

What Makes a Motorcycle Turn?

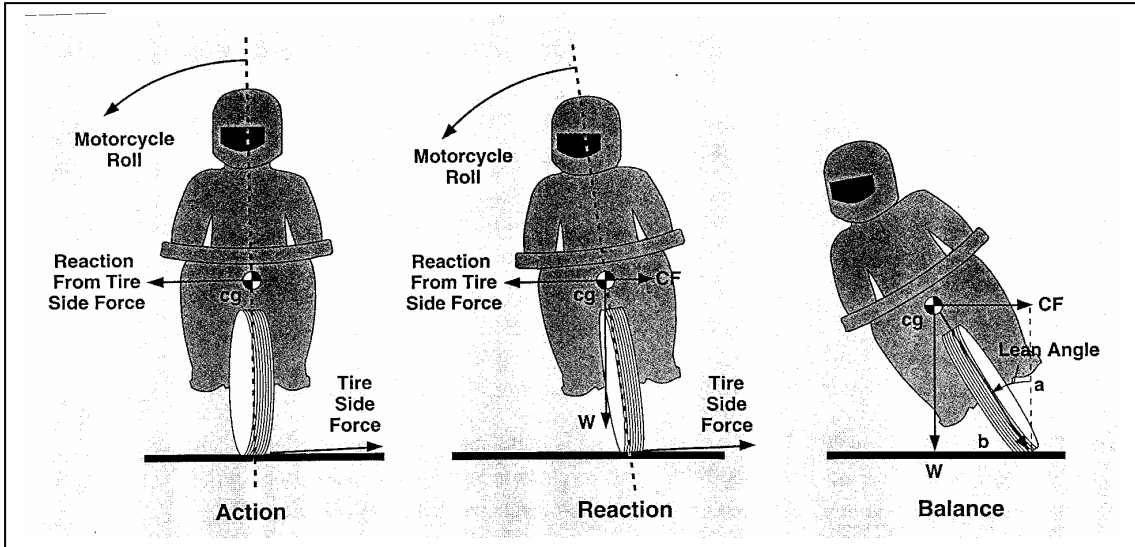
The information presented here was taken primarily from two sources: The Motorcycle Safety Foundation's Guide to Motorcycling Excellence and Mark Yager's Safety Bits.

There are several forces that tend to keep a motorcycle upright while moving. The front end's trail (which is the distance between the steering pivot point and where the wheel actually hits the ground) provides a castering force which keeps the front wheel pointing straight forward. The rotating wheels are big gyroscopes, which try to stay upright and keep the motorcycle in balance. If you started your motorcycle rolling on a straight road without a rider, it wouldn't fall over until it ran out of speed or hit something.

The two rider-control inputs that make a motorcycle turn are weight shifts and steering. If you are traveling in a straight line at 60 MPH and lean your body to one side or another without turning the handlebars, the motorcycle will begin to slowly lean in that direction. You are only a small fraction of the moving mass, and the maximum distance that you can displace the center of gravity by shifting around is quite small. If weight shifts were the primary input to turning at high speed, cornering on a motorcycle would be difficult indeed!

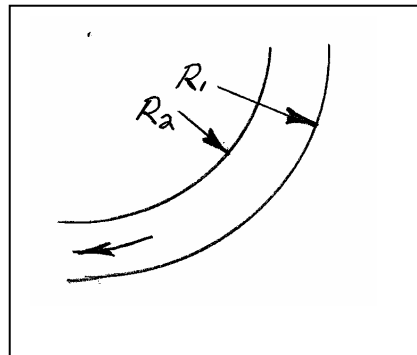
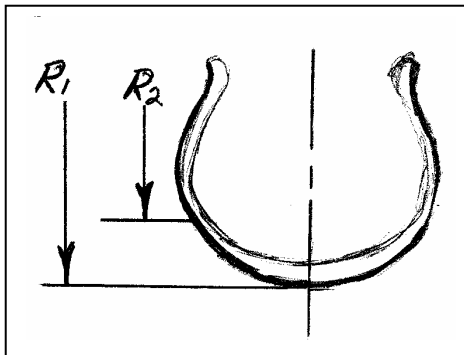
A motorcycle must lean to turn when it is moving even at slow speeds. The real task involved in getting a motorcycle to turn is to get it to lean. **The turning happens as a result of the lean angle. Counter-steering** is the term we use to identify the principal technique for maintaining balance and for controlling motorcycle lean angle. Try to imagine riding at 40 MPH in a straight line on a huge parking lot. Now turn the handlebars slightly to the left. The motorcycle's front-tire contact patch will immediately start steering to the left, but what about everything else? The motorcycle wants to continue in a straight line; it has momentum. Steering the tire to the left will try to roll the entire motorcycle about the center of gravity, which results in a lean to the right. This lean creates side thrust and, aided by steering trail, immediately turns the front wheel to the right to make a right turn. **The turning forces are created by the motorcycle's lean without any significant additional rider input. It's that simple!**

When you turn the handlebars to the left (counterclockwise, looking from the rider's perspective), the motorcycle's front tire momentarily steers to the left, producing a side force at the contact patch, as shown in "**Action**". If the rider maintains pressure on the handgrip, the tire side force and the motorcycle's weight will work together to continue to lean the motorcycle even more, as shown in "**Reaction**". As the motorcycle begins to lean, steering trail immediately forces the front wheel back to the rider's right to follow the turn that has been initiated. Finally, when steering pressure is relaxed, the lean angle will stabilize at the point where the centrifugal force and weight arrive at a standoff, as shown by "**Balance**".



In summary, countersteering is essentially nothing more than using steering inputs to produce forces that efficiently and easily initiate a change in lean angle. It is more effective and quicker than shifting rider weight because of the greater rolling moments that small steering inputs produce.

One of the forces that actually causes a motorcycle to turn is called **camber thrust**. Camber thrust is a side force due to tire lean. A cross-section of your tires would show that they are rounded with the outside edges actually having a smaller radius (R_2) than the center portion (R_1). In a lean, the contact patch has a smaller radius on the inside than on the outside. The rolling tire can be likened to a Styrofoam cup rolled across a table. If you try to roll the cup in a straight line, you won't have much luck. That is because the cone shape is thin at one end. Each rotation of the thin end will travel less distance than a rotation at the thick end. Since the thin end is traveling slower, the cone turns. The sides of your leaning motorcycle's tires travel along the road slower than the center in the same way. This camber-generated force combines with your steering angle to make your motorcycle turn when you are in a lean.



When we ride we utilize counter-steering without even realizing it. It is the only way to control the motorcycle. However, in an emergency situation, even an experienced rider

may turn to steer away from an obstacle in his path. This is what we do when driving a car, turn right to go right. But on a motorcycle we must steer left to go right. In the example above, by steering away from the obstacle, the rider may actually turn his bike into it. So remember: **“Push left, turn left. Push right, turn right.”** Repeat this to yourself while you ride. Once you get the hang of it, counter-steering will become instinctive – your body probably knows how to do it, it’s just your mind that is lagging. Understanding the principles behind counter-steering will make you smoother and give you a better feeling of control over your environment. It may also save your life. Like any safety technique, it only works if you practice it. Unless the action is second nature, you will return to your old habits during an emergency. So, practice, practice, practice.