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FLY SLOW, BANK STEEP

Why we learn these twin paths to precision

By LeRoy Cook

Flight training often builds on a foundation laid down by previously learned maneuvers. The skills acquired from the most basic turn or altitude change will transfer to the next objective, which arranges those same basic talents in a new sequence. We learn the art of aviation, just as a brick wall is built, by placing one layer on top of another, each set solid to support the ones above.

Two of the most beneficial maneuvers for pilots are slow flight and steep turns, both of which demand timely, progressive control movement and anticipation of where the aircraft is going next—precisely the skills we'll need to handle the rapid-fire sequences of takeoffs and landings.

When we progress through the four fundamentals of flight, we find that the airplane often must slow down or speed up, stabilizing at a new speed to maximize the desired performance. Once you have learned to climb, glide, turn, and fly level, you proceed to making changes in speed with precision

Take it slow

Slow flight is a seemingly simple task. Slowing down and speeding up, while maintaining a constant altitude and heading, yields benefits in practically every aspect of flying. It's an excellent tool to sharpen landings, it helps to make stall recovery second nature, and it teaches us to think ahead of the airplane.

SLOW FLIGHT—ALSO CALLED MINIMUM CONTROLLABLE AIRSPEED—requires a nose-high attitude to maintain altitude at the slow airspeed (above).

A TYPICAL INSTRUMENT DISPLAY DURING SLOW FLIGHT—notice the power setting, which is usually around 2,000 rpm in single-engine trainers.

From straight-and-level flight, reduce power to a setting that will assure a rapid decay in airspeed, but less than full idle; I use about 1,500 rpm and leave the carburetor heat off unless conditions warrant otherwise. The nose is raised gradually at first, adding just enough back-pressure to keep a constant altitude, by steadily withdrawing the energy reserves of the excess airspeed. More and more force is needed to hold the nose up as the speed deteriorates, unless trim is added, normally avoided in small airplanes for the temporary task of slow-flight training.

The initial target airspeed is usually 10 knots more than stall speed, which avoids triggering the annoyance of a constant stall warning. As we near this speed, power is brought back up to a setting that will exactly maintain altitude in slow flight, no more. Don't wait for the airspeed needle to touch the target, because there'll be a second of response time while the thrust builds up to halt the momentum of deceleration. To maintain the heading, a bit of right rudder will be needed to offset p-factor, and often a small adjustment in nose attitude is required as the prop wash increases, to keep the airspeed stable.

We're now engaged in a balancing act—using just enough power to maintain altitude, holding nose attitude steady to keep airspeed on target, and applying rudder to hold the heading. Don't make altitude corrections with pitch changes, or speed adjustments with the throttle. The drill is to learn that power primarily controls altitude, and raising or lowering the nose changes airspeed.

You can demonstrate this by adding 200 extra rpm, which initiates a slow climb—and then reducing power to 200 rpm less than the level-flight number, inducing a sink if airspeed is held constant. In the absence of other available energy, power is obviously the source of altitude. Raising the nose causes the stall warning to sound as speed drops off, and lowering it regains speed and silences the horn.

Flap extension usually delays the beginning of stall warning to a lower airspeed, although the nose attitude will require adjustment and power must be increased to offset the added drag. Low-time students can practice slow flight without the complication of lowering the flaps. Once the principle is learned, it's easy to adapt to a different airspeed target or configuration.

Recovery from slow flight involves adding full throttle, retracting half of any flaps used, nudging in more right rudder to offset the added p-factor, and gradually relaxing back-pressure to lower the nose while accelerating at a rate just fast enough to halt a climb, while avoiding any loss of altitude from lowering the nose too early. The aircraft should wind up in hands-off, straight-and-level flight—right where it started out.

The task of entering, maintaining, and recovering from slow flight can consume all of one's concentration. Control forces change throughout the process, as airflow decreases and increases, p-factor fluctuates, and trim is affected by power application. Students will have to learn to think slightly ahead of the airplane's permutations, instead of reacting to the needle movements. Paying attention to the aircraft's attitude will place the airspeed on target; adding power in advance of need will make the altimeter stay where it should. Chasing the desired values, on the other hand, will only divert attention away from other parameters, creating even more diversions to correct. You must plan ahead.

Precisely steep

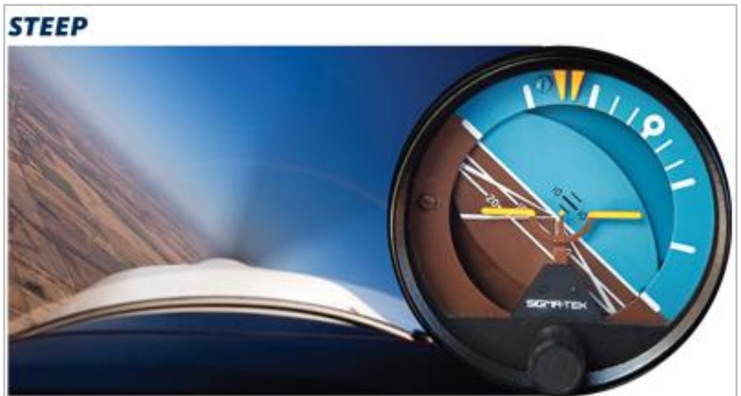
Steep turns often seem more challenging than they are. They're nothing more than ordinary turns, with some extra bank angle thrown in to speed up the process of changing heading. When attempted for the first time, however, the difficulty becomes apparent.

