



Introduction to Vehicle Dynamics

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Introduction

This poster displays a brief overview on a vehicle dynamics lecture, by Andrew Noble.

The lecture included a wide variety of topics, such as centre of gravity, drivetrain configurations, suspension geometry etc.

The lecture went over how individual components that make up a vehicle has a direct effect on how the vehicle drives/feels. The lecture glossed over how and why the different choices made in a vehicles manufacturing process are better suited for either road or track use, or sometimes both.

Suspension Geometry

Vehicles have 3 main variables when it comes to suspension geometry, being **toe**, **caster** and **camber**, which each have a large influence on vehicle handling.

Toe relates to where the front wheels are **pointing**, **relative** to the vehicle's **longitudinal centre-line**.

Caster is the measure of how far forward or behind the **steering axis** is to the **vertical axis**, when looking from the side, and has a direct influence on steering **self-centering** and overall steering **effort**.

Camber is the angle of the wheel relative to the road surface, and controls influence of attitude change during cornering. It is considered **-ve** when the top of the wheel **leans in**, and **+ve** when the wheel **leans out**, in relation to the **centre of the car**.

References

All information/graphs/images included in this poster have been sourced from the UWTSD "Introduction to Vehicle Dynamics" PowerPoint, written by Andrew Noble.

Vehicle Drivetrain Configurations

Vehicles, whether road or track, often come with varying drivetrain configurations, depending on the use of the vehicle.

They come in many layouts, most common being **FF**, specifically **FF-T (transverse-mount front engine, front wheel drive)**. This layout is often the cheapest to produce, simple to design/assemble, and tends to require less components as opposed to other configurations.

Another common setup, **usually used in "sportier" cars**, is **FR (front engine, rear wheel drive)**.

This set-up requires the use of **new components**, such as an entirely **independent rear differential**, and the **propeller shaft** (which connects the gearbox to the differential, with driveshafts out to the driven wheels.)

Forces Acting on a Vehicle

A vehicle will experience several forces acting upon itself at any one point.

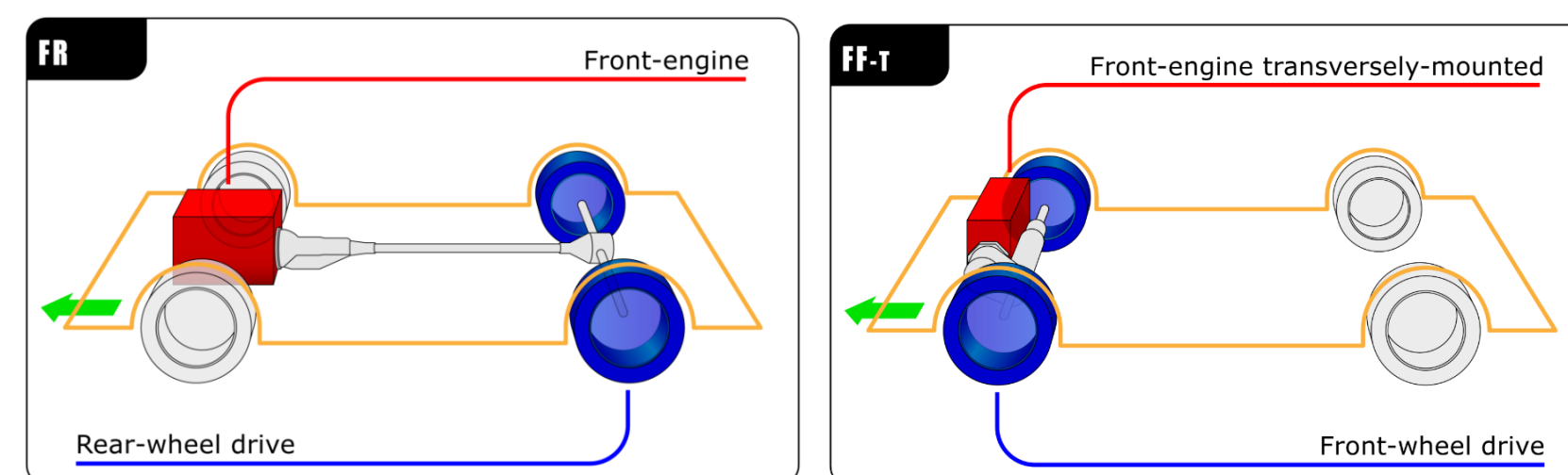
The vehicles **mass** constantly produces **vertical forces**, with the **weight** of the car producing a **downward force**. The **tyres** of the vehicle produce an **equal reactive force**, acting **upwards simultaneously**, an example of **Newton's 3rd law**.

Upon the vehicle's **acceleration**, yet another force, **aerodynamic drag**, which reacts in the **opposite** of the **direction of travel**, relative to the **speed** of the vehicle.

Drive force (also known as **tractive effort**), when **accelerating**, is what pushes the vehicle forwards or backwards, **dependent** on the active **selected gear**.

