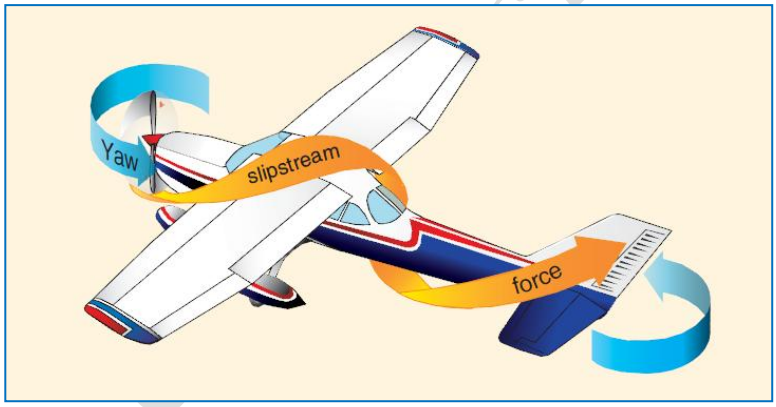
LEFT-TURNING TENDENCIES

CORKSCREW EFFECT (SPIRALING SLIPSTREAM)

The first left-turning tendency encountered during a takeoff roll. The prop-wash is not forced straight rearward. It rotates around the fuselage of the airplane in the direction of rotation of the propeller (clockwise) and strikes the left sides of the tail surfaces causing the airplane to yaw to the left. This effect is most pronounced at high propeller speeds and low forward speed—like takeoffs and approaches to power-on stalls. Some manufacturers (not Cessna) mounted the vertical stabilizer at a slight angle to correct for this effect at normal speeds. The corkscrew effect also causes a rolling moment to the right—sometimes counteracting the yawing moment to the left. The forces vary and the pilot must be aware and counter whichever is most prominent at the time.

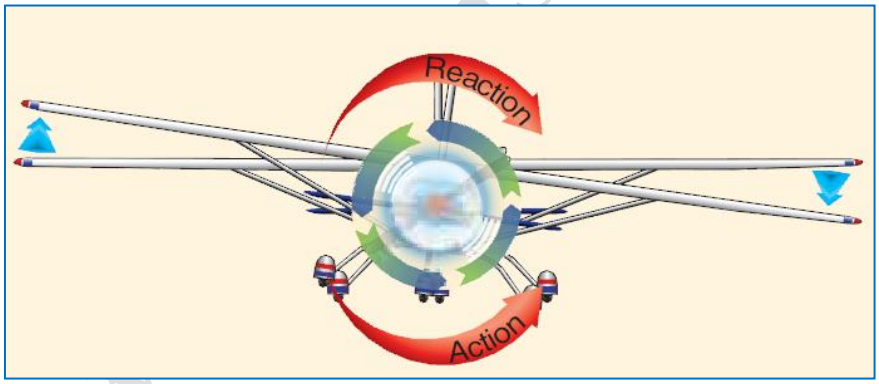
During the takeoff roll—this force requires the use of right rudder.



LEFT-TURNING TENDENCIES (cont'd.)

TORQUE

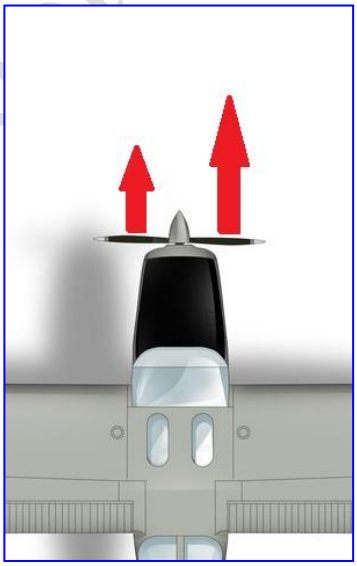
- The propeller, as seen by the pilot from the cockpit, rotates clockwise.
- Newton's law states that to every action there is an equal and opposite reaction.
- The airplane has a slight tendency to rotate opposite the propeller. Since the prop is turning clockwise, the airplane experiences a counter-clockwise roll moment (left wing down.)
- During the takeoff roll, the roll moment causes more weight to be on the left main gear. The added weight creates more drag. The added drag on the left side causes a yaw to the left.
- During the takeoff roll—this force requires the use of right rudder.
- During climb—this force requires a small amount of right aileron that causes more drag on the left wing (down aileron.) The added drag on the left wing causes a left yawing moment and must also be countered with right rudder.



