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By David Jack Kenny

Why Do We Stall?

The record suggests our current approach to stall training isn't preventing them. Shouldn't that be one of its objectives?

Fixed-wing pilots start learning stall recognition and avoidance during pre-solo training. The private and sport pilot checkrides require recovering from developed stalls with minimal loss of altitude, and stall and spin awareness are (or at least should be) refreshed during flight reviews for the duration of one's flying career. But unintended stalls still put dozens of airplanes into the ground every year. Is it possible that stall training as currently practiced isn't as effective as it might be?

If so, there are reasons. Chief among them is that most of the situations that lead to accidents—close to the ground and often uncoordinated—can't be duplicated in the airplane with a reasonable margin of safety, and existing light-airplane simulators don't achieve convincing visual or kinesthetic fidelity. (Try putting one into a spin.) Instead, we practice at altitude. Having the cushion needed to recover from botched initial efforts eases the alarm that accompanies real-world excursions.

In short, we practice stall entries and recoveries in ways that don't resemble the sequences that wreck airplanes. Along the way, we probably pick up some bad habits. If you've trained for a commercial certificate, you probably noticed that those test standards require recovering at the first indications of an impending stall, while private pilot applicants have to pull all the way to a full break first. If you find this counterintuitive, you're not alone.

What Actually Happens

In 2017, AOPA's Air Safety Institute (ASI) published an analysis of more than 2000 accidents over 15 years that involved unintended stalls. Nearly half were fatal, about three times higher than in accidents without stalls. Almost 95 percent, including 96 percent of fatal crashes, were on flights operated under Part 91, the great majority for either personal or training purposes. Nearly half—45 percent—were flown by commercial pilots or ATPs, almost exactly the same proportion as in non-stall accidents.

In fact, if you scroll through the report (which is available for free on the "Publications" page of AOPA ASI's web site), you'll see that none of the risk factors presented—pilots' certificate levels, purpose of flight, aircraft size and complexity—show much difference between accidents with and without stalls except that stalls cause significantly more fatalities. A slightly higher share of stall accidents actually happened in visual conditions during the daytime (90 vs. 84 percent), and they were nearly twice as likely to involve amateur-built or experimental light sport airplanes. Otherwise, the circumstances were almost indistinguishable.

Almost exactly half the stalls took place in the traffic pattern, though these included departures and arrivals as well as pattern work per se. Half the pattern stalls occurred during takeoff attempts or the climb to the crosswind turn; landings and go-arounds made up 21 and 18 percent, respectively. The base-to-final turn showed up less often than might have been expected but earned its lethal reputation, with fatalities in fully 80 percent.

In the half that took place away from the airport, various brands of showboating played a prominent role, as did poor understanding of the aerodynamics of turns (see sidebar, "Stupid, or Just Sloppy?" above). Notable is the very small number that happened while deliberately practicing slow flight or stalls: just five. Another five took place during flight reviews or checkrides, but the specific maneuvers attempted aren't known. And survivability diminished rapidly with initial altitude: fatality increased from just 15 percent in stalls that broke below 50 feet to more than 65 percent of those above 100.

Teaching the Teachers ...

The test standards for the CFI-Airplane rating require being able to demonstrate and recover from a full suite of stalls: not just the familiar power-on and -off, but accelerated stalls during steep turns, trim stalls (where excessive nose-up trim pitches the nose up as power is applied, as in a poorly managed go-around), secondary stalls caused by overly aggressive recovery from the initial break and the cross-controlled stalls that readily precipitate spins. A candidate who's practiced each of these to enough to be comfortable simultaneously demonstrating and explaining them should have developed a fine sense of the sight picture and kinesthetic cues (or lack thereof) accompanying each. A CFI candidate must also be prepared to demonstrate spin entries and recoveries upon request, though most examiners accept a logbook endorsement attesting to "instructional proficiency."

No other certificate requires nearly this level of stall awareness, suggesting that it has more to do with preventing accidents during the training process than instilling comparable expertise in students. To that extent, it seems to work. While one-eighth of stall accidents happened on instructional flights, nearly half were student solos.

... vs. Teaching the Students

Test requirements for the sport, private and commercial certificates are limited to power-on and power-off stalls at bank angles no greater than 20 degrees. It's more than possible to earn even airline transport pilot certification without ever having experienced a stall in anything much different from a straight-ahead, wings-level attitude—or without full expectation that it's about to occur and close attention to the indications. And once out in the big, bad world, many of those who don't study aerobatics or teach stay pretty close to the middle of the flight envelope. It's not surprising that this style of training doesn't provide thorough preparation for stalls that surprise pilots focused on something else.

