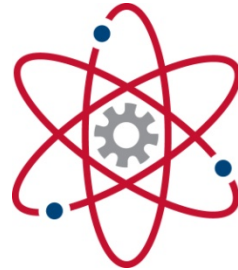




Gateway To Technology



PROJECT LEAD THE WAY

**PLTW**

Parts of an Aircraft



# What is an Airplane?



- Aircraft
  - More general term
  - Refers to any heavier-than-air object that is
    - Supported by its own buoyancy
    - Supported by the action of air on its structures
- Airplane
  - Heavier-than-air craft propelled by an engine
  - Uses aerodynamic surfaces (wings) to generate lift

# What is an Airplane?

Every airplane is an aircraft, but not every aircraft is an airplane.

- Space shuttle
- Gliders
- Helicopters



# Why So Many Types?

Every modern aircraft is built for a specific purpose.

- Different altitudes
- Different speeds
- Different weight-carrying capacities
- Different performance

# Why So Many Types?

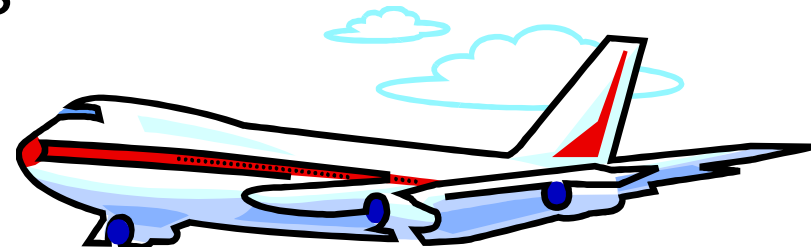
- Jet fighters

- Relatively lightweight
- Highly maneuverable and very fast
- Carry small amount of weight, including fuel
- Must refuel on long flights



