Cornering Supplement # 5

Cornering

The Long and Winding Road

Cornering is one of the things that makes motorcycling so enjoyable. The challenge of setting up the perfect line and properly executing cornering technique is almost like ballet in its precision and grace. Many riders search for the "perfect" road, but any twisty passage can be more enjoyable through knowledge and skill. The basic cornering technique is similar for all types of roads, motorcycles, and riders. Slow, Look, Lean, and Roll . . . that's all there is to it! Of course, every situation is different, and this simple four-step process doesn't tell the whole story. That's where the challenge comes in: knowing the how, where, and why of Slow, Look, Lean, and Roll when riding through turns.

The mental activity of riding using a management strategy such as SIPDE has already been discussed a few times. Our cornering procedure is one example of applying this basic strategy to a specific riding situation. No corner exists all by itself; it is part of a ride that extends in both directions. You have to aggressively Scan, Identify, Predict, Decide, and Execute up to the corner, through it, and beyond. Let's begin with the approach to the turn and set the scene for our cornering procedure.

What You See Is What You Get

When you first see a turn in your path of travel, you face two decisions. The road is quite a bit wider than you or your motorcycle. In order to be prepared to negotiate the curve, you have to choose a path through it (or your "line") and an appropriate speed. Both of these decisions require judgment, based on your knowledge and the facts you have about the curve ahead. There is not a lot of time to assess the situation as you ride, so take the time now to examine some of the things you will need to consider.

First, you have to decide what sort of corner it is. It might be a sharp corner or a wide "sweeper." Does it stand alone, or is it a part of a series of turns? What about the radius—does the turn get tighter or widen? Remember the effect of road camber on traction and lean angle? Surface defects or hazards will surely affect your path, like conflicting traffic or potholes. Can you see completely through the corner? If your line of sight is restricted, you might have to make assumptions about several of these things.

That's a lot to find out in a short period of time. A mistake evaluating any of these facts could mean trouble. Sight is your most effective tool for gathering information. The earlier you detect a problem, the more time you have to react. It is pretty clear that it helps to see as much of the corner as possible. Remember the concept of maintaining an aggressive search with a 12-second visual lead? That applies to more than just urban situations. It may not be possible to always maintain a 12-second line of sight, but the inability to scan far enough ahead should put you on alert. You must consciously work to maximize your line of sight.

