Flight Controls

Why do we learn about flight controls?

To understand the primary and secondary flight controls on an airplane, how they work, and how to use them.

Motivation

Knowledge of the flight controls is important so you can gain an intuitive understanding of how they operate, and be able to recognize normal and abnormal operations.

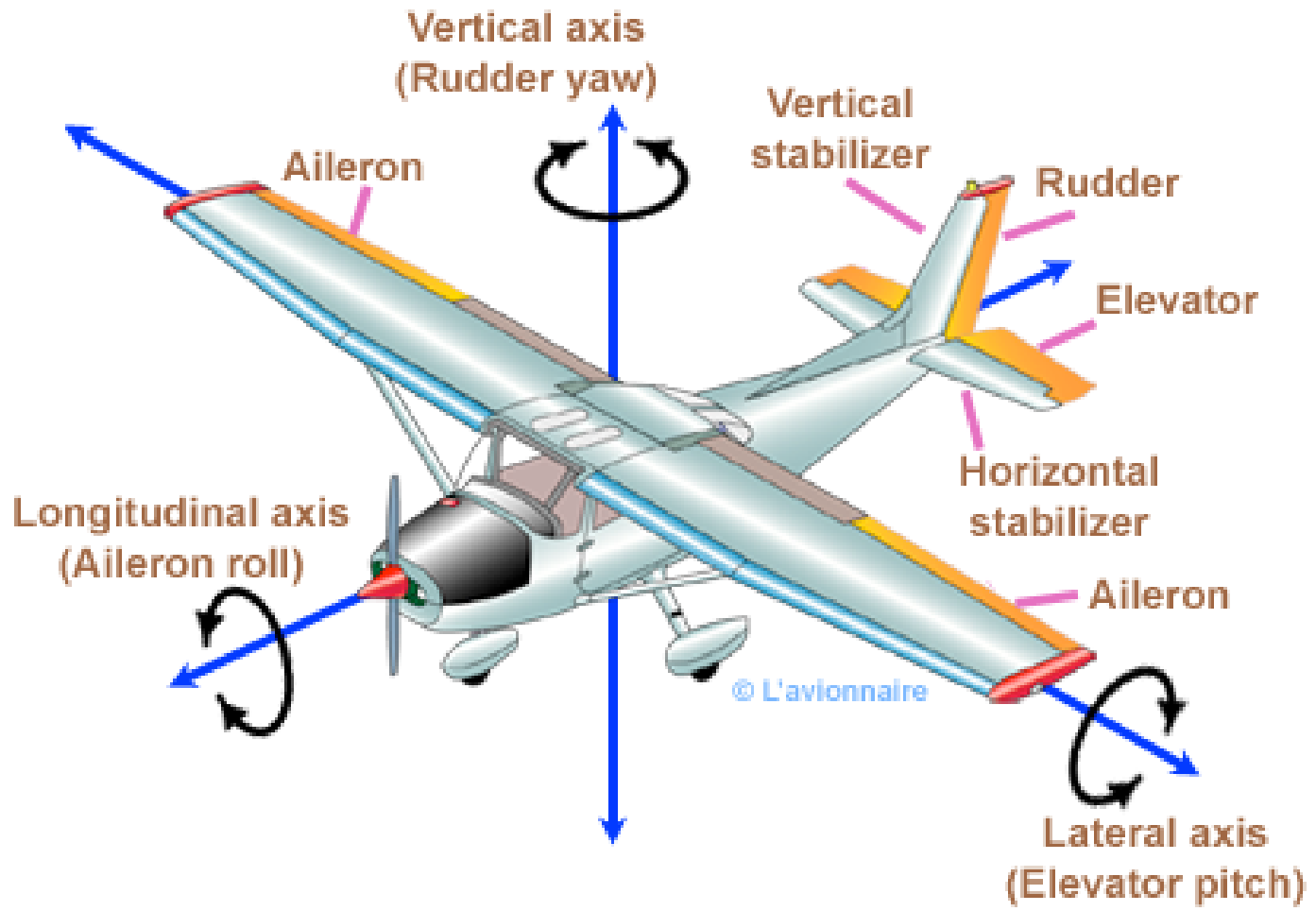
Overview

- Primary flight controls: Elevator, aileron, rudder
  - Types of ailerons
  - Stabilators
- Secondary flight controls
  - Flaps
  - Trim tabs
  - Leading edge devices

Primary Flight Controls

The main way we control the airplanes movement

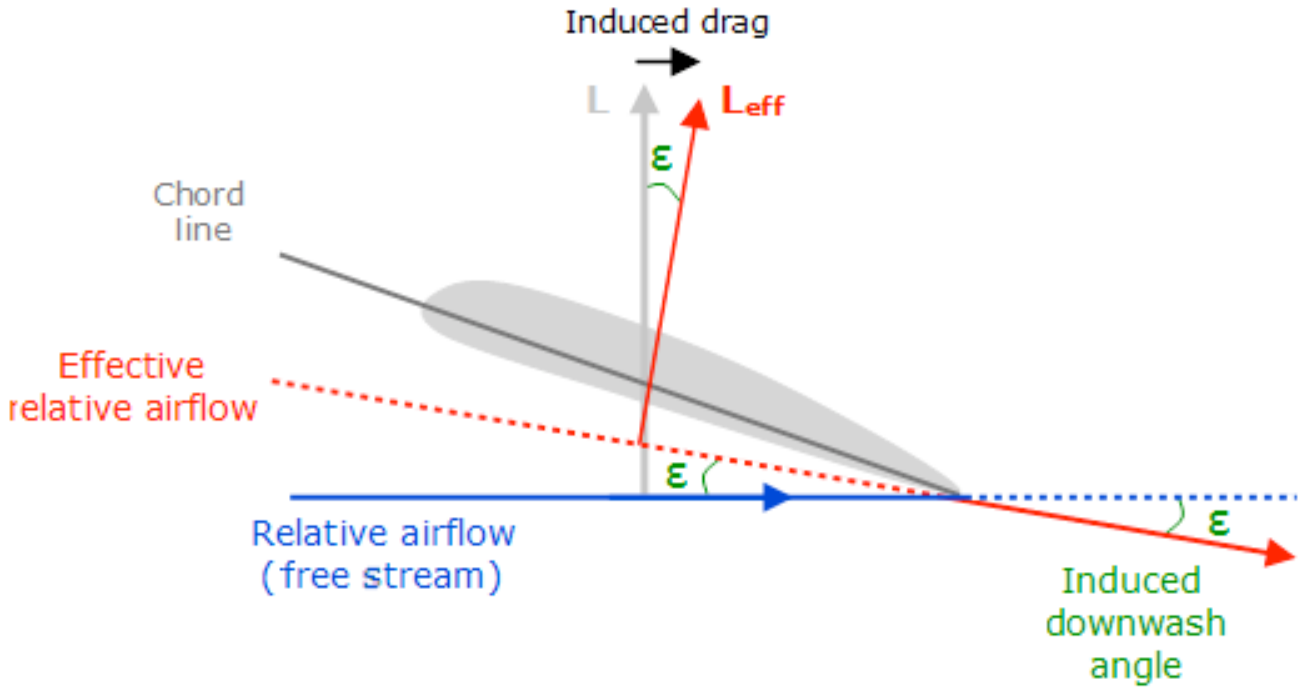
Three basic flight control: Elevator, aileron, and rudder



