

The background of the slide features a large, faint watermark of the Lafayette University seal. The seal is circular, with a profile of a man's head in the center. The text "LAFAYETTENSE" is arched over the top of the head, and "VERITAS" is arched over the right side. Below the head, the year "1862" is visible. The word "LAFAYETTE" is written in large, serif capital letters across the middle of the seal.

Automobile Aerodynamics

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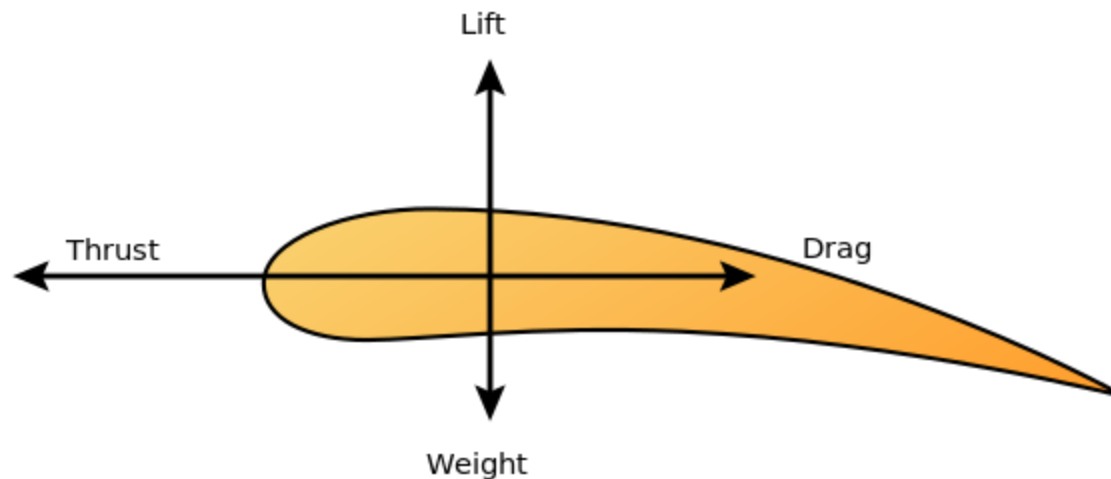
Purpose

- Reduce drag
 - Improve fuel consumption
- Reduce wind noise and reduce noise emission
 - Comfort Characteristics
- Prevent Lift and aerodynamic instability
- Create Downforce
 - Increase driving characteristics



Aerodynamics

- Branch of fluid dynamics the deals with how air interacts with objects
- Early efforts based around flight
- Principles began to be applied to cars in 1920's



Fundamental Concepts of Aerodynamics

- Flow Classification
 - Subsonic (incompressible)
 - Transonic
 - Supersonic
 - Hypersonic
- Continuum assumption
 - Avoid molecular level collisions
 - Density and Flow Velocity anywhere in the flow
- Laws of Conservation
 - Mass
 - Momentum
 - Energy



Drag

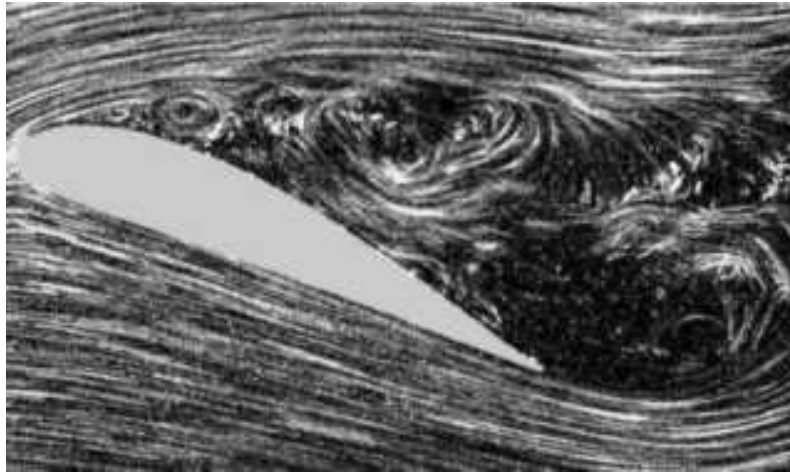
- Air Resistance
- Heavily dependent on velocity
- 3 Types
 - Parasitic
 - Wave
 - Lift-Induced

