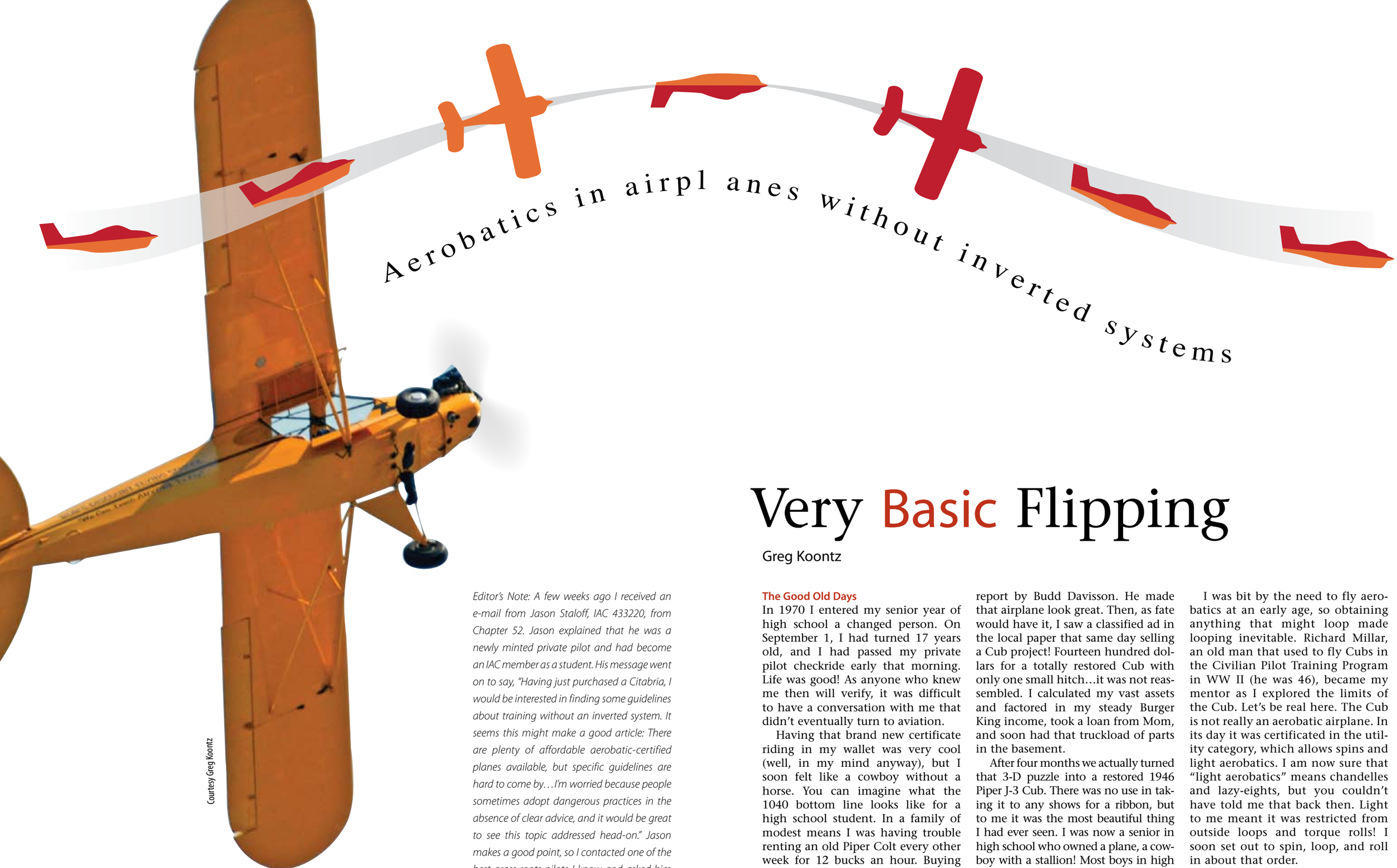


Courtesy Greg Koontz

Editor's Note: A few weeks ago I received an e-mail from Jason Staloff, IAC 433220, from Chapter 52. Jason explained that he was a newly minted private pilot and had become an IAC member as a student. His message went on to say, "Having just purchased a Citabria, I would be interested in finding some guidelines about training without an inverted system. It seems this might make a good article: There are plenty of affordable aerobatic-certified planes available, but specific guidelines are hard to come by…I'm worried because people sometimes adopt dangerous practices in the absence of clear advice, and it would be great to see this topic addressed head-on." Jason makes a good point, so I contacted one of the best grass-roots pilots I know and asked him to pen some advice. Greg Koontz was happy to oblige. Thanks for the idea, Jason!