Airplane rotates about its center of gravity

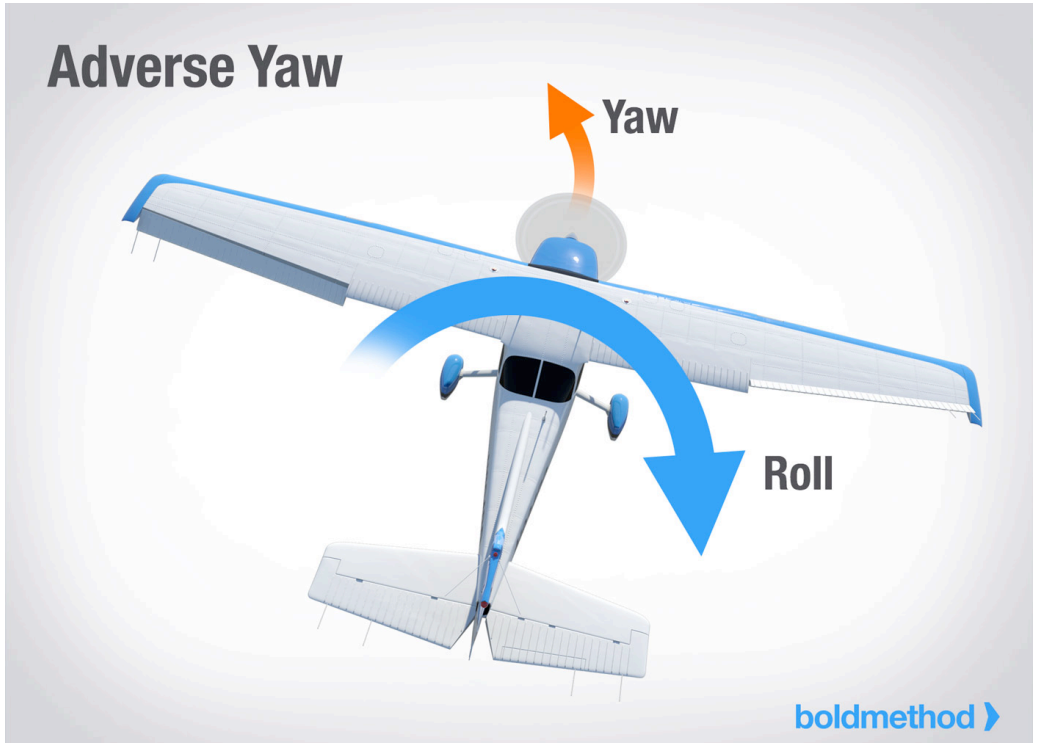
Control surfaces are lifting surfaces

- Require airspeed to function
- Control effectiveness increases as airspeed increases
- The more disturbance the more drag



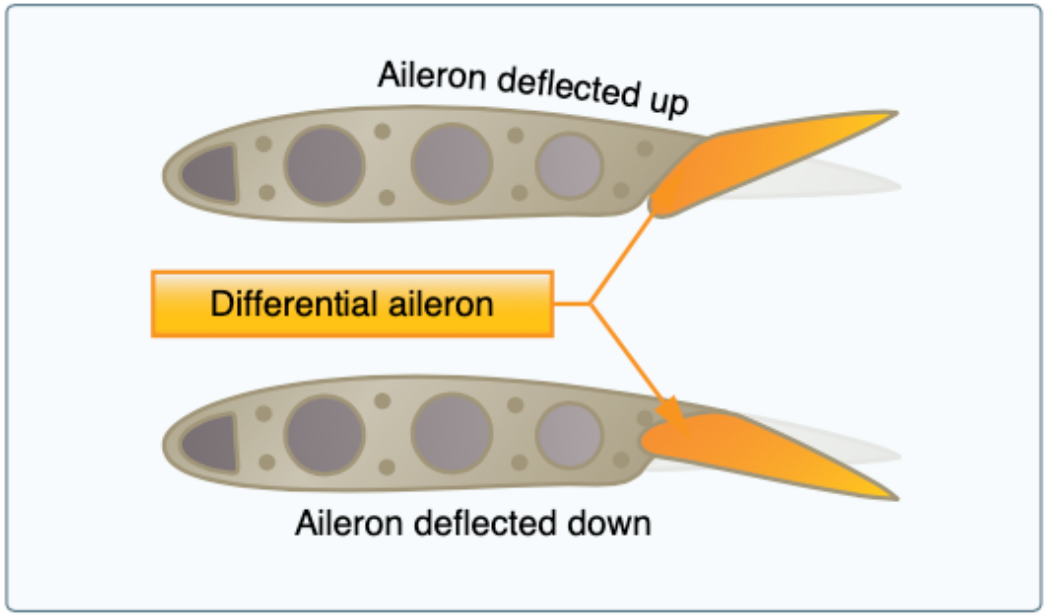
Ailerons: Control wheel, bank left or right

Adverse Yaw



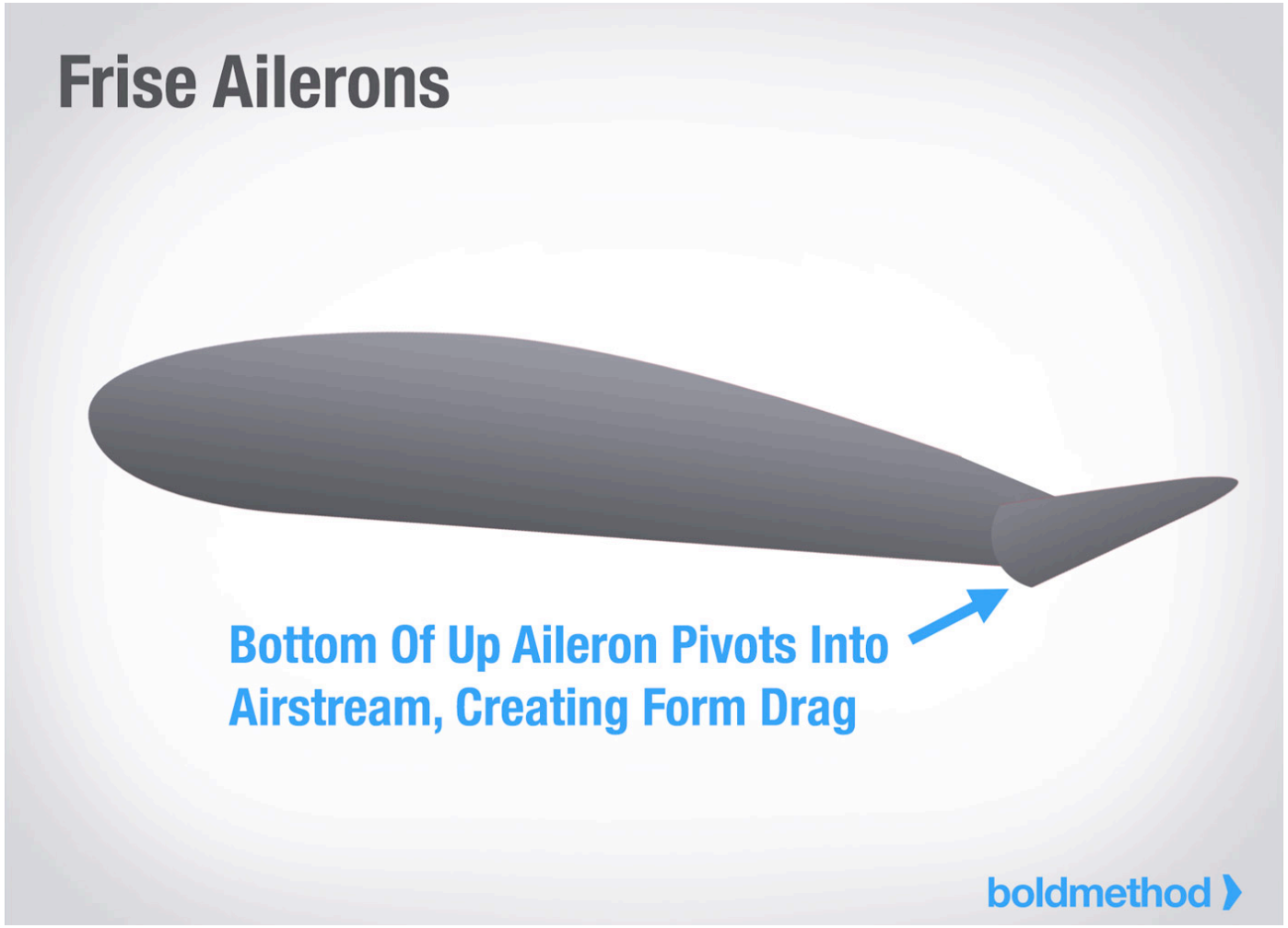
- Down aileron produces more lift, thus more drag
- Up aileron produces less lift, thus less drag
- This causes a yaw in the opposite direction of the intended turn

