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flying the classic loop

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We described our primary controls as "maneuver motivators" in the first installment in this series. Since then we have devoted separate articles to two of those controls and the corresponding maneuver each inspires: the normal upright spin, during which rudder inputs are the main event, and the aileron roll, during which aileron inputs are our primary focus. Other actions are certainly involved, but they are relegated to supporting roles. Let's now look at the third fundamental maneuver we can do in an aerobatic airplane: the loop.

The classic loop, of course, is a vertical turn; consequently, airspeed and *g*-load will vary throughout the maneuver. Similarly, a level "360" is simply a loop performed in the horizontal plane and is typically characterized by constant airspeed and *g*-load trends. Yet elevator is the motivating control surface in both cases. And for all of the things we ascribe to our elevator inputs (angle of attack, airspeed, *g*-load, stalling), we routinely regulate pitch to bend and shape our flight path. The featured airplane performing our basic loop is a 210-hp RV-7 equipped with a constant-speed propeller but lacking inverted fuel and oil capability.

"Hold on a minute," many who fly RVs, or Glasairs, or other so-called slippery-yet-aerobatic-capable airplanes exclaim, "ya gotta be careful when pointing downhill, as airspeed can accelerate out of sight in a big hurry!" While it's true that an aerodynamically clean airplane can pick up speed rather quickly it is equally true that a Decathlon or even a Pitts will accelerate beyond V_{NE} (never exceed speed) when pointing the nose well below the horizon, if you are passive or tentative during the pullout that is. Proactively manage your pitch inputs, however, and you'll find that excessive speed is not the foregone conclusion that some automatically assume.

G-LOAD AS SPEED BRAKE

Back in "Basic Stall Review" (June 2006), we introduced the V*g* Diagram. A key operational relationship was established between airspeed, *g*-load, and the aerodynamic and structural limits of an airplane. The stall constrains us on the lower-speed end of the spectrum, whereas the design *g*-load typically becomes our operating limit on the higher-speed end. Optimizing the loop will require that *g*-load and airspeed trends mirror each other as follows: as airspeed increases, increase the *g*-load; as airspeed decreases, decrease the *g*-load. But if we allow airspeed and *g*-load trends to converge (e.g., decaying speed with rising *g* on the front side of a loop), an accelerated stall is in the offing.

On the other hand, allowing airspeed to increase without a commensurate buildup in *g* (say, during the back side of a loop), or escalating the *g* too rapidly, will negatively affect the exit conditions: the loop closes lower and faster than it started in the former instance; it closes higher and slower, or possibly even encounters a stall, in the latter. Judicious manipulation of *g*-load as airspeed changes will make the flight path conform to the desired arc of the loop.

THE INSTRUMENTS

The loop is performed using outside visual references throughout. Even so, the airspeed indicator, altimeter, and *g*-meter provide useful feedback that we can use to refine our loops. We certainly won't be staring at the instruments during the loop itself. We will, however, compare the readings before and after the fact. Beginning and ending airspeeds should match, for instance. So, too, should the altitudes. And the *g*-meter, which we'll reset between attempts for now, should register a peak load of +3.5*g* and close to zero *g* as the minimum.

To develop an awareness of symmetry during the maneuver, the sensations on your body during the pullout should be equivalent to the sensations on your body during the pull into the loop. If the feel was noticeably different, then the entry and exit *g*-loads were not equal and the loop was asymmetric. Keep adjusting the pulls during subsequent loops until the pull in and the pull out have a comparable feel and the *g*-meter displays +3.5.

SETUP

The nice thing about a constant-speed prop is that we can set it and forget it during the loop. In the featured RV-7, we'll configure the engine and prop at 24-squared. This yields 145-150 knots in level flight at 4,000 feet mean sea level. No need to gain additional speed for the loop in this case.

