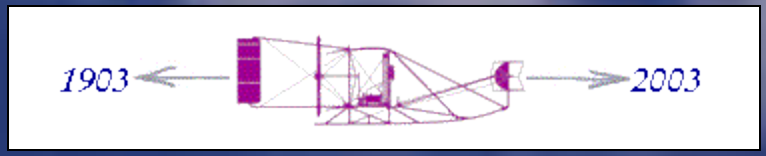
Aerodynamics: The Wright Way

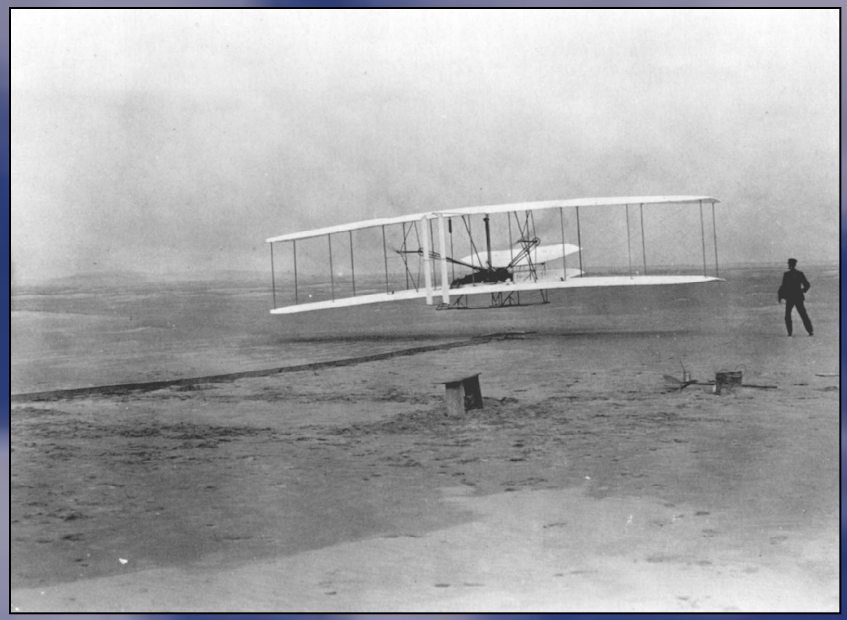
NASA Dryden Flight Research Center

Jennifer Cole



Powered, Controlled Flight: The Wright Understanding

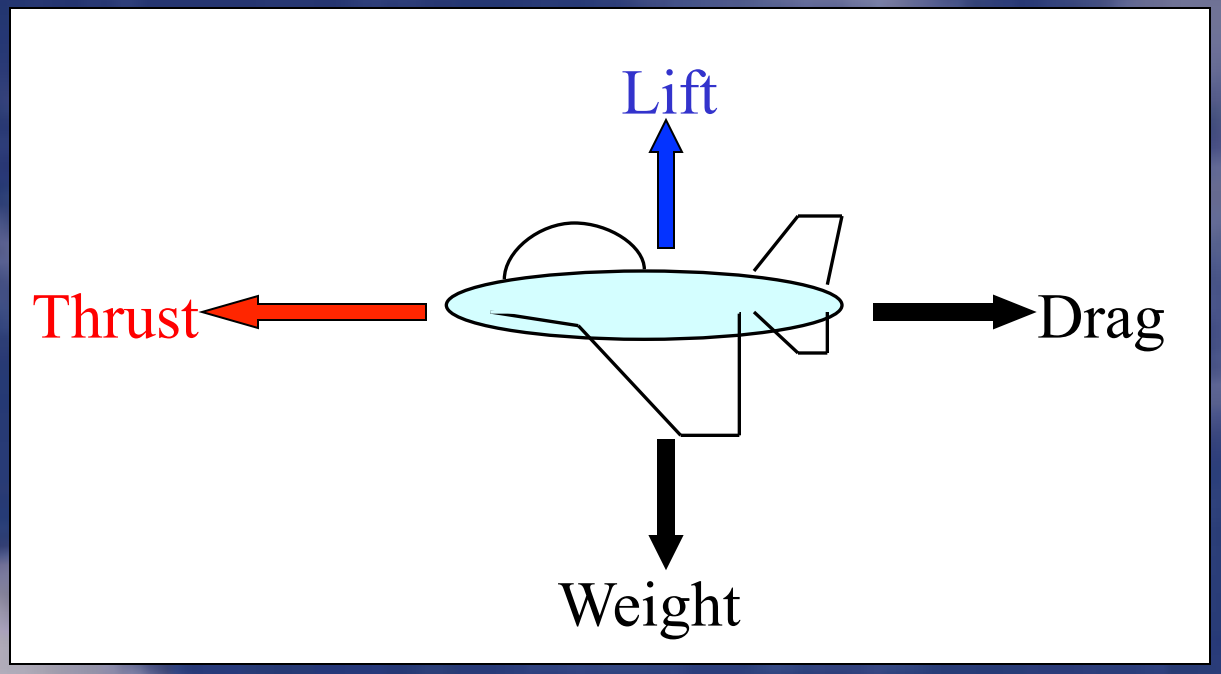
The first “Aerospace Engineers”...



And their invention that changed the world...

The Force Family

The FOUR Forces of Flight….



