Audi Club
NORTHWEST

# Driver's Log and Handbook

**Provided by your Safety Committee**
**Version 1.5 - April 2011**

# Preface

Welcome to the Audi Club Northwest Drivers and Safety Training School. These schools are designed to improve the driving skill level of our members and provide an organized venue for enjoyment of the one thing we all have in common ... our cars!

After completing one of our schools, you will be joining a group of drivers who have acquired advanced knowledge and skills. The experiences will add to your confidence and enjoyment, both on the track and on the highway.

We would like to stress that it is NOT the intention of the club to teach or demonstrate actual fender-to-fender racing techniques. There are several high-quality professional schools available for this training. Many of our club members have extensive driving experience and are more than willing to share information if you're interested.

It IS our intention to help you acquire a basic understanding of theories and the terminology associated with SAFE high performance driving.

Our club instruction and this handbook are designed to share information for a solo track experience that heavily relates these track experiences to your everyday driving.

As such, this handbook is divided into chapters that will supplement the instruction and provide definitions of common terminology, as well as maps of local performance driving 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 hopefully will make us all safer drivers in our daily commute.

Our special thanks goes to the BMW Car Club of America Puget Sound Region for their help and some of the content provided in this handbook.

We are pleased that you have elected to become involved in our club events and we look forward to providing experiences for you that can become the basis of your driving skill set.

# Driving Log Book

Name _____

Address _____

City _____ State _____ Zip _____

Phone (_____)_____

Driver _____
Signature

Date First Issued _____

**Driving Level***

Level **1**N_____ _____
(Novice) Instructor Date

Level **2**N_____ _____
(High Novice) Instructor Date

**Driving Level***

Level **3**I _____ _____
(Intermediate) Instructor Date

Level **4**I _____ _____
(High Intermediate) Instructor Date

_____ _____
1st Instructor for Advanced Date

Level **5**A_____ _____
(Advanced) 2nd Instructor for Advanced Date

Selected _____ _____
(Technician) Chief Instructor Date

Certified _____ _____
(Instructor) Chief Instructor Date

*Reference Handbook's Licensing System for Guidelines.

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# Table of Contents

## Performance Driving Overview

The Performance Driver is not someone who constantly races around the streets at a great rate of speed. The Performance Driver is not necessarily a trained racecar driver either.

Being a Performance Driver means many things: always driving in control of your vehicle and being aware of the situations and conditions around you; always driving smoothly and with finesse; being confident and sympathetic; and always thinking about what you're doing behind the wheel.

Your mental attitude is extremely important in working towards becoming a proficient Performance Driver. You may already feel that you are a confident driver. You may well be, but it is extremely important to keep an open mind about driving. You should always feel there is something more to learn about driving. It would be very unusual if there wasn't something you could learn. The best Performance Drivers are always the ones who are ready to learn something new every time they get behind the wheel.

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 also what is beside you and behind you. Use your mirrors regularly. Being aware of the conditions behind and beside your car may allow avoiding potentially dangerous situations by anticipating and reacting quickly and effectively.

The Performance Driver never drinks and drives. We cannot stress this enough. And why would you want to drink and then try to drive? Besides the danger to you and others, it wreaks havoc with the enjoyment that comes from being in control of the vehicle. Remember that the effects of alcohol can last 24 hours.

The Performance Driver ALWAYS wears their seat belt and insists that passengers wear them as well.

Finally, the Performance Driver should practice patience and courtesy on the road. If you are considerate to other drivers, you are reading the road and the traffic patterns - you will notice the driver trying to get out of the side street and be able to avoid an incident involving yourself or the cars behind you.

Remember to save your car's performance for appropriate times. There are times when it is safe to drive quickly and there are times when it is extremely dangerous. You won't impress anyone by speeding through a school zone or busy intersection. Bring yourself and your car safely back to the track for future events, a place where driving is more challenging and fun.

## Chapter 1- Licensing System for Track Driving

Our Driving Schools and high performance driving events (HPDE) are not intended to promote or teach race strategies; there are other schools available in the area for this type of venue. The intent of our driving events to promote better, safer drivers and to provide an appropriate way to experience the most from their cars and from themselves in a safe and controlled environment.

The club track licensing system is a guideline to ensure safety and build knowledge and confidence from our driver's experience.

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. There are many driving events in the area, which Audi Club Northwest members are welcome to attend to give you plenty of seat time!

The licensing system has the following goals:

1. **To allow the club to sponsor safe driving events.** Safety is always the most important concern at any club-driving event. The licensing system provides a means to qualify people for high performance track driving.

2. **To qualify instructors.** The licensing system will provide an objective means to determine who is qualified to serve as instructors at the club schools and to determine who is able to upgrade drivers to the various levels within the licensing system.

3. **To encourage members to increase they're driving skill level.** A desire to achieve a high driving skill level is a very worthy goal for any driver but especially for an Audi owner. The club's HPDE events and licensing system provide a structured means for becoming very skilled drivers over time.

4. **To encourage increased participation in high performance driving events.** The licensing system will make it clear that a high skill level of performance driving may only be acquired through much practice over time. Members will be encouraged to participate in HPDE events on a regular basis to upgrade their skill levels.

5. **The licensing system has five levels of driving skills**. These five levels are:

   a. **Level 1 (Novice)**: A person who has little or no track driving experience.

b. **Level 2** (**High Novice)**: A person recognized for substantial skill and confidence improvement, which comes from on-track experience, exercises, your own reading, and additional coaching on the track.

c. **Levels 3, 4 (Intermediate, High Intermediate)**: A driver who has achieved a competence level allowing them to solo at club high performance driving events.

d. **Level 5 (Advanced)**: A driver who demonstrates the highest level of driving competence, car control and peer-recognized experience.

e. **(Technician, Instructor)**: Technicians and Instructors are selected for their ability to effectively teach others.

The following outlines the skill levels required of drivers at Levels 1, 2, 3, 4, and 5:

## LEVEL 1, 2 (Novice levels)

**Level 1, 2 Technical Skills**

*Seating and hand positioning* - The driver understands the proper seating position and position of their hands on the steering wheel while driving. The driver always uses a seatbelt and wears a helmet while on the track.

*Braking* - The driver demonstrates smooth braking before corners.

*Shifting* - The driver upshifts and downshifts smoothly by matching the engine and transmission RPMs. The driver does not allow their hand to linger on the shift lever.

*Cornering* - The driver understands and demonstrates a general knowledge of the proper line and how to apex a corner.

*Understeer and Oversteer* - The driver is able to explain the concepts of understeer and oversteer and can identify each while driving. The driver knows how to correct excessive understeer (ease off brakes to gain steering) or oversteer (steer into the skid with slight acceleration).

*Skid control* - The driver is capable of controlling and/or correcting some skids. The driver demonstrates knowledge of how to correct a skid but may be successful only infrequently.

**Level 1, 2 Attitude**

The driver has a responsible attitude. The driver takes constructive criticism well and has a desire to learn and improve his/her driving. The driver is safety conscious, attentive to track marshals and corner workers.

**Level 1, 2 Mechanical**

While mechanical aptitude is not necessary, the driver's car should exhibit the appearance of proper maintenance. In order for the vehicle to be safe, the driver should understand the importance of vehicle maintenance for a car to be driven in a high speed environment that puts stress on the car.

**Level 1, 2 Overall**
The driver demonstrates reasonably good car control in general. The driver is not excessively nervous while driving and is aware of their surroundings (other cars) while on the track. In short, the driver must not be a hazard to themselves or others. Generally the driver knows what to do but must think of the proper reaction for a given situation, thus reaction times are slower.

**Note:** Level 1 (Novice) requires a signature from an instructor, which may be given upon completion of the first driving school. Level 2 (High Novice) requires a second signature from an Instructor and is not given at the student's first driving school but may be obtained after their second instructed driving event.

## LEVEL 3, 4 (Intermediate levels)

**Level 3, 4 Technical Skills**
*Seating and hand positioning* - The driver has a thorough understanding of the proper seating position and position of their hands on the steering wheel. They know why they are used and habitually uses the proper positions while driving. The driver always uses the seat belt and always wears a helmet on the track.
*Braking* - The driver demonstrates smooth and forceful braking. The driver is adept at brake modulation to prevent lockup. The driver has some knowledge of and may demonstrate trail braking.
*Shifting* - The driver is able to perform heel and toe and/or double-clutch down shifts. The driver shifts smoothly by matching engine and transmission speeds. The driver does not allow his or her hand to linger on the shift lever.
*Acceleration* - The driver accelerates smoothly out of corners and has good control over power oversteer.
*Cornering* - The driver demonstrates knowledge of the ideal line. The driver understands the theory and shows the ability to turn in, apex, and exit a variety of corners.
*Understeer and Oversteer* - The driver has a thorough understanding of understeer and oversteer and can identify both of these conditions while driving. The driver can sometimes induce them while on the track and knows the effect of acceleration and braking (trailing throttle, power oversteer, etc.). The driver is able to compensate for excessive amounts of understeer or oversteer.
*Skid Control* - The driver is capable of controlling and/or correcting almost all skids at moderate speeds and some skids at higher speeds.
*Vehicle Dynamics* - The driver understands and uses weight transfer and transient response. The driver understands the interaction of the car setting on its suspension and its cornering ability. The driver understands the significance of the tire contact patches, air pressures, and suspension modifications on the car's cornering ability.

**Level 3, 4 Attitude**
The driver has a responsible, serious attitude. The driver takes constructive criticism well and has a desire to learn and improve their driving. The driver is safety conscious, attentive to track marshals and corner workers while driving. The driver is knowledgeable enough to assist in course marshaling and running a track event. The driver displays interest and sound judgment in evaluating the driving of others.

**Level 3, 4 Mechanical**
While mechanical aptitude is not necessary, the driver's car should exhibit good to excellent maintenance in keeping with the driver's ability to push the car to higher limits. The importance of proper maintenance should be thoroughly understood and appreciated.

**Level 3, 4 Overall**
The driver demonstrates good car control in all situations. The driver is not nervous at speed and is comfortable and predictable in traffic. The driver is also just as comfortable as a passenger even under stressful situations. He or she is able correct for most errors and is able to drive quickly and safely at high speeds. The driver not only understands how to correct a given situation but also has begun to develop an instinctively correct reaction. Thus, reaction times are considerably quicker than all Level 1 or Level 2 drivers. The driver is able to discuss driving skills and is able to judge the skills of other drivers. The driver is courteous, conscientious and responsible in all situations and sets a good example for novice and other intermediate drivers.

**Note: The Level 3 signature allows the driver to drive solo at club events**.

## LEVEL 5 (Advanced level)

**Level 5 Technical Skills**
*Seating and Hand Position* - The driver habitually uses excellent seating and steering wheel positioning and has a thorough understanding of why they are used.
*Braking* - The driver exhibits smoothness under maximum braking force, which is considerable. The driver is adept at brake modulations to prevent lockup and at trail braking. The driver can identify situations when trail braking is and is not appropriate. The driver may demonstrate left foot braking skills.
*Shifting* - The driver demonstrates smooth up and down shifting skills by matching engine and transmission speeds. The driver is adept at heel and toe and/or double clutch down shifts. The driver never allows his or her hand to linger on the shift lever. The driver can manually shift an automatic transmission smoothly to maximize the cars ability.
*Acceleration* - The driver accelerates smoothly out of corners and is able to control power oversteer. The driver understands power and torque peaks.

