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Skywords

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The News Letter of the Burlington Radio Control Modelers Club

Box 85174 Brant Plaza, Burlington, Ontario, L7R 4K4

Editorial

This is the last edition of this series that began last September. I hope you have found the editions worthwhile and/or informative. For my part, I have enjoyed the role of editor-come-author but now it is time for me to stop writing and go flying.

For this edition, I have an article from my favourite oracle: **Harry Curzon** and I have written some stuff too. Most of you will know that Harry has contributed several articles for this newsletter - all of them explaining some of the more contentious issues surrounding the theory of flight. In these two articles, Harry writes about the rudder and I write about the elevator.

We have a temporary field in operation at **Bayview Park** thanks to the hard work of **Peter Hagens** & **Bill Montgomery** and a number of their helpers. However, we have experienced some serious rule infractions and have found it necessary to draw up a set of rules to preserve our flying privileges at the field. The rules will be mailed with this edition and are available on our web site through a link in the Newsletter page.

If you're desperate for reading material, our web site now includes the last nine issues of Skywords - one whole year. Just go to the site, navigate your way to the Newsletter page and select whatever you wish to download. Sorry, no index.

That's all from me. Have a good season, enjoy your club, and remember, the club is what *you* make it.

Cheers, Lawrence.

Thursday, May 23rd.
"Show and Tell"
followed by the
Mall Show setup.

Another magnificent, scratch built creation by Laddie Mikulasco

The Rudder

This is from ***Harry Curzon,*** *an experienced full size and model pilot as well as a notable builder and writer. Above all, a friend whom I hope to meet one day. Harry caught the January article about how to use the rudder and offered this rebuttal. Ed.*

You published an article in January about how to turn an aircraft using the rudder. It seems to be an example of some of the terrible misinformation that is so abundant on the web. It would lead you into bad flying, and at times it could lead you into a spin at low altitude.

To see why almost everything in that article was wrong, we need to understand the mechanics of a turn. For an aircraft, a turn is a change of direction which is in balance. A bike rider leans the bike in a turn so that, for a given rate of turn, the gravity pulling him down on the inside balances the centrifugal force pulling him outwards. An aircraft turn is the same, the rate of turn and the speed mean that there is only one angle of bank at which the two forces will be in balance. When the two forces are in balance, neither the bike rider or the pilot and passengers will feel that they are leaning over – the result of the two forces is straight down their spines, just like gravity is when they are upright. If this does not happen in an aircraft, then either it is bad flying, or an aerobatic manoeuvre in which the rudder has been used to deliberately put the plane out of balance such as a knife edge or a flat control-line style turn.

An aircraft can be put into an unbalanced turn but the passengers will feel it. Anyone standing in the aisles gets thrown across the seats, and those in their seats feel themselves being pushed sideways. They soon feel ill. If the bank is not sufficient such as a control-line turn, the aircraft is said to be "sliding", the slip-ball on the instrument panel swings to the outside of the turn to tell the pilot to dab the rudder in that direction. For gliders, the tail of the yaw string, which sits in the airflow on the outside of the canopy, swings to the inside of the turn thus the head of the string points to the outside foot that needs to be pressed to the rudder to regain balance. If the bank is too much, the aircraft and passengers fall inwards. This is called "slipping" into the turn, hence the slip-ball instrument. The ball falls to the inside and the yaw string swings outside thus the head of the string points to the inside foot to be pressed on the rudder.

Model aircraft get away with unbalanced turns because it does not make us feel ill, nevertheless that is no reason to deliberately fly an unbalanced turn (other than aerobatic manoeuvres) for that is bad flying and leads to flicks, spins, or, in a glider, too much loss of height due to the extra drag.

A turn has two different motions, so each requires its own force to accelerate the mass. Turning involves a change in the direction of travel and a change in the direction in which you are pointing. There is no law of nature that links the two. To turn an aircraft we want both to happen and happen in harmony so that we always point the way we are going. If not, the slip-ball shoots out from the centre and the passengers feel ill. The wing is used to change the direction of travel, and the tail fin changes the direction of pointing. By banking the aircraft the wing's lift is tilted to one side so the aircraft starts to travel sideways in addition to its existing forward flight. We have now changed the direction of travel. That imposes a sideways airflow over the aircraft, this alters the angle of attack of the fin which produces a force that yaws the aircraft into the airflow. We now have a change of direction of travel and of pointing. The whole process happens smoothly as soon as bank is applied, so that the aircraft keeps yawing to point into the direction of travel.

By tilting the wing, some of the lift is used to change the direction of travel leaving less lift to counter gravity, so the aircraft descends. To stop this, and make a level turn, we must increase the angle of attack by easing back on the elevator. By pulling back we lose speed due to extra wing drag. The steeper the turn, the more the wing lift is angled away from gravity and so the more *total* lift we need to keep the aircraft up *and* turning. That means pulling back harder and harder as the turn steepens. If the aircraft is going up or down in the turn, it is the elevator that you move to adjust the AoA to bring the total wing lift into balance with the gravitational and centrifugal forces.