- Passenger airplanes

- Larger, carry more weight, fly longer distances
- Less maneuverable and slower



# Why So Many Types?

- Wing types

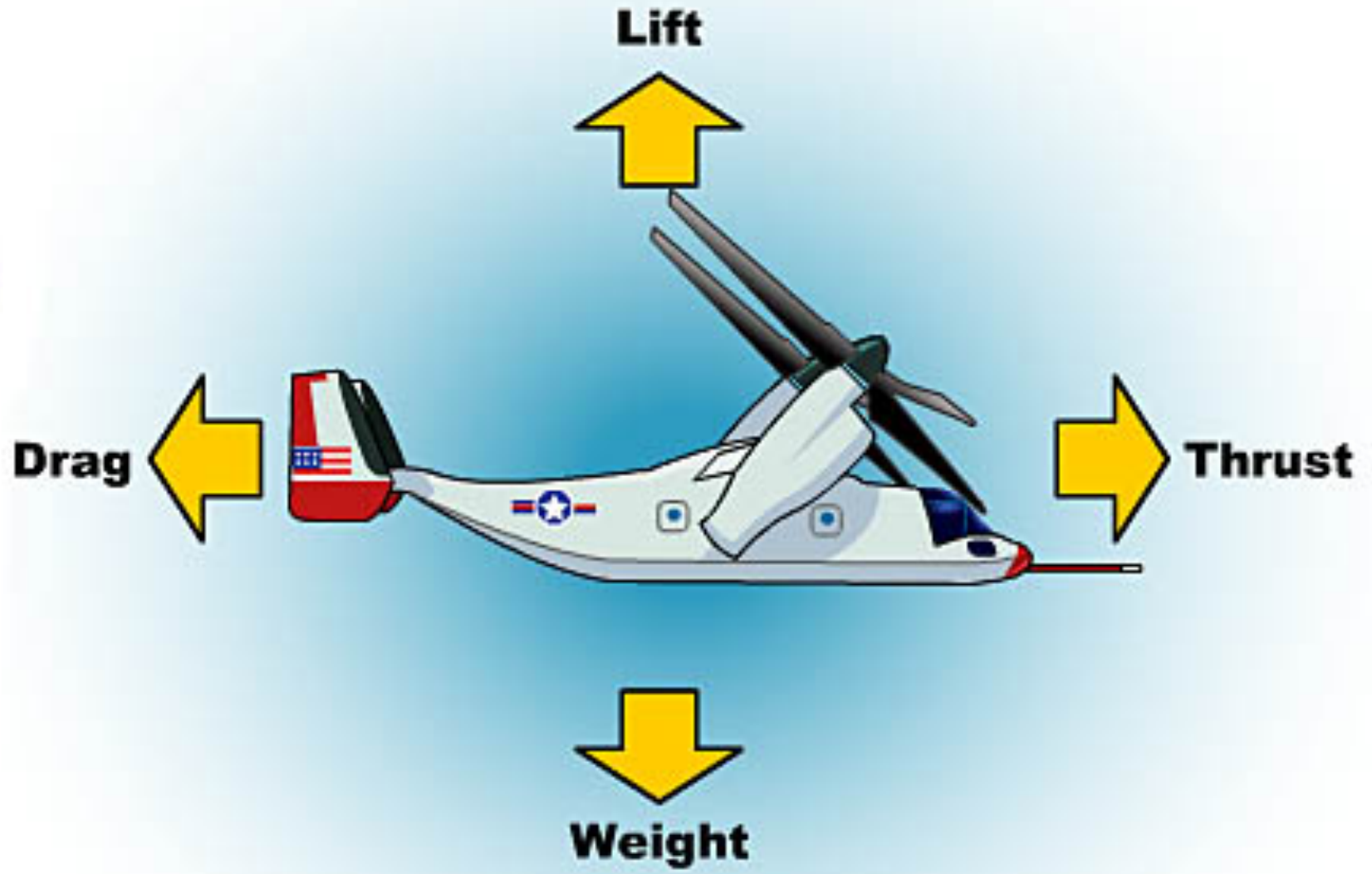


# Why So Many Types?

## Speed

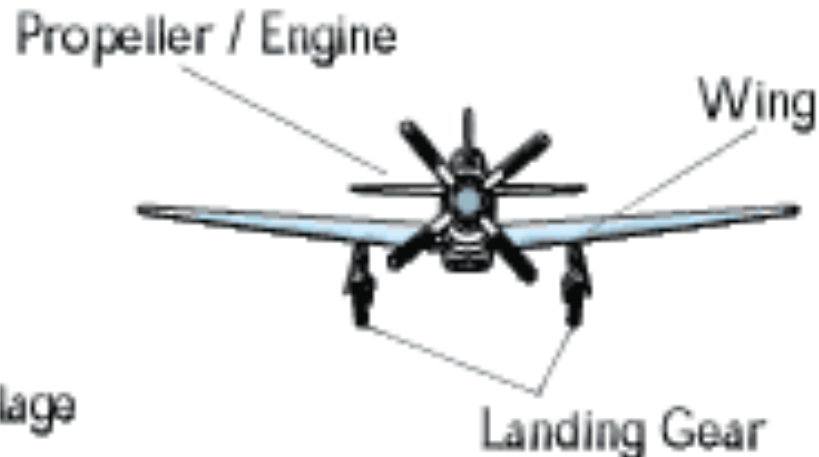
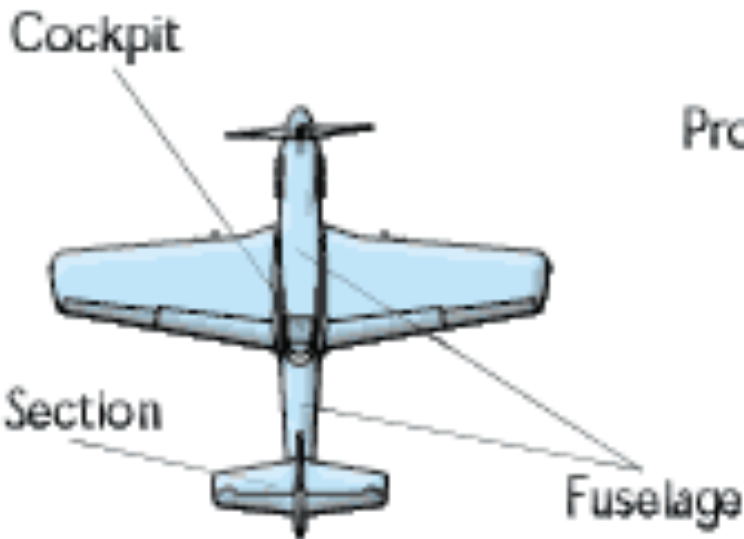
- The speed of sound is dependent on altitude and atmospheric conditions
- Mach is the term used to specify how many times the speed of sound an aircraft is traveling
- Subsonic: Less than Mach 1
- Transonic: Mach .9 to Mach 1.5
- Supersonic: All speeds above Mach 1
- Hypersonic: All speeds greater than Mach 5





# Parts of an Airplane

- Five basic structural components
  - Fuselage
  - Wings
  - Empennage (tail structures)
  - Propulsion system
  - Undercarriage



# Fuselage

- Main body structure
  - All other components are attached to it
- Contains
  - Cockpit or flight deck
  - Passenger compartment
  - Cargo compartment
- Produces a little lift, but can also produce a lot of drag



# Wings

- Most important lift-producing part of the aircraft
- Also carries the fuel
- Designed so that the outer tips of the wings are higher than where the wings are attached to the fuselage
  - Called the dihedral
  - Helps keep the airplane from rolling unexpectedly



# Wings



High-wing



Mid-wing

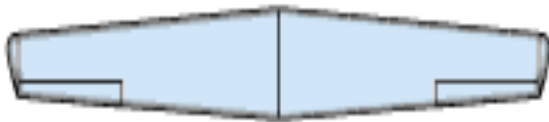


Low-wing

# Wing Designs



Rectangular Straight Wing



Tapered Straight Wing



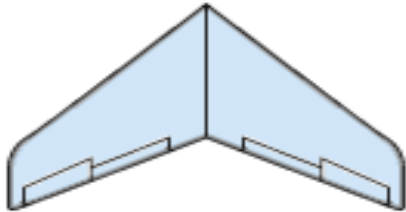
Rounded or Elliptical Straight Wing

- Straight Wing
  - Found mostly on small, low-speed airplanes
  - Good lift at low speeds
  - Not suited to high speeds
  - Creates a lot of drag because the wing is perpendicular to the airflow
  - Provides good, stable flight
  - Cheap and can be made lighter

