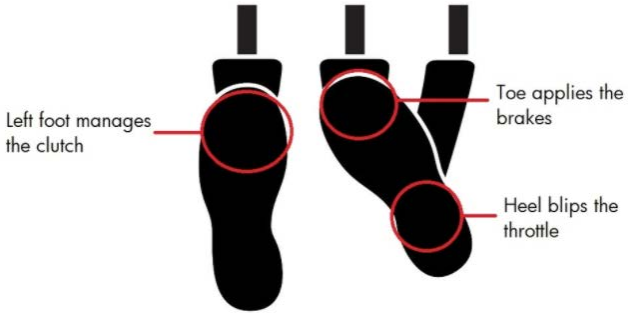
The initial braking effort needs to be a solid squeeze. But just short of losing adhesion or invoking the ABS (if fitted) and this is where ABS will be of assistance, reducing the possibility of locking the steered wheels to ensure steering inputs result in movement to the desired direction. If the vehicle does not have ABS then the driver needs to be more sensitive to braking inputs to minimise any lock up. One good trick to use is if you do lock up the brakes, lift your toes off the foot doing the braking to feather the brake pressure off and enable adhesion to be regained, otherwise, completely lifting off the brake pedal pressure and reapplying can provoke imbalance to the vehicle and another set of negative / undesirable / unwanted consequences.



As the vehicle turns in, it will be still okay to have some **reduced** braking input into the corner if what is needed is to wash off more speed, or to maintain balance to the car's attitude by keeping weight on the front wheels to keep the vehicle being steered in the desired direction. This is called Trail Braking and can be used as a matter of course because of the vehicle's suspension set up, tyre issues, Front-wheel drive, front to rear weight inequality etc. If the vehicle inherently understeers, then trail braking will be helpful.

Use of "compression braking", is a fancy term for down changing to a lower gear to let the engine help with the braking force **as well as** to set up the car to be in the correct or ideal gear to exit the turn. It is important to be on the brakes before starting to down changing gears.

In vehicles with modern double clutch automated manuals (DCT) and automatic transmissions this is relatively easy and smooth. If a manual transmission is fitted to the vehicle, then best to learn how to perform "rev-matching" on the down change although some recent manual transmission cars have this as a programmed feature e.g. Hyundai i30N, Porsche and no doubt the new G series M cars. To down change smoothly without the electronic aids, and maintain the vehicle's balance, which will be close to or on the limit of adhesion, is the trick, and the technique is **"heel and toe"** down shift. This permits the rev matching achieved using the heel (or side) of the right foot on the accelerator to do the throttle input and rev matching and at the same time the toe of the right foot applying the desired braking pressure. If you cannot do this as a first nature process, I do suggest practice in your day-to-day driving first up and it then becomes part of 'muscle memory' action. A missed gear change on track can have unintended consequences. What you will find is that it will be smoother to engage the lower gear and therefore to retain vehicle balance into the corner, and this is also a technique if you are to try down shifting without using the clutch.



7. What is Understeer?

Depending on the vehicle's suspension set up, front/rear or all-wheel drive, front or rear engine, front/rear weight balance, tyre grip, entry speed and a combination of these conditions can create a situation where upon entering a corner, the front of the car does not want to turn in but rather tends more to be ploughing straight ahead. (As above), This is understeer and at this point the grip to the front wheels is insufficient and the vehicles momentum too great to permit the vehicle to move to the intended direction. This situation can also arise when in a front wheel drive vehicle, entering a corner under power. Lifting off the power or applying a light braking effort can apply weight to the front wheels and restore some grip and the vehicle can turn in …. However too much braking or sudden braking can create another problem where the weight transfer is too great and too sudden, causing the rear of the car to overtake the front …. Which turns out to be oversteer – in fact a term called lift-off oversteer.

Front wheel drive cars will generally react positively to the vehicle understeering with smooth throttle control (lift off) through a corner to help bring the car into line.

8. What is oversteer?

Oversteer is where the rear of the car starts to overtake the front. (see the photo to the right.) For modern vehicles, any tendency to oversteer will be reduced by the actions of the vehicles Traction Control (if it is 'on').

If Traction control is off or non-existent, then:

Oversteer is caused by:

a. Application of too much throttle too soon and/or too much whilst exiting a turn.
b. An inadvertent loss of adhesion (wet surface or oil) AND too much throttle.
c. Lifting off too quickly or braking to create weight transfer when not in a straight line which lightens the rear of the car and causing a loss of adhesion at the rear – lift-off oversteer.

How do you correct oversteer?

Regardless of what has caused the oversteer problem, applying some opposite lock (being fast enough to react and applying the right amount of lock) and **easing off the throttle** can bring the vehicle's

attitude back into line. If the reaction to apply opposite lock is too slow, the likelihood of not being able to recover the situation is high. Depending on the escape route available, and the driver's sense of self preservation, it might be best to apply the brakes so the wheels are fully locked up but only once the vehicle is heading towards something that will afford a "soft exit". Whatever happens it is going to be best to stay on the brakes until the vehicle comes to a full stop and of course preferably not on part of the track. The other solution if driver reactions are up to the job and especially if the vehicle has a limited slip differential is to apply more power along with the opposite lock to keep the slide going through to the exit of the turn.

