The Art of Aerobatics

by Brian Green

Back when we used to build our own models the mantra was, “build it straight, build it true. That was the past, now the majority buy their models ready to go, where the building accuracy is determined by the manufacturer.

That is one reason why competitive ARF aerobatic models are more expensive. It takes time and careful workmanship to build an extremely accurate model, time that we pay for. Another reason is that royalties are paid to the designer, usually a high profile aerobatic competitor.

You’ve bought the model, installed the gear, now we have to get it to perform. Flight trimming is simply to get the model to respond accurately to each control. For example, aileron input should cause only a roll, no yawing or pitching. Rudder should cause only yawing, nothing else. And so on. Sounds simple enough, but if it were only so!

In the previous colum we mentioned the position of the centre of gravity and its relationship to elevator sensitivity. Whether you buy it or build it, that is something you can alter.

Think of it a system of levers, like a see saw. The centre of lift is the pivot point and the CG sits closest to it while the elevator is a long way out on the beam. Move the CG further out on the beam and you need more elevator power to compensate.
A typical indication of a very forward CG and this applies to all model types is, the inability to slow the model down on a landing approach. Stick some small bits of plasticine, one at a time, at the tail to move the CG back and just see how it goes.

As the CG moves aft the elevator sensitivity will increase. Of course if you get the CG too far back, the model will be unstable in pitch. If that happens you will have an exciting time.

The maximum elevator throw is that required to initiate a spin entry. This amount may make the model harder to accurately fly straight and level. It really depends on the model’s design. If that is the problem there are two ways to handle it.
One is to use dual rates, high rate for spins, low rate elsewhere. The other is exponential curve setting, soft around centre and steeper towards the extremes of travel. The problem with this method is that a knee can occur in the curve, which will make elevator inputs around this knee extremely sensitive.

Another way to solve this, although it does require some work is to use dual rates and expo on both rate settings. By careful adjustment of the high rate expo curve one can get it to match the low rate expo curve in the travel areas used for the other manoeuvers. Flick into high rate as you fly in for the spin entry and the level flight elevator response will be no different from that when in low rate.

ELEVATOR TRIMMING

Fly straight and level, easy enough, but is it straight and level? We tend to fly with the inner wing lower, with the wing plane aligned with our line of sight. Wrong, you should be able to see the underside of the inner wing.

Starting a loop with the inner wing low, without any other control input, (aileron and/or rudder) means that the top of the loop will be much closer than the bottom. In other words, the loop will not be vertical.
There are two factors that govern the diameter of the loop, the model’s weight and the motive power. Once it was IC engine power, now one can add to that one, electric motor power. Power to overcome the model’s aerodynamic drag, plus lift the model’s weight on the upward path.
Too large a loop for the model’s power and the flight path will become unstable across the top, too small a loop and it will appear rushed due to the higher airspeed. Like most things in aerobatics, it’s a balancing act.

If you fly a loop from the left and then from the right and the model tilts in towards you during both loops, it’s a safe bet that you are flying with the inner wing low.
If however, you complete a loop that is in a vertical plane, no left right deviation in the flight path and fully circular, stop flying immediately and go buy a lottery ticket, you’re sure to win.

The circularity of a loop is governed by the amount of elevator applied, coupled with the power from the engine/motor.
(Engines are Internal Combustion, IC, motors are electric) For the same amount of power the model will slow as it goes up,

Just one way to move the CG back.
International competitor at the Wangaratta World Championships 1991. They are Aussie 50C coins.
For a CG further back would you use a dollar note?

The mixing capabilities of the modern radio can help iron out small in flight defects.

gain speed across the top and really gather speed on the way down.
As the airspeed changes so does the force applied by a constant elevator setting. So its easy right, more elevator as the model slows, less as it gains speed.

Of course we forgot about the wind, hopefully blowing down the flying line. Add in the power and elevator adjustments to compensate for yet another influence on the model's flight path.
So when you think your loops are circular, how do you really know? Ask three judges, the first may say, I thought is was a bit tall, the second, I reckon it was pretty good and the third, it appeared to me to be too wide. When that happens, you finally realise you will never get it any better.

All that's needed now is do multiple loops with every one identical.
NO PROBLEM, right!

Full rolls and part rolls make up a large percentage of aerobatic flight and a slow roll that is as straight as a line with a constant slow roll rate is a very inspiring manouevre. But first we need to get the more normal faster rolls looking good. The model's roll rate needs to be set to one that will give you time to input the required elevator response but fast enough that the model does not spend to long on its side. Then you do not have to worry about any rudder input to keep the nose up.

We will leave that until slow and point rolls are covered. The roll rate is set with the aileron stick held at its limit and the aileron travel adjusted at the servo/aileron horns to give the desired rate, typically about one point five seconds per roll.
We can cheat a bit here by using the servo

The first ever Australian entry at an aerobatic World Championships, the 7th in 1971. Our Author with his Dragonfli, OS 61 loop scavenged two stroke engine, 11x7 prop, Multicon electric retracts and Kraft six channel 27MhZ radio.
Sixty inch span, five kilos with 1.1 horsepower available. Same weight but a third of the power of current designs. And a lot less wing area.

Taken after the team selection in Canberra for the 89 W/C at Chesapeake USA. They finished, Chris White 28th, Eddie Edwards, 26th and Peter Goldsmith 16. Highest team place 7th, since the 9th place in 1977 by team members Tom Prosser, Jeff Tracey and Brian Green.

Not all International competitions are World Championships. Pictured here in China in 1988 were, Hans Litjens, Greg McConnell, Eddie Edwards, kneeling in the front were , David McFarlane, Brian Green and Garry Stewart. We cleaned up in that one.

The Art of Aerobatics

Circa 2010. The electric powered Beryl. This modern two metre FAI aerobatic model weighs just under five kg and has more power than you could imagine. The design requires minimal mixing and this makes it easier to achieve greater accuracy.

You really don't need one of those fancy F3A machines to do aerobatics. If size is your thing, something like Anthony's hanger 9 Extra 260 could be the go.

It doesn't have to be big either because any model will loop and roll just like this 1,350mm span Extra.

travel function in the modern computer transmitter to initially set up the roll rate. Once that is done, the aileron travel can be measured and the mechanical linkages adjusted to give the same amount with the transmitter reset to one hundred per cent.

It is easy enough to leave the servo travel at the transmitter setting but doing so will lessen the resolution of the control system. For example, reducing the transmitter value to fifty percent, simply means that there are now only fifty servo steps from centre to full, compared to the one hundred.

The other factor in performing axial rolls is aileron differential travel, where one aileron travels more than the other. Typically used on non symmetrical wing sections with the up going aileron travelling the greatest.

The reason is that the down going aileron created more wing drag then the up going one. To check simply place the model in a climb while looking up its back side. Move only the aileron stick to full and see if the model yaws off the line. If it does then aileron differential is needed.

We are out of space now so slow and point rolls next time. Keep on looping and rolling!