Mike Slack in Giles G202 ZK-NUT. Wayne Ormrod was flying the camera plane.

Timing is Everything

Most aerobatic manoeuvres require a degree of timing finesse in order to be carried out successfully. It's Grant Benns' focus for this issue as he continues his series. The subject: Square Loops.

Never a truer statement has been said - we can all relate to the expression 'timing is everything'.

The square loop is a prime example of getting the timing right. Whilst the name of this manoeuvre may sound like a contradiction in terms - "isn't a loop round?" - a loop can be flown 'square' and as such poses one of the bigger challenges in competition aerobatics. I'll share some mind-bending variations of a square loop later on, but in the meantime let's ponder the basics of this manoeuvre.

The basics

For a start, a square loop is a full loop in that there is 360 degrees of pitch involved; we finish in the same direction we started and there is no rolling component. I was about to say it is 'pull' manoeuvre, like a regular round loop, but that flat bit across the top actually needs a 'push', so figure on having a plane with some inverted capability and good seat belts.

Judging Criteria

As with every competition manoeuvre there are 'judging criteria' that must be observed in order to please the judges and maximise your score. Specifically:

- All four sides must be equal in length.
- The corners - which incidentally aren't flown as drawn (i.e. a 100 G right-angle turn!) must be flown with an equal radius.
- And just to make it interesting, each radius must look the same from the ground which means they must be corrected for wind.

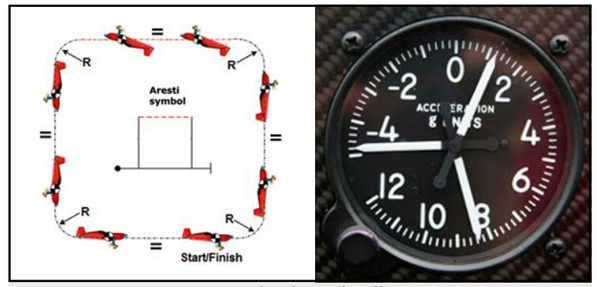
Wind correction

That last point sounds tricky, huh? What this means is that the pilot must adjust his/her stick inputs to vary the 'still-air' radius of the 1/4 loop so that each 'wind-adjusted' 1/4 loop looks both round and also the same size and shape of other 1/4 loops in the manoeuvre. Really?!

Well, in the ideal world, 'yes', but in the real world this is both incredibly difficult to achieve and also incredibly tricky to judge. This last point comes back to a basic limitation (human factor) which differentiates humans from computers - we have quite short and fallible memories. Without having some physical system of measuring the radius, the judge must rely on their somewhat poor memory of what happened 5 seconds ago (or more) to compare the current looping radius with the previous one (or two, or three). The same applies for the judgement of the length of the lines of the square loop. What you may see a judge doing is holding up a pen or piece of card (your sequence card) to mark the beginning of the manoeuvre and/or measure the length of the first line to determine the relative lengths of subsequent lines.

Ground flying

As you can now start to appreciate, the judge is actually in the best position to determine the correct lengths of the lines, which is unfortunate for the poor pilots, grunting and groaning through their manoeuvres, and trying to guess the right times to push or pull. I have watched model aircraft pilots who fly their aircraft in aerobatic competitions, who wonder how we – big plane pilots – cope with both the 'G' and in particular timing the piloting manoeuvres. Of course we can't see what we look like to the judges in real time, whereas the model aircraft pilot obviously can. Conversely, I marvel at how they can fly an aircraft through a sequence without having any inside perspective or seat-of-the-pants feel for the subtleties of flying, such as rudder-balance or G-buffet.



Just another day at the office.

Equal Radii

So back to the world of our poor 'real' pilot trying to judge the radius of the four corners of the square loop. As with a normal, full loop, the stick pressure will vary through the loop to maintain the same radius, although the stick position will be roughly the same throughout – except with the square loop each 1/4 is separated by straight lines, two of them vertical. Bugger. Sadly too, pilot's memories are shorter than judges, so practice and repetition must be carried out to lock in the muscle-memory to determine the correct stick positions. Now you just have to adjust that for the actual entry speed on the day, and consider the wind effect and you will have it nailed!

At some point you just have to accept that it is near-impossible to get each radius exactly the same, and hope that you can dazzle

Vertical in ZK-NUT

the judges with your prowess at getting the lines the same length, which brings me – finally – to my point about timing.

