CHAPTER 18
Wheel Alignment Principles

FIGURE 18.1 A pull is usually defined as a tug on the steering wheel toward one side or the other.

FIGURE 18.2 The crown of the road refers to the angle or slope of the roadway needed to drain water off the pavement.
FIGURE 18.3 Wander is an unstable condition requiring constant driver corrections.

FIGURE 18.4 Positive camber. The dotted line represents true vertical, and the solid line represents the angle of the wheel.

FIGURE 18.5 Negative camber. The dotted line represents true vertical and the solid line represents the angle of the wheel.
FIGURE 18.6 Zero camber. Note that the angle of the tire is true vertical.

FIGURE 18.7 Excessive positive camber and how the front tires would wear due to the excessive camber.

FIGURE 18.8 Excessive negative camber and how the front tires would wear due to the excessive camber.
FIGURE 18.9 Positive camber tilts the tire and forms a cone shape that causes the wheel to roll away or pull outward toward the point of the cone.

FIGURE 18.10 Negative camber creates a pulling force toward the center of the vehicle.

FIGURE 18.11 If camber angles are different from one side to the other, the vehicle will pull toward the side with the most camber.
FIGURE 18.12 Positive camber applies the vehicle weight toward the larger inner wheel bearing. This is desirable because the larger inner bearing is designed to carry more vehicle weight than the smaller outer bearing.

FIGURE 18.13 Negative camber applies the vehicle weight to the smaller outer wheel bearing. Excessive negative camber, therefore, may contribute to outer wheel bearing failure.

FIGURE 18.14 Zero caster.
FIGURE 18.15 Positive (+) caster.

FIGURE 18.16 Negative (−) caster is seldom specified on today’s vehicles because it tends to make the vehicle unstable at highway speeds.

FIGURE 18.17 As the spindle rotates, it lifts the weight of the vehicle due to the angle of the steering axis.
FIGURE 18.18 Vehicle weight tends to lower the spindle, which returns the steering to the straight-ahead position.

FIGURE 18.19 High caster provides a road shock path to the vehicle.

FIGURE 18.20 A steering dampener is used on many pickup trucks, sport-utility vehicles (SUVs), and many luxury vehicles designed with a high-positive-caster setting.
**FIGURE 18.21** As the load increases in the rear of a vehicle, the top steering axis pivot point moves rearward, increasing positive (+) caster.

**FIGURE 18.22** Note how the front tire becomes tilted as the vehicle turns a corner with positive caster. The higher the caster angle, the more the front tires tilt, causing camber-type tire wear.

**FIGURE 18.23** Zero toe. Note how both tires are parallel to each other as viewed from above the vehicle.
FIGURE 18.24 Total toe is often expressed as an angle.

FIGURE 18.25 Toe-in, also called positive (+) toe.

FIGURE 18.26 Toe-out, also called negative (−) toe.
FIGURE 18.27 This tire is just one month old! It was new and installed on the front of a vehicle that had about 1/4 inch (6 mm) of toe-out.

FIGURE 18.28 Excessive toe-out and the type of wear that can occur to the side of both front tires.

FIGURE 18.29 Excessive toe-in and the type of wear that can occur to the outside of both front tires.
FIGURE 18.30 Feather-edge wear pattern caused by excessive toe-in or toe-out.

FIGURE 18.31 Rear toe-in (+). The rear toe (unlike the front toe) can be different for each wheel while the vehicle is moving forward because the rear wheels are not tied together as they are in the front.

FIGURE 18.32 Incorrect toe can cause the tire to run sideways as it rolls, resulting in a diagonal wipe.
FIGURE 18.33  Diagonal wear such as shown here is usually caused by incorrect toe on the rear of a front-wheel-drive vehicle.

FIGURE 18.34  Toe on the front of most vehicles is adjusted by turning the tie rod sleeve, as shown.

FIGURE 18.35  While the feathered or sawtooth tire tread wear pattern may not be noticeable to the eye, this wear can usually be felt by rubbing your hand across the tread of the tire.
FIGURE 18.36 The left illustration shows that the steering axis inclination angle is determined by drawing a line through the center of the upper and lower ball joints.

FIGURE 18.37 The SAI causes the spindle to travel in an arc when the wheels are turned. The weight of the vehicle is therefore used to help straighten the front tires after a turn and to help give directional stability.

FIGURE 18.38 Included angle on a MacPherson-strut-type suspension.
FIGURE 18.39 Included angle on an SLA-type suspension. The included angle is the SAI angle and the camber angle added together.

FIGURE 18.40 Cradle placement. If the cradle is not replaced in the exact position after removal for a transmission or clutch replacement, the SAI, camber, and included angle will not be equal side to side.

FIGURE 18.41 A positive scrub radius (angle) is usually built into most SLA front suspensions, and a negative scrub radius is usually built into most MacPherson-strut-type front suspensions.
FIGURE 18.42 With negative scrub radius, the imaginary line through the steering axis inclination (SAI) intersects the road outside of the centerline of the tire.

FIGURE 18.43 With a positive scrub radius, the pivot point, marked with a + mark, is inside the centerline of the tire and will cause the wheel to turn toward the outside, especially during braking.

FIGURE 18.44 To provide handling, the inside wheel has to turn at a greater turning radius than the outside wheel.
FIGURE 18.45 The proper toe-out on turns is achieved by angling the steering arms.

FIGURE 18.46A Positive setback.

FIGURE 18.46B Negative setback.
FIGURE 18.47 Cradle placement affects setback.

FIGURE 18.48A Zero thrust angle.

FIGURE 18.48B Thrust line to the right.
**FIGURE 18.48C** Thrust line to the left.

**FIGURE 18.49A** Proper tracking.

**FIGURE 18.49B** Front wheels steering toward thrust line.