*Cornering* - The driver demonstrates the ideal line, and the ability to quickly and efficiently execute all types of corners. Turn in, apex and exit are all done smoothly. The driver demonstrates the ability to determine the optimum line, influenced by the vehicle's capability and adjusted to current track conditions. The driver uses the correct technique for on or off camber turns, increasing or decreasing radius turns and double apex turns.

*Understeer and Oversteer* - The driver has a thorough understanding of understeer and oversteer, both theoretical and practical. The driver is able to identify, induce, explain and demonstrate both of them. The driver is able to compensate for excessive amounts of understeer or oversteer. He or she knows and can demonstrate the effect of acceleration, deceleration, and braking on cornering attitude (trailing throttle, power oversteer, etc.).

*Skid Control* - The driver demonstrates the ability to control and/or correct skids at all speeds.

*Vehicle Dynamics* - The driver understands and demonstrates the use of weight transfer and transient response. The driver is adept at using the set of the car's suspension to achieve maximum cornering force. The driver has an understanding of slip angles, polar moment, roll centers, and a good understanding of the friction circle theory. The driver understand the significance of tire contact patches, tire air pressures, and suspension modifications on the car's cornering ability.

**Level 5 Attitude**

The driver has a very responsible, serious attitude. The driver is safety conscious, attentive to track marshals and corner workers while driving. The driver is knowledgeable enough to fully run any club track event. The driver has a mature and responsible attitude towards discussing driving technique other drivers and displays sound judgment in evaluating the driving of others.

**Level 5 Mechanical**

While mechanical aptitude is not necessary, the driver's car should exhibit excellent maintenance in keeping with the driver's ability to push the car to very high levels. The importance should be thoroughly understood and appreciated.

**Level 5 Overall**

The driver demonstrates excellent car control in all situations and is comfortable at high speeds. The driver is comfortable and predictable in traffic. The driver is able to correct nearly all errors and is able to drive quickly and safely near the limits of the car. The driver has quick reaction times to situations due to having developed his or her skills to the point of the proper reaction being instinctive. The driver is involved to help other drivers and is able to judge their skills and converse with them about improvement. The driver is courteous, conscientious and responsible in all situations and sets a good example for all other drivers.

**Note:** Level 5 indicates an expert driver. This level is achieved only by those who have conscientiously improved their skills over a period of years. Level 5 Advanced drivers will have generally graduated from other professional driving schools and may have a senior competition license from a recognized sanctioning body combined with extensive track experience.

Very extensive club experience will substitute for professional schooling or competition experience.

**Level 5 Advanced requires peer recommendations and two Instructor signatures at separate events**.

## Instructor designation

The signature at Technician or Instructor must be approved and signed off by one of the Safety Committee Chairs. In addition to the skills and knowledge expected of them at their own skill level, Technicians and Instructors deliver the club's programs and demonstrate consistent example and leadership to all who attend events. Instructors may also carry passengers on track when approved by the Event Master.

# 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 car, empty trunk, interior of car, no loose items, including removal of all floor mats and items in glove box and center consoles.
- Torque lug nuts, 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/speed event -- Don't forget you are driving this car home later.

## 2.2 Vision: Leading The Way

If a percentage figure 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 the 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 and where you will go. 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 the car will naturally go there. **You go where you look.**

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 thus not actually 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 times and don't just look ahead, think farther ahead.

## 2.3 The Seating Position

The first and 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 required to interpret what the car is doing. As well, make sure you are comfortable - it is much less tiring and easier to concentrate.

Ideally you want a seating position that puts as much of your body in contact with the seat as possible.
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 to allow excellent 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. If your car is equipped with ABS, you need to be able to press the brake pedal with at least 90lbs of force.

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 race 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 such that (with your shoulders square in the seat and your arms straight in front with your elbows locked) your wrist bones rest on top of the steering wheel. This will provide an appropriate amount of bend at the elbow while driving. If your car has a moveable center armrest, push it up and get it out of the way.

## 2.4 The Steering Wheel

The position of your hands on the steering wheel should be at 9 and 3 o'clock. The 10 and 2 o’clock position also works, but it is for vehicles without an airbag. By always holding the wheel in the same position you'll know how much steering

you've put in and where straight ahead is. Grip the wheel firmly but not too tightly.


With this grip you should be able to make most turns without moving your hands from these positions 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 smoothly. Smooth is safe, smooth is quick.

## 2.5 Mirrors

Mirrors are a driving tool. Use them! Remember, it is just as important to know what's behind and beside you as it is to know what's in front. Take time to adjust all your mirrors properly.

## 2.6 Preparing Your Equipment

**Basic Equipment**

- 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, NO HIGH HEELS, NO BOOTS!
- Sunglasses, hat, driving gloves, bug spray and sunblock.
- Rain gear, tarp or cover for your belongings -- You never know in the Northwest... Bring raingear.
- A full tank of gas.
- Tire gauge
- Clean the windshield, rear, and side glass

## 2.7 Clean Interior

It is imperative that all loose objects and any objects that 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, slide or rocket out to take up residence in 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 incident. NEVER CARRY ANYTHING ON THE SHELF UNDER THE REAR WINDOW (on or off the track).

We also recommend that you remove the floor mats to avoid the possibility of becoming tangled in them or interfering with the pedals.

## 2.8 Tire Pressure

People who have auto-crossing experience tend to inflate their tires to very high pressures (we've heard conversations as high as 44 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 is too high for a track experience (or the street).

Due to cornering, braking and acceleration forces on the tires, 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.

If you start with 40+ psi cold pressures, 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 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.

## 2.9 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.

## 2.10 Seat Belts

We stated earlier that you must be firmly installed behind the steering wheel. If your car is equipped with a competition harness, (which is not required for Audi Club Northwest driving events) it's not a problem -- just cinch down the lap belt and tighten the shoulder belts until snug. If you're considering installing a competition harness in your car, a four-point system (two lap and two shoulder belts) is a waste of money. With a four-point system, the lap belt will rise up and will end up around your midsection. Buy and use an antisubmarine strap (it mounts on the car floor, runs between your legs, and attaches to the lap belt) as well as the lap and shoulder belts. It will hold the lap belt in the proper position -- around your pelvic bone and hips.

If you don't have a competition harness (and this is not necessary), not all is 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 solid jerk to fool it into thinking you've just been in an incident. 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 installed behind the wheel.

## 2.11 Warm-Up

1. *Novice Drivers.* Drive the first several (at least two) laps of each of your track sessions at a conservative pace to allow your car, its tires, and you time to warm up. Practice driving the proper line.

2. *Intermediate and Advanced Drivers.* Need to warm-up also. During your warm-up lap or laps, drive at a conservative pace but use the brakes harder; enter the turns at a relatively slow pace but turn in 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.

## 2.12 Cool Down

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, 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. YOU'RE NOT! You're still traveling quite fast so PAY ATTENTION.

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

# 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 here: First, when finished making a shift, get your hand back on the steering wheel! If it's not shifting, it should be steering.

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

Proper downshifting is a must for extracting the full potential of your car. It is not easy - it 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 Performance Driver downshifts during the approach to a corner so that he/she will be in the proper gear, at the optimum RPM range, to allow smooth, balanced acceleration on the exit.

The object when approaching a corner is to shift down to a lower gear while maintaining maximum braking, smoothly, without upsetting the balance of the car. If you simply dropped a gear and let out the clutch while braking heavily, the car would nose-dive -- upsetting the balance -- and try to lock the rear wheels because of the extra compression braking effect. So what is required as one downshifts is for the engine revs to

be increased by stabbing the gas pedal with the right foot. This is called "blipping" the throttle. What you are doing is matching the engine RPM with the driving wheels RPM.

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.

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 maximum 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. Pivot your right foot back off the gas pedal and as the engine RPMs start dropping from the higher revs, move the shifter level into the next lower gear and ease the clutch out.

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 lock up when the clutch is re-engaged. A major no-no! If you blip too much, the car will attempt to accelerate -- you're suppose to be slowing 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. Now obviously to do this properly, your car must be set up correctly. When the brake pedal is depressed fully, it should be directly beside the gas pedal.

Now that you know how to shift, what about when to shift?

The rule in downshifting: "brake first, then downshift". If you don't follow this rule, you will end up badly over-revving the

engine. Think about it. If you are at maximum RPM in fourth gear and you downshift to third without slowing the car - BANG - there goes the engine and you. And remember, downshifting is not a means of slowing the car - unless you have no brakes.

Now, what about skipping a gear when downshifting -- going directly from fourth to second, for example, when approaching a second gear corner. We definitely recommend it as long as you are proficient at good, smooth downshifts and realize you must then slow the car down even more with the brakes before dropping the two gears.

In fact, the less downshifting you do while approaching a corner, the less likely you will make a mistake, and it will be easier to modulate the brakes smoothly.

As you can see, 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 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. Well, the right technique requires shifting it just like a manual. Upshift 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 the left foot that they have learned through using the right foot on the gas pedal. If you start using the left foot now, you won't have the necessary sensitivity and will probably end up locking the brakes or not using them to their maximum capabilities.

### 3.3 Starting and Accelerating

When starting out from a stop, feed 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 full-throttle application.

Always accelerate smoothly in a fluid manner. Squeeze on the gas pedal -- don't pounce on it. It should be completely

progressive. Change up to the next higher gear before you reach maximum RPM. It is not necessary for full acceleration to red-line it on every shift. In fact, 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 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 brakes' capabilities and then usually improperly.

The first step in Performance braking is actually in how you come off the power. Do not come off the gas pedal abruptly but gently ease off the throttle very progressively. Then begin squeezing on the brakes, again progressively, until you are at maximum braking -- threshold braking. If you exceed the limit for threshold braking and begin to lock-up, 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 -- the car will not be balanced.

Remember to squeeze the brakes on smoothly, firmly and progressively and then release it very gently, so that you don't actually feel it coming off. 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 Performance Driver from the average person!

## 3.5 Balancing The Car

Another key to Performance Driving is controlling the balance of the car. By balance, we mean having the weight properly 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 car’s weight has transferred to the rear. Under braking the car nose-dives -- the weight has transferred forward. In a corner the 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. Some cars, especially front-wheel-drive and Audi Quattros naturally understeer - it is a design trait.

Accelerating too hard or not smoothly enough through a corner transfers excessive weight to the rear, decreasing traction and steering ability at the front and causing understeer. Most peoples' first reaction is to turn the steering wheel in more and more. A no-no!

The cure for understeer is to decrease the steering input slightly and ease off the throttle gently to transfer weight back to the front. This increases the traction limit of the front tires and allows you to begin smoothly and progressively accelerating and turning again.

### 3.7 Oversteer

Oversteer is a handling characteristic where the rear tires have less traction than the fronts; the back end wants to come around, and the nose of the car is pointed at 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. Some cars, especially rear engine models, naturally tend to oversteer.

