

# **BMW CCA Puget Sound Region**



## **Driver's Log and Handbook**

**Version 4.0 – September 2004**

# Preface

Welcome to the BMW CCA Puget Sound Region High Performance Driving School. These club sponsored schools are designed to improve the driving skill levels of our members and to provide a venue for some enjoyment of the one thing we all have in common ... our cars! When you have completed one of our schools, you will be joining a group of drivers who have acquired advanced knowledge and skills that will greatly add to your confidence, enjoyment and safety, both on the track and on the highway.

We would like to stress that it is not the intention of the club to teach actual fender-to-fender racing techniques. There are several high quality professional schools available for this and many of our club members have experience in this area and are more than willing to share information if you are interested. It is our intention, however, to pass along to you a basic understanding of theories and terminology associated with high performance driving. Our club instruction and this handbook are designed to share this information in a solo track experience and heavily relate these experiences to

your everyday driving. As such, this handbook is divided into chapters that will supplement the instruction and also provide definitions of common terminology as well as maps of local track venues and tips for the novice driver. Truly understanding what lies within these pages will ultimately accelerate your progress and enjoyment of high performance driving and will hopefully make us all safer drivers in our daily commute.

We are pleased that you have chosen to become involved in our club events and we look forward to providing you with the cornerstone of your driving skill set.

## BMW CCA PSR Driving Log Book

Name \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

Phone (\_\_\_\_) \_\_\_\_\_

BMW Model \_\_\_\_\_ Year \_\_\_\_\_

BMW Model \_\_\_\_\_ Year \_\_\_\_\_

Driver \_\_\_\_\_  
Signature

D/L# \_\_\_\_\_ State \_\_\_\_\_

### Club Affiliation

\_\_\_\_\_

Membership # \_\_\_\_\_

### Driving Level\*

Level 1 \_\_\_\_\_  
(Novice) Instructor Date

Level 2 \_\_\_\_\_  
(Intermediate) Instructor Date

Level 3 \_\_\_\_\_  
(Advanced) Instructor Date

Level 4 \_\_\_\_\_  
(Instructor) Senior Instructor Date

Level 5 \_\_\_\_\_  
(Senior Instructor) Chief Instructor Date

\_\_\_\_\_ Event Chair Date

Date First Issued \_\_\_\_\_

\*See chapter 1, licensing system, for definitions.

## Driving Events Record

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## High Performance Driving Overview

High performance driving in a BMW CCA school setting means learning to always drive in control, aware of the situations and conditions around you while always driving smoothly and consistently. A high performance driver learns the concepts and terms of our sport and ultimately learns how to teach those concepts to others.

High performance driving is not racing. You will hear those terms incorrectly interchanged, often by someone who has done neither. We do not allow timing or any type of competition at our events. There are professional schools for race training. It is the intent of our Club's driving events to teach skills that will make you a safer driver and to provide an opportunity for you to experience your car's performance potential in a safe and controlled environment.

Your mental attitude is extremely important in working towards becoming a proficient high performance driver. You might be a confident and skilled driver. However, it is extremely important to keep an open mind about driving skills development. You should always feel there is something more to learn.

Driving in control means being aware of everything and everyone around you, especially in congested areas. Not only should you be watching in front of you, but you should also be aware of what is beside and behind you. Use your mirrors regularly. Being aware of the conditions behind and beside you may allow you to avoid potentially dangerous situations by anticipating or by reacting quickly.

The high performance driver never drinks and drives. We cannot stress this enough. Loss of your license due to a DUI results in an inability to attend our high performance driving schools.

High Performance Drivers ALWAYS wear their seat belts and insists that their passengers wear them as well.

Safety is the overriding concern at our schools. We have rules designed to protect you and your fellow drivers. You will be required to obey those rules.

1

## Chapter 1 - Licensing System

The club track licensing system is designed as a means for tracking driver experience and advancement. It is also the primary method used to assign students to appropriate run groups at our schools. The driving levels identified should give you something to strive for but remember, it's a learning process and should not necessarily be rushed. Take the time to personally improve your skills. Besides our club, many other local marque clubs and professional schools welcome BMW CCA members, allowing ample opportunity to improve your skills.

Our schools are structured to allow four run groups of approximately equal size. This helps with instructor workload and administration. We try to match driver skill and car performance in a given group. Obviously, however, the registration mix for a given school might place you in a higher or lower than normal run group. Your sign off level in this logbook is the best indicator of your development as a driver.

The licensing system has the following goals:

- 1. To allow the club to organize safe driving events.**  
Safety is always the most important concern at any club driving event. The licensing system provides a structure for identifying and tracking our member's skills as they advance through our program. The objective is to ensure proper training, with the result being safer drivers.
- 2. To qualify instructors.**  
The licensing system also provides an objective means to determine who is qualified to serve as an instructor at our club's schools and to determine who is able to upgrade drivers to the various levels within the licensing system.
- 3. To encourage participants to increase their driving skill level.**  
A desire to achieve a higher skill level is a very worthy goal for any driver but especially for a BMW owner. The club's track events and licensing system provide a structured means for tracking the advancement of your driving skills over time.

2

The licensing system identifies five skill levels with their appropriate sign offs:

**Level 1 (Novice) This** sign off occurs at the completion of the two-part novice-training program. At the end of part two at Pacific Raceways the instructor will sign the student's logbook. This sign-off will generally be automatic. Only in cases of significant problems would the instructor refuse a sign off. In this case the event chair and chief instructor would counsel the student regarding future participation. Drivers with this sign off are assigned to run group D.

**Level 2 (Intermediate) This** sign off indicates the driver has achieved an intermediate skill level and may be allowed to drive solo. This sign off does *not* occur automatically. It will most likely occur when requested by the student and when the instructor feels it is appropriate. We would expect the bulk of our drivers to fall in this category and to be assigned to run groups B and C. They would be allowed to drive solo occasionally, as a means of advancing confidence and self discipline, but would be expected to use an instructor during most sessions.

**Level 3 (Advanced)** Drivers with this sign off have demonstrated advanced skills and would be expected to drive solo at most schools. However, we would

encourage these drivers to have an instructor with them for at least a portion of the first session, particularly at the first school of the year. These drivers are assigned to run group A. This sign off level also permits the driver to enroll in our annual instructor clinic.

**Level 4 (Instructor) These** drivers have been through our annual instructor clinic and have been certified by a senior instructor. They are authorized to instruct and to carry passengers.

**Level 5 (Senior Instructor) These** are our most skilled and experienced drivers and instructors. They are selected by the Chief Instructor after consultation with the Driving Events Chair. They are evaluated not only on driving skills but also on their ability to instruct at all levels of performance. They are responsible for evaluating and certifying instructor candidates.

A Senior Instructor is expected to be capable of standing in for either the Chief Instructor, or the Driving Event Chairman if asked to do so at any time. A high degree of dedication to BMW CCA Puget Sound Region is expected.

3

## Chapter 2 – You and Your Car

### 2.1 Preparing Yourself

- Study the Driver's Handbook carefully; write questions about anything that is not clear to you.
- Get lots of sleep the night before an event.

At the Track:

- Unload your car, empty trunk and interior of all loose items, including removal of all floor mats and items in glove box and center consoles.
- Torque lug nuts/bolts to factory specs and take off trim rings and hubcaps.
- Check tire pressure.
- Clean windshield.
- Relax - eyes and ears open.
- Be on time to driver's meetings.
- Drink lots of fluids.
- Remember - this is NOT a timed or competition event.

### 2.2 Vision: Leading the Way

If a ranking factor could be placed on the various human physical systems required to drive a car, your eyes would have to rank number one. If you cannot see, you cannot drive. At least ninety percent of what takes place in our vehicle is a result of what our eyes report to our brain. So rule number one is: Never overdrive your vision!

One of the first steps in becoming a successful High Performance Driver is learning to look further ahead. Although your hands and arms steer the car, your eyes tell you what to do. Your eyes actually lead your physical movement. Therefore, focus your eyes on where you want to go, not where you don't want to go, or where you are. If there is an object on the road you want to avoid, such as a rock or manhole cover, don't look at it - if you do, you'll hit it. Focus your eyes just to the right or left of it and your hands will direct your car there.

As you drive, sit up and keep your head in a normal position. When you turn, move your head from side to side, but do not lean or tip your head. Your brain is used to receiving information from your eyes in the normal position. If this is changed, you are visually fooling your brain. Curbs, pedestrians or other cars are not actually

4

where you perceive them to be and can often end up under your car.

Do not concentrate on any one particular object in front of you, such as the car you are following. Look well ahead and watch for anything coming into your overall field of vision. Pay attention at all time and don't just look farther ahead, think farther ahead.

### 2.3 The Seating Position

After vision, the second most important element in being able to drive effectively is to be in the correct driving position. You must be comfortable, relaxed and be able to reach all the controls easily.

The correct seating position is extremely important. You gain a tremendous amount of feedback from the car through the seat. If you aren't seated properly you won't be sensitive to the various vibrations and G-forces you require to interpret what the car is doing. As well, make sure you are comfortable - it is much less tiring and easier to concentrate if you are.

Ideally you want a seating position that puts as much of your body in contact with the seat as possible. Preferably,

you want to sit in the seat, not on it. Push the small of your back into the seat. You also want to sit as upright as possible to help stay alert and allow good visibility.

You should be able to fully depress the pedals and still have a slight bend in the leg. This is the least tiring and permits the use of the balls of your feet on the pedals, which are the strongest and most sensitive part of the foot. You should rest the left foot on the dead pedal when not using the clutch.

Make sure before you start driving your car that both the pedals and the bottom of your shoes are dry and clean. Imagine what would happen if your foot slipped off the brake as you approached your favorite hairpin turn!

Most people think racecar drivers sit leaning back in their seats with their arms straight. This is not true. You do not have the proper leverage to turn the steering wheel. The seat should be adjusted so that with your shoulders square in the seat and your arms straight in front with your elbows locked, your wrist bones should rest on top of the steering wheel. This will provide an appropriate amount of bend at the elbow while driving.

5

### 2.4 The Steering Wheel

The position of your hands on the steering wheel should be at 3 and 9 o'clock. By always holding the wheel in the same position you'll always know how much steering you've put in and where straight ahead is. Grip the wheel firmly but not too tight.



**3 and 9 o'clock hand position**

With this grip you should be able to make most turns without moving your hands from this position at all. For a

very sharp turn, reposition your hands slightly before the corner. In turning the wheel, allow both hands to do the work. While one pulls, the other pushes the wheel smoothly. Make small steering corrections with the wrist, not the arms. Every movement with the wheel must be made progressively and extremely smooth.

### 2.5 Preparing Your Equipment

#### Basic Equipment to Bring to Track

- Helmet – does it meet the minimum requirements?
- Clothing – cotton is best. Cotton long sleeve shirt or jacket is better than any synthetic. Wear sneaker type flat-soled non-slip shoes and socks. **No sandals, high heels, boots or running shoes with thick soles!**
- Sunglasses, hat, driving gloves, bug spray.
- Rain gear, tarp or cover for your belongings.
- Full tank of gas.
- Accurate tire gauge.
- Clean windows

6

## 2.6 Clean Interior

It is imperative that all loose objects and any objects which might become loose are removed from the interior of your car before venturing out onto the track. **CHECK UNDER THE FRONT SEAT** – objects tend to gravitate to this area and are forgotten until the first time the brakes are applied vigorously whereupon they roll or slide out to take up residence under or about your feet.

It's bad enough to carry loose objects in your car on the street, but on the track the hazards are magnified. Aside from getting in the way at the wrong time, these items can become lethal projectiles particularly in an accident. **NEVER CARRY ANYTHING ON THE SHELF UNDER THE REAR WINDOW** (on or off the track). We also require that you remove the floor mats to avoid the possibility of them interfering with operation of the pedals.

## 2.7 Tire Pressure

Due to cornering, braking and accelerating forces on the tire, heat transfer from the brakes and the length of time spent on the track, the tires will get hot. As they heat up,

the air in the tire expands resulting in an increase in tire pressure.

People who have auto-crossing experience tend to inflate their tires to very high pressures (we've heard conversations as high as 40 psi). These high pressures might be fine for auto-crossing (only a tire pyrometer will guide you to the optimum pressures) where the car is on the course for only about a minute, but it's too high for a track (or the street) where the car is driven for a longer time period.

If you start with 40-PSI cold pressure, you may end up with eye-popping inflation during a track session. Start with around 4-5 pounds below maximum pressure. When you begin cornering, the tires may feel a bit mushy --- that's where the warm up lap comes in (discussed later). As the tires heat up and the pressure rises the tires should begin to feel very good. Check the pressure often until you have developed an understanding of the proper starting and operating pressures. Track tires behave differently than street tires and have different inflation requirements. Consult the tire manufacturer or vendor for recommended tire pressures, and then ask experienced drivers for their recommendation. Remember that these are

7

recommendations. Monitor your own equipment and adjust accordingly.

