VINTAGE RACER GROUP

VRG

DRIVER EDUCATION

DRIVER DEVELOPMENT PROGRAM

Advanced Topics Supplement

Adapted from original work by Ed Valpey

Revision 2, February 2020

Contents

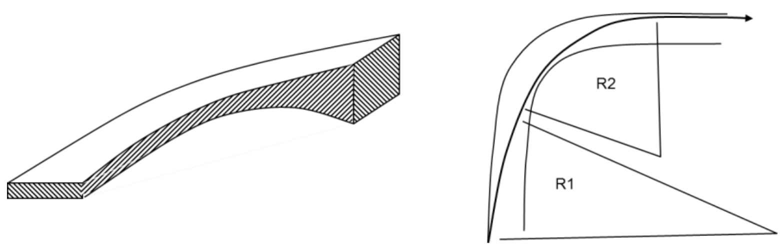
ADVANCED TRACK DRIVING TOPICS

Introduction

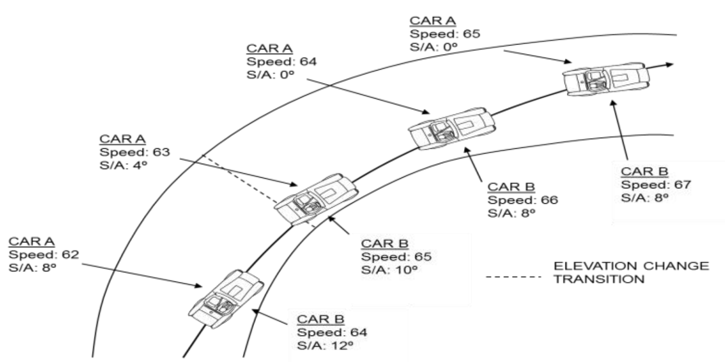
This Supplement complements the VRG Driver School Student Manual and the VRG Driver School Student Supplement. What follows are some more advanced concepts and techniques that highly experienced race drivers employ from time to time. VRG students are NOT required or expected to demonstrate mastery of any of these. However, both students and more experienced vintage racers may find it helpful to have familiarity with them if for no other reason than to better appreciate the skills demonstrated by front runners.

The Magic of Elevation Change

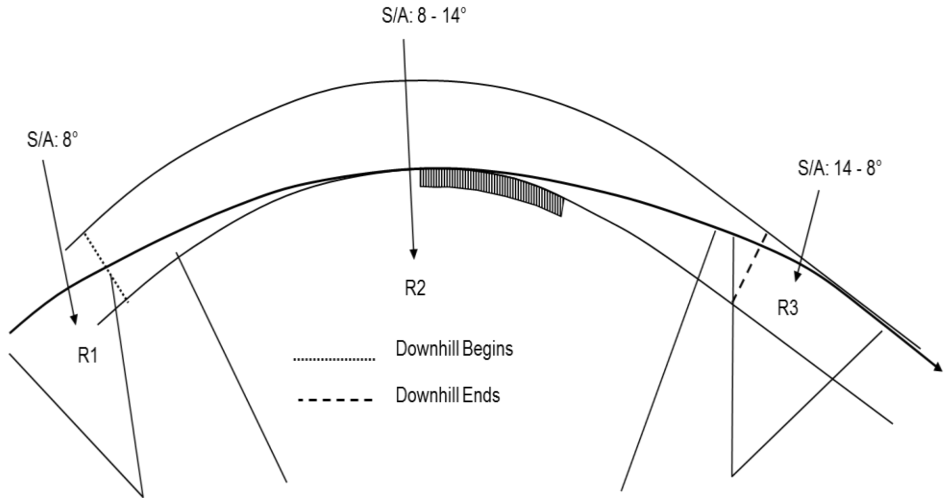
Not all corners are flat, and both camber and elevation change have a significant impact on our driving line. The illustration below is like the Uphill at Lime Rock Park, where the road abruptly climbs in the middle of the corner. This elevation change provides significantly better grip and allows us to enter the corner with an earlier turn-in and larger radius than we could if the corner was flat. While our radius tightens through the second half of the corner, it does so without requiring us to slow the car.