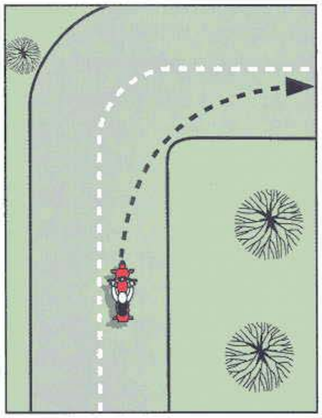

Diagram 14-1:
Simple, constant-radius turn

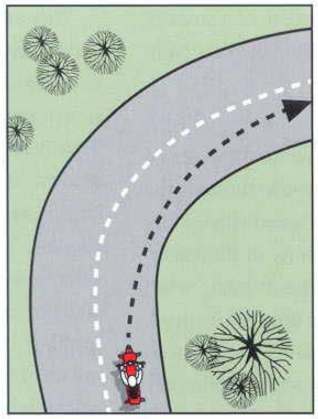

Diagram 14-2:
Increasing-radius turn

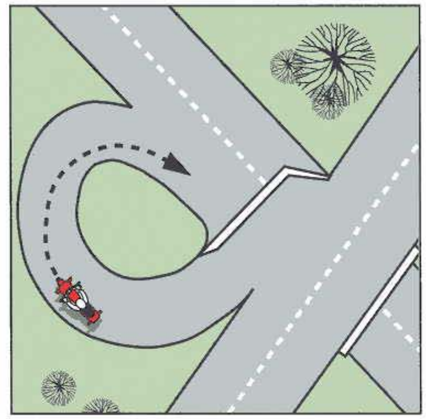

Diagram 14-3:
Decreasing-radius turn

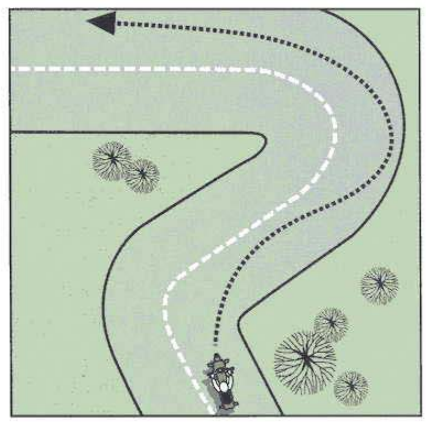

Diagram 14-4: Multiple turns

The decreasing-radius turn is the most challenging of these three types. If you are approaching a blind turn, it would be best to assume the worst: the portion of the turn that you cannot see has a decreasing radius. If you set up for a late/delayed apex, only to discover that the turn has a constant or increasing radius as the exit comes into view, this is a pleasant surprise. The late/delayed apex almost always results in greater reserves and more options for you to adjust to the unexpected. In that sense, it is potentially the safest option for any turn.

Apex—Multiple Turns

We have been discussing apex selection for a variety of single turns. There is still a fine line between each apex when one good turn leads to another, but it's not always the simplest one. The rules that we have covered for individual turns don't always give you the best line through the series of corners. Consider a sequence of two turns where the first is a constant radius and the second is a decreasing radius in the opposite direction. If you select a normal or center apex for the constant-radius section, you wind up on the wrong side of your lane to enter the decreasing-radius part. By delaying your apex for the constant-radius section, you will be in a better place to enter a path with a late/delayed apex for the decreasing-radius turn. This example illustrates why it is so important to Scan well ahead and Identify or Predict what is going to happen next before Deciding on a path and an apex for any turn.

In general, a delayed apex (as in Diagram 14-4) will maximize your line of sight until the exit or next turn becomes visible. Your choice of line after the apex permits you to maximize the effective turn radius through the exit of the turn. In many cases, the "ideal" path and apex aren't available because roadway and/or traffic conditions interfere. Once again, the use of a strategy like SIPDE is valuable in finding the best compromise.

Add Two Teaspoons Throttle . . .

Your speed changes as you slow for a corner and again as you roll on the throttle through the curve. We can describe these speed changes by focusing on three distinct points in the curve. The speed that you happen to be traveling when you first see the corner is your **approach speed.** Approach speed is determined by the environment and your ability to slow to an appropriate **entry speed,** which is the speed you are traveling when you begin the lean. We will call your speed at the exit of the turn, naturally enough, your **exit speed.** Of these three speeds, the entry speed is the most critical, because it determines how safely and smoothly the turn can be made.

Approach/Slow

The first part of the turning technique is to reduce your approach speed to a proper entry speed *prior* to the turn. This is the Slow part of the basic procedure. You already know the mechanics of this process: it involves rolling off the throttle, using both brakes, and downshifting as appropriate. The point where you should begin slowing, and the amount of braking, is determined by the amount of speed to be lost, the distance available, the braking ability of the machine under existing conditions, and your braking skill.

Selecting an appropriate entry speed can be a complex decision. Your perception of the turn radius, surface condition, and slope will come into play. You have to consider limitations on your line of sight and path of travel. These will be affected by the speed, position, and direction of other traffic and the presence of fixed hazards. Your entry speed will depend on how much of the motorcycle's available cornering performance you decide to use. Most importantly, it should allow you to respond to the worst-case scenario Predicted (the "P" in SIPDE) during the approach.

Your entry speed for a blind turn will be limited by any number of possibilities. Even if you know that the turn's radius does not decrease, something could be blocking your path of travel. Your decision is dominated by your worst-case prediction(s). Once you can see the exit, you will be able to judge all of the other factors more accurately. The information you gather works together with your experience, skill, and knowledge to define an *upper limit* on your entry speed. It is the speed that will permit a gradual roll on of the throttle from the entry point (or the point where the exit becomes visible) through to the exit. Entry speed may be lower than this, but it should never be higher.

The Slow portion of the cornering procedure ends once your entry speed is established. You are still traveling in a straight line and you have just arrived at the curve's entry point. The next step is to Look. We pointed out earlier that Look is related to the Scanning that is part of your overall riding strategy, but there is more to it.

