

Forces in Flight

Objective

To understand the effects of the balance of forces on the airplane in different scenarios, and how turning tendencies impact the control of the airplane.

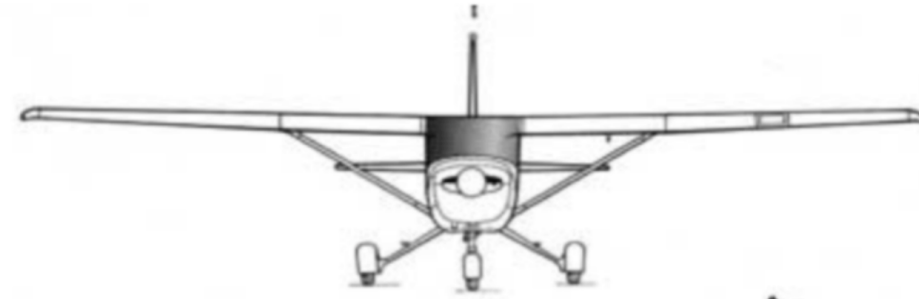
Motivation

Helps a student develop an intuitive understanding of the turning forces present when flying so they can better anticipate and compensate for these forces.

Overview

- Turning tendencies, torque
- Forces in flight
- Forces in straight and level
- Forces in a climb
- Forces in a decent
- Acceleration in a turn
- Forces in a turn
- Adverse yaw

Turning Tendencies



When a pilot is flying a conventional aircraft, there are several factors that can cause the aircraft to turn in an unintended direction. These factors are known as turning tendencies, and they can be caused by a variety of factors, including engine torque, propeller slipstream, and wing drag.

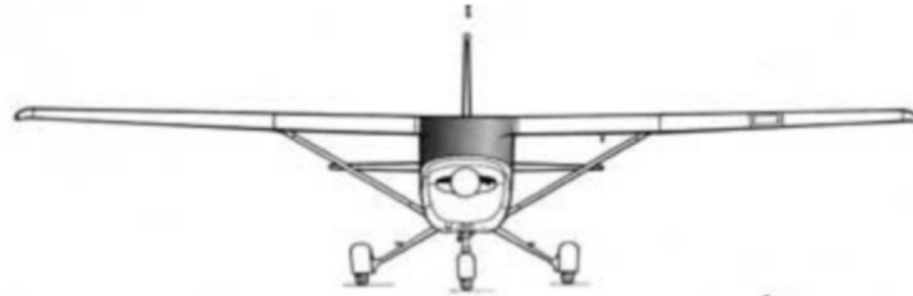
Engine torque is the most common cause of turning tendencies. As the engine rotates, it exerts a torque on the fuselage, which causes the aircraft to turn in the opposite direction. This is known as torque reaction, and it is a natural consequence of Newton's third law of motion.

Propeller slipstream is another factor that can cause turning tendencies. As the propeller rotates, it creates a slipstream of air that flows over the wings. This slipstream can cause the wings to turn in the direction of the propeller's rotation, which can lead to a turn in the opposite direction of the engine's torque.

Wing drag is a third factor that can cause turning tendencies. The wings of an aircraft are not perfectly symmetrical, and this can cause them to drag differently. This difference in drag can cause the aircraft to turn in the direction of the wing with the most drag.