Some Rocket Science…

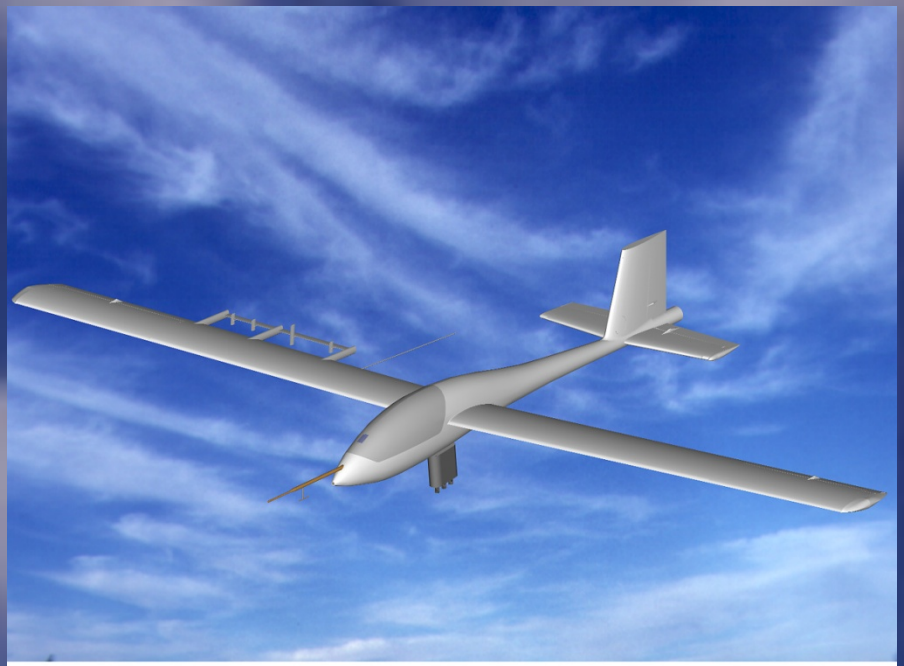
The Thrust of an airplane is Newton's third law in action…

- For every action there is an equal and opposite reaction !!
- Rocket and jet engines produce thrust by burning fuel to generate hot gases which are expelled out the back…

What about Gliders…?

Gliders have no engines or propellers! How do they provide thrust?

- Gravity !!
- Gravity provides the acceleration towards the ground, and the glider picks up speed.

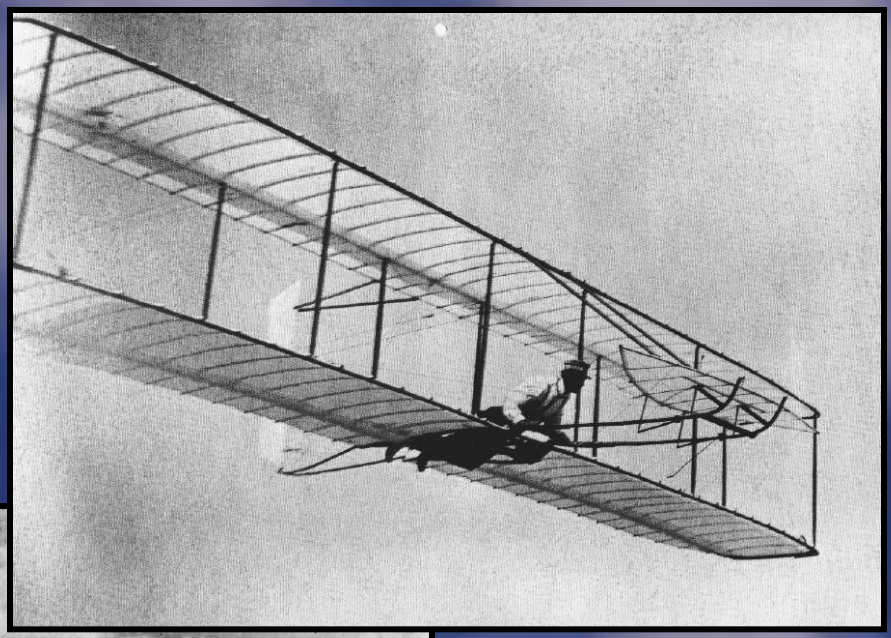


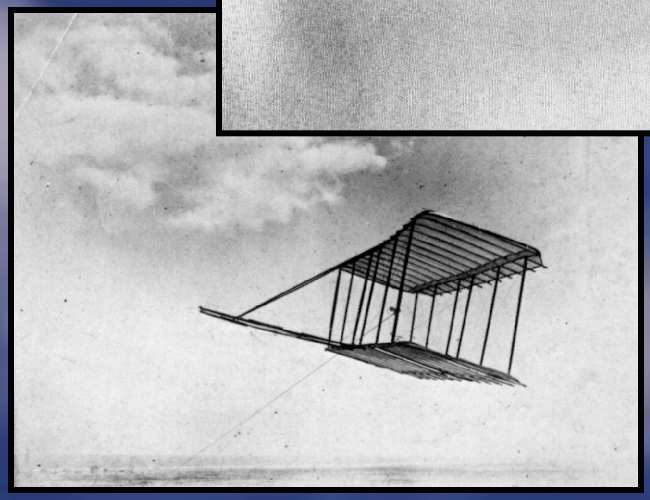
Dryden Flight Research Center ED97-44119-2 Generated SEP1997
This computer-generated image depicts the current design concept of the Apex high-altitude research sailplane being developed by Advanced Soaring Concepts for NASA-Dryden's ERAST program. (NASA/ASC graphic image)

Experiment #1

Try it!!

