

Stability

Objective

To understand the effects of design choices on the stability of an aircraft along its three axes.

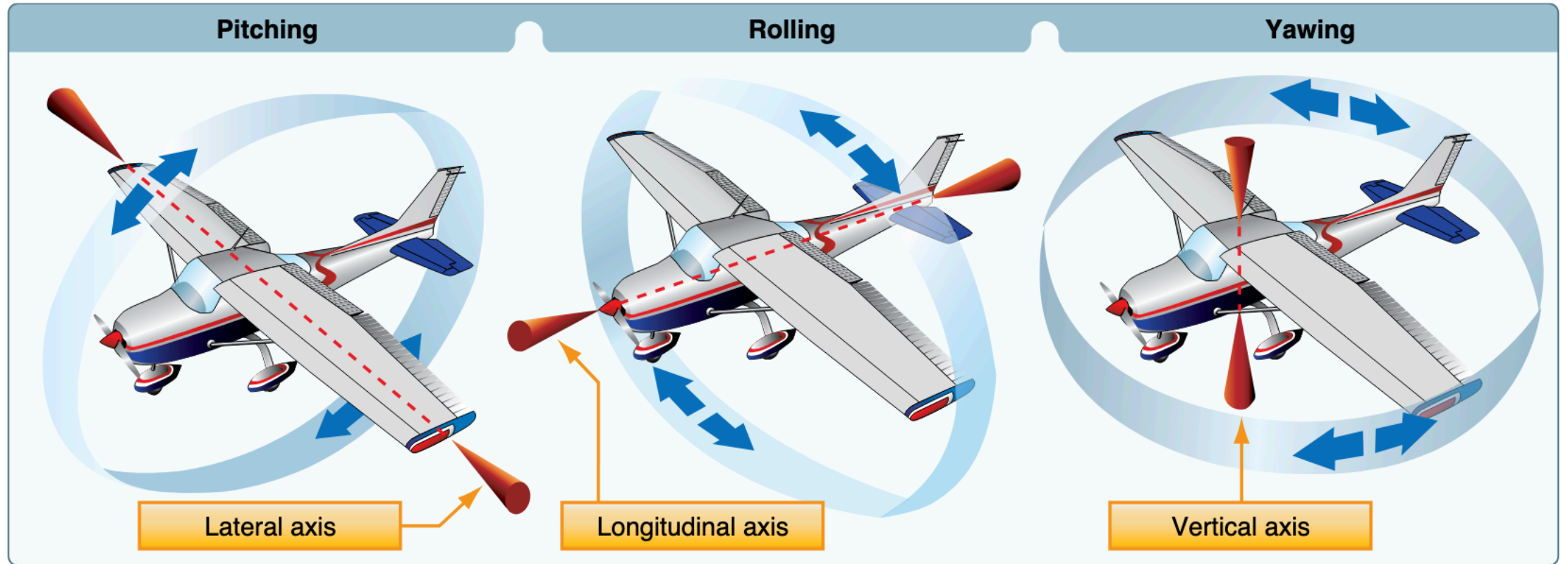
Motivation

Helps a student develop an intuitive understanding of stability and controllability that they can use to make sense of the control inputs as they fly in different conditions.

