contributed by Grant Benns

# Good Aeros Gone Bad

**IT IS** very easy to be upbeat about the joy, freedom and fun of aerobatics, if this is your thing. It can also be easy to write off aerobatics as a dangerous pursuit... "why would you want to do that?" This later attitude, from both within the aviation community and in the mind of the general population, can come about from many influences, but most certainly when an aircraft doing aerobatics has an accident and it is broadcast via the media (or these days via YouTube etc.) the saneness of pilots carrying out 'death-defying' aerobatics is questioned. Having said that, any aviation incident or accident often gets far more column-inches than would seem fair compared to other events in society, maybe because aviation is such a visible and spectacular activity... we defy gravity! You may have friends and colleagues who tell you they love watching the aviation crash/disaster documentaries, despite having no other interest in aviation. Flying (and crashing while flying) seems to fascinate a large proportion of the population!

*A photo of the 'Shoreham Hunter' in happier times. The aircraft was destroyed in 2015 at a UK airshow in a tragic accident claiming 11 lives.*

Sadly, the occasional accident that does occur during an aerobatic routine often ends in tragedy - for the pilot and occasionally people on the ground. Ultimately, the ground is our biggest threat in aviation, being the place where a plane ultimately ends up when things go wrong.

But what can go wrong, and how?

### The way it is supposed to be

As humans, we are designed to work well with our heads up and our feet down - something to do with gravity. Most aircraft are the same, for various reasons. Mainly, the seats work better when fixed to the floor, but also engines have been designed for the oil to be in the bottom and the air in the top, as have fuel tanks. The distribution of loads and aerodynamic forces result in aircraft designs that typically function better 'right-way-up'.

But there is this fringe element of pilots that like mixing things up a little, tipping the plane and its occupant/s upside down, in various ways that we call aerobatic manoeuvres.

### The ground getting in the way

Some would argue that all aerobatic manoeuvres are bad, but I beg to differ! Some are uncomfortable and some are disconcerting, but with the exception of exceeding the design limits of the aircraft there are no aerobatic manoeuvres that should kill you. However, history will show (and history sadly repeats itself too often) that many people have been hurt or killed when aerobatic manoeuvres go bad - and all have that potential.

Having said that, straight and level has killed many people too, for example when a hill gets in the way.

Ultimately, it's as bad as things can get when you either a) hit the ground in your airplane, or b) hit the ground out of your airplane (it having already fallen to bits).

### Mechanical Failure

Starting with the last one first, planes fly to bits because they have exceeded their design limitations, or due to a mechanical failure. It would be easy to assume there will never be a mechanical failure, but the reality is that we must always have that possibility in the back of our mind - planes get old, damage occurs, fatigue can happen. Sometimes, a mechanical failure can occur from an earlier 'event', such as over-stressing the aircraft. Other times it can be just a gradual deterioration in the aircraft structure - this is particularly the case with wooden aircraft, but corrosion can severely affect the structural integrity of aluminium aircraft as well. Some failures will be random, such as many engine problems like a blown crankcase seal or magneto failure. In any case, regardless of whether you are flying acrobatically or not, do you have a contingency plan to cover this? Are you high enough, and/or fast enough to buy time to recover the situation. Sadly, in some aerobatic accidents, this has not been possible. The nature or design of some low-level displays has meant the pilot is totally relying on everything - everything! - working 100% to pull-off the display. A slight cough from the engine or a restriction in the flight controls and there is not enough height to safely recover. Was it the plane's fault?

A structural failure due to exceeding the design limits of the aircraft is quite possible too, for a variety of reasons. Most aerobatic aircraft have a design load of +6 'G' – i.e. the weakest part on the aircraft has been designed and proven to be capable of sustaining a force equal to six times its own weight, with at least a 150% safety factor. Some aerobatic aircraft are much stronger - typically 10 'G' for aircraft such as the Extra 300, MX2, and Giles G202. All aircraft have manoeuvring speed limits, known as Va, which allows for the structural loads imposed when moving the control surfaces. A combination of rolling and pitching results in a maximum 'Snap roll' speed, lower than Va. The aircraft's maximum speed, often set by the consideration of aerodynamic flutter but also other factors such as windscreen strength or aircraft structural loads, is quite easy to achieve in powerful and/or slick airframes. A poorly flown manoeuvre can result in many or any of the various design speeds and loads being exceeded and given sufficient force, even a (flying) brick can be destroyed.

### Flying into the ground

This isn't something you would knowingly do, so when it happens during aerobatics it would be fair to conclude the pilot had insufficient height to complete the manoeuvre, or to recover from a botched manoeuvre.

In the discussions that occur during training for low-level display flying, the term 'margins' comes up repeatedly, and it is a term that can be readily applied to all aspects of aerobatics, or indeed flying in general. A margin may be an excess of altitude to complete the manoeuvre, an excess of speed above the stall speed, or a margin of speed to commence the manoeuvre - most aerobatic accidents result from a deficit of one or more of those margins.

Not having enough height to complete the manoeuvre can come about from insufficient practice and therefore a poor understanding of the height required to complete the manoeuvre, or a flawed decision making process that resulted in making the decision to press on with a manoeuvre from a low level and hoping it will all work out okay. Hope is not a strategy!

