Private

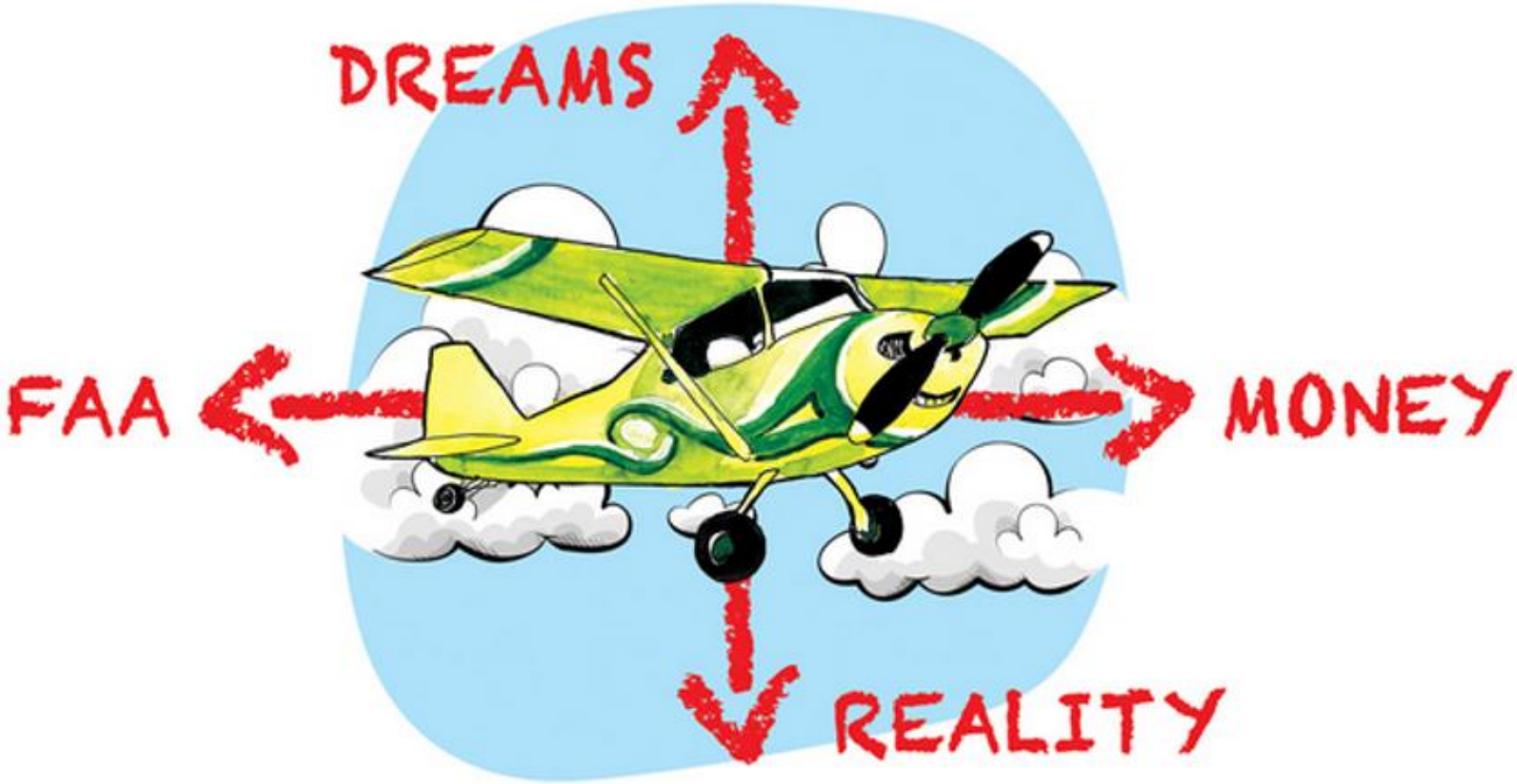
AVP 105 - Ground Lesson (GL) 3

Chapter 3 – Aerodynamic Principles

GL 3 Objectives

- Principles of aerodynamics:
  - Describe the four forces of flight
  - Explain the aerodynamic principles and design characteristics that apply to airplane stability and maneuverability
- Stall awareness, spin entry, spins, and spin recovery techniques
  - Recognize the stall and spin characteristics related to training airplanes
  - Explain how to recognize and recover from stalls and spins

