A FEW MORE WORDS ABOUT STALLS

BY

ALAN MALONE

All of us know what stalls are, and we have been exposed to the clichés about angle of attack and how the plane can be stalled at any speed in any attitude (not true, by the way). But there are some side issues that I think bear some thinking about.

One cliché I hear about sometimes is the so-called "cross-controlled stall." This is a misnomer. It should be referred to as a slipping or skidding stall entry; a ball-out-of-the-center stall, or something like that.

Listen, gang, if you are flying a propeller-driven airplane whose propeller rotates clockwise when viewed from behind it, as is the case in most conventional planes we find in the U.S.A, the airplane usually yaws to the left when we apply "up" elevator with the power on. There is a variety of reasons why this yaw takes place, and I don't mean to go into them in this essay. But I think we can all agree that the left yaw happens.

If we don't correct this left yaw by applying right rudder, the ball will hang out to the right of its little center-dealie, indicating a slip if we're in a right turn or a skid if we're not.

If a stall takes place while the ball is hanging out in either direction, the airplane will tend to roll in the direction opposite to the ball deflection at the moment of truth. If you don't believe this, go up and try it. Stall the airplane deliberately with the ball out to the right, and you'll notice a roll to the left at the instant that the nose breaks downward. If the ball's out to the left, the airplane will roll to the right. It's possible that some airplanes, especially little training planes that get the tar beat out of them in normal instructional operations, might make a liar out of me, probably because they're out of rig and don't fly at normal cruise speed at normal cruise power with the ball centered. Most instructors who have spun training airplanes are familiar with the phenomenon of a plane that spins beautifully in one direction but is hesitant to even enter a spin to the opposite side. So I'll stipulate that the airplane you use in your demonstration should be rigged so that everything evens up under level cruise conditions. Certainly, if you stall your plane with full right rudder, it will not enter a left spin, and vice versa.

The next caveat I have about centering the ball is that, if you apply enough right rudder to center the ball, the airplane will tend to roll to the right. This is a result of something called "roll coupling," which I also don't want to get into here. But I once had a radio controlled model airplane that would do very adequate rolls with rudder inputs alone. This particular little bird didn't even have ailerons.

So here we are with the power in and enough right rudder pressure to keep the ball centered. Unless we're trying to roll to the right, as might happen in the second half or a left chandelle or the roll out of any other climbing left turn, you'll have to add left aileron to the mix. Let me be clear on this point, because I don't think it's emphasized enough in training:

TO KEEP THE BALL CENTERED IN A POWER-ON RIGHT CLIMBING TURN WITH A CONSTANT BANK ANGLE, YOU MUST APPLY RIGHT RUDDER AND LEFT AILERON.

In other words, you must be cross-controlled. If you should happen to stall the airplane in this condition, it will break with no change in bank attitude. It will not roll to the right or to the left. It will maintain whatever bank attitude you had when you produced the stall. If you stall the bird straight ahead with the power on, you will also find yourself with right rudder and left aileron if you want the ball to stay in the center, and the airplane will break straight ahead, not rolling either way, provided that you use whatever control deflections are necessary to keep the ball centered throughout the maneuver.

What I am talking about here is cross-controlled stalls that take place with the ball in the center. You have to hold crossed-control pressure or the ball won't be in the center. My friend Lou Maduell used to enjoy performing what he called his rudderless spin entry. All he'd do would be to put his feet flat on the floor, not anywhere near the rudder pedals. Then he'd apply full power to the Cessna 150 or other typical training plane and pull the nose up. When the stall would break, the airplane would start a brisk roll to the left, since the ball would be hanging out to the right when the stall was produced.

Lou would then exacerbate the situation by applying full right aileron. When he did that, the left aileron would go down and the right one would go up. The downward-deflected aileron would be encountering high-pressure air from under the wing, whereas the other one would be met with a flow of relative wind sometimes called a "partial vacuum" (Gad, how we physics teachers used to hate that term!) from the wing's upper surface. Guess which aileron produced more drag. You got it – the left one, the one deflected downward would produce quite a bit more drag than the right one would, thereby further aggravating the leftward yaw, thereby causing the airplane to roll more vigorously to the left, and producing something that looked to anyone paying attention like a pretty clean entry to a left spin.

Remember, this was not a cross-controlled stall. He wasn't using the rudder pedals at all. [1] The point is that we should do away with the term, "cross-controlled stall" when we're working with students. Like many other phrases we use, it misleads them and produces garbled thinking.

Another mistaken concept has been pretty much eliminated from the curriculum during my days as a pilot. When I learned stall maneuvers, the instructor told me to dump the nose over into a pretty steep-looking dive, to make sure that we had the angle of attack well out of the critical area.

The safety experts of that day realized that they still had a problem with that training concept, because people kept killing themselves at pretty much the same rate, using this recovery technique.

Well, not exactly. Imagine yourself departing a short, obstructed field. Imagine the mythical fifty-foot tree line at the opposite end of the runway. You use perfect short-field technique, keeping the weight of the aircraft on the wheels as you accelerate up almost to V_x, the so-called "best angle of climb" speed. You keep the weight on the wheels because if you pulled the nose up and started the wings generating lift, you'd get a whole sackfull of something that goes along with lift called "induced drag." If the wings are kept at a more or less zero angle of attack, they don't cause a lot of this drag, because they're not generating any lift.[2] The rolling drag of the wheels on the ground is considerably less than the induced drag from the wings, so the airplane accelerates considerably faster, since the thrust vector from the propeller is opposed by less of a drag vector from the wings, since they're not producing much induced drag.[3]

At some speed slightly below V_x, you pull the nose up into a nice climb attitude; one that you have learned keeps the airplane climbing pretty close to its best angle-of-climb speed. The liftoff speed during one of these events is slightly higher than normal, for the reason stated above. As a wise instructor once remarked, "On a short field you should aim at the *bottoms* of the trees until you attain V_x."