Differential Ailerons

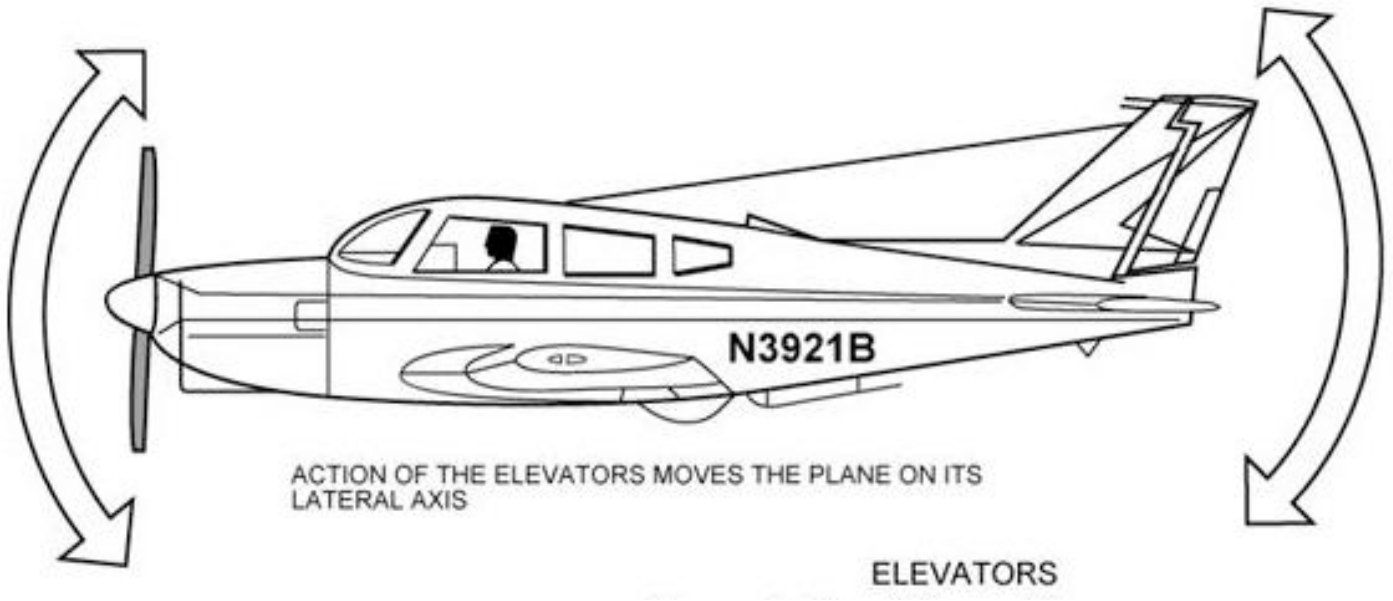


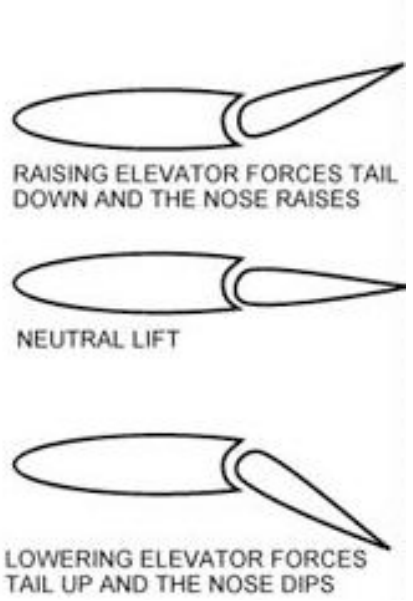
- Adverse yaw isn't symmetrical:
  - The up aileron (lower AoA) decreases drag a relatively small amount
  - The down aileron (higher AoA) increase drag a relatively large amount
- We can raise the up aileron slightly more than we lower the down aileron
  - This compensates for difference in yaw