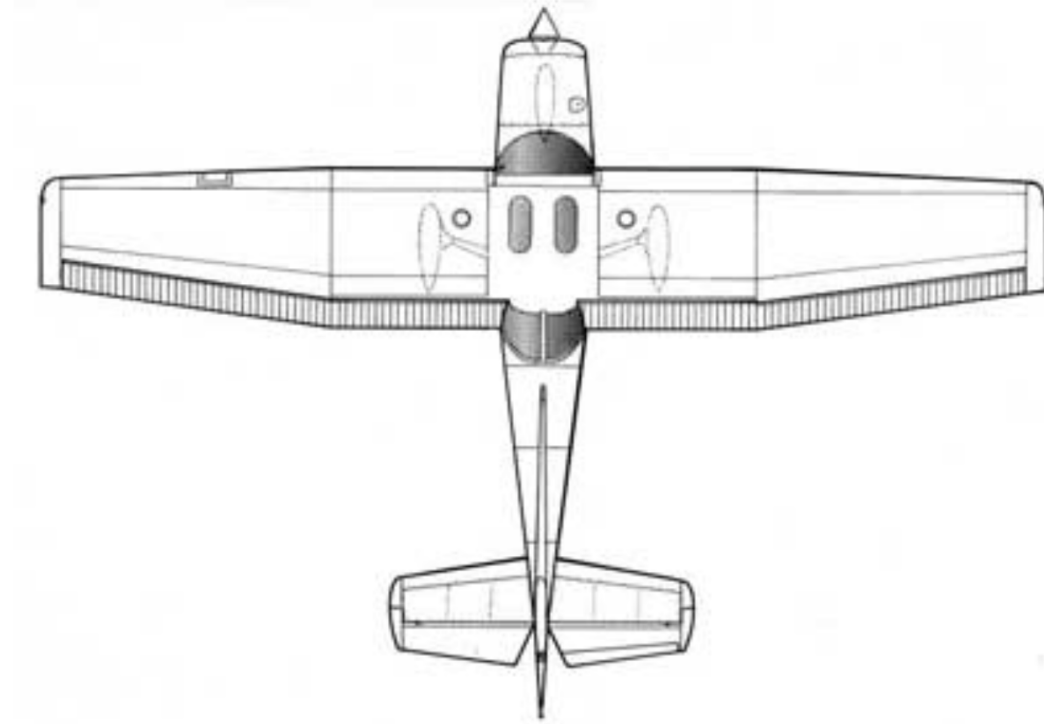
Understanding turning tendencies is essential for a pilot to maintain control of the aircraft. By recognizing the factors that can cause turning tendencies, a pilot can anticipate and correct for them, ensuring a safe and smooth flight.

Turning Tendencies: #1 Torque



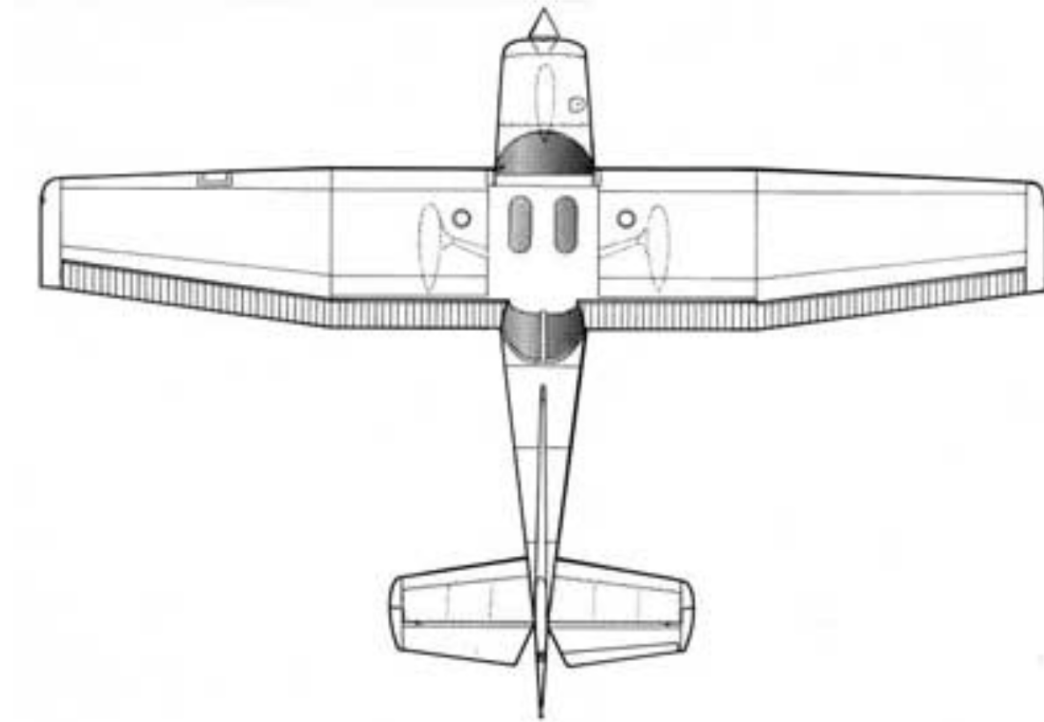
Newton's 3rd law, tendency to roll aircraft to left