But there's a problem. Because of a combination of maybe a little tailwind, a slightly rough or soft runway surface; maybe a tiny bit of uphill gradient, a slightly hotter temperature than you'd expected, producing a higher density altitude than you anticipated, as well as a heavy load and maybe a couple of spark plugs that are slightly fouled …

Maybe you start looking at those fifty-foot trees rushing toward you and you start thinking that if you don't climb a little more steeply, you're going to be eating some pine cones pretty soon. You've already passed the point at which an aborted takeoff is possible without eating some tree *trunks*.

You do the obvious thing, what years of flying in normal circumstances have taught you will work. You pull the nose up just a little bit higher. That should cause the plane to climb more steeply, right? [4]

Actually it does, when you're flying the machine in the so-called "area of normal command." But when you're at your V_x speed, you are unfortunately in the so-called "area of reversed command." You are so near to stalling speed that any increase in angle of attack is going to produce a bunch of drag, unaccompanied by any lift worthy of the name. With just a little bit more pitch-up, you're going to stall the wing and lose most of that lift you've worked so diligently to produce.

Now here's where the training concept of dumping the nose becomes a killer. When you stall, assuming that you have kept the ball centered, the nose will begin to drop and you are now supposed to react by dumping the nose into a steep dive, right? ***Wrong***.

Now, instead of seeing those nice soft pine branches rushing toward you, you see the hard, unyielding ground doing the same thing. The last thing you want to do is fly the airplane into the ground nose-first, right? So every impulse in your brain/body system tells you to *pull up!*

Now when wings reach their critical angle-of-attack, the plane is already coming down, producing a sudden, violent stall, known as a secondary stall. The net result is the flying machine coming down like a sack of wrenches. What's more, it's such a steep stall that the prospect of a recovery in the tiny amount of altitude you've been able to scrape together is not good.

The solution, of course, is not to attempt such a takeoff in the first place. But if all of the circumstances I have enumerated should happen to produce a stall, as you try to hoist the nose up over the treetops, you're probably better off not dumping the nose quite so far in the first place. Flight instructors these days are training their students to pitch down, sure enough, but not to pitch down any more than is needed to get the wings back to a sub-critical angle of attack.

We're talking seconds here – the amount of time it would take a pilot to produce a full-power stall at an altitude of less than fifty feet and then get the wings back to producing some lift before he hits the ground. I think he'd be better off in a flat attitude, coming down not quite so hard – a possibly survivable crash, provided that he can keep his wings level and then be whisked off to an emergency room soon after he has been extracted from the wreckage.

Another thing I hope this hapless pilot does is to keep the ball centered on the way down, so that he'll hit flat and stable and let the structure around him, particularly beneath him, absorb as much of the force of the return to earth as possible. He might have been better off maintaining the V_x speed and flying the thing into the treetops, where the upper branches might have given way to progressively lower branches, distributing the force through a longer time interval, reducing the trauma to pilot and passengers, and, once again, increasing the probability of survival.

Stalls have always been killers of folks in airplanes. We haven't been very successful in reducing the number and severity of accidents involving loss of control as a result of stalls; but the emphasis on stall recognition and avoidance is probably a step in the right direction, and the practice of teaching stall recovery with an emphasis on minimum altitude loss and a prompt return to a condition of positive lift with the ball centered is probably the best approach to the problem.

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Footnote #1 The PA 28 series of airplanes produced by Piper to compete with the Cessna 150/172 flying machines were known to be very manageable when it came to spins. But try a Maduell spin entry sometime with the wings slightly loaded by accelerating a little bit to produce some load factor on the wings, and you'd better be ready to get the nose down and some opposite rudder in. Those little Cherokees were never approved for intentional spins, and avoidance has always been the order of the day in those aircraft.

Footnote #2 If you're flying an airplane with a tailwheel, you'll have to apply forward stick to get the tail up promptly, in order to neutralize this drag from the wings.

Footnote #3 If the surface of the runway is very rough or very soft; or if there is vegetation grabbing at the landing gear as you try to accelerate, your first priority is to suck the gear up off the ground. You should have as much flap extended as the owners' manual allows, and force the airplane to fly at a speed that is probably below its stall speed when the wings are not in ground effect. As soon as you get this done, the next priority is to accelerate in ground effect (within one wingspan of the ground) to V_x before you attempt to climb. This whole process lengthens your ground run considerably, and you may want to think about doubling the takeoff run listed in the book. You may even consider staying on the ground until the field dries up, the farmer cuts the grass, and you get a very cool day with a wind howling down the runway into your face.

Footnote #4 See my essay on negative transfer -- Oops, I haven't yet published that one. I'll try to get to it soon. "Negative transfer" is a term we instructors use to describe doing the right thing at the wrong time. For example, experience teaches us that turning the steering wheel in a particular direction in a car turns the car in that direction. In a conventional (non-Ercoupe) airplane, trying to steer the plane on the ground with the steering wheel is the wrong thing to do. Almost all flying students have gone through a brief period when their instructors have compelled them to sit on their hands to prevent them from trying to transfer the steering procedure that's appropriate for a car to the taxiing airplane. Trying to transfer car-turning to airplane-turning is probably a perfect example of negative transfer. Trying to counteract an unwanted roll with aileron control during a stall is another, much deadlier, one.