Frise Ailerons

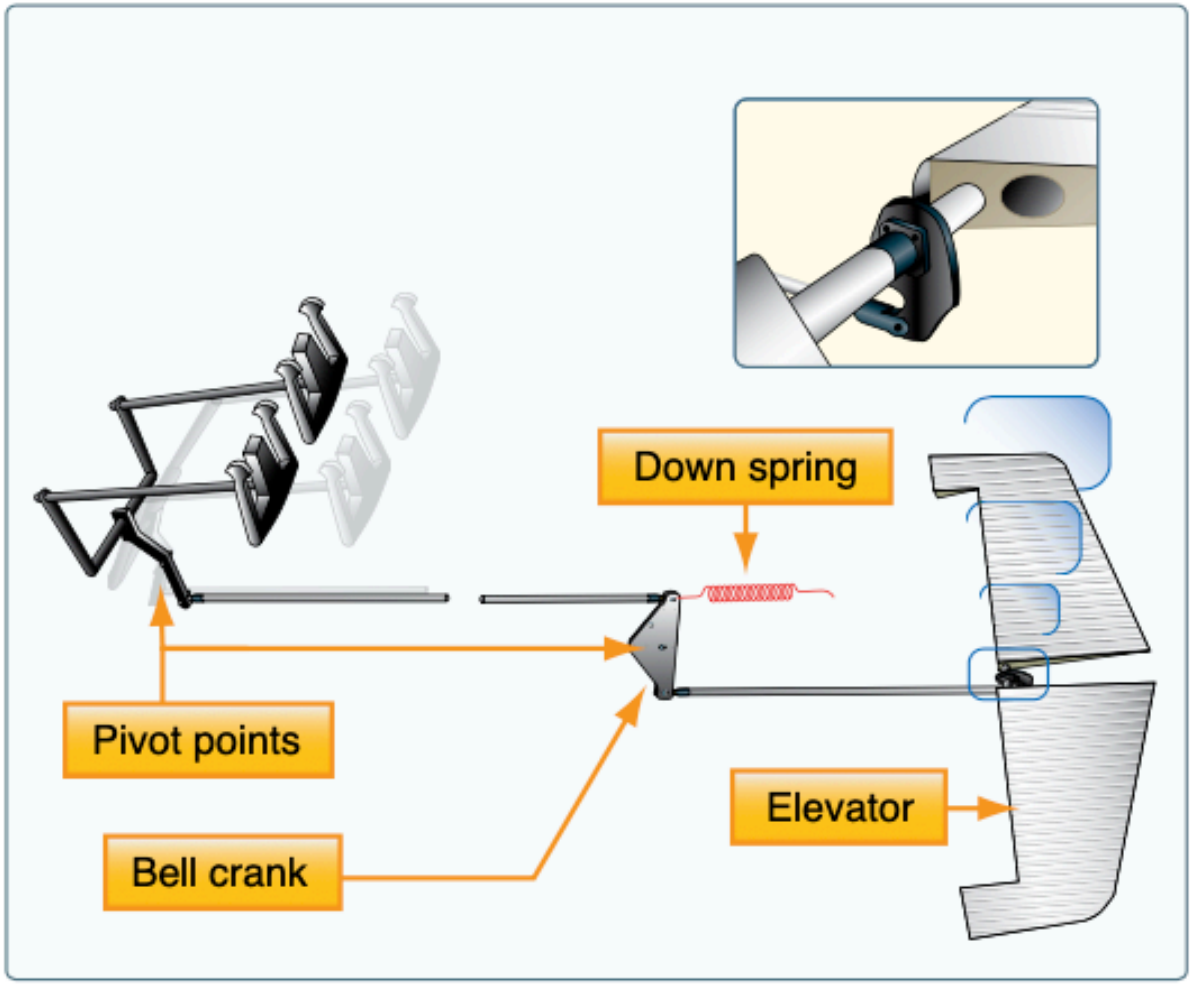


Elevator: Yoke forward/back, pitch up or down

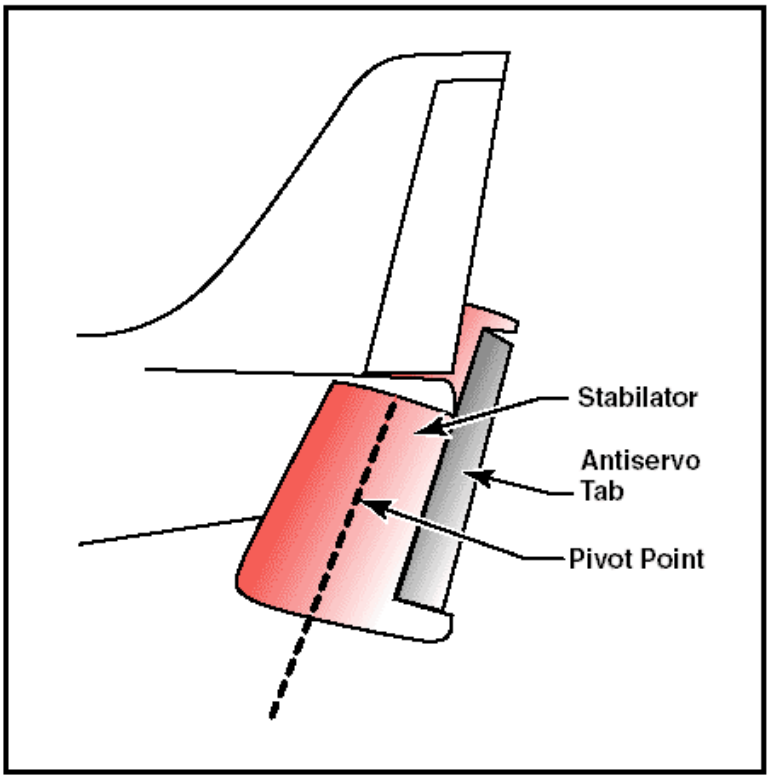




Elevator Operation



Stabilator



Rudder: Yaws airplane right/left

Controlled with rudder pedals

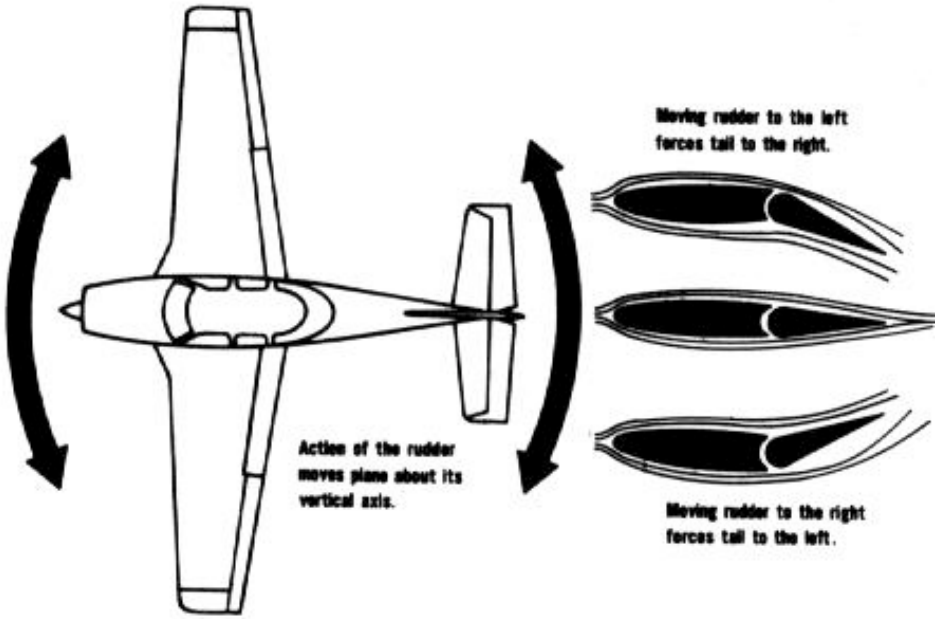
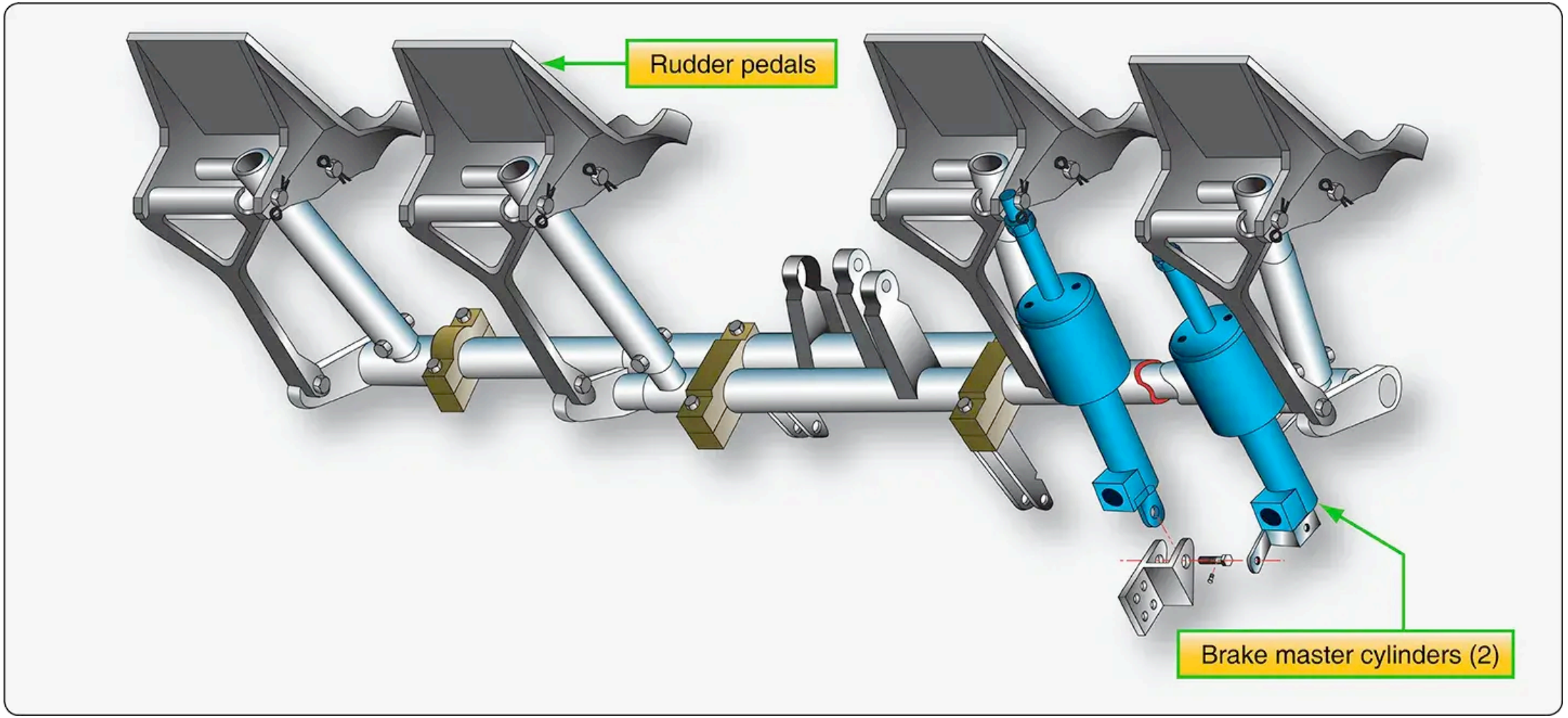