Turning Tendencies: #2 Propeller Slipstream

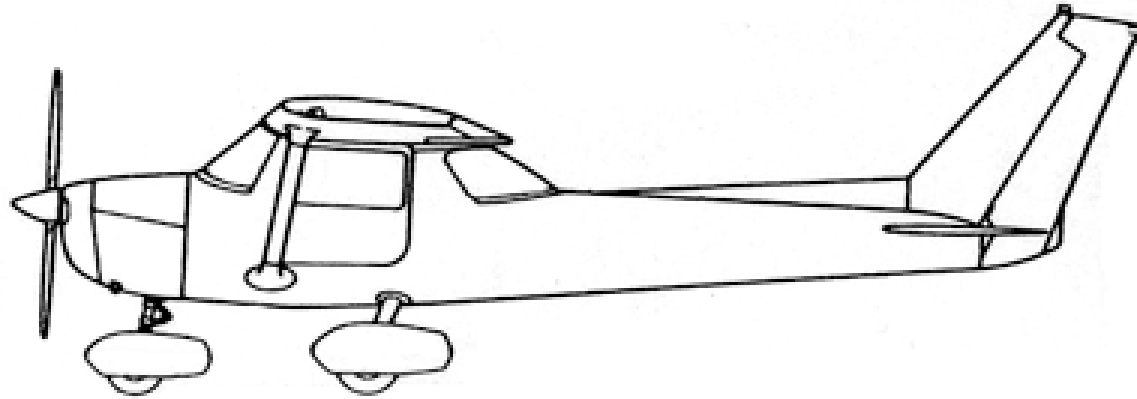


Turning Tendencies: #3 Gyroscopic Precession

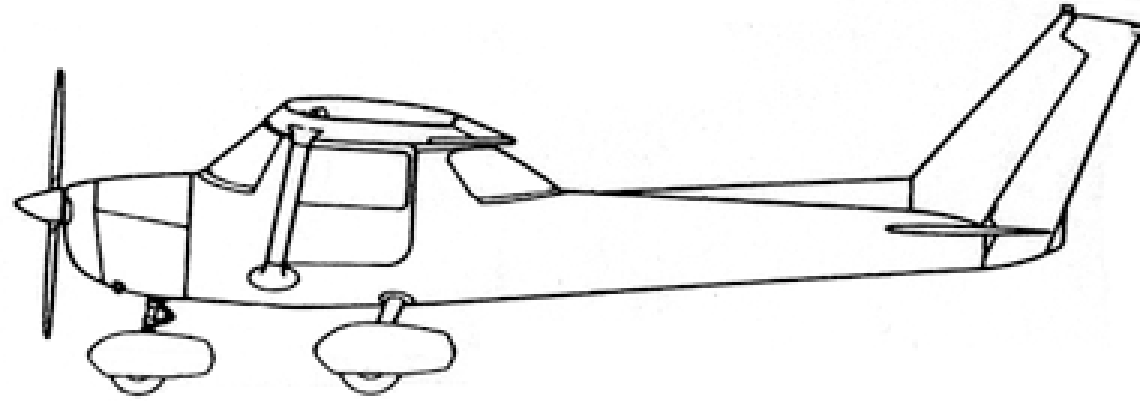
Turning Tendencies: #3 Gyroscopic Precession



