



Introduction To Vehicle Dynamics

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Introduction

This poster shows a condensed version of the Vehicle dynamics lecture by Andrew Noble

The Lecture demonstrated many aspects of vehicle dynamics such as, Forces on a vehicle, Drivetrains, COG, Tyres, suspension setups and geometry etc.

The lecture expanded on how these different parts of a vehicles design, effects how the vehicle drives, and feels. The lecture also looked over how different choices are made when vehicles are designed for motorsport or day to day aspects of driving.

Forces acting on a vehicle

A vehicle experiences a vast number of different forces acting upon itself at any one point.

The vehicles mass constantly produces **Vertical Forces** with the weight of the car producing a downwards force. The vehicles tyres then produce an equal reactive force acting upwards (Newtons 3rd Law)

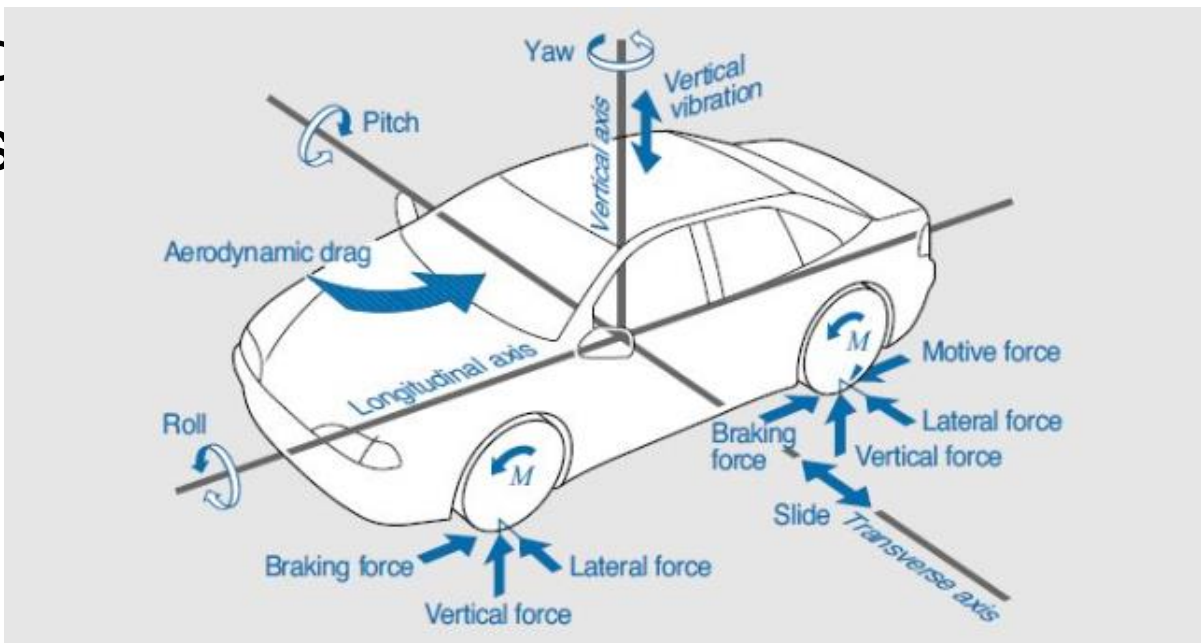
Longitudinal Forces also act on the vehicle depending on whether the vehicle is accelerating or braking.

When accelerating the **Drive force (tractive effort)** pushes the vehicle either forwards or backwards (Depending on selected gear).

As soon as the vehicle is in motion, an **Aerodynamic Drag force** acts on the opposite of the direction of travel (this increases with speed)

There is also a friction force called **Rolling resistance**, acting against the intended direction of travel.

Picture illustrating forces on a vehicle
(UWTSD-Andrew Noble)



Drivetrain Configurations

Vehicles are produced with many different drivetrain configurations, the most common layout for a typical road car is a **Front engine – Front wheel drive setup**. This is known as **FF**.

This layout is cheap to produce, easy to assemble and generally requires less components.

Another common setup often used in higher performance cars is a **Front engine – Rear wheel drive setup. (FR)**

This setup is more complex, requiring a long centre prop shaft to connect to the rear wheels, and is generally higher cost.

However, a **FR** setup often offers better weight distribution and allows the front and rear wheels to do independent things. Rear wheels only drive the vehicle, and the fronts are only used for steering.

