



Rolling, Rolls and Rollers

CONTINUING the theme of earlier articles in this series, this time around we shall explore another basic manoeuvre fundamental to aerobatics called the Aileron Roll, sometimes called the stick-roll in other parts of the world or a slow-roll, even though it may be done at 400°/second.

When you consider the origins of fixed-wing flight, at some point one of the early pioneers must have realised that just going in a straight line would be fairly limiting, and also require a huge amount of fuel to get back to where you started. Along these lines, anybody who has seen Dick Rutan talk of his epic, non-stop, around-the-world flight in Voyager will recall him talking to his designer-brother, Burt Rutan, about the abysmal rolling characteristics of the aircraft - Burt's retort being "Dick, it's a world-flight... it doesn't have to turn at all".

Some early flying machines, such as the Wright Flyer, utilised 'wing-warping' - a good idea at the time, copied from nature, however this would become structurally challenging on larger and faster aircraft, and ultimately did not provide the required roll control that another invention - the aileron - could produce.

Another early invention that came about from observing the further effects of utilising ailerons - adverse yaw - was the rudder. As an aside, have you ever seen a bird with a rudder? Natural evolution still beats all of mankind's best efforts, although perhaps we are slowly catching up with aircraft like the B2 bomber.

Of-course, you don't have to 'roll' to 'turn', but rudder-only turns can be mighty uncomfortable and, at low-speed, actually quite dangerous. Don't try this yourself unless you are in an aerobatic aircraft with lots of height, but the effect of a skidding turn with speed decaying towards the stall will lead to a spectacular uncommanded roll, with resultant height loss...

So, thus armed with ailerons, a rudder and elevator, we are taught early-on in our flying training the art of turning - roll with aileron



The passenger's view from an L-39 Albatros cockpit.

to the desired bank-angle, balance with rudder and maintain the desired vertical profile with elevator. With practice, this becomes second nature.

At some point, early on in the piece, some bright (or not-so-bright) spark kept his airplane rolling, beyond what was required to change direction, until the wings were level again - yet the plane hadn't changed direction at all, and thus was born the aileron roll. Thank-you, bright/dim spark!

In considering the flight path of an aircraft carrying out manoeuvres, and especially aerobatic manoeuvres, mention is often made of distilling the entire bulk of the aircraft into just one little dot, acting though the aircraft's centre of gravity. When viewed from the ground, either by spectators or competition judges, many manoeuvres are prescribed by the movement of this imaginary dot rather than the attitude of the larger aircraft around it. An aileron roll is such a manoeuvre. In the world of competition aerobatics, during any aileron roll this dot must prescribe a straight line whilst the aircraft is rolling.

As alluded to above, a movement of a particular control surface will often produce a secondary effect such that motion in one axis often produces motion in another axis - for example, the further effect of roll is pitch, the further effect of yaw is roll etc. A pure, roll-only rotation of the aircraft around its longitudinal axis is very hard to produce, although watching a high-speed aircraft such as a jet fighter (an A4 Skyhawk best comes to mind) looks as close to perfection as I can recall. Modern aerobatic monoplanes such as the Extra MX, Edge and Giles can also do a reasonably good job of this, assisted by full-span ailerons. However, most low-speed aerobatic aircraft, and particularly trainers like the Robin, Cessna 152A, Tiger Moth, Chipmunk, and Yak 52, etc. produce a roll which, from the outside, has a combination of differing pitch and yaw movements and quite often the flight path of the 'dot' moves

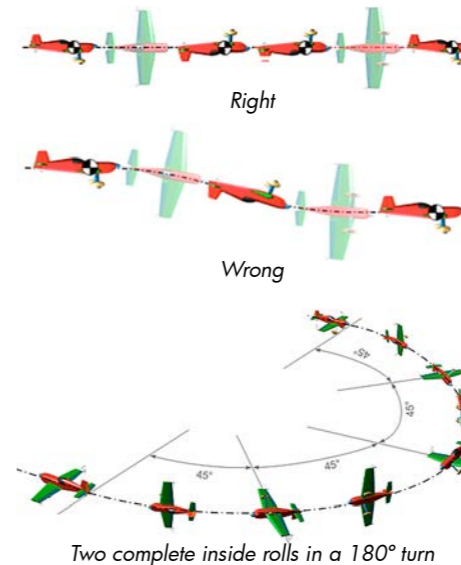
up and down somewhat. The slower the aircraft, and the slower the roll-rate, the greater the control inputs must be in all axes to keep the aircraft rolling in a manner that minimises movement of the 'dot'. To watch an aircraft like a Cessna 152 Aerobat carry out a perfect aileron roll is to marvel at the skill of the pilot, much more so than in a high-speed, dedicated aerobatic aircraft.