Very Basic Flipping

Greg Koontz

The Good Old Days

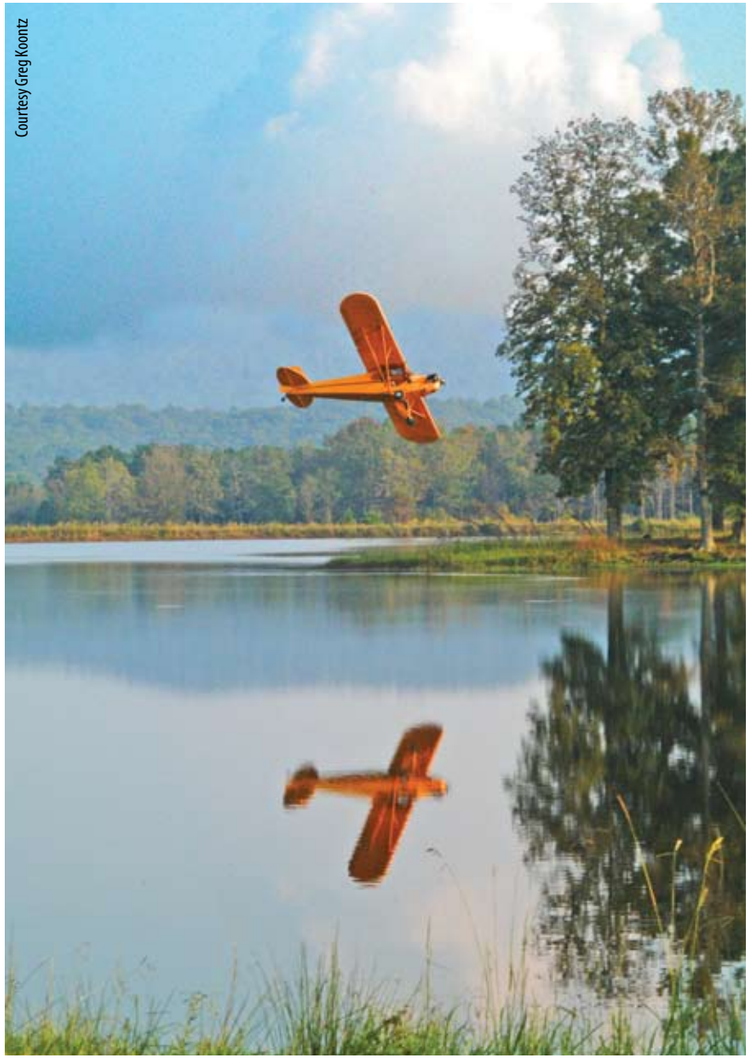
In 1970 I entered my senior year of high school a changed person. On September 1, I had turned 17 years old, and I had passed my private pilot checkride early that morning. Life was good! As anyone who knew me then will verify, it was difficult to have a conversation with me that didn't eventually turn to aviation.

Having that brand new certificate riding in my wallet was very cool (well, in my mind anyway), but I soon felt like a cowboy without a horse. You can imagine what the 1040 bottom line looks like for a high school student. In a family of modest means I was having trouble renting an old Piper Colt every other week for 12 bucks an hour. Buying a plane seemed out of the question. But one day I was looking through a magazine and found a J-3 Cub pilot report by Budd Davisson. He made that airplane look great. Then, as fate would have it, I saw a classified ad in the local paper that same day selling a Cub project! Fourteen hundred dollars for a totally restored Cub with only one small hitch…it was not reassembled. I calculated my vast assets and factored in my steady Burger King income, took a loan from Mom, and soon had that truckload of parts in the basement.