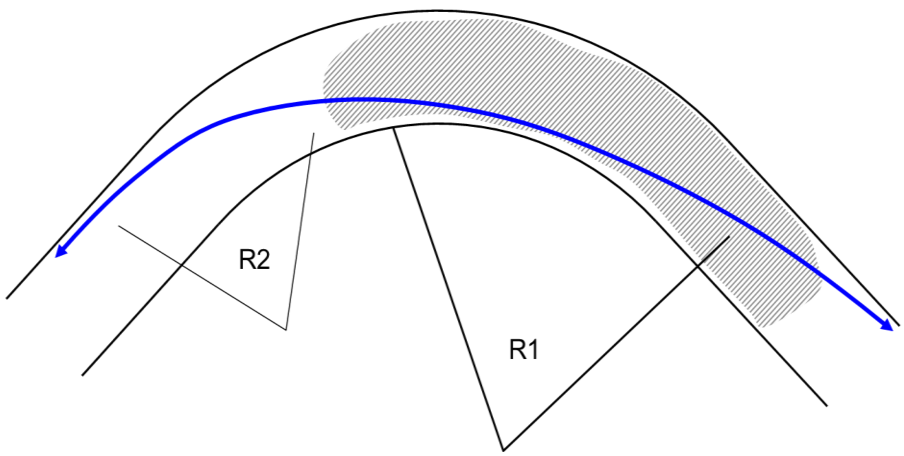
More advanced drivers have the greater challenge of entering the corner enough above the limit – generating extreme slip angles – so that as the car compresses the slip angles fall back to optimum. They are, in essence, throwing the car into the corner and relying on the elevation change to catch them. This is illustrated below. Note the changes in speeds and slip angles on entry compared to the speeds and slip angles approaching the exit.



This may work in reverse as well… the road may drop out from under us, as it does in Turn 7 (short course) at Pittsburgh International Race Complex. This is a wonderfully challenging corner that has both elements… the road drops away after turn-in, but then flattens and catches the car at track-out. In this case our slip angles go from optimum to excessive and back to optimum again. To set up properly, we turn in on a line that aims us partially into the dirt well before the apex, but as the road drops away, we drift *out* to the apex. This same drift then takes us toward the dirt on the outside of the corner, but the transition catches us, tightens our radius and keeps us on the track. When you do this properly you hear angels sing.



Lastly, just as elevation and camber may vary, so may the actual grip of the track surface. Whether due to repairs, shaded areas that remain damp after a storm, etc., we at times need to modify our line to accommodate changes in grip, as illustrated below.

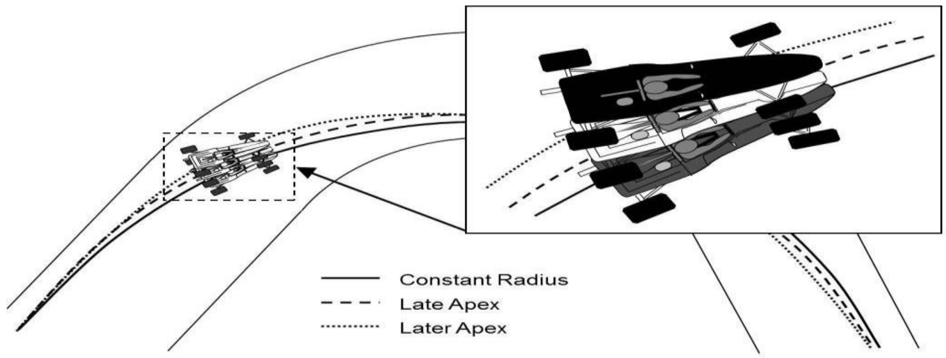


There is a far greater variety of corners than we've show here, but we've covered most of the strategies a driver might employ in order to drive through almost any corner successfully.