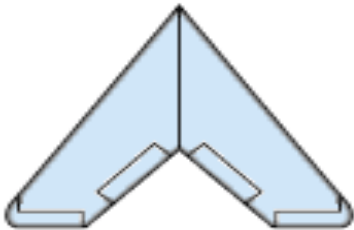
# Wing Designs



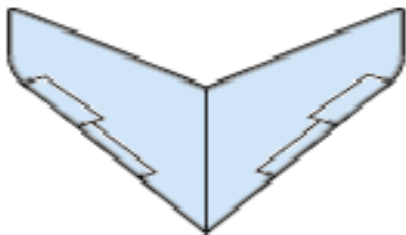
**Slight Sweepback Wing**



**Moderate Sweepback Wing**



**Great Sweepback Wing**

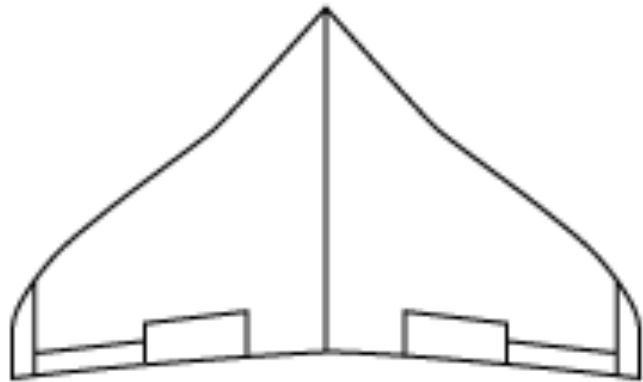
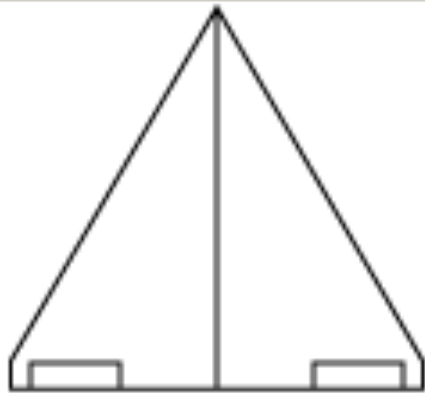


**Forward Sweep Wing**

- **Sweepback**

- Used on most high-speed airplanes
- Less drag, but more unstable at low speeds
- Amount of sweep depends on the purpose of the airplane
  - Commercial airliner has moderate sweep
  - High speed airplanes (e.g., fighters) have moderate sweep
  - No forward sweep wings are in mass production

# Wing Designs



Simple Delta Wing (top)  
and Complex Delta Wing  
(bottom)

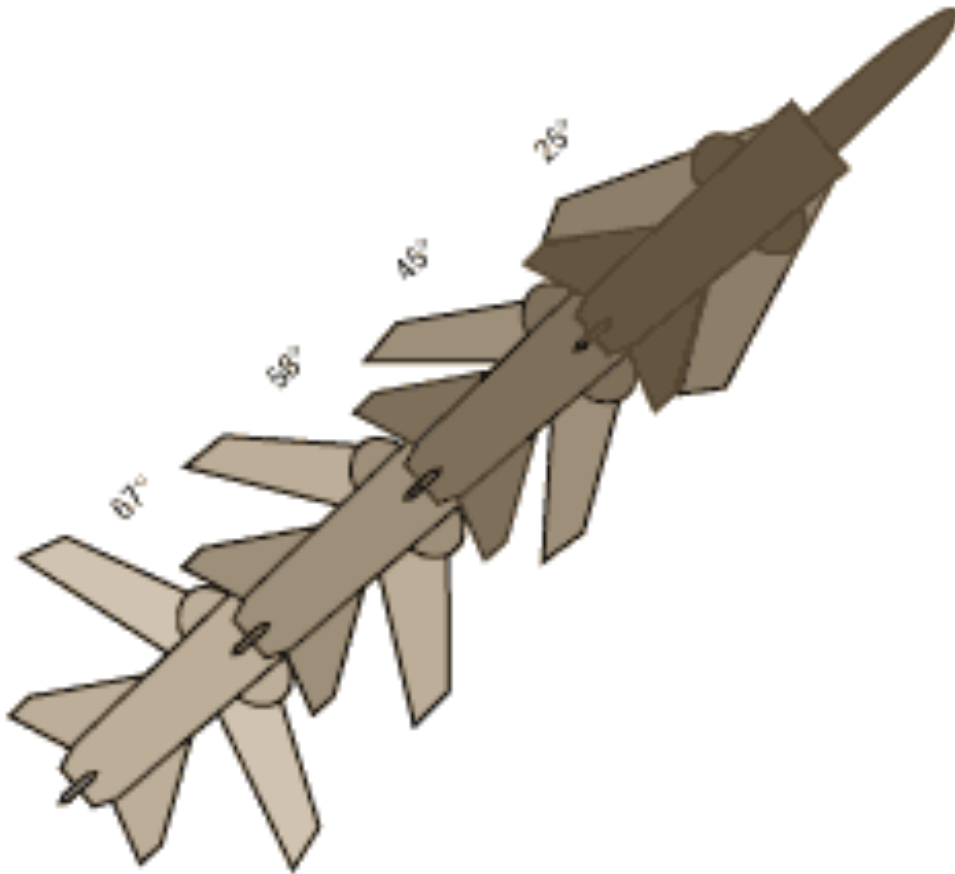
- Delta Wings
  - Looks like a large triangle from above
  - Can reach high speeds
  - Landing speeds are very fast
  - Wing shape found on the supersonic transport Concorde