Fixed pitch fliers, unfortunately, must coordinate power changes with their pitch inputs to maximize efficiency and to prevent possible engine over-speeding. Power management would go something like this: Establish level flight at 2500 rpm. Check the airspeed. Listen to the ambient engine noise. If airspeed decreases below this value (as it does during the first half of the loop), rpm and ambient engine noise will decrease as well. Thus, we want to increase power smoothly as we bend the flight path skyward. If airspeed increases (as might be required in a pre-loop dive to gain the recommended entry speed and during the second half of the maneuver), ambient engine noise and rpm will likewise increase. Thus, we must reduce power continuously as airspeed increases beyond the level flight speed. The pilot takes on the role of constant-speed prop governor. With some practice, you can keep the rpm fairly constant throughout most of the loop. But if you're going to err with your throttle movements, it's better to reduce the power too much whenever heading downhill rather

Courtesy Rich Stowell

Upon entering the loop, sight down the left wing as you pull into the maneuver.

Courtesy Roch Stowell

Note the g-meter at the apex of the loop. Ease the stick forward to float a bit across the top of the figure.

than not enough. And upon completing the loop, avoid shoving the throttle forward indiscriminately. See where you are rpm-wise first.

Okay, back to our RV-7. Knock out a couple of horizontal loops to clear the area and then we can take it vertical.

ENTRY

Initiate the loop from level flight by pulling the stick straight back. The amount of displacement necessary to generate +3.5*g* will vary from airplane to airplane. Lower-performance airplanes usually require greater displacement of the elevator control than higher-performance airplanes. What's more, we need to appreciate the difference between stick movement and stick force.

We want to find a suitable blend of pitch rate and stick position that yields +3.5*g* as early in the start of the loop as possible. Initially pulling too softly often results in the stick moving a long way but never attaining the desired entry *g*. But don't jerk the stick back abruptly either, which could spike the *g*-load well above our target. Move the stick smoothly, firmly, and purposefully. You need to pull harder and feel heavier in your seat than you do in a steep turn (at least at the beginning). Now freeze the stick where it is! That's right, you're going to generate +3.5*g* by the time the stick reaches a particular spot in the cockpit. Now adjust the force you are applying to the stick so the stick position does not change.

If we can keep the stick frozen in essentially one place, airspeed and *g*-load will take care of themselves as the airplane carves out the front portion of the loop. Each time stick position varies from the ideal spot, however, the smooth curvature of the loop will have a kink in it. More force on the stick than necessary, for instance, will cause it to move farther aft. The result: the radius of the loop shrinks, the second quarter of the maneuver becomes pinched, and the probability of encountering an accelerated stall increases (*g*-load and airspeed trends may be converging!). On the other hand, releasing too much force on the stick too soon will allow it to move forward. The result: the radius expands, the second quarter of the maneuver flattens out and grows vertically, and you could run out of the steam needed to get up and over the top.

The front part of the loop does go by quickly. So in reality, you won't be holding the stick in one place for very long. And managing the elevator isn't the only thing you have to do, either. Turn your head to the left at the same time you pull into the loop. Sight straight down the wing and focus on a point on the horizon. Not only will this allow you to see your progress, but it will also give you feedback about the airplane's pitch rate to inverted. If you continue to look over the nose instead, the featureless blue visual field (well, here in Southern California anyway) will provide little or no feedback; consequently, the tendency will be to relax the pull, sapping the airplane's energy. Look down the left wing; make it pivot continuously toward inverted.

THE APEX

The top portion of our loop begins when the cord line of the left wing is 20 degrees from level, inverted flight. Do two things now: look back over the nose and slide the stick forward until you feel a little light in your seat. The objective is to float gracefully across the top. But it's important to look over the nose before you push. You've got to see where you are to know how quickly or how slowly to move the stick away from your body.

Did you look forward too soon only to see the nose still well above the horizon? Slowly, very slowly ease the stick forward. Did you look forward a bit too late only to see the nose collapsing rapidly toward the horizon? Get that stick moving forward quickly. If you look forward and see little or no blue sky between the nose and the horizon, forget about the push! You missed it. Move directly to the exit inputs.