## 2.8 Mirrors and Gauges

Before attaching your seat belt, adjust your rear view mirror and side mirrors. **WHILE DRIVING ON THE TRACK, YOU MUST CONSTANTLY MONITOR YOUR MIRRORS.** This should be your regular practice whenever and wherever you're driving. You must constantly be aware of what's going on around you – to accomplish this, you must use those mirrors. On the track, you need to be aware of traffic that may wish to pass you. Since you'll be busy in the corners, you won't have time to check the mirrors but check them several times on each straight. Adjust the mirrors so that the rear quarter of your car is not visible when in the normal seating position. Although awkward at first, this will open up your rear area of vision.

In addition, while on a straight, check the engine function gauges or warning lights – engine temperature, oil pressure and charging system (a malfunctioning charging system may mean that the fan belt has broken). Forget about the speedometer.

## 2.9 Seat Belts

As stated earlier, you must be firmly seated behind the steering wheel. If your car is equipped with a competition harness, just cinch down the lap belt and tighten the shoulder belts until snug.

If you don't have a competition harness, all is not lost. Attach the OEM (Original Equipment Manufacturer) belt/shoulder harness and crank the seatback down. While you're staring at the roof of your car, grab the shoulder belt and give it a quick jerk to fool it into thinking you've just been in an accident. The inertia system will lock. Once it's locked, lean your body forward against it to hold it in the locked position and at the same time crank the seatback back up to your driving position. You are now firmly seated behind the wheel.

## 2.10 Warm-Up Lap(s)

1. *Novice Drivers.* Drive the first several (at least two) laps of each of your track sessions at a conservative

8

pace to allow your car, its tires, and you time to warm up.

2. *Intermediate and Advanced Drivers.* You need to warm-up also. During your warm-up lap or laps, drive at a conservative pace but, using the brakes very hard, enter the turns at a relatively slow pace but turn in hard and accelerate hard out of the turn. In addition, pinch the car in a little at the exit of the turn (i.e., don't unwind the steering wheel as much as you normally would coming out of the turn). You need to begin heating the tires, brakes, and bring engine temperatures up. Both novice and intermediate drivers need to remember that cold tires will not provide the same traction as they do when warm. Be careful not to overdrive the traction limits of your tires.

## 2.11 Cool Down Lap

At the conclusion of each track session, you will be given a cool down lap. **USE IT TO COOL DOWN** – yourself and your car. Slow down and use the brakes as little as possible to assist in their cooling off. **DO NOT TURN OFF YOUR BRAIN.** The cool down lap can be extremely dangerous because compared to your speed on the previous lap it will feel like you're traveling very slowly.

# Chapter 3 – Practical Skills

## 3.1 Shifting

You can tell a lot about a driver's abilities and skill by the smoothness and finesse of his/her shifts. The first rule in shifting is: speed is not as important as a good clean shift. You won't gain anything with a real fast shift, other than possibly a broken transmission. Smoothness, precision and finesse are the keys.

Treat the shifter like it is an eggshell – be gentle. As an example, when shifting from first to second, cup the palm of your hand over the knob, fingers down, and guide the lever back into position. For second to third, simply use the heel of your palm and light finger pressure on the knob. Third to fourth is the same as first to second and fourth to fifth is the same as second to third. The palm, thumb and two or three fingers are all you need to "place" the shifter in gear – be gentle but firm with the movements.

Three very important points to remember: First, when finished making a shift, get your hand back on the steering wheel! If it's not shifting, it should be steering.

**YOU'RE NOT!** You're still may be traveling quite fast so **PAY ATTENTION.**

Use this lap to drive the best "line" that you can while not having to worry about car dynamics, braking points or other cars. This will accomplish several things:

- By concentrating on driving the perfect "line" your brain will be engaged and you will be less likely to make a mistake.
- You will be installing an image in your head of what that perfect "line" looks like so that when you go back on track the next time you will have a visual image and a goal to achieve.

When entering the paddock area, remember that you have been driving very fast. Safe speeds in the paddock are **DEAD SLOW!** Remember that there are pedestrians and often children in the area.

When you finally stop in the pit lane or paddock, **DO NOT SET THE EMERGENCY BRAKE. DO NOT HOLD THE BRAKE PEDAL DOWN WHILE THE CAR IS STOPPED.** At this point, your brake rotors are hot and doing either of the above may warp the brake rotors.

9

Don't ride the shifter. Second, don't ride the clutch pedal with your left foot! Use the dead pedal, if available, to brace your body when shifting. Third, don't slip the clutch! It's better to let out the clutch quickly than slip it. It will last much longer that way.

Proper downshifting is a must for extracting the full potential of your car. It's not as easy as it sounds and requires timing, skill and practice but once mastered, smoothness and improved car control will result. It is also something you can practice every time you get behind the wheel.

Most drivers think the reason for downshifting is to use the engine's compression braking effect. Wrong! In fact, by doing so you actually hinder accurate brake modulation and balance. The accomplished driver downshifts during the approach to a corner so that they will be in the proper gear, at the optimum RPM range, to allow smooth, balanced acceleration on the exit.

When approaching a corner the object is to shift down to a lower gear smoothly without upsetting the balance of the car while maintaining maximum braking. Two things happen if you simply drop a gear and let out the clutch while braking heavily. First, the weight of the car will

transfer to the front tires and away from the rear tires. This reduces traction to the rear tires and is explained in more detail in Chapter 6. The compression braking effect, in the case of a rear wheel drive car can cause the rear tires to begin to rotate slower than required to keep from sliding. The overall effect is to induce oversteer.

To smoothly down shift you have to increase the engine RPM to match the lower gear by “blipping” the throttle. What you are doing is matching the engine RPM with the RPM of the driving wheels.

This ability to be braking and blipping the throttle at the same time requires a technique called “heel and toeing.” The best way to learn and practice this technique is to try it before the car is even started. If you practice it sitting still, then you’ll find it easier. The next step is to practice while driving on the street. Practicing every day will make heel and toe down shifts much easier while on the track.

Before you start, one word of caution. Make sure you have slowed the car down **prior** to letting out the clutch in the next lower gear. The rule in downshifting: “brake first, and then downshift.” If you don’t follow this rule, you will end up over revving the engine and potentially

causing major engine damage. Remember that downshifting is not a means of slowing the car – unless you have no brakes.

Here is a step-by-step explanation of how to heel and toe:

1. Begin braking, squeezing the pedal with the ball of your right foot.
2. Get your left foot in position to depress the clutch – but not yet.
3. Continue braking, increasing pressure to the required braking effort.
4. Depress the clutch pedal and gently move the shift lever into neutral.
5. Continue braking and with the clutch still depressed, pivot your right foot at the ankle and let the right side of it squeeze the gas pedal, blipping the throttle.
6. Move the shift lever into the next lower gear and back off the gas pedal with your right foot. As the engine RPM starts dropping ease the clutch out.

Now, what about skipping a gear when downshifting – going directly from fourth to second, for example, when

11

approaching a second gear corner. While this is a technique used by many drivers, we do not recommend it.

One of the most important aspects of heel and toeing is blipping the throttle. You must match the speed of the engine with the speed of the gear you are selecting. When doing this, don’t watch the tachometer – the eyes must be looking ahead. The correct blipping of the throttle and matching of revs depends on practice and input from the ears and the forces on the body. If you don’t blip enough, the driven wheels will try to lock up when the clutch is re-engaged - a major no-no! If you blip too much, the car will attempt to accelerate when you are trying to slow down.

Remember, it takes practice – constant practice. It may seem like there are a lot of things to do all at once, but once you get the hang of it, you will be able to complete a heel and toe downshift in less than a second. Obviously to do this properly, the pedals of your car must be set up correctly. When the brake pedal is depressed fully, it should be directly beside the gas pedal. Many cars are not designed well for heel and toe downshifts and adjustments in style and/or pedal positions must be made.

As you can see, High Performance shifting is not quite as simple and easy as you once may have thought, but the good thing about it is that you can practice it in everyday driving. That’s what will make you a High Performance Driver.

### 3.2 Automatic Transmissions

An automatic transmission car can be almost as fast as a manual if you use the right technique. Most people put their automatics in drive and leave it there. The right technique requires shifting it just like a manual. Up shifting through the gears when accelerating, and downshifting when approaching a corner. You can even heel and toe with an automatic. Again, the key is to slow the car down with the brakes, blip the throttle and drop to the lower gear so you can accelerate out of the corner in the proper RPM range.

We don’t recommend using the left foot for braking unless you have been doing this for many years. The average person just does not have the delicate feel with their left foot that they have learned through using the right foot on the brake pedal. If you start using the left foot now, you won’t have the necessary sensitivity and will probably end

12

up locking the brakes or not using them to their maximum capabilities.

### 3.3 Starting and Accelerating

When starting out from a stop, let the clutch out gently yet briskly, making sure not to slip it. Once the car is rolling with the clutch fully engaged – and your left foot is back on the dead pedal – then, and only then, do you begin application of full throttle.

Always accelerate smoothly in a fluid manner. Squeeze on the gas pedal – don't pounce on it. It should be completely progressive. Shift up to the next higher gear before you reach maximum RPM. For full acceleration, it is not necessary to redline the engine on every shift. In fact, by doing so you are likely to over-rev the engine and/or exceed the peak torque range.

### 3.4 Braking

The brakes on the modern high performance car are far more powerful than almost any engine. In other words, the car is capable of stopping much quicker than it can accelerate. Yet the average driver never uses half the braking capabilities of their car.

Remember to apply the brakes smoothly, firmly and progressively and then release it smoothly, firmly and progressively, so that you maintain the balance of the car. Practice this every time you come to a stop on the road – see if you can modulate the brakes so you can't feel the exact point where the car comes to a complete stop. Work on developing a real feel for the brakes. A very sensitive touch is important, especially in poor traction conditions. This is what separates a High Performance Driver from the average person!

### 3.5 Balancing the Car

Another key to High Performance Driving is controlling the balance of the car. By balance, we mean having the weight equally distributed over all four wheels. But to increase the traction limit in any one particular driving direction, we may want to increase the weight (or weight transfer to be exact) over a certain pair of wheels.

We all know that as a car accelerates, the rear-end tends to squat down. That's because a percentage of the weight has now transferred to the rear. Under braking the car nose-dives – the weight has transferred forward. In a corner the

The first step in High Performance braking is coming off the power properly. Do not come off the gas pedal abruptly but gently ease off the throttle very progressively. Then begin squeezing on the brakes, again progressively, but firmly until you are at maximum braking, or "threshold braking." If you exceed the limit for threshold braking and begin to lock up the brakes, ease up slightly on the pedal and then reapply again. Thus, you modulate the pedal pressure using the feedback from the tire noise, the forces on your body and the balance of the car. Abrupt hard braking will cause the car to nose dive, putting most of the braking effort on the front brakes while the back tires begin to lock up.

For those cars with ABS brakes, the technique is the same for coming off the gas and firmly applying brake pressure. The difference is how you respond when the wheels begin to lock up. The ABS system has the ability to modulate the brakes much faster than any driver can do manually. This is especially evident in conditions where traction is reduced due to rain, snow or the road surface. When the ABS system begins to work, you will feel the brake pedal pulsing under your foot and possibly pushing away from the floor. For maximum braking, it is important to keep a steady pressure on the brake pedal.

13

weight transfers laterally to the outside causing the car to lean.

We want and have to control this weight transfer to our advantage. Again, as the weight transfers onto a pair of wheels, pushing them into maximum contact with the road, we achieve better traction with those wheels. Conversely, the wheels that become unweighted lose traction. This "weight transfer" will be more thoroughly covered later in the handbook, but for now know that during cornering, this weight transfer balance can cause the car to either "understeer" or "oversteer".

### 3.6 Understeer

Understeer is a term used to describe the handling characteristics when the front tires lose traction in relationship to the rear, and regardless of your steering corrections, the car continues "plowing" or "pushing" to the outside of the turn. Understeer effectively increases the radius of a turn and is rarely desirable. Manufacturers usually design in a little understeer as generally easy to control. Some cars, especially front wheel drive cars, will exhibit large degrees of understeer.

14

Accelerating too hard or not smoothly enough through a corner transfers excessive weight to the rear, increasing traction at the rear tires and decreasing traction at the front which results in understeer (unless you have applied so much power that the rear wheels have broken loose which results in “power oversteer”).

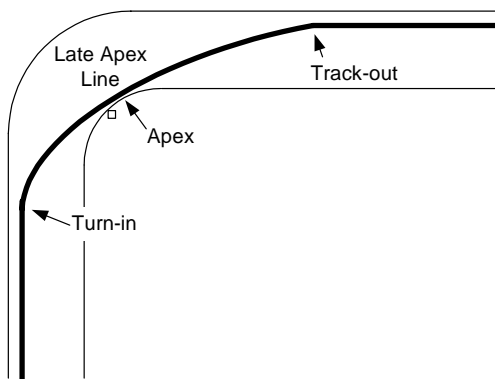
To correct understeer, the natural reaction is to turn the steering wheel in more and more. Because the front wheels have already started to lose traction, this only aggravates the understeer. The correct response is to decrease the steering input slightly and ease off the throttle gently to transfer weight back to the front. This increases the traction of the front tires. Once traction is regained, you can begin to smoothly and progressively accelerate again.