# Wing Designs

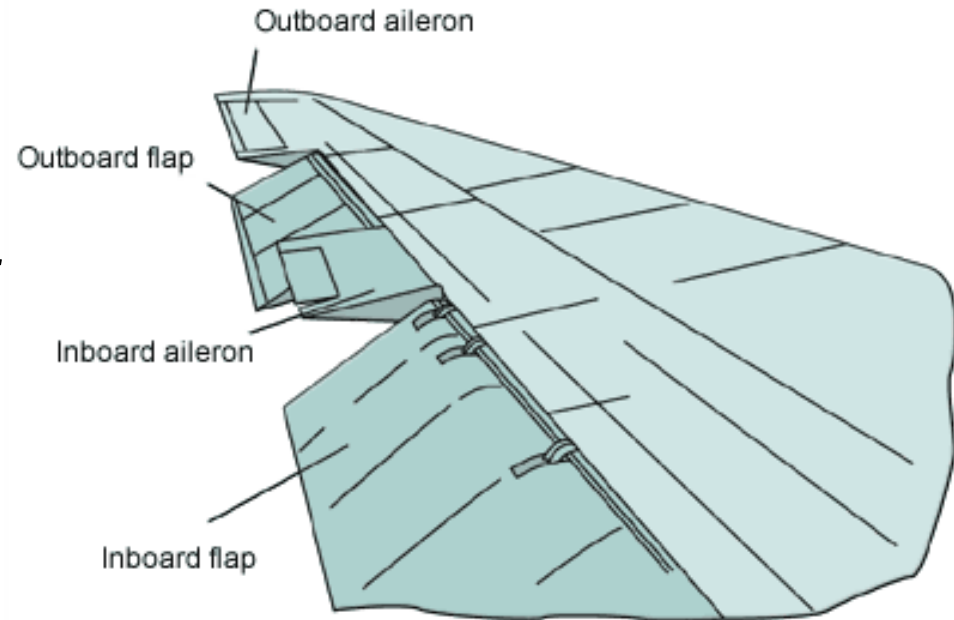
- Swing Wing

- This design combines the high lift characteristics of a straight wing with the ability of the sweepback wing to move at high speeds
- During landing and takeoff, wing swings into an almost straight position
- During cruise, wing swings into a sweepback
- Hinges that enable wings to swing are very heavy



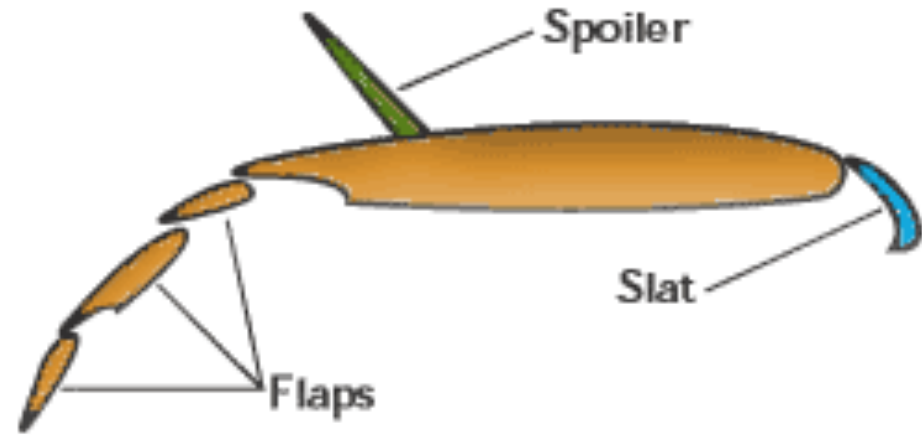
# Wing Components

- Trailing edge equipped with flaps
  - Move backward and downward
  - Increase the area of the wing and the camber of the airfoil
  - Different from the ailerons, also located on the trailing edge of the wing



