How Planes Fly

Marymoor R/C Club, Redmond, WA
AMA Charter 1610

Version 3.0 – Feb 2023

Controls, Aerodynamics, and Stability

- Elevator, Rudder, Aileron
- Wing plan form
- Lift and Wing Design
- Wing section (airfoil)
- Tail group (empennage)
- Center of lift, center of gravity
- Characteristics of a “speed stable” airplane

Ailerons, Elevators, and Rudder

Control *Roll, Pitch,* and *Yaw*

Ailerons

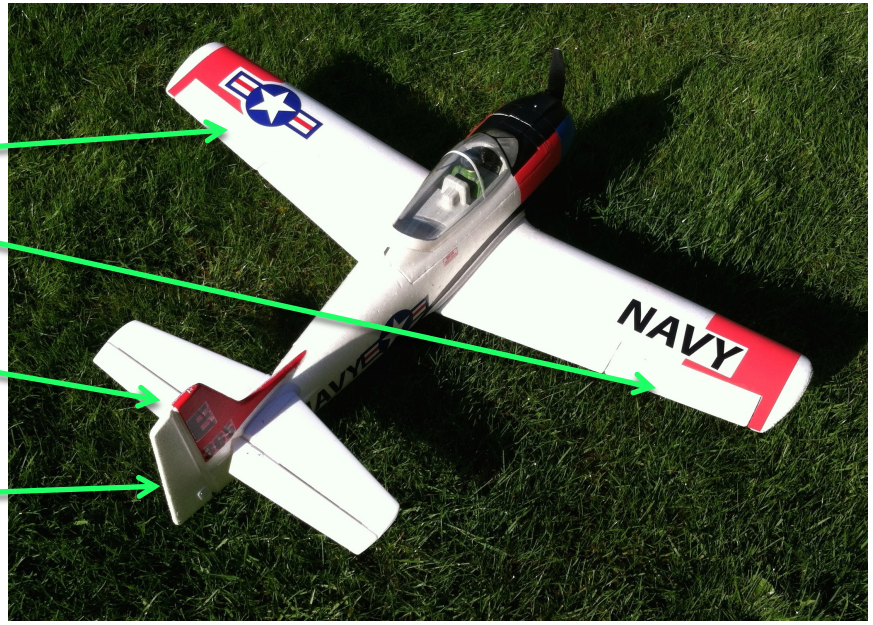
- ***Roll***, left and right

Elevators

- ***Pitch***, up and down)

Rudder

- ***Yaw***, left and right



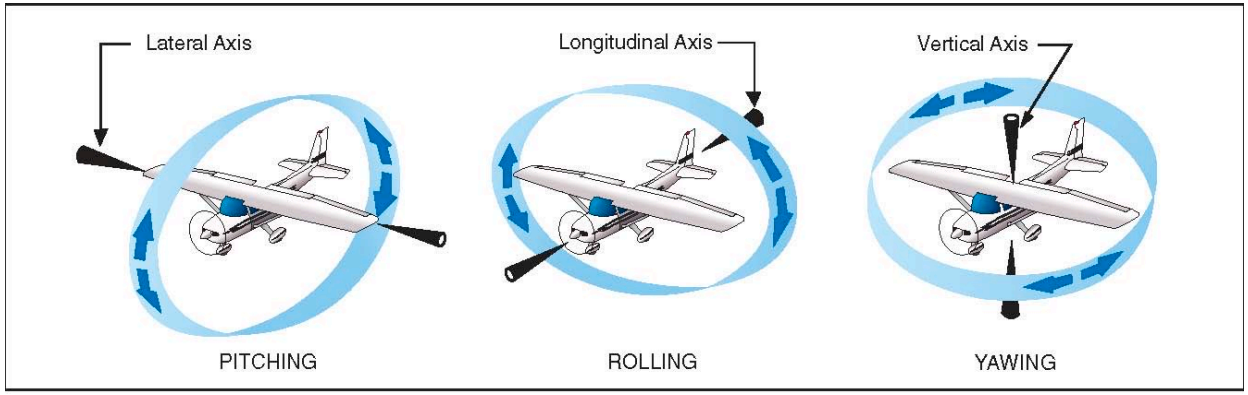


Figure 3-9. Axes of an airplane.