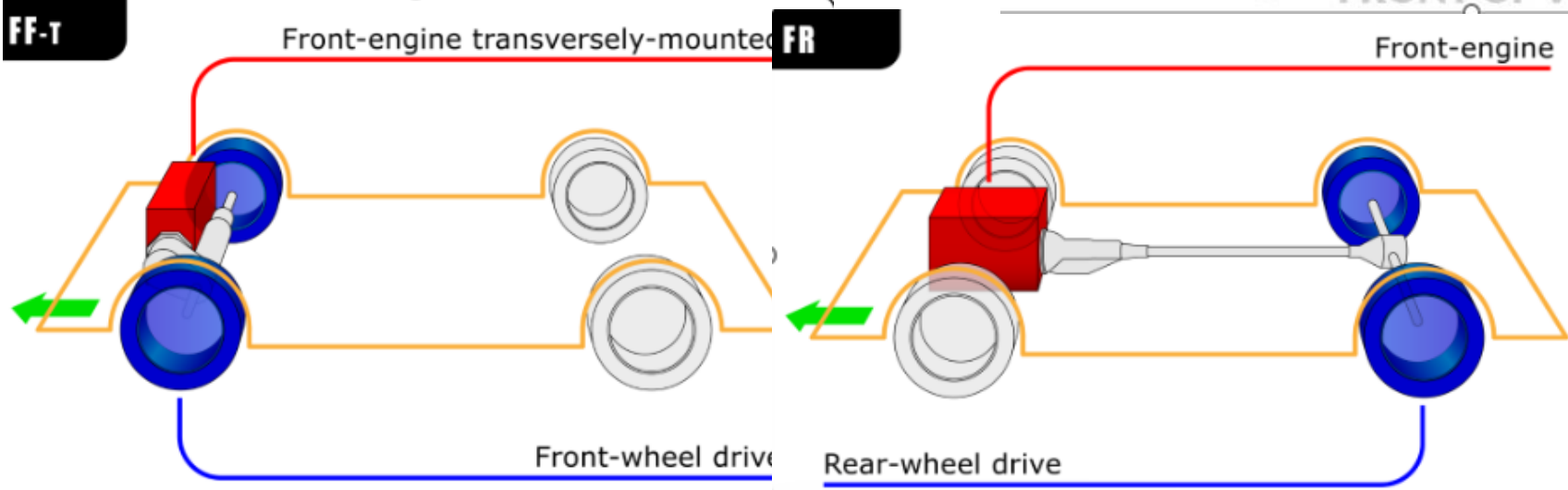


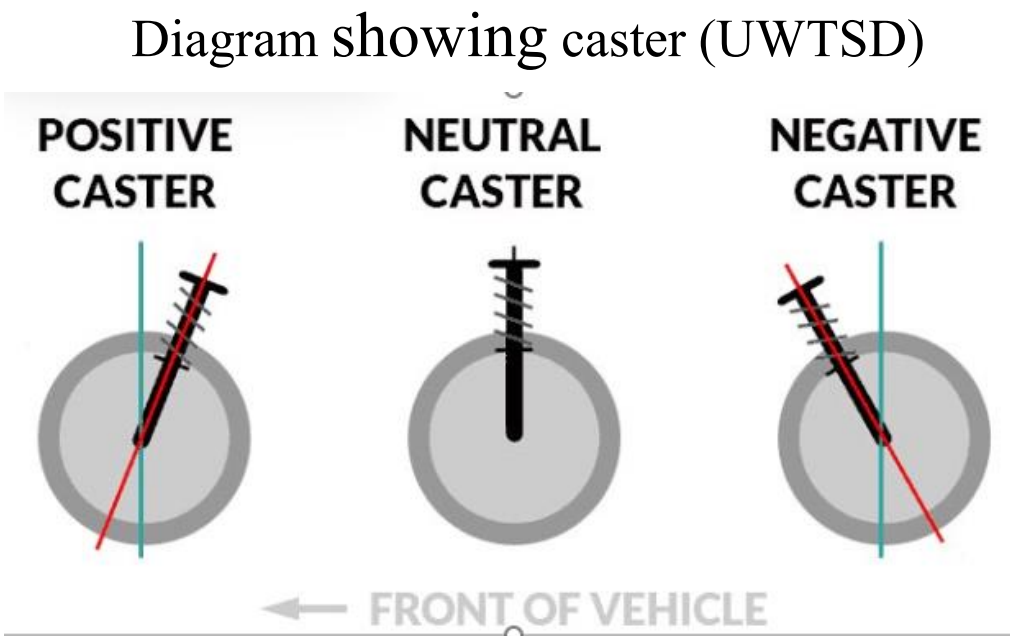
Photo illustrating the difference between FF and FR setups (UWTSD-Andrew noble)

Suspension Systems

The main responsibility of suspension systems is **comfort, ride** and **handling**.

Suspension systems support the weight of the vehicles body. They also isolate the occupants of the vehicle from changes in the road surface, Aswell as maintaining the contact patch of the tyre to the road.

Suspension systems must allow **vertical movement** in the wheels while also minimising changes in the alignment of the wheel during motion.



Suspension Geometry

There are 3 Main parameters in suspension geometry which have a massive influence on how the vehicle feels and handles.

These are **Camber, Caster** and **Toe**

Camber is the angle of the wheel relative to the road surface, being either **-ve +ve** or **neutral** (top of wheel pointing in or out)

Produces a small amount of lateral forces from the tyre.