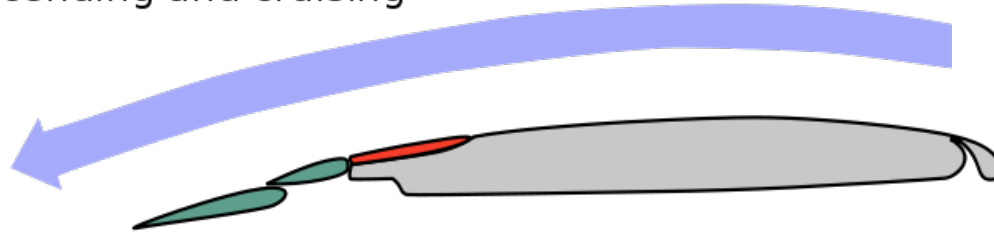
# Wing Components

- Slats
  - Located on the leading edge
  - Slide forward and increase the area of the wing and the camber of the airfoil
- Flaps and slats
  - Used during takeoff and landing
  - Increase lift at slower speeds.

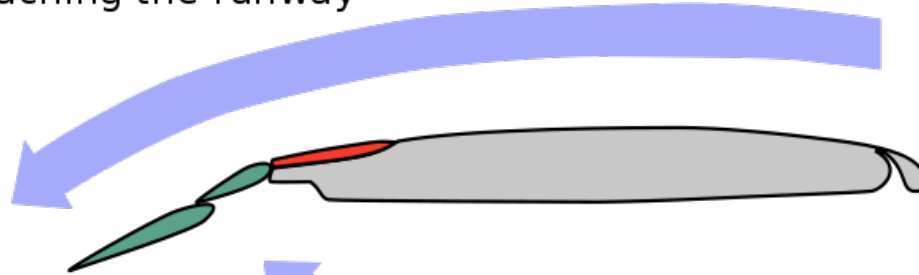


# Wing Components

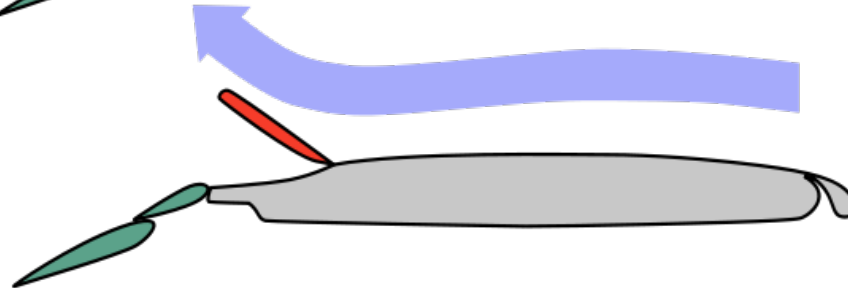
Ascending and cruising



Approaching the runway

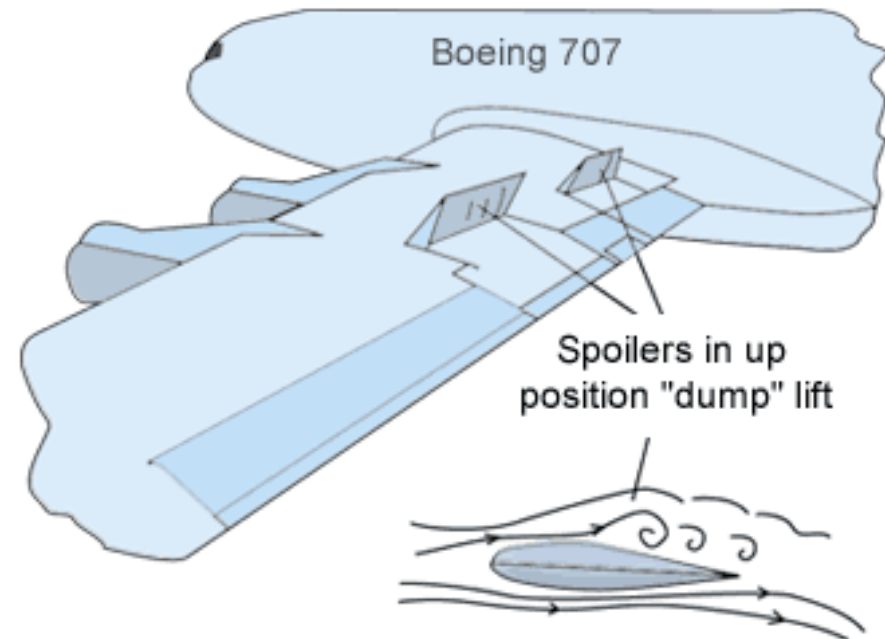


Landing



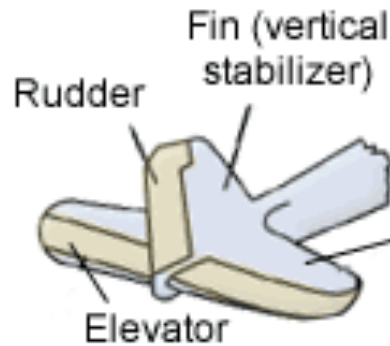
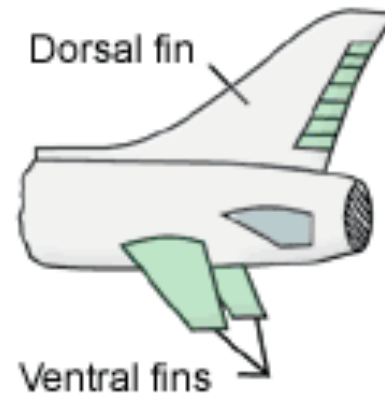
# Wing Components