Radio Controls

Motor Power
(fast)

Rudder
(yaw)

Slow, Stop

Trim Controls
Adjust the center point
of the surfaces

Elevator
(Pitch)

DOWN

Ailerons
(roll)

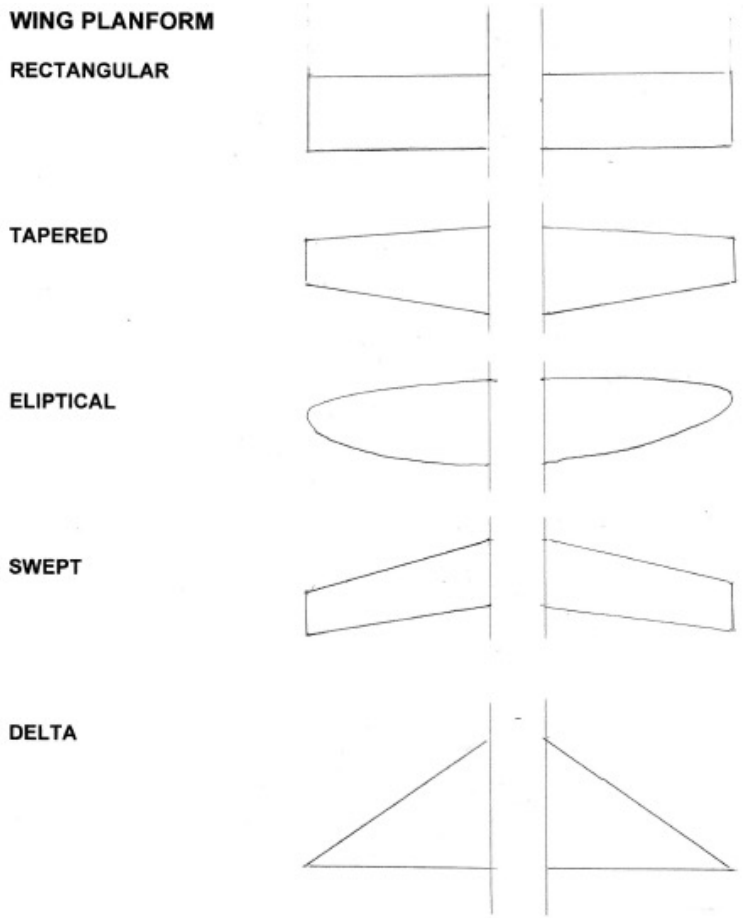
UP

Right stick is just like a real airplane

Pull toward yourself to pitch UP

Wing Planform

- Rectangular (best for trainers)
- Tapered
- Elliptical
- Swept
- Delta



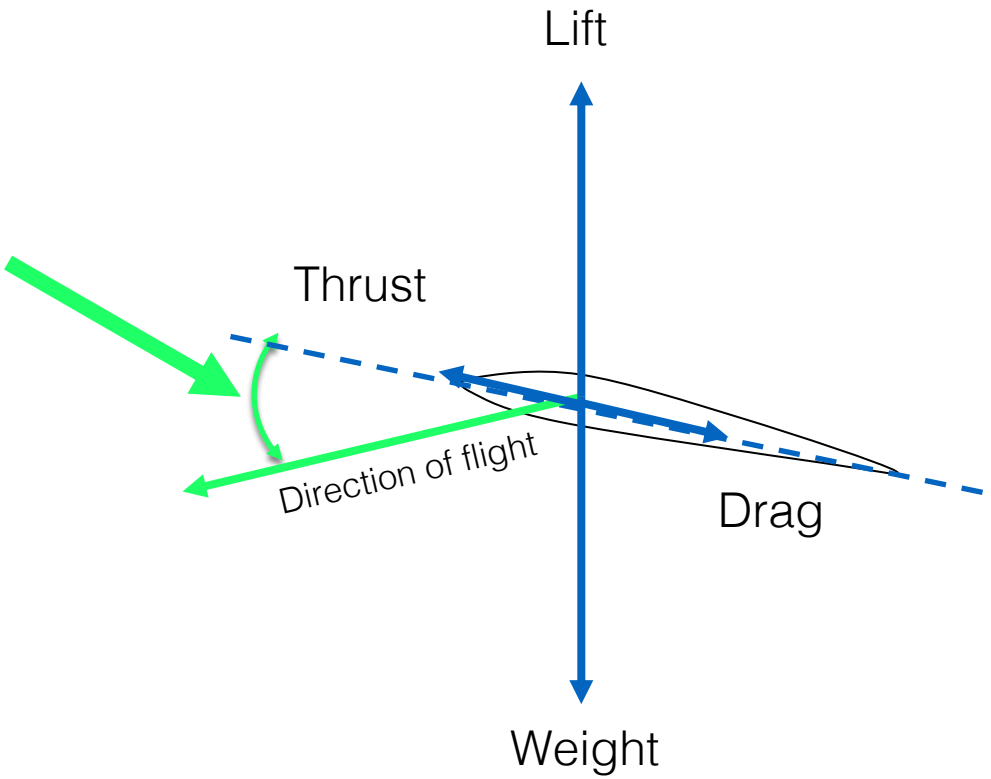
Lift, Weight, Thrust, and Drag

Lift comes from:

- Angle of Attack
- Wing Area
- Airfoil Shape
- Airspeed

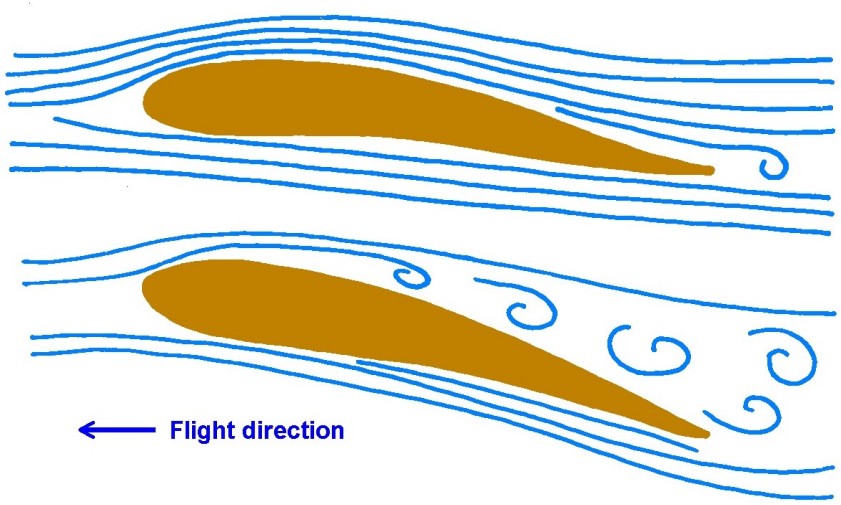
