Looping the Loop

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WE DO LOVE THE loop, don't we? In many ways it represents aerobatics. Seeing those first loops fired our imaginations and our yearning for all-attitude flight. Someday, we thought, that would be us.

Later, though, we found it was much more difficult than we imagined to make it vertical, keep it round, and remain oriented.

I'm speaking about the loop mostly to new people, especially those who are coming to us with slick experimental airplanes, and those whose airplanes do not have inverted systems. I'm also speaking to those in low-horsepower/high-drag airplanes, and to our new competitors.

The loop is a finesse thing, not a brute force thing, and done right it is not hard on the airplane.

Also, the loop seems so simple, yet it beautifully illustrates the mental leaps made by the Wright brothers in the creation of controlled maneuvering flight. (See sidebar.)

FIGURE 1
Aresti symbol of the loop.

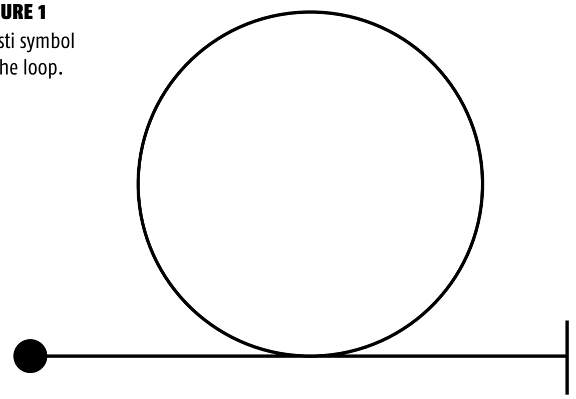
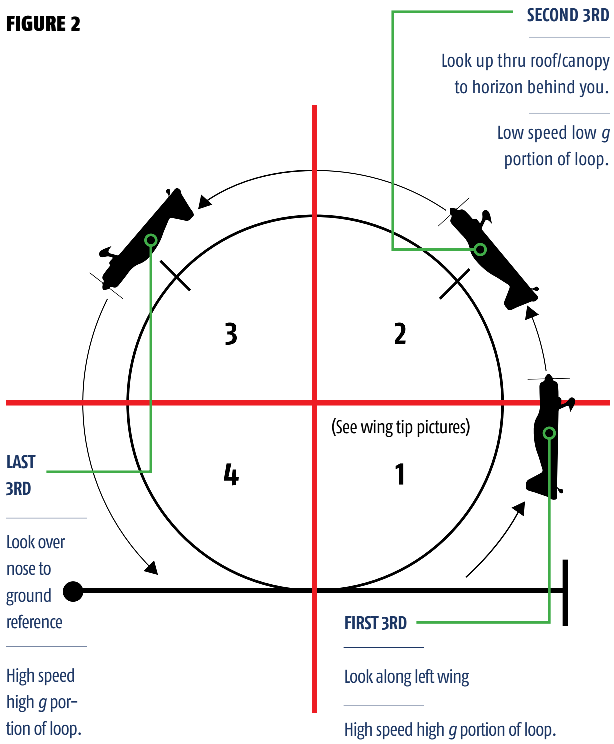


FIGURE 2



To do a decent loop we must not just look over the nose and pull the elevator back until the ground reappears. (Bad dog! Bad dog!). Looking at nothing but blue sky for the first half of the loop gives no reference for control. This first half of the loop is where most people get their loops leaned over from vertical, and twisted off heading.

The main idea in aerobatics, nicely said by 1972 World Champion Charlie Hillard in the EAA video *Getting Started in Aerobatics* is "*where to look and when.*" Looking in the right place at the right time during each maneuver makes them all easier to fly.

I highly recommend that EAA video for new people, with great instruction given by three-time U.S. National Champion Clint McHenry. Clint didn't start competing in aerobatics until he had retired! You can't be too old.

As we break down the loop into segments, we will talk heavily about where to look, and when. During most of the loop we will be looking along the left wingtip, not over the nose. Making pitch, roll, and yaw inputs using a wingtip reference takes some getting used to. Controlling the wingtip in relation to the horizon in the first half of the loop is the key to staying oriented and keeping the loop vertical.

We fly the loop in thirds, but we must analyze it in quarters. See figure 2. From the middle of Quarter 2 over the top to the middle of Quarter 3 is the hardest portion to fly as the airplane's energy state is at its lowest.