Overview

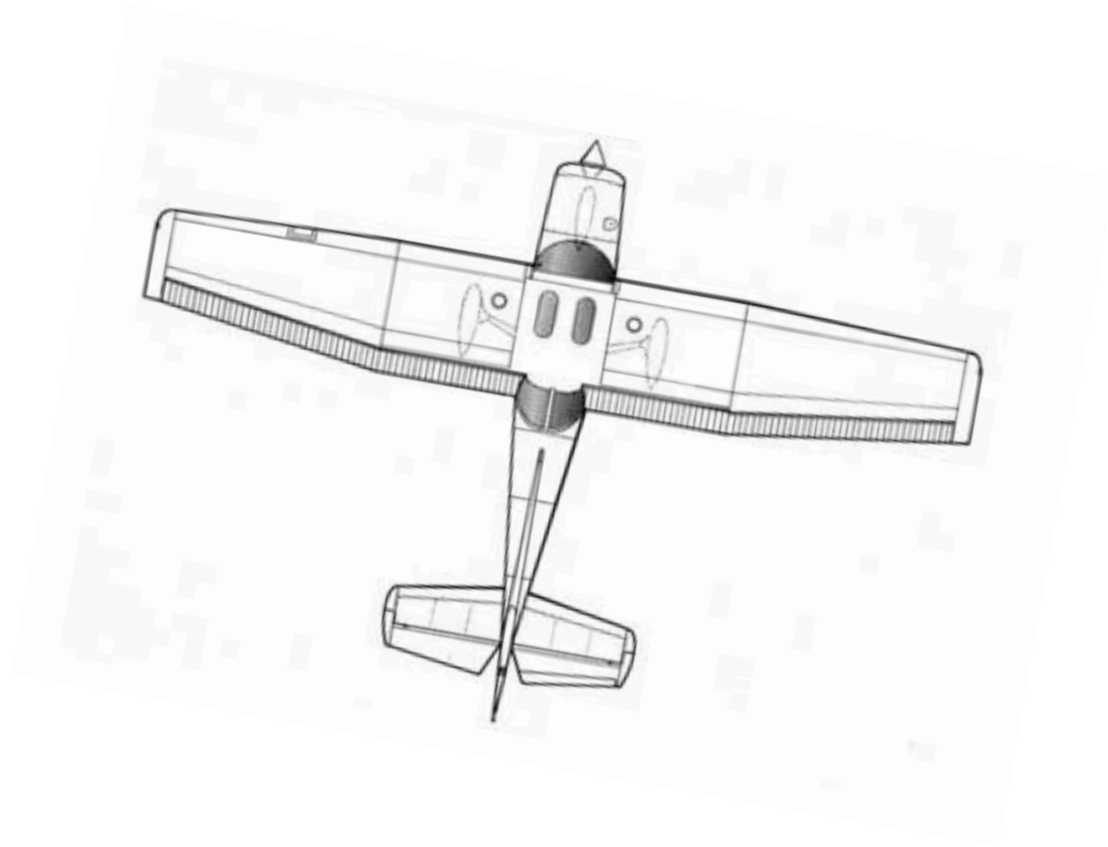
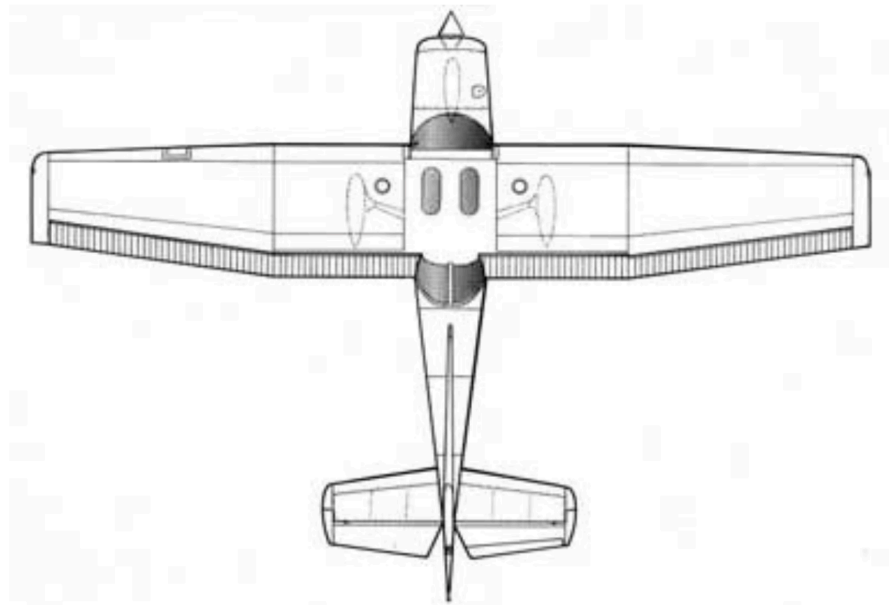
- Airplane Axes
- Static Stability and Dynamic Stability
- Yaw / Directional Stability
- Longitudinal / Pitch Stability
- Lateral / Roll Stability
- Maneuverability vs Controllability