- Spoilers
  - Located on the top of the wings
  - Opposite effect from flaps and slats
  - Reduce lift by disrupting the airflow over the top of the wing
  - Deployed after the airplane has landed and lift is no longer needed
  - Increase drag

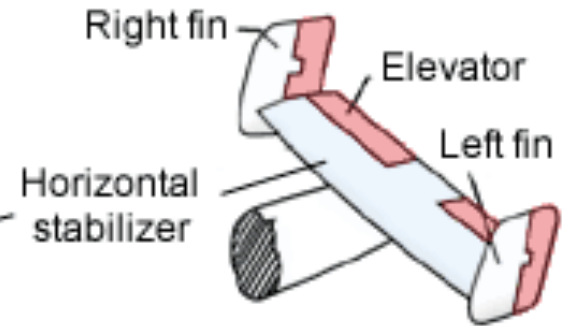


# Empennage

- Also known as the tail assembly
- Provides stability and control
- Two main parts
  - Vertical stabilizer (fin) to which the rudder is attached
  - Horizontal stabilizer to which the elevators are attached



**Standard Tail**



**Twin Tail**



**T-tail**



**V-Butterfly-Tail**

# Undercarriage

- Also known as the landing gear, which is made up of
  - Struts
  - Wheels
  - Brakes
- Can be fixed or retractable





# Propulsion System



- Provides thrust for the airplane
- Many different types of engines
  - Piston engines and propellers
  - Turboprop
  - Turbojet
  - Turbofan
  - Scram jet



- These will be discussed in a later activity.