### 3.7 Oversteer

Oversteer is a handling characteristic where the rear tires have less traction than the front tires and the back end wants to come around, and the nose of the car is pointed toward the inside of the turn. This is also called “being loose,” “fishtailing,” or “hanging the tail out.” Its effect is to decrease the radius of a turn and if controlled properly can sometimes increase your speed through a corner.

in mind so that when you complete this performance driving school you can apply the principles you’ve learned to your everyday driving. Now, let’s look at corners and the line more closely.

As seen in the following diagram, the “correct line” involves starting any turn from the extreme outside edge of the roadway (turn-in), then touching the extreme inside edge of the roadway (apex) and finally touching the extreme outside edge of the roadway (track-out) as you exit the corner.



The Correct Line

Some cars, especially rear engine models, naturally tend to oversteer.

Turning into a corner with the brakes applied (trail braking) causes the weight to transfer forward, increasing front wheel traction and reducing rear wheel traction. The result is oversteer. To control excessive oversteer turn the steering wheel toward the outside of the turn. At the same time, gently and smoothly ease on more throttle to transfer weight back to the rear, and increasing traction. Whatever you do, avoid any rapid deceleration. This will result in a spin as you decrease the rear wheel traction even more.

### 3.8 The Line – Preliminary Discussion

The line is the path described by a vehicle as it travels on a road or, for our purpose, as it travels around a track.

The correct or ideal line through a corner will almost always involve using the entire available roadway. This and the other information in this manual are applicable no matter where you’re driving. For example, the correct line doesn’t change, only the amount of roadway available to you changes. On a track, the entire roadway from one shoulder to the other is available; whereas on a public road, only a single lane may be available to you. Keep this

For our schools, we will identify these important points on the track for you by placing cones at all corner turn-in points, the Apex, and in most cases, the correct track-out point on the outside of the track at the exit of the turns.

### 3.9 Segments of a Turn

Any given corner can be divided into three segments: Entry, apex area, and exit. Each segment can be dealt with in detail separately, but the ultimate goal is to combine all three into a smooth, fluid line through a corner.

The entry is the most important part of a turn, as this will dictate all that follows - where, how fast and how balanced you exit. Basically, this is the part of a road where you do your braking, downshifting, and initial turning into the corner. The initial turn-in point is determined by where you want to apex the corner.

The apex of a corner is actually an area of the corner, not just a point, where the inside wheels run closest to the inside of the road. The word apex can also be thought of as the area of a turn where you are no longer driving into the corner, but are now driving out.

Where you apex is directly related to where and how you entered the turn, and it will affect how you exit the turn. The apex for a corner can be either early in the turn, in the middle, or late in the turn. As a general rule, most corners on the road are late apex turns. A late apex is also inherently safer than an early apex as the tendency is to exit the turn farther in from the outside edge of the track.

To properly exit a corner you want to use the entire road - allow the car to come out wide to the edge of the lane or track. This allows the car to smoothly and gently balance the weight transfer and achieve maximum acceleration.

### 3.10 Driving the Ideal Line

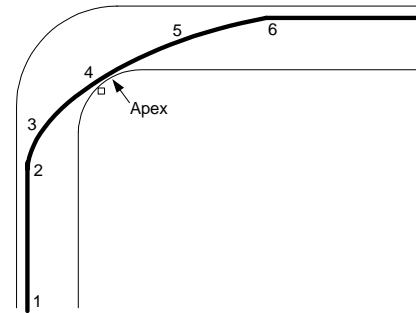
The fastest possible speed through any given corner is achieved by driving a line formed by the largest possible radius (the reasons will be explained later). Basically, you are straightening the corner as much as possible. But this is not necessarily the fastest way around the track - not the ideal line.

The High Performance Driver is not dealing with one particular corner but rather a series of corners connected by straights. Considering this and the fact that a car's brakes are more powerful than its acceleration

capabilities, superior exit speed and balance is far more important than corner entrance speed.

Following are two types of corners and their "ideal lines". Study them carefully and later on in the handbook you can refer back to them with a more clear understanding as to why these are the ideal lines.

The ideal line for a corner that then leads onto a straight is one with a late apex, approximately two-thirds of the way around the corner. So the general routine when driving this type of turn is as follows:

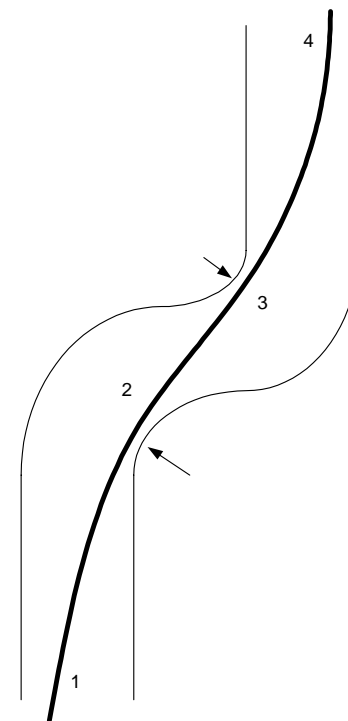


The Single Corner Ideal Line

1. Maximum threshold braking; downshift into the gear required before turning (2).
2. Maximum braking complete, begin turning into the corner.
3. Balancing point - the transition from braking to throttle application.
4. Apex area approximately two-thirds of the way through the corner. Should be at, or very near your maximum throttle application.
5. Allow the car to "unwind" out of the corner.
6. Exiting at maximum acceleration, using the entire road to make a smooth arc onto the straight.

Once again, in this type of turn it is better to brake early, get the car balanced and then accelerate out onto the straight. It is much more effective to go into this type corner slow and come out fast.

Another type of turn is compound curves -- where two or more turns are linked together, such as 'ess' bends. The rule here is to get set up for the last curve which then leads onto a straight. Drive this last corner like you would any corner leading onto a straight -- with a late apex. The first curves in the series are unimportant and must be used to get set up for the last one. Try to get into a smooth gentle rhythm in this series of turns.



The Compound Curve Ideal Line

1. Turn in at a point that allows a late apex.
2. Line up the two turns and use the entire road making this apex.
3. Late apex on the second turn, maximum acceleration.
4. Exit onto the straight using the entire road.

When we talk about using the entire road, we mean using all the area allowed to us -- the full width of our lane on a multi-lane road or the full width of the pavement on a track or road. On a section of roadway you don't know, give yourself a little extra room on the exit of the corner. As stated before, this can be accomplished by driving a late apex.

### 3.11 Turning the Steering Wheel

Because your back muscles are larger and stronger than your shoulder muscles, when turning the steering wheel always pull down rather than pushing up. For example, in a right turn, pull down with your right hand rather than pushing up with your left. When your car reaches the turn-in point, your goal is to turn the steering wheel toward the Apex in one continuous, smooth motion. This will take some practice. At the Apex and you begin to accelerate, you will begin to unwind the steering wheel in one continuous, smooth motion so that the car touches the

edge of the track at the track-out point. In high speed performance driving, the steering wheel should be moved as infrequently as possible and no more than is necessary to put the car where you want it. The less the steering wheel is moved, the faster the car will go. When you're driving slowly, you can make these mistakes without getting into trouble, but when you're driving near the limits, mistakes can be costly.

LEARN TO DO IT CORRECTLY NOW!

### 3.12 Some Common Errors

**Entering a corner too fast:** If you misjudge your braking effort or the distance required to slow your car down effectively, you may arrive at the turn-in point for a corner at a speed which is too high. Should you turn in at this point, the momentum of your car will simply push it to the outside of the turn, possibly even off the track. If you are continuing to slow as you turn in, you may induce oversteer and spin.

**Turning too soon for a corner:** As speeds increase, you may have a natural tendency to turn earlier because the corner is approaching faster. This is a natural reaction which unfortunately is very wrong.

19

Let's examine what may happen if you turn too soon for a corner. If you begin turning the steering wheel before your car is at the turn-in point for a corner, you will reach the inside edge of the corner earlier than the apex (early apex) and the outside edge of the track well before the exit point. This may cause you to drop one or more wheels off the asphalt, which can lead to contact with whatever lies on the edge of the track. To avoid going off the track you have to continue to slow down and exit the corner much slower than if driving the correct line.

**Turning too late for a corner:** If you turn in later than the turn-in point, you will reach the inside edge of the corner later than the apex. Your exit will be somewhere near middle of the road but not on the outside edge where you should be.

**Not using the entire road:** Drivers occasionally come into the corner in the middle of road, turn in, miss the apex, and exit the corner in the middle of the road once again. This means they are driving a line through the corner whose radius is much tighter than the ideal line, and their exit speed will be much slower. Driving correctly on a road course requires more precision than driving on the highway. Visualize where you want to place the car on the track and then practice. Practice so

that you can repeatedly put a tire within a foot of where you want, at the correct speed, every time and you are well on your way to becoming a proficient high performance driver.

### 3.12 Track Layout

Memorize the track so that you will know exactly what's coming next. You cannot drive fast if the next turn comes as a surprise, and you merely react to it. Know what's coming next, and what you are going to do when you get there. Study the terrain near the exit of a turn to determine if it provides a safe escape path in the event that you do go off the track.

Use some of your rest period time to go off by yourself and think about the track and your driving. Mentally drive the track several times - talk your way through the track. Imagine that you will drive it perfectly every lap. During your next track session, you'll be surprised how much you've improved since the previous session.

20

## Chapter 4- Driving in the Real World

### 4.1 Evaluating and Reading the Road

It is important to know a road before attempting to drive it quickly. On a road that is totally unknown to you, drive all corners with a late apex. This will allow you a little extra room on the exit if it's a tighter turn than you thought. Remember to look far ahead, read the road and identify the early and late apex corners. Apply this to your everyday driving - you don't have to be going fast to drive the ideal line.

Learn to read the road -- the direction, the traction capabilities, as well as what is going on around you. On winding country roads with many dips and rises, a glance at the tree line or the telephone poles can give an advance indication as to the direction and inclination on the other side of hills.

At night, shadows will advise of an impending bump. Since light travels in straight line, if you see a shadow, the road is dropping at that point. Likewise, if the surface is gathering light, it is rising. Since oil and antifreeze leaking from cars are more likely to be shaken off and onto the

accident potential you should be wary of. Does the driver wander across his/her lane of traffic or into other lanes? Is he/she tailgating another vehicle?

If the vehicle in front of you has only one person inside, watch for signs of fatigue. If this vehicle has two or more persons, watch to see if the driver is keeping his/her mind on the business of driving or turning and talking to the other passengers. The same distractions can be expected from cell phones.

Do everything reasonable to let a tailgater pass you. Too many drivers take the vehicle behind as a personal assault. If you come up behind a slow driver, give him a chance to get out of your way.

To read another driver, look in your mental mirror. What do you look like under various conditions? Be patient while driving. Driving in traffic is like being part of a symphony. Drive to the tune of the traffic. You'll be a lot safer. Read other drivers and stay alert for changes in the traffic patterns.

ground by a bump, we can assume that where there is dark stained roadway, there is a bump - possibly to be avoided.

Watch for uphill, downhill, banked and off-camber corners. They will have a great effect on the acceleration, deceleration and turning of any car. The High Performance Driver uses these to his advantage - and conversely, attempts to minimize their disadvantages. Just remember that a car going uphill or turning on a banked corner has better traction than one going downhill or turning on an off-camber corner.

Traction capabilities can and should be checked at very low speeds, whenever possible - especially in adverse conditions. Don't wait until you are approaching a stop sign, or in an emergency situation to find out this information. Then it's too late.

### 4.2 Reading Other Drivers

Let's begin our analysis of other drivers by looking at the seating position of the driver. Is he/she alert and upright? Can you see his/her face in their mirrors? If not, then he/she can't see you. What condition is the vehicle in? Does it look well cared for? If not, the driver may not mentally take good care of their driving either. This is an

21

### 4.3 Skid Control

Most skids, spins or out-of-control situations are a result of loss of concentration, driving beyond the limit (too fast) or simple mistakes (which usually upsets the balance of the car). Getting into this kind of trouble is quite easy. Getting out of it can be as well, with a little knowledge, some thought, and experience.

The most common skid you will probably face is when the rear end slides out on you - the oversteer skid. What do you do? First, stay off the brakes! If you touch them you will most likely lose your steering control or spin right around. Second, quickly steer into the direction of the skid - in other words, in the direction the rear end is sliding. Third, maintain even throttle application. Don't completely release the throttle because the result is the same as if you applied the brakes. This takes discipline because the natural reaction to an oversteer situation is to want to slow down. Focus on the correct reaction - even on the throttle, quickly turn into the skid.

