AVIATION QUARTERLY

Room To Manoeuvre

by Bryan Quickmire

Of Avalanches And Humpties

Avalanche. What happens when snow falls off a mountain?

Humpty Bump. What happens when an egg falls off a wall?

No! Here's a clue: Goldfish.

Here's another: Shark's Tooth.

Give up?

Aerobatics! They're all aerobatic manoeuvres. At a competition, common English words can be Greek to the uninitiated!

In advanced aerobatics, in addition to interesting names, we encounter some interesting and perhaps unexpected aircraft behaviors in dark corners of the envelope.

Here the book value for stall speed is virtually irrelevant. The airplane will fly unstalled at half that number or stall at two times it. We can experience positive Gs while upside down and negative Gs while rightside up! Eyeball-jarring rates of roll can be achieved - without using the ailerons. And if that isn't enough, a push on the stick may swing the nose rapidly to the left!

Let's see how the Avalanche and Humpty Bump appear to defy the normal principles of flight!

The Avalanche

The Avalanche consists of a loop with a snap roll at the top. The challenge is to fly a perfectly round loop and while upside-down interject a quite violent manoeuvre exactly at top dead centre.

The snap roll is an autorotational figure, like the spin. Unlike the spin it is entered from a speed close to cruise. A strong, smooth, very rapid application of back stick raises the nose extremely quickly. Before the flight path can change, the wings exceed the critical angle of attack and stall.

A fraction of a second after the pull is initiated, an equally forceful and rapid dose of full rudder is applied. This causes a pronounced yaw just as the wings enter the accelerated stall. One wing swings backwards and becomes more deeply stalled. The other swings forward and develops more lift.

The huge difference in lift across the entire wing area is vastly more powerful than any aileron deflection! The airplane snaps into a roll of dizzying speed. The sudden pitch change and almost instantaneous onslaught of the roll can be quite startling to the uninitiated!

Enough talking, let's try an Avalanche for ourselves! Put the throttle and prop levers full forward and push over to dive for speed.

Choosing an entry speed is a juggling act. Too little energy and instead of an Avalanche there'll be a half loop with a spin off the top! Alternatively, hitting the snap too fast may well break the crankshaft, engine mount or other useful component. We'll go in with 160.

Pull back to nail 5 Gs, tighter than a vanilla loop to conserve energy for the snap. As the airplane slows, gradually ease off back pressure to keep the radius of the loop constant. Head arched back, look for the horizon as the airplane passes vertical. We're playing the centrifugal force against the force of gravity, waiting until 15 degrees before coming level inverted.

Now! Stick way back, full right rudder! The nose moves sharply towards the earth, then to the side. Wham! A giant hand whacks the wing hard and around we go! The world blurs instantly. Release some back pressure to find the sweet spot where the least energy is lost.

As the airplane passes through upright there's a distinct sensation of sitting atop a bucking bronco! What a ride! The plane corkscrews along, tracing a ballistic trajectory, hopefully of the same radius as the loop.

When things happen this fast, the pilot has to initiate the recovery based more on an internal sense of timing than on sight cues. Only after many, many Avalanches does one learn when and where to look for a glimpse of the horizon unobstructed by the gyrating airplane. Just before completing 360 degrees of roll, intuition says: "Now!"

Full opposite rudder, stick forward of neutral! The yaw stops, the wings unstall and we pop out of the snap, as quickly as we entered. The airplane is inverted with wings level and the nose 15 degrees below the horizon, aligned with the plane of the loop.

It’s not time to relax yet! A gentle pull is required to get the airplane tracking down through the second half of the loop. As the nose drops through the vertical and starts coming back up to the horizon we’re continually increasing back pressure to keep the high speed fourth quarter the same radius as the first three. Pulling 5 Gs we return to level flight, at the same altitude as the start of the figure.

The Avalanche is very fuel intensive - it takes a lot of practice to get the hang of it. Once you do though, it’s extremely satisfying, especially when it scores well in front of judges!

The Humpty Bump

There are actually 32 different types of Humpty Bump! An uncomplicated one looks like the letter U upside-down. This Humpty starts from upright level flight with a pull up into a vertical climb which is capped with a half outside loop followed by a vertical dive and a pull out to level flight.

Let’s beam ourselves into the airplane as it reaches the peak of the vertical climb. We push on the stick and start curving through the half outside loop.

The prop now reveals its split personality. As the good Dr. Jekyll claws at the air to haul the airplane up and over, the gyroscopic Mr. Hyde shoves the nose forcefully to the left. The forces created by a six-foot prop whirling at 2700 rpm are enormous. As speed diminishes, even full right rudder may not have the authority to counteract this and it will be necessary to reduce the gyroscopic forces by slowing the pitch rate or backing off the throttle.

In the Avalanche, when we pulled the stick to start the snap, we were loaded up with positive Gs even though the airplane was inverted. Now the airplane is upright but the G loading is negative because of the push. The indicated airspeed is on its way from 40 to 30, about half the stall speed, yet there’s no buffeting, no sudden pitching of the nose, no wing drop! The wings are not stalled because the angle of attack is below the critical value.

We need a fine touch here. If the push is too timid the airplane runs out of steam before the outside loop is finished. If the push is too brutish the wings exceed the critical negative angle of attack and stall. In either event, the controls will be positioned to enter an inverted flat spin, so we’d best have the recovery technique down pat!

Once we pass the apogee and start accelerating downhill these strange effects diminish until in the vertical dive we’re back to a more normal flight regime.

Adventures In Wonderland

In this topsy-turvy world of tail slides and Lomcevaks airplanes even go backwards or perform impossible tumbling somersaults. Underlying this delightful nonsense in the land of Alice the Aerobat is a strong vein of sense.

The deeper we delve into aerobatics the more obvious it becomes that all those facts memorized in conventional training only apply to the tiny percentage of the flight envelope encountered during cross-country cruises.

Our seemingly arcane world is actually governed by sound principles of aerodynamics and physics. Understanding the theory and practice of these principles is essential to achieving true mastery of the airplane. The effort though is well worth it!