



Vehicle dynamics

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Introduction

Vehicle dynamics has shaped the development and creation of vehicles for decades. The list below covers the main considerations vehicle engineers need to take when designing new vehicles, notice most of these considerations will have huge influence over a vehicles handling properties. Along with creating vehicles that can handle harsh road conditions and cornering, the consideration for passenger comfort and space is included – this began variation in vehicle design. Through the last 100 years, cars have developed from saloon and coupes, to SUVs, estate cars and hatchbacks all of which vary with advantages but also with how they were packaged.

Key considerations

- Forces acting on a vehicle – this includes forces from acceleration, braking and vertical forces acting on the vehicle.
- Vehicle drivetrain configurations – how the engine is situated within the vehicle, but also which axle/s are driven.
- Vehicle's centre of gravity – heavily influences vehicle handling characteristics
- Tyres – Tyre load, coefficient of friction values, slip angle and lateral forces are important considerations for tyre design.
- Suspension systems – Required to support the vehicle body's weight and maintain tyre contact with the road
- Suspension geometry fundamentals – this includes camber, castor and toe. These 3 parameters have a large influence on vehicle handling.

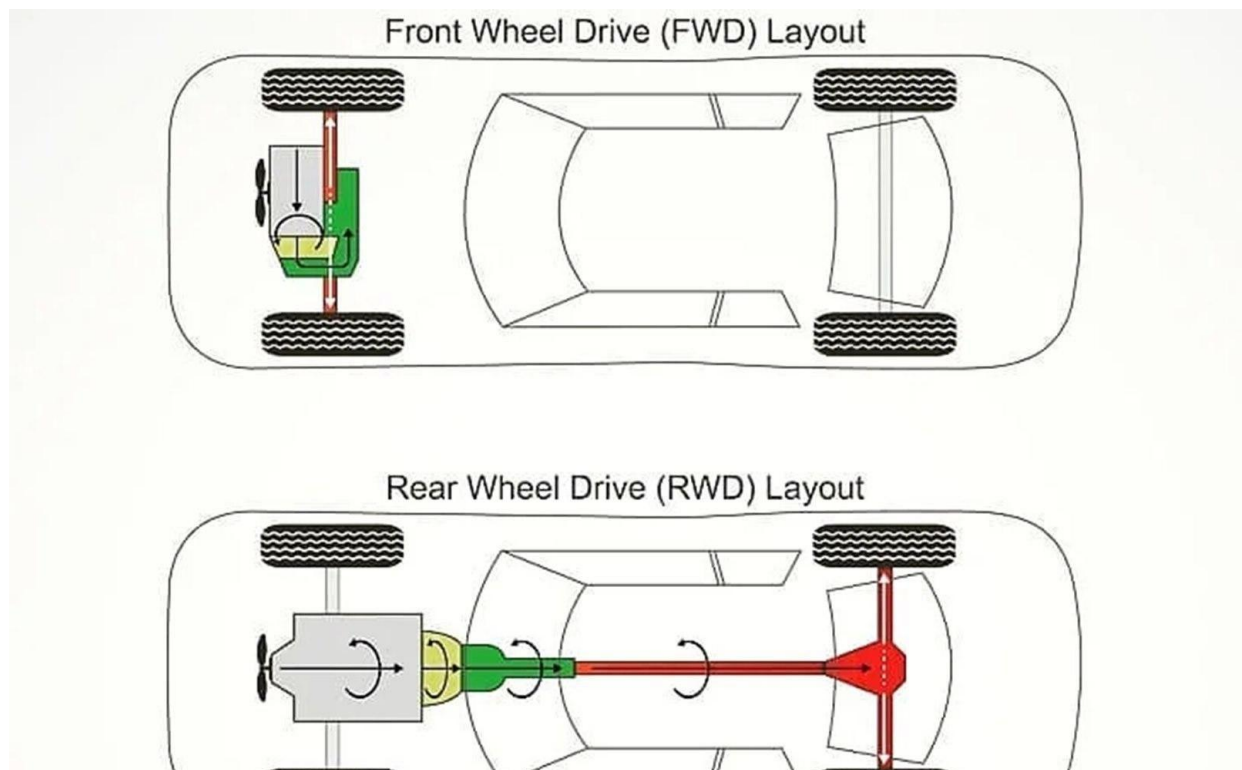
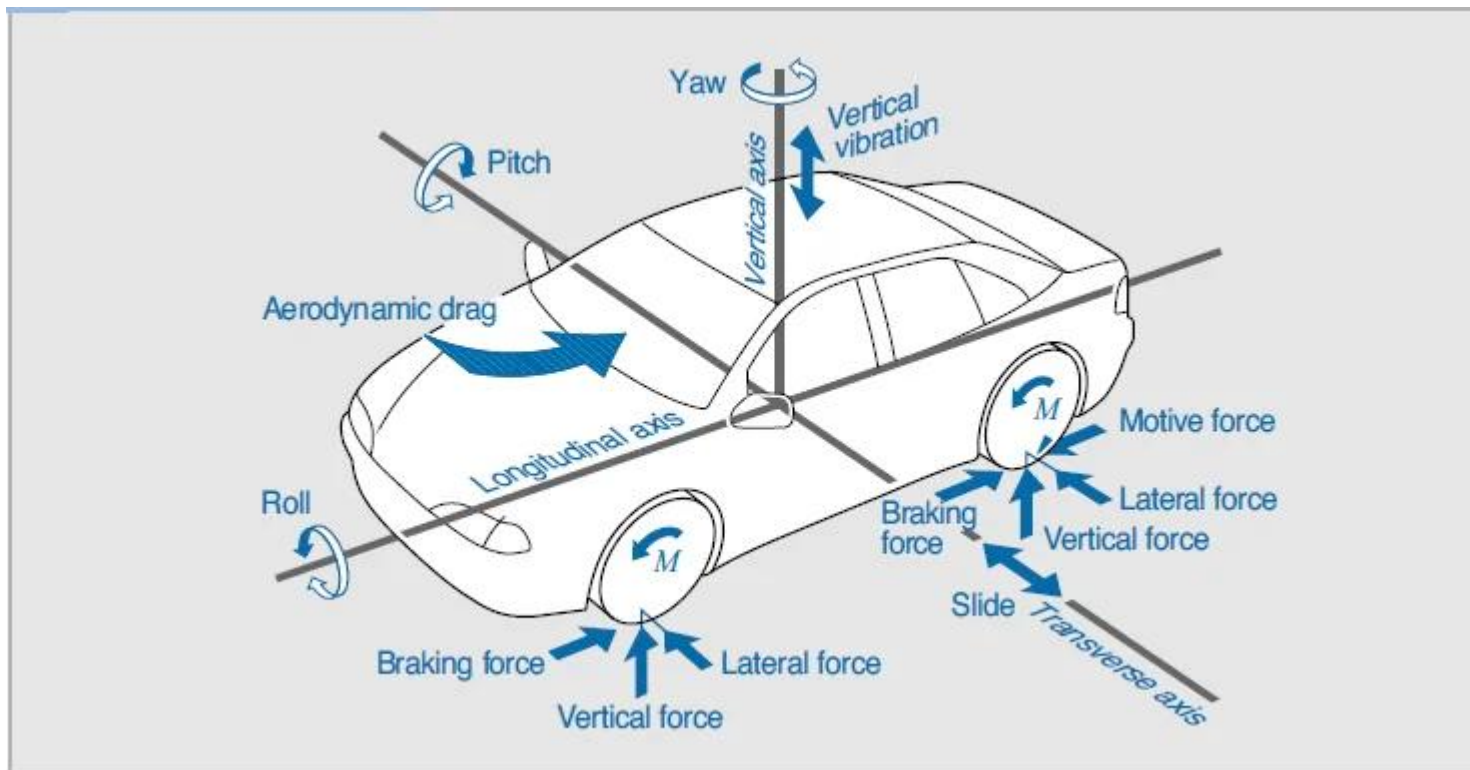


Figure 2 – The key difference between the two layouts is the need for a prop shaft for RWD, this causes packing issues for passenger comfort.