$$F_D = \frac{1}{2} \rho v^2 C_D A$$



Parasitic Drag

- 3 Types
 - Form
 - Interference
 - Skin-Friction












http://upload.wikimedia.org/wikipedia/commons/6/67/Flow_separation.jpg

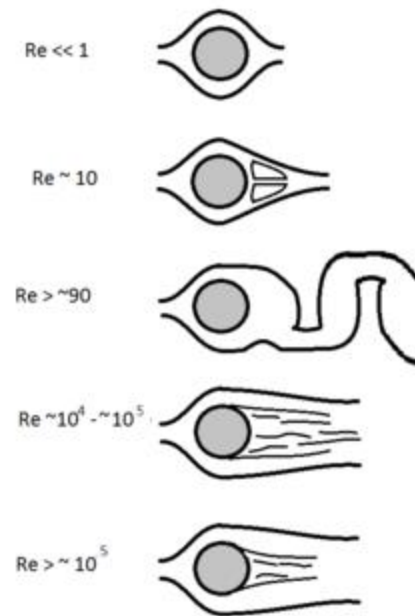


Drag Coefficient

Based off the shape of the object and Reynolds Number

Shape	Drag Coefficient
Sphere → 	0.47
Half-sphere → 	0.42
Cone → 	0.50
Cube → 	1.05
Angled Cube → 	0.80
Long Cylinder → 	0.82
Short Cylinder → 	1.15
Streamlined Body → 	0.04
Streamlined Half-body → 	0.09

Measured Drag Coefficients



Automobile Drag Coefficients

Average automobile is around: .3 - .35

SUV: .35-.45

Formula1: .7 - 1.1

Truck: .4

Drag Area

Drag Coefficient * Area





http://upload.wikimedia.org/wikipedia/commons/thumb/e/e7/2012_NAIAS_Red_Porsche_991_convertible_%28world_premiere%29.jpg/1280px-2012_NAIAS_Red_Porsche_991_convertible_%28world_premiere%29.jpg



http://upload.wikimedia.org/wikipedia/commons/thumb/0/04/Hummer_H2_black.JPG/1280px-Hummer_H2_black.JPG



Reducing Automobile Drag Coefficients

- Remove

- Roof rack
- Mud Flaps
- Rear Spoiler
- Mirrors
- Antenna

- Add

- Wheel Covers
- Modified Front Bumper
- Partial Grille Block
- Undertray
- Fenderskirts
- Boattails & Kammbacks



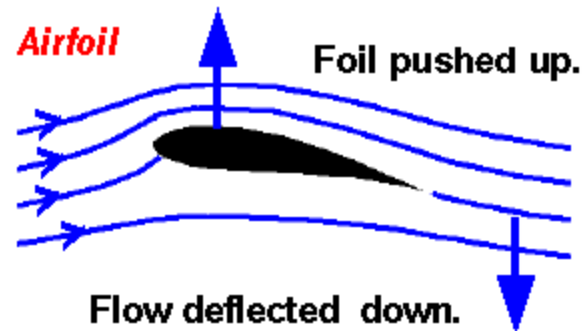
Lift



Lift

The object will exert a downward force on the air. Which will cause the air to exert an upward force on the object