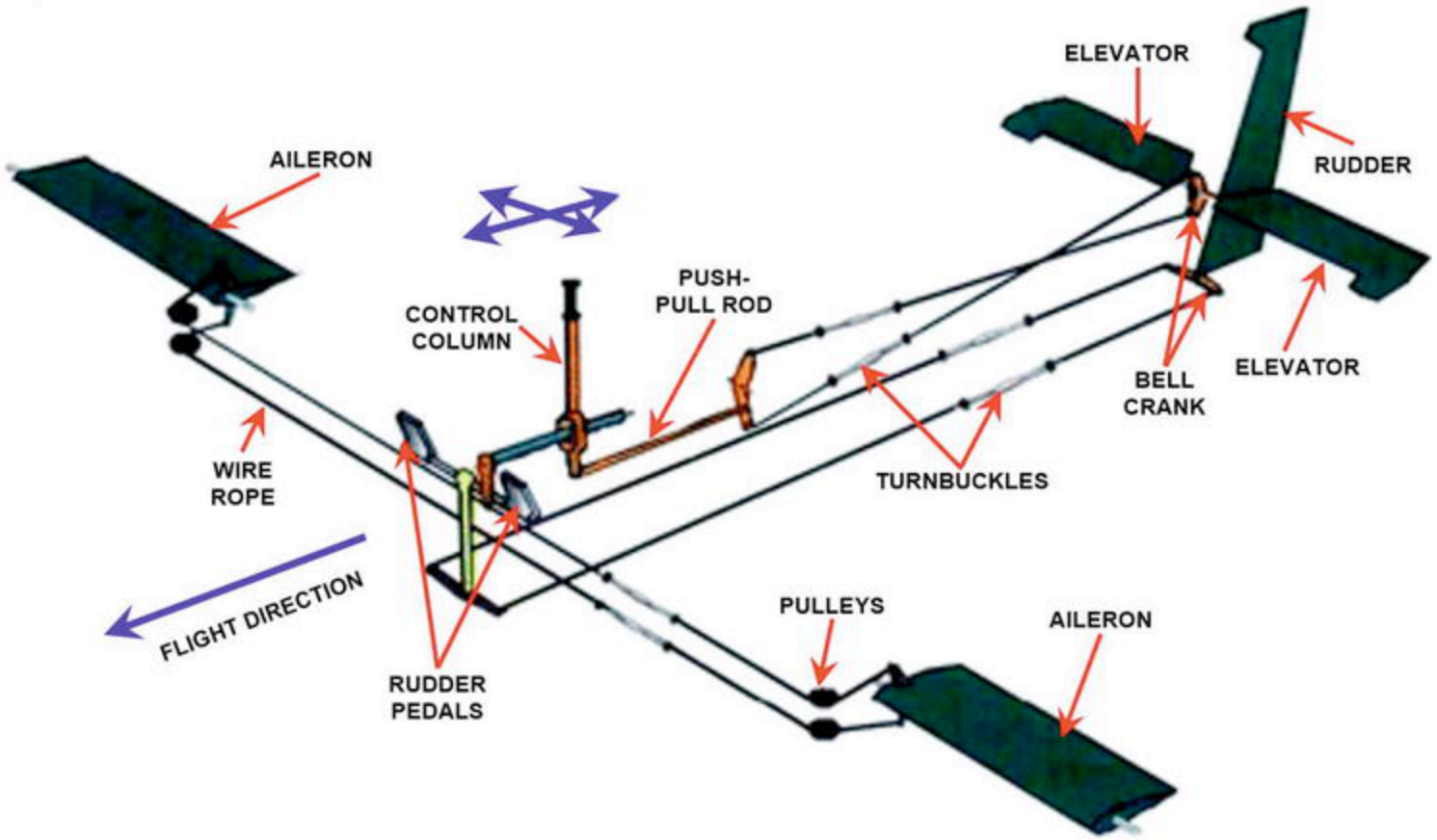
Figure 4–6 Use and Effect of Rudder

Toe Brakes



Construction

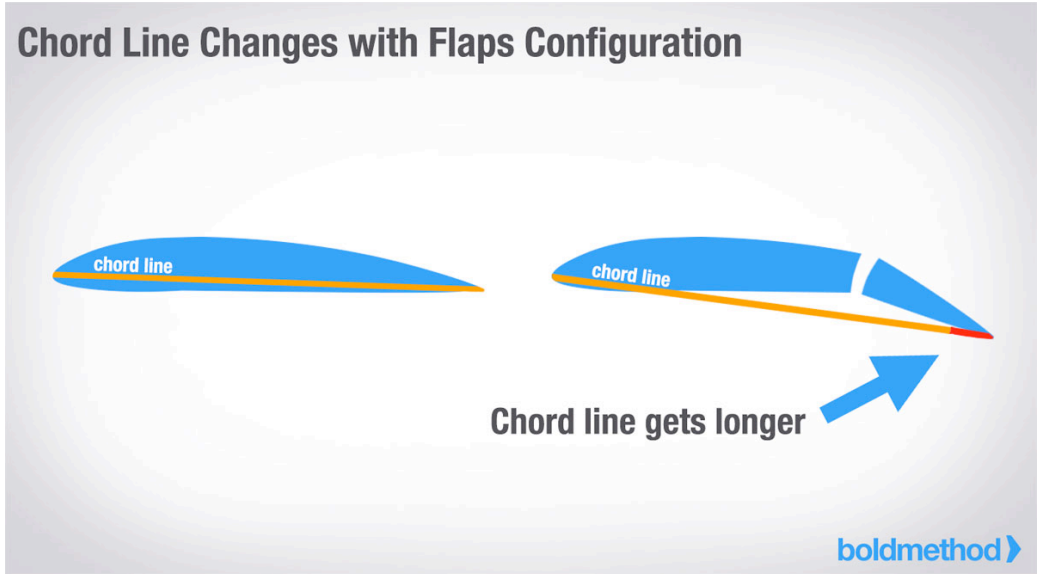
- Most flight controls are cable driven
- Flaps are often driven by an electronic motor, or a manual rod



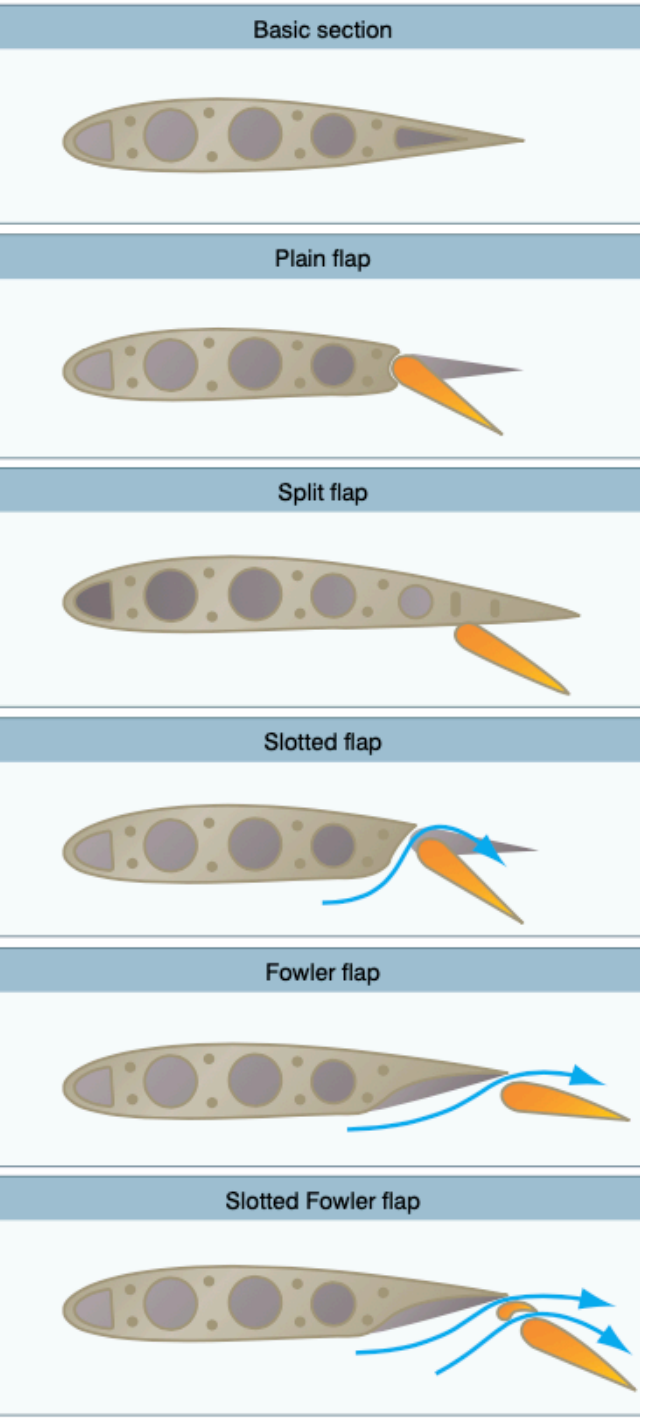
Secondary Flight Controls

Flaps

Effect of Flaps



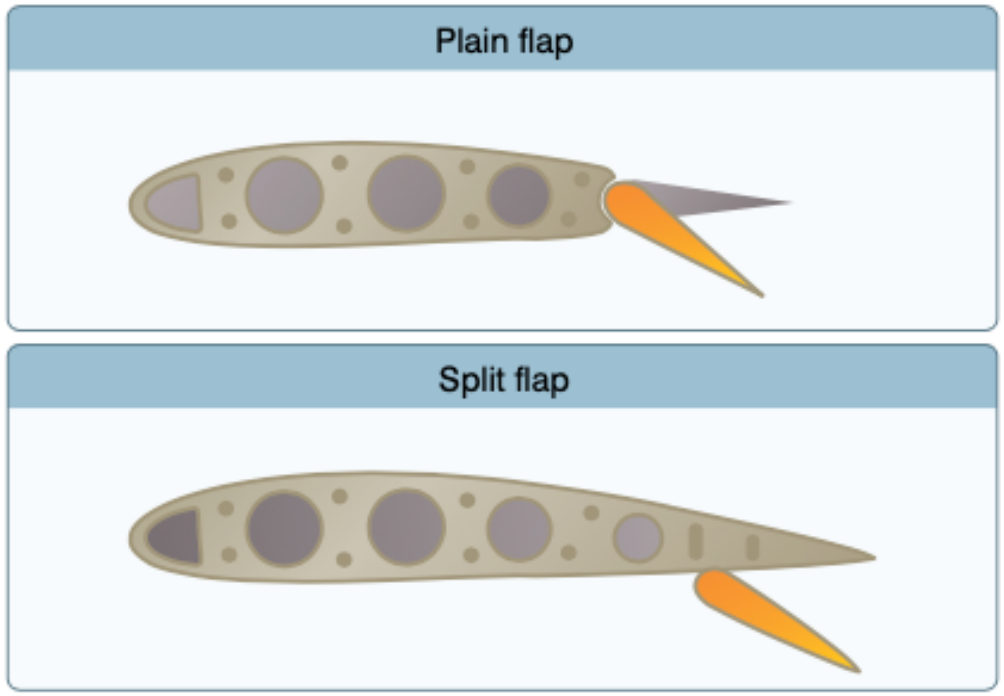
- Increase chord of the wing, which increases angle of attack
- Increases lift and increases drag
- Useful when you want to descend without gaining airspeed, like during landing