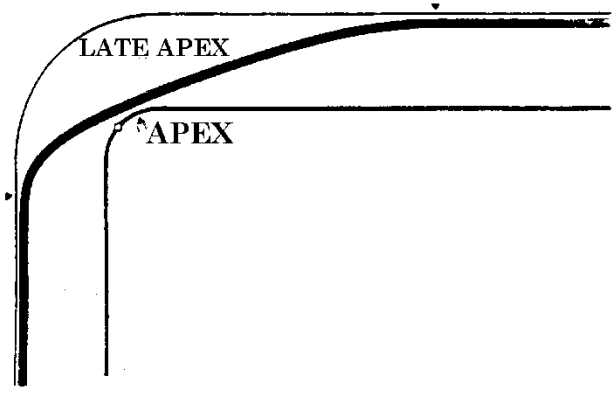
Turning into a corner with the brakes applied (trail braking) causes the weigh to transfer forward, making the rear-end lighter, thus reducing rear wheel traction. The result -- oversteer. To control excessive oversteer turn the steering wheel the other way, out of the turn (opposite lock), thereby increasing the radius of the turn and reducing the slippage at the rear. At the same time, gently and smoothly ease on more throttle to transfer weight to the rear, and thus increasing traction. Whatever you do, avoid any rapid deceleration. This will surely 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 all of the available roadway. This, and the other information in this manual, is 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 race 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 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.

The "correct line" involves starting any turn from the extreme outside edge of the roadway, then touching the extreme inside edge of the roadway and finally touching the extreme outside edge of the roadway as you exit the corner. Since a picture is worth a thousand words, refer to the following diagram. The point on the inside edge of the roadway touched by the car as it travels through the turn is called the Apex.
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 roadway 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 probably 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 in side 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 of the it, or late in the turn. As a general rule, most corners on the road are late apex turns.

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

## 3.10 Driving The Ideal Line

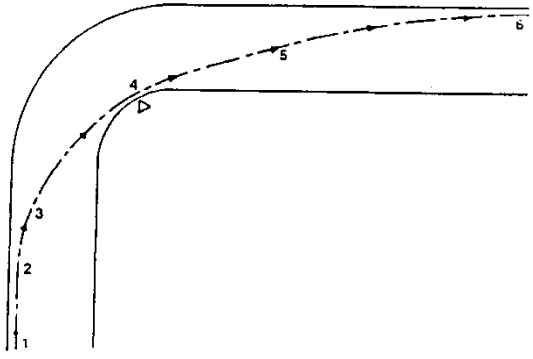
The fastest possible speed through any given corner is achieved by driving a line formed by the largest possible radius (the reasons will be explained later). Basically, you are straightening the corner as much as possible. But this is not necessarily the fastest way around the track - not the ideal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

The 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 the 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 the lines through these corners are this way.

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:

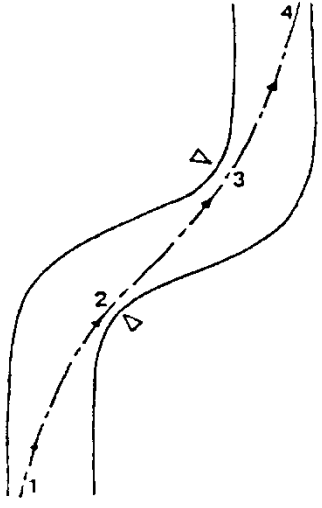
1. Maximum threshold braking; downshift into the gear required before turning (2).
2. Maximum braking complete, begin turning into the corner.
3. Balancing point - the transition from braking to throttle application.




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 all the 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. Is much more effective to go into a corner slow and come out fast than vice versa.

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 leads onto the straight. Drive this last corner like you would any corner leading on straight -- with a late apex. The first curves in the series are very 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.




1. Turn in at a point which allows a late apex.

2. Line up the two turns and use all the road making this apex.
3. Late apex on the second turn, maximum acceleration.
4. Exit onto the straight using all of the road.

When we talk about using up all the road, obviously 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 single-lane track or road. On a section of roadway you don't know, give yourself a little extra room on the exit of the corner.

## 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 pylon, the steering wheel motion required to get pointed toward the Apex must be one continuous, smooth motion.

Avoid turning the wheel too little or too much, avoid making corrections. This will take some practice. At the Apex, you must begin to unwind the steering wheel in one continuous, smooth motion so that the car touches the edge of the roadway at the exit pylon. 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. No sudden herky-jerky steering inputs. 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 (or worse). 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 turning point for a corner at a speed which is altogether 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.

**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, and which you must fight from the start.
Let's examine what happens 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 and 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.

**Turning too late for a corner:** If you turn in later than the turning 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 altogether, 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.

### 3.13 Track Layout

Getting to know a particular track layout takes time, but once you have learned a track layout, you will know exactly what's coming next. You cannot drive safely if the next turn comes as a surprise, and you merely react to it. Knowing what's coming next, and what you are going to do when you get there, is easier, once you have learned the track. Study the terrain near the exit from the turn. (Is there any room to go off the road there without serious consequences if a car is blocking your way?)

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. The great thing about this is that your will do it well every lap.

During your next track session, you'll be surprised how much you've improved since the previous session.

# 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 a 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 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 Performance Driver uses these to his advantage -- and conversely, attempts to minimize their disadvantages. Just remember, 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 a potential incident 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 his/her business or turning and talking to the other passengers.

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. Too many drivers use the freight train approach to clearing the roads.

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.

## 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. Go to the **Understeer, Oversteer, and Winter Driving Tips/Techniques** section in Appendix B for specific details that can be used along with an instructor for controlling skid behavior.

If the car begins to oversteer skid 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 do -- besides avoiding the spin in the first place. 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.

## 4.4 Accident (Incident) Avoidance

The next trouble situation can occur during incident avoidance. It may be a child or a dog running out in front of you or a car pulling out ahead. If your car is equipped with an Anti-Lock Brake System (ABS), brake hard (At least 90lbs of pedal force) and steer your vehicle away to avoid the object. If you don’t have ABS, and do not have enough distance to stop safely, then, ease off the throttle and 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 incident is at hand. Steer, do not brake heavily. Keep steering control over all 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. 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 an impending incident. One chance in a million is better than no chance at all. Even if an incident is inevitable, 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 cannot be stressed enough.

On a wet, slippery road the ideal “dry” line through a corner is not necessarily the correct “wet” line. In the rain, the tracks 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 can 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.

Under normal conditions, such as a level road with a constant rain, your front tires will aquaplane first. The rear tires are riding in a empty wake made by the fronts and therefore will remain in contact with the road longer. 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 skid 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. 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

Performance Driving can take on some special dimensions when driving a Front-Wheel Drive (FWD) car, or an All-Wheel Drive (AWD) car. Since there is a strong trend by the manufacturers towards production of cars with FWD, and AWD, understanding the car control differences between FWD, AWD and Rear-Wheel Drive (RWD) vehicles is becoming increasingly important.

In normal, straight driving, 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 FWD and AWD 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 (RWD).

How do you control excessive FWD and AWD understeer? If you use your brakes too hard, you will make matters worse. That increases the weight transfer onto to the front tires and overloads them even more. The way to regain control is to ease off the accelerator, unwind the steering wheel, and brake slightly until you have slowed down enough to regain steering control.

And how do you control FWD and AWD oversteer? The phenomenon is probably 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 skid and gently accelerate to increase rearward weight transfer. More on weight transfer later.

# Chapter 5 -Technical Skills and Theories

## 5.1 Physics Of 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 subjects covered in depth (some of which you've already read about) but explained in detailed terms of the "friction circle", "heat", and the "tire patch".

## 5.2 Friction Circle

An automobile contacts the road surface through its tires (at least that's the position you should strive to maintain). 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.

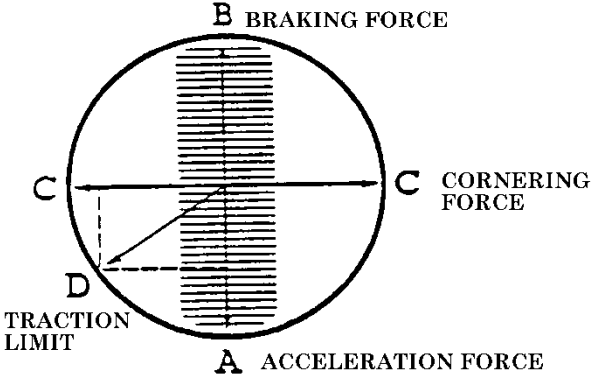
Sometimes you hear people say that they put wider tires on their car to get more rubber on the road. Wider tires will change the shape of the tire patch, making it wider, but the total area of the contact patch remains the same.

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 and 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, or cornering.

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 traction limit. "D" represents the traction limit of a tire being subjected to both lateral (cornering) 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. This figure is a representation of the Friction Circle.




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.

## 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=(MPH). 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, hopefully, 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. The Friction Circle again. This friction is affected by the type of tire, the car's suspension, drive system - RWD, FWD, or AWD (Quattro Advantage), road condition, and balance of the car.

Generally, on a dry road maximum acceleration occurs when there is approximately 8-20% wheelspin. At this rate, there will be a faint squeal of tires and a faint gray line on the road. Exceeding this amount of wheelspin, or friction limit, will result in dramatic but less than maximum acceleration. If you should begin to get this kind of wheelspin, 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 /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 at 70 MPH, then you're strapped to approximately 409,700 ft. lbs. (2500 x 70 /29.9) of Kinetic energy!

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 section) 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 the sliding tires on the ground can not shed the heat as effectively as the braking system itself. Therefore, the time required to reduce total kinetic energy will increase as will stopping distances. Research shows that maximum braking therefore occurs when there is approximately 8-20% wheelslip depending on the road surface and type of tires used. 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, less just before reaching the turn-in point and even less or not at all at the turn-in point. Once your braking is complete, now 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 so, since it's more important that you drive the correct line, slow down earlier until you can do it correctly.

## 5.6 Application

OK, how does this information relate to 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 achieve maximum braking traction, but if you turn the wheel while using maximum braking, or if you accelerate to the maximum traction ability of your tires, and attempt to turn you will lose control of the vehicle, and you will become merely a passenger. The Audi Quattro has the advantage in this respect, as it can distribute the acceleration force with all 4 tires. You brake hard in a straight line, then relax the 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 level of performance in a safe manner, is to drive at the limits of your vehicle and stay within the friction circle of your tires.

## 5.7 Slip Angles

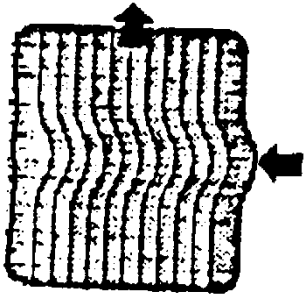
"But how will I know when I'm approaching the limit of adhesion of my tires?"

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

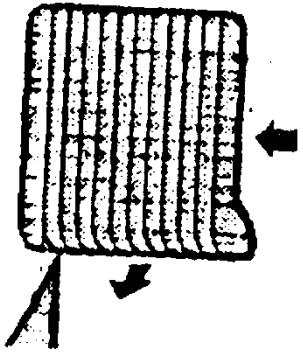
Let's look at a car traveling at a sustained rate of speed. The first law of physics to affect your car as you begin to turn into a corner is the law of Inertia. Simply stated, a car traveling in a straight line will always resist being turned off that straight line and into a corner. In order to overcome 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 disagreeing 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, the 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.



