FlightFantastic Aerobatics

Unrecoverable Spins

When I took my first serious spin training with Randy Gagne some years ago I was a little uneasy with the idea that we were about to tempt fate by purposely putting the aircraft into spins that had claimed the lives of some very experienced pilots. We talked at length about Art Scholl's Pitts S2B accident that occurred during the filming the movie “Top Gun”. I really had a strong need to believe there was a specific reason why a very experienced pilot would not be able to recover the same model aircraft we were flying from a spin that we were about to commit. While the official record of this accident is not unambiguous, many believe that the placement of heavy camera equipment on the aircraft created a situation where the rate of rotation was too high for the rudder to sufficiently slow. Buying into this explanation allowed me to comfortably continue with my spin training. Multiple times over the years since that time, after hearing of yet another spin accident involving an experienced aerobatic pilot, I have had to reassure myself that there was always a reason. After all, we would really have to be nuts to continue doing what we do if we had real doubts that we could recover from any spin that we might find ourselves in. And yet, we see the term “unrecoverable spin” associated with pilots that, in some cases, have been flying Advanced or Unlimited competitions for years. My spin mentor, Randy, lost his life in an unrecovered spin a few years ago. I know for certain that Randy had an excellent understanding of spin recovery (his accident may have been due to mechanical or medical reasons).

I think it is safe to assume that not all spin accidents are due to mechanical or medical problems. Is there really some “mystery” mode of spinning out there, ready to smite the unlucky, or do we have a situation where pilots don’t always do what is necessary to recover? I’m forced to believe the latter.

Any spin has the potential for being labeled “unrecoverable” if the pilot allows it to continue to the point of ground contact. Certainly there are situations (i.e. spin entered at a low attitude, extreme aft CG, broken aircraft, pilot incapacitation) where there is no possibility of recovery. We have, however, lost a number of pilots to spins where there was sufficient altitude for recovery, the CG was OK, and the aircraft and pilot were not known to have problems. Should we all have some fear of these “unrecovered” spins? Some of us should!!

Aerobatic pilots that have not had a rigorous training in the many spin modes possible in an aircraft should have some fear of spins. There is nothing quite like the feeling of making a control input to stop an accidental spin and seeing the spin continue at an even faster rate. Most competition pilots have experienced the “brain lock” that can surface in the heat of a competition flight when something goes wrong. Typically, this condition is really only dangerous to the pilot’s score for the flight. A similar “brain lock” following a failed attempt at spin recovery can have far more serious consequences. Training and experience are the only viable preventative.

Trick Questions

Do our favorite aerobatic mounts have unrecoverable spin modes? Yes!…………and No!

Yes!

Any spin requires two things: yaw and critical angle of attack. Once in the spin, the most practical first step (after taking power to idle) for stopping the spin is to significantly reduce the rate of yaw (it's a complicated world so there are exceptions!). Attempts to reduce the angle of attack after a spin has started without first slowing the yaw rate will typically result in spin acceleration. If a pilot is to succeed in sufficiently slowing the yaw rate, the aircraft must have enough rudder authority to get the job done. Obviously the aircraft rudder must be physically large enough – that was the designer's job. Did the designer make the rudder large enough to handle every mode of spin the aircraft is capable of? Probably not. This means that there may be spin modes for a particular aircraft that are technically "unrecoverable" (at least not directly). As an example, the Pitts S2B often can not be recovered directly from either an accelerated or flat spin. In both cases the yaw rate will be faster than the normal spin and will therefore require more rudder to get the job done. In some cases, there is simply not enough rudder to slow the rate of yaw sufficiently to recover directly. In a flat spin the problem is much worse since, in addition to causing the spin to rotate faster, the flatter attitude may also cause the horizontal stabilizer and elevator to blank or shadow the rudder such that it will be even less effective. Make it a "flat, accelerated" spin and watch the world go around with the rudder apparently completely useless.

No!