There's also that business of "primacy," which anyone who's ever struggled through FAA-approved educational theory will recognize as one of the "six principles of learning." Briefly, it holds that people often revert to the way they initially learned things, particularly under stress. Why does that matter? Well, recall that perplexing contrast between the private and commercial ACS.

Student pilots, after all, usually hear the stall warning while instigating stalls. (Having it chirp just as the mains touch down after a perfectly timed flare is a far less common experience for students.) To pass the checkride, they're taught to respond by continuing to pull back until the nose drops or full back pressure induces a nose-high mush and only then reduce the angle of attack and add whatever power is available. This isn't an appropriate response after the checkride, so why teach it before?

Yeah, it's on the test. But maybe that should be an operational detail, not the focus.

Can We Do Better?

Given economic reality, teaching to the test can't be eliminated altogether. But within the confines of the existing ACS, there's still room to visit some of the less benign stall sequences. An instructor introducing steep turns, for example, might say, "Now what do you think would happen if I kept pulling back while banked this far?" Voila: the accelerated stall. And a trim stall demonstration helps prove the importance of timely configuration changes during go-arounds.

More fundamental, in our view, is to emphasize stall avoidance from the beginning of primary instruction, making clear that forcing the break is an exercise for demonstration purposes. We'd suggest that early stall training focus on recognizing the initial indications and recovering without delay (just as in the commercial ACS!) and that students be encouraged to vocalize the distinction between what they would normally do ("Now, this is where I'd lower the nose and add power.") and what they do specifically for the test ("But since I need to demonstrate a full stall, I'll keep pulling back instead.").

And as all the various ACSs suggest, there's considerable value in creating distractions in situations where the instructor can recover from an upset. During a cross-country, a CFI might ask the student for a better view of something on the ground. "Is that a moose? Let me get a picture! Can you slow down and circle tight but hold this altitude?"

And once the student understands that "stall speed" is a very limited concept, it's okay to acknowledge that it has some relevance near the middle of the envelope (see sidebar, "Airspeed vs. AOA," on the opposite page). A more dynamic understanding of the variables driving angle of attack is key to reducing the risk of unintended stalls.

Airspeed vs. AOA

We've all heard it: "An airplane can stall at any airspeed, in any attitude, at any power setting." Some aerobatic pilots have stalled at full throttle pitched 90 degrees straight down—say, by pulling too hard trying to tighten a loop. Exceeding the critical angle of attack is the one and only cause of a stall, and that critical AoA is always the same for any given airfoil.

But of course airplanes don't stall at every combination of airspeed, attitude and throttle setting—otherwise they couldn't fly at all. And while airspeed isn't a direct measure of AoA, it's not that bad a surrogate in most normal operations—say, pitch attitudes between plus and minus 10 degrees and banks of 30 degrees or less. Where they diverge enough to be dangerous is when pitch attitude increases very quickly, pulling through the critical AoA before airspeed bleeds off (as in the misnamed "airshow pass") or when the pilot tries to compensate for the higher load factor of steep banks with back pressure (increasing AoA) rather than airspeed. Either triggers a stall at airspeeds well above the wings-level VS0 published in the POH—precisely the definition of an "accelerated stall."

What About Spin Training?

Until 1949, private pilot applicants had to demonstrate spin entries and recoveries as well as stalls. That requirement was eliminated after the CAA (predecessor to today's FAA) concluded that more people were being killed in training than saved afterwards. While the factual basis of that decision has been called into question, today only CFI candidates are required to receive spin training, though it's allowed at any level.