The first third of the loop is the high-speed, high-*g* portion that includes all of Quarter 1 and the first half of Quarter 2. The middle third, and the part where most people get in trouble, is from the last half of Quarter 2, up and over to the middle of Quarter 3. This is the low-speed, low-*g* portion of the loop.

The last third is from the last half of Quarter 3 and all the way through Quarter 4. This is another high-speed, high-*g* portion that is a mirror image of the first third.

Yes, I know the thirds aren't exactly equal, but they each have their own character, their own energy states, their own sight lines, and their own control challenges.

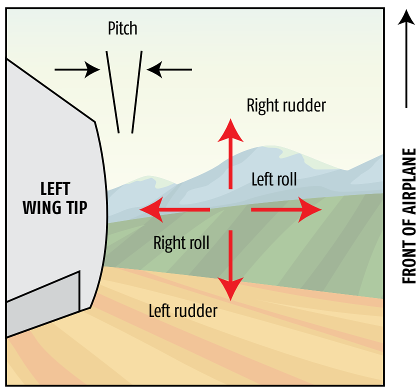
The first key, especially in a low-performance airplane, is to pull enough *g*'s to make the first third small enough. You must also be at or above the handbook entry speed for the loop. It is very important to pull enough *g*'s in the first quarter, at least 3*g*'s, or you won't have enough horsepower and leftover speed to get around a larger loop. In fact, if your energy state is low enough you may not even get over the top of the loop, falling out of the maneuver.

Learning tip: Because of that low energy state over the top of the loop, when you are new and learning the loop we do not want you to make it round. Make it a little taller than it is wide, spending very little time across the top. That will give you less time to get into trouble. This makes your loop a good old-fashioned "barnstormer's" loop, which still looks good. Once you are proficient in these tall loops you can work at making them more round if you wish, which means spending more time in the low-energy area in the middle third. The barnstormer's loop is also a good ride for a passenger.

Also, enter the loop fast. Think of book looping speeds as minimums: More is better. This is good advice in general for all maneuvers except for the snap-roll speeds, which are maximums.

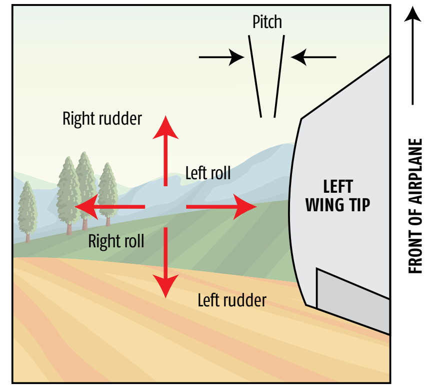
Learning tip: Make yourself a goal, whether you are doing a loop, a barrel roll, or an aileron roll, that you will begin and end the maneuver at the same altitude. Finishing lower can get dangerous. More on that later.

FIGURE 3: HIGH WING AIRCRAFT



Left window view when vertical, beginning of Quarter 2.

FIGURE 4: LOW WING AIRCRAFT



View when vertical, beginning of Quarter 2.

Now, we're going to fly using the wingtip reference. Pilots are initially taught to fly using the tip-of-the-nose reference for pitch, roll, and yaw. Flying by a wingtip reference is not hard, but it is not in most pilots' experience. This discussion will be using the *left wingtip as a reference, with an American (clockwise-turning) engine.*

Control of the wingtip with the flight controls is done the same way as if the regular nose reference is used, but the orientation is different. Once the pilot has pulled to vertical, and is at the beginning of Quarter 2, a wingtip up or down motion on the horizon is yaw and is controlled with the rudder. Wingtip left and right motion along the horizon is controlled with the ailerons. You must also keep pitching around the loop. Challenges your brain at first, doesn't it?

WITH THEIR DESIGN, WRIGHT BROTHERS CREATE ATMOSPHERE FOR AEROBATICS

YES, THE LOOP SEEMS SO SIMPLE, yet it beautifully illustrates the mental leaps made by the Wright brothers in the creation of controlled maneuvering flight. The Wrights succeeded where other more highly funded efforts failed.

Author Annette Carson, in her 1986 book *Flight Fantastic: The Illustrated History of Aerobatics*, hit it on the head: "Wilbur and Orville made a decision to go out on a limb and flout the doctrine of the *inherently stable* aeroplane. … It was the genius of the Wright brothers that they dared build *inherently unstable* machines which would wholly depend on the pilot's skill in handling the controls." Think of a bicycle or motorcycle: It is unstable, yet quite capable once the rider is added.