If the car begins to oversteer and you can't catch it, you are going to spin-out. Nothing wrong with that if you keep cool, watch where you are going, declutch and lock up the brakes and hopefully don't hit anything. That is all you can

22

do - besides avoiding the spin in the first place. If you are on a track you should already be aware of your escape paths and hopefully have not spun where the escape paths are limited or non-existent. Remember the simple phrase, "If you spin, both feet in!" Left foot on the clutch, right foot on the brake, both to the floor and hold them there until you come to a complete stop. The reasons for doing this are simple. First, depressing the clutch will keep the engine running so that when you come to a rest, you can get the car off the track or off the road to get out of the way of on-coming traffic. Second, locking up the brakes will result in the car continuing to travel in the same direction rather than suddenly turning in the direction the tires are pointing – if you are spinning down the center of the track, you will continue to slide down the center. One word of caution when locking up the brakes in a spin - newer cars with ABS brakes may not allow you to actually lock up the brakes. The safety system in the car will do it's best to keep the wheels rolling and keep the car traveling in the direction the wheels are pointing.

#### **4.4 Accident Avoidance**

The next trouble situation can occur during accident or obstacle avoidance. It may be a child or a dog running out in front of you or a car pulling out ahead. First, don't

chance at all? Even if it's inevitable you're going to crash, try to choose the best place to do it. Wouldn't you rather hit a shrub on the side of the road than another car head-on?

#### **4.5 Driving in the Rain**

Adverse weather conditions create even greater hazards and it is even more critical to be smooth and to concentrate. Smoothness in the rain can not be stressed enough.

On a wet, slippery road the ideal line through a corner is not necessarily the same line you would drive in the dry. In the rain, to maximize traction, you want to drive where everyone hasn't driven in the dry. Through years of cars driving over a particular part of the road, the surface becomes polished and the pores in the pavement are packed with rubber and oil. That is exactly where you don't want to be. You want to search out the granular, rough surface, even if it means driving around the outside of a corner. When the water depth or speed of the vehicle increases, or a combination of both occur, a tire will no longer remain in contact with the roadway and may ride up on the water being built up in front of the tread. This is known as hydroplaning or aquaplaning.

overuse your brakes! Simply back off the throttle and transfer weight to the front wheels giving the front end more traction. Then, steer to avoid the object. At speed, a slight turn is all that is required, then immediately correct to your forward direction and feed in the throttle. Of course, you've been watching the mirrors so you know whether it is safe to move to the right or left!

Always drive with an escape route in mind. Know what's going on around you as if an impending accident is at hand. Steer and do not brake heavily. Keep steering control over all other options.

What if you should drop a wheel or two off the edge of the road? First, keep the wheels pointed straight ahead. If you try to steer back on immediately, you are most likely going to dig a wheel into the dirt or hook it on the edge of the pavement, sending the car careening back across the road or trying to flip over. Once the wheels are straight, back off the throttle until the car is at a safe, reasonable speed then gently ease it back on the road. Again, stay off the brakes as the car will be very difficult to control with two wheels on the pavement and two in the gravel.

Remember, it is extremely important not to give up in a crash situation. Isn't one chance in a million better than no

23

Under normal conditions, such as a level road with a constant rain, your front tires will aquaplane first. The rear tires are riding in an empty wake made by the fronts and therefore will remain in contact with the road longer. You will recognize this as a reduction in turning capability. If you attempt to travel at a rate of speed far greater than is necessary to aquaplane then both front and rear tires will ride on the water, and you will lose the ability to control your car.

Since aquaplaning normally starts with only the front tires, it should be relatively easy to get away from this condition. If your front wheels feel a bit light or uncontrollable, ease your foot off the throttle just slightly and do not turn the steering wheel. Do not take your foot completely off the throttle, as the compression braking effect of the engine may cause your rear wheels to slip. Under no circumstances should you hit the brakes. This will only cause you to slide even quicker.

A few more tips for rain driving: Because water runs downhill, it's especially important to drive a high line through a banked corner. Do not drive in the wheel ruts of a well-worn road, which are full of water. Avoid rivulets where the water runs deeper. During hard rainstorms,

24

watch for areas where there is a splash from the raindrops. This indicates areas of standing water. Be very smooth with your shifts and generally run one gear higher than normal. Be careful of pavement changes and painted road markings as they are much slicker than the surrounding asphalt.

Finally, when driving in the rain, make sure you have good visibility. De-fog and clean your windows before driving. Driving in the rain can be enjoyable, as it is an extra challenge, as long as you slow down, concentrate on the conditions and drive smoothly and precisely.

#### 4.6 Peculiarities of Front-Wheel Drive Vehicles

High Performance Driving can take on some special dimensions when you are driving a front-wheel drive car. Since there is a strong trend by the manufacturers towards production of cars with front-wheel drive, understanding the car control differences between them and rear-wheel drive vehicles is becoming increasingly important.

In normal, straight driving and while braking, vehicle handling is changed only slightly. The greatest difference, in terms of handling and potential safety hazards, occurs when you are cornering. The natural tendency of a front-

wheel drive car is to understeer. Therefore, you should alter your ideal line to compensate for this. Generally speaking, you want to turn into the corner and apex a little later than you would with a rear-wheel drive.

How do you control excessive front-wheel drive understeer while accelerating out of a corner? The way is to use the throttle in short, gentle bursts. By quickly accelerating and decelerating, the tires alternate between getting traction and pulling the car out of the turn, and scrubbing speed off until you have slowed down enough to regain control. Advanced techniques may include left foot braking but as stated earlier, this requires a great deal of practice and will not be covered in this handbook.

Front wheel drive oversteer is most often caused by entering a corner with too much brake applied. This transfers weight forward, leaving the rear tires with very little traction. To regain control, simply turn the front wheels into the slide and gently accelerate to increase rearward weight transfer. More on weight transfer later.

25

## Chapter 5 - Technical Skills and Theories

### 5.1 Physics of High Performance Driving

There are several physical concepts that are important to high speed driving. These concepts are interrelated and while you may find the following discussions to be somewhat dry, as your skill level increases it's important for you to understand what is happening to your vehicle during spirited driving. The following topics are covered in depth (some of which you've already read about) and explained in terms of the "friction circle", "heat", and the "tire patch".

### 5.2 Friction Circle

An automobile contacts the road surface through its tires. A tire's contact patch is about the size of a postcard. The contact patch area for any given weight automobile at rest remains constant regardless of the size of the tire.

Sometimes you hear people say that they put wider tires on their car to get more rubber on the road. Wider tires will change the shape of the tire patch, making it wider,

but the total area of the contact patch remains the same. This is due to the relationship of weight per square inch that the tire is supporting; if the patch gets wider, it will also get shorter.

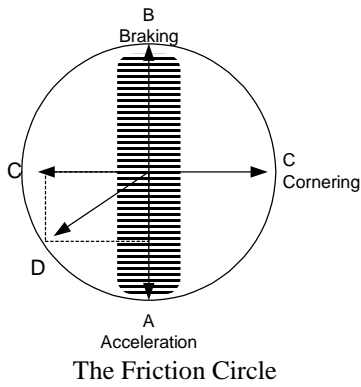
These four contact patches and their ability to grip the road surface ultimately determine the car's limits for accelerating, braking, and cornering. The tire's ability to grip the road surface depends on a number of factors including the road surface, tire compound, size and shape of the contact patch, weight on the tire, inflation pressure, age of the tire, the amount of the tread on the tire, etc.

Every tire has a maximum limit of adhesion - its traction limit (taking into consideration all of the above factors). Until this traction limit is reached, the tire is able to influence the motion of the vehicle. If this limit is exceeded, the tire will lose its grip on the road surface, the traction is reduced and the tire will spin or skid.

A tire's traction limit is roughly equal in all directions -- forward, backwards, or sideways. Stated another way, the traction limit is the same for braking, accelerating, and cornering.

26

Look at the following diagram. The point in the center represents a tire. The circle represents the traction limit of that tire. "A" is the acceleration traction limit, "B" the braking traction limit, and "C" the lateral, or cornering traction limit. "D" represents the traction limit of a tire being subjected to both lateral and acceleration forces. Notice that when the tire is called upon to do more than one thing at a time, there is less traction available to turn (C) and less to accelerate (A). The total traction available, however, remains the same.



Given this, let's look at the individual forces and discuss the driver's ability to use these to get the most out of a vehicle's tires.

Exceeding this amount of wheel spin, or friction limit, will result in dramatic but less than maximum acceleration. If you should begin to get this kind of wheel spin, back off the throttle, feathering it until you have controlled traction for maximum acceleration gain.

### 5.5 Braking

Braking is the last force to contend with and controlling it will require a quick course on brake theory. Brakes function by turning kinetic energy from a moving car into heat energy that can be absorbed into the brake components and later released into the air, allowing the car to slow down. Remember High School Physics? Energy is neither created nor destroyed within a system, it only changes form. You've just accelerated with the help of your favorite premium fuel and converted chemical energy into kinetic energy.

For those of you that care, the formula is:

$$K.E. = W * S^2 / 29.9$$

Where W is the car weight and S is the car speed in MPH. Assuming your car weighs 2500 lbs and is traveling 70 MPH, then you're strapped to approximately 409,700 ft. lbs. (2500 x 70<sup>2</sup>/29.9) of Kinetic energy!

### 5.3 Speed in a Turn

On the surface, cornering is a relatively simple subject. It can be stated that the maximum speed a vehicle can attain in a turn can be expressed by the equation:

$$15gR = \text{Speed (MPH)}^2$$

Where 15g is the traction limit of a particular tire on the particular road surface, and R is the radius of the turn. You need not remember this equation but do remember (and you probably already instinctively know) that the larger the radius of the turn, the faster the car can travel through that turn without losing traction. If you refer back to the discussion on turn-in and apex points, the whys and wherefores will begin to make sense and get clearer as we move along.

### 5.4 Acceleration

Under acceleration, as well as cornering, there is a definite traction limit. This is established by the coefficient of friction between the tires and the road. This friction is affected by the type of tire, the car's suspension, road condition, and balance of the car. Generally, on a dry road maximum acceleration occurs when there is approximately 15-20% wheel spin. At this rate, there will be faint squeal of tires and a faint gray line on the road.

For the rest of us, all that is important here is that we should know that we need to shed a tremendous amount of energy, and the two factors involved in how quickly we shed it are the brake equipment on the car (beyond the scope of this handbook) and the friction of the tires on the road and the management of that friction.

It should be obvious for any driver that you do not slam on the brakes. The wheels at that point will lock and generally speaking the coefficient of sliding friction is less than the coefficient of static friction. Therefore, the time required to reduce total kinetic energy will increase, as will stopping distances. Maximum braking therefore occurs when the car's braking system is being used 100% and there is approximately 15-20% wheel slip. This means the wheels are actually turning slightly slower than they should be for a given car speed. When at maximum braking a faint squeal or howl will be heard and a small amount of tire smoke may be visible. Energy in the form of heat is being absorbed most effectively by the car's braking system, and a little extra is being shed by the friction created by the tires sliding slightly on the ground.

We have one more item to maximize braking which cannot be stressed enough. **FINISH ALL BRAKING**

## WHILE THE CAR IS TRAVELING IN A STRAIGHT LINE.

Remember the Fiction Circle? 100% braking cannot be applied if you're also attempting to turn the car. For example, the brakes should be used very hard, early on, as you approach a turn-in point. Braking pressure should be reduced just before reaching the turn-in point and even less or not at all at the turn-in point. Once your braking is complete, you can turn. The idea here is that you want the transition from full braking to no braking to be gradual and complete before the corner. You may find it difficult to brake hard and release just before turn-in and still drive the correct line. If this is the case, slow down earlier until you can do it correctly because it is more important to drive the correct line.

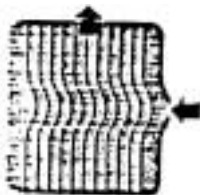
### 5.6 Application

How does this information relate to high performance driving?

Remember, we told you to complete your braking in a straight-line? You know from the explanation of the Friction Circle that braking without turning the steering wheel will result in maximum braking. If you turn the

turned off that straight line and into a corner. In order to overcome the inertia of our car, we have to turn the front wheels at a sharper angle than our intended line through the corner due to some interesting things happening between the tire and the road surface.

With our car attempting to go straight and the tires trying to turn the car into the corner, these two opposing forces distort the flexible structure of the tire around the contact patch. This is known as tire distortion, which leads to the slip angle.



As the tire turns, a new portion of the tread contacts the road slightly towards the outside of the path an undistorted tire would have followed. This causes the car to move sideways as well as forward. The ratio of the forward motion to the sideways motion is called slip angle.

