

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.

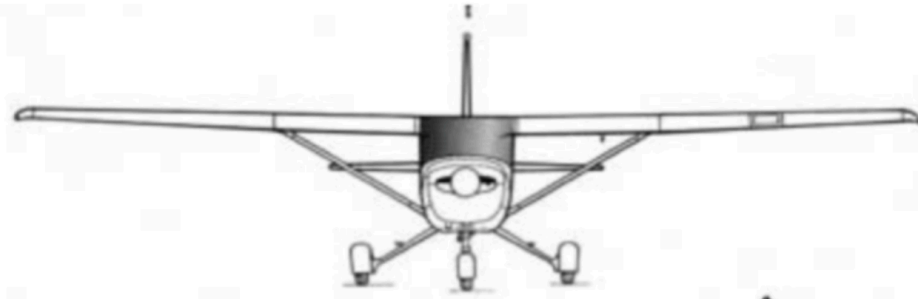
Motivation

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. 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 causes the fuselage to rotate in the opposite direction. This is known as torque reaction, and it can cause the aircraft to turn to the left or right, depending on the direction of rotation.

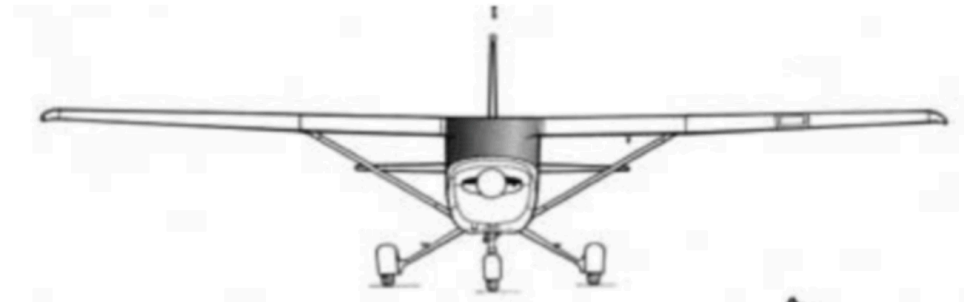
Propeller slipstream is another factor that can cause turning tendencies. As the propeller rotates, it creates a slipstream that flows over the wings. This slipstream can cause the wings to turn, which can in turn cause the aircraft to turn.

Wing drag is a third factor that can cause turning tendencies. As the wings move through the air, they create drag. This drag can cause the wings to turn, which can in turn cause the aircraft to turn.

There are several ways to counteract turning tendencies. One way is to use ailerons to turn the wings in the opposite direction of the turning tendency. Another way is to use the rudder to turn the fuselage in the opposite direction of the turning tendency.

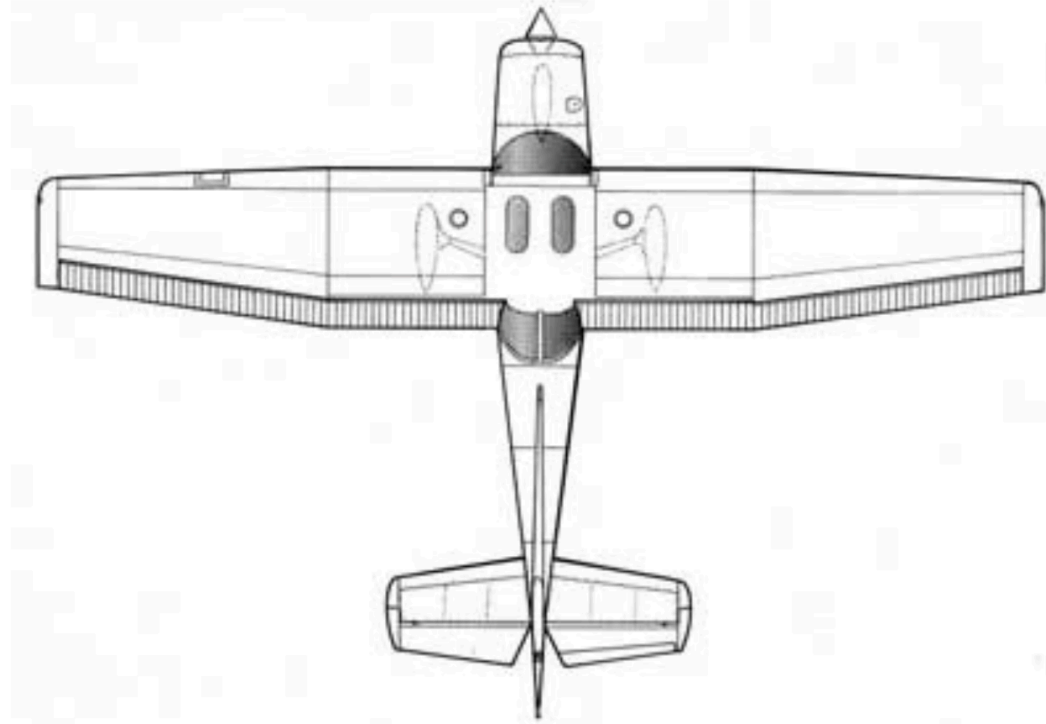
Understanding turning tendencies is important for pilots, as it allows them to anticipate and counteract any unwanted turns. This knowledge is essential for safe and efficient flight.