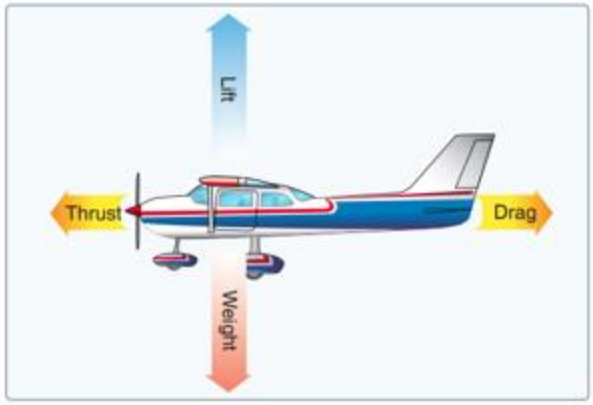
THE FOUR FORCES OF FLIGHT

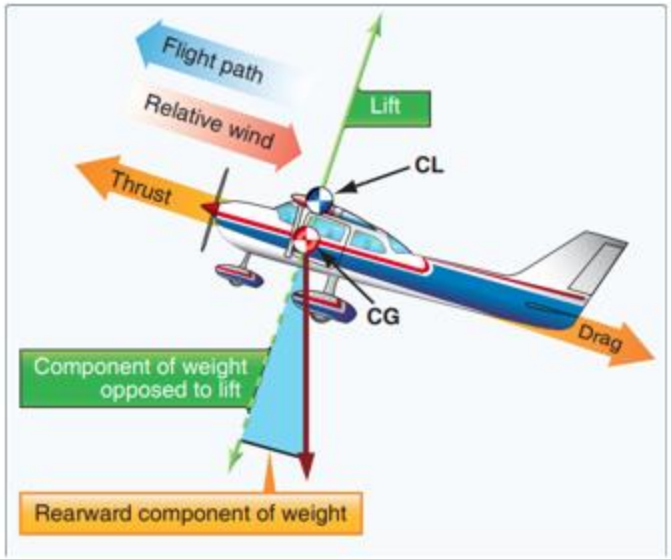


Four Forces of Flight

- Lift
- Weight
- Thrust
- Drag

- In steady flight, the sum of these opposing forces is equal

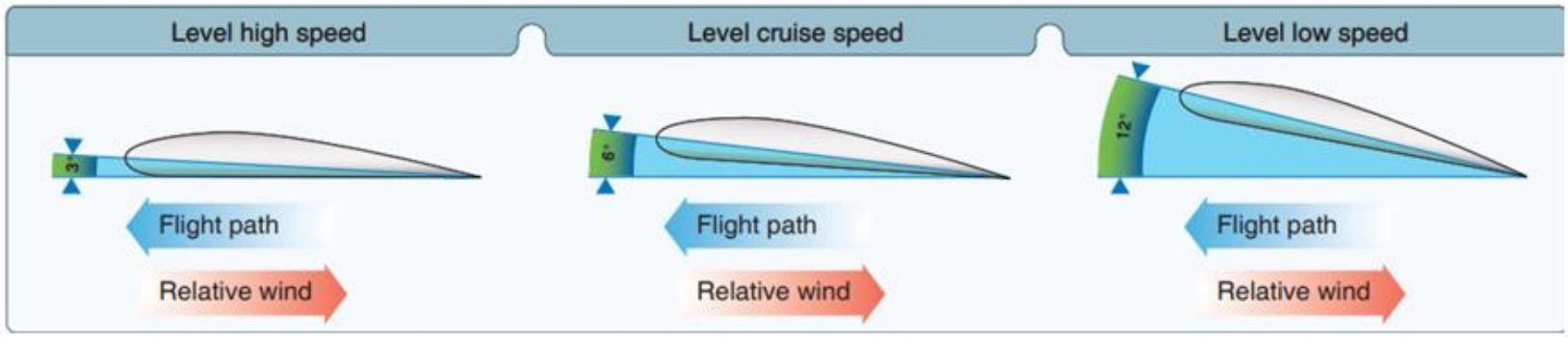




Lift

- Newton's Laws of Force and Motion
  - A body at rest tends to remain at rest…..
  - Force = mass x acceleration
  - For every action there is an equal and opposite reaction
- Bernoulli's Principle
  - As the velocity of a fluid increases, its internal pressure decreases
  - Derived from Newton's second law
- Angle of Attack
  - The angle between the chord line and the direction of the relative wind
- Relative Wind – The airflow which is parallel to and opposite the flight path of the plane

Angle of Attack



Pilot Control of Lift

WING FLAP SYSTEM

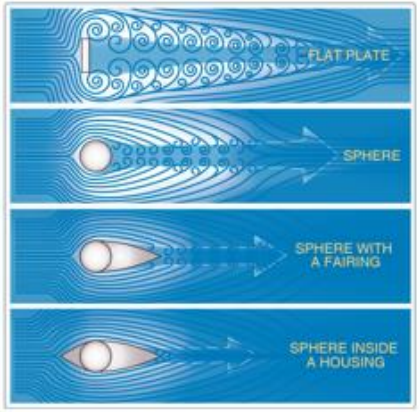
The wing flaps are of the single-slot type (see figure 7-3), and are extended or retracted by positioning the wing flap switch lever on the instrument panel to the desired flap deflection position. The switch lever is moved up or down in a slotted panel that provides mechanical stops at the 10° and 20° positions. For flap settings greater than 10°, move the switch lever to the right to clear the stop and position it as desired. A scale and pointer on the left side of the switch lever indicates flap travel in degrees. The wing flap system circuit is protected by a 15-ampere circuit breaker, labeled FLAP, on the left side of the instrument panel.

Stalls

- Exceeding the **Critical Angle of Attack**
  - **Critical angle of attack -** The angle of attack at which a wing stalls regardless of airspeed, flight attitude, or weight.
- Does not necessarily happen all at the same time along the entire wing. Wing Twist. Advantages?
- Indications
  - Mushy Controls
  - Stall Warning Horn – 5 – 10 knots before the stall
  - Buffeting
- Recovery from Stall – Decrease Angle of Attack (AoA)
  - Depending on Design, Aircraft will decrease AoA all by itself when stalled
- Angle of Attack, not a speed