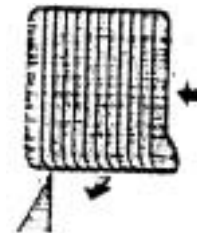
wheel while using maximum brake pressure while attempting to turn you will reduce the ability of the car to turn or stop. Brake hard in a straight line, then reduce braking when you reach the point of turning so the car can maximize the cornering ability of the tires, and then begin unwinding the steering wheel and begin accelerating until maximum acceleration is reached when the car is traveling in a straight line again. The trick to driving at a high performance level is to drive at the limits of your vehicle and stay within the friction circle of your tires while all the time being as smooth as possible.

### 5.7 Slip Angles

"But how will I know when I'm approaching the limit of adhesion of my tires?"

In a straight line accelerating or braking, the amount of sound and wheel spin indicates how close you are to the limits of your tires. When cornering, the indicator is called "slip angles"

Let's look at a car traveling at a sustained rate of speed. The first law of physics to apply to your car as you begin to turn into a corner is the law of Inertia. Simply stated, a car traveling in a straight line will always resist being



The magnitude of the slip angle is affected by many things. Deep tire tread allows the tire surface to distort which then generates unwanted heat and increases the slip angle. Dedicated track drivers will often shave the tread of their track tires to minimize this distortion as this generates excess heat in the tire and reduces both traction and tire life. Slicks generally distort the least amount, generating the smallest amount of slip angle. This is the reason street tires are much more predictable than racing tires. When a track tire approaches its limit of traction, it gives little warning before beginning to slide. All tires are affected by tire pressure which then affects the distortion, slip angles, and the amount of warning given before losing traction.

At the instant a tire loses all traction, the slip angle is zero but as long as the direction of the car can be influenced by the steering wheel, there is a slip angle. When cornering the slip angle of a tire can range from very large (very

high cornering force) to very small (very little cornering force) to zero (no cornering force, the tire has lost all adhesion). Maximum cornering is achieved with slip angles of about 8 degrees.

When the slip angle is relatively small, you will hear a faint squeal from the tires. As the slip angle becomes larger, the squeal will become louder. When the slip angles jump to zero, the tires will screech loudly, and you will not be in control of the vehicle. You will become, as we say, a passenger. Loud squeals are good, loud screeches are to be avoided.

Just before screeching loudly, the slip angles become very large. The tires have lost some of their traction and are sliding sideways somewhat but they still have some traction, and the tires are still exercising limited control over the direction the car is traveling. This condition is called "A Drift". A Drift through a turn is desirable.

A drift is the reason you should be driving the correct line precisely. If you turn in too soon (early "Apex") or don't get to the apex, you may drift right off the exit side of the turn. If you're a foot away from the apex, you will have a foot less roadway on the exit side of the turn. If you miss it by four feet, the exit side of the turn becomes at least

four feet narrower. Take an early apex and you'll have a lot less roadway on the way out. It is very important to drive the correct line.

## 5.8 Understeer and Oversteer

If the slip angles of the front tires are much greater than those of the rear tires, the car is said to understeer, push, or plow. To the driver, it feels as if the car won't turn in and the driver must continue to add steering input (or slow down, or both) to get the car pointed into the apex. A car that understeers is a safe car for an inexperienced driver because to correct it, the driver need only back off the throttle and add more steering in the direction he wanted the car to travel. A car with a lot of understeer is however, not a very satisfying car to drive quickly, and it's generally not a quick car around a road course.

When the slip angles of the rear tires are greater than those of the front tires, the car is said to oversteer or to be loose. The front of the car turns in easily. In fact it begins to prescribe an arc that is tighter than the driver had intended. This happens because the rear of the car is sliding out, helping to "steer" or "rotate" the vehicle through the turn.

31

A car that oversteers is more fun for the experienced driver to drive quickly than a car that understeers. However, it is more difficult for the inexperienced driver. A vehicle may understeer in some turns and oversteer in others. It may also do both in the same turn. Most cars will understeer if the turn is entered at too high a speed. It may then transition to oversteer when the throttle is released.

Ideally, you want a neutral handling car; one that neither oversteers nor understeers. You want to have the same slip angle at both the front and rear so that you can drift through the turn with the rear tires following the front tires. The handling of your particular car can be influenced by tire pressure or suspension changes in springs, shocks, and sway bars. However, this is beyond the scope of this handbook. There are many good books on car setup theory and techniques.

## 5.9 Skid Control

You, the driver of the vehicle, must be keenly alert to what the car is doing so that you are able to detect the first signs of the rear of the car coming unglued (oversteer). The experienced driver will detect the condition very early and will merely maintain a constant throttle position

(or back off the throttle slightly and very gently) and add a small amount of opposite steering (turn the steering wheel in the direction he/she wants the front of the car to go). Don't overreact. Don't attempt to correct the problem before it happens. If you know you are about to change the balance of the car by adjusting the throttle, changing gears, or slowing down, you can anticipate how the car will react and be ready to make the correction. Just wait for it to happen and correct simultaneously.

If the correct action is not taken soon enough, you will not be able to correct it. If the skid progresses to the point you cannot regain control (this evaluation must also be made rather quickly), PUT BOTH FEET IN, which is left foot on the clutch and right foot on the brake. The car's brakes will lock and as you remember, the tire's slip angle goes to zero when it they are sliding. The result is that the car will continue to slide in the direction it is traveling, even though it may be spinning, while dissipating speed. If you engaged the clutch early on, the car's engine will still be running when the car comes to a halt, and you can put the car into first gear, check for traffic and bring the car back onto the track. If you spin, drive back to the paddock and stop, reflect on why the spin occurred, what you could have done and should have done to prevent the spin and what you will do next time. Also, check the car over to

32

make sure nothing was damaged and the tires are okay before going back onto the track.

Classic teaching of skid control is to turn the wheels in the direction of the skid. This means is that you turn the wheels in the direction you want the front of the car to go. When you have to make a big correction for a spin at high speed, the car will be bleeding off speed lessening the demand placed on the wheels. As this happens, it is easy for the rear tires to suddenly regain traction and reverse the spin. Your car may spin out in the other direction. You may find yourself trying to control in one direction and then the other, again and again. Knowing this may happen, you want to continually adjust the wheel back to neutral as the skid is correcting. You can also affect the skid by measured amounts of throttle inputs – either reducing or increasing the amount of throttle.

Counter Steer Only Enough To Correct The Original Skid.  
Too little is preferable to too much. Don't overreact.

If you're in a drift, you are right at the tire's limit of adhesion. As you approach the track out point, if you see you are running out of track, keep your composure and think. Don't try to turn the wheel more because you are already using all the traction available from the tires.

up the brakes is a last resort to slow the car as quickly as possible. Again, if you have already assessed escape paths, you know where you want to steer the car and what your best option is.

As a skid progresses, the quick and correct reaction of the driver can often control the skid and bring it back under control, or at the least make the best of a bad situation. The instinctive reactions to control an advanced skid come with training and experience. Evaluate your experience and knowledge and stay within your limits and the limits of your car. Staying safe and making sure your out-of-control car does not become a safety hazard to others is your responsibility and cannot be taken lightly.

## 5.10 Brake Points

The correct braking points vary from car to car and depend on the skill and desire of the driver. Brake components, tire compounds, car speed and weight will determine how quickly a car can slow down. Finally, you as the driver will determine how much braking force you *want* to use depending on your skill and experience.

Determining the correct braking points is relatively easy but it is often hard to overcome the “seat-of-the-pants”

Turning the steering wheel more may induce a spin and you may lose control as you exit the track surface.

Anytime you leave the track surface you want the car facing forward and controllable.

If only the outside tires drop off the road, gradually slow down and only after you have slowed return the tires to the track surface. If all four wheels leave the track, you may have a real problem. How big your problem is will depend on the geography on the outside of the turn. As stated earlier, if you have already assessed your escape paths all around the track, you know what to expect. The car is going to continue its drift -- perhaps at a faster rate due to the reduced traction. If you are certain that you are going off the road, anticipate the reduced traction and slightly straighten the steering wheel to ensure you have steering control once off the track. If you have a clear escape path, you can lightly lift off the throttle and apply the brakes to slow the car. In the worst situation where there is no safe runoff to the outside of the track your options are reduced greatly. Above all else, continually try to control where the car is going to lessen the consequences. If recognized early enough, reduce throttle input or slightly apply the brakes. This will induce trailing throttle oversteer and if your speed is not too great, you will spin off to the *inside* of the curve. Locking

33

desire to brake too soon. Start by picking out a marker of some sort near the turn (preferably a permanent one even though braking cones are often set up at critical turns). When you get to that point, begin threshold braking. If you slow down more than desired well before the turn-in point, your brake point is too early. Move your brake point closer to the turn-in point. Keep moving it until you have the desired entry speed at the turn-in point. You have now determined your brake point for this turn.

The ideal brake point is one which, using threshold braking, slows the car enough to negotiate the turn on the proper line and permits the earliest application throttle. Two factors may have an effect on the brake points that you establish for yourself. As your driving improves, you'll be going faster when you reach your brake point. You may find that your brake point is too late. On the other hand, as your driving improves, you may be able to handle higher cornering speeds. You should also keep in mind that the track surface will have an effect on braking:

- New asphalt – generally slippery
- Gravel or dirt – obvious
- Rain – obvious
- Oil or coolant – less obvious

34

All increase braking distances -- BE ALERT OF THESE CONDITIONS.

If it is obvious you have missed your brake point and are traveling too fast to make your turn in, it may be best to continue threshold braking to the edge of the track so that you leave the track in a straight line. Your knowledge of escape paths will tell you if this is the correct decision.

If you're going too fast to make the turn and turn anyway, you will still be going to go off the track, but not in a straight line. Refer to Section 5.9 to know how to handle this situation.

### **5.11 Advanced Rain Driving**

Driving on wet surfaces requires you to be extremely smooth. Your vehicle will have considerably less traction. On a wet surface, you will have only about 70 percent of dry acceleration traction, about 50 percent of braking traction, and a mere 20 percent of dry cornering traction. The result is a much smaller traction circle although all the principles remain the same. It should be clear to you from this that a wet surface requires a considerable reduction in speed. If the surface is extremely slippery, use even throttle through the turns and don't apply throttle

until the car is traveling in a straight line. If you learn and practice to be smooth in dry conditions, you are way ahead in being able to drive effectively in wet conditions. Conversely, driving in the rain (or on ice or snow) is great for working on your smoothness. Someone who can drive effectively and quickly in wet conditions will be even better in dry conditions.

At most tracks, you may find that the "line" becomes extremely slippery. In fact, there is often a "dry line" and a "wet line." Cars running on the track deposit rubber from their tires and any leaking fluids on the Line. When it rains, the oil and rubber float to the surface and ride on top of the water. If the line becomes unreasonably slippery, try avoiding the line. Drive around the outside edges of the turn or inside the turn-in point. Be aware however, that even if you drive the outside edges of the turns, you will still be braking on the same slippery line. If you drive inside the turn-in point you will at some point in the turn again meet and cross the line. The traction available to you throughout the turn may be changing.

Finally as adjustments are made to your driving style, adjustments can be made to your car. A couple of extra PSI of cold inflation tire pressure will help the tire channel water through the grooves in the tire and

35

compensate for the lower operating temperatures. For those with adjustable suspension components like shocks and sway bars, softer settings are better in the rain.

**6.1 Weight Transfer**

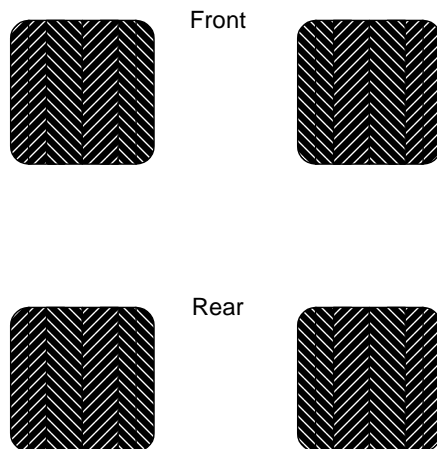
Until now our discussions have revolved around driving techniques for both track and commuting driving. Now, let's get down to techniques usually reserved for track driving.

A tire's ability to provide good grip and traction (the fiction circle again!) is directly linked to the weight that is being placed upon it by the driver. As you drive, you are continually shifting the weight of your car forward and backward, left and right, alternately loading and unloading the four tires.

It is this ability to control weight transfer that separates good drivers from the great ones and allows the driver to use the throttle and brakes to control the ultimate turning ability of the car. Following is a brief discussion about the topic without getting into car setup.