Assuming the aircraft is in good condition and the CG is where it should be, there are clear piloting methods that can be used to recover from any spin that these aircraft can be subjected to. Since the limitation of rudder size (and in the case of a flat spin, rudder shadowing) may not allow accelerated or flat spins to be recovered directly, they should be converted to spins that can be reliably recovered. Thankfully, our aircraft maintain sufficient control authority during these spins to allow a trained pilot to convert the "unrecoverable" spins to "recoverable" spins before actually attempting the recovery. This process of conversion can be integrated with the actions required to stop the spin to reduce altitude loss.

How Much Knowledge is Enough?

Most CFI's get their "Spin Endorsement" after experiencing a one turn spin to the left and a one turn spin to the right. Clearly, an aerobatic pilot (arguably ANY pilot) should know far more about spins. Since a botched aerobatic maneuver can easily result in an upright or an inverted spin it seems clear that anyone wishing to commit aerobatics at ANY level should thoroughly understand those spins.

So, if a pilot becomes proficient in handling upright and inverted spins with and without acceleration and flattening, are there any other spin modes to worry about? Unfortunately, the answer is yes – and a couple of them can be deadly.

Bad Language

I find the accepted terminology used in most English language texts on spins to be confusing. I'm sure I am not the only pilot to read descriptions of spins and then have trouble visualizing the spin or hand flying it. I had this problem until I realized that the terminology itself was misleading me.

Snaps and spins are quite similar in nature. They are both auto-rotations that require yaw and angle of attack. Our terminology for snaps is (to me) quite clear. We talk about positive (or inside) snaps when referencing a snap that requires the pilot to pull the stick to achieve a positive angle of attack. Negative (or outside) snaps require the pilot to push the stick to achieve a negative angle of attack. We do NOT refer to upright snaps or inverted snaps since the characteristics of the snap have nothing to do with the aircraft attitude. When discussing spins, however, we refer to upright or inverted spins – even though aircraft attitude again has nothing to do with the characteristics of a spin. If we change the terminology convention for spins to match that used for snaps it is much easier to explain what is going on in some of the more interesting spins.

By this convention the major classification for spins would be (as in snaps) positive or negative (inside or outside). This classification identifies the true characteristics of the spin independent of aircraft attitude. The aircraft attitude then becomes a secondary classification for spins. Using this terminology, the current "upright spin" becomes a "positive, upright" spin. An "inverted spin" becomes a "negative, inverted" spin.

While cross-over spins have been eliminated from the CIVA catalog, they will never be eliminated from the list of spins pilots might find themselves accidentally executing. Our former "cross-over from upright" spin would be described as a "negative, upright" spin and the former "cross-over from inverted" would be described as a "positive, inverted" spin.

Control input required for recovery from a spin has nothing to do with aircraft attitude and everything to do with angle of attack. Aircraft attitude only impacts the view available to the pilot. Many of our texts on spins suggest that recovery decisions should be made solely by watching the yaw direction. This is fairly easy to do in 50% of the possible spin cases (those cases where angle of attack and attitude "agree" – positive, upright spins and negative, inverted spins). Attempting a recovery using the same decision process for the other 50% of spin cases (positive, inverted spins and negative, upright spins) may cause the spin to actually speed up!

In cross-over spins, the yaw direction is opposite of the roll direction and it can be very difficult to differentiate the two in the heat of reacting to an accidental spin. Granted, the 50% of spin cases where the documented recovery methods have a potential problem do not represent anywhere near 50% of the spins that happen "in the wild" but though they only represent a small percentage of likely accidental spins, we need to understand the recovery process for them.

I suspect we have lost some experienced aerobatic pilots to this class of spin.

Accidental Cross-over Spins

The 50% of spin cases that can cause a recovery decision problem are the various "Cross-over" spins (any spin where angle of attack and initial attitude do not match). I am very grateful that I started flying Advanced competition while the cross-over spin was a required unknown figure. The figure has recently been struck from the CIVA catalog after much confusion over the proper execution and grading for the figure. I think this action illustrates part of the problem we have with these spins: they are generally not well understood. I admit to flying them initially without a clear understanding of what was going on. Once I started thinking of the spins in the same way that I think of snaps, a clearer picture emerged. Being subjected to the cross-over as a requirement is what forced me to work with them long enough to have some understanding of them. Now that we don't allow them in unknowns for any category, I suspect fewer pilots will be working with them. That is, they won't be working with them on purpose. It is quite easy to execute a cross-over spin by accident.