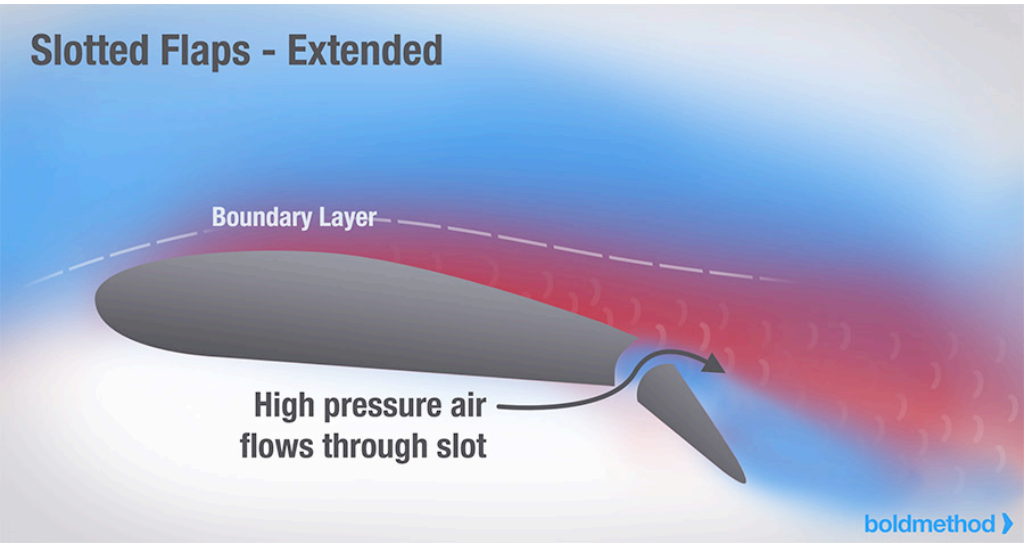
Types of Flaps

- Some types produce more lift
- Some types produce less pitching up movement when deployed

Plain and Split Flaps

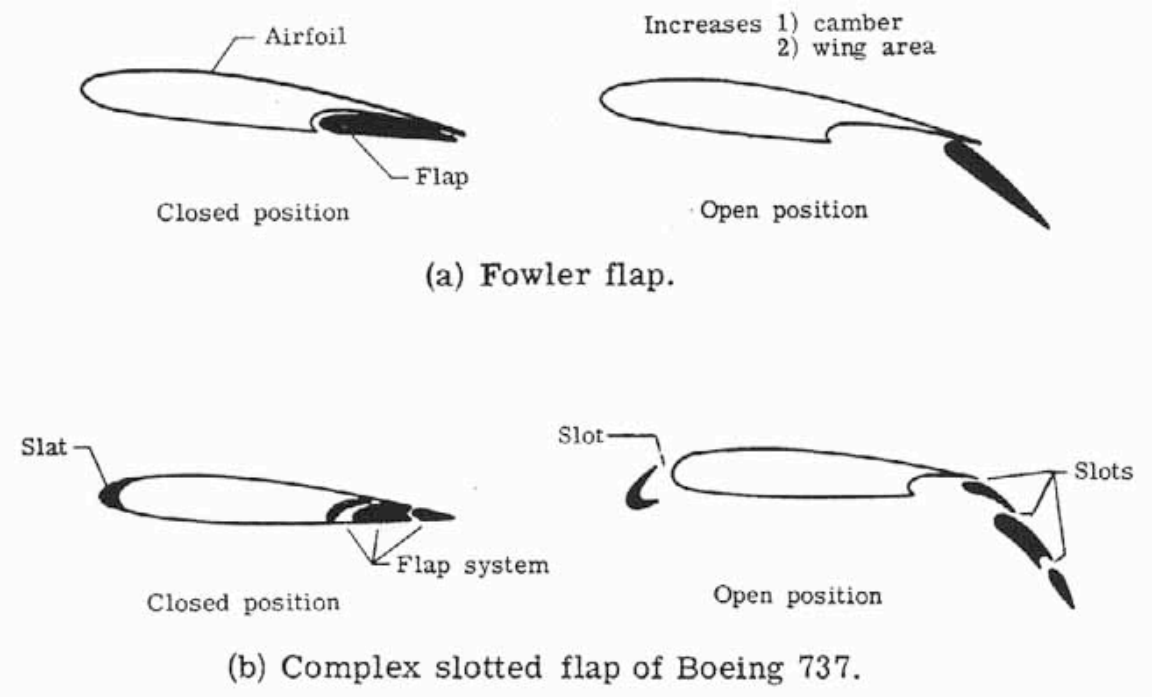


- Plain flap
  - Increases camber of the wing
  - Creates drag
  - Moves center of pressure backwards
  - Creates nose-down pitching moment
- Split flap
  - Deflects
  - More lift than a plain flap
  - Same amount of drag as plain flap



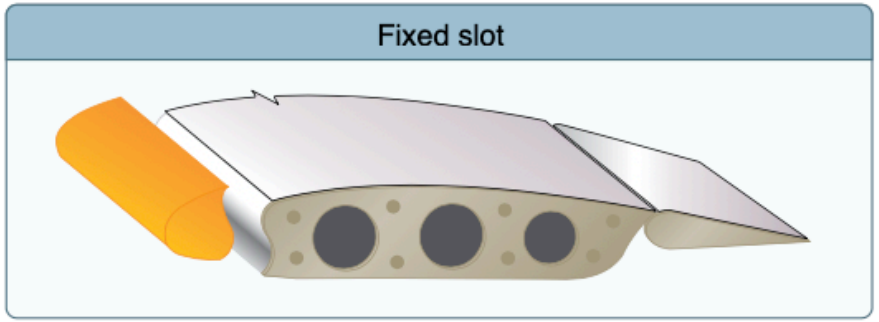
Slotted Flaps

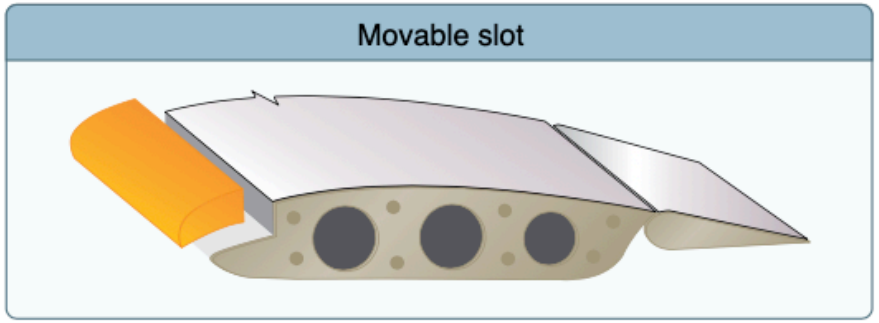
- Most common type of flap
- Like a split flap, but there's a gap between the wing and the flap
- Slot energizes boundary layer behind the flap, which delays the critical AoA before stall
- Can have multiple slots