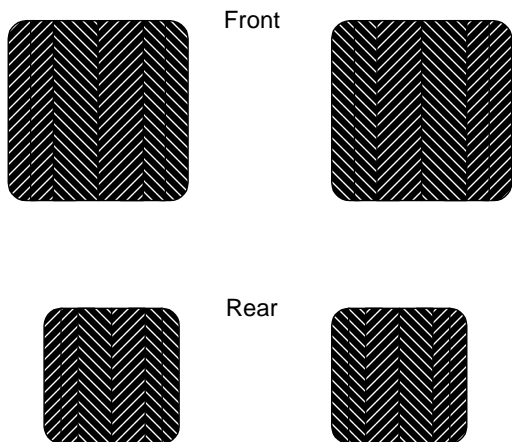
As your car is traveling in a straight line at speed, the weight distribution and the wheel loadings are fairly equal

on all four tires. The following diagram represents the respective sizes of the contact patches of your tires.



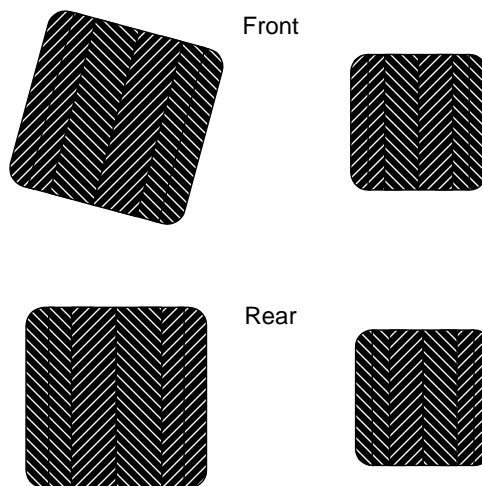
Weight Distribution at Constant Speed

As you brake for a corner, you create a weight transfer which loads more of the car's weight on the front tires.



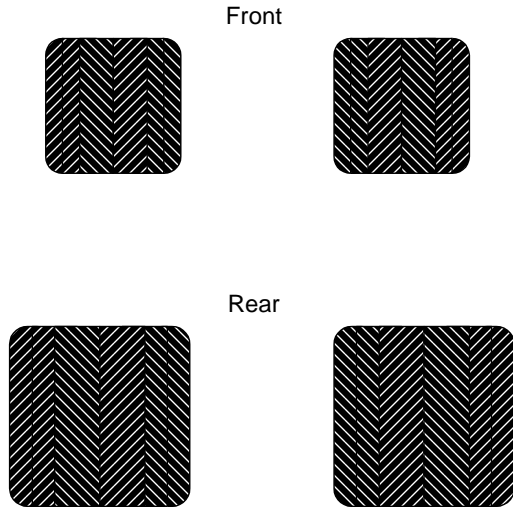
Weight Distribution Under Braking

Begin cornering, and you will find that the weight is shifted once again, this time to the outside of the wheels.



Weight Distribution While Cornering

Under acceleration, the rear tire's contact patches increase in size due to the shifting of the car's weight toward the rear wheels.



Weight Distribution Under Acceleration

Hopefully it's clear with the diagrams now why in the middle of a corner it can be disastrous to suddenly snap off the throttle. As the weight suddenly shifts forward, the front tires, which are turned, have more traction and the

rear tires suddenly have less. Controlled, this results in the car quickly turning into the turn. Uncontrolled, the car will turn in too much and spin to the inside of the corner. This unfortunately is one of the most common incidents at the track. If you lift off the accelerator and detect the car is turning in too much, you want to quickly increase power without applying too much power to the rear tires (rear wheel drive).

Also, with these diagrams and an understanding of the physics, you can get a feel for what's referred to as "throttle steer" or the ability to turn a car with the gas pedal. If the car is mildly understeering and you feel you're going to be wide of the apex of a corner, come off the gas slightly (and smoothly) without adding steering input and you will find with the subtle weight transfer to the front, that the apex is now reachable. In the same vein, when exiting a corner, if a late apex was hit and you find you have extra roadway left, without dialing out more steering than normal, applying more throttle will help the car to drift wide and your exit or track out point will be right on! The key is small inputs made smoothly.

## 6.2 Trail Braking

During our school, we stress that all braking must be completed while your vehicle is traveling in a straight line. There is, however, another theory ascribed to by some experts. The theory is that to be fast, the driver must trail the brakes into the turn. Those who advocate Trail Braking include Skip Barber and Bob Bondurant schools, and others.

Former World Champion Jackie Stewart, among others, has the view that braking should be completed before turning in. Mr. Stewart, when asked about trail braking as advocated by Barber, Bondurant, et al., responded with a question of his own, "How many world championships have they won?"

Whichever technique is correct, a very good driver should know how to do both. Trail braking works very well in some turns in all cars (particularly very slow corners) and perhaps for all corners in some cars.

Here's how it works. Threshold braking is used just as we've discussed earlier until you reach the turn-in point. However, at this point the brakes are not fully released but are continued slightly as the car is turned in. If you use too

much brake, the car may spin. If you find your speed in the corner is too slow with this technique, adjust your brake point accordingly as discussed earlier.

To get the proper amount of braking, imagine that your hands are on the wheel, and your foot on the brake pedal are connected by a rope. In order to turn the wheel, you must also raise your foot off the brake pedal. The more you turn the wheel, the more your foot must lift off the brake pedal.

Trailing the brake will keep more of the vehicle's weight on the front tires yielding more traction there, and the car will turn in very well. The rear tires, however, will have less weight and therefore less traction. As the vehicle is turned in, the rear of the vehicle will begin to slowly come around (rotate toward the outside of the turn) and point the front-end toward the apex. As soon as the car is pointed toward the apex, smoothly release the brakes and apply power to transfer weight (and traction) to the rear tires. The rear tires will gain traction, stop sliding, and the car will accelerate toward the apex.

**CAUTION;** The transitions between threshold braking, trail braking, turning in and application of throttle must be performed smoothly. We recommend that novices do not

attempt trail braking. If you want to learn trail braking, wait until you have more high performance driving experience.

### 6.3 Downshifting

As discussed earlier in the text, downshifting is an integral part of driving at the limits of the car and its tires. Hopefully now you can see with the help of the "tire patches" the importance of being smooth and not upsetting the balance of the car as you go down through the gears and why all this must be done before turning into a corner. Take a minute and re-read Section 3.1 and picture in your mind what is happening to the weight distribution of your vehicle during the heel-and-toe exercise.

### 6.4 Ideal Line – Detailed Discussion

Now, with all this information under our belt, the last thing to think about is our ideal line around a road course.

We already know that an apex is an imaginary point at the inside edge of the roadway that the car touches as it travels through a turn.

Theoretical Apex and Largest Possible Turn - If a vehicle is driven from the extreme outside edge of the roadway, then touches the "Theoretical Apex" and then touches the extreme outside edge of the roadway, the vehicle will have prescribed a line through the turn which will have the largest possible radius.

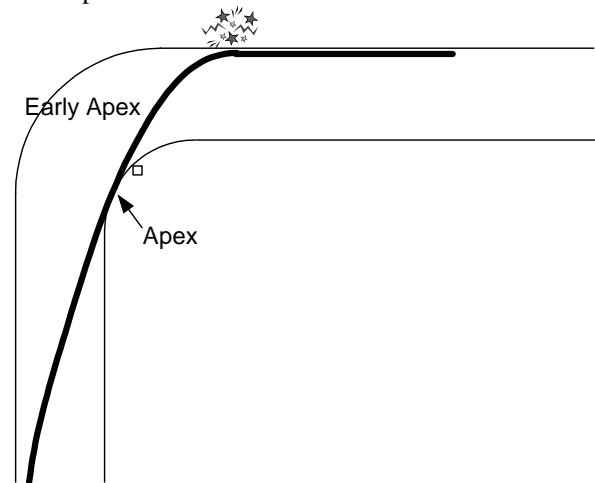
We know from our equation  $15gR = \text{Speed (MPH)}^2$  that the larger the radius turn, the faster a car can travel through that turn. The largest possible radius is the fastest way to go through a turn. However, it is generally not the fastest way to go around a road course. If we were to add up the time spent on turns and the time spent on the straights on one lap of the track, we would find that we spend considerably more time on the straights than in the turns. Therefore we want to maximize our speed on the straights and give priority to straight away speed over cornering speed.

Late Apex Line - a late apex line is the line prescribed by a vehicle that touches an apex occurring after the Theoretical Apex. Generally, this is the line that we teach in our schools because it is the safest line, and the line you should use all of the time on a road course and on the street.

41

Why it's the Fastest - Look again at the diagram that shows the late apex in Section 3.10. Note that the beginning of the turn is much sharper than it would be if the largest possible radius were used. Because of that initial sharp turn, we will need to slow down more than if we used the largest possible radius. Notice also that after that sharper turn, the balance of the line has a much larger radius than even the largest possible radius through the whole turn. Therefore we can and should begin to accelerate almost immediately after making that sharp turn. How much you can accelerate will depend on a number of factors, the radius of the turn, whether the roadway is banked, flat or off-camber (sloped toward the outside of the turn), the power of the car, whether or not you wish to induce oversteer, etc. The rule of thumb, however, is that steady throttle is used approaching the apex and slowly increased to full throttle at the apex (as the radius increases); your instructor will help you on this point. Assuming that you have driven the correct line, have not entered the turn too fast, and the road is not slippery, you should never coast through a turn. Always apply power after the car is turned toward the apex. This application of throttle transfers weight to the rear tires, increasing their traction for acceleration (refer to Section 6.1).

Early Apex - Look at the diagram below. It illustrates an Early Apex Line. (The apex occurs before the theoretical apex.) If you take this line while applying full throttle at the apex you will likely drive off the roadway before the track out point.



The Early Apex

Notice that with an early apex, the sharpest part of the turn occurs after the apex. It cannot be negotiated at the same

42

speed as the early part of the turn. It requires slowing down before the sharp part of the turn.

The most common error made by drivers is turning in too soon resulting in an Early Apex Line.

The Early Apex Line has its application in high performance driving as it might be the best line to take if a long straight is followed by a very slow section of track with more than one turn. An Early Apex in this situation permits you to carry your straightaway speed longer as you slow through the turn. You would threshold brake up to the turn-in point, but because the early part of the turn has a relatively large radius, you should continue some braking all the way to the point where the radius becomes smaller.

An Early Apex might also be useful if you're approaching a turn too fast and can't get slowed down enough to take the proper line. The Early Apex Line will give you more braking distance to work with and it might prevent an off road excursion. When you are traveling on an unfamiliar road, NEVER, EVER apex early. Stay out wide until you can see what's on the other side, then apex!

Finding the Correct Line - Start by using a very late apex (usually later than you think). If you apex too early, you

the straight so that regardless of the gear used for the turn, you are always in the same gear when you pass your marker. The gear that results in the highest RPM at your marker is the gear to use for that turn. You will frequently find that you can use a higher gear than you originally thought.

Entry Speed - The speed at which you should enter a turn is more or less a seat of the pants proposition. The tendency is to go too fast in slow corners and too slow in fast corners. We recommend that, at first, you concentrate on exit speed. Go in slower than you think you need so that you can get full throttle at the apex. As you become more experienced you can begin to pick up your entry speed. Remember, the underlying principle is to accelerate as soon as possible so that you go faster on the straights. If you enter too fast, you won't get to your apex or you will have an Early Apex and you will not be applying full throttle until after the apex and possibly as late as the track out point.

## 6.6 Conclusion

In high performance driving, no one is a natural; everyone must learn. Those who concentrate on smoothness and consistency learn faster. Those who think charging down

will find that you are unable to unwind the steering wheel as you clip the apex. If you can't get to your apex, or your track out point is not all the way to the outside of the track it means you turned in too late.

Once you have found an apex and a turn-in point that works reasonably well, start refining it. If the turn leads onto a straight, you want to maximize exit speed. Exit speed is measured by engine RPM. Pick out a spot or convenient mark on the straight some distance after the corner. The distance doesn't matter as long as you use the same mark every time.

Each time you pass your marker, check the RPM and note whether or not you've used the entire roadway on the exit side. If you still have some room on the exit side, try a slightly earlier apex and check the RPM at your marker.

Is your engine RPM higher or lower? Keep experimenting until you find the line that consistently yields the highest RPM at your marker. This exercise can also be used to determine the correct gear for a particular turn.

Don't trust the seat of your pants. Lots of noise and wheel spin does not generally equate with the fastest way through the turn. Your marker must be far enough down

43

the track is the answer, braking at different spots each time, reacting rather than anticipating, learn nothing.

No matter how long you've been driving on the street; or how fast your car is, or how expensive your tires are, until you are willing to rethink any driving habit, you aren't ready to learn to be a truly good driver. You have the opportunity to vastly improve your driving skills and with an open mind and a lot of concentration, you'll do just that.

Don't forget to ask questions. No matter what level you are, there will be someone who is faster or smoother, and we will be able to find that person to help you with any problems and questions you may have. Finally, there is no substitute for seat time, so go to as many events as you can, and you'll find that eventually high performance driving will become second nature.

BE SAFE!

GO FOR IT!!