The degree of this angle is affected by many things. Have you ever heard of racers running "shaved tires"? Seems silly to buy new tires and then spend money to have tread removed from the tires, doesn't it? The truth is though, deep tread allows the tire surface to distort more, generating unwanted heat and enlarging the slip angle. 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 race tire approaches its limit of traction (the edge of the friction circle) it gives little warning until the moment it's too late. All tires are affected by tire pressure and higher cornering forces; both of these directly effect 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 small (very little cornering force) to very large (very high 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 angles become 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 at the front tires are much greater than those of the rear tires, the car is said to understeer, push, or plow. To the driver, if feels as if the car won't get itself turned in and the driver must continue to add steering lock (or slow down or both) to get the car pointed into the apex. An understeering car is a safe car for an inexperienced driver because to correct it, the driver needs only back off the throttle and add more steering lock in the direction he wanted the car to travel. An understeering car is, however, not a very satisfying car to drive quickly, and it's generally not a quick car around a race track.

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 real well; in fact, it begins to describe an arc, which 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.

An oversteering car is more fun for the experienced driver to drive quickly than a understeering car; however, it is more difficult for the inexperienced driver. Suddenly lifting off the throttle (the natural tendency) will transfer weight off the rear tires, reducing their traction, increasing the slip angles and inducing oversteer. This little exercise in futility is called "Trailing Throttle Oversteer" or merely TTO. TTO can be induced by lifting off the throttle while turning. This might be useful for auto crossing, but don't do it on the track.

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. Most Audi Quattros understeer, and they tend to oversteer if you suddenly brake or let off the throttle in the middle of a turn. If you detect excessive understeer, you are entering the turn at too high a speed.

Ideally, you want a neutral handling car; one which neither oversteers nor understeers. We want to have the same slip angle at both the front and rear so that we 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. Again, 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 lock (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. Wait for it to happen and correct simultaneously.

Total Loss -- If you don't try to drive over your head, this will not happen to you.

If the correct action is not taken soon enough, you will not be able to correct it. If you lose it badly (this evaluation must also be made rather quickly), PUT BOTH FEET IN. Left foot on the clutch, right foot down on the brakes. The car's brakes will lock and with any luck the car will spin violently, dissipate its speed on the track surface and stop on the inside of the turn's track surface facing approximately in the originally intended direction of travel. 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 slip the gear selector into first, check for traffic and motor off like a Chitwood Stunt Driver. It may also be a good idea to now motor into the pit area and stop there until your heart rate returns to normal.

Less than a Total Loss -- Somewhere between catching the skid very early and losing it completely is an area where the car can still be brought under control. The dilemma: if you suddenly jump off the accelerator, you will lighten up the rear end and reduce the traction available at the rear of the car. Staying on the throttle, however, will make matters worse because you've already lost the lateral traction of the rear tires and in persisting on the throttle, you're asking the tires to do two things at once (remember the Friction Circle Theory).

The trade off favors backing slowly out of the accelerator, disengaging the clutch, and counter-steering.

"Counter-steering?"

Somewhere in our meager driver's training, we have all heard about controlling a skid on ice or snow, and some of us have actually done it. We were always told to turn the wheels in the direction of the skid. All this means is that you turn the wheels in the direction you want the front of the car to go.

Controlling a skid at high speed on a dry surface is just like controlling a skid on ice or snow, ...well almost. If you crank the steering wheel a lot on ice or snow, the rear end will swing out of the skid and continue swinging into a skid in the opposite direction where upon you crank the steering wheel the other way and the rear end now swings around in the opposite direction and so on and so on. All the while, the car is slowing down, and the swings from side to side become smaller and smaller until eventually you regain control of the car.

If you crank the wheel a lot in the direction you want the front end to go on dry pavement at high speed, which will likely be the last time you are in control of the vehicle. That gentle counter skid you experienced on the icy street becomes a violent counter skid on dry pavement at speed. The counter skid will occur so violently and so quickly you will likely not be able to catch it. If you cranked the wheel far enough, you probably won't even know what happened.

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

If you think you're going to run out of road, DO NOT LIFT OFF THE THROTTLE.

DO NOT ADD STEERING LOCK -- if you're in a drift, you are right at the tire's limit of adhesion. If you now request more rudder, you'll lose traction.

Keep your composure -- think. If only the outside tires drop off the road, nothing much is going to happen. DON'T TURN THE WHEEL until you are sure the car is under control. Gradually slow down and gradually return all four wheels 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. The car is going to continue its drift -- perhaps at a faster rate. We probably don't need to tell you this but lift off the throttle very gently. If you are certain that you are going off the road, it helps to steer further off the road. This will increase the radius of your turn and might restore traction so that you control the car. This, of course, is not much help if there is a large tree or concrete wall in the way. If this is the case, and conditions on the other side of the track are better, you may want to opt for TTO.

## 5.10 Brake Points

"OK, now I understand what's going to happen to me in the corner and I know I've got to slow down and control the "friction circle", how close should I get to the turn before I start to brake?" We don't know. Your brake point is personal to you and your car. We can only tell you how to go about finding it.

Pick out a marker of some sort near the turn (preferably a permanent one. Don't use a lawn chair that someone may move). When you get to that point, begin threshold braking. If you come to a stop well before the turn-in point, obviously your brake point is too soon. 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.

Remember, you want to be able to begin accelerating as soon as possible after turning in. Therefore, each time you move your brake point closer to the turn-in point, note where you are able to begin acceleration. If you are unable to begin accelerating as early as you could with the previous brake point, your brake point is too late. Move it back. 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 of throttle.
Two factors may have an effect on the brake points that you establish for yourself early in the day. As your driving improves, you'll be going faster when you reach your brake point than you were earlier. You may find that your brake point is too late. One the other hand, as your driving improves, you may be able to handle higher cornering speeds. You may

find that your earlier brake points are too early. JUST KEEP THIS IN MIND.

You should also keep in mind that the track surface will have an effect on braking:

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

Braking going downhill

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

Very few things decrease braking distances. Braking going up hill is one. Hitting the car in front of you is another. WATCH YOUR INTERVAL.

"What if I can't get slowed down enough to make the turn?" Then don't make the turn, but congratulations on recognizing that you're going too fast. The general rule is if you're going too fast to turn in, don't. Continue threshold braking and drive straight off the turn. You will be able to steer the car when it leaves the track and you will hopefully be able to bring it to a stop before coming into contact with something hard, or at least you might be able to steer around the hard object.

If you're going too fast to make the turn and turn anyway, you're still going to go off the track, but you won't be in control of the car. You will be unable to steer, brake or exercise any control whatsoever over the car.

## 5.11 Advanced Rain Driving

Driving on wet surfaces requires smoothness to the Nth degree. Your vehicle will have considerably less acceleration and braking traction and a whole bunch less cornering 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. (Another, smaller friction circle?) It should be clear to you from this that a wet surface requires a considerable reduction in speed. If the surface is extremely slippery, coast through the turns and don't apply throttle until the car is traveling in a straight line.

At most tracks, you may find that the "Line" becomes extremely slippery. Cars running on the track deposit rubber from their tires on the Line. In addition, if a car leaks any fluids, it will generally be deposited 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 (you've spun three times in a row at the same turn), try avoiding the line.

Drive around the outside edges of the turn. Be aware, however, that even if you drive the outside edges of the turns, you will still be braking on the same slippery line and at some point in the turn you will again meet and cross the line. You may go from reasonable traction to "Oh, my God", in a fraction of a second.

Driving in the rain (or on ice or snow) is great for working on your smoothness. Also, a couple of extra PSI inflation will help the tire channel water and lower operating temperatures.

# Chapter 6 - Advanced Track Skills

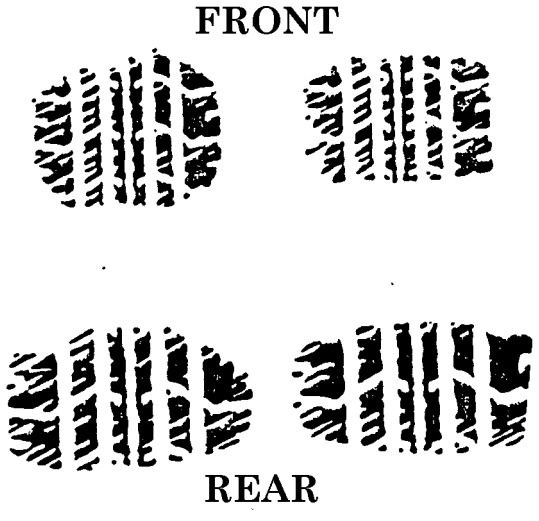
## 6.1 Weight Transfer

Up 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. Although these techniques can be practiced on the highway, it will not add much to the safety of your commute, only to the speed. We'll start with weight transfer.

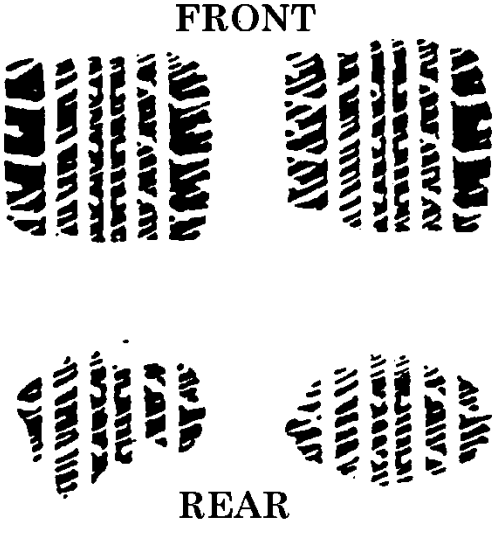
A tire's ability to provide good grip and traction (the fiction circle again!) is directly linked to the weight that is being placed upon it by the driver. As you drive, you are continually shifting the weight of your car around and loading its 4 wheels.

It is this ability to control weight transfer that separates good drivers from the great ones and allows trail braking to work as well as late apexing. Following is a brief discussion about the topic without getting into car setup.

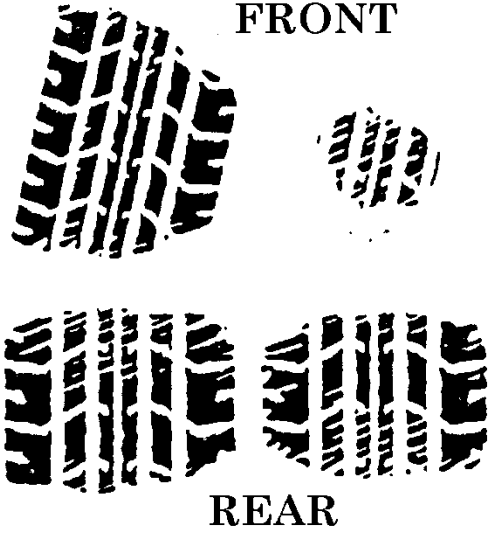
As your car is traveling in a straight line at speed, the weight distribution and the wheel loadings are fairly equal on all 4 wheels. There is perhaps a slight advantage to the rear wheels, as you can tell from the diagram representing the respective sizes of the contact patch of your tires



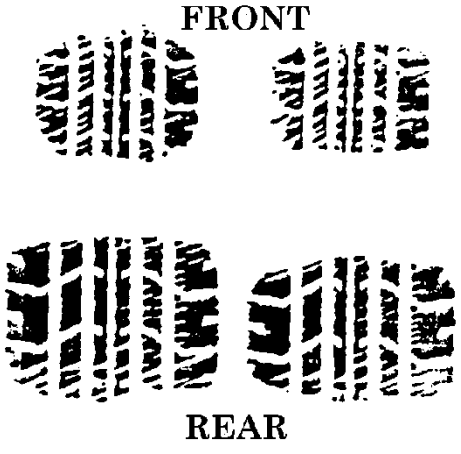
As you brake for a corner, you create a weight transfer, which loads more of the car's weight on the front tires.