Across the top of the loop, we want to slow the pitch rate down without stopping it altogether. Continue feeding the stick forward until you reach the high point of the maneuver—the level, inverted attitude—then back away from the push. Allow the stick to slide aft and let gravity take over.

We normally wouldn't look at the instruments at the loop's zenith. But if you did steal a glance in the RV-7, the airspeed indicator would show around 60 knots; the altitude gain, around 800 feet; and the *g*-meter, close to zero.

Courtesy Roch Stowell

As soon as the nose drops toward the horizon, begin the exit pull.

EXIT

We've completely backed off our push, and we're now allowing gravity to pitch the nose earthward. But as soon as the nose touches the horizon, it's time to bend the flight path back around to level flight. Overcome the impatient urge to yank the stick back. Instead, smoothly accelerate the stick aft until reaching the same spot you held during the front side of the loop. Now apply whatever force is necessary to hold the stick stationary, which generally requires more and more effort as airspeed increases. Don't let up until the nose swings up to the level flight attitude. Release the aft elevator all at once and fly away.

AILERON & RUDDER

The ailerons must remain neutral during the loop. Move the stick in pitch only. Even if you wind up crooked at the top, don't fiddle with the ailerons. Trying to figure out how to correct the problem while inverted usually leads to confusion and a loss of focus on the elevator control. Just finish the loop, crooked as it may be. Evaluate what you may have done to cause the problem, and adjust your control movements accordingly on the next loop.

As for the rudder, proactively use it to maintain heading throughout the maneuver. Performing loops along a prominent reference line makes this much easier. In general, little or no rudder action is required at the start unless flying airplanes with significant gyroscopic effects, such as the Pitts. In that case, a dash of left rudder is needed.

The top of the loop is slow flight; so if the heading seems a little off there, try squeezing in some right rudder. And although neither pulling into the loop, nor floating across the top will always require corrective rudder, the last quarter of most loops in most airplanes typically needs some left rudder to preserve your alignment.

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SOME COMMON TENDENCIES

Problems pilots often encounter when learning the loop:

1. Crooked pulls. In the case of the RV-7, where the left-seater grips the stick with the left hand, watch out for the tendency to pull the stick aft and left. If flying with your right hand on the stick, avoid pulling the stick aft and right. Straight pulls only.

2. Inadvertently applying unneeded left rudder when sighting down the left wing. To ensure you're not bracing your feet on the rudder pedals during the entry, consciously release some pressure on both pedals as you turn your head toward the wing.

3. Pulling too softly during the entry, or too hard during the exit. Calibrate yourself to +3.5*g*. Hit that target early during the pull-up. Correlate the sensations with pitch rate and stick position, and try to match those sensations during the exit.

4. Accelerated stalls during the transitions between entry and apex, and between apex and exit. Relax across the top of your loop. Low speed demands a low-*g* environment here. If you should encounter stall buffet, it's likely as a result of too much aft elevator. Hold a general heading with quick, active movements of the rudder. Immediately move the stick forward to unstall, then gingerly ease the stick aft again to continue with the loop. Unload, reload, hold heading with rudder—do this as many times as required until the stall is fully recovered.

Remember to breathe during your loops, too! Take a deep breath and exhale (forcefully if need be to counter any symptoms of gray-out) as you enter the loop, and again later as you exit. Parachutes are required if you are not looping solo (even then, wearing a chute is a good idea). And keep Jim Taylor's words in the back of your mind: "The purpose is not to make the loop perfectly round, but to make it perfectly safe." Have fun looping—up high, of course.

Rich Stowell is a NAFI Master Instructor-Aerobatics and the author of the new book *The Light Airplane Pilot's Guide to Stall/Spin Awareness.* His videos are now available on DVD. We hope you have been enjoying Rich's series on recreational aerobatics, and we encourage you to share your ideas for future articles. *E-mail rich@richstowell.com.*