As per our earlier discussion on loops, rolls can be either 'passenger rolls', i.e. comfortable for the passenger but pretty ugly when viewed from outside, or 'competition rolls', which hopefully look great but can feel pretty odd from the inside. Why? Consider the control deflections required to achieve the result of the 'dot' staying level - the easiest way to talk about this is to break the roll into quarters (although in reality the whole roll is a continuous blend of control inputs):

1st Quarter

You initiate the roll with left aileron (let's assume a left roll from this point) and a smidgen of up elevator to counter the nose dropping with roll, but as you don't want to turn you must start to progressively feed in right rudder and ease off the elevator. Your reference point is a spot in the distance, just above the horizon, so keep that nailed front and centre. At the end of the first quarter you will have quite a bit of

right rudder, to keep the nose up, but no elevator - any elevator will tend to pull the nose further left.



2nd Quarter

The aileron position shouldn't change throughout the manoeuvre, so the stick should be hard left throughout to maintain the roll. You now start landing out the rudder but increasing the forward stick until you reach the wings-level inverted position... half-way there! Depending on the aircraft, this may be quite some way forward - trainers designed for upright cruising need a high inverted attitude to maintain straight-and-level when inverted. This is also the bit when you are at -1G and hanging in your belts - beware falling objects and a years worth of dust and grass. At the completion of the second quarter the rudder should be reasonably neutral to maintain the direction of the aircraft towards the reference point ahead.

3rd Quarter

Same as the first, but from inverted - start feeding in rudder and easing off elevator in order to switch their rolls again by the end of this quarter. Because the aircraft has been slowing throughout the manoeuvre due to the drag associated with cross-controls, you will need bigger rudder inputs this time, lest you start sliding into a knife-edge descent!

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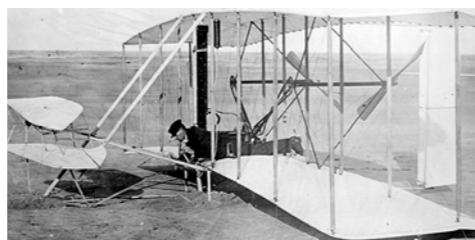
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A rate of roll measured with a calendar: The Rutan Voyager.



Some early flying machines utilised wing warping, copied from nature, but without the roll control of the later ailerons or yaw control of a rudder, which birds manage quite well without. At right, the B2 Bomber.





contributed by Ruth Allanson

Competition Aerobatics Events Calendar 2015

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

- October 31**
Flying NZ Central Region Competitions,
Taumarunui Aero Club
- November 7**
Flying NZ Alpine Region Competitions,
Mid Canterbury Aero Club, Ashburton
- November 14**
Flying NZ Lakes Region Competitions,
Venue to be confirmed
- November 21**
Flying NZ Cook Strait Region Competitions,
Wanganui Aero Club
- November 13-15**
Pitts 70th Anniversary Fly-in & Competitions,
Omaka Airfield
- November 21**
Brian Langley Memorial Trophy,
North Shore Airfield
- November 28**
Flying NZ Northern Region Competitions,
North Shore Aero Club
- February 23-28**
Flying NZ Nationals,
Mid Canterbury Aero Club, Ashburton
- March 16-19**
NZ Aerobatic Club National Championships,
Hood Aerodrome Masterton

4th Quarter

The ugly quarter - this is where things can go pear-shaped. You may have lost 20 knots by now - a good reason to start the manoeuvre with speed - so the co-ordination of the controls is very important; the size of the control inputs needs to be big enough to keep the nose up and the 'dot' flying level. The common mistake is to transfer the job of keeping the nose up from the rudder to the elevator too early - the result will be a sink (from the nose dropping) and yaw (from the elevator pulling the nose off-line) which judges often refer to as 'scalloping' the finish. It feels ugly and looks worse. At the completion of the roll, you will need a higher nose attitude to maintain level flight - the judges are looking for the level flight path of your 'dot', not your nose attitude - so don't be tempted to plonk the nose back in the same place you started - you are probably 30 knots slower than when you started.