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



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




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 now quite suddenly have less, and the car spins. Of all incidents at club events, this one is the most popular and also the easiest to avoid. DON'T SUDDENLY LIFT!

Also, with these diagrams and an understanding of what's going on, 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 now the apex is reachable. In the same vein, when exiting a corner, if a late apex was hit you may find you have extra roadway left, without dialing out more steering than normal, lightly stand on the throttle and when the weight comes off the front end (reducing tire patch size) the car will drift wide and your exit or track out point will be right on! The key is small inputs, smoothly.

## 6.2 Trail Braking

During our school, we stress that all braking must be completed smoothly 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 safe, if you are going 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, holds to 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?"

Who knows who is correct; however, we think a very good driver should know how to do both. We have found that 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 instructed, 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.

To get the proper amount of braking, imagine that your hands are on the wheel, and a solid rod connects your foot on the brake pedal. 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 rise 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, the throttle is squeezed on, transferring weight (and traction) to the rear tires. The rear tires will gain traction, stop sliding, and the car will accelerate toward the apex. If throttle is not applied at the proper instant, the rear may continue to skid which may result in a spin.

For corners that trail braking works well on, it works very, very well.

CAUTION, the transitions between threshold braking, trailing the brakes, turning in and application of throttle must be performed extremely smoothly. We recommend that novices do not attempt trail braking. If you want to learn trail braking, wait until you have more performance driving experience or go to a professional and learn trail braking from them in their cars.

## 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 though 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 through the heel-and-toe exercise to the load on your vehicle.

The only point to add to downshifting is when you begin to master the basic heel-and-toe downshift, try to double clutch.

Double Clutching is employed to minimize wear and tear on the vehicle's drive train. It brings the shafts and gears in the transmission up to speed before selecting a lower gear. When done properly, the engine, transmission, and drive wheels will all be spinning at the same speed when the shifting process is being completed. It is used along with heel and toeing. If you want to become a really accomplished driver, you should learn to double clutch, but it is not essential to performance driving.

Here is a step-by-step explanation of how to double-clutch.

1. Threshold Braking (which continues through Step 8).
2. Depress the clutch.
3. Move the shift lever to neutral.
4. Release the clutch pedal.
5. "Blip" the throttle.
6. Depress the clutch.
7. Move the shift lever into the desired gear.
8. Release the clutch pedal.

## 6.4 Ideal Line -- Detailed Discussion

Now, with all this information under our belt, the last thing to think about is our actual lapping times which for the most part are regulated by our line around the race track.

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 described a line through the turn which will have the largest possible radius.

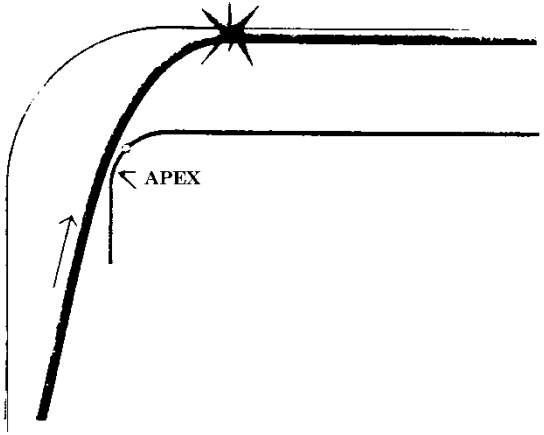
We know from our equation 15gR=(MPH) that the larger the radius turn, the faster a car can travel through that turn. The largest possible radius is the fastest way to go around a turn. It is generally not, however, the fastest way to go around a race course. If we were to add up the time spent on turns 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. We can go very fast on the straights but not so fast in the turns.

The largest possible radius would be the line to use if our course consisted only of corners that could be driven at our car's top speed (and it is the line to use when negotiating such a turn).

Late Apex Line - a late apex line is the line described by a vehicle that touches an apex occurring after (later than) the Theoretical Apex. This is the line you have (should have?) been driving all day, and the line you should use all of the time on a race track OR ON THE STREET (unless you have a good reason for doing otherwise. Brain fade is not a good reason).

Why it's the Fastest - Look again at the diagram that shows the late apex. 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. (Remember the friction circle). Notice also, however, 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 (the opposite of banked), 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 to the apex (to maintain the maximum cornering speed for the given radius) and full throttle at the apex (as the radius increases); your instructor will help you on this point.

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 with full throttle at the apex you will fall off the roadway, the car will likely then accelerate sideways, you will become a passenger instead of the driver, and you will not like it.




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

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

The Early Apex Line is not totally without socially redeeming value; however, it might be the best line to take if a long straight is followed by a very slow section of track. For example, several slow turns in quick succession where the only line you're concerned about is the line through the last turn in the succession of turns. A Late Apex in this situation permits you to carry your straight away speed longer. You would threshold brake up to the turn-in point, but because the early part of the turn has a relatively large radius, you could continue some braking all the way to the point where the radius becomes smaller.

If you're astute, you have probably already figured out that it 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. You can forget about a good lap time, but it might prevent an off road excursion. When you are traveling on an unfamiliar road, NEVER, NEVER apex early. In fact, don't even think of apexing until you can see where the road is going. 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 it is). If the apex is too early, you will find that you are unable to unwind the steering wheel as you clip the apex (falling off the road is also a clue). If you can't get to your apex, it means you turned in too late.

Once your have found an apex and a turn-in point that works reasonably well, start refining it. What you want is exit speed. Exit speed translates into RPMs, which translates into speed at the end of the following straight. 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 RPMs and note whether or not you've used up 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 RPMs at your marker.

Are your RPMs higher or lower? Keep experimenting until you find the line that consistently yields the highest RPMs 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. Note your marker must be far enough down the straight so that regardless of the gear used for the turn, and you are always in the same gear when you pass your marker. The gear that results in the highest RPMs 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, and you'll be fighting to control the car at the point where you should be accelerating.

## 6.6 Conclusion

In performance driving, no one is a natural; everyone must learn. Those who concentrate on smoothness and consistency learn faster. Those who think charging down 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 fast driver. You have the opportunity to vastly improve your driving skills -- and with an open mind and a lot of concentration, you'll do it.

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. And finally, there is no substitute for seat time, so go to as many events as you can, and you'll find that eventually performance driving is second nature.

ENJOY YOURSELF!!

# Chapter 7 - Flags and Track Safety

While attending one of the Audi Club Northwest Driving Schools or any one of the many other local auto club driving events, you will have the opportunity to drive some of the finest road racing courses in the country. While driving on a track at potentially high speeds, you need to be informed of situations that occur during the lapping session by paying attention to the flags displayed at the corner stations situated around the track. This communication to you is done by qualified course workers who use a series of internationally recognized flags. Described below are the flags, their colors, and their meanings in road racing situations. **YOU SHOULD ALWAYS ATTEND THE DRIVERS MEETING, WHERE ANY FLAG CHANGES MAY BE EXPLAINED.** For the most part, flags represent cautions, and each flag should be viewed in that context. Failure to heed a flag or course marshal creates not only a dangerous situation but can 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. Also used to signify the start of a race or the resumption of a track session. Normally this flag will be in the possession of the Starter only, and shall not ordinarily be displayed at the corner stations around the course.

**B. YELLOW FLAG** (Solid Yellow)
**STANDING YELLOW** - Take care, Danger, Slow Down, and NO PASSING!!
**WAVED YELLOW** - Great Danger, Slow Down, Look Immediately Ahead! In both these situations use extreme caution. A driver may encounter several yellow flags before reaching the emergency area. The requirements are the same, 'SLOW DOWN, NO PASSING'. Watch your mirrors, watch ahead, and continue to use caution until the green or other flag is displayed. DO NOT STOP unless flagged to do so.

**C. BLACK FLAG** (Solid Black)
**CLOSED BLACK FLAG** (Furled) - Pointed or shaken at an individual car by a course worker: WARNING! You have been observed driving in an unsafe and/or improper manner. If the action continues you shall be given an OPEN BLACK FLAG.

**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!!
Note: If the black flag is displayed open at all stations, the session has been halted, and all cars shall proceed to the pits.

**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, 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 course workers.

**E. BLUE FLAG** (Also Blue with diagonal Yellow Stripe)
Check your mirrors, other drivers are lapping at a faster pace than you and are trying to pass. A blue flag may be displayed either standing or waving depending upon your attention to its presentation. A waving blue flag demands your careful and immediate action. Follow Audi Club guidelines for the let-by (passing) procedure under the Track Etiquette section.

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

**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. 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. If shown at start/finish, the white flag indicates one lap to go.

**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 pits.

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

# Chapter 8 - Student Track-Session Tips

## Overall:

- 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, "read" the tire for correct inflation pressure.
- 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 and depending on the track.
- Helmet on snugly and buckled.
- Seat belts on very snugly.
- 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 moving to the left "on line"

## Driving The Track:

- Signal to pass.
- Signal to allow passes - hand out the window.
- Don't pass unless signaled.
- After the checkered flag is thrown, reduce speed and cool down car and driver. Acknowledge the corner workers.

## Re-entering The Pits:

- Signal your intention to leave the track - left arm out and up.
- Slow down to less than 15 MPH through the pits.
- **DO NOT** set your parking brake when you return to the paddock.
- Allow your car to idle in neutral for several minutes before shutting off, preferably with the hood up. **This is especially important for Turbo Charged Vehicles.**

# Chapter 9 - Instructor Guidelines

## Instructor Recruiting

**Instructor Package - Benefits**

- Self-satisfaction of contributing to a positive educational experience for students.
- The importance of a well planned, organized event.
- Safety.
- Fun/Entertainment.
- Instructor run time or scheduled run sessions.

**Instructor Recruiting/Selection**

- Personality, demeanor, communication ability, positive attitude, professionalism, work ethic, self-confidence.
- Experienced student.
- Referrals from senior instructors.
- Other club or organizations.
- Other AUDI CLUB Chapters.
- SCCA/ICSCC Driving Instructors.
- Professional driving schools.
- Manufacturer ride and drive programs

**Objectives of the Instructor Team**

- Safety for both students and instructors.
- Education on and off the track.
- Fun and entertainment.
- Provide value to students.
- Be on time.
- Respect the student's car.
- Constantly upgrade the instructor group.
- Be professional. – Take pride in the effort.
- Emphasis on instructor teamwork.
- Enforce instructor code of conduct.