In level flight

- Lift = Weight
- Thrust = Drag



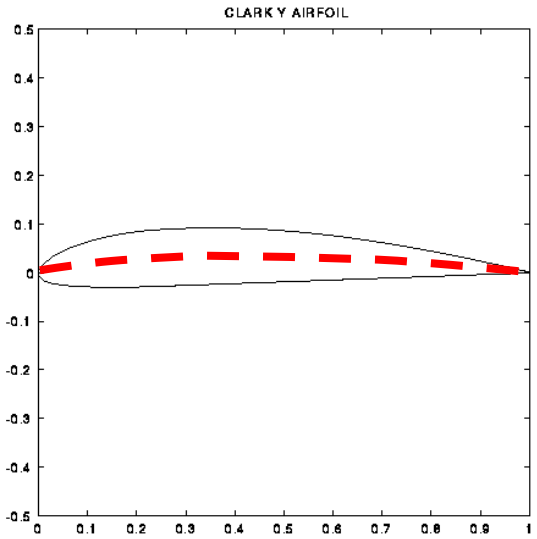
Lift is greatly reduced when the Wing Stalls

- Stall can occur when:
  - Too slow
  - Pulling too much up elevator
  - Steep bank angle in a turn
  - Any combination of these three
- Occurs at the *critical angle of attack,* about 15 degrees
- Trainers have gentle stall characteristics. The warbird you want to fly someday will not.
- One wing can stall before the other, resulting in a sharp roll, and if it continues, a spin. A good trainer won't do this.