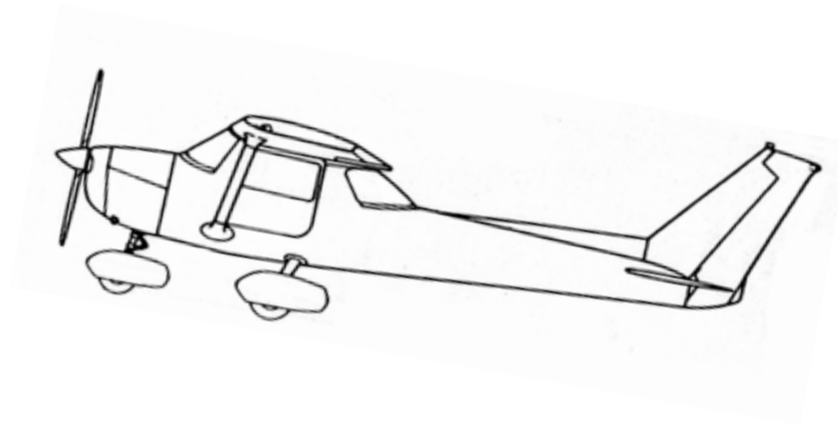
Turning Tendencies: #4 P-Factor



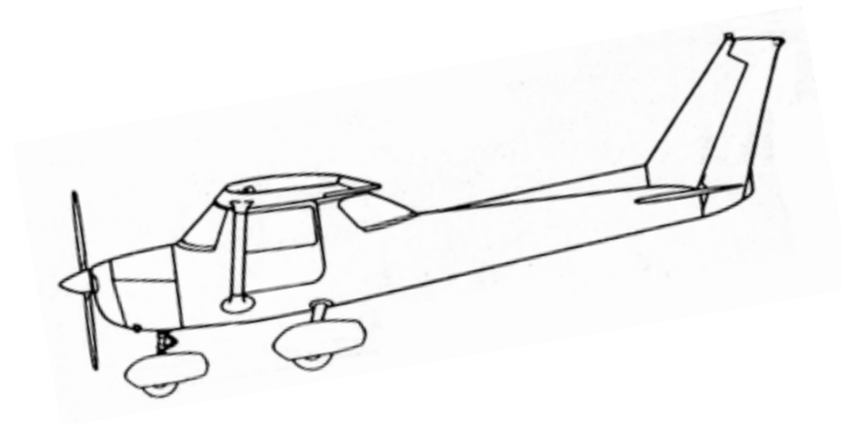
Forces in Flight: S&L



Forces in a Climb



Forces in a Descent



Turns - Centripetal Acceleration

Force is proportional to acceleration