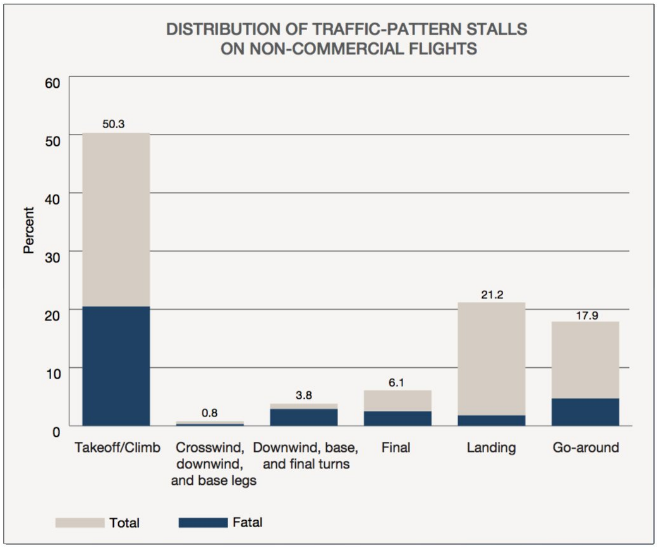
As for whether it helps, a NASA study in the 1970s established that most light airplanes lose at least 1200 feet once a spin is established. Most stall accidents are initiated below 1000—so while it's helpful to learn the attitudes and kinesthetic cues that precede spins, this won't save pilots who enter them at low altitudes. Similarly, upset recovery training heightens awareness of the precursors to spins—and drives home just how unrecoverable they are at pattern altitude.

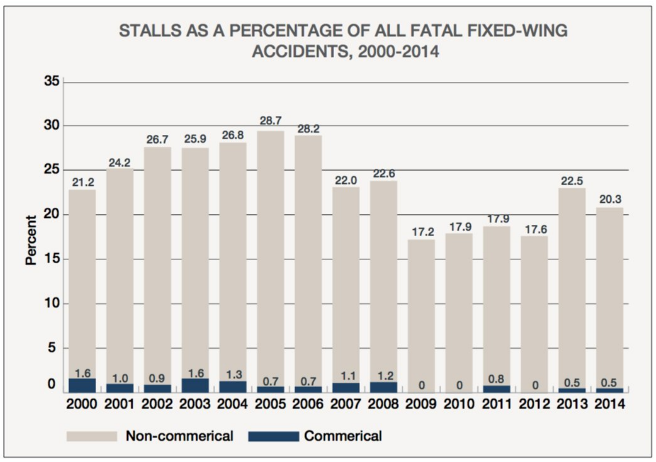
Technology to the Rescue?

After the FAA eased regulatory barriers to installation, avionics manufacturers responded by introducing relatively inexpensive in-cockpit AoA indicators. These provide a much more direct, precise measurement of the airplane's proximity to the critical angle, and pilots who've learned to use them report advantages include improved precision in spot landings. However, most rely on a single sensor on one wing, leaving some vulnerability when the other wing happens to be at a higher AoA. And AoA indication is being built into the latest electronic flight decks and flight instruments, without the need for an external sensor.

Vortex generators can effectively increase an airfoil's critical AoA and improve control effectiveness after a stall by keeping the boundary layer attached longer, but results differ substantially between models. They often reduce top cruise speeds, too.

Neither VGs nor AoA indicators have penetrated much of the rental fleet, however, and owners with a few thousand dollars to spend may choose to apply them elsewhere. And while helpful, neither is essential. Alert, skillful pilots have safely gone without for more than a century now.





The two bar charts above are adapted from the AOPA Air Safety Institute's publication, Stall And Spin Accidents: Keep The Wings Flying. The bar chart at top shows that accidents resulting from stalls happen about 25 percent of the time as recently as 15 years ago, dropped into the high teens, then bounced back. Stalls in the traffic pattern, meanwhile, most often happen during takeoff or climb.

Stupid, or Just Sloppy?

In "Safety Second" (1932), humorist Robert Benchley listed "being just a plain damned fool" as one of three major accident causes. ("Daydreaming" and "worry" were the others.) An AOPA ASI analysis suggests foolishness plays a significant role in unintended stalls. Most result either from pilots not knowing how to handle their aircraft or succumbing to the temptation to try things they probably knew they shouldn't.

Nearly half of the accidents analyzed took place in the traffic pattern (though not necessarily during pattern work), and most of those fall into the first category: premature rotations and early flares, botched go-arounds, and skidding base-to-final turns. These betray weak aerodynamic understanding and often a poor grasp of systems and procedures (see "Just Go Around," April 2018).

The second group isn't limited to "Hold my beer—watch this!" episodes, but they make a healthy contribution. At the top of the list are buzz jobs and their first cousins, low-altitude high-speed pull-ups. Yanking steep turns into steep climbs is best learned at altitude in aerobatic airplanes with adequate thrust. And the outcome of attempting tight circles at low altitude and airspeed—moose or no moose!—is a lesson that should be taught during primary instruction.

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