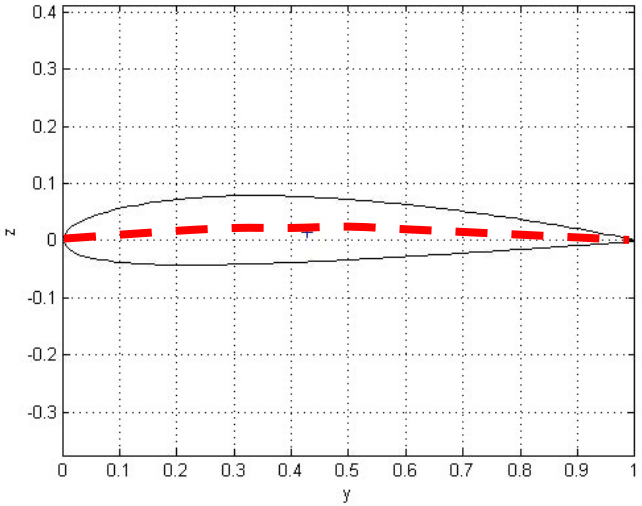


Airfoil Shapes

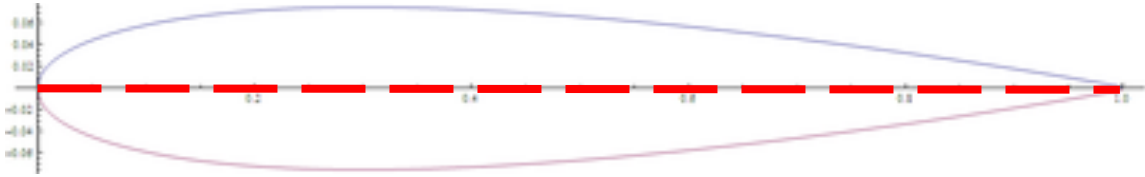
Flat bottom airfoil
- much camber (mid-line is curved)
- Often used on trainers and Cubs
- Good at low speeds



"Semi-symmetrical" airfoil
- has some camber
- sometimes used on trainers
- Good all-around airfoil

