AVIATION QUARTERLY

Room To Manoeuvre

by Bryan Quickmire

High Roller

In our last issue we examined some rather strange, unexpected behaviours of the aerobatic airplane.

In this issue we'll examine some rather strange, unexpected behaviours of the aerobatic pilot!

There is an aerobatic manoeuvre where the airplane does exactly as instructed - no bizarre gyroscopic forces, no accelerated stalls, no autorotation. There's no blackout-inducing high positive Gs and no eyeball-popping high negative Gs. In fact there's never more than 2 Gs of either flavour.

However, if you look closely you'll see the ailerons hard over and the elevator and rudder flapping wildly. In the cockpit, the ball in the turn coordinator is shooting back and forth, from one end of the glass tube to the other. The G meter is fluctuating rapidly between positive and negative.

The pilot looks for all the world like someone churning butter and stomping grapes while looking all around to avoid being pounced by the Red Baron. Limbs are flailing, the head is pivoting every which way. Blood and internal organs ebb and flow in conjunction with the G reversals.

Are these the spasms of someone who flew through a cloud of nerve gas? Are the controls experiencing flutter? Or are their linkages broken?

None of the above! The movements of the limbs are synchronized with the motion of the tail surfaces. The movement of the head is targeting the eyes at fleeting visual references. A complex rhythm can be sensed.

What we are viewing is a perfectly executed Rolling Circle!

The Rolling Circle

In the Rolling Circle, or Roller for short, the nose prescribes a horizontal circle while the wings roll continuously. In effect, we do a turn and a roll at the same time, both at constant rates, without gaining or losing altitude!

The Roller has multitudinous variations. The entry and exit can be upright or inverted and any number of rolls and circles may be included. The rolls can be towards the inside of the circle, towards the outside, or even alternating inside and outside. Difficulty factors can be astronomical!

Let's try one. "Mirror, Mirror, on the wall. What's the fairest Roller of them all?"

"Oh mighty Aerobat, the fairest Roller of them all is a complete circle, entered and exited upright, with four slow rolls interspersed evenly throughout."

Why so? Because we can break this one down into four quarter circles, each with a full roll imbedded. This allows a reasonable rate of roll, not too fast and not too slow, and affords good visual reference opportunities.

We'll do this one to the left. Enter with full power but slower than cruise speed. Pick a point on the horizon off the left wing tip. That's the 90 degree mark where the nose should be aimed when we're upright after the roll.

Pick another point to the left, mid way between the nose and the wingtip. That's where the nose should be pointed when we're inverted half way through the roll.

Bank to the left as if starting a turn but use much more left rudder to get the nose skidding. Forget everything your instructor taught you about coordinated flight!

How fast do we roll and how fast do we circle? The first time I tried a Roller I used full aileron and couldn't move the elevator and rudder fast enough to track the circle. That resulted in about 17 rolls in a quarter circle. The answer lies in practice, lots of practice.

Halfway to the inverted aiming point we should be in knife edge flight, wings vertical. Substantial back stick keeps the nose going around the circle. Substantial right rudder is required to force the nose above the horizon. The combination of engine thrust and lift from the inclined fuselage is preventing the loss of altitude.

In the vicinity of inverted, much forward stick is required to get enough negative angle of attack for the wings to maintain altitude. Full right rudder, as perceived from the cockpit, is required to skid the nose left, as perceived from the ground. We're continuing to hold left aileron to maintain the roll. Does this feel like an unnatural act yet?

It's a real challenge to keep the ailerons in a set position while moving the elevator and rudder from stop to stop, particularly while your body is being tossed every which way. It's only too easy to get so fixated on making the nose circle that the roll is inadvertently stopped.

At knife edge again, with left wing up and right wing down, opposite to last time, we should be halfway between our two checkpoints. A really hard push on the stick is necessary to keep the nose circling. The plane arcs belly first through the sky. Now the rudder is way over to the left, keeping the nose up to maintain height.

Approaching the end of the first roll and quarter circle, we're once again using left rudder to skid the nose and holding back pressure to fly level. Meanwhile we're picking the next two aiming points so we can flow into the second roll and quarter circle without interruption.

One quarter down, three to go. This is one of the most time-consuming figures in competition - it seems to take forever! Now do you understand why those limbs were flailing?

The Roller I find the most challenging is three rolls in a full circle, entering and exiting inverted. In this variation the tough part is, while upside down, picking reference points at precisely 60 and 120 degrees, angles virtually impossible to eyeball.

The Roller in Competition

The Roller is rarely seen in recreational aerobatics and is not often performed at airshows. It does however appear at least once in every sequence flown at the advanced level in aerobatic competition.

To do a good Roller requires a sense of the rates of rolling and circling which harmonize as well as the coordination to pull it all off precisely. Also mandatory is the situational awareness to do all this while fighting the wind to stay centered in the 3,300 foot square box in front of the judges!

The availability of visual references, aligned with the box, is a critical factor. Ideally they should be readily obvious, since they must be picked up quickly while the airplane is moving rapidly about all three axes.

The New England Aerobatic Championships are notorious for the lack of such references. Many of the aerobatic box markers are missing and the rolling green terrain is too homogenous to be useful.

Fortunately runway 14-32 is parallel to one edge of the aerobatic box. Unfortunately, two other runways, roughly the same appearance as the friendly one, are set at random angles to the axes of the box. These vicious red herrings lie waiting to devour the unwary contestant.

Once upon a time, in the middle of a Roller, I was coming back around to inverted when I took a bead on the wrong runway and thought I was way behind in the circle. That triggered flatulence of the cerebrum, in the vernacular, a brain fart, which made me tromp on a rudder to hurry the nose along to where I mistakenly thought it should be.

The result was a half snap roll into a spin, at 800 feet above ground. Happily, recovery from the mess was intuitive and instant. Unhappily the episode was of course witnessed by the judges, who were unanimous in their zeros. Even more unhappily, it was also witnessed by my fellow competitors, who christened this newly invented figure "The Quickmire Rolling Snapper Spin".

The Why Of It

Why people would expose themselves to such travails is perhaps another strange and unexpected behaviour! Sir Edmund Hillary's "Because it's there!" doesn't quite capture the essence of this one though.

An expertly executed Rolling Circle is one of the most graceful, flowing manoeuvres you'll ever see. It's considered by many cognoscenti to be the most intricate, demanding figure to perform. If you're the maestro at the stick and rudder, you're realizing about as much satisfaction as aviation has to offer!