Turning Tendencies: #1 Torque



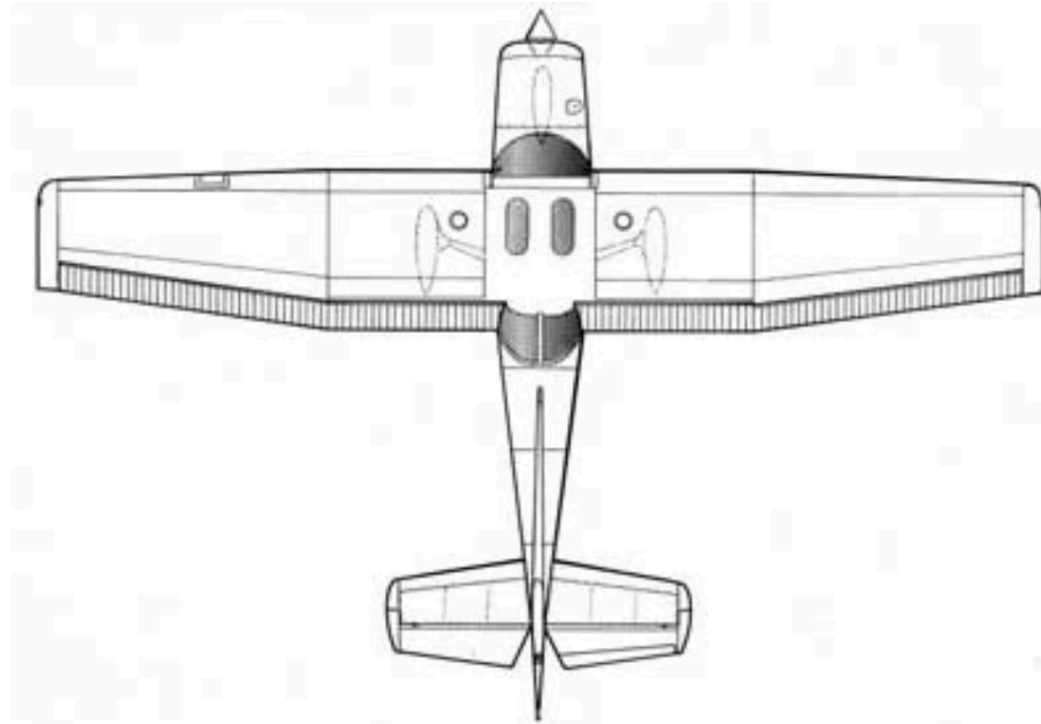
Newton's 3rd law, tendency to roll aircraft to left

