contributed by Grant Benns

Spinning Out

IN some aviation circles, the mention of spinning may bring on a cold sweat, dry mouth and trembling hands. Thoughts (or memories?) of an aircraft tumbling out of control towards the ground are conjured up. Hollywood has done a great job of perpetuating this image, complete with the increasingly loud whine of a piston engine howling towards self-destruction - despite the said aircraft often being a jet.

In the circles of highly practiced, steely-eyed competition aerobatic pilots (!), the spin is yet another symbol on the sequence card in which to demonstrate mastery of that untamed beast - the heavier-than-air flying machine. It is in fact a very predictable manoeuvre and one that can often score highly - as well as providing judges with a few conundrums on their interpretation of the judging criteria.

Predictable Spins

But to set the record straight on the above 'predictable' statement - not all aircraft are created equal when it comes to spinning. Certification rules require a Normal Category single-engine aircraft to be able to be recovered from a one-turn spin in one additional turn following initiation of the first control action for recovery, unless they can be proven to be 'spin-resistant'. Another sub-category for those that can do neither requires further mitigation… a parachute!

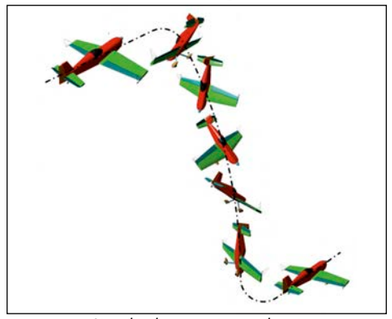
However just because the Normal Category aircraft has been tested to this standard doesn't mean it can now be intentionally spun - far from it! Unless it has been specifically approved for intentional spinning, in the flight manual, DON'T. And most certainly don't try it unless you are competent and trained, or receiving training from somebody who is competent and trained. People still die entering spins (normally unintentionally, but sometimes intentionally) in aircraft.

The rules for Aerobatic Category aircraft basically require a bigger rudder - after a six-turn spin the aircraft must be recovered after one-and-a-half turns. A six-turn spin (assuming the aircraft can be held in the spin that long (many can't) generates significant spin inertia and possibly airflow issues, hence the large and powerful rudder. For both categories, there are rules about differing configurations, weights, physiological effects on the pilot, etc.

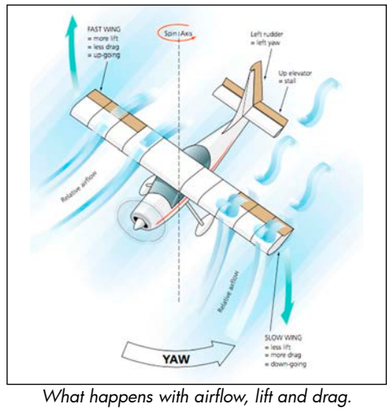
And it must be remembered that type-certified aircraft in both categories go through an extensive flight-testing regime to prove their abilities in spin recovery. The same cannot be said for experimental or special category aircraft, or for that matter any aircraft that has undergone extensive repairs or modifications - will they still spin 'to spec'? Add into the mix differing weights and the location of the centre-of-gravity for a given aircraft, each time you fly, and you can imagine that the word 'predictable' can become somewhat stretched. The aircraft flight manual is the best source document to discover the spin capabilities of an aircraft, including the recommended spin recovery action. This can subtly vary across aircraft types, and will have been learnt the hard way by a factory test pilot.

In display or competition flying, the predictability of the spin entry and exist is a 'must'. It must look good to impress the ice-cream lickers and/or judges. Predictability comes from understanding the basics, practice, knowing your plane, practice, and more practice!

Doug Brooker performing inverted flat spins for fun at the recent Tauranga Airshow.



Standard spin entry and exit.



What happens with airflow, lift and drag.

The Basics

From an aerodynamic point-of-view, an established and stable spin is a thing of beauty (IMHO!). All the various aerodynamic forces are balanced and the aircraft seemingly spirals downward, like a sycamore seed pod.