If you have ever made a spin recovery input that seemed to (at least momentarily) accelerate the spin rather than slow it, you may have touched on a cross-over. A poorly executed recovery from a competition spin is one scenario that can easily lead to a cross-over. Practiced spins normally should not create a dangerous situation but we all make mistakes from time to time and this is one of those times that can create considerable danger.

How to make an Accidental Cross-over Spin

Working hard to prepare for a contest (or actually flying in a contest), it is pretty easy to get tired and less precise. Flying a practiced spin (lets make **it a 1 ¼ positive upright spin to the left**), most pilots get used to the specific timing that has proven to work for them and have a good feeling about when they need to apply anti-spin rudder prior to pushing the stick to stop on heading. A tired pilot is more likely to get a little mechanical in controlling the aircraft. If the rudder (in this case, right rudder) is pressed a little early or a bit more aggressively than usual, the left yaw may actually cancel early and then progress to a right yaw. If the pilot still attempts to stop the spin on heading with an aggressive push on the stick, a cross-over spin in the same direction as the original spin can easily result.

Pushing the stick changes the angle of attack. If the stick is pushed enough, the angle of attack will go from positive to negative (the difference between positive and negative angle of attack is only about 22 degrees in a Pitts) and the rudder input meant to stop the spin (right rudder) is just what is needed to continue the "left" spin with an outside angle of attack and right yaw. The aircraft may very well NOT move to an inverted attitude until it has rotated as much as another full turn. If the pilot attempts to stop the spin by reference to outside visual queues without recognizing that the yaw is opposite of the more visually apparent roll, the spin will further accelerate. Since most pilots will make their decision on what rudder to push very quickly after the spin starts, the attitude of the aircraft (still upright) will probably convince the pilot to press the wrong rudder (right since the nose is seen to be moving left) actually increasing the yaw. With the spin now rotating faster, the pilot may fear he is accelerating the spin by accident and pull the stick back. This will cause the spin to speed up even further (now it IS accelerated since this is a negative spin even though the aircraft happens to be in an upright attitude for the moment). If all of this is being done at competition altitude, the pilot will not have much time to sort out what is going on. This would not be a good time for "brain lock".

I can easily believe we may have lost aerobatic pilots to this scenario.

Yet Another Exciting Spin Mode

Flat spins are only one way you can create a situation where the rudder is made ineffective due to a shadowing or blanking effect caused by the horizontal stabilizer and elevator. When the condition is caused due to the spin being flat, it can be fixed by pulling power and aileroning into the spin to unflatten the spin.

It is also possible to get an aircraft to spin normally (not flat) but have the rudder blanked. The rudder will feel much the same as it does on the ground (pushing rudder just flaps it in a partial vacuum).

I had believed the Mueller-Beggs emergency spin recovery technique was bullet proof for the Pitts S2B. As a review (you already know Mueller-Beggs right?):

1. Power to idle
2. Hands off stick, feet off rudder
3. Push rudder first one way then the other and then hold the (working) rudder
4. Wait for yaw to be significantly reduced
5. Grab the stick and pull or push out as required

I still believe it is an excellent emergency recovery tool but I have modified it slightly after finding a case where it did not work in a Decathlon and in the Pitts S2B.

An "Unrecoverable" Decathlon Spin

I thought it was odd when I saw that the Pilot Operating Handbook for the Decathlon calls for stick first followed by rudder. Classical spin recovery dictates that rudder be used first to significantly reduce the yaw BEFORE the stick is pushed forward (assuming a positive spin here). Using the stick first WILL accelerate the spin – if it is accelerated too much there may not be enough rudder to slow the yaw sufficiently!

I may have inadvertently discovered why the POH dictates elevator first.