**Instructor Training – Rookie Orientation**

- Clearly establish objectives.
- Minimum instructor run time.
- Review most common – recurring student problems.
- Pair rookie with senior instructor.
- Emphasis on in-car instructor and rookie technique.
- School manual.
- Communication review - standardized terminology.
- Teaching at each students level.
- Attend classroom sessions.
- In car time with chief instructors.
- Personal appearance standards.

- Importance of instructor team concept.

## Instructor Guidelines

### General

- Instructor must be in control of the situation always.
- Leave your ego at home.
- Be courteous, cooperative, charming, and professional.
- Be punctual for meetings and don't talk during meeting.
- Watch your language.
- Be outgoing - explain technique carefully.
- Be positive when instructing.
- Remember your attitude sets an example for students.
- You are being **observed** by everyone.

### Instruction In Car

- Introduce yourself.
- Always be in control of the situation.
- Relax student if possible.
- Explain objectives for run session.
- Ask student about their problem areas.
- Correct use of eyes - no object fixation and make sure to look further down the track.
- Student seat position, mirrors, hand position 3 and 9.
- Communicate with student and explain - be concise.

### If Instructor Is Riding

- Seat forward with feet firmly on the floor.
- Left hand close to hand brake.
- Be within reach of steering wheel.
- Act casual, relaxed.
- Sit at slight angle, watch footwork, students eyes.
- Flip visor down - use vanity mirror for rear view.

### Technique

- Smooth hands and footwork.
- Importance of being in a straight line for maximum period.
- Turn-in Point, Apex, Track Out.
- Correct gear - Safe RPM, don't rush.
- Braking early and light, increase pressure.
- Explain/show passing zones, worker stations.
- Check gauges, front and back straight.
- Importance of mirrors - passing safety, passing zones.
- Explain accelerating onto track, slow in pits.
- Importance of re-entry onto the track, Stewards.
- Crisis management - Discuss with student in advance.

**Instructor Driving**

- Explain what you are doing, where you are looking.
- No ego, no exhibitionism, no racing.
- Be perfect, everyone is observing you.
- Be very, very smooth - slow gearshifts.
- Slow all your movements in car, be a good example.
- Give students space, don't tailgate.
- Get passing done early.
- Brakes, early and light pressure.
- If you make a mistake, tell student.
- Don't let students chase instructor cars.
- Don't abuse students' cars.

**Incident Response**

- First two instructors stop at major incident.

**Sign Off**

- Review with Instructor Leader

## Student Briefing

**Objective for Day**

- Safety - Education - FUN!

**Cooperation of Students**

- Be alert to PA announcements.
- Be punctual for meetings and run sessions.
- Be ready in car 5 minutes in advance.
- Importance of maximizing track time. Explain costs.

**Program Explanation - Schedule**

- Depending on the student's willingness and comfort level, and track insurance requirements, the instructor may drive your car a few laps.
- Instructor can swap seats for demonstrations.
- At end of session - sit in car and visualize. Review track session.
- Driver's window down unless weather or track requirements prohibits.
- Helmet on during all track sessions.

**Track Etiquette – Let-by (Passing) Zones**

- Be courteous.
- Stay on the driving line when being overtaken. The overtaking car goes off line to perform the let-by. Be mindful of speed differential when overtaking and judging the space available for making the pass.
- Use road rules for use of turn signals to indicate your intentions. Do not slow or signal prior to entering the designated let-by zones.
- Slow down when being passed. Don't use brakes. Neither car should push the boundaries of the let-by zones.
- Use your mirrors - hand signals or turn signal. Don't do anything unpredictable.
- Watch corner workers, flags.
- Watch pit marshals. Slow speed in pits and staging areas.
- Last lap after checkered flag is the cool down lap.
- Avoid traffic bunching; pit to get a gap in traffic.

**Instructors**

- Group leader system.
- First two sessions - instructor is assigned.
- Use a variety of instructors.
- Location of instructors during sessions.
- Personality conflicts.
- Sign off / solo procedure.

**General**

- Drink plenty of liquids.
- Concentrate.
- Fatigue factor.
- No egos.
- Take a bathroom break before your session.
- Be receptive to instructor input.
- Friends, spouses - riding with instructors.
- Don't use hand brake.
- Helmet at all times.
- No novice students to give rides.
- Common sense.

**Flags** - Explanation of flag signals.
**Crisis Management** - Off course car control.
**Classroom sessions** - Where and when.

## APPENDIX A- Understeer, Oversteer, and Winter Driving Tips/Techniques

### Cornering & Handling

On slippery surfaces there is only a limited amount of grip that is available for the tires. The grip can be used for turning, braking, acceleration, and possibly a combination of them. However, on slippery surfaces using a combination of braking, turning or acceleration is only asking for a skid or slide. If you feel your vehicle begin to skid through a turn, you are likely experiencing "understeer." Understeer is usually caused by entering a corner too fast, or by braking while trying to turn, or from excessive acceleration while cornering.

To most effectively control your car on a slippery road, and prevent understeer, lower your speed, and only use one aspect of grip control at a time. The proper way to negotiate any curve is as follows:
1. Brake on the straightaway before the curve, adjust speed.
2. Coast and steer through the turn.
3. Accelerate only when the road becomes straight again.

In other words while cornering, you should be off the brake and off the accelerator, coasting through the turn and using all available grip for steering.

Please note that excessive acceleration in a Quattro except when very slippery or with very high power will always create understeering, but you can accelerate a little harder than front or rear wheel drive cars because of the extra acceleration grip available from two more tires. This is another example of the “unfair advantage."

If you're already in a corner and your car is not responding to your turning input, (steering seems light) you are understeering. The way to stop understeering is:
1. Get off accelerator (Transfers weight to the front tires)
2. Reduce the amount of steering input. (Straighten the wheels)
3. Wait, and wait again, for the front wheels to grip again before turning into the corner again.

If you're in that corner and the back end of the car seems to be coming around faster than the front is turning you are oversteering. To stop oversteering:
1. Immediately and quickly input a counter steer (Steer into the direction of the skid)
2. Add touch of throttle
3. As the car begins to correct itself quickly counter steer the other way briefly and
4. Immediately and quickly steer straight or you will be over steering the other direction in a heartbeat

5. It is better to counter steer twice than to countersteer too long.

Generally on ice and snow quick steering does not have much effect on turning. Therefore when steering you must begin each turn slowly and progressively increase the speed at which you turn the steering wheel as the car begins to turn. The only time to turn the wheels quickly is when correcting for an oversteer situation. I've just described how to negotiate curves safely but perhaps a bit slower than you want to go. What then?

The trick is to never allow the car to understeer by creating continuous oversteer and negotiate curves and corners with the throttle and brake. The Scandinavian Flick, or Pendulum Turn is a proactive cornering technique used by professional drivers to set the car up for maximum control in the corners and avoid understeer altogether. This will be taught to club members at the Winter Driving School at Steamboat Springs Colorado in February, when held.

**Stopping and Reducing Speed**

In an emergency with ABS to stop or reduce speed in a straight line get on the brakes very hard. Don't wait. The first few feet are very important. Use your leg muscles. Your ankle is not strong enough! You have to press on the brake pedal with at least 90 pounds of pressure. If you press with less that than 90 pounds you may feel the ABS working, but it is only working on the rear wheels. You have not reached the maximum braking with the front wheels yet. This minimum brake pressure is absolutely required for maximum stopping power! Simultaneously disengage the clutch so that you do not have to stop the rotating mass of the transmission and drive train. Keep pressing hard and steer.

**When do you turn off ABS?**

On some Quattros you can turn the ABS off. For those who can there are only two times when you should turn the ABS off if there is compact snow or ice with fresh slippery snow on top, or loose gravel-covered road in contrast from simply a gravel road.

If your Quattro is without ABS keep the clutch engaged to possibly keep the wheels from locking up. However, with the clutch engaged you could kill the engine and loose your power steering. Remember you must come off the brakes to turn. In other words only when you are going straight ahead brake as hard as you can. Hold the brakes on to the last moment, come off the brakes, turn the steering wheel with progressive increase in speed to change direction, immediately correct the counter skid you created, come back to straight, and nail the brakes again when going straight.

# Appendix B - Track Directions and Layouts

**Bremerton Motorsports Park**, Bremerton, WA.

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

**Pacific Raceways International**, Kent, WA.

**Spokane Raceway Park**, Spokane, WA.

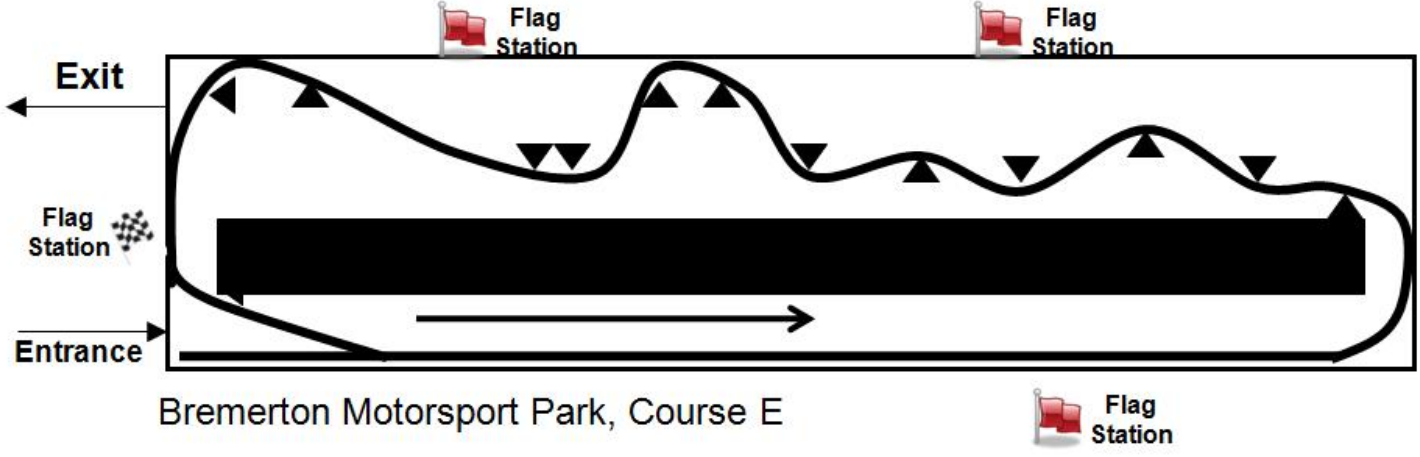
**Thunderhill Park**, Willows, CA.