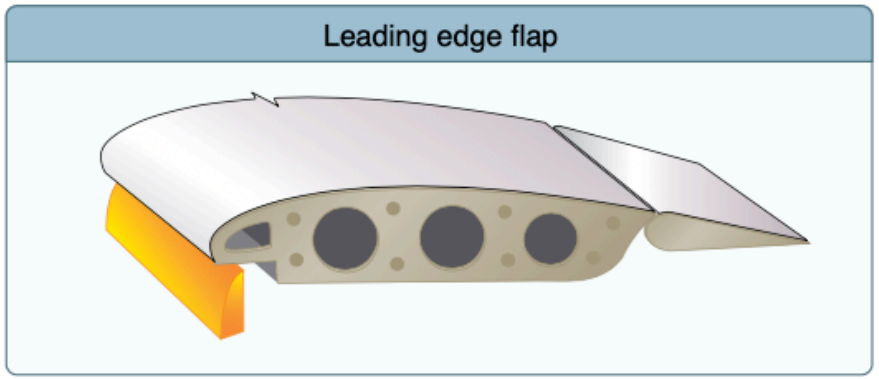


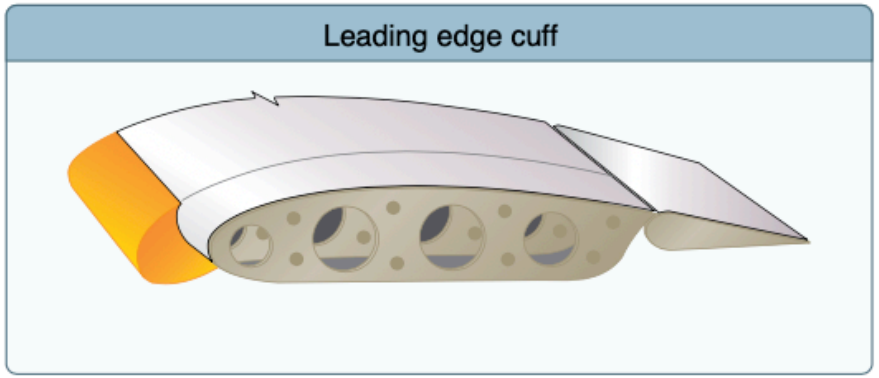
Fowler Flaps

- Fowler flap
  - Flaps which "slide" down and back from the wing
  - Increase wing surface area
  - Small deflection adds lift
- Slotted fowler flap
  - Combines the advantages of fowlers and slotted flaps









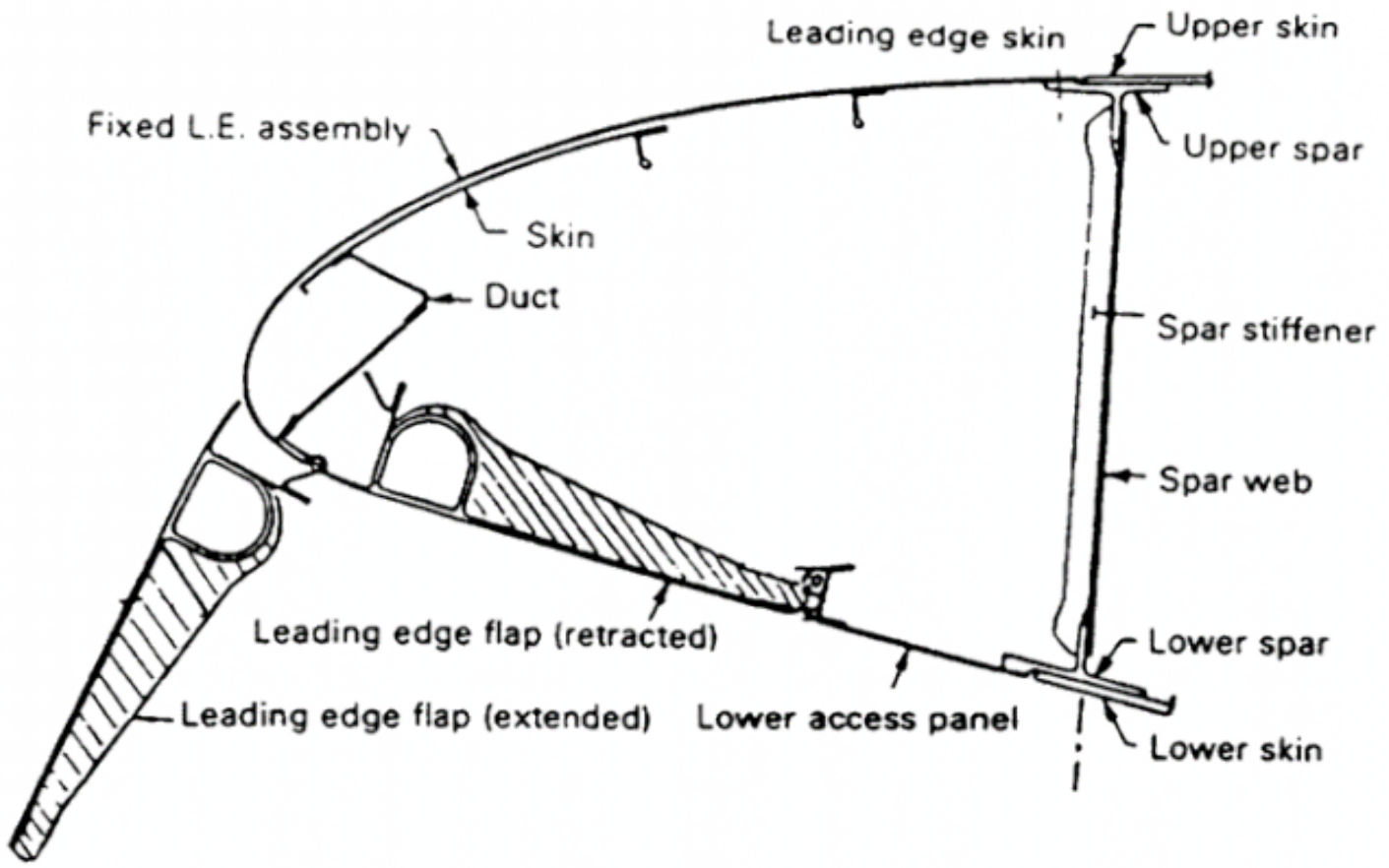
Leading Edge Devices

- Delay the separation of the boundary layer until a higher AoA, meaning more lift/slow stall speed
- Fixed slats are set out in front of the wing
- Moveable slats more in and out with AoA, or deployed manually
- Leading edge flaps: Change wing camber
- Leading edge cuff: Extension of the wing camber