After four months we actually turned that 3-D puzzle into a restored 1946 Piper J-3 Cub. There was no use in taking it to any shows for a ribbon, but to me it was the most beautiful thing I had ever seen. I was now a senior in high school who owned a plane, a cowboy with a stallion! Most boys in high school think only of football, cars, and girls, but I forgot them all (well, maybe two of them) for flying my Cub.

I was bit by the need to fly aerobatics at an early age, so obtaining anything that might loop made looping inevitable. Richard Millar, an old man that used to fly Cubs in the Civilian Pilot Training Program in WW II (he was 46), became my mentor as I explored the limits of the Cub. Let's be real here. The Cub is not really an aerobatic airplane. In its day it was certificated in the utility category, which allows spins and light aerobatics. I am now sure that "light aerobatics" means chandelles and lazy-eights, but you couldn't have told me that back then. Light to me meant it was restricted from outside loops and torque rolls! I soon set out to spin, loop, and roll in about that order.

Millar would give me advice, and then I would launch into the wild blue to try this stuff. Spins scared


Courtesy Greg Koontz

With appropriate instruction, many classic aircraft provide a great platform for learning basic aerobatics.

me silly, but after a few dozen I learned that they would settle down into a really stable swirl. Loops were just a matter of pulling hard, letting up a little, and then pulling hard again. No sweat so far. But then came rolls.

To roll a Cub one must do a barrel roll or at least a roll involving a bit of a positive twist. After a few rather terrifying split-S maneuvers, I tried to push a bit to keep the nose up and soon found out the Marvel-Schebler carb does not supply fuel in negative flight. Who would have known! I mean, I couldn't even spell Marvel-Schebler!

Luck Is Not a Substitute for Knowledge

Looking back on those days I thank my creator for keeping my dumb butt in one piece. With some maturity I did learn there are lots of well-qualified aircraft for my aerobatic ambitions that are also quite affordable. The more-suited Reed clipped-wing Cub would have served me better. Citabrias, Stearmans, and a huge list of aerobatic homebuilts are out there waiting to do a loop and a roll. The ones I am referring to here share a common denominator; they have no system for running the engine inverted. What might be overlooked in our modern world of really advanced equipment is that these aircraft make fun and capable aerobatic mounts with the right amount of knowledge and understanding of their limitations.

If you're new to aerobatic flying, let me help a little here. The problem of making an engine run upside down is supplying fuel and oil. The run-of-the-mill carburetor works on a bowl and float valve that accumulates fuel and mixes it with the all-important air. This means they rely on gravity to accumulate that fuel. Now rather old and always expensive to repair PS-5 pressure carburetors have been adapted to our engines to bypass this problem. The nice people at Ellison came up with a more modern and simple slide-type carb, or throttle body, that creates a spray of fuel under a few pounds of pressure to eliminate the need for gravity to fill a bowl. This cures the running upside-down problem. So does fuel injection. The oil problem has been addressed in many ways over the years with methods of basically trapping some oil for a little help during brief periods of inverted flight. More than 30 years ago the Christen company came out with a neat system that picks up the inverted oil from the top of an engine and re-circulates it through the engine using the existing oil pump. This created reliable and continuous oil pressure and opened up a whole new generation of aerobatics.

The planes without these systems may seem outdated to some people, but I disagree. It would be great to see a special competition category created for this niche as these airplanes are lots of fun and a source for getting started in this great sport — so let's go fly.

First, be sure your aircraft was actually meant to do what you're about to attempt. Refer to the aircraft type data sheet to verify just what it was certificated to do. An experimental type certification requires a flight-test program and appropriate logbook endorsement for each aircraft intended for aerobatics. Then give it a thorough inspection. It takes almost 4*g*'s to do even basic aerobatics and maybe 6*g*'s to do not-so-basic recoveries, so investigate and be sure what you are flying is up to the task. Remember that it takes a healthy powerplant to endure some of those large temperature changes and power adjustments. I have seen some of those tired old float-type carbs get their float stuck in the top of the bowl during an inadvertent venture into negative *g*. This will result in fuel starvation and a possibly challenging forced landing. Safety is good equipment.