- Stand up
- Hold your glider high
- And just DROP IT!

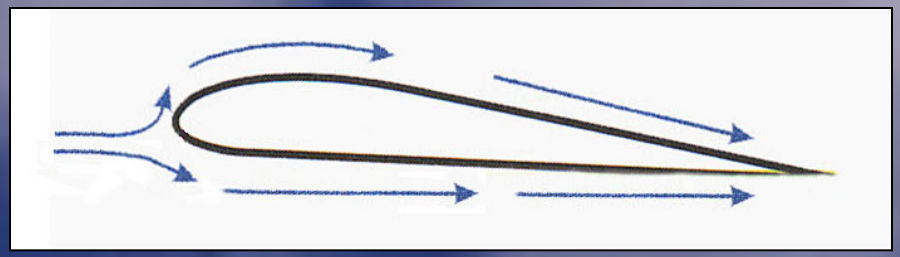


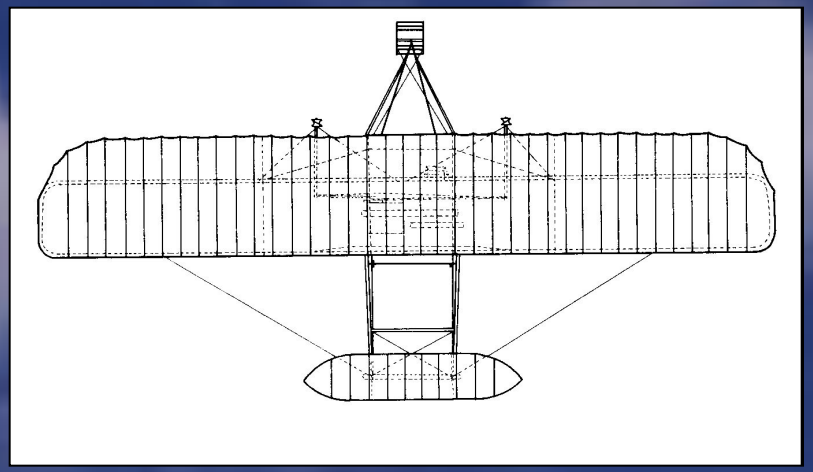


Lift: What Makes It Work

Lift depends on a few things:

- Wing Shape (airfoil)
- Velocity
- Angle-of-attack
- Altitude

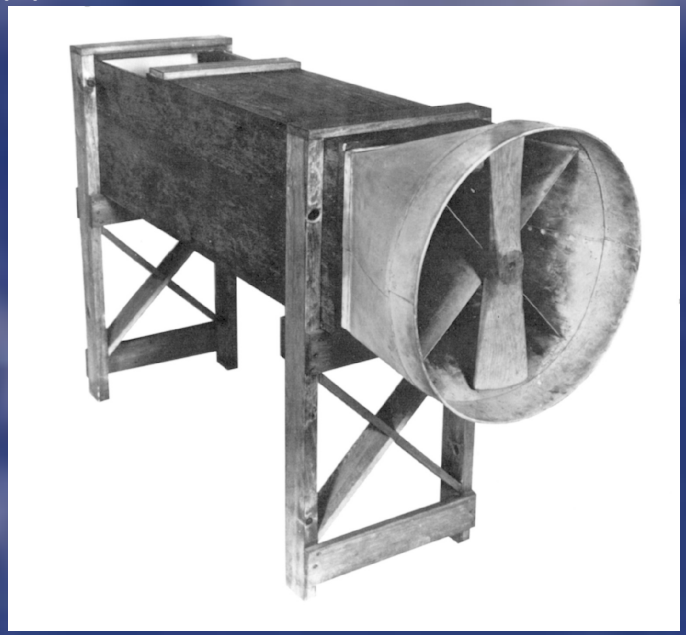




Experiment #2

Try it!!

- Take your piece of paper between your fingers
- Hold it just under your mouth…
- And blow!!!



The paper rises because of the pressure difference YOU created…

Bernoulli's Principle!

Bernoulli's Principle

Bernoulli's Principle says:

For any fluid flowing through an area, the smaller the area, the faster the fluid…
Ex: a pinched garden hose

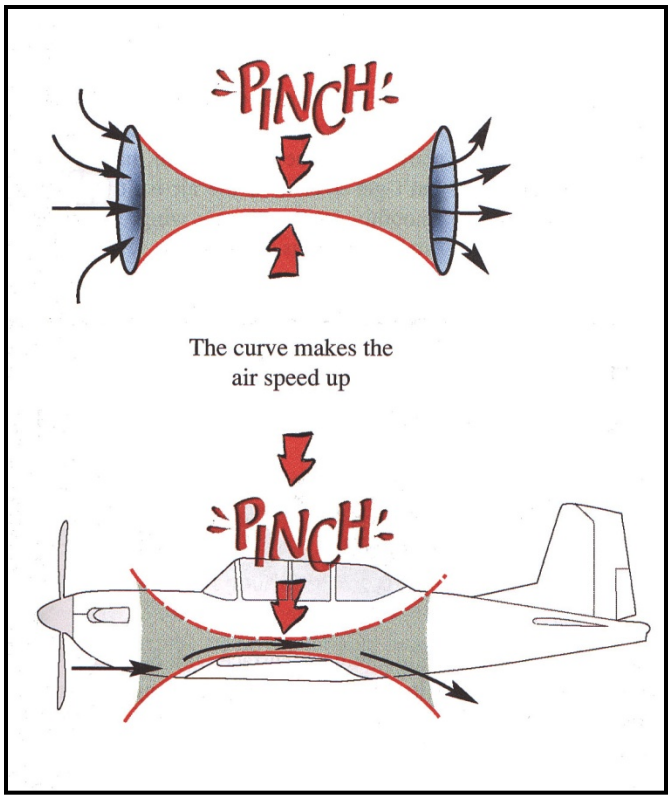
What does this mean???