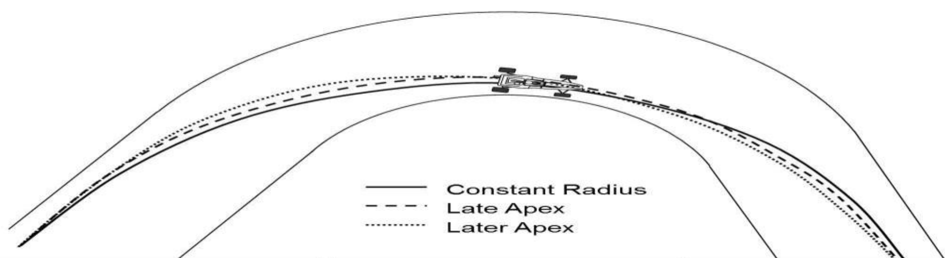
Advanced Oversteer / Understeer

Our discussion of these conditions has thus far revolved around the more extreme examples that novices are likely to experience and need to correct. Ironically, advanced drivers deal with these conditions far more – almost constantly – but at a more subtle level.

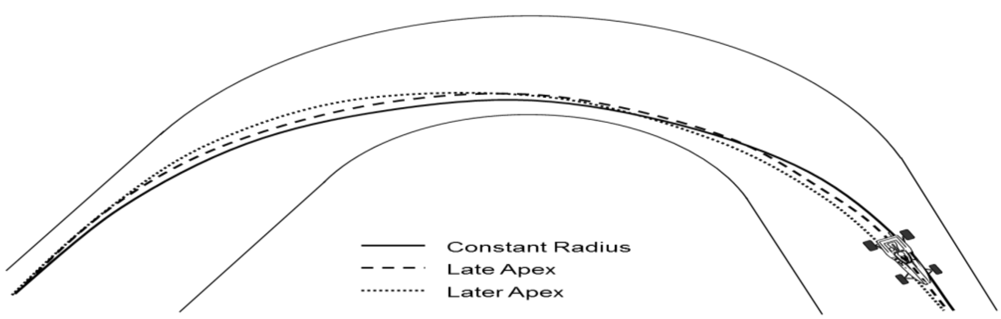
A good guinea pig for illustrating this is a Formula Ford, which can be tuned to handle from one extreme to the other. The illustrations on the following three pages show the subtle differences (numbers are representative) in the condition and driver inputs of the same car set up three different ways. Snap-shots are taken just after corner entry, mid corner and at track-out. In particular, note the subtle differences in slip angles and the distribution of tire potential.



UNDERSTEERING CAR	NEUTRAL CAR	OVERSTEERING CAR
Tire Potential:	Tire Potential:	Tire Potential:
- Braking: 30%	- Braking: 20%	- Braking: 0%
- Cornering: 70%	- Cornering: 80%	- Cornering: 100%
- Accelerating: 0%	- Accelerating: 0%	- Accelerating: 0%
Front S/A: 14º	Front S/A: 10º	Front S/A: 0º
Rear S/A: 0º	Rear S/A: 10º	Rear S/A: 16º
Steering Input: 30%	Steering Input: 20%	Steering Input: -5%
Throttle Input: 0%	Throttle Input: 0%	Throttle Input: 0%
Lateral g: 0.75	Lateral g: 0.92	Lateral g: .90
Speed: 60mph	Speed: 62mph	Speed: 61mph



UNDERSTEERING CAR	NEUTRAL CAR	OVERSTEERING CAR
Tire Potential:	Tire Potential:	Tire Potential:
- Braking: 0%	- Braking: 0%	- Braking: 0%
- Cornering: 100%	- Cornering: 90%	- Cornering: 70%
- Accelerating: 0%	- Accelerating: 10%	- Accelerating: 30%
Front S/A: 10º	Front S/A: 10º	Front S/A: 8º
Rear S/A: 0º	Rear S/A: 10º	Rear S/A: 12º
Steering Input: 50%	Steering Input: 30%	Steering Input: 0%
Throttle Input: 20%	Throttle Input: 50%	Throttle Input: 100%
Lateral g: .80	Lateral g: .94	Lateral g: .92
Speed: 58mph	Speed: 61mph	Speed: 63ph