Speed and G

Consider you are flying the square loop in your very capable, advanced aerobatic mount – I shall use the Giles G202 as my example. Typical entry speeds for most upward manoeuvres including the square loop are 170-180 kts. Because the aerobatic 'box' you are competing within is quite small at just 1000 m long, wide and high, you have to 'pull' at least 5 G – and sometimes up to 8 G - to keep the overall loop small enough. From the aeroplane's point-of-view that's fine, as it is stressed to 10 G, has 240 hp and weighs about 1400 lbs fuelled-up with you and your parachute. From the pilot's point-of-view that's okay too – you are a practised, G-fit, finely-tuned machine (cue Top Gun music). To be honest, the 'G' just becomes background noise and a bit of a nuisance after a while - especially when things occasionally go a bit 'dark' (you temporarily lose your vision) – therefore you should have plenty of mental capacity available to focus on the subtleties of stick-pressure and looping radius. Yeah, right!

When to pull

So, picture you are zooming in straight-and-level for your square loop, at 180kts. You execute a perfectly curved ¼ loop and are now looking straight up, climbing vertically at about 10,000 feet per minute (briefly). How long do you wait to pull on to your back for the top of the loop? As logic would suggest, the line across the top of the square loop is going to be commenced at a speed much slower that 180 kts – think about 60kts, the slowest speed you will get to during the whole manoeuvre – so therefore this up-line doesn't have to last for very long at all, relatively. As well as the length of the line to consider, you will want to have some speed in hand to craft a ¼ loop of an equal radius to the first ¼ loop that you wrenched at 6 G, so perhaps you start the pull for the second ¼ loop at 120 kts, to be flying straight-and-level (but inverted) at around 60 kts. Now level inverted, with the fantastic power-to-weight ratio of the Giles you quickly accelerate to about 80 kts and commence another finely-judged ¼-loop to the vertical down-line. Nice. But now you have gravity helping you and that pumped-up Lycoming to accelerate, so the down-line will be of similar length of time to the first vertical up-line – can you remember back that far? – before the final big pull to horizontal flight. A quick check of the altimeter (same height that you started at – geez, you're good), a little buffet as you fly through your own wake-turbulence from the start of the manoeuvre, and you have finished the forth side to 'close' the square loop.

Vertical lines

Regarding the vertical lines, and this goes back to the judging criteria, they are flown on the zero-lift attitude of the aircraft, i.e. the wing is at zero degrees angle-of-attack, versus the horizontal lines that are flown in level flight, albeit at differing attitudes depending on the speed.

If you have made it this far with me, well done - it is quite hard describing and understanding in a thousand words *(actually you're nudging 1300, Ed.)* something the hands can convey in seconds. Such is flight.

Timing

By now you'll appreciate how this manoeuvre, more than most, relies on timing - and the measurement of time in your head - to achieve the equal length of the lines. Yes, you can use speed references as I have done above to decide when to commence various 'pulls', but this only comes from practise and, importantly, ground critiquing, to relate the visible length of the lines to another unit of measure that is usable in the cockpit. As with many aerobatic manoeuvres, using a mental metronome in your head, ticking away at a steady pace, to time the separate segments will help with your rhythm. For the square loop, it might sound like this:

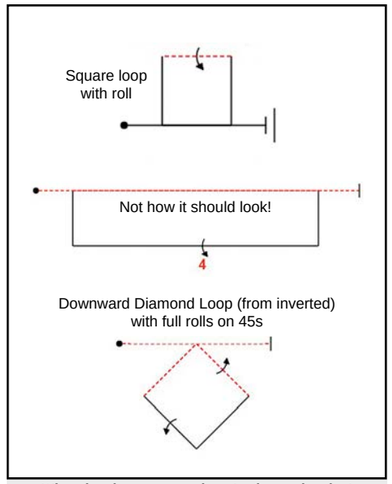
"Pull – one...two – Pull – one…two… three...four – Pull – one…two – Pull." (Add your own tick-tock noises).

Getting evil

After reading and digesting the above, how much more 'evil' can a square loop get? How about adding a roll across the top line? Obviously, you will need a fast rate-of-roll to achieve that, which most of the advanced/unlimited aircraft have.

How about a downward square loop? With a 4-point aileron roll across the bottom? I saw this flown by all of the Unlimited competitors at the Australian Nationals a couple of years ago. It was hideous to watch, but not from the point-of-view of physical discomfort – the time it took to fly the 4-point roll at the high speeds achieved after pulling out from the first vertical down-line meant the bottom line was about 2 km long. The results were more of a rectangle than a square and we lost sight of some competitors, into the heat/brown dust haze!

How about a downward diamond loop, with a couple of rolls thrown in? Truly evil !



When hard gets easy, there's always harder!

Footnote: These articles are intended to whet appetites for advanced flying and to offer tips to aerobatics beginners. Dual instruction and observance of CAA rules is a must-have - especially for safety and also for learning correct techniques and finesse of manoeuvres for the particular aircraft you are flying. For more information, enquire about aerobatics instruction at your local aero club or see www.aerobatics.co.nz