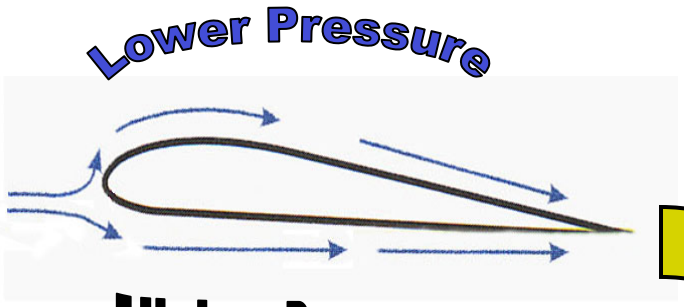
Faster air *creates lower pressure, and* ***slower air*** *creates* ***higher pressure.****.*
Ex: Paper Strip

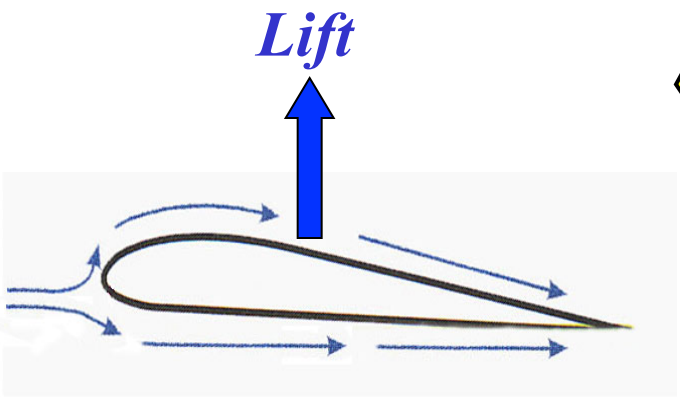
What does this REALLY mean???

An airplanes' wing creates lower pressure on top, and ***higher*** *pressure on the bottom, which results in* ***LIFT*** *!!!*

Bernoulli's Principle

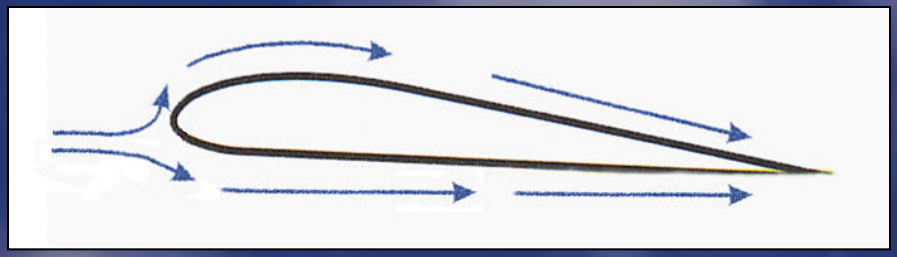






Airfoil: The Blueprint for Lift

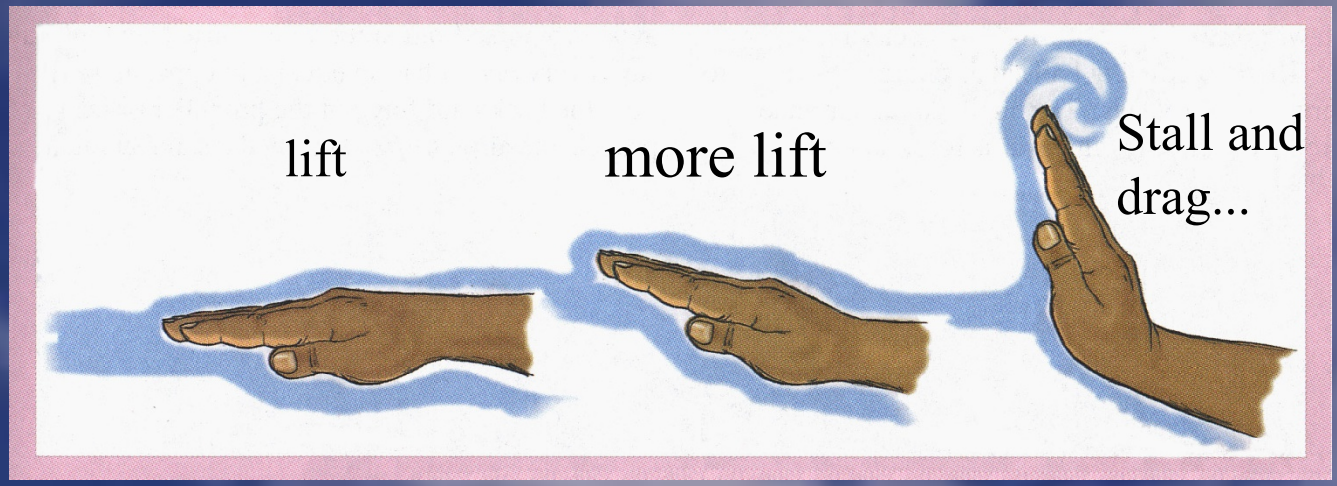
The shape of the wing is called the airfoil.