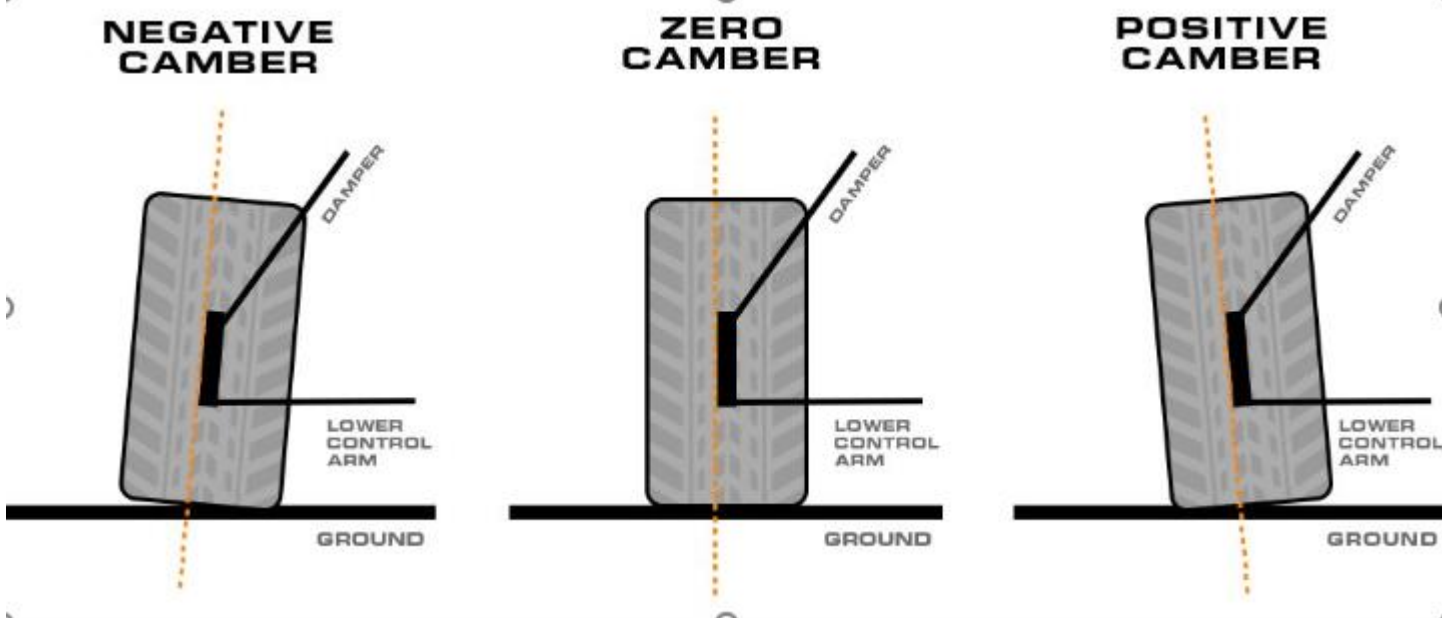


Diagram showing camber (UWTSD)

Caster is the position of the wheel relative to the top mount of the vehicle

Most vehicles run positive castor however excessive castor creates heavy steering

Negative caster is inherently unstable

Toe

Toe is the direction the front wheels are pointing relative to the vehicle's **centreline**. It affects the turn in and response of the vehicle

Running **Toe In** creates better straight-line stability while sacrificing turn response.

Toe out creates better response when turning however reduces straight line stability

Excessive Toe creates scrub that will wear tires faster

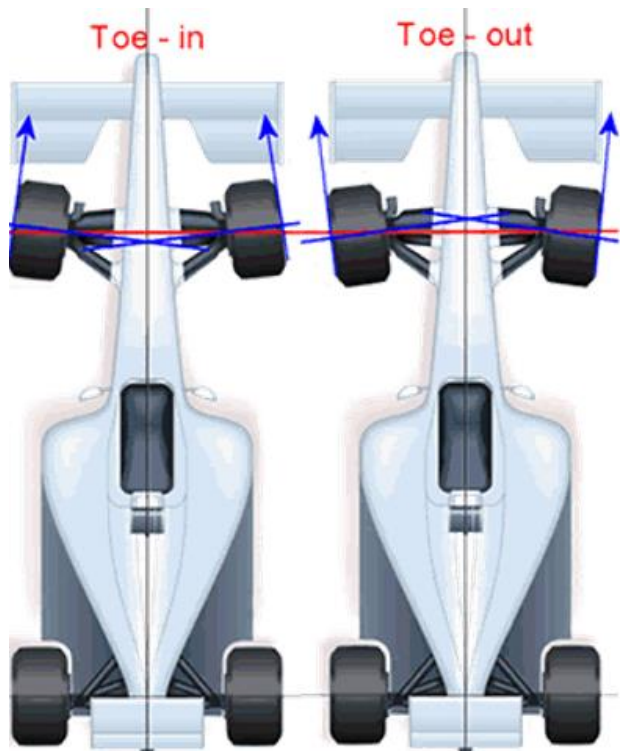


Diagram illustrating Toe (UWTSD)

All information and graphs included are extracted from UWTSD Powerpoint (Andrew Noble)