Airplane Axes

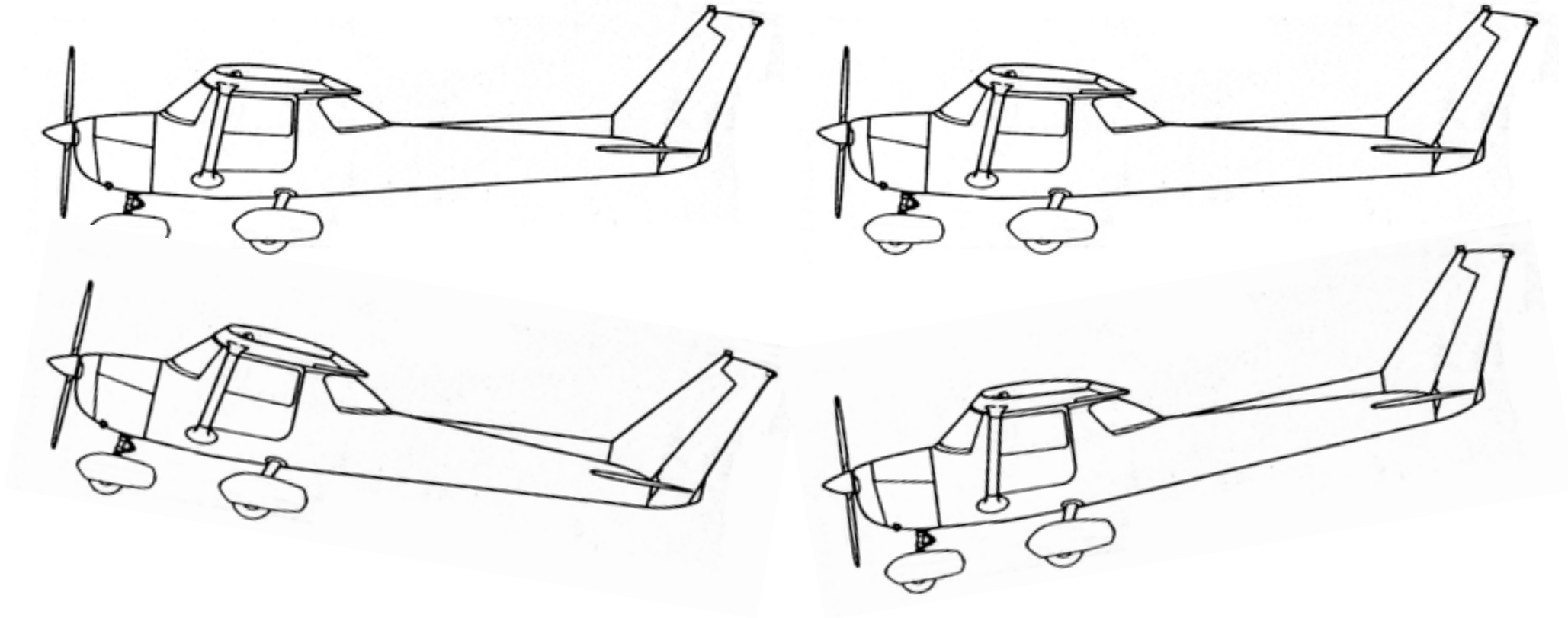


Static Stability and Dynamic Stability