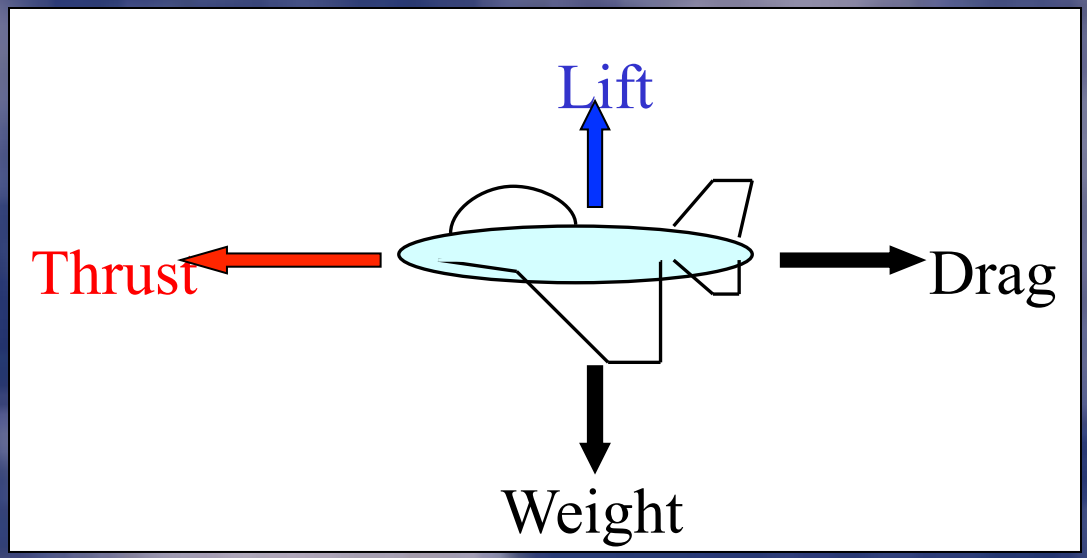
A wing can produce more lift by

- speeding up
- changing the shape of the wing (with ailerons)
- increasing angle-of-attack (by ‘pitching up’)

Angle-Of-Attack: Do-It-Yourself



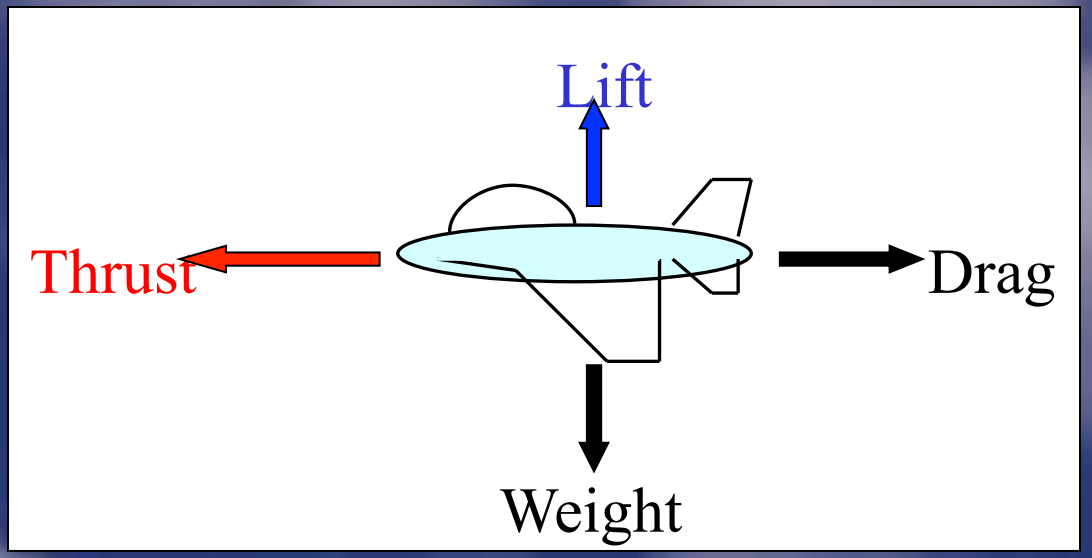
What about Drag and Weight??



Changes in Drag and Weight affect fuel and velocity and range…

Balancing the Forces

So we have LIFT on the wing, plus weight, drag and thrust…



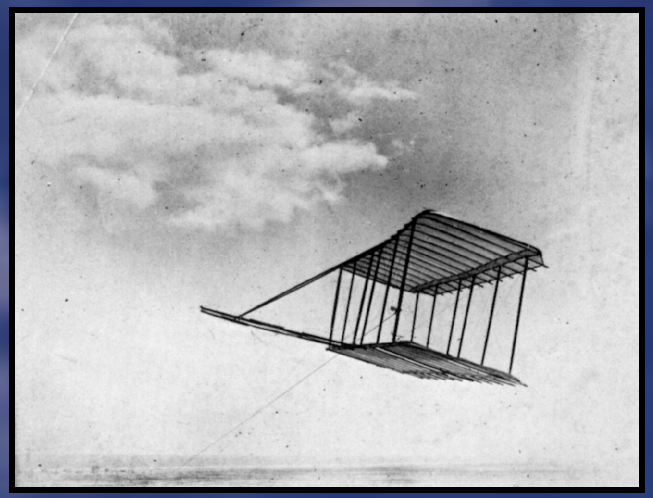
1) How do we balance the forces on the airplane so it doesn't fall out of the sky???

