

Lecture 1: How we study aerodynamics

Thursday, August 27, 2020 10:55 AM

AERODYNAMICS

Air

Movement due to force

The study of how AIR moves around and FORCES objects

How fluids move
Fluid Dynamics
liquids + gas

Planes & stuff
Aerospace Eng.

Aero dynamics

- ↳ Materials
- ↳ Flight Mach.
- ↳ Propulsion
- ⋮

Why just air??

Humans regularly encounter 2 Fluids on Earth

AIR (Gas)



vs.

WATER (Liquid)





"Aerodynamics"

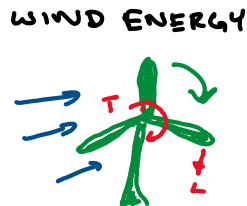
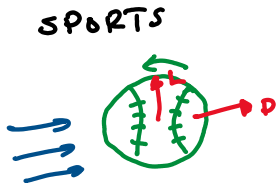
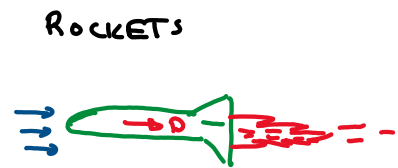
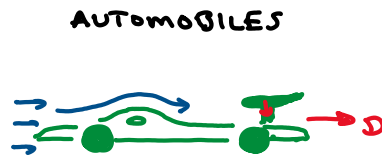
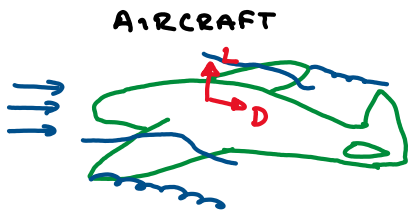
"Hydrodynamics"

- The fluid mechanics (conservation eqns) are the same

- WATER** is **INCOMPRESSIBLE**, Air is not
 $\rho = \text{const.}$ (const. density) $\rho \neq \text{const.}$

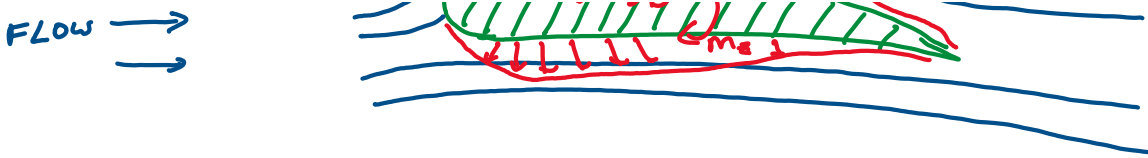
- WATER** is **HEAVY**, so **BUOYANCY** holds you up (generally) 
- AIR needs a **LIFT** force 

What can I do with **AERODYNAMICS** ?



A. How we study **AERODYNAMICS**





1. Focus on BODY FORCES

Recall FLUID MECH.



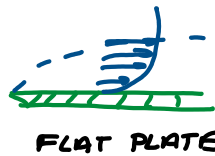
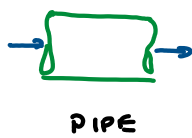
In AERO there's less focus on

$u, v, w = \dots$
 and more focus on **BODY FORCES** (F_x, F_y)
MOMENTS (M_x)
PRESSURE Dist. (P)

2. Less EXACT, more LOOK-UP TABLES

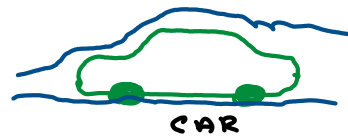
- In FLUID MECH., the CONSERVATION Eqn's were solved exactly

Focus on simple geometry

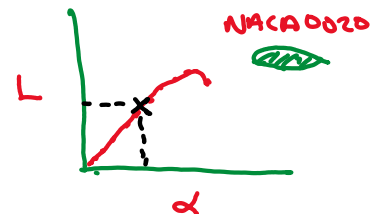
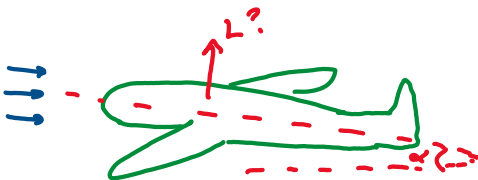


- In AERODYNAMICS, hard to find exact solutions

· Complex geometry



So, we look for **EMPIRICAL EVIDENCE**

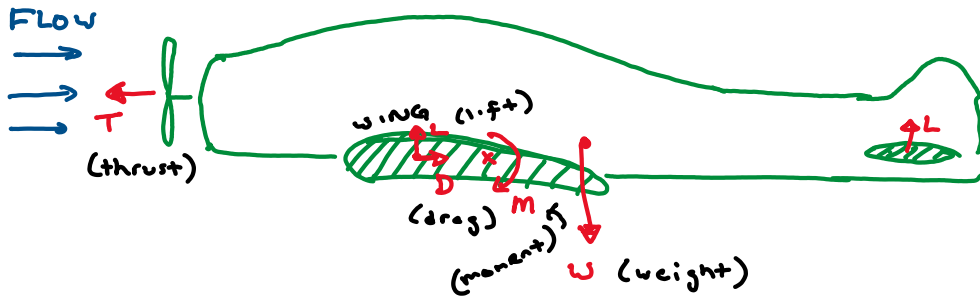


3. Force balances (like free-body diagrams)

- When an **OBJECT** moves through **AIR**

it feels **FORCE**

- To keep our **OBJECT** steady (not accelerating)
we need to counter these **FORCES**



BALANCES

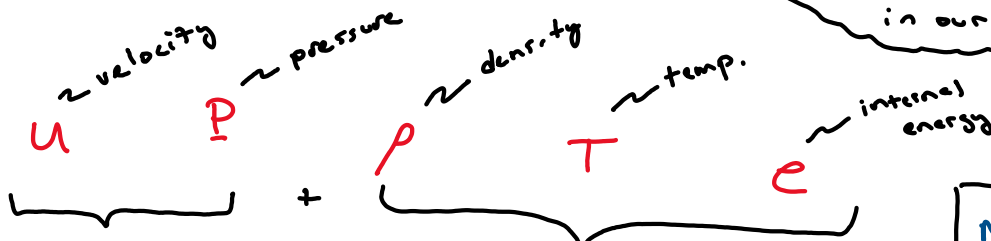
LIFT = WEIGHT
... or you fall

DRAG = THRUST
... or you slow / speed up

MOMENTS countered
... or you spin

So, much of **AERO** (and Flight mechanics) becomes a **FORCE BALANCE**

4. We care about more flow variables

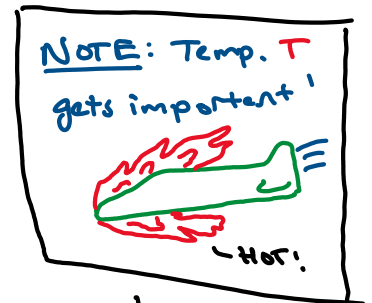


FLUIDS 101
(incomp. flow)

- Need:
- Cons. mass
 - Cons. momentum

AERODYNAMICS

- NEED:
- Cons. mass
 - Cons. momentum
 - Cons. energy → more unknowns!
 - eqn. of state + perfect gas



So, to approach **AERODYNAMICS** we use:

BODY FORCES



FORCE BALANCES



PREVIOUS OBSERVATIONS



MORE FLOW VARIABLES