Yaw / Directional Stability

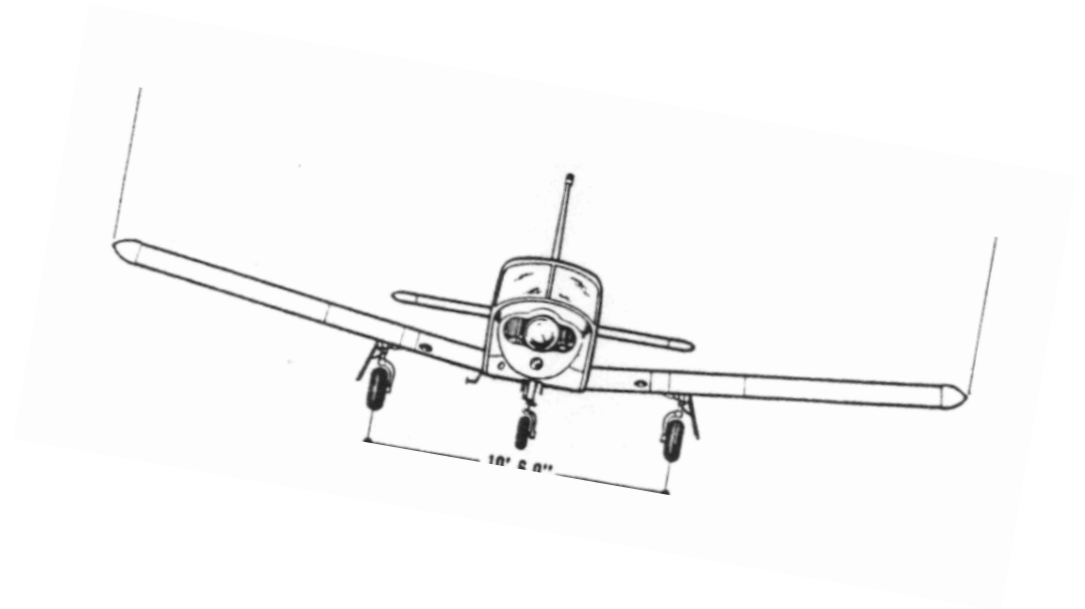
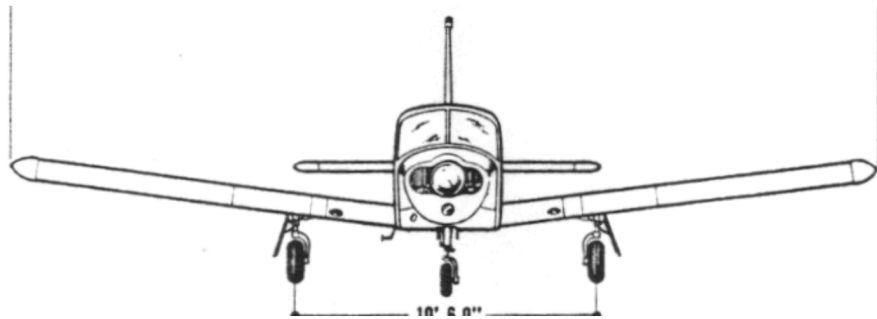