We know that the Wrights made the first powered and controlled flight in December 1903. Wilbur was 35 and Orville was 31. More importantly for us, back in Dayton they made an improved version of the airplane called the Flyer II. "It was from here with the Flyer II that they achieved the triumph of the first full 360-degree banked turn in history, *lasting 1-1/2 minutes*, on 20 September 1904," Carson wrote.

"The distinction should be noted, however, that this rudder/wing-warping system was an automatic linkage," she continued. "With the Flyer III of a year later, September 1905, the Wright brothers came up with the winning combination. They separated the wing-warping controls from the rudder and thus permitted their *independent or combined* operation in any desired degree. Now the pilot was wholly in charge of the handling of the machine. … The art of piloting had been born, and with it the beginnings of aerobatics."

1904 Flyer Flight

We must also separate the terms of the aircraft being inverted from whether the aircraft is negatively or positively loaded. Inverted only means the aircraft is upright or inverted in relation to the horizon. Loading, or *g*, is different. Positive *g* means the blood is going to the pilot's feet. Negative *g* means the blood is going to the pilot's head. *g*-load is controlled by elevator.

These terms are important because at the top of the loop the aircraft is inverted, but positively loaded. The pilot is light in the seat over the top, approximately +0.5*g* (1/2 *g* positive), but is not truly weightless, meaning 0*g*.

That also means that the fuel and oil will flow correctly and the engine will still run while flying over the top of the loop, even in a "non-inverted capable" aircraft. Inverted fuel and oil systems are really negative-*g* systems.

Swing a bucket with water in it quickly in a circle over your head. The water stays in the bottom of the bucket even when the bucket is upside down. Centrifugal force keeps the water there. Same with the airplane, where the airplane is the bucket and your blood is the water!

As to how and where to look, I will get the students directly over a long, straight road or section line and have them dive to get above their entry speed. They must then look along the left wing to the horizon before they pull.

I have the students look along only the left wingtip from the beginning of the pull, all the way through Quarter 1 and to just past the halfway point of Quarter 2. At this point the aircraft is 135 degrees nose up and inverted (or 45 degrees nose down from vertical and over on its back), and pointing back in the direction it came from. The aircraft is now approaching the top of the loop. Here is where the pilots must ease off the pull on the stick/yoke a bit and float over the top of the loop.

Pulling back on the elevator control when inverted just pulls the aircraft to the ground faster, finishing lower than it started. This action will cause the aircraft to get too fast, possibly exceeding the airspeed redline, which will lead to aircraft damage in the pull back to level flight.

Now I have the student crank their head back hard as they relax back pressure and float over the top. They must now look through the roof window or canopy and get the horizon behind them in sight. They should also see the road or section lines underneath them going to that rear horizon. Now they are using the nose reference, inverted, in relation to a point on the horizon to cancel out yaw and keep the wings level, inverted, with their ailerons.

Once they get to the middle of Quarter 3 and into Quarter 4 I have them look over the nose, using rudder and aileron in conjunction with the slowly increasing elevator pull (back up to 3-4*g*) to keep the airplane tracking along the road. They are now upright and back on the original heading, still over the road.

PHOTOGRAPHY COURTESY OF **WRIGHT-BROTHERS.ORG**

As you can see, the focus in getting the whole loop to be vertical is to have the airplane flying vertical in the initial pull up. At this point you must not have a low wing, which is controlled with rudder. But what is wings level?

To know where the left wingtip should be in relation to the horizon, we must calibrate ourselves. Before we try a loop, we get faster than minimum looping speed, pull to vertical, then hold the vertical. Now look back and forth between wingtips, holding them level with rudder. We now know where the left wingtip should be on the horizon when vertical without having a low wing.

I don't have students look back and forth when pulling vertical in an actual loop. Looking back and forth, interpreting what input is needed, and making that input before all the speed is gone is usually beyond a new person. Besides, rapid head movement is a great way to make yourself sick or get vertigo. The actual loop is performed looking along one wingtip only for the first third of the loop.

The engine at full power has strong torque, which has a stronger effect as the aircraft slows. This will cause the aircraft to roll left, which is a downgrade. This looks to the pilot as the wingtip wanting to walk across the horizon when vertical. Put in right aileron as necessary.

In a low-horsepower aircraft pulling 3-4*g*'s, as the aircraft slows on the upline with the engine at full power, the left wingtip will start to drop, which is a left yaw motion. You must use some right rudder to keep the wingtip in position on the horizon.