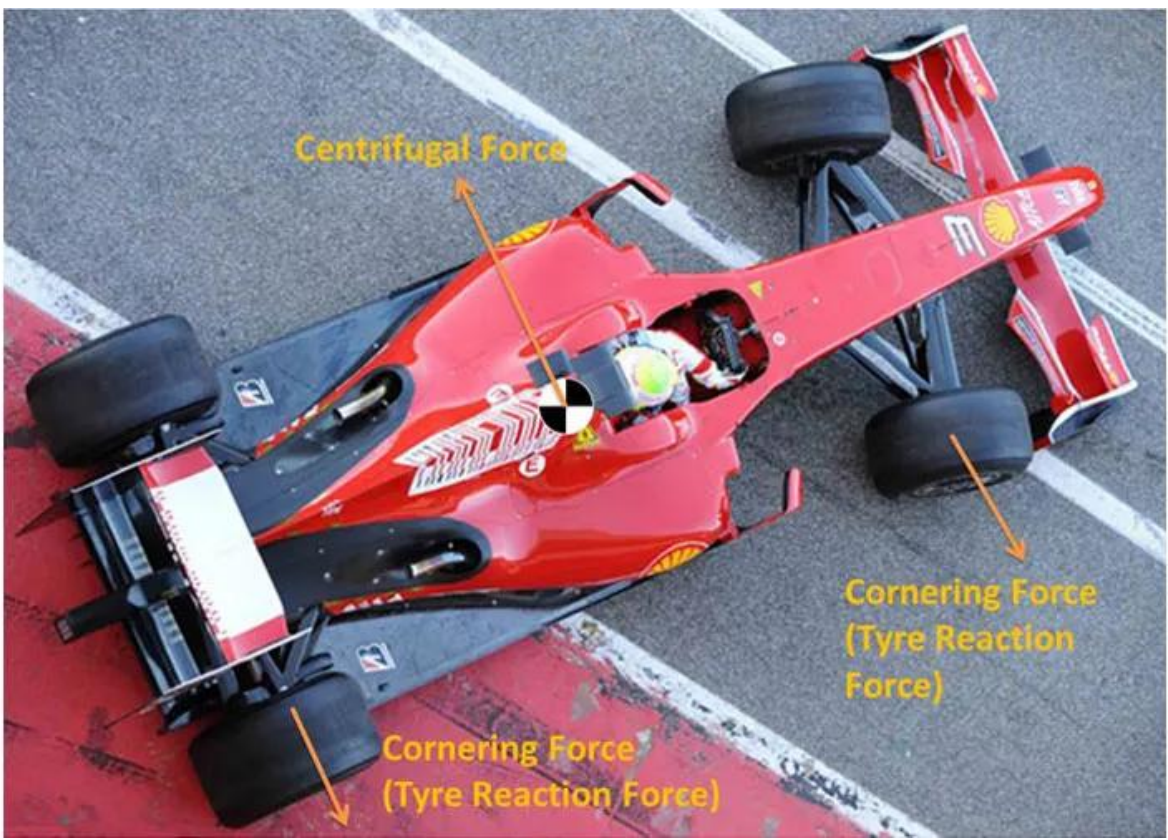


Figure 3 – shows how centrifugal forces act to pull a vehicle away from its circular path. It is important for maintaining cornering that centrifugal and centripetal forces remain balanced.

