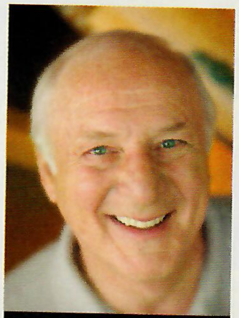
BY BARRY SCHIFF

Quit stalling around

Last December I mentioned that some airplanes, especially Beech Bonanzas, threaten to enter an over-the-top spin when stalled with full power and flaps extended ("Proficient Pilot: The No-Spin Zone," December 2011 *AOPA Pilot*). This is why, I continued, Beech does not suggest using flaps for takeoff. This caused a flurry of reaction from some members of the American Bonanza Society, stalwart defenders of the venerable airplane. But before defending my comments about the Bonanza, it would be appropriate to review the effects of power and flaps on aircraft stall characteristics and behavior.



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A goal of those who design and manufacture GA aircraft is to create an airplane with mild-mannered stall characteristics. This often is done by developing a wing such that a stall begins near the aft, inboard portion of the wing and then spreads (or propagates) outboard and forward as the pilot continues to increase the wing's angle of attack and deepens the stall.

This happens almost naturally when an airplane has rectangular wings. The challenge increases for the designer when wings are tapered or swept. In these cases, the stall tends to begin near the wing tips and propagates inboard. The problem with an "outboard" stall is that this can reduce aileron effectiveness during flight at minimum airspeeds. It also reduces roll damping, the characteristic of an airplane to resist rolling. In other words, a wing-tip stall can induce a sharp roll and make it difficult for a pilot to maintain a wings-level attitude.

The horizontal tail surfaces are not behind the stalled portions of the wings during a tip stall. As a result, pilots might not be provided with the stall-warning buffet we are conditioned to expect. Also, a "self-correcting," nose-down pitching moment might not occur to assist in stall recovery.

Designers go to great lengths to avoid these undesirable characteristics and employ a variety of aerodynamic techniques to ensure that a stall begins to develop at the aft portion of the wing root instead of at the tip. One trick of the trade is to install spanwise stall strips on the inboard leading edges of some wings. At large angles of attack, these sharp-edged strips interfere with airflow at the wings' leading edges—they "trip" the air—and induce a stall to occur behind each such strip.

A more expensive technique is to vary airfoil shape in such a way that the inboard airfoils (wing cross-sections) stall before the outboard airfoils do. A third and popular technique is to twist the wings slightly so that the inboard wing sections have larger angles of incidence than the outboard wing sections. This is called "washing out" a wing and is characteristic of high-wing Cessnas. The wing twist (wash-out) of a Cessna 172, for example, is 3 degrees. When the inboard wing section of a Skyhawk has an angle of attack of 14 degrees, for example, the outer wing panel has an "alpha" of only 11 degrees, a scheme that forces a stall to begin near the wing root instead of the tip.

It is not difficult, however, for a pilot to overcome a designer's best efforts to provide benign stall characteristics. All he need do is stall the airplane with full power and deployed flaps, what we commonly refer to as a *departure stall*. If the engine is developing full or substantial power during stall entry, propwash helps to protect the inboard sections of the wings against stalling. Consequently, the airplane can be forced into a deeper stall that involves greater (outboard) wing area. This partially explains why power-on stall speeds are lower than power-off stall speeds. The outboard spread of the stall partially defeats some of the design features and can result in surprisingly strong and rapid roll rates toward the wing most deeply involved in the stall. Deploying flaps exacerbates the problem because flaps further protect the inboard wing sections against stalling. The stall is forced even farther outboard.

A few decades ago I was involved in the forensic study of a tragic accident involving a heavily loaded Beech 35 V-tail Bonanza that had departed California's Big Bear Airport toward the east on a day when density altitude on the ground approached 10,000 feet. Initial climb rate and angle were anemic, and the pilot apparently raised the nose in a misguided attempt to increase both. Observers said that the airplane rolled rapidly into an inverted attitude before plummeting headlong into the ground from an estimated height of 100 feet.

Subsequent flight testing confirmed that the flaps-down, power-on stall characteristics of the Bonanza can be too difficult for many pilots to handle, and that it would be wise for Beech not to recommend using flaps for a short- or soft-field takeoff. This is why checklists and pilot's operating handbooks for the iconic Bonanza V35B (as well as the popular F33A straight-tail model) do not indicate the use of flaps for takeoff. Interestingly, using flaps for takeoff in any Bonanza was never prohibited and the mention of flaps for takeoff has been inconsistent between various models of the "short-wing" Bonanza.

Two lessons can be taken from this. The first is that a full-power, flaps-down stall in a Bonanza is more "adventurous" than in any other four-place, high-performance single in which I have performed the same maneuver. The second is the absolute necessity in any airplane to "maintain thy airspeed lest the Earth shall arise and smite thee." AOPA

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