44

## Chapter 7 - Flags and Track Safety

While attending one of the BMW CCA Puget Sound Region Driving Schools or any of the many other local auto club driving events, you will have the opportunity to drive some of the finest road courses in the country. While driving on a track at potentially high speeds you need to be kept informed of situations that may arise. Turn workers will use a set of internationally recognized flags to accomplish this communication. Described below are the flags, their colors and meanings at all of our track events. You must always attend the drivers meeting where any flag changes will be explained. Some venues may have a slightly different interpretation for some flags. For the most part, flags represent cautions, and each flag should be viewed in that context. Failure to heed a flag or course marshal not only creates a dangerous situation but also may lead to exclusion from that and other driving events.

### A. GREEN FLAG (Solid Green)

When displayed, the green flag indicates that the course is open and will be displayed by start/finish throughout a track session. Normally this flag will be in the possession

### C. BLUE FLAG (May be Blue with Diagonal Yellow Stripe)

Another driver is following you very closely and will likely overtake you in the next designated passing zone. This flag may be displayed standing or waving, depending upon the speed with which you are being overtaken. Watch your mirrors. The car being overtaken should be aware of the other car and when the passing zone is reached, signal their permission to pass.

### D. RED FLAG (Solid Red)

Used only in an emergency, this flag means the session has been called to a halt. Come to an immediate, smooth and controlled stop at the side of the track. Continuing further may only delay the prompt response of emergency crews to the scene of an incident. DO NOT PROCEED until directed to do so by one of the turn workers or track event official.

### E. BLACK FLAG (Solid Black)

Closed Black Flag (Furled) and pointed or shaken at an individual car by a course worker. This is a warning that you have been observed driving in an unsafe and/or improper manner. If the action continues you shall be given an Open Black Flag.

of the Starter only, and shall not ordinarily be displayed at the corner stations around the course.

### B. YELLOW FLAG (Solid Yellow)

Standing Yellow or Waving Yellow- Take care, Danger, Slow Down, NO PASSING in the designated passing zones until the yellow flag is withdrawn!! Waving Yellow - Great Danger, Slow Down, Look Immediately Ahead! The yellow flag is displayed in two ways, as a standing yellow and a waving yellow, which are indications of the severity of the situation initiating the flag. Use extreme caution in both these situations. Slow down so you can easily stop within your sight distance. Use extreme caution until you know why the yellow flag is being displayed. Watch your mirrors for approaching cars that may not have seen the yellow flag. Raise your right hand inside the car and wave it back and forth to notify following drivers that you are slowing. A driver may encounter several yellow flags before reaching the emergency area. The requirements are the same, 'SLOW DOWN, NO PASSING', watch ahead, and continue to use caution until the green or other flag is displayed. DO NOT STOP unless flagged to do so.

45

Open Black Flag displayed and pointed at an individual car by a course worker. Proceed directly to the pits to speak with the course officials. DO NOT TAKE ANOTHER LAP! Reasons for an open black flag may be that there is something wrong with your car that may be unsafe or you may have been observed driving in an improper or manner and have ignored the earlier warning. Talk to an event official to understand the problem or resolve any disputes before returning to the track. Safety is our first concern and your behavior can affect the safety of those around you. Therefore, if there is sufficient cause you may not be allowed to continue your participation for the rest of the day. Note: If the black flag is displayed open at all stations, the session has been halted, and all cars shall proceed to the pits.

### F. BLACK with ORANGE BALL FLAG (Meatball)

Note: This flag is not normally used at our track events but may be used at others. This flag is used to warn a driver that something is mechanically wrong with their car. Something may be dragging or broken that the driver is unaware of. Report to the pits in a safe manner to have it checked out.

46

### **G. RED and YELLOW FLAG (Stripes)**

This flag is to warn drivers of hazardous conditions on the track surface ahead. This may mean the track is slippery because of oil, water, gravel or dirt, or the track may be partially covered with some debris. Slow down and use caution until the condition is cleared.

### **H. WHITE FLAG (Solid)**

This flag means a slower vehicle is on the course. Use caution, it may be a disabled car or an emergency vehicle.

### **I. BLACK and WHITE CHECKERED FLAG**

This flag signifies the session is over! Proceed at a reduced pace around the track (cool down lap) and report to the paddock area. Remember that the cool down lap is a time to let your car literally cool down and for you to reflect on the session on what you did well and what you wish to improve. Take time to wave to each and every turn worker. Because of their dedication and presence, you were able to have a great time that day.

For our driving events, safety is everyone's business. If you see or are involved in any incident that compromises the safe environment in which we all wish to operate, you owe it to yourself and the club to exit the course and report the incident to a event official so that appropriate

actions can be taken. Don't wait for someone else to take responsibility for it. Don't wait for someone to draw a flag. The sooner we can address and resolve an issue, the sooner we can all return to enjoying ourselves.

47

## **Chapter 8 - Student Track Session Tips**

**This section is provided as a quick reference. The full details are provided throughout this handbook. It is strongly recommended that you read and comprehend the concepts discussed in this handbook to further your enjoyment and safe participation in our high performance driving schools.**

### **Overall:**

- Safety is the first concern for everyone.
- Helmets and seat belts must be worn at all times by driver and passengers when on the track.
- No fender to fender racing!! Anyone caught violating this rule will be asked to leave.
- Don't forget you have to drive this car home!
- Drink lots of fluids.

### **Paddock Area:**

- Engine-fluid levels, no leaks, belts tight, wires snug.
- Tire/wheel-lug bolts torqued
- Check tire inflation pressures.

- Body: sunroof closed and latched (no pop-ups), doors unlocked, brake lights work, hood closed and latched, windshield wipers work.
- Interior: floor mats out, glove box empty, garage door opener out, radar detector out, cellular phone hand set out or duct taped in place.

### **Hot Pit Area:**

- Proper seating position - as vertical as possible, thigh supported, knee slightly bent when clutch is pushed to the floor, back against seat and elbows slightly bent with hands at 3 and 9 o'clock.
- Adjust mirrors.
- Driver's window down, weather permitting.
- Helmet on snugly and buckled.
- Seat belts on very snug.
- Doors unlocked and sunroof closed and latched.

### **Entering the Track:**

- Wait for starters signal to move.
- Keep to the right upon entering.
- Check mirrors behind before moving "on line"

48

## Driving the Track:

- Signal to pass.
- Signal to allow passes - hand out the window.
- Don't pass unless signaled.
- Be aware of flag stations and observe their signals. Acknowledge checkered flag at the end of session.
- After the checkered flag is thrown, reduce speed and cool down car and driver. **Acknowledge the corner workers – their motto is “No wave, no save.”**

## Re-entering the Pits:

- Signal your intention to leave the track - left arm out and up.
- Speed is “Dead Slow” through the pits.
- Do not set your parking brake when you return to the paddock.
- Allow your car to idle for a couple of minutes before shutting off, preferably with the hood up.

49

## Chapter 9 – Becoming an Instructor

The following section provides basic information into taking your driving to the next level – becoming an instructor.

### Role of an Instructor

- To assist students in learning basic car control skills in a safe and controlled environment
- To teach and set by example club safety rules
- To communicate the club's rules and standards
- To know the club's licensing system
- Be a mentor so students can reach their goals
- To encourage students to improve
- Respect student's cars
- Be objective
- Demonstrate proper technique
- Provide student reports to track events director
- Assist in the smooth operation of track events
- Work as a team with other instructors
- Continually improve

### Instructor Benefits

- Satisfaction for giving back to the club and improving driving skills of students
- Accomplishment in achieving the next level
- Instructor driving time or scheduled sessions
- Contributing to the best regional club driving program
- Continual improvement
- Instructor shirts

### Instructor Recruiting Process

- Instructors selected from:
  - Level 3 drivers
  - Other clubs or organizations
  - Other BMW CCA Chapters
  - Referrals from Instructors or experienced students
- New instructors are selected at our spring Instructor clinic, signed off by the Driving Events Chairman or Chief Instructor

50

# Appendix A - Track Directions and Layouts

Pacific Raceways, Kent, WA.

Bremerton Raceway, Bremerton, WA.

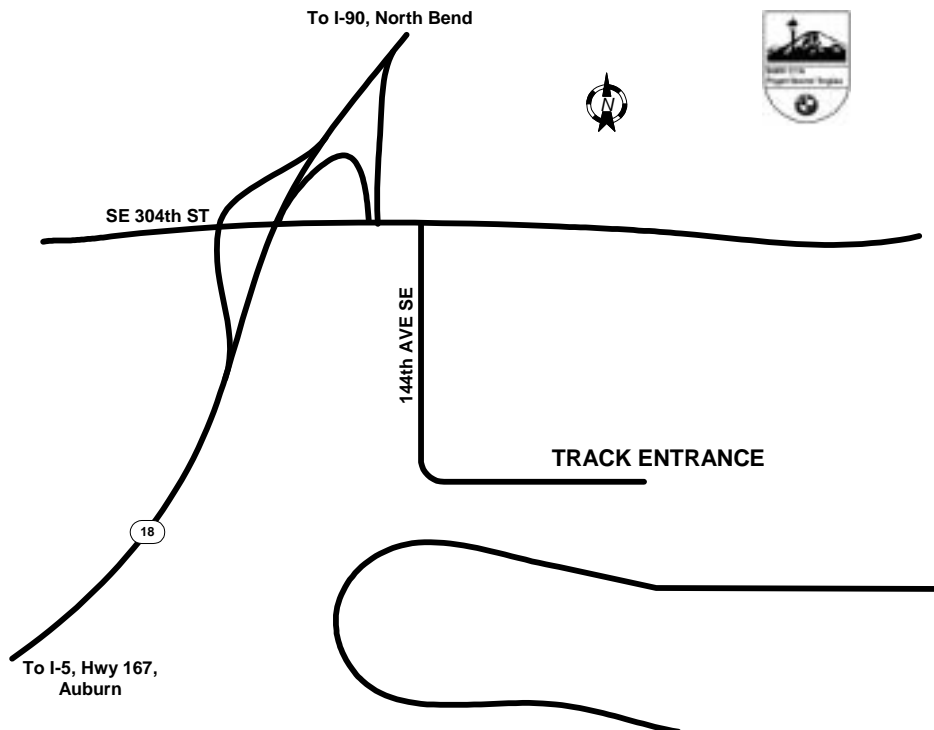
Portland International Raceway, Portland, OR.

Spokane Raceway Park, Spokane, WA.

51

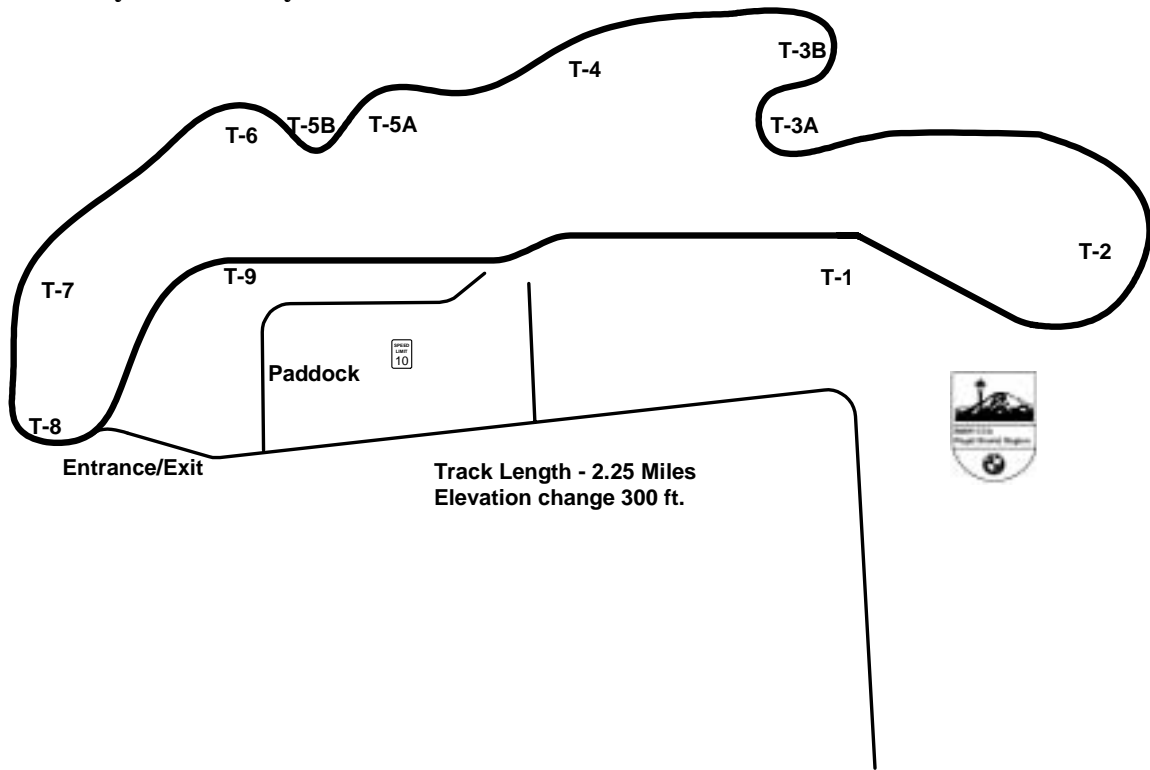
## Pacific Raceways, Kent, WA.