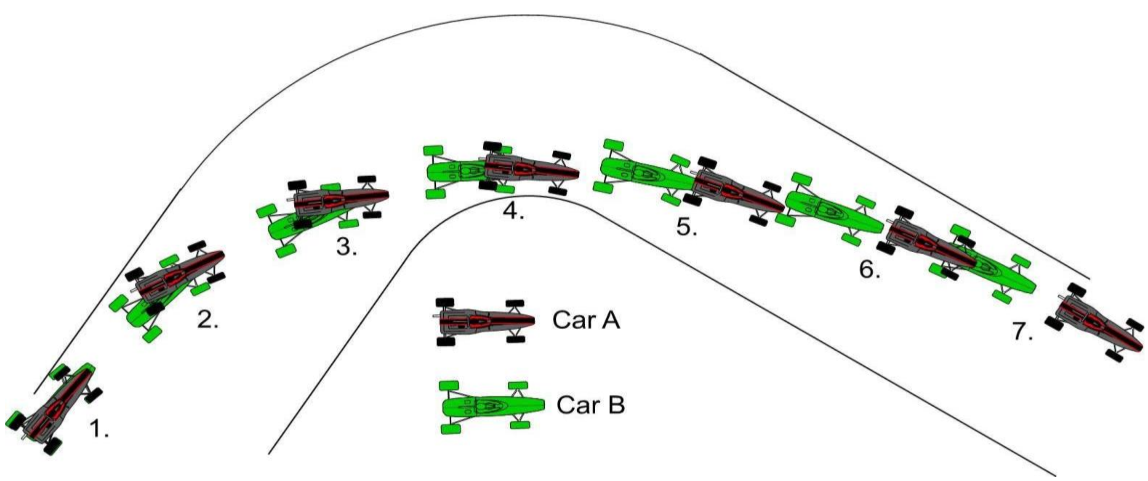
UNDERSTEERING CAR	NEUTRAL CAR	OVERSTEERING CAR
Tire Potential:	Tire Potential:	Tire Potential:
- Braking: 0%	- Braking: 0%	- Braking: 0%
- Cornering: 100%	- Cornering: 50%	- Cornering: 70%
- Accelerating: 0%	- Accelerating: 50%	- Accelerating: 30%
Front S/A: 10º	Front S/A: 10º	Front S/A: 10º
Rear S/A: 0º	Rear S/A: 10º	Rear S/A: 10º
Steering Input: 50%	Steering Input: 20%	Steering Input: 0%
Throttle Input: 20%	Throttle Input: 80%	Throttle Input: 100%
Lateral g: .80	Lateral g: .84	Lateral g: .78
Speed: 58mph	Speed: 62mph	Speed: 65mph

Again, these numbers are representative, but they do describe reasonably well the subtle differences in the vehicles' conditions in various parts of the corner, as well as the subtle difference in the balance of steering, brake and throttle input that the advanced driver must manage. Advanced drivers, as a rule, have their braking points and driving line well established. Their primary effort is focused on timing their rotation during corner entry, and their application of throttle in late corner entry, to generate the greatest possible exit speed at track out. Drivers of Spec Racer Fords, for example, will judge their performance in a corner not by hundreds of RPMS, but instead by portions of needle widths representing tens of RPMS.

This brings us to an important point. In order for any driver to improve his or her performance, that performance must be quantified in some way. Data Acquisition (DA) has provided at a modest cost an amazing source of information formerly available only to teams in the advanced formulas. As much as we encourage the use of DA, however, most of what a driver really needs to know in order to quantify performance is revealed by memorizing and monitoring RPMs at a point just past the track-out of each corner. Our exit speed correlates with these RPMs, and both correlate directly with lap times. Subtle changes in driving line, braking point, brake release (all of which make up corner entry rotation), will alter our ability to go to power, and the effect of these changes on our lap times will be revealed by our exit RPMs. This real-time feedback is cheap, easy and very effective.