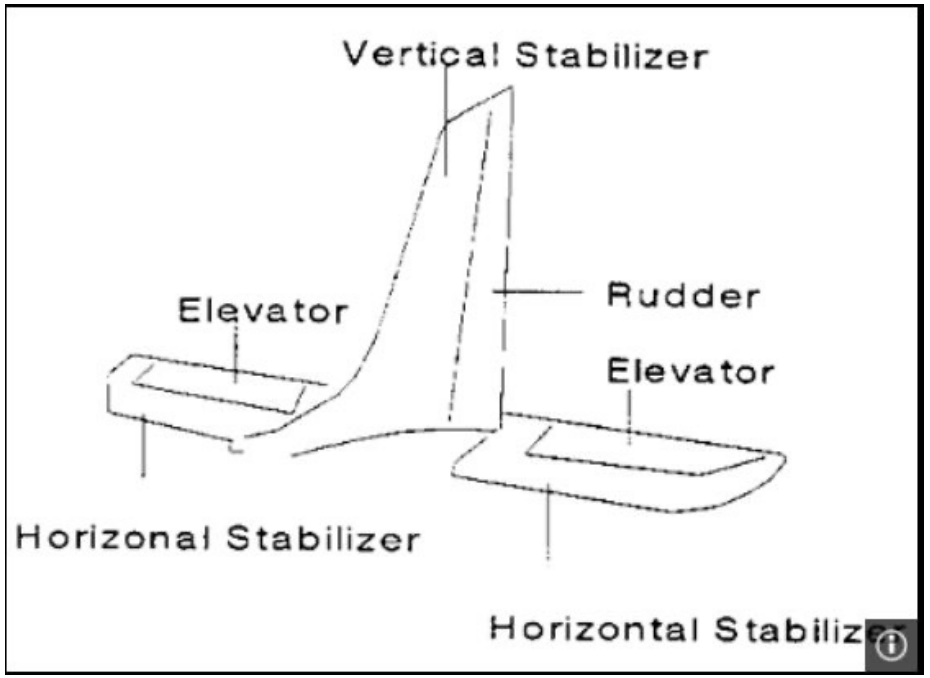


Symmetrical wing
- Zero camber - mid line is straight
- Used on aerobatic airplanes



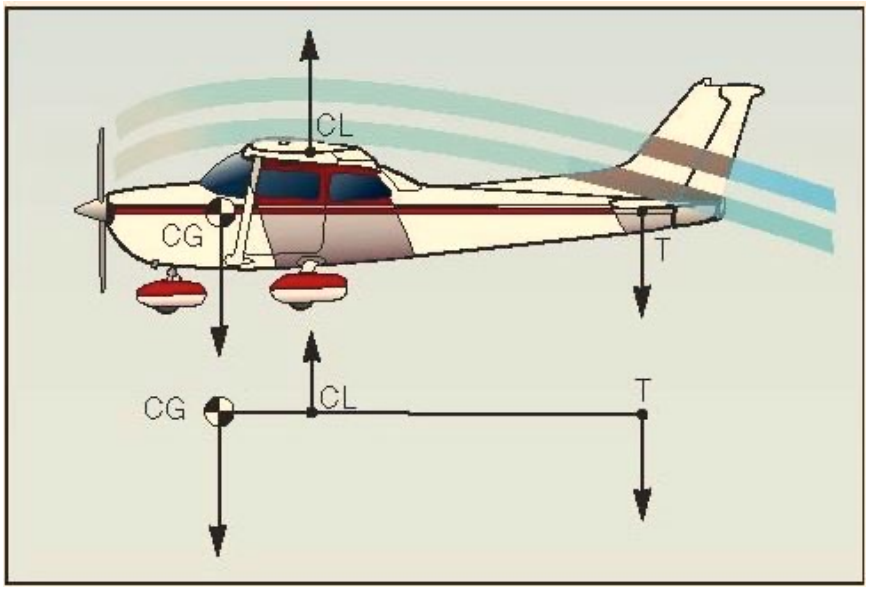
Empennage (The tail Group)

- Large tail surfaces, longer aft fuselage, and relatively small elevator and rudder result in a more stable airplane that is easier to control