Longitudinal / Pitch Stability



Pitch dampens over time

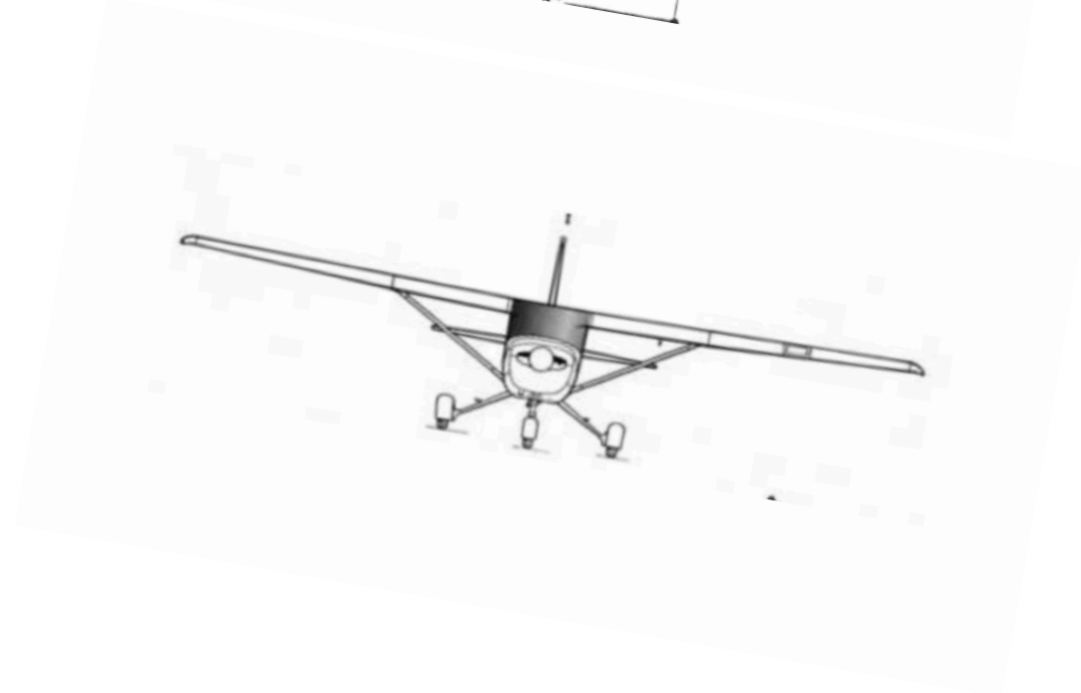
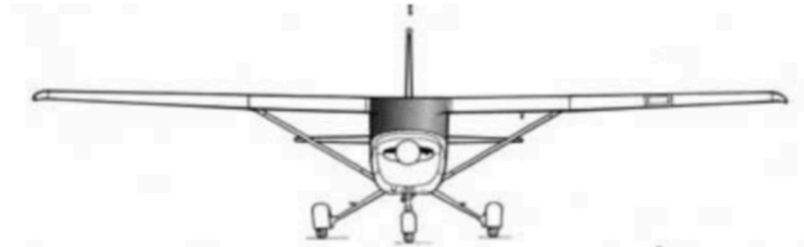
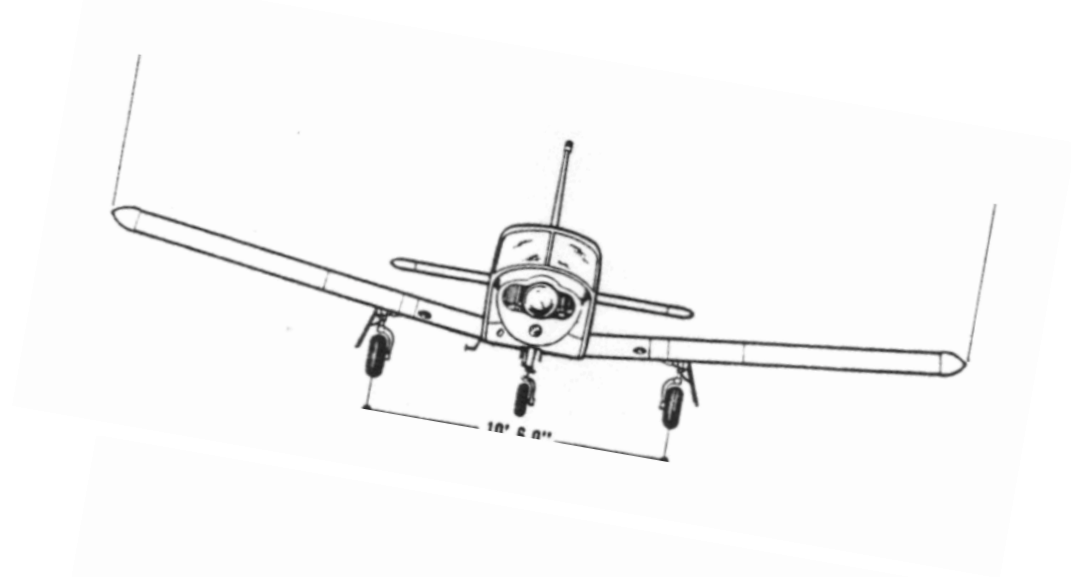
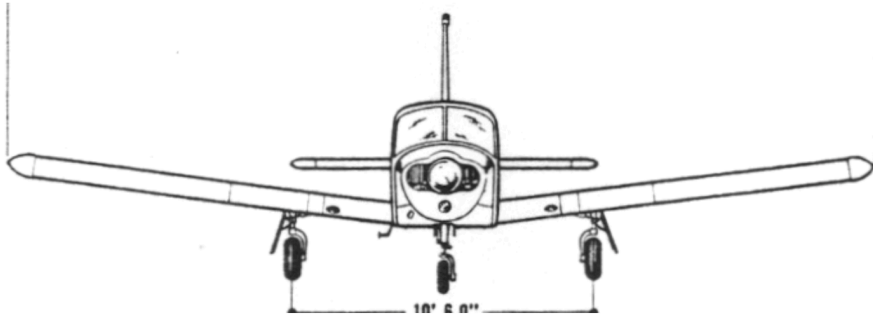
Lateral / Roll Stability



