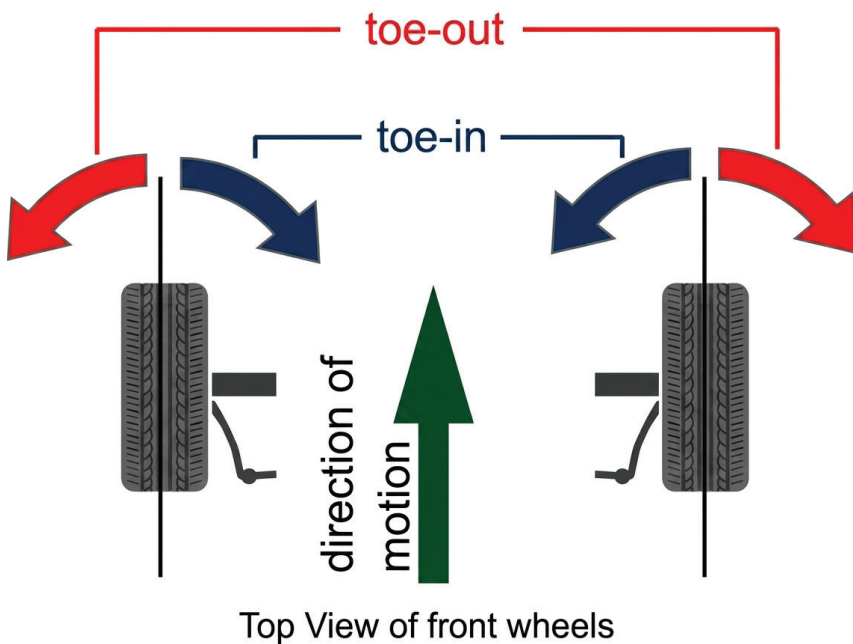


Basic Wheel Alignment

By William E. Lehman

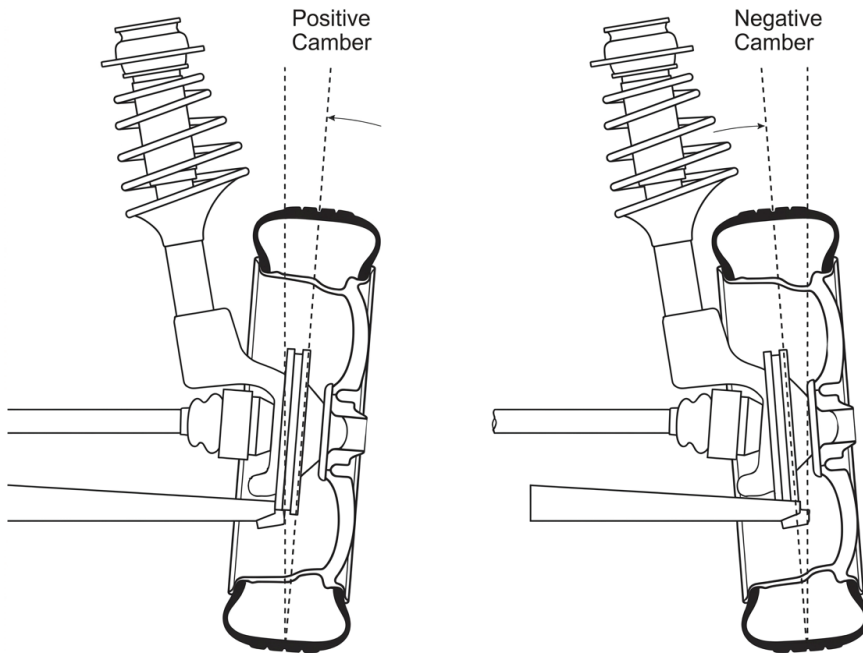
After attending your first autocross or driver's education event, it's likely that you'll be thinking about improving your car's handling. During discussions with other drivers and "interested spectators" you might be advised to get a "track" alignment or find a way to get "more negative camber". This article will explain what the alignment parameters of toe, camber, and caster mean and how changes in their settings may affect performance. Finally, I'll discuss the benefits of having a wheel alignment done on your vehicle. Alignments require specialized equipment and knowledge to do safely. Although I will mention where adjustments are made on a vehicle, this is not a "how to" article.

Toe – If a pair of front or rear wheels is pointing straight ahead, then you have zero toe. However, if their leading edges are pointed slightly toward each other you have toe-in. On the other hand, if the leading edges are pointing slightly outboard, you have toe-out. Toe is measured at each wheel. It is the difference in length between the front edge and the trailing edge of the wheel as measured from the centerline of the car.



Toe settings affect tire wear, directional stability, and corner entry handling characteristics. Any toe causes the tires to scrub. Too much toe-in causes excess wear on the outside of the tire and too much toe-out wears the inboard edges. A little toe-in at the front wheels helps with straight line stability but the trade-off is some loss of turn-in ability. A little toe-out helps the car initiate a turn. Most performance drivers are willing to sacrifice a little straight line stability for improved corner entry. Excessive toe-in or toe-out can cause darting under braking or over bumps. Toe at the front is adjusted with a threaded connection in the steering tie rod. Cars with independent rear suspension can adjust rear toe. On modern Porsches this is done by an eccentric adjustment at the in-board end of the rear tie rod. Generally, toe-out in the rear is to be avoided as it can cause excessive over steer.