You will have seen these things happen in race meetings, but invariably race cars are well balanced where weight is equally distributed front to rear and when they spin they do just that, spin. For cars which do not have this balance of weight, they are less inclined to keep spinning and more likely to head off track, destination somewhat unknown!

9. Stability and Traction Control

There are various acronyms for electronic control of both traction and stability controls and also different ways in which the control is implemented. Dynamic Stability control (DSC) is used to maintain the vehicles lateral control and to help maintain a desired driving line, whilst Traction Control Systems (TCS) intervenes by reducing the wheels from spinning against the road's surface. Both DCS and TCS for different car manufacturers (and models) can intervene in different ways and provide different technologies to bring the vehicle back into control once traction is deemed to have been lost or about to be lost. And example here is some TCS systems apply the brakes to the driven wheels, whereas the other technique is to limit engine power. And to make matters more complicated, some vehicles offer several different levels of control (like 10!).

With the different stages of intervention, it will be a matter of experience in the vehicle and something that really does need to be on the "suck and see" list of things to do and test. In some instances, turning off the DSC and TCS does not actually turn it off, but rather, "partially off", and spirited driving can create a situation where your driving senses and input reactions are fighting against those of these electronic control mechanisms. This is something the driver needs to experiment with but of course best to use the electronic aids to begin with until the driver comes to terms with dealing with over and under steer.

10. Tyre pressures

What tyre pressures should you use on track? This is something that deserves research and will depend on the weight of the vehicle, the brand/type and model of tyre. Example

- Yokohama A048 tyre pressures 29 to 31 psi hot.
- Yokohama AD08R tyre pressures 32 - 34 psi hot.
- Toyo R888 tyre pressures 28 - 40 psi hot.

However, the pressure will build up after a few laps and this can result in an increase in pressure of several psi. Best to canvass the fellow members and see what they are using but make sure you select someone who's vehicle is similar weight and maybe even the same tyres. Otherwise experiment. Typically, a hot temperature of around 30 to 34psi is a good starting point.

A point to note is that where the vehicle has tyre pressure monitoring, the electronics can intrude if you drop the starting pressures below what (say) BMW have programmed as acceptable and safe and the vehicle's system will turn on traction control, take you out of Sport or Sport+ mode, speed limit you, and send you back to the pits driving like a granny.

There is more to the subject of tyres than what pressure to use on track, or how much $'s. Three technical elements to consider will be:

Treadwear, Traction and Temperature.

There is a de-facto American standard (Uniform Tyre Quality Grading Systems – UTQGS) which is used to compare tyre performance. And under UTQGS:

a. Treadwear considers a reference or control tyre rating of 100, and the higher the rating the more treadwear the tyre will provide compared to the reference tyre. Example: treadwear of 200 will theoretically last twice the reference tyre.
b. Traction is graded or rated as AA, A, B or C where AA has the highest amount of traction. The traction is determined by the tyres ability to stop a vehicle on wet concrete however what it does not tell you is the ability of the tyre to resist hydroplaning or cornering capability.
c. Temperature is rated as A, B or C where A is best with the rating indicating how effective the tyre is at dissipating heat assuming the correct amount of inflation for the vehicle to which it is fitted.

The two images above are both by Michelin, one being the PS4S and the other being PS4.

The image to the left is from the Yokohama AD048 showing:

Treadwear = 200
Traction = AA
Temperature = A

Other factors about tyres will be speed and load rating as well as tread pattern being Directional, Symmetrical or Asymmetrical. Some tyre models have specific designators for vehicle type, and this normally is where the tyre manufacturer has worked collaboratively with the vehicle manufacturer and developed a tyre which is specific for a vehicle model.

Being in a Car Club affords drivers the camaraderie with members where the willingness to share information is common practice and Tyres is certainly one of the common discussion items. Always worth mingling with fellow members and get their feedback on tyres, whilst keeping in mind vehicle similarities.

It might be great to get a cheap tyre, but how do they affect safety (read: grip), comfort, noise, and reliability? Usually, cheap and quality are mutually exclusive.

Speed Rating	Maximum speed km/h
L	120
M	130
N	140
Q	160
R	170
S	180
T	190
U	200
H	210
V	240
Z	240+
W	270
Y	300
(Y)	300+

In summary:

There is a lot to take in with this document. And a few of the important take-aways are:

1. Seating position – get comfortable and into the position to be able to control pedals and steering wheel.
2. Vision – keep the eyes up and well ahead of where you are physical. Always look where you want to go.
3. Maintain Vehicle balance and do this with smooth driving inputs – remember, braking and throttle input are not binary or on/off devices.
4. Brake in a straight line (for the most part).
5. Only accelerate on the exit of the turn after you unwind steering lock.
6. Learn the driving lines for the track – both dry and wet lines – track knowledge equates to fast lap times.
7. **You will never stop learning.**

Summary items 1 through to 5 is hopefully driving tips which should be able to translate into your day to day driving techniques and practice. Some of the other driving techniques in this document relate to driving on the track …. So, do not try all of this at home, unless on PlayStation!

There are books written by professional race drivers which are worth reading. "Driving on the Edge" by Michael Krumm is an excellent example.

Acknowledgement: Incarnation Australia's Mark Williamson and Stuart Greaves

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