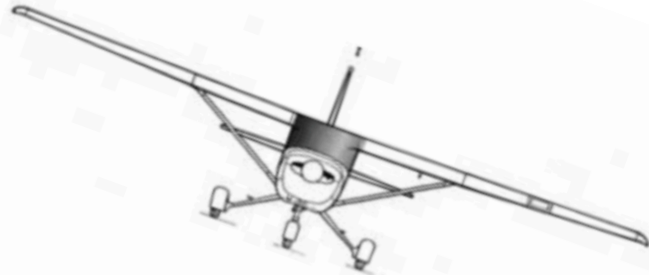
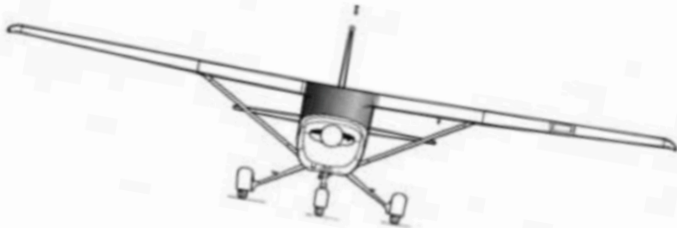
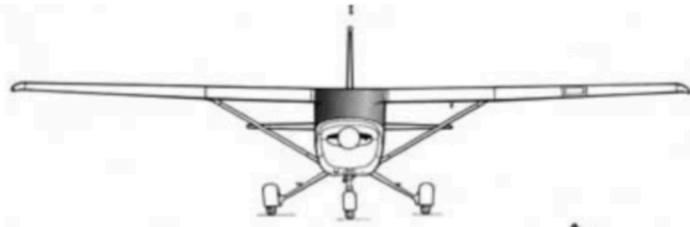
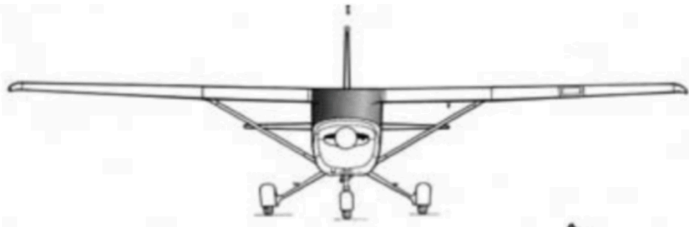
Dihedral angle make large AoA on down wing, raising wing

Deeper, Commercial-Level Discussion

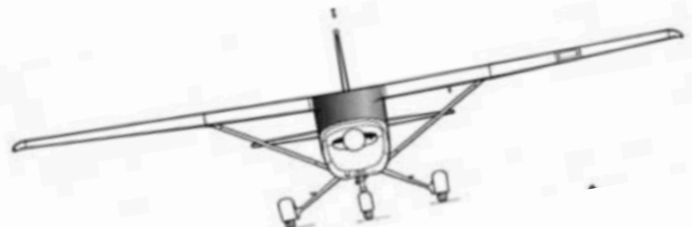
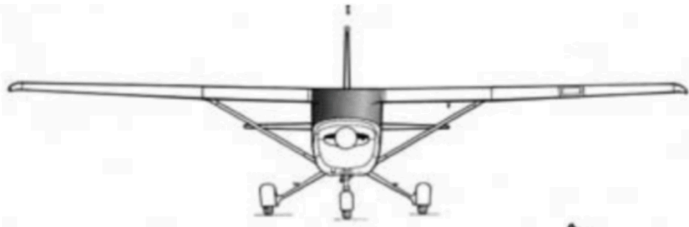
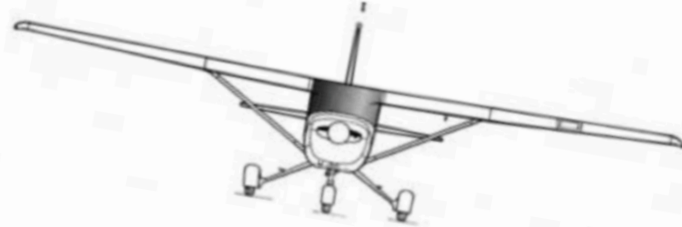
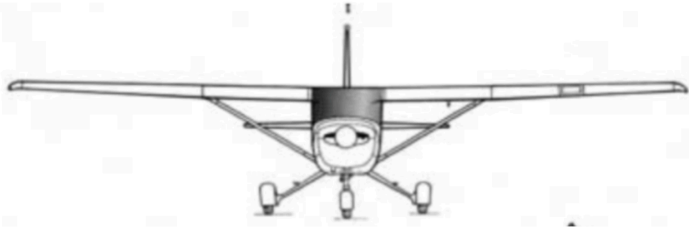
Lateral / Roll Stability - High vs Low Wing