Balance and Pitch Stability

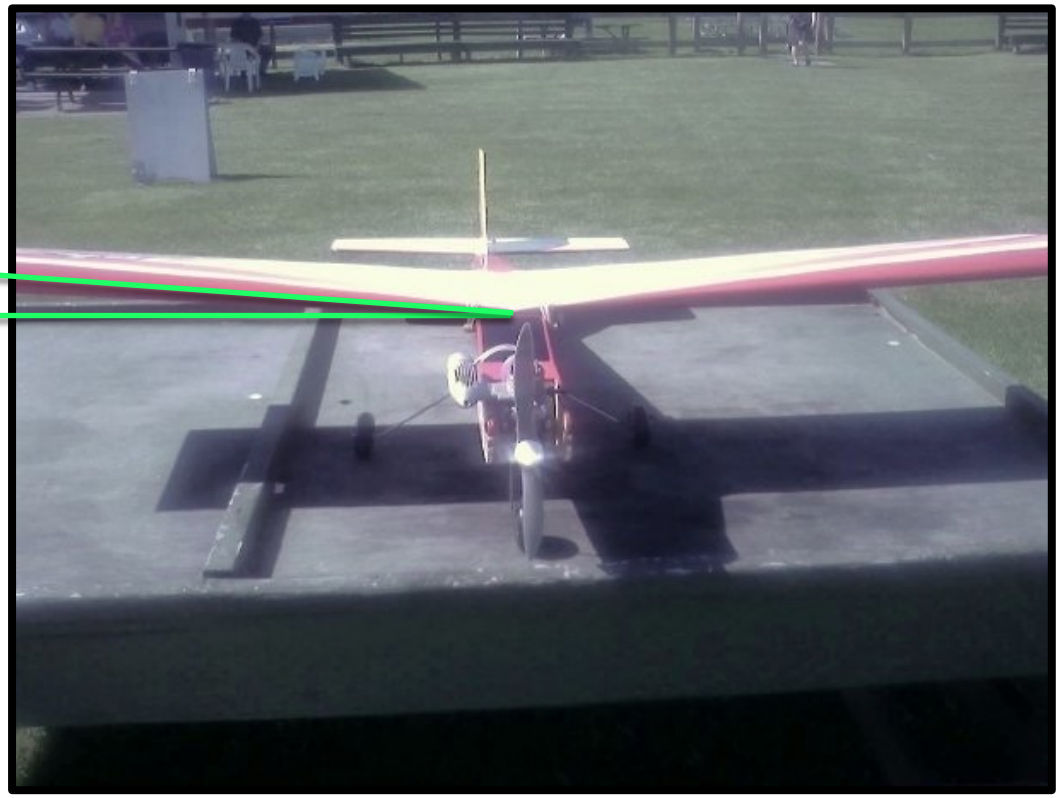
- A stable trainer type airplane will have the balance point, or center of gravity (CG) ahead of the center of lift.
- The horizontal stabilizer in this case will push down to balance the center of gravity of the airplane being forward of the center of lift.
- ALWAYS make sure your model balances at the point recommended by the manufacturer, or slightly forward of that point.



Roll Stability

- Dihedral effect helps to right the airplane in roll, making it easier to fly.

Typical trainer
Dihedral angle



- A zero dihedral high wing airplane will still have some dihedral effect
- Swept wings have dihedral effect
- Aerobatic airplanes usually have zero dihedral and low or mid wings so they also fly well upside down

Disclaimers

MAR/C provides advice. After you gain solo flight privileges,
only you are responsible for your
model aircraft readiness, your actions, and abilities

Any instructions provided by the manufacturers of
equipment such as but not limited to aircraft, radio controls,
batteries, motors or engines
and anything installed in your airplane have
precedence over any advice provided by instructors, this document,
or the mar-c website..

Flying and teaching techniques
vary widely in our hobby, and vary from one instructor to another.

The goal of this document is to encourage some standardization and
provide a practical minimum amount of knowledge.

Version Information

Version	Author	Date	Description
1.5	Brian Kelly	April 2017	Aligned Flight Training Syllabus with new flight log. Misc corrections and refinements
1.6	Brian Kelly	4/19/2017	Misc edits, repaired links, to prepare for website update
1.7	Brian Kelly	4/26/2017	Corrections and misc edits
1.8	Brian Kelly	9/28/2017	Updated Proficiency Check and misc edits
2.0	Brian Kelly	Nov 2018	Broken into separate standalone chapters for quicker access on the website.
3.0	Brian Kelly	April 2023	Updated to reflect club-owned fleet of electric training planes and miscellaneous improvements

Notes for Instructors

- Experience shows we used to have the most training accidents and damaged airplanes doing takeoffs
- Takeoff is best taught ***after*** the student has practiced go-arounds in Phase 3.
- If the student over-rotates, or rotates while steering with a rudder input, the plane might not have enough power and the instructor may not have enough time to save the plane.
- Teaching go-arounds first ensures that the student knows how to smoothly pitch up, and fly a straight-ahead climb in wind
- Teach the student to fly intentionally – to force the plane straight along runway heading. Teach not letting the plane turn left doing what it wants to do, but instead what the pilot wants to do.