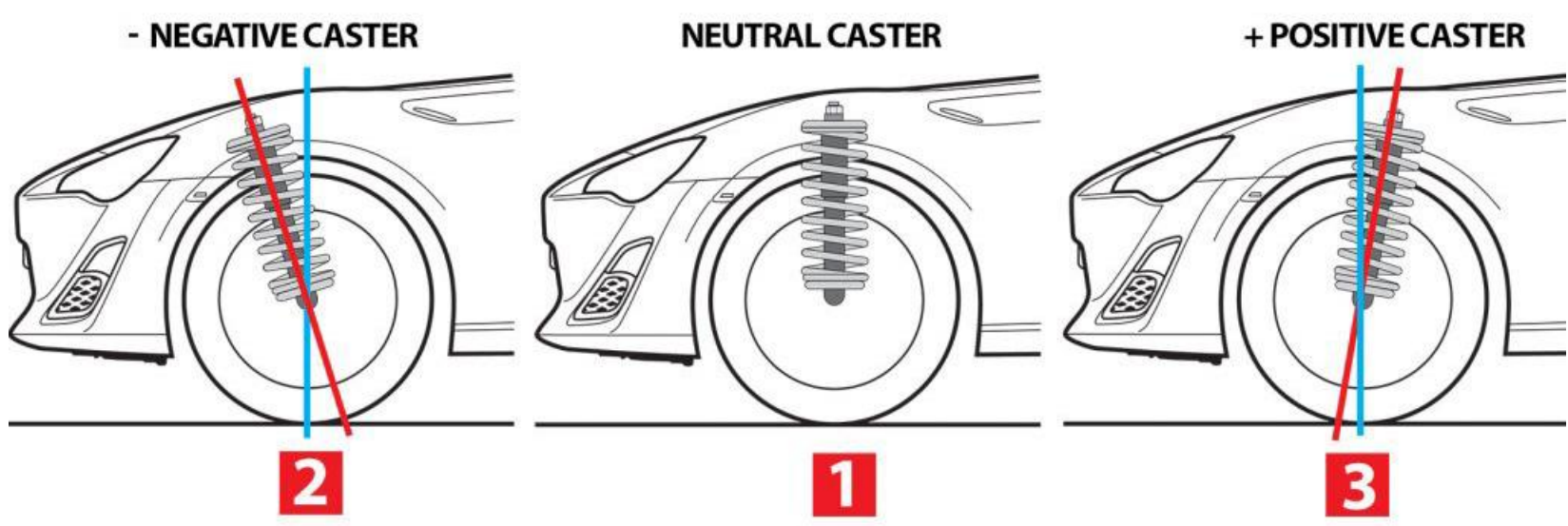


Figure 4 – Castor influences steering characteristics such as steering effort and self centering, positive is most favourable in road use as it maintains straight line stability. However excessive castor creates heavy steering.