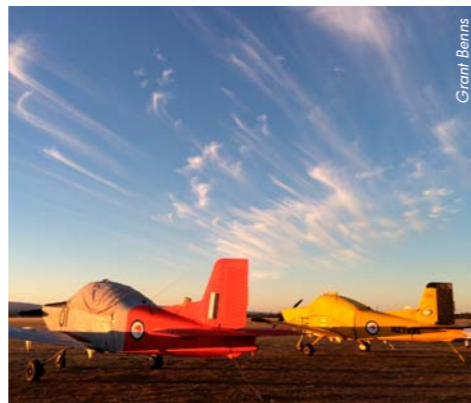
The above sequence is for the geometrically 'perfect' competition roll. The 'passenger' roll is, in-reality, more of a barrel-roll, which is a whole other subject, but essentially uses more back-elevator and balanced rudder to keep everybody in their seats and the dust on the floor. You won't score high marks for this one, unless your 'judge' is sitting beside you.

The versatility of aileron roll is huge, and the variations countless. They progress through rolls on different lines - vertically up/down and on 45° lines - as well as hesitation/point rolls and ultimately 'The Roller'. Not the car, but this is turning the aircraft whilst continuously rolling, sometimes in the direction of turn, sometimes away from the direction of turn and sometimes an alternating combination of both. From the ground, the rolling circle defies aerodynamics and common sense, but they are actually not too difficult to do (averagely) and great fun - kind of like taking a ride in a tumble drier!

As with all the advice I have dispensed - don't try this at home kids, until you can track down the right instructor with the right (aerobatic) aeroplane.

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: CT/4 Airtrainer



Grant Benns

DGY and JMV at the 2015 Nationals - Masterton

MOST people associate the CT/4 Airtrainer with our Air Force, where it was a great aerobatic training aircraft for many years. Fortunately, the Airtrainer has become available in the private market subsequent to their disposal from Air Force service and we regularly see one or two at NZ Aerobatic Club and FlyingNZ events. Murray Rogers of Tauranga is quite possibly the most precise aerobatic flyer of the CT/4 anywhere in the world, on the basis of his numerous trophies gained over many years flying his ex-RNZAF CT/4B. Murray has taken his plane all the way through to Intermediate-category success on many occasions, against vastly more capable aircraft, which says much about Murray's prowess, skill and commitment to quality practice time.

Whilst in need of a few more horsepower (remedied somewhat by the 300hp 'E' model), and a few less pounds, the CT/4B has a handy roll rate and great visibility. It sounds great too - rule number 2, after rule 1 (aerobatic planes must look cool) - courtesy of its 210hp Continental IO-360 engine. Another regular attendee is the NZ Warbirds CT/4B 'DGY', notable and historic as the prototype of the CT/4 family, famously flown from NZ to the Paris Airshow in 1975. Syndicate owned with a low share price and reasonable operating costs, DGY is a great aircraft in which to commence aerobatic training utilising experienced and knowledgeable Warbirds instructors.

Places to Go: Lake Station - St. Arnaud

Saint Arnaud (previously known as Rotoiti until 1921) is a small alpine village located in the north of the South Island, west of the mountains of the St. Arnaud Range and 90 km southwest of Nelson, near the historic Tophouse Settlement. It is situated at the northern end of Lake Rotoiti providing services for skiers, trampers and tourists, found on State Highway 63 between Murchison and Blenheim.

Tophouse is named after a hotel, which was established in the 19th century to house drovers moving sheep between Canterbury and Marlborough. The first drovers established a house on a terrace above the Wairau River, named Top House, as it was higher and further inland than any other. By 1856 the place was used as accommodation for other folk driving their sheep from Nelson or up from North Canterbury. In 1859 another gentleman, Adolf Wiesenhavren built a hotel of the same name, on the south side of the road which still stands today as the historic hotel.