Ex: Balance your glider on your finger...

Experiment #3

Try it!!

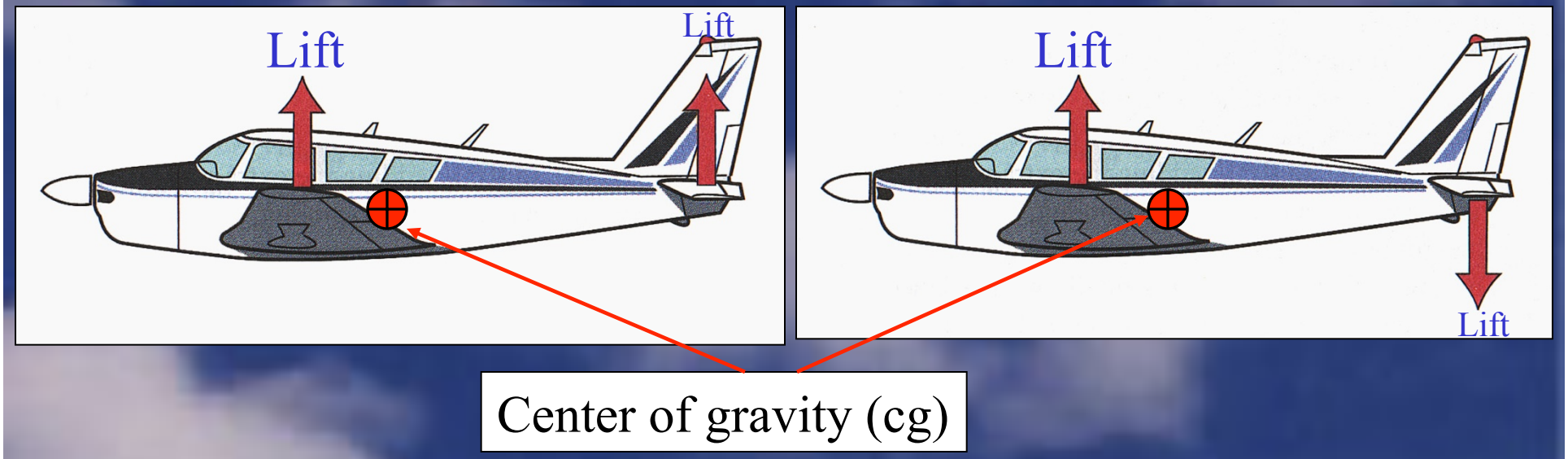
- Try to balance your glider on one finger!!
  - Find the Center of Gravity (CG)!
- Now blow on your glider!
  - Newton's first law (object at rest tends to stay at rest unless acted upon by an outside force!)



Control: The ‘Center’ of Gravity

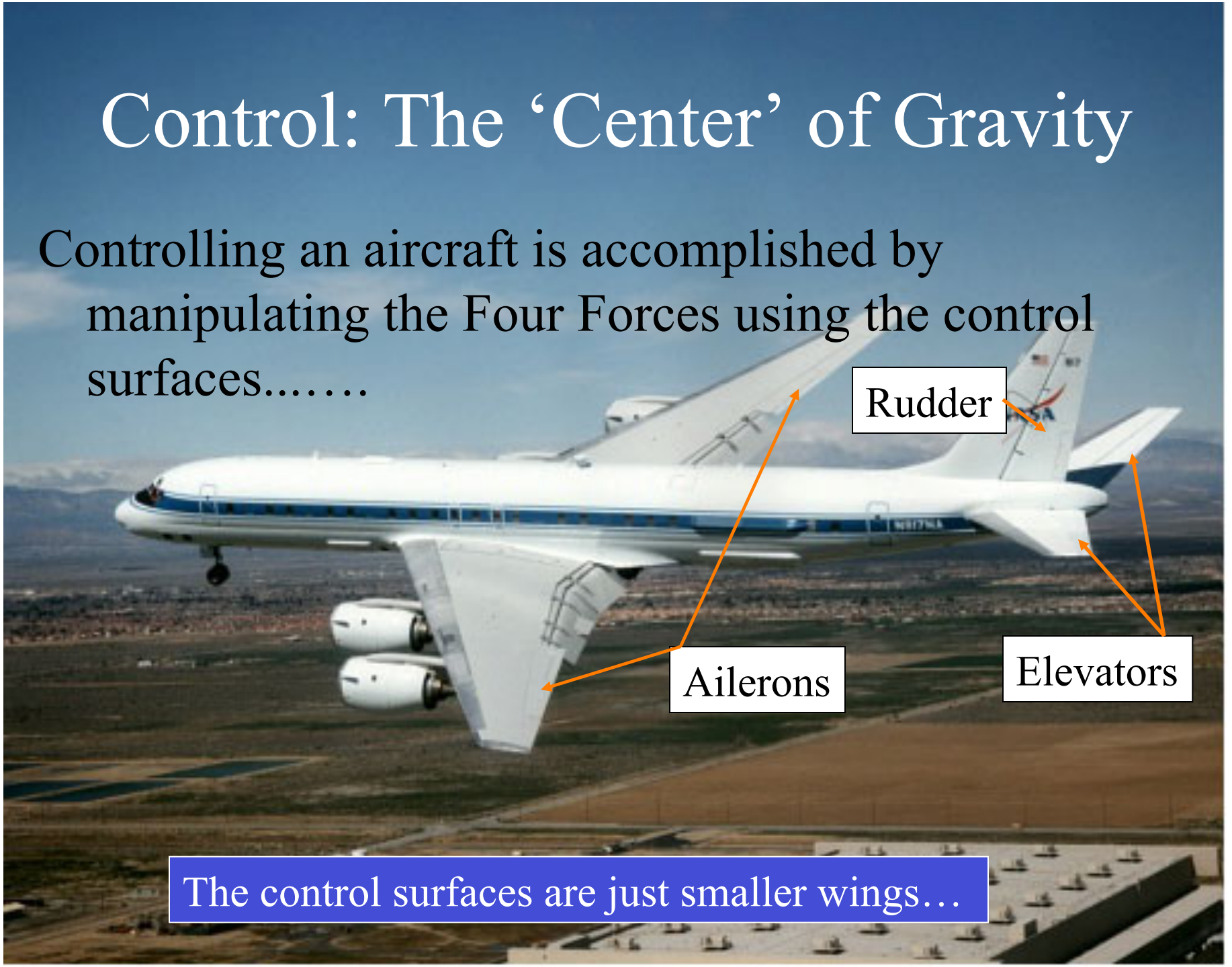
First Question: How do we balance the LIFT ??