I had been teaching spins in a Decathlon using classical rudder first techniques without any problems for some time when I flew with a pilot that had been checked out in the Decathlon and wanted to fly front (command) seat. While our load and CG were well within limits, this did mean that we were flying with a more forward CG than previously flights. An attempted recovery from a one turn negative upright (cross-over) spin did not work – the spin continued without accelerating. Resorting to the Mueller-Beggs emergency spin recovery method, I was surprised to find that neither rudder had any pressure on it (the rudder was blanked). I pushed the stick forward while holding the rudder I thought should have worked and immediately was rewarded with pressure on the rudder and a slower yaw rate. Pushing the stick forward DID accelerate the rate of rotation but at the same time, it allowed enough air to reach the rudder to make it once again useful. I suspect that the Decathlon is CG sensitive to a spin condition that can result in blanked rudder. Perhaps the POH documented recovery technique of elevator first was an attempt to provide a single spin recovery method that should work in all conditions for the Decathlon.

An "Unrecoverable" Pitts S2B Spin

I like to use a zero G trim setting to help reduce the pushing forces required for negative maneuvers and make it easier to maintain the vertical without pressure on the stick. I wanted to try an experiment (up high!) to see how well the aircraft would track on the vertical line with this trim setting. I pulled vertical and released the stick. Sure enough, the aircraft continued up the line as expected. I decided to release all control inputs toward the top of the line just to see what the aircraft would want to do on its own. As expected, the aircraft went into a spin (positive, upright to the left in this case). I figured this was a good time to prove to myself, once again, that the Mueller-Beggs method always works in the S2B. When I got to the step for finding the rudder requiring the most pressure, I was surprised to find the rudder felt just about as it does while parked on the ground. As in the Decathlon spin previously discussed, I pushed the stick forward to get some air to the rudder and felt the rudder quickly bite solid air and stop the yaw.

Back on the ground, I was still puzzled by what had happened until I realized that, since the spin was entered from a vertical line up (no forward movement), the aircraft had zero forward velocity and was spinning around a vertical line. A spin entered normally from a level line by stalling the aircraft DOES have forward movement (decelerating) since the stall occurs when forward velocity is still some 60 MPH. Our spin from vertical, with no forward velocity, made it much more difficult to get some air moving over the rudder.

Unrecoverable Spins

The same characteristics should be found in a very well developed spin after all of the initial forward momentum has been bled off. Entering a spin from a poorly executed hammerhead is another good way to encounter this spin mode since most forward velocity will have been bled off in the vertical line. Spins from hammerheads are unfortunately quite common for beginning aerobatic pilots and I can think of several fatal accidents that were reported to result from spins entered from a hammerhead.

Modified Mueller-Beggs Emergency Spin Recovery Method

To cover the above cases I have modified the Mueller-Beggs method for myself as follows:

1. Power to idle
2. Hands off stick, feet off rudder
3. Push rudder first one way then the other and then hold the hard (working) rudder
4. If neither side has pressure (blanked rudder!!):
   a. Push the stick
   b. Push rudder first one way then the other and then hold the hard (working) rudder.
   c. If neither side has pressure (rudder is still blanked!!!):
      i. Pull the stick
      ii. Push rudder first one way then the other and then hold the hard (working) rudder.
      iii. If neither side has pressure (Plan B)
         1. Bailout!!
5. Wait for yaw to significantly slow
6. Grab the stick and pull or push out as required

An emergency recovery method is just that – for emergency use only. It will not result in the least altitude loss when compared to the application of exactly the right control inputs at exactly the right time but it will certainly recover a spin faster than random control movements from a confused pilot. Pilots that are drilled in the method can fall back on it anytime they feel confusion setting in after a failed attempt at spin recovery. Since we can not always sense whether the aircraft is at a positive or negative angle of attack and are therefore subject to possibly making the wrong control inputs when the sight picture presented does not tell the whole story, it is a good idea to have something like Mueller-Beggs as a backup. Remember that the correct control inputs for stopping a spin with positive angle of attack will act to accelerate the spin if the wing should actually be at a negative angle of attack. The flip side is also true: The correct control inputs for stopping a spin with negative angle of attack will act to accelerate the spin if the wing should actually be at a positive angle of attack.

Wrap-up **Page 8 of 8**

This article has touched on some of the complexities of spin recovery. There is a lot more to it. The best insurance for any aerobatic pilot is a thorough understanding of all spin modes and recovery techniques.

Fly High!!

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