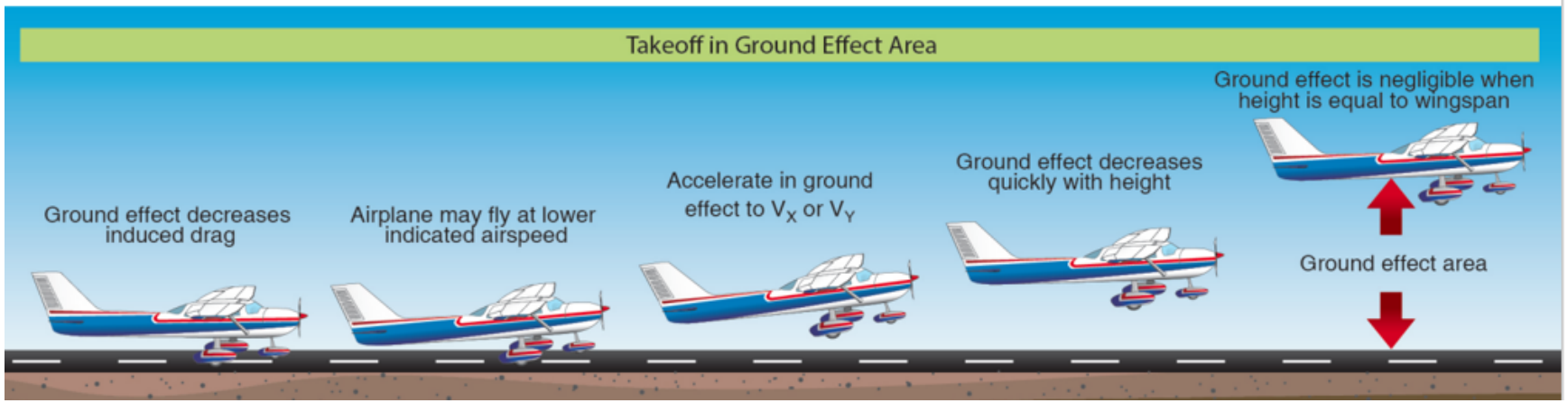
Weight, Thrust and Drag

- Weight – The force of gravity pulling the aircraft down
- Thrust – Forward acting force provided by the propeller
- Drag
  - Parasite – Aircraft surface in the airflow
    - Form – Turbulent Wake caused by the separation of airflow
    - Interference – varied currents of air meet and interact around the aircraft
    - Skin Friction – Roughness of the airplane surface
  - Induced – Airflow around the wings to create lift
  - Total – Sum of Parasite and Induced
    - Parasite increases with speed, Induced increases with AoA



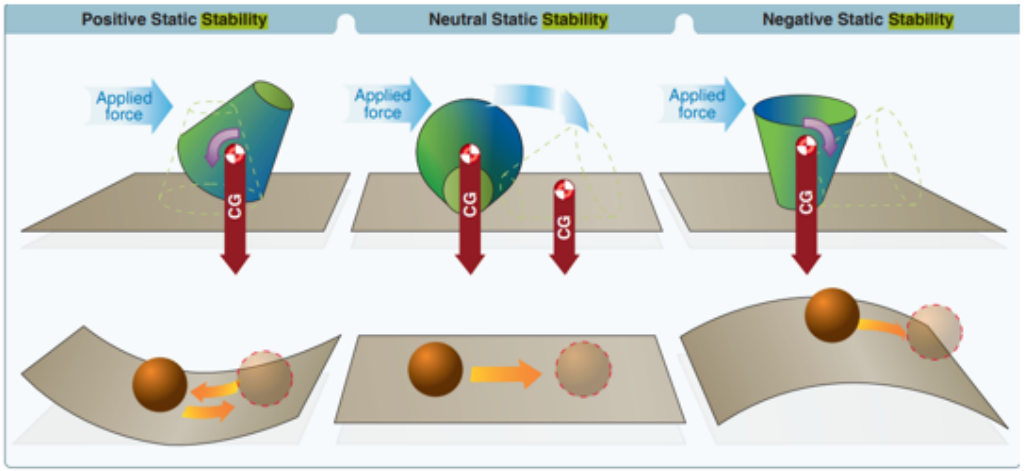
Ground Effect

- The result of the ground altering the airflow pattern around the plane
- Reduces induced drag
- Reduction in Drag increases (drag is less) the closer the wing is to the ground
  - More prominent in low wing planes