LEFT-TURNING TENDENCIES (cont'd.)

P-FACTOR (ASYMMETRICAL LOADING OF PROPELLER)

- The propeller as seen by the pilot from the cockpit rotates clockwise.
- The right side of the propeller disk is the "descending blade" side, and the left side is the "ascending blade."
- The right side of the propeller disk is also the "advancing blade" side. In other words, at high angles of attack it is travelling in the same direction as the airplane (into the wind.)
- The right side of the disk has a greater angle of attack and airspeed and therefore produces more lift/thrust.
- More lift/thrust on the right side of the propeller disk causes a yawing force to the left. This is similar to the right engine of a multi-engine airplane producing more power than the left engine.
- The left-yawing moment be countered with right rudder.
- P-factor is most pronounced at high angles of attack and slow airspeeds.
- For tricycle gear airplanes this effect begins at rotation.
- For taildraggers it is a factor during the takeoff roll before the tail is lifted, and again during and after rotation.



For a more advanced explanation of P-factor, see "P-Factor Explained – Advanced" Schiff's Notes on www.captainschiff.com.

GYROSCOPIC PRECESSION

- Generally only a left-turning tendency for taildraggers.
- The rotating propeller has similar properties to a gyroscope.
- Anytime a force is applied to a gyroscope that would deflect it out of its plane of rotation, the resulting force is 90^{o} ahead of and in the direction of rotation.
- Here is what happens during a takeoff roll:
    - Early during the takeoff roll, a taildragger's tail is lifted off the ground.
    - This upward force on the tail creates the effective force of pushing forward on the top of the propeller disc (12 o'clock position).
    - Since the propeller is rotating clockwise, and the resulting force applied to a gyro is 90^{o} ahead in the direction of rotation, the resulting force of lifting the tail on takeoff occurs on the right side (3 o'clock position) of the propeller's plane of rotation.
    - This "push" on the right side of the propeller disc causes a left yawing moment that must be corrected with the application of right rudder while the tail is being lifted off the ground.
    - When an airplane rotates for liftoff, the opposite occurs—a force applied to the bottom of the propeller disc resulting in a force on the left side (90^{o} in the direction of propeller rotation) of the propeller disc causing a right yawing moment for the period while the nose is being lifted. At this time the force is slightly countering the other left-turning tendencies.

SUMMARY OF LEFT-TURNING TENDENCIES

Force	Moment	Direction	Prevalent
Spiraling Slipstream	Yaw	Left	Takeoff roll
Torque	Roll	Left	High power settings
P-factor	Yaw	Left	High power/low airspeed
Gyroscopic Effect	Pitch & Yaw	Left, right, up, down	High power, during pitch changes

Spiraling Slipstream: The slipstream of a propeller-driven airplane rotates around the airplane. This slipstream strikes the left side of the vertical fin, causing the airplane to yaw. Vertical stabilizer offset is sometimes used by aircraft designers to counteract this tendency.

Torque: The tendency of the aircraft to turn (roll) in the opposite direction of rotation of the engine and propeller

P-factor: A tendency for an aircraft to yaw to the left due to the descending propeller blade on the right producing more thrust than the ascending blade on the left. This is pronounced at high angles of attack. (P-factor would be to the right if the airplane had a counterclockwise rotating propeller.)

Gyroscopic Precession: An inherent quality of rotating bodies, which causes an applied force to be manifested 90^{o} in the direction of rotation from the point where the force is applied.