The technique of **corner entry rotation** keeps cropping up, but it has yet to be fully explained, so let's cover that in detail.

Corner Entry Rotation



The above illustration shows two cars entering the same corner at the same time. Note that the two cars are driving on the same line, with a late turn-in and an increasing radius exit path (the entry line, in fact, is a decreasing radius). Note also that the two cars' front tires are following nearly identical paths, while their rear tires are following different paths during corner entry. The two cars have the same weight, the same cornering potential, the same gearing and the same horsepower (Car B has been made slightly larger for clarity). The only difference is that Car A is employing the **"rotation"** technique that we've mentioned previously. An underlying principle that we must keep in mind while dissecting this technique is that the traction potential of our tires is finite, whether we're using this potential for braking, turning or accelerating, or for a combination of these things. When used in combination they have an inverse relationship. If we use more tire potential for braking, for instance, we have less available for turning… the more steering input we have, the less throttle we can use. The technique of rotating a car during corner entry cheats this relationship, allowing the driver of Car A to slow and turn the car using neither brakes nor steering. In fact, this technique turns the car far more effectively than steering and positions it, well before the apex, in such a way that most of the tires' grip potential can be used for acceleration out of the corner.

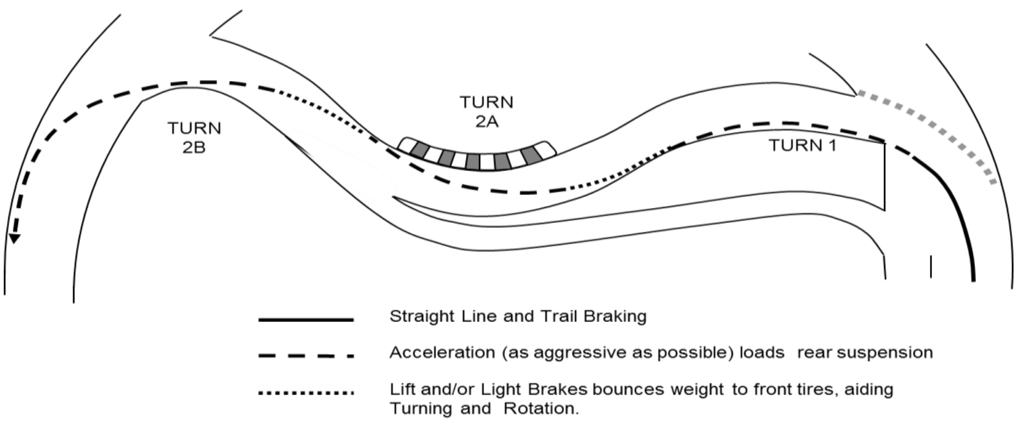
1. At the **turn-in point** the four contact patches of both cars are in the same place and the cars are neck-and neck. The difference is that Car A is carrying a bit more speed.
2. Our speed is limited by the radius we're driving on and, closely related, the amount of steering we have to input. The driver of Car A has used the proper combination of braking and turning to create rotation. The slip angles of the rear tires are larger than those of the front tires and the car has begun to slide into the corner. In this state, the car will continue to scrub speed even after the brakes have been released and, depending on the amount of rotation, the car will continue to turn even after steering input has been reduced or eliminated. It is, in other words, in the process of spinning. At this point the driver of Car A is no longer using brakes and his steering is being used to control the slide rather than actively steer the car, yet the car is still slowing, and it is still turning. In fact, it's using the grip of all four tires to do so while the majority of this burden for Car B has been placed on the front tires only. Car B, relying mostly on the grip of his front tires, still has more steering to do and must have some brake input to slow his speed and keep the front tires loaded so that they will continue to turn.
3. For Car A the greatest degree of rotation is experienced well-prior to the apex. Here it's pointed well into the corner and the front tires have little or no steering input. In fact, if the car is **oversteering** the driver may even be **counter-steering** to a degree. This is the critical point in the corner, for the driver needs to stop the car from sliding or that slide will become a spin. He could do this with counter-steering, but a better option is to start adding power. With throttle input, weight is transferred to the rear tires and they get better grip… their greater slip angles are reduced and subsequently balanced with those of the front tires. Car B has slowed enough to make the turn so he can stop braking, but his car is still pointed out of the corner so he must maintain his steering input. If he goes to power at this point, he will unweight the front tires and diminish their cornering capabilities which induced **understeer**.
4. The driver of Car A is now in an optimal position for exiting the corner. Most of his turning is done and the car is pointed in a direction that will allow him to exit on an increasing radius. By this point the driver should be at full throttle and as the car accelerates it will seek a progressively larger radius. The driver doesn't unwind the steering, but instead holds his steering lock as the exit radius increases with acceleration. Car B is getting there but is still pointed relatively more out of the corner and the driver cannot yet go aggressively to throttle. At this point in the turn Car A will begin to dramatically pull away.
5. The driver of Car A, which is at full throttle with a fixed steering input, isn't doing much other than watching his track-out point to be sure that his increasing speed/radius won't cause him to drop wheels at the exit. If he feels he might drop wheels, he simply needs to breathe off the throttle a bit to decrease or "tighten" his exit radius. The driver of Car B can now start to straighten his steering wheel and go to full throttle.
6. At this point both cars are in roughly the same condition… full throttle with sustained steering input. Car A, however, is a car length ahead and is carrying more speed.
7. At track-out Car A has gained more than a full car length and has, say, 3 mph more exit speed. That 3 mph will gain him 4.5 feet per second over Car B in the ensuing straight. If that straight lasts 10 seconds, Car A will be roughly 4 car lengths ahead when he goes to brakes for the next corner.