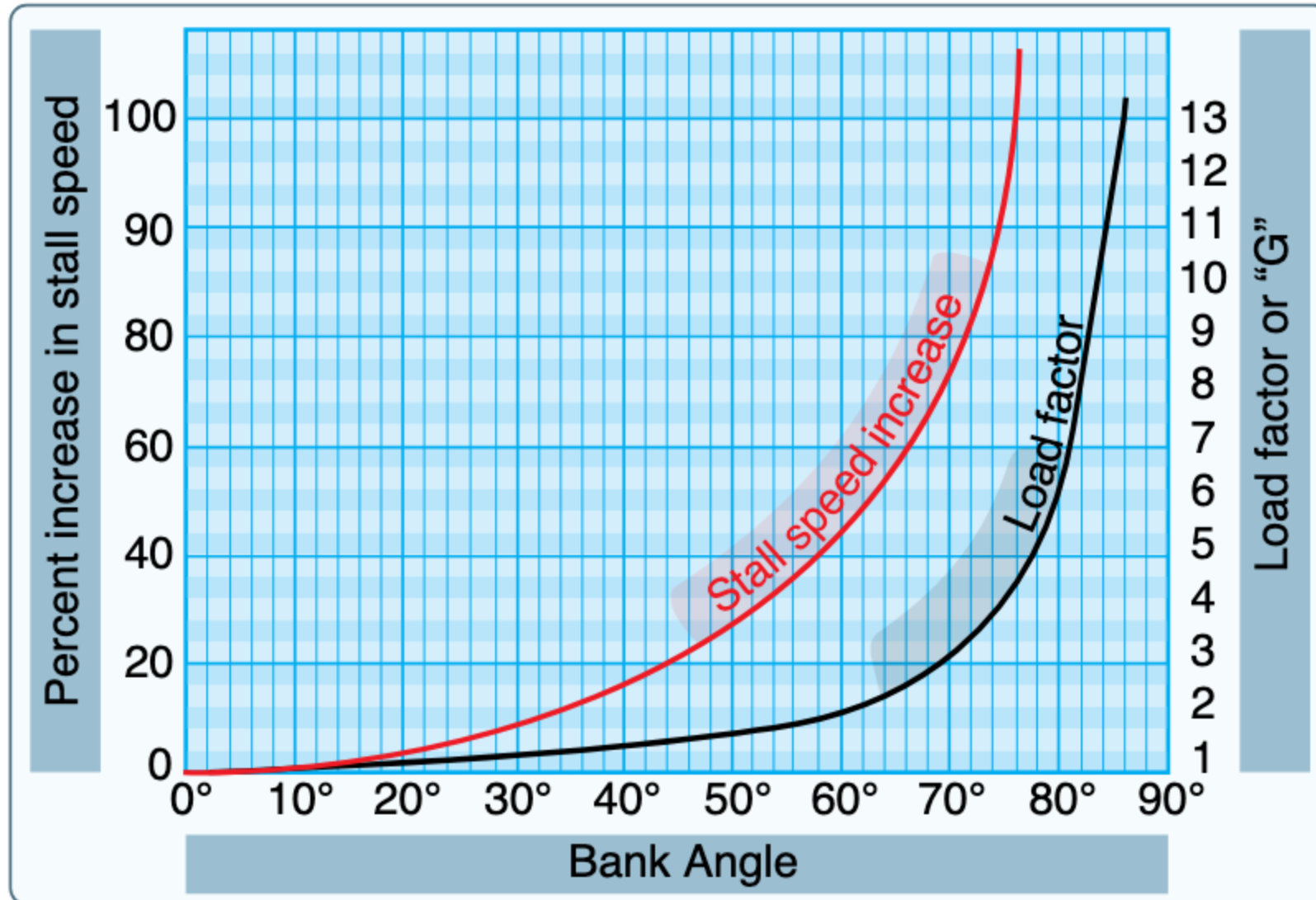
Forces in a Turn

S&L, Medium Bank, Steep Bank

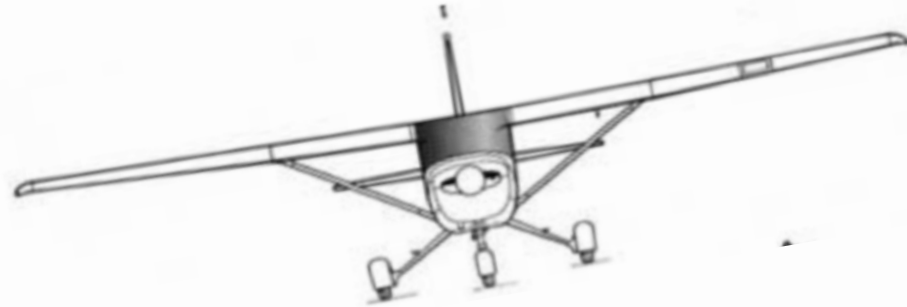
Forces in a turn widget

Load Factor = Lift force / Weight force

Load Fa



Adverse Yaw - Initial Turn