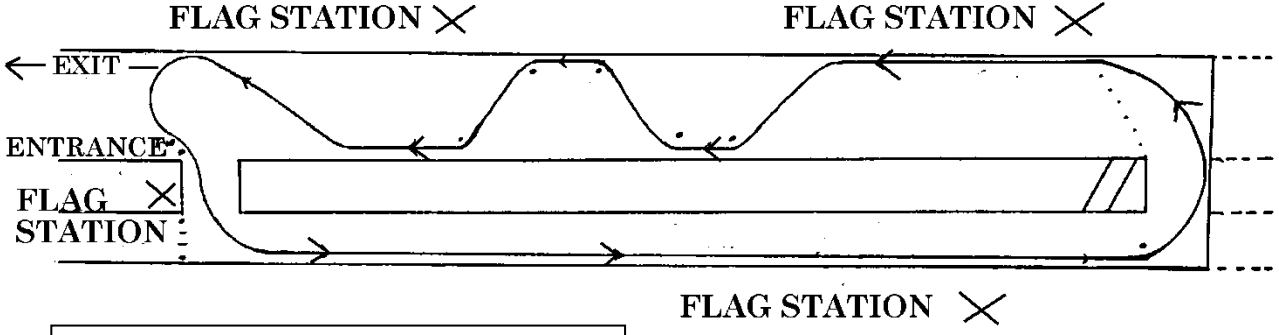
**BREMERTON MOTORSPORTS PARK**, Bremerton, WA

**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 Cliffton Road Exit located just past mile Marker 26. Turn left at the stop sign at the bottom of the hill. Follow the Old Cliffton Road for about 4 miles to the intersection of Sunnyslope Road and Victory Drive. Turn left and then right and proceed so that you pass the Texaco station on your left. Keep going straight for about a mile and you will come to the entrance of the track.

**Respect local residence and the posted speed limits.**

**Bremerton Motorsports Park**
PO Box 5046, Bremerton, WA 98312
Message/Fax: (360) 478-4067
http://www.bremertonmotorsportspark.com/






Bremerton Motorsport Park, Course A

## **PORTLAND INTERNATIONAL RACEWAY (PIR)**, Portland, OR

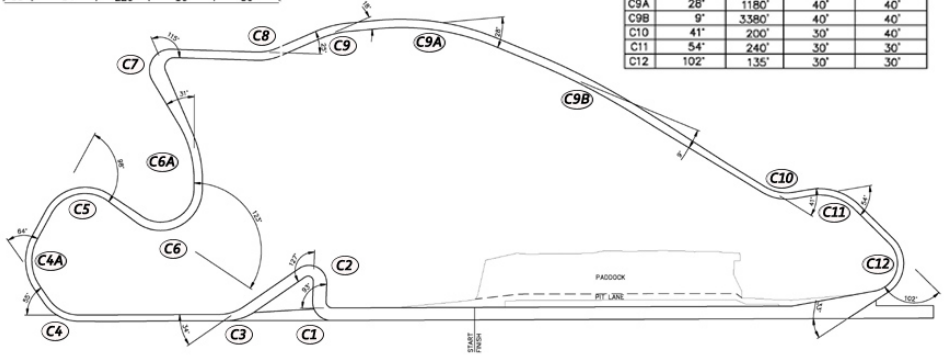
**Directions:**

Portland International Raceway is within the city limits of the City of Portland and is located just west off from the I-5 Freeway (exit 306-B), about 6 miles west of Portland International Airport, 2 miles south of Vancouver, Washington and about 3 miles north of downtown Portland. PIR and Heron Lakes Golf Course make up West Delta Park, with PIR's road course sitting in 180 acres of Park.

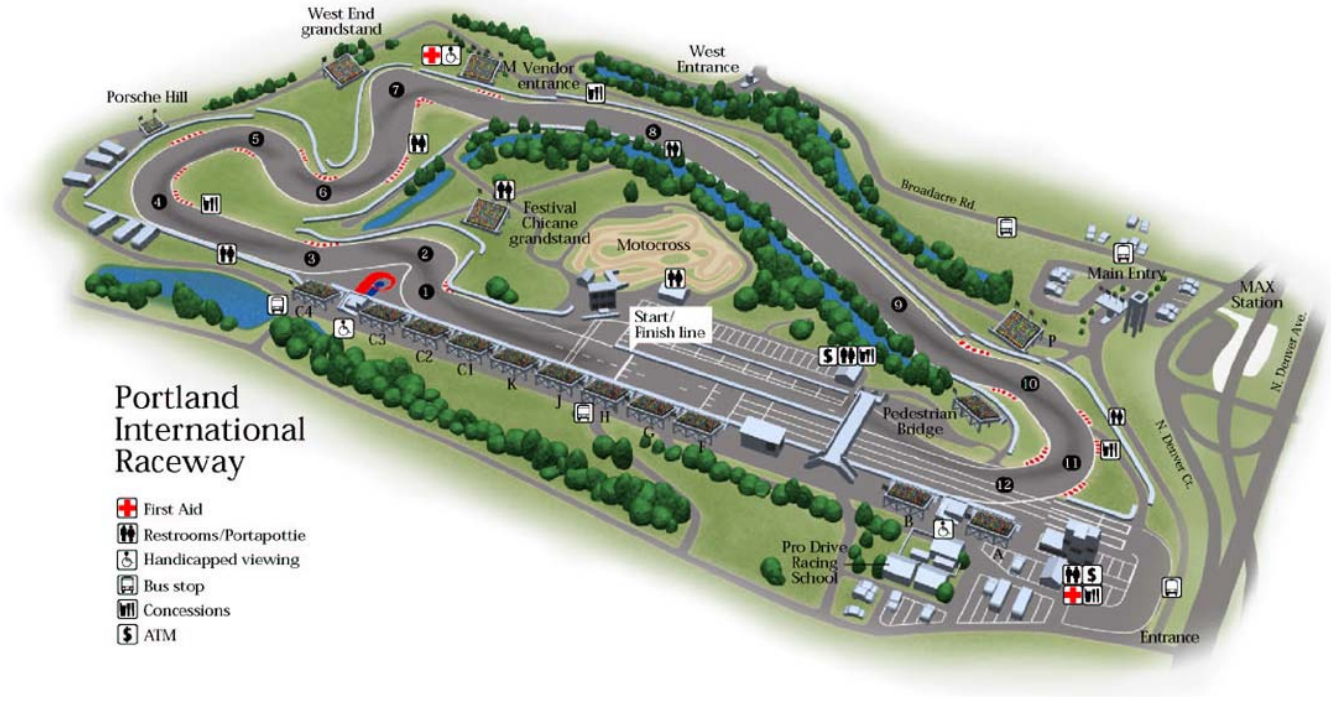
**West Delta Park**
**1940 North Victory Boulevard**
**Portland, Oregon 97217**
Phone: (503) 823-RACE
Fax: (503) 823-5896
http://www.portlandraceway.com/

HORIZONTAL CURVE DATA

| I.D. | DELTA | INSIDE RADIUS | TRACK WIDTH IN | TRACK WIDTH OUT |
|---|---|---|---|---|
| C1 | 93° | 20' | 60' | 65' |
| C2 | 127° | 25' | 65' | 50' |
| C3 | 34° | 220' | 50' | 30' |
| C4 | 55° | 175' | 30' | 30' |
| C4A | 64° | 210' | 30' | 30' |
| C5 | 98° | 185' | 30' | 30' |
| C6 | 123° | 160' | 40' | 40' |
| C6A | 31° | 520' | 40' | 40' |
| C7 | 115° | 45' | 78' | 40' |
| C8 | 25° | 229' | 40' | 40' |
| C9 | 18° | 485' | 40' | 40' |
| C9A | 28° | 1180' | 40' | 40' |
| C9B | 9° | 3380' | 40' | 40' |
| C10 | 41° | 200' | 30' | 40' |
| C11 | 54° | 240' | 30' | 30' |
| C12 | 102° | 135' | 30' | 30' |



## PORTLAND INTERNATIONAL RACEWAY



## **PACIFIC RACEWAYS, INC. (PRI)**, Kent, WA.

**Directions:**
From I-5 at Federal Way (it's a city, not a street), take the SR 18 EAST exit toward Auburn. Go past Auburn and take the exit for SE 304th/SE 312th (a sign about 1/4 mile before the exit will also identify it as Green River Community College/Pacific Raceway). At the end of the ramp, turn right; at the next opportunity, turn right again (this is about 1/3 of the way down the exit road you used to reach from 144th SE). Proceed on the track access road.

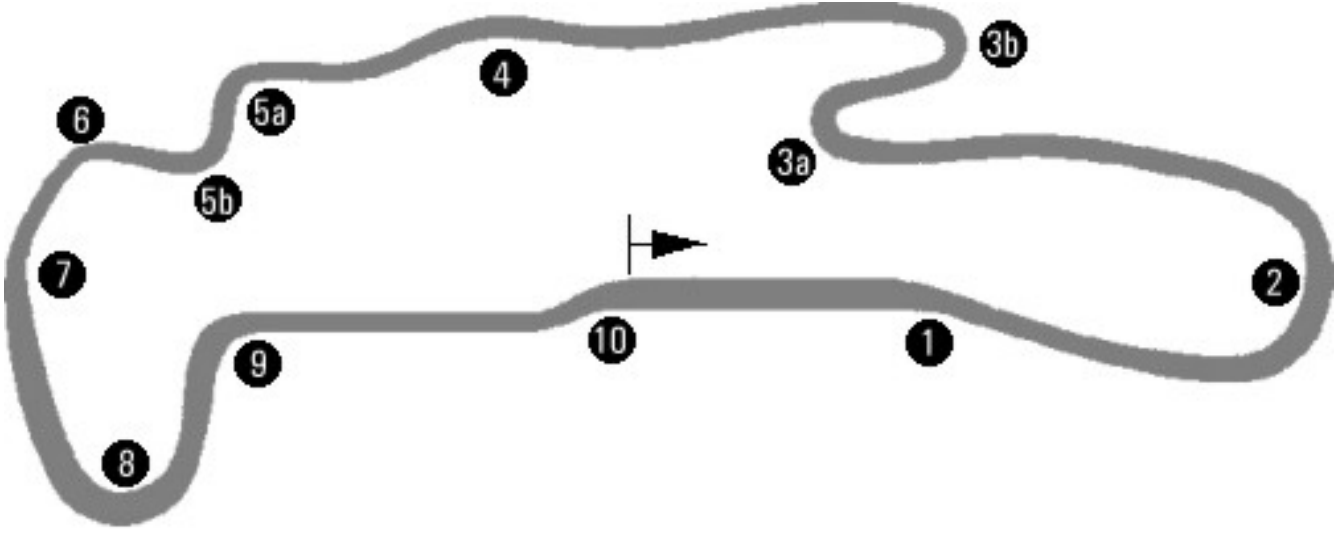
From SR 167 southbound take the Central Avenue exit and turn left (south). Go to downtown Kent. At Smith Street (signs also identify it as SR 516), turn left (east) and go up the hill. Bear right onto Kent-Kangley Road and continue east toward Covington. At the junction of Kent-Kangley/SR 516 and SR 18, turn right toward Auburn. Take the exit for SE 304th/SE 312th. At the end of the ramp, turn left; at the next opportunity, turn right (this is about 1/3 of the way down the exit road you used to reach from 144th SE). Proceed on the track access road.

**For information about the availability and cost of testing, call the PRI office at:**
**253-639-5927**
http://www.pacificraceways.com/

The track's public address system also broadcasts at 540 kHz, so you can pick it up on any AM radio.

There is no air at the track, but water is available. Restrooms and a concession stand are available. There are gas stations, fast food establishments and a shopping center north of the track in Covington. There is no electricity available. Camping is allowed at the track; see driver's packet for details. There are several hotels nearby in Auburn, Kent, and Renton.