Answer: With another wing !!



Control: The ‘Center’ of Gravity

Controlling an aircraft is accomplished by manipulating the Four Forces using the control surfaces…….



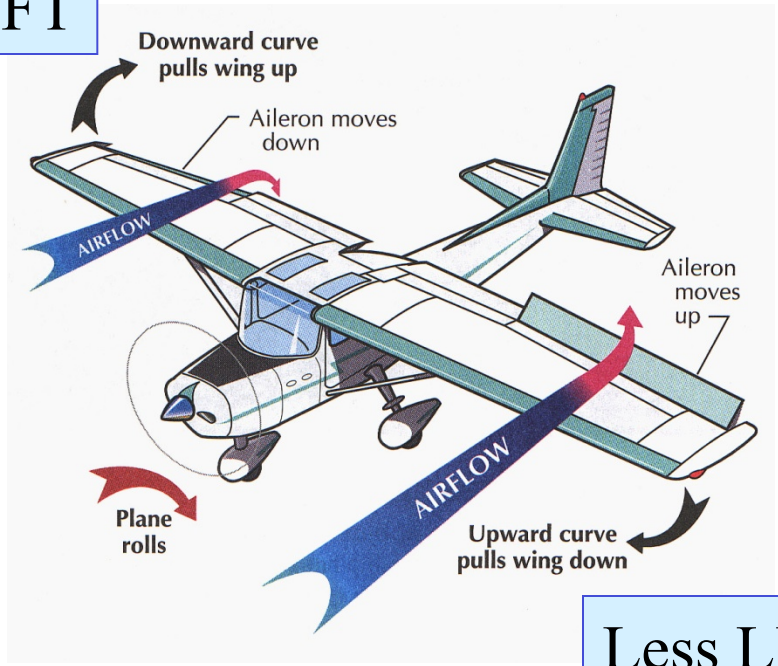
The control surfaces are just smaller wings…

Controlling the Airplane - ROLL

More LIFT

To make the airplane **ROLL** to one side, you **INCREASE** the **LIFT** on one side of the wing using **ailerons**...

With more lift on one wing, and less on the other, the aircraft **ROLLS** towards the weaker side...



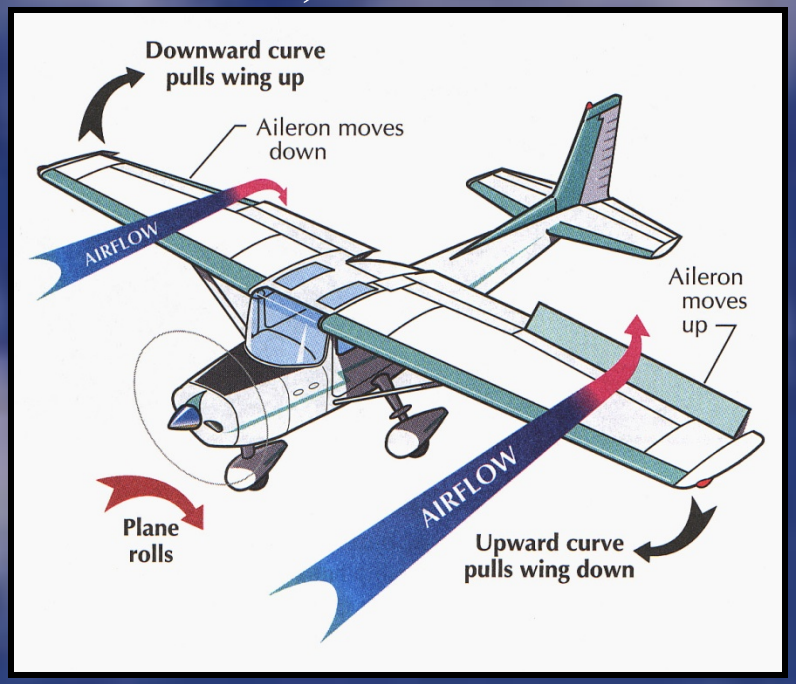
Less LIFT

The aircraft is controlled by changing the lift on the wing and tails…
The direction of the movement depends on where the cg is...