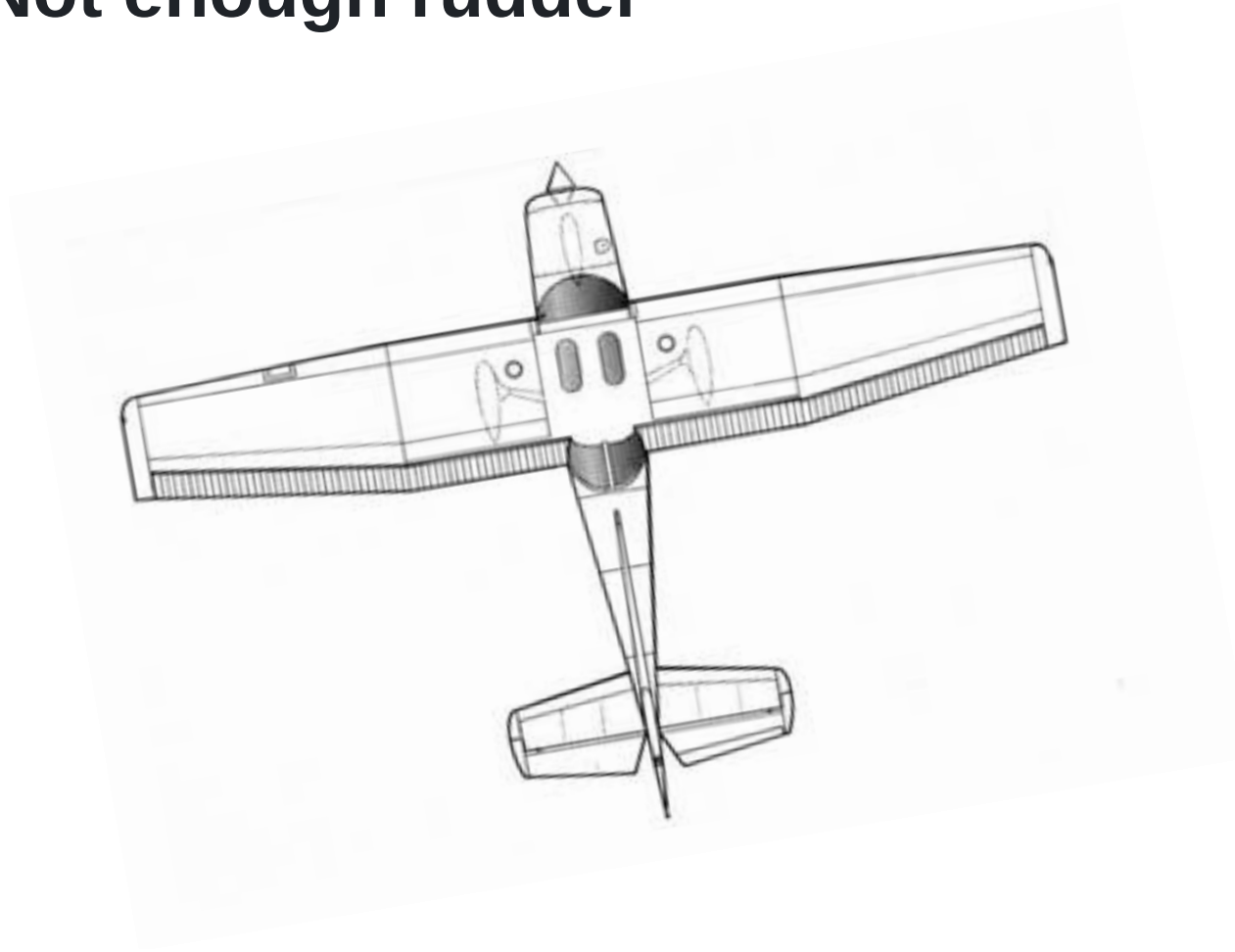


Adverse Yaw - Established in the Turn

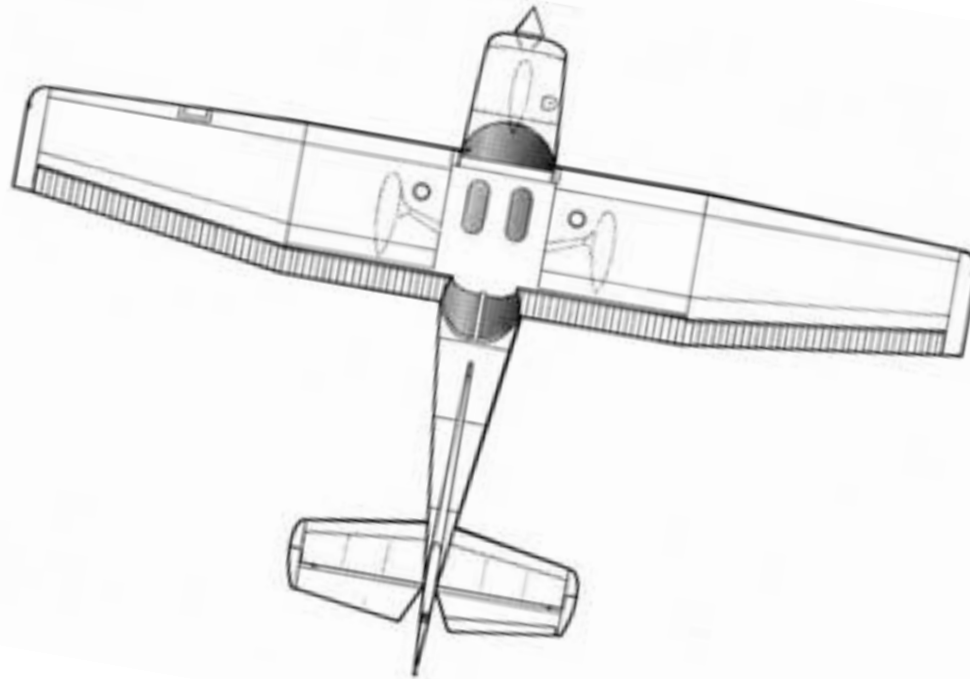


Rudder with roll rate

Turns - Slip: Not enough rudder



Turns - Slip: Too much rudder



Summary

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