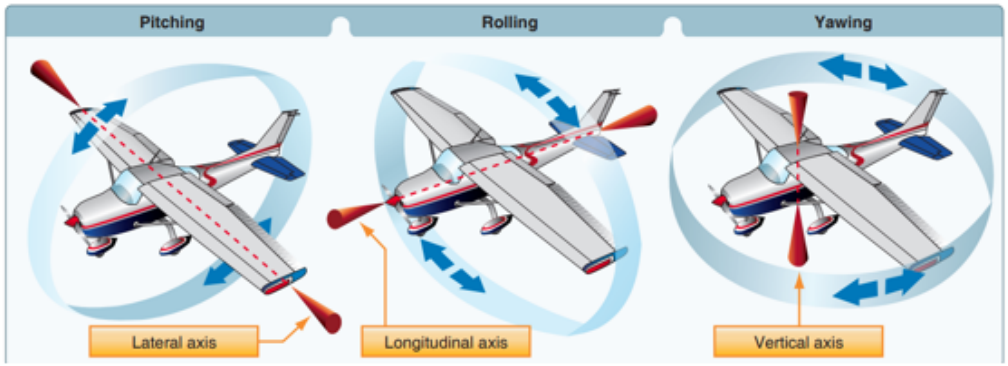
Stability

- Inherent quality of an aircraft to return to a condition of steady flight
- Positive Static – Initial tendency to return to the position from which it was displaced
- Positive Dynamic – Returns to the position from which it was displaced over time



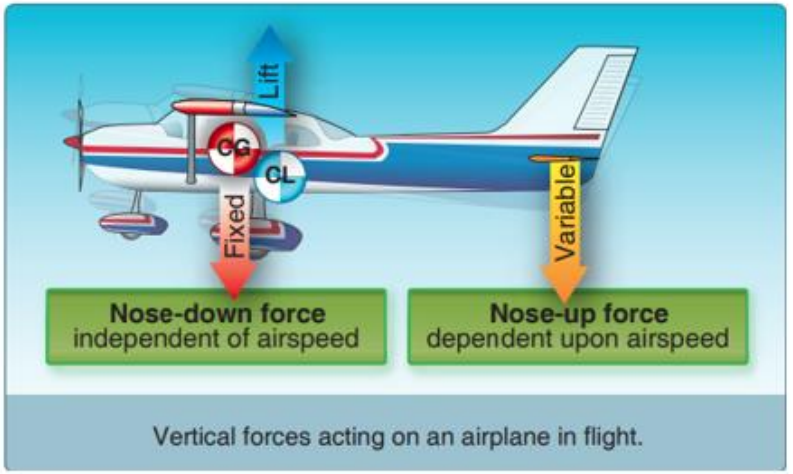
Three Axes of Flight

- Longitudinal – Nose to Tail (long part of plane)
  - Controlled with Ailerons (bank angle, roll)
- Lateral – Wing tip to Wing tip
  - Controlled with Elevator (pitch)
- Vertical – Top to bottom
  - Controlled with Rudder (yaw)



Center of Gravity

- CG generally in front of Center of Lift (Pressure)
- CG too far Forward
  - More stable
  - Longer takeoff distance
  - Higher stalling speed
- CG too far Aft
  - Less stable at all speeds
  - Better MPG
  - Harder to recover from Stalls and Spins



Vertical forces acting on an airplane in flight.

Types of Stalls

- Power Off
  - Landing Configuration
  - Simulates conditions during a normal landing
- Power On
  - Take off Configuration
  - Simulates conditions during normal takeoff'
- Accelerated – under load (Gs)
- Crossed-control – e.g. Left Aileron, Right Rudder

Stall Recovery

- Reduce Angle of Attack
- Full Power
- If needed, Flaps raised to 20°
- Minimize Altitude Loss
- Level, Once at Vx, Pitch for Vx, Positive Rate, Climb above any obstacles
- Climb out by reaching flaps up speed (C172N, 60 knots), pitch for Vy

Spin Definition and Recovery

- Spin – Stall with Rotation
- Recovery - PARE
  - Power – Idle
  - Ailerons – Neutral
  - Rudder – Opposite direction of Spin
  - Elevator – Neutral (or Nose Down) see POH
- Recover from the dive

Completion Standards

- Demonstrate understanding of the four forces of flight, stability, maneuverability, stalls, and spins
- Complete with Chapter 3A, 3B, and 3C quizzes with a minimum score of 80 percent

Any Questions?

- Next – AVP 105 - Ground Lesson 4 – The Flight Environment
- Read Chapter 4, all sections