Look

When you Look through a curve, you *turn your head* to face the exit and the intended path after the turn. Your eyes continue to move about and scan the riding environment, but the center of your field of vision is where you will be going. This is a minor turn of the head for gradual turns. You may need to exaggerate the head turn for sharp turns to face the exit. For U-turns, it means turning your head *as far as it will go.*

This technique not only allows you to Scan more effectively, it provides "visual directional control." Your mind tends to automatically make the control inputs necessary to cause the motorcycle go where you are looking. Have you ever found yourself drifting toward the side of the road while looking at some attractive scenery? That's visual directional control. Facing the turn's exit also tends to discourage looking down, which may cause balance problems. It helps you to perceive the turn as a single coordinated maneuver rather than a series of short arcs and can result in a smoother line.

When you turn your head to Look through a curve, it helps to keep your eyes level with the horizon. Some people tend to become disoriented if their head is tilted while in a turn. Keeping your eyes level helps you to better judge distances, maintain a sense of balance, and avoids possible orientation problems.

Lean

As you Look through the turn, you need to Lean the motorcycle. We know from the previous chapter that your motorcycle must lean to turn and that lean angle is most quickly, effectively, and precisely controlled through handlebar pressure. This begins a series of events, as illustrated in the previous chapter (see page 128).

A motorcycle needs to lean in a turn for two reasons. First, the lean of your tires produces much of the cornering force necessary to make the bike turn. The other reason that you have to lean in a turn is to maintain balance. When a motorcycle turns, centrifugal force acts through the center of gravity (cg) to try to lean the motorcycle toward the outside of the turn. To maintain balance, the motorcycle must be leaned into the turn so the weight can counteract the centrifugal force. We end up with a "balance" between two opposing torques, like in arm wrestling.

When you are perfectly vertical on your bike and not moving, weight has no lever arm to tip it to the side and it will be balanced when you pick up your feet. If anything moves even slightly, the weight will then have a lever arm to act, and you fall to the side unless you put your feet back down.

Let's put the bike in motion in a steady turn. Diagram 14-5 shows that the centrifugal force ***(CF)*** acting with lever arm ***a*** (the height of the cg above the ground) generates a torque to the right that tries to straighten you up. The weight ***(W)*** acting with lever arm ***b*** (the sideways displacement of the cg) generates a torque that tries to lean you more to the left. These torques are simply the product of the force ***(CF or W)*** multiplied by its respective lever arm ***(a or b)***. When they are equal ***(CF x a = W x b)***, you are balanced and the lean angle remains constant. If the two torques are not equal, then your lean angle will change until balance is restored.

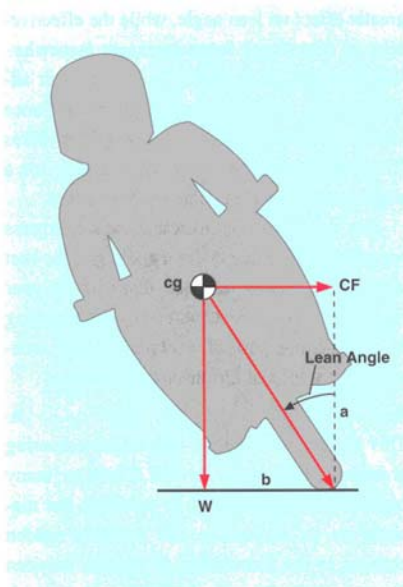

Diagram 14-5: Basic balance condition

When you are vertical and moving in a straight line, the weight has no lever arm to affect the lean, just like when you were stopped. Centrifugal force has its maximum lever arm at zero lean angle, and its maximum potential for affecting lean angle. Any change of direction, even slight, will involve tire side forces that create a sideways force (centrifugal force), which acts through its maximum lever arm to lean the motorcycle in the direction of the turn. *This is the principal reason why steering input is your most effective way of initiating a lean.* It is also why shifting your weight is relatively ineffective for that purpose. Since your weight is only a small fraction of the moving motorcycle, you cannot produce a sideways cg shift big enough to create a significant lever arm for the weight.

The lever arm for weight gets larger as your lean increases, and the lever arm for centrifugal force gets smaller. This means that weight has a greater effect on lean angle, while the effectiveness of centrifugal force decreases somewhat. Weight shifts can therefore be used to your advantage for making fine adjustments once you've initiated a turn. One example involves "dropping" the inside knee off the tank for a slight increase in lean angle while in a turn.

The most important idea that we can express regarding lean is that countersteering is the best way to initiate *any* turn and that shifting your body weight is a poor substitute. Countersteering is an essential part of everyday riding technique—it's not just for obstacle avoidance.