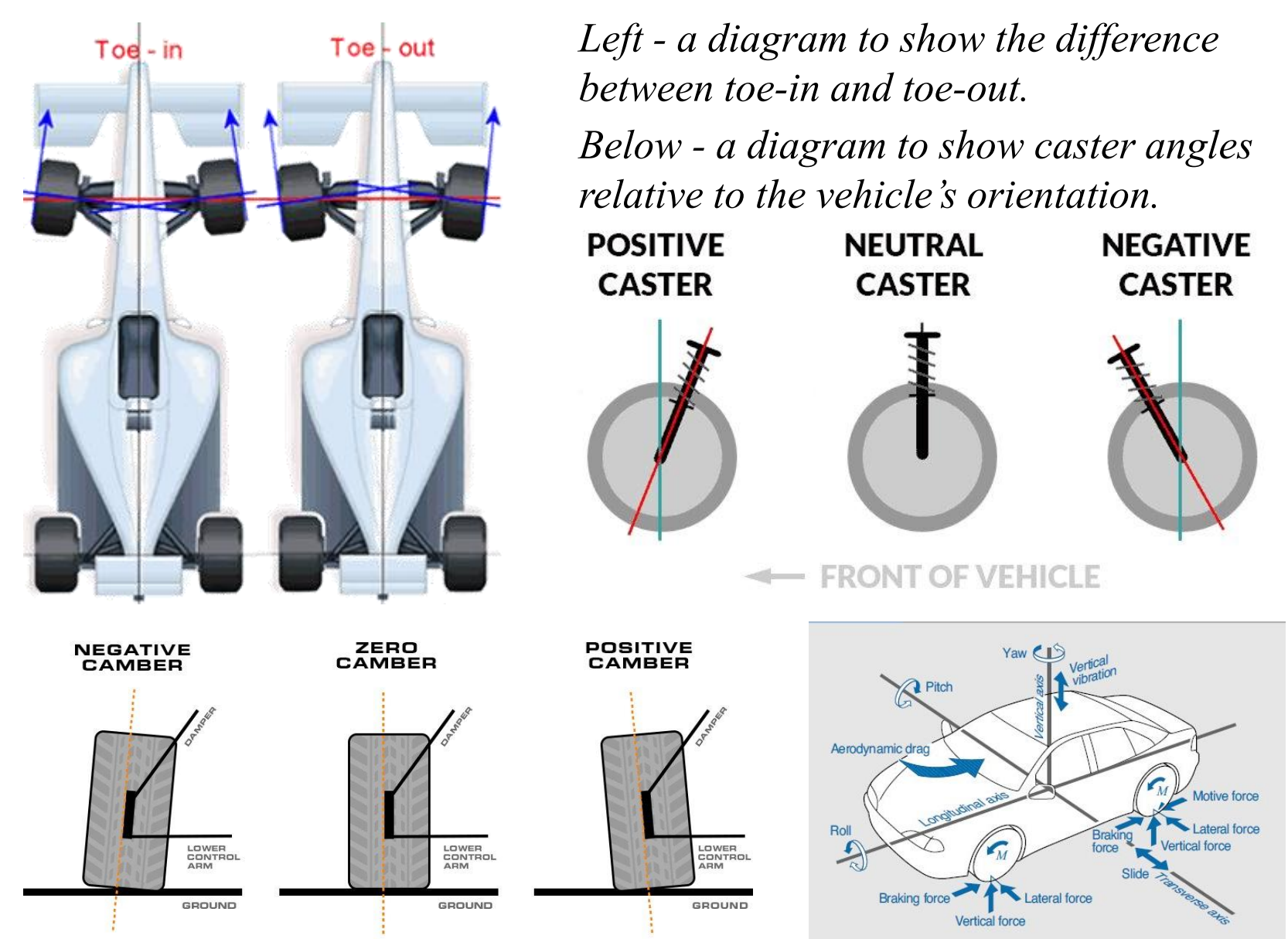
Longitudinal forces come into play depending on whether the vehicle is **accelerating** or under **braking**.

Rolling resistance then acts **against** the **intended direction of travel**.



Left (above) – a diagram showing the “FR” drivetrain configuration.

Right (above) – a diagram showing the “FF-T” drivetrain configuration.



Left (above) - a diagram to show different camber angles, relative to the centre of the vehicle.

Right (above) – a diagram to show different forces a car experiences.

Suspension Systems

The suspension systems' main purposes consist of:

- **Supporting** the vehicles body **weight**
- **Isolating** the **occupants** from changes in road surface (bumps etc.)
- **Maintaining contact** between the **tyre** and the **road surface**
- **Maintaining** the **attitude** of the **tyre** to the **road** (as best as possible)

Suspension is responsible for the **comfort**, **handling**, and **ride** characteristics of the vehicle.

Specific requirements are applied to each type of vehicle when it comes to suspension systems, as they often come in different **formats/configurations** such as air-ride (**hydro-pneumatic**), or MacPherson (**coil-spring** and **damper**.)

Suspension **must** allow **vertical movement** of the wheel and tyre, **minimise** changes in **wheel alignment** during **dynamic motion** and **steering**, and allow sufficient **angular travel** for the steering wheels/tyres.