Turning Tendencies: #2 Propeller Slipstream

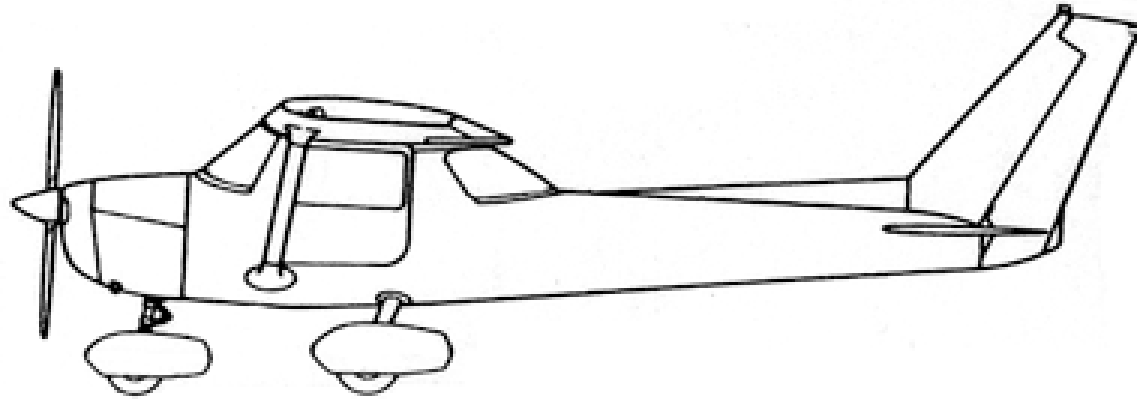


Turning Tendencies: #3 Gyroscopic Precession

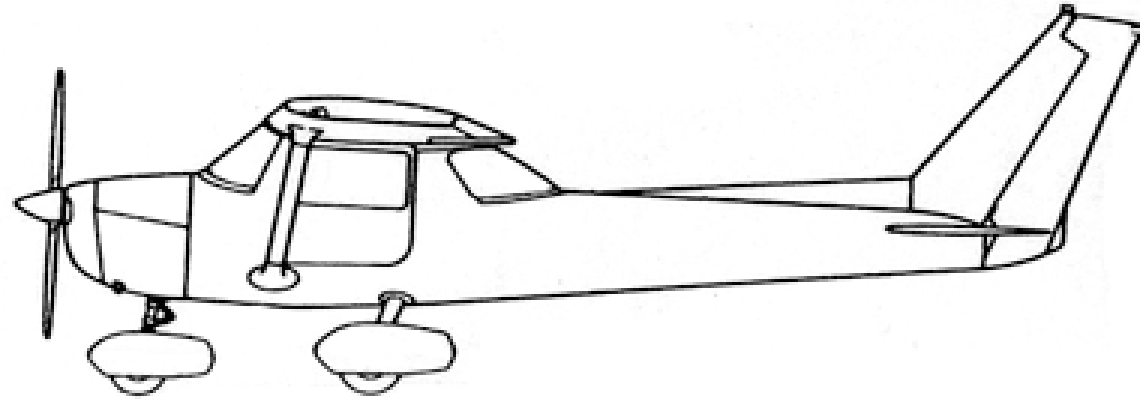
Turning Tendencies: #3 Gyroscopic Precession