Raising the bar by adding 50 percent more bank angle demands a finer touch, greater concentration, and anticipation of the aircraft's response. Beginning students can sometimes manage a medium bank turn of 90 degrees' duration by just twisting the control wheel left and right. That won't do, as the instructor points out when the slip ball wobbles to and fro and the altimeter needle follows the drooping nose attitude. You should attain reasonable proficiency in coordination and altitude control in medium-bank turns, using 30 degrees of bank angle, before attempting steep-bank turns.

While the methodology is the same, there's simply less tolerance when you crank the bank angle over to 45 degrees. Here, you will begin to encounter the airplane's over-banking tendency—the greater lift produced by the faster-flying outside wing tries to increase the bank, requiring a bit of opposite rudder to keep a steady, steep bank.

For grading purposes, you may enlist the aid of the bank index markings on the attitude indicator, even though your primary attitude reference is outside on the natural horizon. Be careful; most AIs are marked in 10-degree increments up to the 30-degree position, and then jump to 60 degrees. Don't go there. Visualize a bank exactly halfway between 30 and 60 degrees.

The other common error when using a mechanical attitude indicator is attempting to fly the tip of the horizon bar to achieve a bank index, rather than the center triangle that rolls through the bank indices. The wandering horizon bar will lead you astray; it's a pitch reference, rather than a bank indication. The world outside will be our primary source of orientation, with the bank indicator, directional gyro, and altimeter used for precision scoring of our effort.



STEEP TURNS are a lot of fun, but they also require quick, decisive corrections because things are changing quickly.

Be sure not to lean toward the outside of the turn, attempting to avoid falling out of your seat. This is unnecessary and distorts your natural view. If the turn is coordinated, keeping the inclinometer ball properly centered, you'll stay upright, with the force of 1.45 Gs acting precisely down through your spine. To reassure the reluctant student, I reach for the spare bottle of oil in the baggage bin and stand it on the glareshield. Then I roll into a 45-degree banked turn, fly a 180-degree change in direction, and roll out, with the jug immobile. Centrifugal force does the trick.

The steep turn will require added back-pressure to hold altitude, because the wing is being called upon to generate about 50 percent more lift just to maintain level flight. It's also helpful to add a bit of extra power, because the drag caused by increasing angle of attack will result in a loss of airspeed unless thrust is increased. A fixed-pitch propeller shows a decrease in rpm under the load of a steep turn, so I'll typically add an extra 100 rpm as I enter the steep bank.

For entry, pick a straight road, fence row, or stream that runs toward the horizon on a cardinal heading; clear the airspace you're about to occupy; and roll into the turn with coordinated use of rudder and aileron. As you roll past 30 degrees of bank, bring in extra back-pressure and stop the roll as you reach 45 degrees of bank. You'll need to carry a small amount of rudder, opposite to the direction of the turn, to offset the overbanking tendency. However, aileron remains the primary roll control, if turbulence or a heavy hand causes bank displacement.

It's important to maintain orientation while speeding around the turn much faster than you're used to. You'll need to begin the rollout earlier to stop precisely on the reference line or chosen heading. That's the reason steep turns are normally performed for at least 360 degrees; I like to make two continuous circles, for a total of 720 degrees of turn, because one turn goes by quickly. Besides, on a smooth day we need that second turn to get some added value from fighting our own wake turbulence. On the rollout, remember to relax the heavy back-pressure you were holding in the turn, or you'll zoom up 100 feet before you can get the nose back down.

Don't forget that steep turns must be performed with the same precision in a right bank, as well as the commonly chosen left bank. Slightly different visual references will be used to maintain level flight, but the aerodynamics are identical. A common error is allowing bank angle to wander five or 10 degrees from the 45-degree target, which affects altitude because the load factor changes while your compensating increase in angle of attack stays steady. So, you'll chase the altimeter needle when you really need to work on bank control, often the result of aileron displacement while pulling back on the stick or yoke.

Don't let the nose droop enough to lose more than 25 feet of altitude before you take action. In a medium-bank turn, there's no great urgency, but in a steep-bank turn any altitude loss multiplies when the speed goes up and the bank steepens even more. Get the nose back up right now, and that's going to mean pulling some added G-load for a few seconds, not just yanking back on the stick and then releasing it. If the dive continues to accelerate, roll out of the steep bank to avoid high G-loads and return to level flight, then re-enter for another try.

When a student has been fighting bank and altitude particularly hard, I'll take the controls to give him or her a break, and demonstrate how easy a steep bank turn can be. As I roll past 30 degrees of bank, I twist in two precisely measured turns of nose-up trim, put my toe against the outside rudder pedal, and take my hands off the yoke while the airplane tracks around the circle on its own. The lesson is that less is more; keep the nose up and the bank steady with just the merest control input, and the turn will be stable. Don't make big control movements unless you've allowed a gross deviation.

Steep turns require a little more deft touch on the controls, which makes them a great brush-up maneuver for pilots needing to rebuild their skills. In conjunction with slow flight, they teach anticipation, coordination of controls, and attitude references. The precision duo will be valuable tools throughout your pilot experience.

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