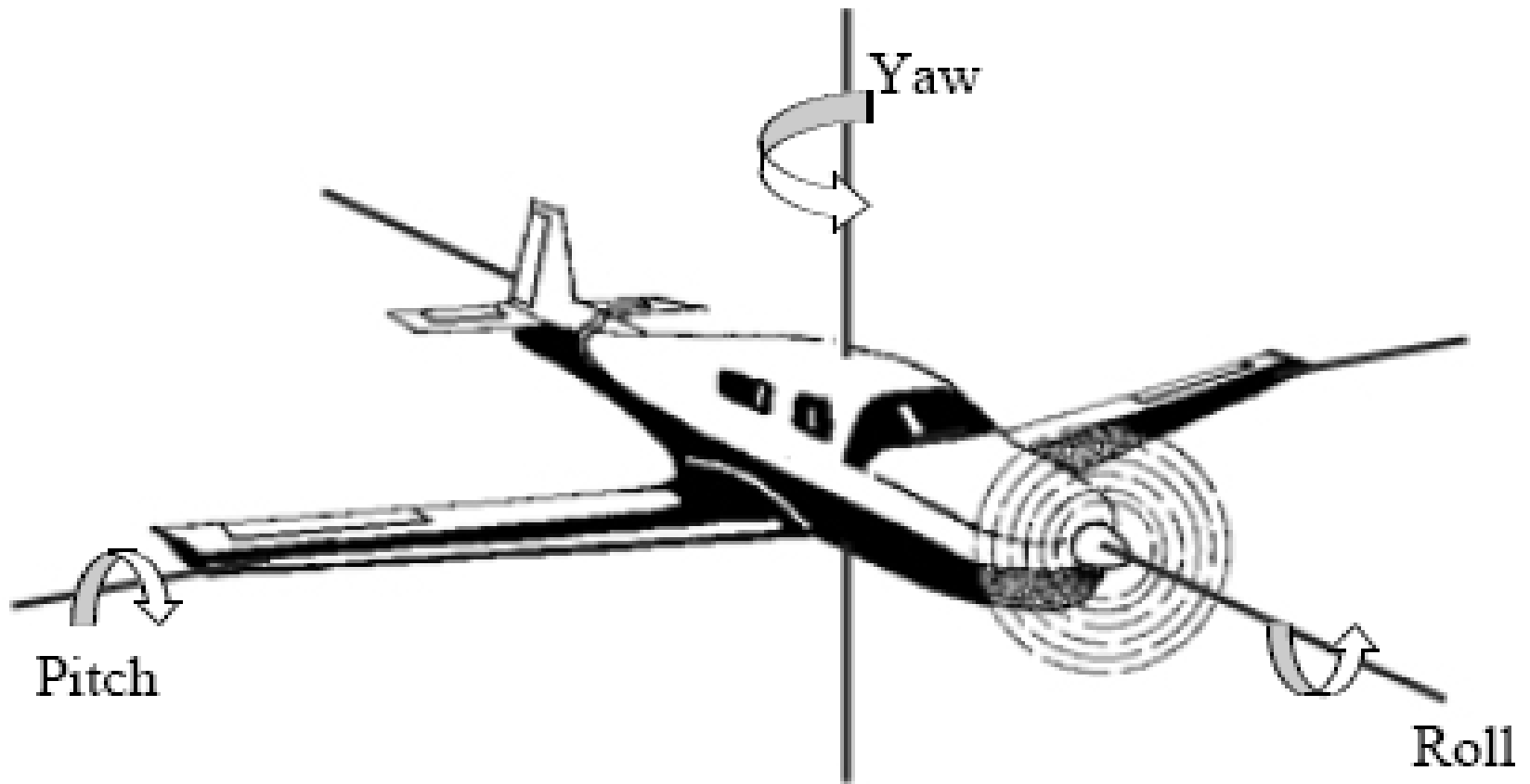


# Controls

- Instruments and Controls
  - Supply information
    - Altitude
    - Direction
  - Provide control
    - Steering in the air and on the ground
    - Engine power
    - Braking



# Controls

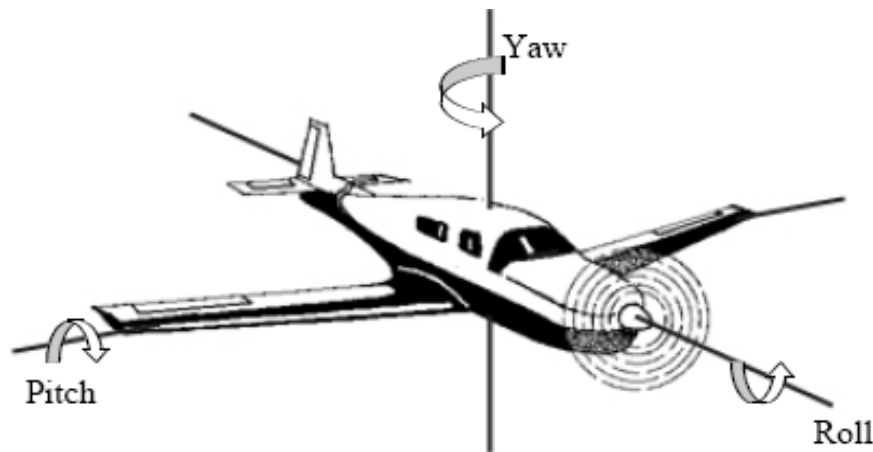


# Controls

- **Roll** is controlled by the ailerons
  - Used to raise and lower the wings

Turning the control wheel left causes the left aileron to raise and lowers the right aileron. The plane rolls left.

Turning the control wheel right causes the right aileron to raise and lowers the left aileron. The plane rolls right.

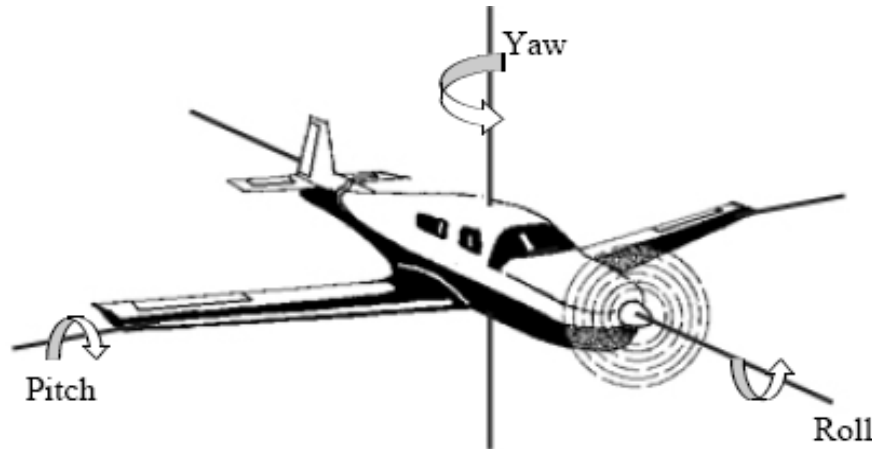


# Controls

- **Pitch** is controlled by the elevators on the tail of the plane.
- They are controlled by the control wheel (i.e., stick).

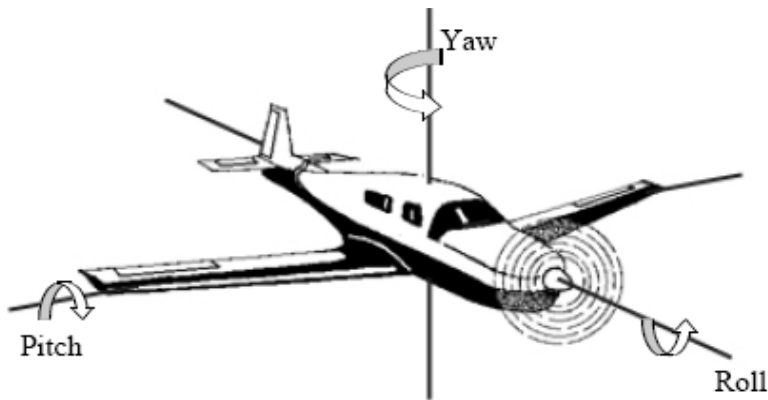
If the wheel or stick is pulled back, the elevators go up, causing the nose to point up and the plane to climb.