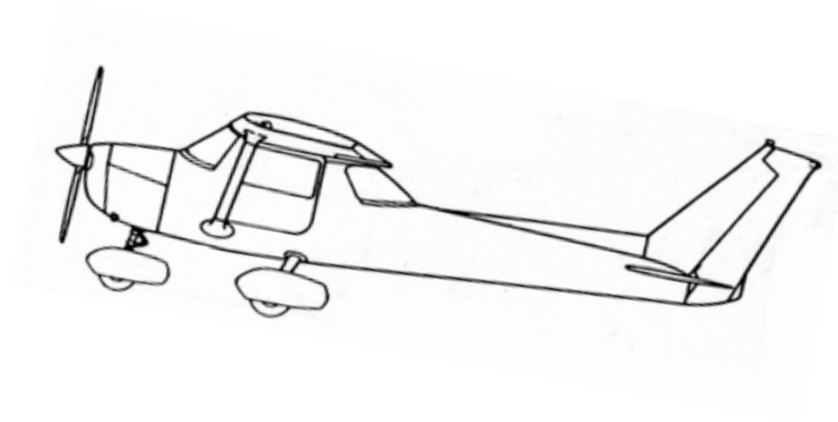
Turning Tendencies: #4 P-Factor



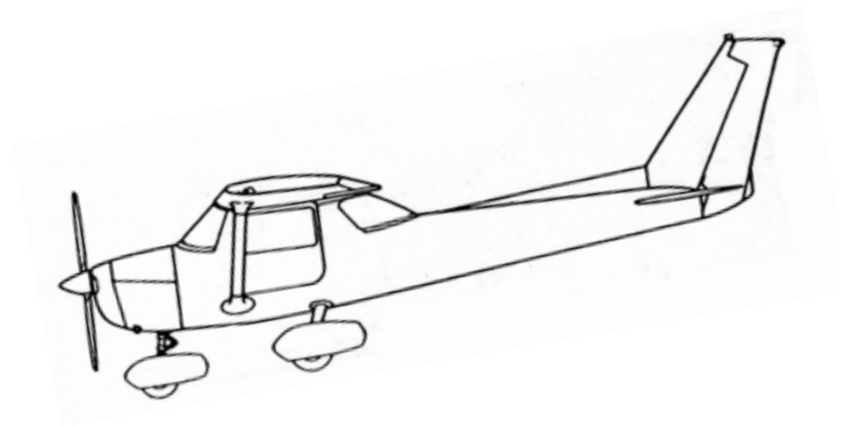
Forces in Flight: S&L



Forces in a Climb



Forces in a Descent