$$L = \frac{1}{2} \rho v^2 C_L A$$



Downforce

$$D = \frac{1}{2} \rho v^2 (W S) H F \alpha$$

Opposite of Lift

Two primary components

- Shape of Body
- Use of Airfoils

Better Handling

Proportional to Drag



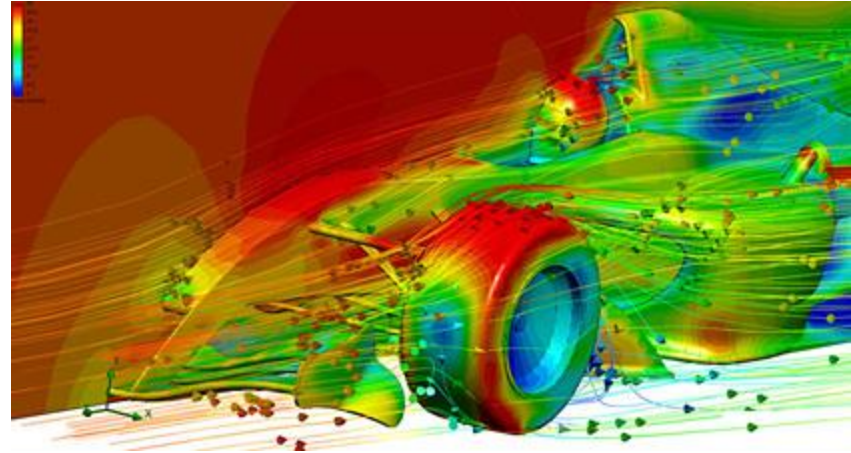
Modeling

Wind Tunnel

Computer Modeling



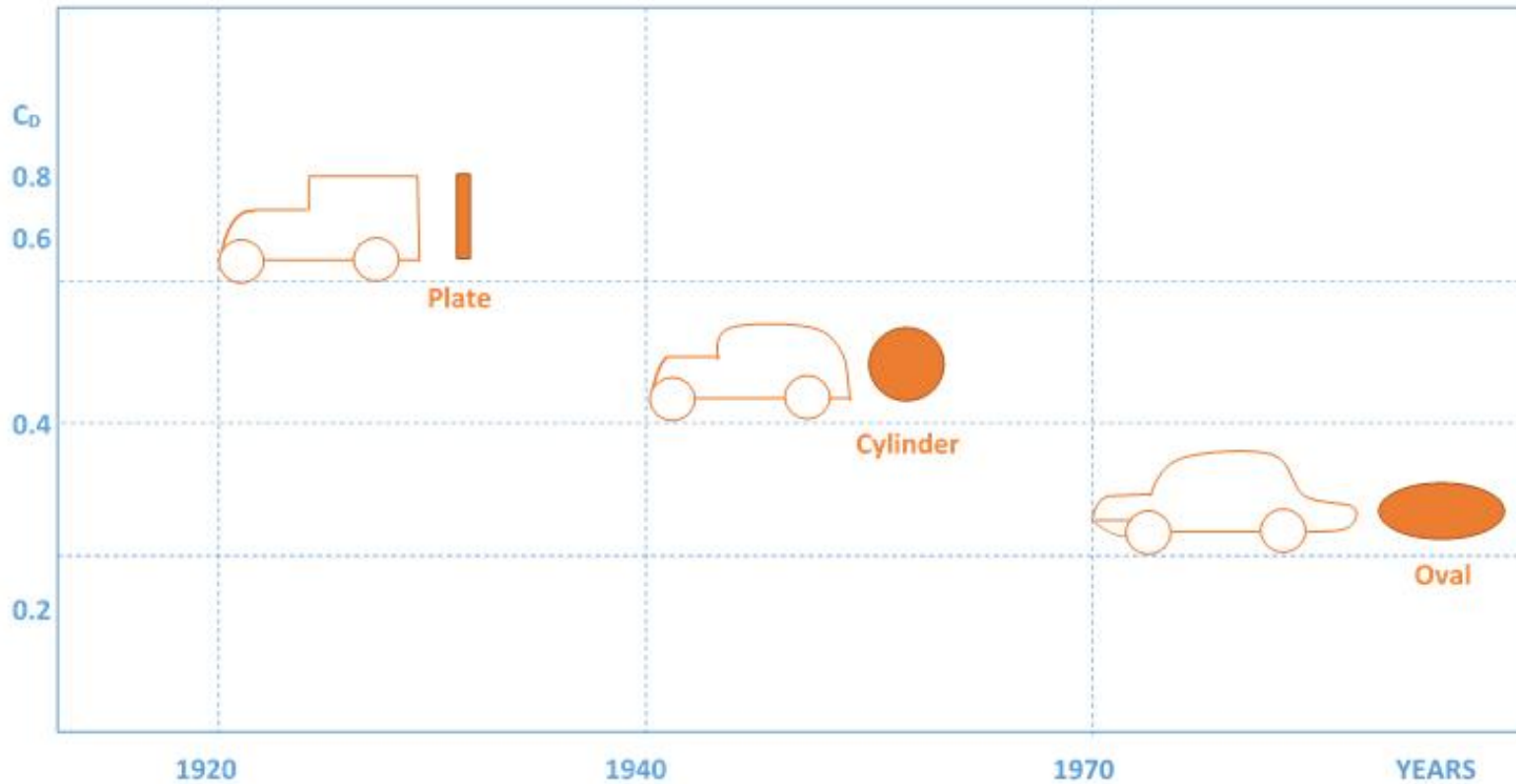
<http://cdn.speedhunters.com/wp-content/uploads/2008/09/2008-TechArt-GTstreet-RS-based-on-Porsche-911-GT2-Wind-Tunnel-1024x768.jpg>



http://www.mentor.com/company/news/f1-limitation-on-use-of-cfd-software-could-benefit-more/mainColumnParagraphs/0/column1ColumnParagraphs/0/content_files/file0/Voxdale1_smaller_420.jpg



History



http://upload.wikimedia.org/wikipedia/commons/5/58/Aerodynamic_Drag_of_Car.jpg



Comparison to Aircraft

- Shape of a road vehicle is much less streamlined compared to an aircraft.
- Operating speeds are lower
- Ground vehicle has fewer degrees of freedom than an aircraft, and its motion is less affected by aerodynamic forces.



Moving Forward



<http://www.uvmaero.org/wp-content/uploads/2014/05/team-pic-2014.jpg>



Questions?

LAFAYETTE