If the wheel or stick is pushed forward, the elevators go down, causing the nose to point down and the plane to lose altitude.



# Controls

- **Yaw** is controlled by the rudder.
- The right foot pedal turns the rudder to the right.
- This action causes the tail to yaw to the left and the nose to yaw to the right.



To smoothly bank a plane or to turn it left or right, the pilot uses the ailerons and the rudder together.

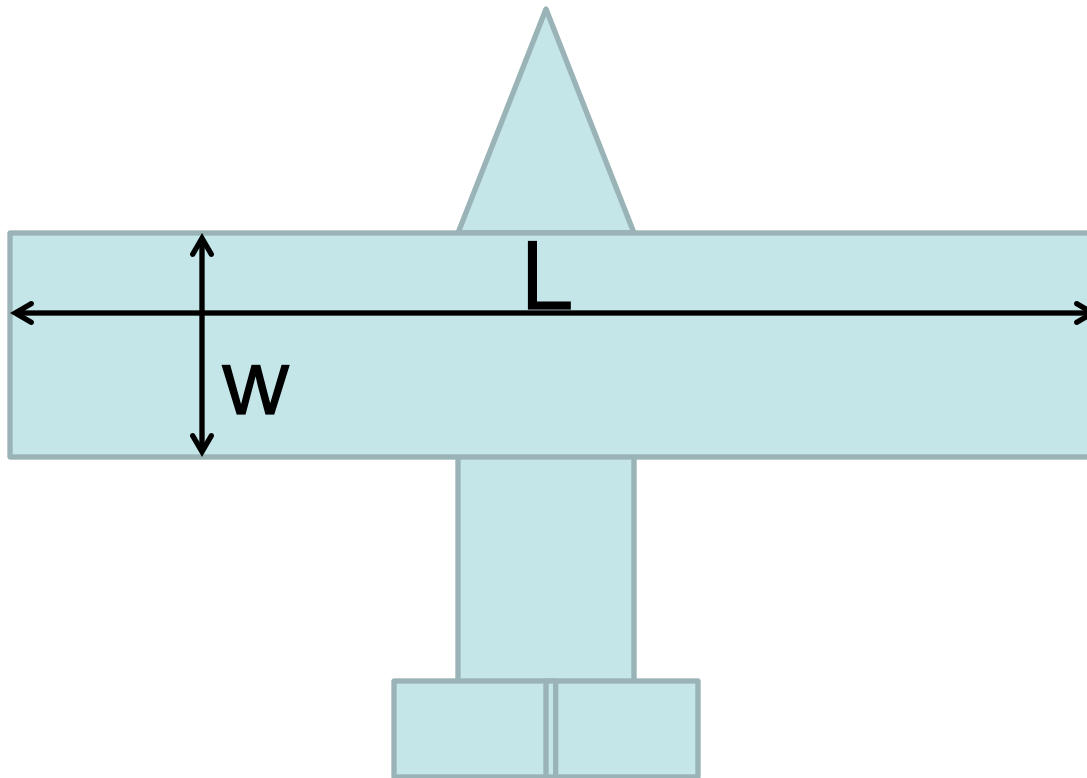
# Controls

- On the ground, the plane's direction is controlled by steering the nose wheel. Pilots use their feet on the rudder pedals to control the ground movement
- The rudder pedals are also used to apply the brakes.



# Aspect Ratio

- $AR = L^2 / L * W$





**Low** aspect ratio wing ( $AR=5.6$ )  
of a Piper PA-28 Cherokee



**High** aspect ratio wing ( $AR=12.8$ ) of the  
Bombardier Dash 8 Q400



**Very high** aspect ratio wing of the  
Glaser-Dirks DG-808 glider ( $AR=27.4$ )



**Very low** aspect ratio wing ( $AR=1.8$ ) of the  
Concorde



# Aspect Ratio= $(L^2)/L*W$

## advantages

- Planes with a **high** ratio:
  - More stable in flight
  - Capacity to carry larger loads
  
- Planes with a **low** ratio:
  - More maneuverable
  - Faster
  - Smaller take-off and landing area

## disadvantages

- Planes with a **high** ratio:
  - Slower
  - Less maneuverability
  - Require a large landing area
  - Storage
  
- Planes with a **low** ratio:
  - Small capacity for loads

# Stirland's Challenge

## **Build 2 Different Paper Airplanes**

- You must complete your worksheet at the same time.
- Compare and contrast them.

# Image Resources

Microsoft, Inc. (2008). *Clip art*. Retrieved June 24, 2009, from <http://office.microsoft.com/en-us/clipart/default.aspx>

National Aeronautics and Space Administration (NASA). (n.d.). *Virtual skies: Aeronautics tutorial*. Retrieved June 24, 2009, from <http://virtualskies.arc.nasa.gov/aeronautics/tutorial/intro.html>