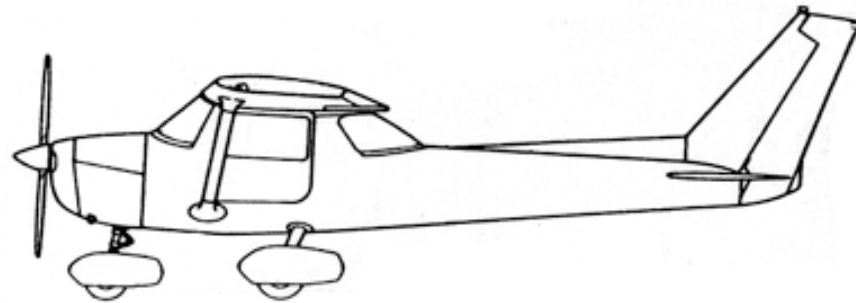
Spiral Instability - Strong directional (yaw) stability and weak lateral (roll) stability



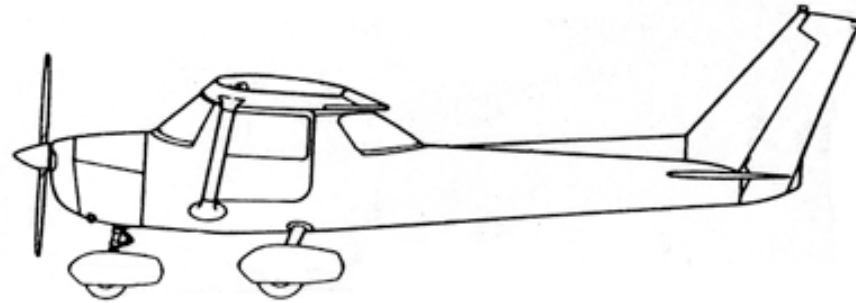
Dutch Roll - Strong lateral (roll) stability and weak directional (yaw) stability



Maneuverability vs Controllability

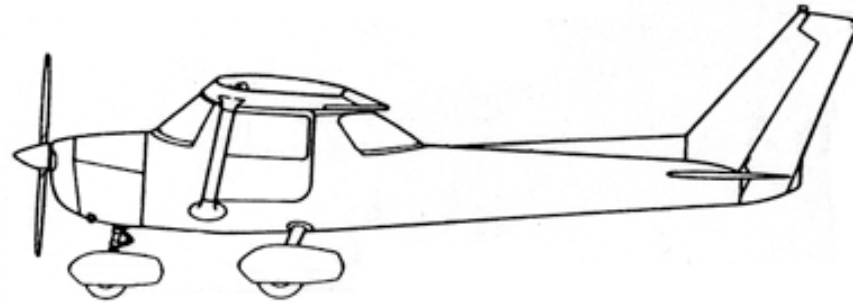


Maneuverability vs Controllability - Forward CG



Nose heavy, more stable, higher stall speed, lower cruise speed, more drag

Maneuverability vs Controllability - Aft CG



Tail heavy, less stable, sensitive controls, lower stall speed, higher cruise speed, less drag

Summary

- Airplane Axes
- Static Stability and Dynamic Stability
- Yaw / Directional Stability
- Longitudinal / Pitch Stability
- Lateral / Roll Stability
- Maneuverability vs Controllability