Turns - Centripetal Acceleration

Force is proportional to acceleration

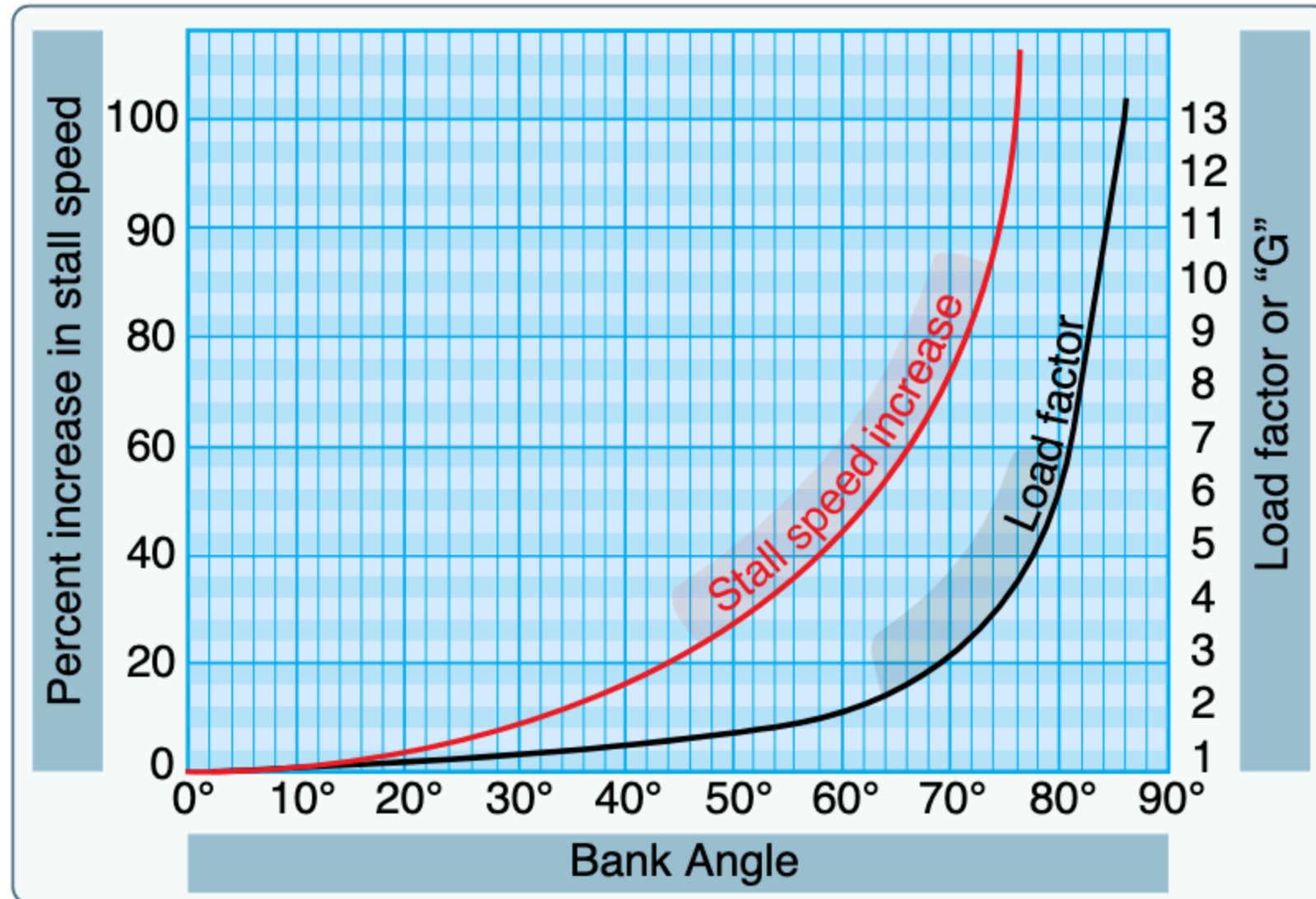
Forces in a Turn

S&L, Medium Bank, Steep Bank

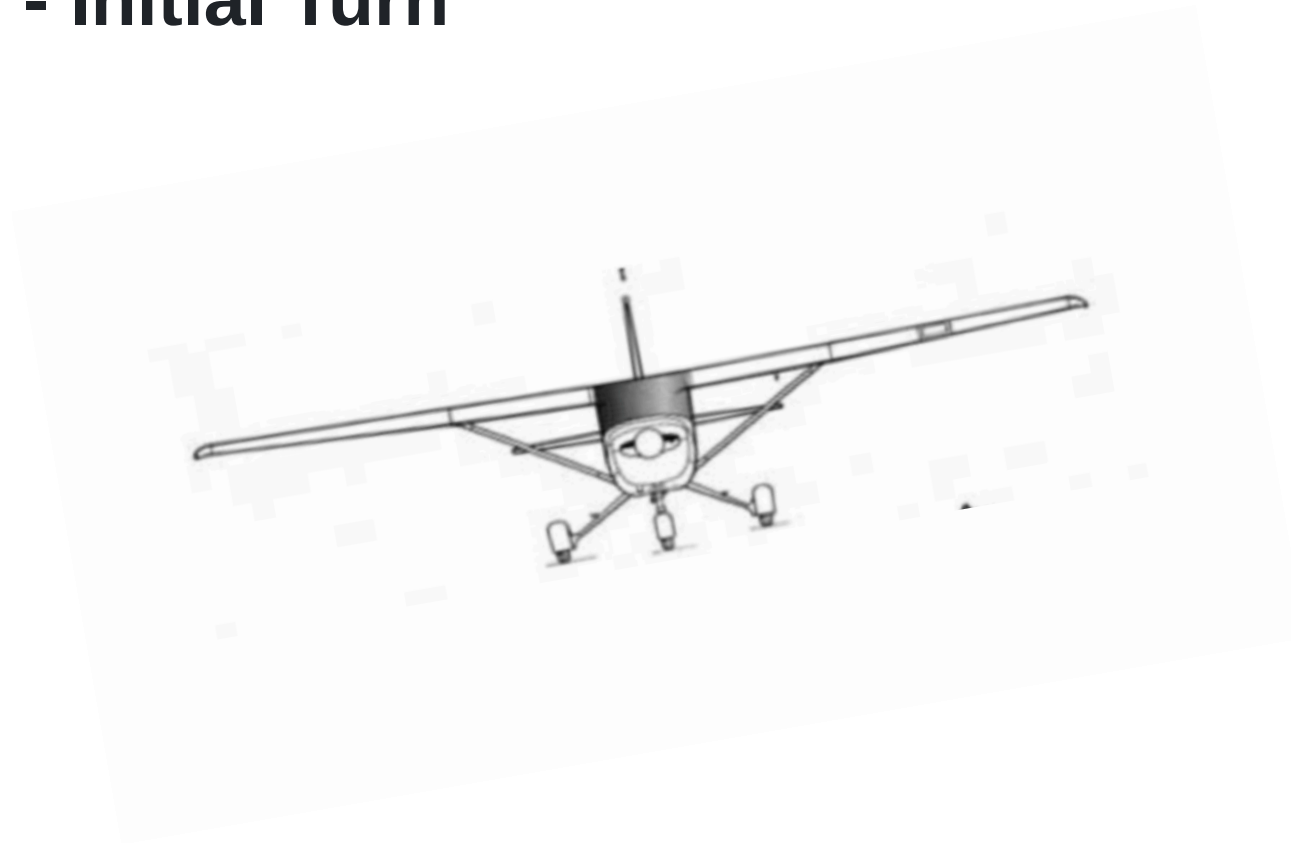