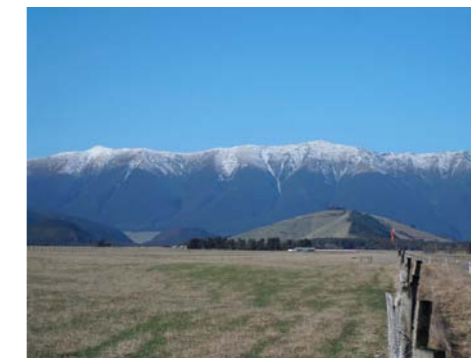
Pre European times, the Tophouse pass was an important Maori escape route from the rest of the South Island and for the Europeans it became the main route to the Wairau valley and the lakes district. In 1876 a telegraph station was built not far from the hotel, which provided a link to the Wairau and Buller area and wasn't decommissioned until the 1930s.

The hotel became run down and was rebuilt with cob, and in 1894 there was a double murder and suicide involving a jealous response to a rejected courtship with the local school teacher. Those staying at the historic hotel today can still search for bullet holes in the veranda roof.

Entering the area, the first thing that is noticeable is the scrubby alpine vegetation, due to the elevation of 2631 feet.

The easy way to get there is of course to plan a flying weekend to land at NZLE, Lake Station. This long grass gliding field is situated alongside SH63 and is 8 kms west of St. Arnaud. The Nelson Lakes Gliding Club flies from here most Saturdays so even though the field is well outside traffic near the NS control zone, a good look out for gliding activity is a wise idea when flying in the vicinity.

When arriving during the winter months you may like to bring your ski gear and tramping boots. Rainbow ski field is open from mid July to mid October, a little later in the season than other NZ ski fields. It boasts over 50% intermediate terrain and is only 35 minutes away from accommodation in the St. Arnaud village. The



Lake Station Airfield



Lodge style accommodation on the main road



Lake Rotoiti Wharf



St. Arnaud Garage and General Store

ski field has full facilities including a shuttle to the village. Day lift passes are \$75 for an adult with many package saver deals and multi day passes: www.skirainbow.co.nz.

There are many walking tracks in the area and my pick would be the one that goes around Lake Rotoiti. There is a water taxi that runs all year that does pick up and drop off for the tracks if you don't wish to backtrack. www.rotoitiwatertaxis.co.nz also offers transport for hunters and fishermen and tourist trips. The tours offer history of the area, tea and coffee and of course stunning scenery. Hamish is your friendly host; check out his website for scheduled departures or book in by phoning 021 702 278. Prices are reasonable and I would recommend this is a must-do while in the area.

Accommodation is varied; there is a very nice DOC camping ground right by the lake called Kerr Bay. It has hot showers and is surrounded by beech forest only a couple of kms from the village. Prices start at \$10 per adult per night for an unpowered site but bookings are essential during summer.

There are lodges in the village available for group bookings such as tramping clubs, and there is a holiday park, B&Bs and motel style accommodation for couples and families. I visited during the winter and found all the shops open and friendly. The dairy, which had a café attached, impressed me by selling all sorts, including the fancy Nescafe coffee sachets as individuals and had super friendly staff. Searching www.newzealand.com reveals more information on accommodation, eateries, fishing and articles on the local walks.

Synonymous with Lake Station is an annual fly-in called the Brass Monkey. It has been running for the last 25 years and anyone who has attended arrives home with great memories and great stories. I have attended twice, both of which involved staying in lodges as a large group, participating in fun competitions at the field and one particular time a winter midnight dip off the wharf at the lake. The camaraderie is exceptional with people flying in from all over

NZ. This year it has been shifted to Tapawera, which is still in the Tasman basin. Contact Kevin Allport if you wish to join in 2016: allport@actrix.co.nz.

Do enjoy your flying this summer. Definitely pull the old girl out - it is still the best way to explore the further away places such as Saint Arnaud. And do remember to be diligent on your checks if you haven't been out for a while.

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