Getting the aircraft into such a state, and keeping it there, is a combination of design elements of the aircraft (out of your control) and placement of control (most definitely in your control). Removing the aircraft from the spin is the correctly ordered input of control deflections.

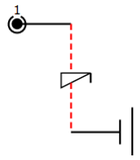
When considering a basic, garden, upright spin, the entry is commenced well before pulling back the throttle - are you high enough? If not, keep the throttle all the way in and keep climbing. Height is your friend, as even just a one-turn spin can lose you 1000 feet or more. Now with sufficient height, the entry can be made by closing the throttle and maintaining straight and level flight as the aircraft decelerates towards its 1g stall speed. Remember how drag increases significantly as you approach the stall? The last few seconds will require significant elevator deflection to maintain level flight. Now comes the difference between a normal stall recovery and the spin entry… rudder. By quickly but smoothly applying full rudder at the point of stall entry, a large yaw is induced which simultaneously slows one wing and speeds up the other. The localised airspeed and angle of attack of each section of each wing changes dramatically - one wing has now suffered a significant decrease in lift whilst the other one has had a sudden increase.

A 'roll couple' is produced and the aircraft rolls in the direction of the rudder input. By continuing to hold back on the stick, the speed is kept low and the angle of attack is kept high, sufficient for one and normally both wings to be kept beyond their critical/stall angle. In this high-drag situation, the airspeed does not increase and thus the relative angle-of-attack of each wing stays the same. The rudder is held in the full direction of the spin in order to counteract the natural force of the longitudinal stability of the aircraft to return the aircraft to straight flight. The higher drag of the slower wing (with the higher angle-of-attack) also produces a drag couple, which assists the rudder input in maintaining the yaw. All the forces will now be in balance and an 'auto-rotation' is underway - the aircraft will be 'spinning' downward at low speed.

Generally, recovery is made using the controls in the opposite and reverse order to the entry - unwinding what you have done. Full opposite rudder is applied to stop the yaw, and forward elevator is then applied to reduce the angle of attack and get the wings 'flying' again. Of-course, we don't want to keep descending, so power can now be added to regain straight-and-level flight at a reasonable airspeed.

That's the basic theory - there is much, much more than that if you are really interested. A few years ago an American chap by the name of Rich Stowell was bought to NZ, courtesy of Air NZ and in conjunction with the RNZAC and the NZ Aerobatic Club, to discuss spinning. At that point he had done 30,000 spins in over 100 different types, over a vertical distance of 1500nm! His talks were very illuminating, and if you got the chance to fly with him both his knowledge and manner were superb. He has produced a series of books and on-line tutorials on the subject of spinning, and if you want to explore the subject more his website is definitely worth a look - www.richstowell.com

Competition Spinning



The dark art of impressing the judges with your prowess of spinning involves both an understanding of the judging criteria for a competition spin, and presenting the aircraft throughout the manoeuvre in a manner which satisfies the criteria. As always, precision is the name of the game. Taken from the NZAC rules, judging criteria includes the following:

When the aircraft stalls, the nose will fall and at the same time the wing tip will drop in the direction of the spin. Failure to achieve this should be considered a 'forced entry'…

After completion of the prescribed number of turns, the aircraft must stop rotating precisely on the pre-stated heading, then a 90 degree down, wings-level attitude must be seen

Be alert for early stopping of the stalled autorotation followed by 'aileroning' to the pre-stated heading.

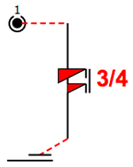
No account is to be taken of the pitch attitude of the aircraft during auto-rotation, as some aircraft spin in a nearly vertical pitch attitude while others spin quite flat in conventional spins. Speed of rotation is also not a judging criterion.

If the aircraft never stalls, it is apparent that it cannot spin. You will see 'simulated' spins where barrel rolls or flick rolls are offered as spin entries. In both cases, the flight path will not be downward.