Forces in a turn widget

Load Factor = Lift force / Weight force

Load Fa



Adverse Yaw - Initial Turn

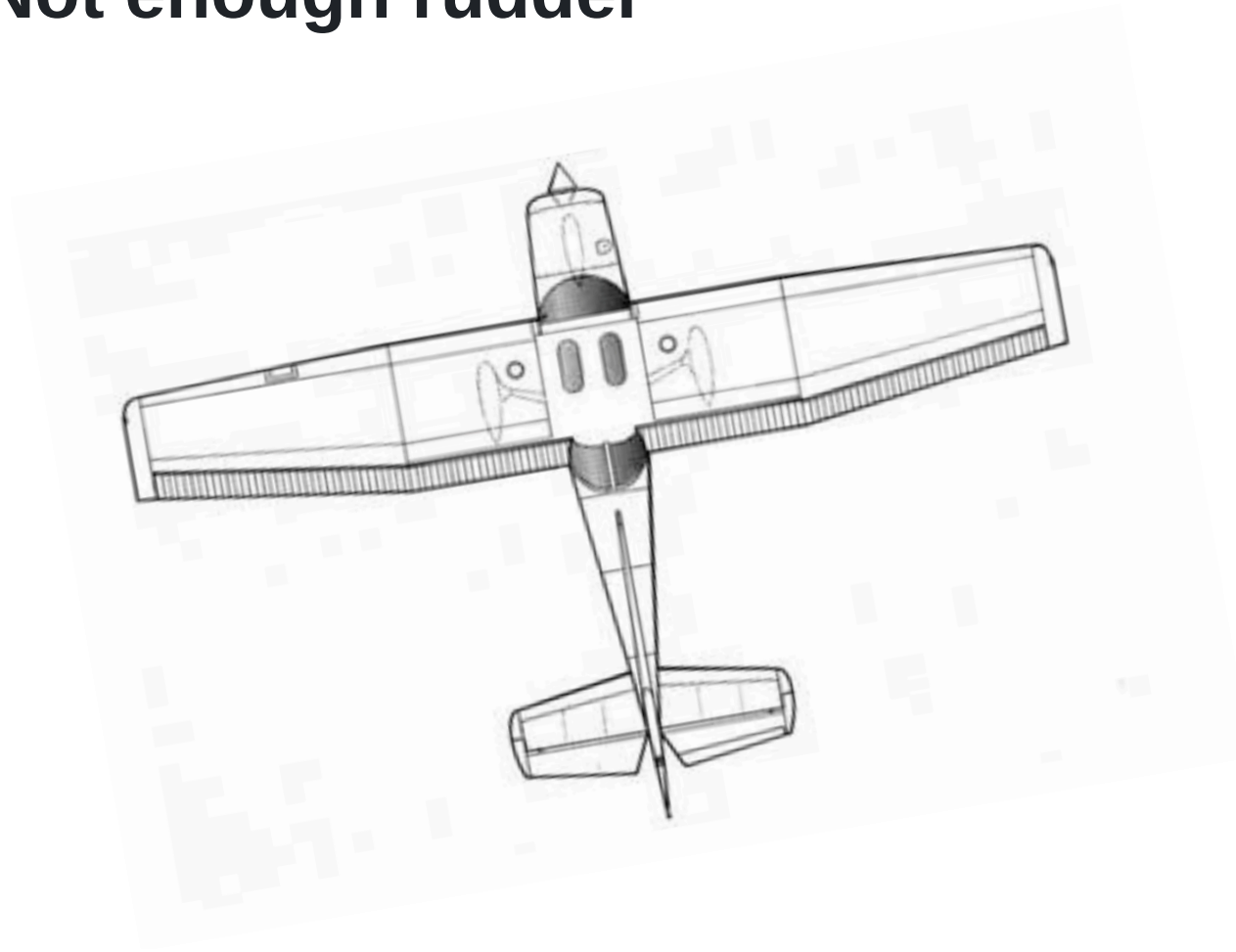


Adverse Yaw - Established in the Turn