In some more powerful aircraft the propeller gyroscopics will cause the airplane to yaw right, needing left rudder to keep the wings level while vertical. For your particular aircraft use the rudder controls as necessary to keep the wings level while vertical and pulling around the loop.

The elevator cannot just be pulled back at the beginning of the loop and then frozen. As the aircraft approaches vertical, the speed is bleeding off fast, reducing the airflow over the elevator. This makes the elevator weaker, and the *rate* of pitching (meaning the degrees per second the nose is moving around the looping course) will slow.

You will have to move the elevator more aft to keep the nose coming around the loop. If the pilot is watching the wingtip correctly, he or she will move the elevator as necessary after the initial pull to keep the wingtip pitching around the loop.

Assuming you are keeping your wings level to the horizon with your rudder control, the left wingtip will draw a loop figure out there on the horizon as you pitch around the loop.

When on the downhill side of the loop, do not pull hard on the elevator too soon. Be patient. Allow some energy to build up first, then ease into the finishing pull smoothly.

As you finish the loop, pull 1/2*g* less at the end of Quarter 4 than you did in Quarter 1. The aircraft is going a little slower in Quarter 4 than it was in 1, and most people tend to finish the loop "high." For those of you not competing, I still want you to begin and end your loops (and your barrel rolls and aileron rolls) at the same altitude.

When it comes to aerobatic judging, Quarter 1 of a loop is free to the pilot and sets the standard. Whatever radius the pilot draws in Quarter 1 must be re-created in quarters 2, 3, and 4. That would make it perfectly round, with a lot of time spent over the top.

In competition, loops and parts of loops must also be wind-corrected. When presented with a strong headwind or tailwind, you can make an adjustment, widening out into the wind and tightening up with the tailwind. Just don't overdo it. A 5 percent to 10 percent adjustment should do it. The full loop must begin and end over the same spot. The half-loop up must end directly above the spot where the initial pullup began.

Loops are hard to do well in competition and usually suffer under the judges' pens. *I highly recommend every Sportsman pilot fly a Freestyle,* even if he or she borrows it from someone else. The first thing I do when creating my Freestyles is get rid of the loop! Why do the loop three times?

What if you are having trouble across the top of the loop?

As soon as you find the airplane doing anything you didn't expect, discontinue the maneuver *IMMEDIATELY.* As they say in (the first) *Top Gun*, "Don't push a bad position." Strongly center the rudder, aileron, and elevator controls, and once the nose is at or below the horizon, pull the throttle hard to idle. The heavy end of the aircraft will seek the center of the earth, and it will begin flying again.

Since aircraft have natural stability, once you stop using the "offending" inputs as soon as things start getting ugly, the aircraft should never fully depart into the spin. If a spin does result, using the Rich Stowell PARE spin recovery procedure (power idle, ailerons neutral, rudder full opposite the spin, elevator sharply through neutral) works whether upright or inverted.

I am assuming, of course, that when practicing this maneuver you have obtained sufficient altitude, put your parachute on, loaded the aircraft within the aerobatic CG range, and already had spin training. You can also see that you should not teach yourself this or any other aerobatic maneuver. Get proper training first.

A well-done vertical loop that begins and ends at the original altitude is a thing of beauty. It is also one of the first things a student learns, and it brings a strong sense of joy and accomplishment. We've also seen in the sidebar what the simple loop represents over and above itself.

Enjoy, and make it your own. ***IAC***

FIRST MEN TO DO FULL LOOPS

The first men to do full loops were a Russian and a Frenchman. The Frenchman, Adolphe Pégoud, was doing flying and testing work for manufacturer Louis Blériot, the man who first crossed the English Channel by air in 1909. Adolphe and Louis were both working on inverted flight and trying the loop in pieces, working up to a full loop. Unaware of what was going on in France, Lt. Pyotr Nesterov of the Imperial Russian Air Service beat Adolphe by 12 days, doing a complete loop on September 9, 1913. "His immediate reward was ten days close arrest for having taken 'undue risk with a machine, the property of his Government!' This was quickly forgotten, however, and within a few days he was promoted to Staff-Captain."

Annette Carson, *Flight Fantastic: The Illustrated History of Aerobatics*

World War I started less than a year later, in the summer of 1914. By 1916 the life expectancy of a young pilot at the front was two to three weeks. The ability to "stunt" would soon mean the difference between life and death.


Adolphe Pégoud


Lt. Pyotr Nesterov

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