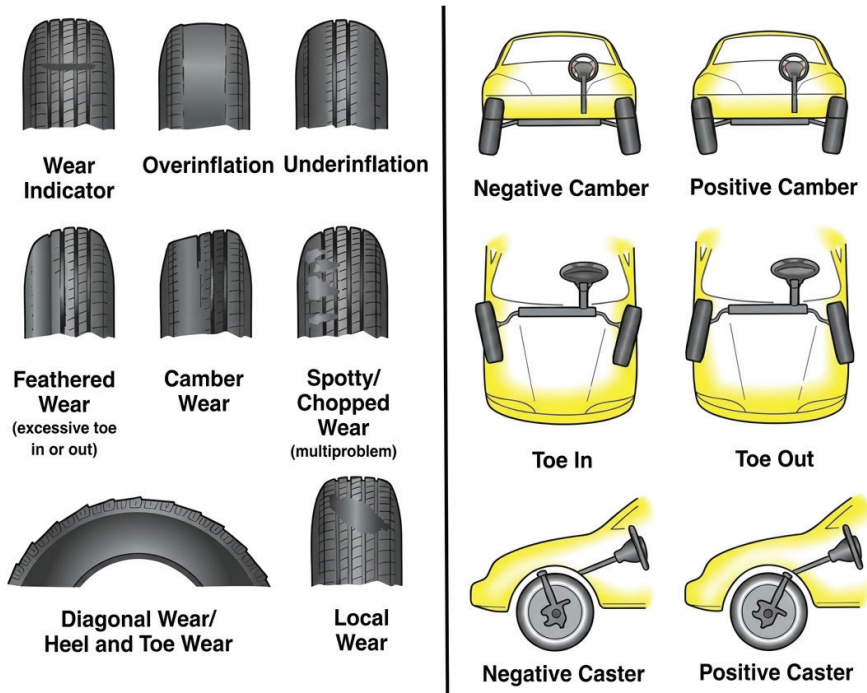
Camber – Camber is the angle of the wheel relative to vertical when viewed from the front or the rear. If the wheel leans inboard, it has negative camber. If it leans outboard, it has positive camber. Camber is usually defined in degrees. The cornering force that a tire can develop is dependent upon its angle relative to the road. Maximum cornering power is developed with a small amount of negative camber due to camber thrust and deformation of the tread. As the body of the car rolls during cornering, more camber is required to maintain the proper tire tread relationship with the road surface.



A proper racing suspension has geometry which gains negative camber as the body rolls. Modern Porsches with their MacPherson strut suspension have limited camber gain as the body rolls during a corner. Given this condition, plus the fact that some negative camber maximizes cornering power, an increase in static negative camber can be helpful. The trade-off is that increasing negative camber will increase wear on the insides of the tires. The final camber settings should be similar between the front and rear wheels. In other words, you would not want 3 degrees negative in the front and 1 degree negative in the rear. Without aftermarket parts, camber in the front is changed by moving the top of the strut towers within the slotted holes where they are attached to the body. At the rear it is adjusted by an eccentric bolt at the inboard end of the lower control arm.

Caster – Caster is the angle at which the steering axis is tilted forward or rearward from vertical as viewed from the side. A shopping cart has its steering axis set forward of its contact patch and as you push it, the front wheels follow the steering axis. This is negative caster. Most automobiles are built with positive caster and the steering axis meets the plane of the ground ahead of the contact patch. Like the shopping cart, the trail created by the positive caster pulls the wheels in line. This tilted steering axis has another effect on suspension geometry. Since the wheel rotates about a tilted axis, the outside wheel gains camber when it is turned. This is favourable for cornering. The modern Porsche does not have adjustments for caster without installing after-market parts so you have to live with the caster built in at the factory. However, caster should be checked during an alignment to make sure it is about the same side to side and to check for evidence of bent suspension parts or damage to body attachment points.

Tire Wear and Wheel Alignment



Alignment – Most cars can benefit from an alignment for two reasons. First, even a new car's alignment will change from the settings made at the factory due to settling of the springs, wear-in, and compliance of the various bushings and hardware at the suspension pivot points. Hitting potholes and curbs can also change the initial setting. All of this is also true for an older car. Secondly, the factory alignment specification tolerances are, from a performance perspective, fairly loose. For example you could have one wheel set at 0° camber and the wheel on the opposite side set at -0.5° camber and still be within spec. For the purposes of this article, I will define a "track alignment" as an alignment which has the most aggressive performance specifications available within the adjustment range of the stock vehicle. This translates into maximizing negative camber and setting appropriate toe. A "true" track alignment would have camber settings in the range of -2° to -2.5° and for a pure track car running slicks, camber could exceed -3° . Altering the alignment settings beyond what's available on the stock vehicle will be the basis for a future article. As mentioned in the preface, it takes skill and specialized equipment to do a proper alignment. For example, when you change camber, toe will also change and will need to be readjusted.