Second, if you are just getting started, get a little dual from a *qualified* aerobatic instructor. If you are flying a single-seater, then rent something like a Citabria for the instruction. A little instruction goes a long way! Our non-inverted system plane is limited then to positive flight, which creates real problems performing Cuban-eights, Immelmans, and certain types of rolls. Level inverted flight is quite obviously not good, while normal spins and loops are relatively unaffected. It all boils down to positive or negative, or if you are creating your lift from positive angle-of-attack or negative angle-of-attack. Bottom line:


Jim Koepnick

Tapping into the fun and excitement of basic aerobatics does not depend on an inverted system.

Courtesy John Mohr www.mohrbarnstorming.com

John Mohr and his stock Stearman prove that dazzling aerobatic displays depend on practice, not on inverted systems.

If you pull on the stick all is well; if you push on it your engine is going to stutter or momentarily quit. This limits our ventures into upside-down flight to a curved path called a parabolic arc.

An airplane will track through the air on a parabolic arc when it is creating no lift at all. This happens at the precise angle-of-attack that divides the relative wind into two parts that have equal distances to travel to the trailing edge of the wing. I call this the zero-lift angle-of-attack (AOA). You will know the stick position for this AOA because when you are creating no lift, you are also creating no *g*-force; therefore, you are weightless. This will still cause a stutter in most aircraft carbs, so you might be more comfortable with an AOA that is close to, but not exactly at, this AOA. A plane flying in a true parabolic arc will fly a straight path like a dart, uninterrupted by the forces of lift or aileron drag. A wing with equal airflow on both sides is in neutral lift and has two ailerons that, at that exact AOA, are creating equal amounts of drag. If you choose a slightly positive AOA (we're talking maybe one-tenth of a *g*) to keep your engine from sputtering, then expect a slight "corkscrew" flight path that requires a light amount of rudder to correct for aileron drag.

Now You're on a Roll

Rolls create the main challenge here. A roll has many definitions. We call it a slow roll when the flight path is in level flight, therefore creating the lift needed to maintain level flight all around the roll. This involves a constantly changing AOA to get the wing, and even the fuselage, to accommodate the lift requirements. An aileron roll, in contrast, is a roll that ignores the level flight requirement and simply flies the roll on a parabolic (no lift) arc. This eliminates the need to alter the AOA so the pilot simply sets the nose up to give an even arc across the horizon, pushes forward until a weightless feeling indicates the zero-lift AOA, and then applies full ailerons (while maintaining that forward pressure) to cause a roll while this arc is being flown. That's it! In this format no rudder is required since there is no aileron drag. If you choose to use rudders to increase your control, you could reduce the amount of nose-drop at the end by first adding a slight amount of top rudder at the last knife-edge position and then adding back-pressure at the last 45 degrees of roll. The top rudder will be tapered off during that last segment but not too fast. You will need to leave a little in for the aileron drag you will introduce when adding back-pressure. The old Cub just didn't have much rate of roll to do this, but an airplane designed to do some aerobatics will most probably have the required roll rate. The barrel roll, basically a loop/roll combo, should not create a problem for the non-inverted plane since AOA during this maneuver should approach, but not completely reach, zero lift. And for positive snap rolls, well, they're positive, so no problem.

A pseudo-inverted flight can be accomplished with a little finesse controlling AOA. Flying a long arc is possible with plenty of speed and careful stick placement. You can even keep a touch of positive *g* if necessary and still work out a four-point roll. Watch Mark Henley of the AeroShell Aerobatic Team do a solo act, and you will surely see this in action. His T-6 has a carb that doesn't quit instantaneously after going inverted, and with a little skill he makes a long inverted pass down the show line hiding a slight curved flight path. If your airplane lacks 600 hp and 180 knot entry speed capability, you will need to be sure to have all the speed you can and plenty of up-pitch before rolling. John Mohr seems to defy all our theories with his stock Stearman. His low-level routine includes a roll on takeoff. Remember John was practically born in a Stearman and has developed his skills over a lifetime. And, if I'm not giving anything away here, his carb on that bird does continue running a little longer than most, giving him some help passing through inverted. John is an inspiration to all aerobatic pilots strapping into airplanes that do not have an inverted system.