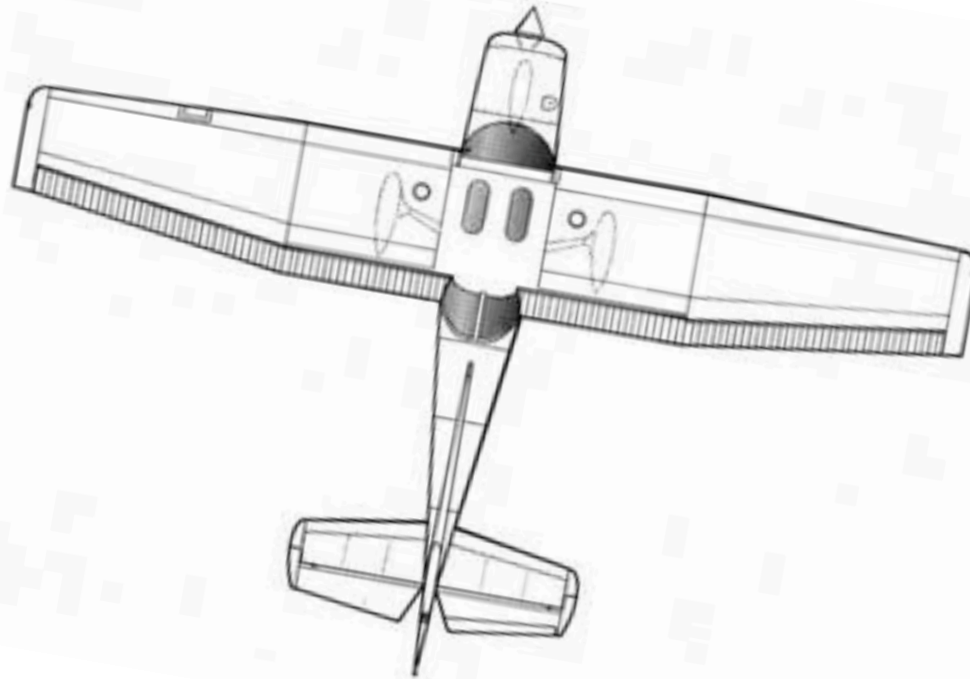


Rudder with roll rate

Turns - Slip: Not enough rudder



Turns - Slip: Too much rudder



Summary

- 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