Numerous points can be lost in the entry and exit - the entry must be clean, with a simultaneous departure in pitch, roll and yaw from straight-and-level (no sinking into the spin). Likewise the exit must be a simultaneous return to a 90 degree vertical down line, with no visible use of ailerons to achieve the desired stoppage of roll. Pleasing the judges and getting a good score is all about the correct and timely use of rudder and elevator.

The big difference between a training spin and a competition spin is achieving, albeit briefly, a vertical down line following the completion of the spin. From an up-right spin, this requires a 'push' to the vertical - not a particularly pleasant sensation for the uninitiated, but a requirement nonetheless. In aircraft without inverted systems, a loss of both fuel-and oil-pressure will likely occur, although this is only a momentary transient before a 'pull' back to level flight concludes the manoeuvre. The judges have a very keen eye for vertical lines!

Getting tricky



To mix things up, as the competitor moves into higher categories of competition, spins progress through additional quarter turns from one to two turns, e.g. a 1 1/4 turn spin, or a 1 1/2 turn spin. Used in this manner, the spin can be positioned in a sequence to turn the aircraft across the aerobatic box, or to change direction 180 degrees. Practice brings about judgement and precision in stopping the spin in the correct direction - you will be heavily penalised for being 'off-heading', including 'zeroing' the whole manoeuvre when you go beyond 45° off-heading.

At Advanced and Unlimited levels of competition, spins may be required to be commenced from the inverted attitude, creating a whole new series of sight-pictures and sensations. Surprisingly, many competitors prefer inverted spins to upright spins - the recovery involves a 'pull' to the vertical downline (as opposed to a 'push' as described above) and, with the rudder in a cleaner, undisturbed airflow, the recovery can be more precise... once you have figured out your orientation to the inverted scenery!

Setting Records

Spin record holder Spencer Suderman

On March 20th this year, American Spencer Suderman broke his own World Record for inverted spins. He did a 98-turn inverted spin! Using a Sunbird S1X (a Pitts-type aircraft with 260+ hp), he chronicled his 46 minute flight as such:

08:41 Takeoff from Yuma International Airport
09:15 24,000 feet
09:18:17 Roll to Inverted
09:18:22 Enter spin
09:20:47 5300feet, 82nd turn complete - Record Broken!
09:21:17 Begin recovery at 2,000 feet agl…98.5 turns complete!
09:21:24 Level flight at 1,200 feet
09:27 Land at Yuma International Airport/MCAS Yuma

By all accounts, Spencer's first words to his crew after landing were deemed unprintable!

When you study the numbers a bit more, you will note he took 34 minutes to climb to 24,000 feet - not bad for a stubby-winged, normally aspirated bi-plane. He then took just over 3 minutes to lose most of that height in the spin - almost 8000 feet per minute. Presumably with clear sinuses!

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 go to www.aerobatics.co.nz*

Alas, the weather didn't quite play ball for our annual event, held in 'sunny' Masterton. It did allow co-Contest Director Terry Johnson time to produce a 'light painting', captured in the remarkable image shown. A hardy 14 competitors stuck it out until a full day of flying took place on Saturday, March 19, under the watchful eye of our guest Chief Judge Jeremy Miller, from the Australian Aerobatic Club. As usual, a group of much-appreciated volunteers helped with various ground duties, and the support and hospitality of the Wairarapa and Ruahine Aero Club was superb. Results were as follows:

Primary - Ross Brodie (Robin 2160)
Sports - Overall - Murray Rogers (CT4/B)
- Unknown - Richard Collett (Robin 2160)
Intermediate - Overall - Morris Tull (Pitts S1S)
- Unknown - Fred Zayas (Lazer 230)
Best Newcomer - Richard Collett (Robin 2160)
Highest Unknown - Richard Collett (Robin 2160)
Most Improved - Ross Brodie (Robin 2160)
Champion of Champions - Morris Tull (Pitts S1S)