Experiment #4

Try it!!

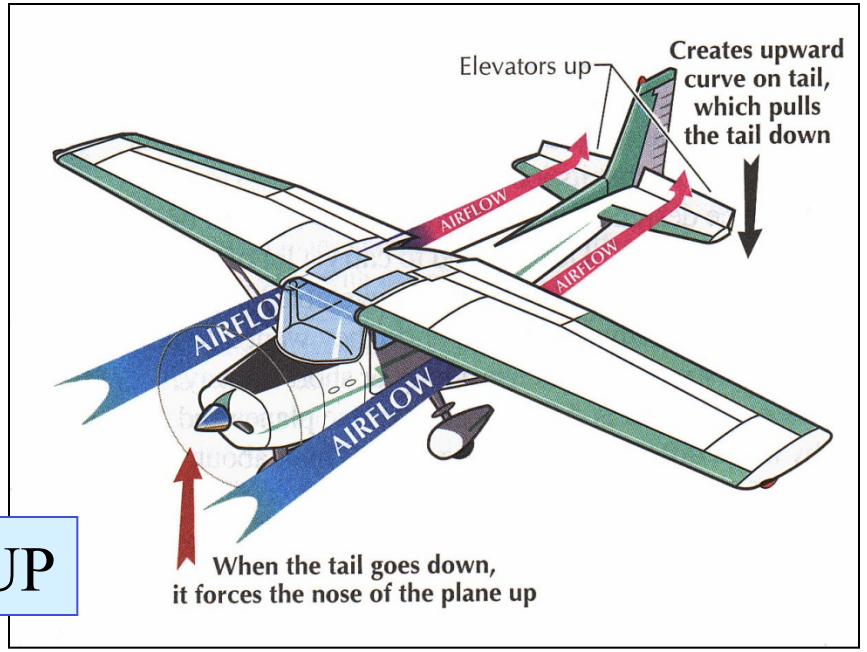
- Affix a Post-It note to each wing
  - (left side bent up, right side bent down)
- Now throw your glider!
- Which way did it roll?



Controlling the Airplane - Pitch

The **elevators** control the **lift** on the **horizontal tail**, and make the nose go **up and down**...

Less LIFT on tail



With less lift on the horizontal tail, the aircraft nose goes UP...

Nose goes UP

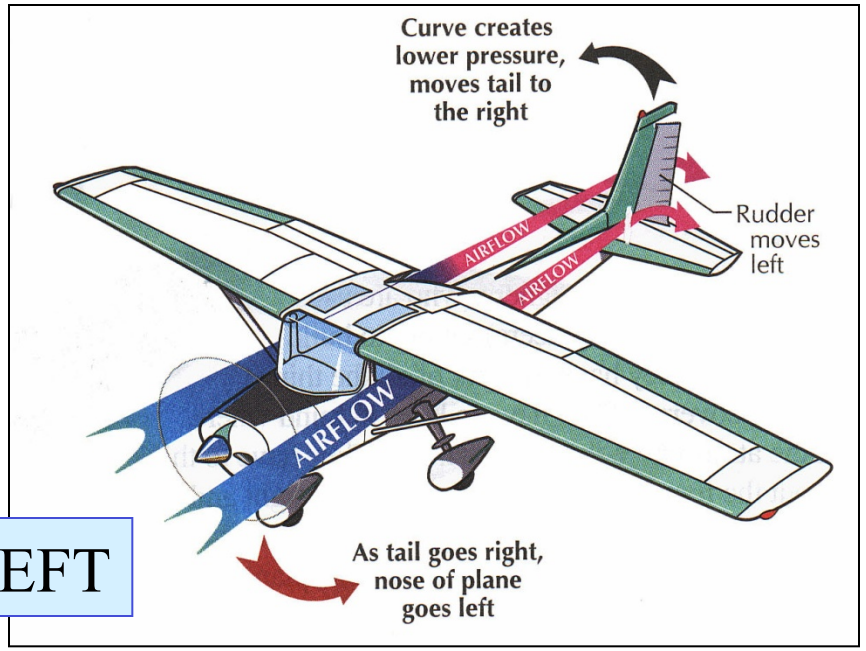
Controlling the Airplane - Yaw

The **rudders** control the **lift** on the **vertical tail**, and make the nose go **left and right**...

Lift moves tail to the RIGHT

The lift on the vertical tail pushes it to the **RIGHT**, and the aircraft nose goes **LEFT**…

Nose goes LEFT



Enjoy your gliders!

NASA Dryden Flight Research Center Photo Collection
http://www.dfrc.nasa.gov/Gallery/Photo/index.html
NASA Photo: ED06–0045–4 Date: April 14, 1981 Photo By: NASA JSC

The Space Shuttle Columbia touches down on lakebed runway 23 at Edwards Air Force Base, Calif., to conclude the first orbital shuttle mission.

Any questions ???