Courtesy Greg Koontz

There are some maneuvers that demand help from an inverted system, including prolonged inverted flight.

Build a Strong Foundation

Obtaining and maintaining a zero-lift AOA (parabolic arc) is the fundamental skill necessary for this kind of aerobatic flight. After learning this skill with your instructor you will need to practice until finding the arc is second nature. You have no system to fly inverted, and a half-roll to *confusion* is not an option. It must be second nature to control the arc and to keep rolling until you are right-side up. To end up upside down, confused and out of ideas, will probably lead to a split-S maneuver at too high an entry speed. That's where the not-so-basic 6-plus *g* recovery might come into play. The moral of this story is don't ditch the instructor until you are at home in the roll environment.

Once you're proficient at rolls you will need to learn loops, hammerheads, and spins (if you haven't by now). These complete the four fundamental maneuvers of aerobatics and should be accomplished as a group to give you skills flying in most attitudes, situations, and recoveries needed to be safe. These additional maneuvers do not require an inverted system but will eventually be a part of a maneuver that will.

The next step requiring your zero-lift arc will be adding on Cuban-eights and Immelmans. The Cuban, as you probably know, is a loop that is stopped on the inverted 45 degree downline and, in the middle of a straight line of flight, is rolled to right-side up and followed by the same to create the shape of a sideways "8." In the non-inverted system plane we can mimic this maneuver by sacrificing the straight line for our arc. Depending on your rate of roll, you will need to begin your roll at or soon after reaching the top of the loop. Pause only for an instant then initiate your roll. As the plane rolls around to positive flight, first help the nose stay up on the line with a small amount of top rudder through knife-edge and then on the last 45 degrees of roll let that rudder input linger to correct for the aileron drag that is going to be introduced when you add back-pressure to keep the line. With a little (make that a lot of) practice, this rudder-then-back-pressure move will smooth out. At the end of the half-roll to right-side up, hold the line for a brief track and then repeat if you want a full Cuban-eight.

When the moves for the Cuban sink in, then go on to the Immelman. This maneuver is technically a perfect half-loop followed immediately by a perfect slow half-roll. For us non-inverted fliers this means going back to the arc for this transition. Once again it depends on the rate of roll you have. Make your loop a bit tighter than normal so you'll have some speed to work with at the top. Then, according to your rate of roll, start your roll out just a few degrees prior to the peak of the loop, making sure you are in zero *g* flight at the start of the roll. A little top rudder through the knife-edge portion will help followed by a little back-pressure starting at the last 45 degrees of roll. You don't have an inverted system so you are flying a curve. Some nose-down flying might well be necessary.

Smooth Flight

Hopefully by now you see that using the arc to replace inverted flight can be inserted into many maneuvers and will give you the opportunity to learn aerobatics in some alternative aerobatic aircraft. I use the same technique to give a passenger a nice ride even if I do have an inverted system. That hanging from the belts stuff is fine for those accustomed to it, but the non-pilot does not know the difference and will appreciate the smoother technique. Saving them from the discomfort of hanging on the belts will go well in making you the "smooth pilot" that gave them their first aerobatic ride.

As always, aerobatic flight requires a great vigilance on safety. Please have a good instructor/mentor and remember all the aspects of safety including a good parachute with a clear exit plan, the right airspace/altitude for aerobatic flight, and a reasonable engine failure plan. Be prepared. Then go out there and enjoy it!

Greg Koontz has held a flight instructor certificate since 1972. Of his 22,000 flight hours 7,000 have been as a flight instructor. He has flown most aerobatic types as well as 165 total types of aircraft. Greg spent 20 years as a corporate pilot and retired in 2002 to expand his aerobatic business into a full-time operation. He performs in about 16 air shows each year, and his major sponsor is American Champion Aircraft. Greg operates Sky Country Lodge as his home base and aerobatic flying school. You can learn more about his school at **www.GKAirShows.com** *or contact him at* **greg@gkairshows.com.**