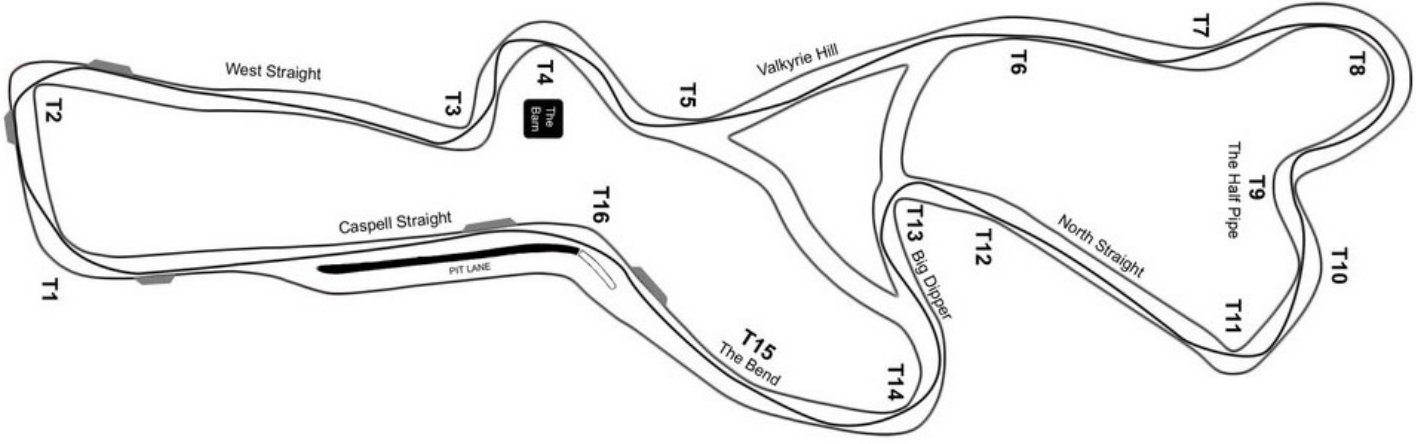
**PACIFIC RACEWAYS**




**Track Layout, Lap Length 2.25 miles. Natural road course with significant elevation changes.**

**OREGON RACEWAY PARK (ORP)**, Grass Valley, OR

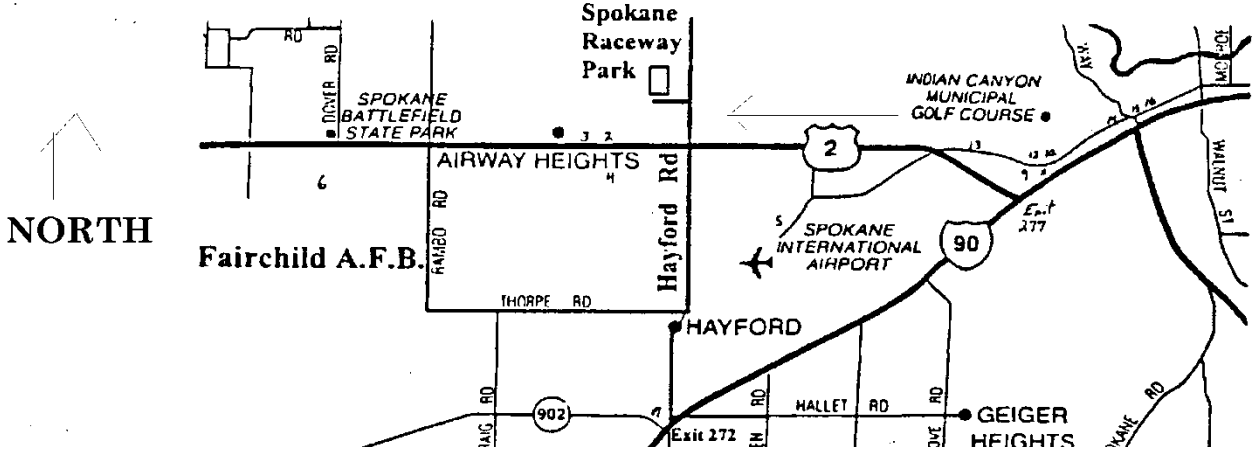
Oregon Raceway Park is a new 2.3-mile road course south of Biggs on Highway 97 in the natural landscape of central Oregon. The 16 turn road course, including the signature "Half Pipe," is very challenging and technically interesting with significant elevation change and completely blind corners to learn and practice.
**http://www.oregonraceway.com/**



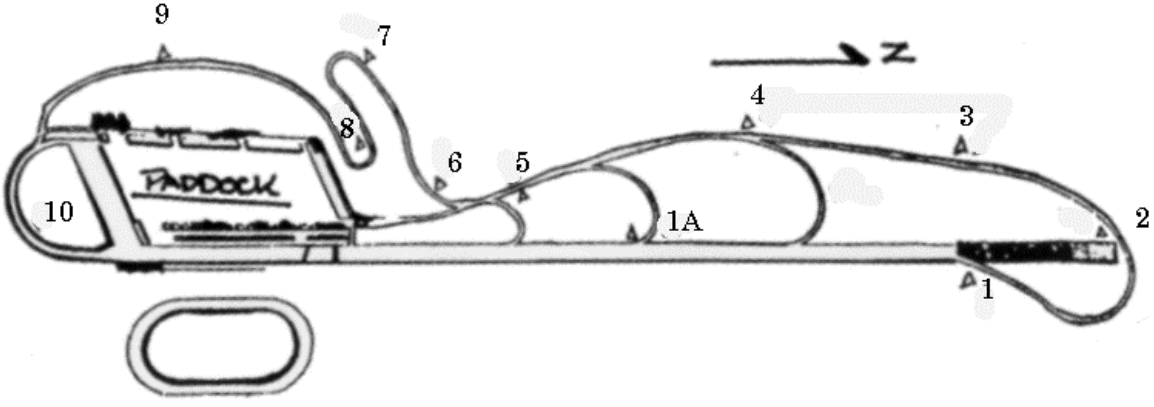
**SPOKANE RACEWAY PARK**, Spokane, WA.

**Spokane Raceway Park is a 2.5-mile road course just west of Spokane, Washington. The revived 10 turn road course and facility includes power in the paddock and showers.**
**http://www.spokaneracewaypark.com/**

**Directions:**
Travel south/west from Spokane on I90 then west from Spokane on US 2 to Hayford Road (about 6 miles from the city limits), and turn right (north). The track is about one mile up Hayford Road.



**SPOKANE RACEWAY PARK - Track Layout**



## **THUNDERHILL PARK RACEWAY,** Willows, CA (Northern California)

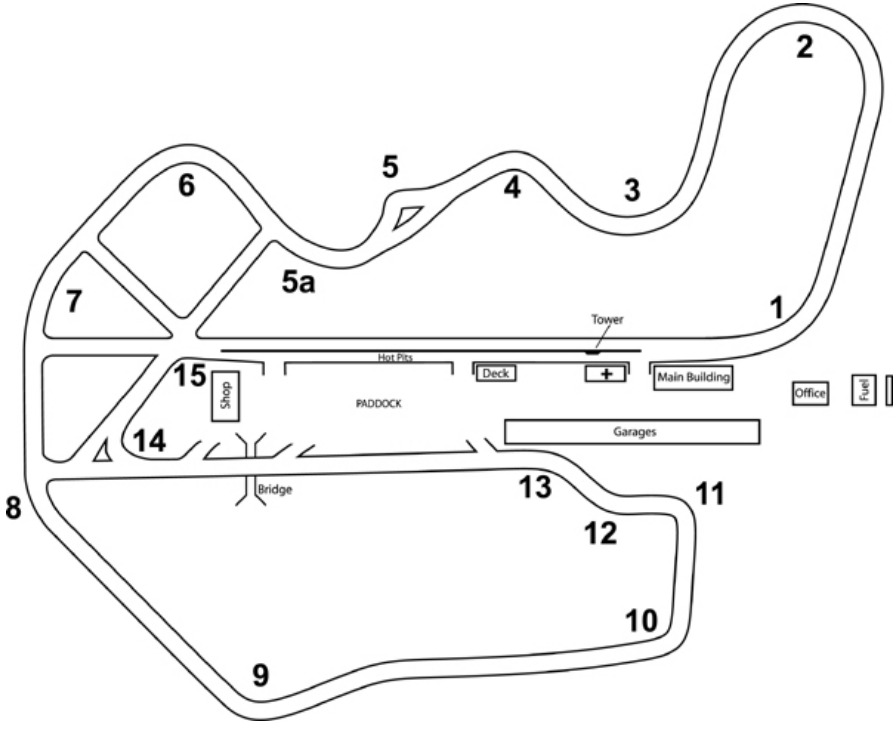
The track is relatively young. The first races were held in 1994. It is located inside of the Thunderhill Ranch; the owners of Thunderhill Ranch sold a small section in the center of their property to the San Francisco Region of the SCCA for the express purpose of building a racetrack there.

Track time is available for testing, special events, TV & movie production.

**Thunderhill Park Raceway**
**5250 Hwy 162, PO Box 966)**
**Willows, CA 95988**
Phone: (530) 934-5588
Fax: (530) 934-8794
**http://www.thunderhill.com/**

**Directions:**
From the San Francisco Bay Area, take I-80 east to I-505 north and then to I-5 north. Exit in Willows on Highway 162, and head about 6 miles west of town to Thunderhill. From Oregon, take I-5 south, exit in Willows on Highway 162.

## THUNDERHILL PARK RACEWAY



# Glossary of Key Terms

**ABS -** Anti-lock Braking System, which prevents wheel lockup under hard braking. We also refer to it as 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 -** Referencing the force applied to the brakes. Modulating between lock-up and wheel rotation at maximum braking. (What ABS does for you).

**Braking Point -** The point at which the throttle is released and the brakes are applied, not a physical location. Your braking point will move as your brakes get hot, you increase your skill, you change tires etc.

**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 or race, 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.

**Double-clutch -** When heel & toeing incorporates an additional clutch depression, primarily to reduce stress on drive train components.

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

**Early Apex -** Apexing earlier than ideal for 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. Usually oval in shape because of weight transfer on a vehicle under acceleration and braking.

**HDPE – High Performance Driving Event –** Drivers education event commonly using a race track as a learning venue.

**Heel and Toe -** The method of down shifting while maximum braking through blipping the throttle. "Toes on the brakes, heel on the gas."

**Performance Driver -** (See Overview)

**Ideal Line -** The line through a corner that affords the greatest exit speed. (Usually involving a late apex).

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

**Late Apex -** Apexing later then the Theoretical Apex, 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. It wants to come around.

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

**Shift Point -** The point at which the driver makes an upshift 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 skid.

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

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

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

**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"**, the** front of the car has more slip angle than the rear. It doesn't want to turn any sharper. A design trait of most front wheel drive and all-wheel drive vehicles.

**Upshift -** Going from a lower gear to a higher gear.

**Warm Up Laps -** The first couple of laps of the day or session to accustom the driver to higher speeds and to familiarize the driver to the track. Also the time to bring the cars fluids, tires, and brakes up to operating temperatures.

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