Losing situational awareness is also a killer - not keeping an awareness of the entry height to safely complete a manoeuvre, or the height of the terrain below. A safe recovery requires sufficient height AGL (above ground level), not AMSL (above mean sea level).

Visual illusions can play a part in this - spatial orientation can be compromised over water or with an irregular horizon, such as above the level of the cloud base or in mountainous terrain. Getting 'busy' in the cockpit during a sequence, or wanting to please the audience, can distract you from monitoring your altitude.

Many experienced display pilots will note 'entry gates' - heights and speed - at various points in their low-level display sequence. The professional aviator will adhere to these gates religiously, or break-off to gain more height and energy. The novice trying such things should be a dot in the sky!

### Good manoeuvres that go bad

Every manoeuvre has the capability of going bad, even straight and level, as mentioned above. A hill can 'suddenly' jump out in front of you due to poor planning, situational awareness or risk-taking.

To give you an idea of just how some good manoeuvres can go bad, here is a far from exhaustive list.

- **Loops:**
  - start too slow... fall over the top, maybe into a spin
  - pull too little 'G' at the bottom... fall over the top, maybe into a spin (again!)
  - pull too hard going up... 'G' stall and wing drop
  - roll while pulling... end up in totally the wrong direction
  - not pull hard enough at the completion... overspeed and lose height
  - pull too hard during the completion... 'G' stall, wing drop, and lose height (again!)
- **Rolls:**
  - descending flight path... airspeed increasing, ground getting closer
- **Barrel Rolls:**
  - roll-rate too slow for pitch-rate... airspeed increasing and ground getting closer
- **Stall Turns:**
  - falling off the turnaround at the top... spin (upright or inverted!)
  - rudder too early... ugly
  - rudder too late... tail-slide, damage
- **Half Cubans:**
  - steep 45... overspeed, ground getting closer

- **Reverse Half Cubans:**
  - not enough height at start... killer
  - shallow 45... not enough height gained, overspeed, ground gets closer
- **Half-roll then half loop down:**
  - not height enough at start... killer
  - nose drops during the roll... over speed, ground getting closer
  - too fast at entry... overspeed, over-stress, ground getting really close
- **Half loop up then half roll:**
  - pull too little 'G'... too slow for the roll, stall/spin
  - roll with nose too high... decaying airspeed, stall/spin

These are just some of the more typical scenarios that can happen, and have been observed! Notice how many of them result in an overspeed, often followed by the ground getting bigger - you can imagine this situation is ripe for an over-stress of the airframe, or worse - a total structural failure.

Also, notice how many can result in stall/spin. Are you current with spinning, in different modes such an inverted or accelerated? Fortunately, most training aircraft struggle to achieve these last two modes for very long, but the more exotic and powerful aircraft love them!

**Recovery**

Prevention is better than the cure, although in some cases the cure can be fun too, i.e. spin recovery, so get current with spinning.

Prevention starts with training, followed up by regular practice. You will not see any of the regular airshow performers unintentionally falling out of manoeuvres. In the rare case of an airshow accident it will most often be a case of disorientation and/or a bad decision made to press-on with margins in deficit.

Many of the botched aerobatic manoeuvres mentioned above result in high angle of attack scenarios, so consequently getting instruction and familiarity with high angle-of-attack manoeuvring is vital. And high speed recoveries require some delicate but positive control inputs to minimise height loss and airframe stress.

Suffice to say, whether it be low speed, high speed, or spin recoveries, altitude is your friend - not too many people have got into trouble by being too high!

*__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*

# Planes of the NZ Aerobatic Club

## Zlin Z50LS


**ANOTHER** one-of-type on the NZ register, this aircraft was imported in 2005 by David Cranna, who is a rather tall guy and struggled fitting into the Pitts S2B of the time. Fortunately, the Zlin Z50 has generous seating adjustments and good canopy clearance.

Also fortunate is the relative affordability of this very capable aircraft, partly due to the fact they are from the Czech Republic but also due to the passage of time and newer designs coming along that are more capable at the highest levels of the sport.

Originally designed in 1973 with a 260 hp Lycoming and designated the Z50L, the more prolific (34 built!) Z50LS came along in 1982 with the 300hp Lycoming fitted for better vertical manoeuvres. Construction is a beautifully built aluminium monocoque, and it is surprisingly light for a reasonably large aerobatic plane that is stressed to +9/-6 'g'.

During the late '70s and early '80s the design had good success for the mainly Eastern-bloc pilots who flew it - the type won the 1978, 1984 and 1986 World Aerobatic Championships. About that time, the Russians upgraded their designs with aircraft such as the Sukhoi SU26, which became the plane to beat, and the Zlin faded from the world scene, at least at the top level. However, it is still a very capable performer and continues to compete in Advanced and Intermediate competition.

With a relatively large wing and a big Hoffman composite propeller, the aircraft is particularly good at low-speed gyroscopic manoeuvres (tumbles), something David shows to great effect in his displays.



**Competition Aerobatics Events Calendar 2016**

| February 23-28 | March 16-19 |
|---|---|
| Flying NZ Nationals | NZ Aerobatic Club Nationals |
| Mid Canterbury Aero Club, Ashburton | Hood Aerodrome, Masterton |

For more details check out the events page at: **www.aerobatics.co.nz**