Directions:



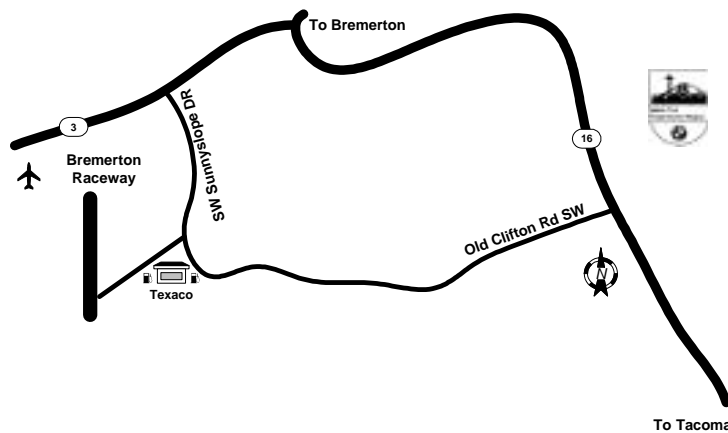
52

**Pacific Raceways - Track Layout**

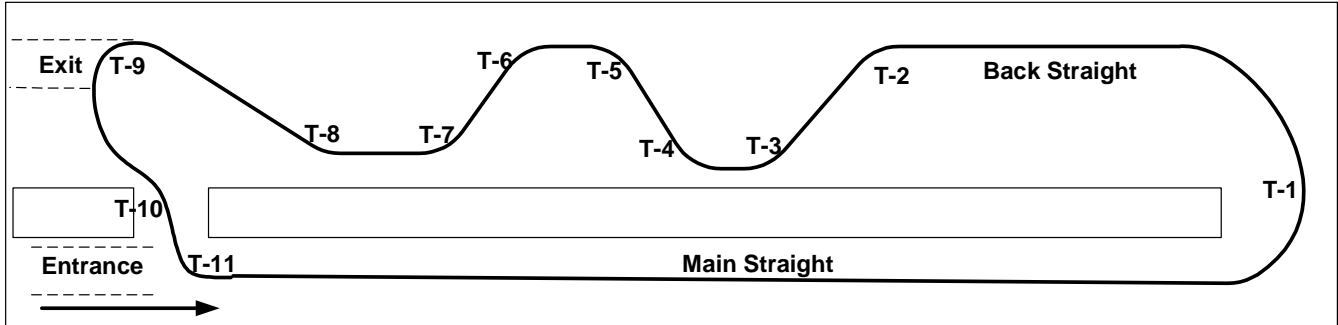


**Bremerton Raceway, Bremerton, WA.**

**Directions:** Take I-5 North or South to Tacoma. Follow the signs for Bremerton and HWY 16 West, over the Tacoma Narrows Bridge. Go about 16 miles to Port Orchard/Old Clifton Road Exit located just past mile Marker 26. Turn left at the stop sign at the bottom of the hill. Follow the Old Clifton Road for about 4 miles to the intersection of Sunnyslope Road and Victory Drive. Turn left and proceed so that the Texaco station is on your left. Keep going straight for about a mile and you will come to the entrance of the track. Please respect local residence and the posted speed limits.

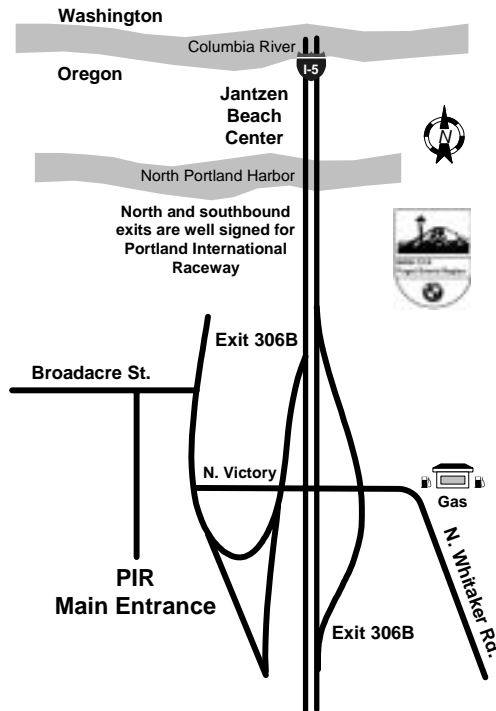


**Bremerton Raceway - Track Layout**

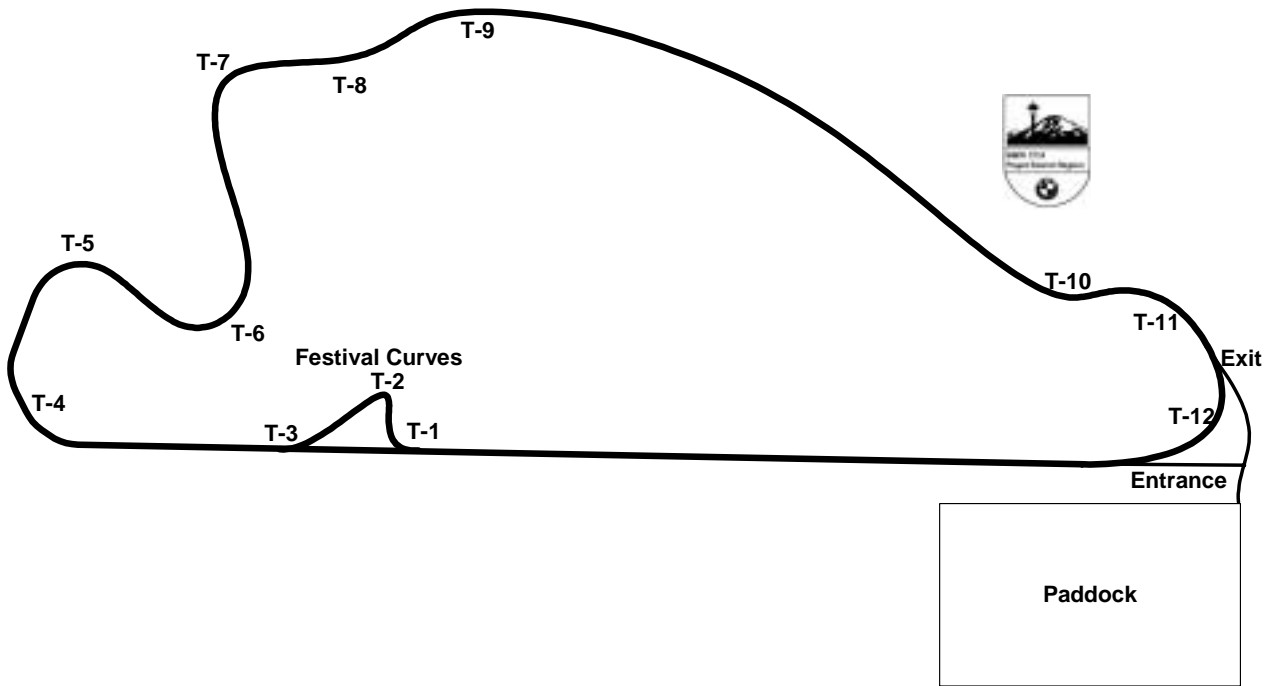


**Portland International Raceway, Portland, OR.**

**Directions:**



### Portland International Raceway - Track Layout

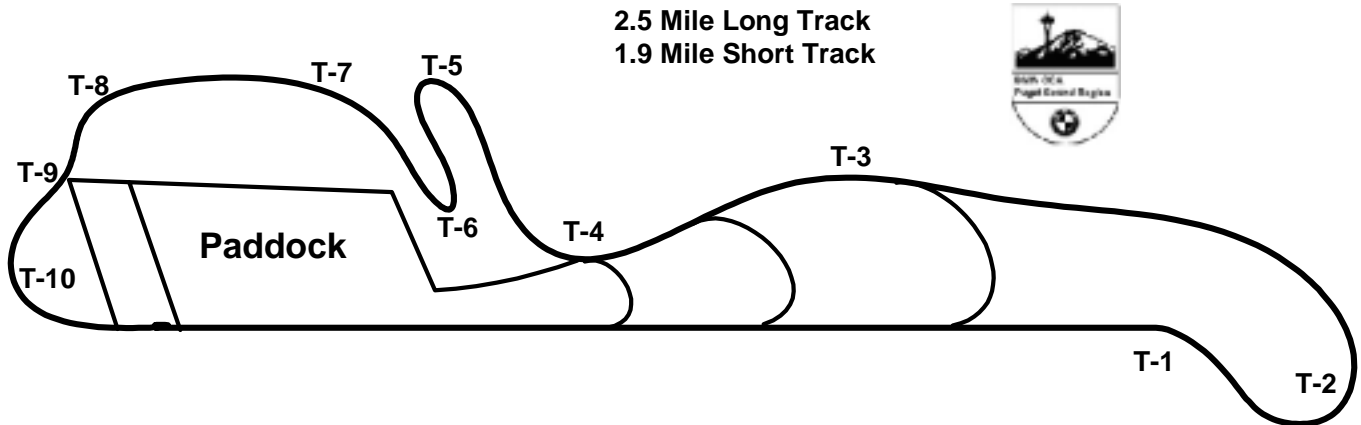


### Spokane Raceway Park, Spokane, WA.

Directions:



## Spokane Raceway Park - Track Layout



59

### Glossary of Key Terms

**ABS** - Anti-lock Braking System, which prevents wheel lockup under hard braking. Another way to think of it is the Ability to Brake and Steer.

**APEX** - The point along the inside of a corner where the tires should touch the edge of the road or lane.

**Brake Modulation** – The act of balancing the force applied to the brakes between lock-up and wheel rotation at maximum braking. (What ABS does for you).

**Braking Point** - The point at which the brakes are applied prior to entering a corner

**Car Balance** - The attitude and handling of a car as it is being driven at its limits.

**Closing Rate** - The rate at which a faster vehicle is overtaking a slower vehicle. The higher the closing rate the more caution should be exercised.

**Contact Patch** - The small area of the tread pattern of a tire that is actually in contact with the road surface.

**Cool Down Lap** - After a lapping session, one lap must be driven using the brakes as little as possible to allow the brakes, cooling system and driver to cool down and relax before pulling into the pits.

**Dead Pedal** - The resting place for your left foot when it's not on the clutch. Very useful in holding yourself in the seat.

**Decreasing Radius Turn** - Corner whose radius gets smaller as you go through it, requiring a very late apex.

**Down Shift** - Going from a higher gear to a lower gear.

60

**Early Apex** - Apexing earlier than the theoretical middle of a given corner, resulting in slower exit speeds but allowing for more braking in a straighter line if carrying too much speed into the corner.

**Friction Circle** - The circle representing the traction abilities of a given tire

**Heel and Toe** - The method of down shifting while braking by blipping the throttle.

**Ideal Line** - The line through a corner that results in the greatest exit speed.

**Increasing Radius Turn** - A corner whose radius increases as you go through, allowing an early apex.

**Late Apex** - Apexing later than the Theoretical middle of a corner, generally allowing higher exit speeds and more run-off room (the safest line).

**Oversteer** - Otherwise known as "loose." The rear of the car has more slip angle than the front.

**RPM** - Revolutions Per Minute, usually used when discussing engine speed.

**Shift Point** - The point at which the driver makes an up shift or downshift. Not a physical location. Shift points will change depending on the vehicle and driver ability.

**Slip Angle** - The difference between the forward motion and sideways motion of a tire as the car is negotiating a corner.

**Spin** - Uncontrolled slide.

**Threshold Braking** - 100% maximum braking with 15-20% wheel slip.

**Tire Pyrometer** - Gauge that measures tire surface temperatures.

61

**Track-Out Point** - The point as you exit a corner, where your tires should touch the outside of the road or lane.

**Trailing Throttle Oversteer (TTO)** - Oversteer induced by lifting off of the throttle.

**Turn-in Point** - The point as you enter a corner where you first apply steering input to move your car away from the outside edge of the road or lane.

**Understeer** - Otherwise known as "plowing" or "push" when the front of the car has more slip angle than the rear. The car doesn't want to turn any sharper. This is a design trait of most front wheel drive vehicles.

**Up shift** - Going from a lower gear to a higher gear.

**Warm Up Laps** - The first couple of laps of the day or session to bring the cars fluids, tires, and brakes up to operating temperatures and to prepare the

driver for higher speeds and to familiarize the driver to the track.

**Weight Transfer** - The transfer of the car's weight through braking, cornering, and accelerating.

62

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