Roll

This leads us to the final step of the cornering procedure, **Roll** on the throttle. There are many benefits of a gradual roll. It stabilizes the machine on its suspension and prevents sudden changes in the distribution of traction between the two tires. Ground clearance is improved, while the centrifugal forces associated with balance are not disrupted.

We examined how accelerations that produce changes in speed result in a shift in the relative loading of the tires in the traction chapter. They also extend or compress your suspension as the motorcycle's weight is transferred. Both of these effects have an impact on your ability to smoothly negotiate a curve.

Cornering can use a significant portion of your available traction. Side forces that make the bike turn are combined with the steering and driving forces necessary to maintain speed and control. Any excess traction is your reserve for making changes or responding to surprises.

We also know that the cornering force required depends greatly on speed. For large-radius turns, both of your wheels are tracking along nearly equal arcs and traveling at approximately equal speeds. In tight turns, the front wheel tracks an arc of somewhat greater radius than the rear wheel. This means that your front tire is traveling faster and its demand for traction may be greater than the rear.

We have already discussed the factors that determine the distribution of available traction between the tires in some detail. In a curve, the traction distribution remains fairly constant as long as nothing changes abruptly. Sudden shifts in tire loading or power would result in a rapid shift in available traction from one tire to the other. This could leave one tire without enough traction to meet the demands of its users.

Traction Shifts—Abrupt Deceleration

Suppose that you abruptly roll off the throttle completely when the bike is at a large lean angle. The deceleration would cause a shift in available traction away from the rear. This might be enough to produce a skid of the rear tire if the engine braking were strong enough.

Deceleration would make more traction available at the front because of the weight transfer. This same transfer of weight will have a relative sideways component that adds to the demand for side force because the motorcycle is leaning. With more traction available *and* more being used, the balance of supply and demand may still produce a skid of the front tire if you roll off the throttle while turning.

Large lean angles aren't the only situation where abruptly closing the throttle might be a problem. The same kind of difficulties may arise at a small lean angle on an off-camber surface, for example.

Traction Shifts—Abrupt Acceleration

Rolling the throttle on abruptly or excessively may produce some more traction on the rear tire due to weight transfer, but the increased demands of driving and side force can quickly eat up any additional reserve. For very abrupt inputs, the rear tire would likely begin to slide out from under the motorcycle before any significant weight transfer could take place.

Abrupt Speed Change—Other Difficulties

Other difficulties can arise from abrupt increases or decreases of power in a turn. The suspension extends or retracts in response to changes in speed, which affects the ground clearance and steering geometry of your motorcycle. This can introduce oscillations in the suspension, which reduce its effectiveness or cause instability. Reduced ground clearance limits your lean angle and in extreme cases can result in loss of traction if parts of your motorcycle start to drag. Steering and suspension changes combine with lessened ground clearance and limited traction reserve to reduce directional stability and produce possible control problems.

Rolling Home

The solution to all of these problems is to avoid abrupt speed changes in a turn. Since greater ground clearance and extension of the front suspension tend to add to overall stability and control, deceleration can be avoided by gradually rolling on the throttle to produce a steady speed or a gentle acceleration. A gradual roll-on prevents too much acceleration or speed from driving the demand for traction beyond the limit and causing a skid.

The rewards of practiced and proper cornering technique are a greater traction reserve and a better feeling of stability and control. These are some of the goals that help make motorcycling safer and more enjoyable.

Self-Test for Chapter 14: Cornering

Choose the best answer to each question.

1. What are the two things you must choose when preparing to negotiate a corner?

   ____

   ____

2. What is the apex of a corner?
   a. Widest point of the turn.
   b. Point closest to the inside.
   c. Midpoint of the corner.
   d. Highest point of the curve.
3. A late or delayed apex is best used for what type of turn?
   a. Constant radius.
   b. Increasing radius.
   c. Decreasing radius.
   d. Off-camber turns.
4. The speed at which you enter a corner is the most critical. True or false?
5. Why is it important to turn your head to look when cornering?
   a. So that you will face the turn's exit and your intended path of travel.
   b. So you can spot potential danger in the adjoining lane.
   c. To maintain balance through the turn.
   d. To see if anyone is following you through the corner.

(Answers appear on page 176.