Leading Edge Slots

Moveable Slats

Leading Edge Flap



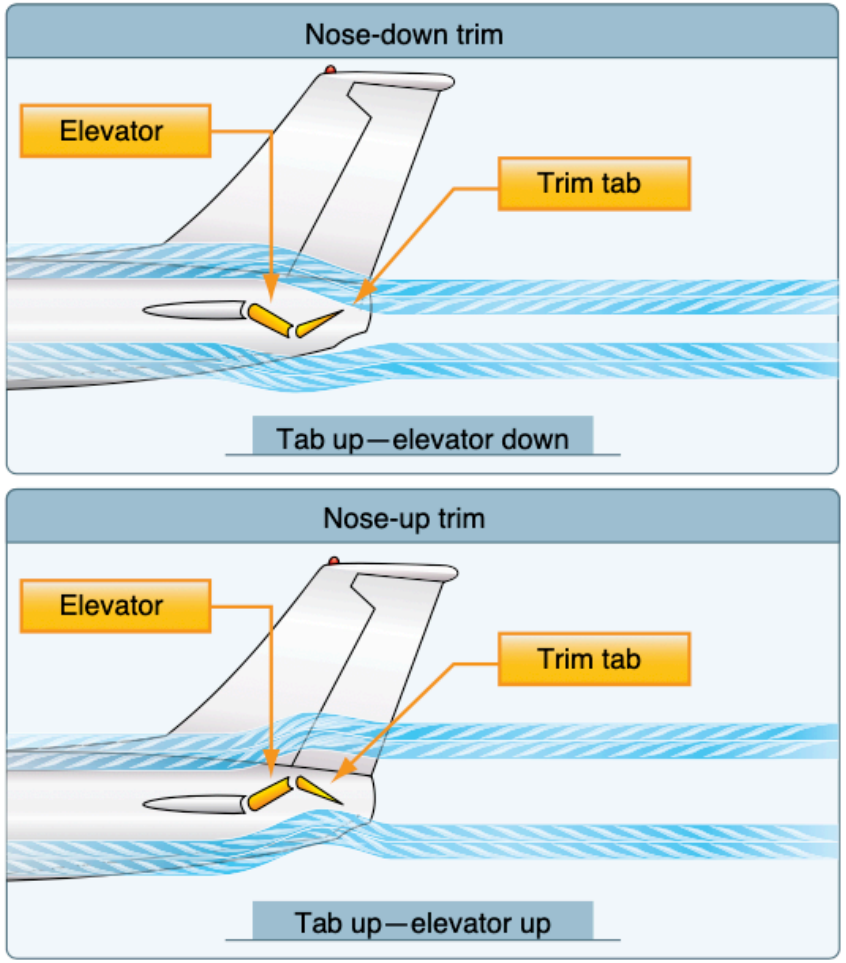
Leading Edge Cuff

Trim

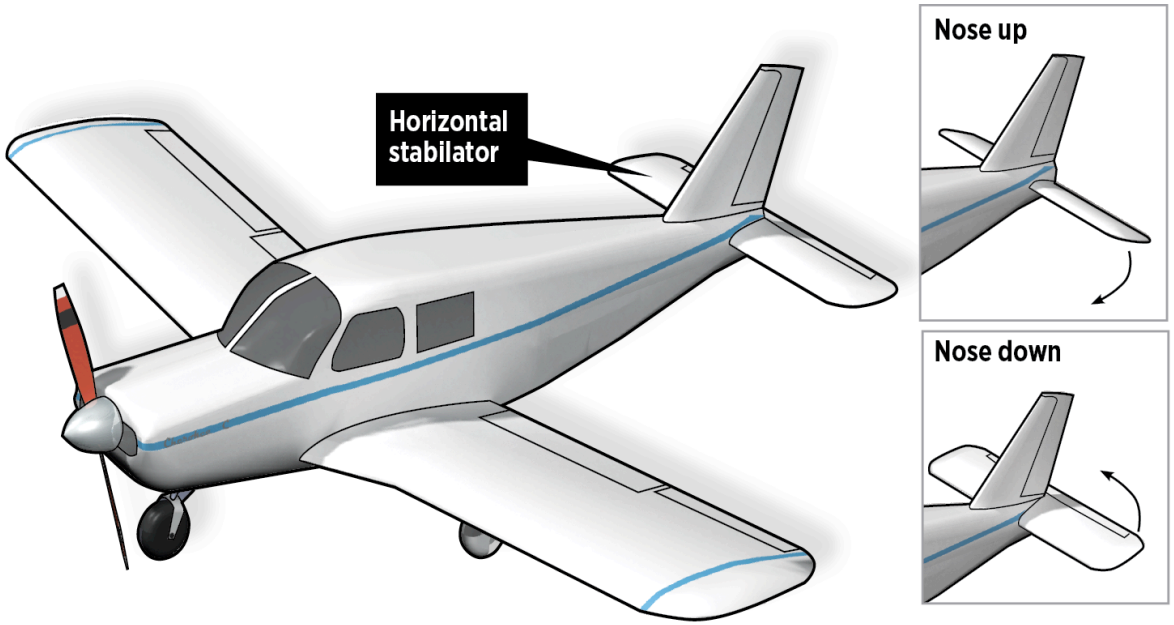
Elevator Trim

- Help hold elevator pressure at a certain position
- Cessna's use a trim tab

Trim Tab Movement

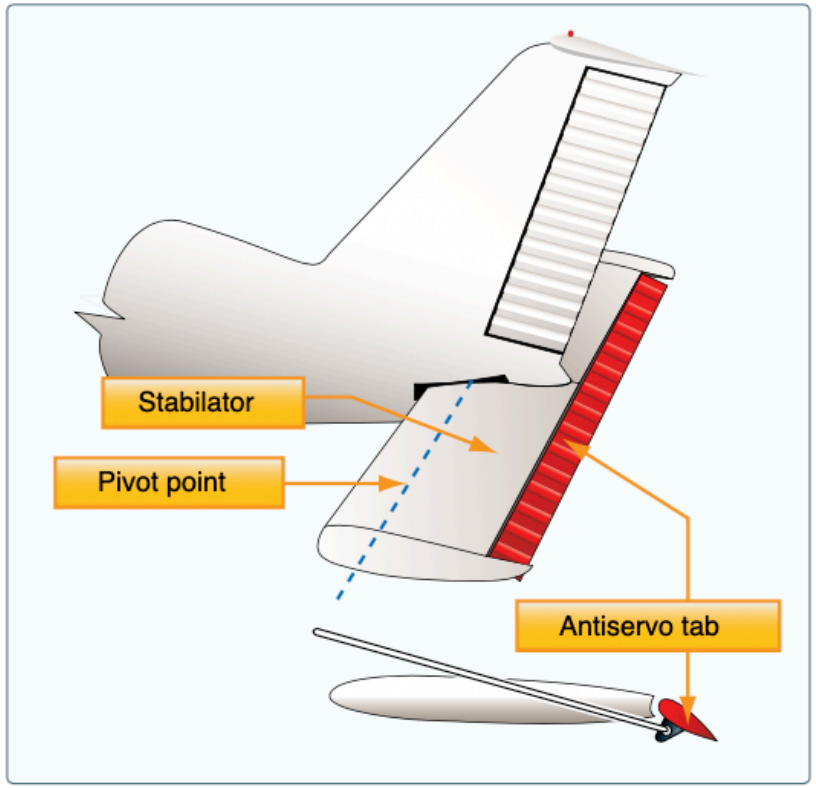


Elevator Alternative: Stabilators



- Entire horizontal stabilizer moves instead of just an elevator
- Common on Piper aircraft

Anti-servo Tab - Stabilators

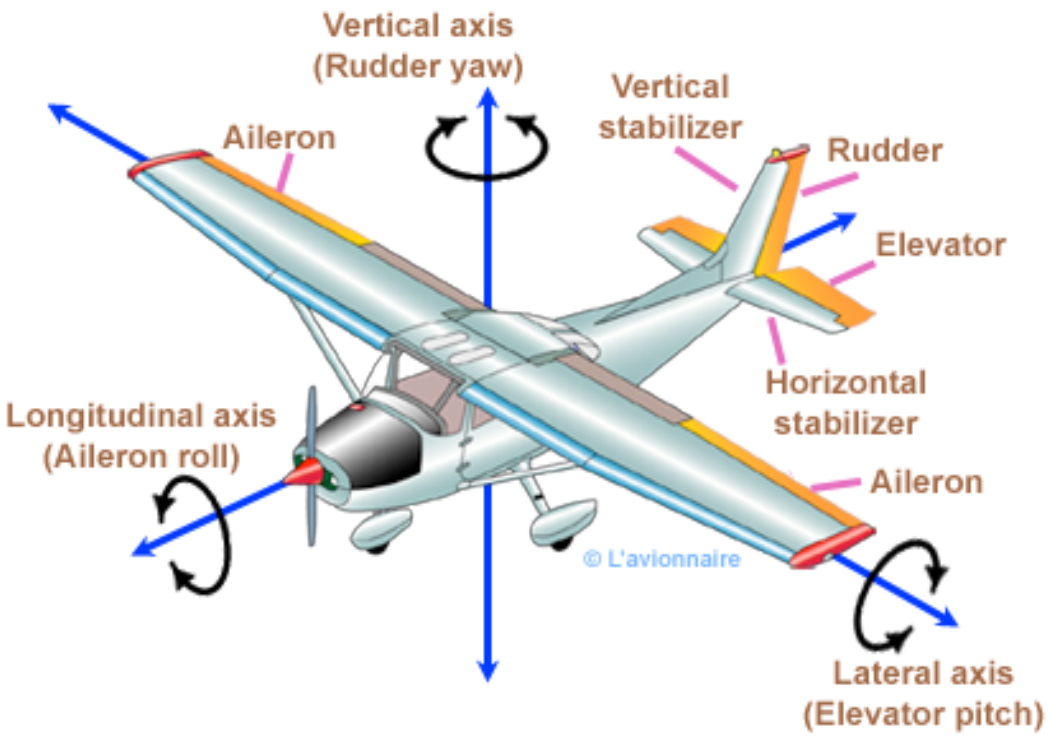


- Stabilators can produce a lot of force, so the antiservo tab counteracts the motion, making the controls less sensitive
- They are still adjusted up/down with the trim control in the cockpit

Rudder Trim

- Help hold coordinated flight in a given flight attitude
- May be flight or ground adjustable

Summary



- Primary fight controls:
  - Rudder (yaw), aileron (roll), elevator (pitch)
- Secondary flight controls
  - Flaps
  - Trim tabs
  - Leading edge devices

Knowledge Check

How does the trim tab help us control the airplane?

Knowledge Check

If we were unable to lower our flaps, how would our approach to landing change?

Knowledge Check

If our elevator were to get jammed, what could we use for pitch control?