

Basic Aerodynamics

- The Four Forces
- Angle of Attack and Stalls
- Load Factor
- Weight and Balance

The Four Forces

- Lift vs. Weight, Thrust vs. Drag
- Applies to all airfoils and aircraft

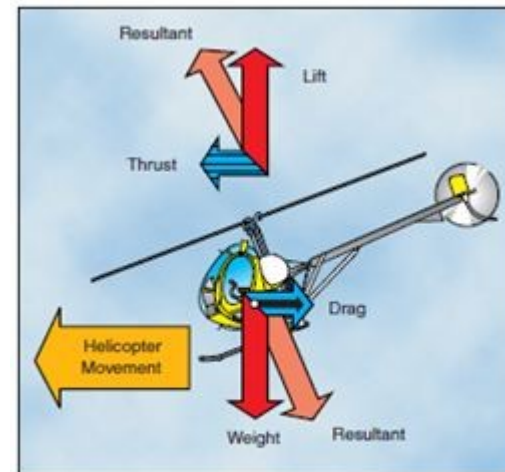
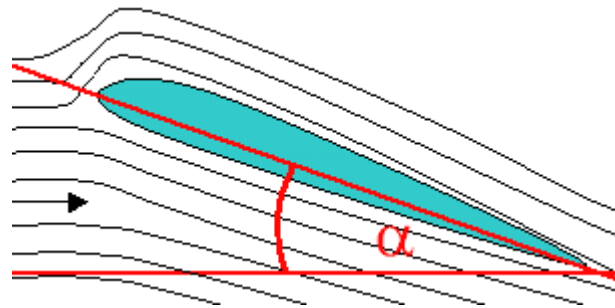


Figure i-2 Rotor-produced Thrust

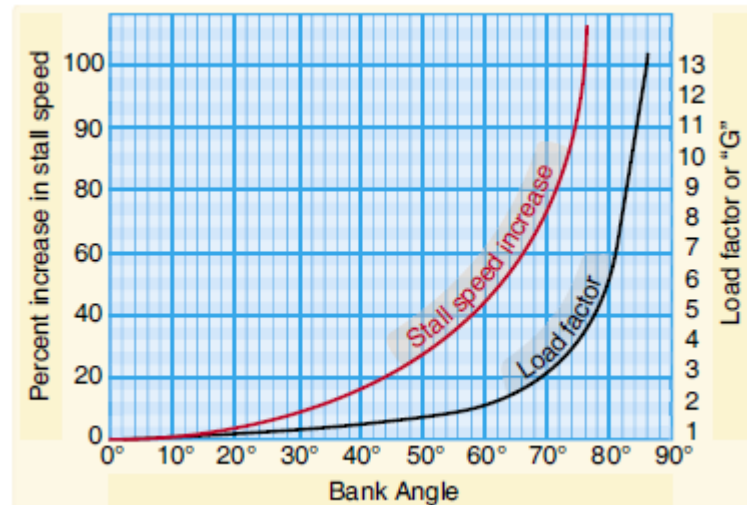
Angle of Attack – alpha (α)

- Chord line versus relative wind
- Lift proportional to angle of attack
- Aerodynamic stall at fixed angle of attack
- Can stall in any attitude and any airspeed



Load Factor

- Increase in weight by acceleration
 - Can cause mechanical failure
- Increases stall speed – accelerated stall
 - Can cause loss of control



Weight and Balance

- Determines aircraft stability and performance
- Key concepts:
 - Center of Gravity (CG)
 - Reference Datum
 - Calculation of Moments

Center of Gravity

- Balancing point
- When an object rotates, this is the center of rotation
- Affected by distribution of weight on object
- Quad-copter typically has it at physical center
- All aircraft have acceptable limits on CG position

Reference Datum

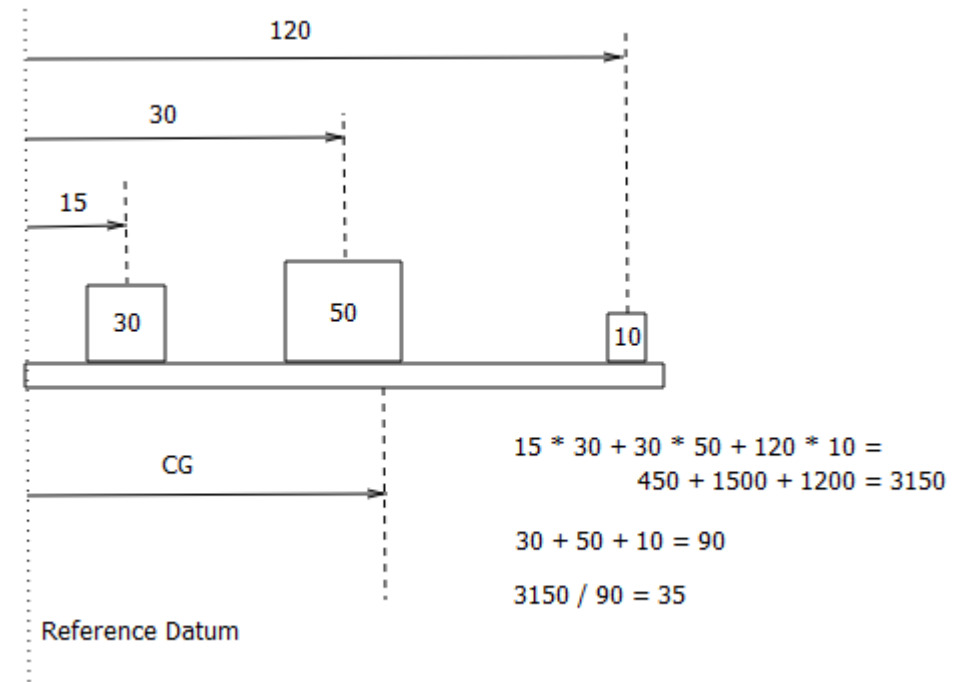
- Part of how CG is calculated and described
- An arbitrary point chosen
 - For a small airplane, it's often the firewall
- The distances to all weights and the CG itself are measured against the reference datum

Calculation of Moments

- “Moment” is mass times distance (“arm”) to datum
- CG is sum of all moments divided by total mass
 - Set up problem same way every time
- Questions are usually asked about weights on balance beam
 - May be given weights and asked for CG, or CG and asked for a weight or distance
 - Balance beam may have its own CG and weight; treat as just another object
 - No, weight and mass are not the same, but pretend they are

Example 1: Calculate CG

- Typical problem
- Add up moments
- Add up weights
- Divide to get CG



Example 2: Calculate Weight

- Substitute “X”
- Add up moments
- Add up weights
- Divide, set = to CG
- Solve for X