Brake Bias

We've mentioned how **brake bias** plays a role in allowing us to threshold brake at an optimum level. Proper brake bias is also crucial to our ability to rotate the car on corner entry. We can have excessive front brake bias without knowing it, because even with optimum brake bias the front tires will still lock first. If our rear brakes aren't approaching threshold levels, however, the rear tires won't reach their limits, they won't start to slide and the car won't rotate. If you get a consistent understeer when trying to rotate the car, check your brake bias.

Weight Transfer

We traditionally view weight transfer (load transfer) as a by-product of the driver's inputs. In fact, it's a tool that can be used to great advantage in certain circumstances. VRG's inaugural event was at New Hampshire Motor Speedway in 2004, and there are a couple of very challenging sections of this track. One of them, the South Chicane, is a series of corners where a driver using weight transfer effectively can gain several car lengths on the competition in the space of about 500 yards. These series of corners are illustrated below.



Most drivers take this series of corners at constant throttle. In doing so, however, they are neglecting the benefits of proactive **weight transfer**. When we teach **oversteer** on the skid pad, we usually need to tell the student to "Lift... Kick." "Lift" means to jump off the gas, unweighting the rear wheels, and "Kick" means nail the throttle until the rear wheels start to spin. If one cycle doesn't work, you can do them back-to-back, effectively bouncing the weight fore and aft until the back end gets light enough to come around. In NHMS's South Chicane we bounce our weight to put grip where it is needed most, and this is most effective with softly sprung cars. In the above illustration, with notes that describe our inputs, the solid line represents braking, while the dashed and dotted line represents our throttle input. Depending on the car we're driving, we may also brake in the dotted lines rather than simply lift, but the rhythm remains the same. Rather than drive through the series of corners at a constant speed, we're aggressively on and off the throttle, bouncing the weight fore and aft to help the car turn and rotate. This technique not only gets the car more quickly to the turn-in of Turn 2B, it also sets the car up to go very early to power in 2B while still using the largest possible radius.