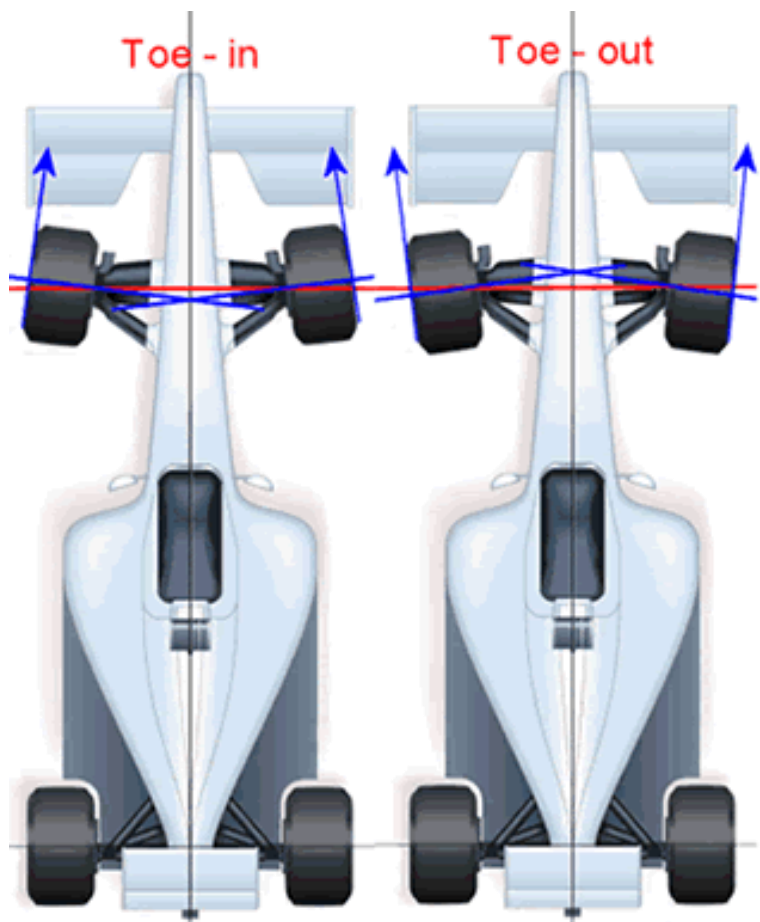


Figure 5 (left), shows toe which is relative to where the front wheels are pointing to the vehicle longitudinal centreline, toe in compliments straight line stability and toe out improves steering responsiveness.

Figure 1 (left) shows all the forces acting upon a vehicle through everyday normal use – of course values for each change when driving under different conditions. For example, high speed in a straight line will cause high aerodynamic drag but low body roll.

Camber

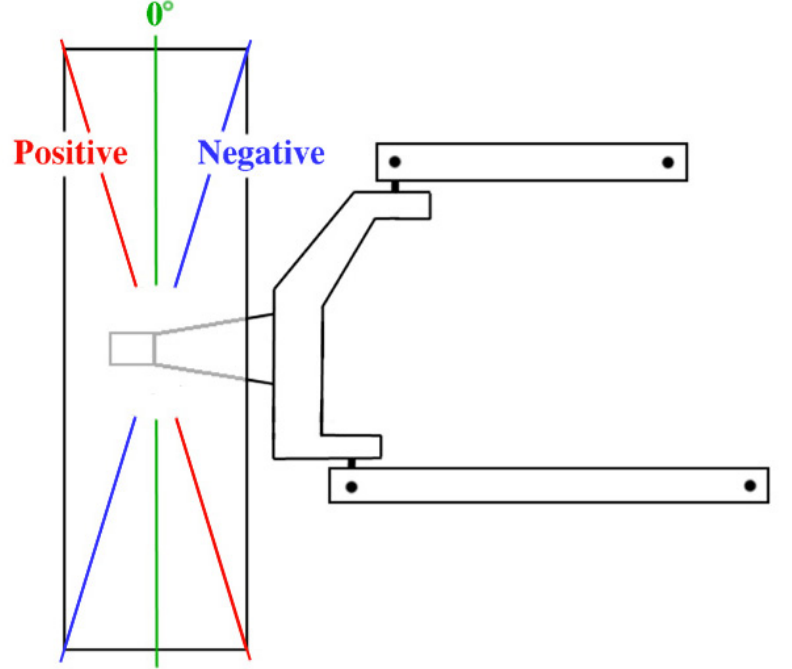


Figure 6 (above) shows a diagram representing camber. This is the angle of the wheel relative to the road. Negative is when the top of the wheel leans into the car – this improves stability and handling. Positive camber is when the bottom of the wheel leans into the car – favourable for HGVs and agricultural vehicles as it improves stability on uneven terrains.

Suspension is a key consideration to how a vehicle performs. How a suspension is set up provides benefits to most noticeably cornering and handling but also provides benefits to straight line stability. As well as responsiveness, suspension set up relates to tyre wear – this leads to vehicle tracking which can be checked/corrected at garages and tyre centres

Acknowledgements

Thank you to Andrew Noble for the inspiration for this poster, providing technical insight about the subject.

References

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- Figure 3 - Suspension Secrets. (2018, June 7). Lateral and Longitudinal load transfer. Retrieved April 17, 2026, from Suspension Secrets: <https://suspensionsecrets.co.uk/lateral-and-longitudinal-load-transfer/>
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