By now you are wondering where the rudder comes into all of this, for I have not used it yet, no matter how shallow or how steep the turn. That's the whole point of this. The rudder does not turn the aircraft and should never be used to turn the aircraft. The wing and tail fin do that. Oh, if only things were so simple. No matter how well designed, the tail fin is not perfect for every flight condition. Every part of an aircraft is a compromise. So we need to assist the fin sometimes, and that is what the rudder does. Ailerons can cause an aircraft to yaw out of the turn, this sideways airflow causes the fin to produce a force that yaws the aircraft into the airflow but, if the yaw force from the ailerons is greater than the yaw force from the fin, the ailerons win and adverse yaw is the result. The fin needs some help and the rudder does that. Once in a turn, especially a steep turn, the tail area can be partially blanked by the fuselage and wing, reducing the fin's power, and rudder can help it. Propellers at the nose produce a spiral airflow which hits the fin at an angle and causes yaw. The aircraft is designed so that at cruise speed and power no yaw is produced, but if you alter the speed or power then the spiral angle changes and the fin yaws the aircraft back to straight – straight for the fin but not necessarily the rest of the aircraft. In a steep turn you are at high AoA, high power, different speed, and the fin needs its AoA adjusted to cope with the changed spiral airflow – the rudder does this. So rudder does not turn the aircraft; it helps the fin cope with changing conditions to keep the aircraft straight. In certain conditions you can have rudder to the outside of the turn to keep the aircraft in balance.

How do you do a flick roll or enter a spin? Up elevator and rudder. As you slow the aircraft on landing approach or turn it tightly to get back on the runway for a deadstick, what are you doing? Pulling back on the elevator. You are now halfway towards a fatal spin. Do you steer with rudder or aileron? Rudder is the other half of the spin. Steering an aircraft by rudder is asking for trouble, especially when low and slow coming in to land. Try that in full size and the instructor/examiner will give you a right smack on the head because he does not want to die and anyway all you get is yaw, not a turn. You always turn an aircraft by banking it. If the wind is across the runway and you have pointed the aircraft along the runway, you drift off to the side. To stop this you turn the aircraft slightly into wind. You do not yaw it, you turn it by banking it and giving it time to change direction. The rudder's job is to assist the fin to keep the aircraft pointing straight into the direction of travel through the air. Landing approaches where the aircraft is crabbing sideways into the sidewind are not done by holding on the rudder. Once the aircraft is properly turned slightly into the wind, the controls are all back at neutral.

Ah, but what about 3 channel models, surely they turn by rudder? With generous dihedral the rudder will roll the model but only after it has yawed it. Watch how they wallow, especially at low speed. Anyone on board would be sick. We only have 3 channel models as a legacy from the days when radios had 1 channel, then through the era of 4 channels but servos were so expensive that buying a set with 3 servos was a whole lot cheaper than with 4 servos. If a 3 channel model was turned by rudder there would be no need for all that dihedral. The dihedral is there so that the yaw produces bank, and that bank inclines the wing lift to alter the direction of travel. Once again the wing does the turn, not the rudder.

The Elevator

This article is a compendium of writings about the Elevator. Some from Harry Curzon, some from me, some from John Denker's "See How It Flies" plus a generous dose of common sense from that remarkable old book "Stick & Rudder" which is still going strong after it was first published in 1944.

One of the hardest habits to overcome when training new pilots is the automatic instinct that equates throttle with speed. From our earliest years we are used to the idea in cars, bikes, boats, etc., that the throttle is a pure speed controller. We naturally carry this habit into aircraft and if you are getting too slow on final approach the first instinct is simply to open the throttle. With trainers, more than any other type of model, this can be disastrous due to the strong pitch up leading to a hammerhead stall. Conversely, if the aircraft is going too fast, the instinct is to close the throttle and to expect that action to slow it down. Both actions are wrong: it is the elevator that controls speed, not the throttle.

If elevator controls the speed, how come all the diagrams show drag being balanced by engine thrust? Surely more thrust must mean more speed until drag once again balances thrust?

The problem is that the Elevator doesn't "Elevate" although, when first applied, it seems to do just that and it is this apparent effect that leads to the difficulty. The labelling is simply wrong. Perhaps the best label we could apply would be "nose up" and "nose down". The current label [elevator] is wrong not only "in theory"; it is wrong in practice. It is dead wrong; if you really did try to use the controls that way in a full size aircraft, you would kill yourself. An airplane will not go up, nor will it stay up, simply because the pilot pulls the stick back. In fact, in all the more critical situations of flight, that is, when climbing steeply, or gliding slowly, or in turning flight, it is all too likely to do exactly the contrary! In the glide, for instance, the farther the stick held back, the more steeply downward will the flight path be – even though the nose may not point down steeply. In a stall or a spin, the aircraft is dropping precisely just because the stick is held too far back!

So what does the Elevator do? Quite simply, it alters the Angle of Attack [AoA]. In effect, it is a quickly adjustable extension of the horizontal stabilizer. If the Elevator is pulled up, the nose will swing upward as long as the new position of the Elevator is held constant. But it will presently stop this upward swing and then fly steadily in the new attitude; the aircraft has stabilized at a new AoA. But how did it do that? At first, the aircraft climbed and converted some kinetic energy (speed) into potential energy (altitude); it achieved stable flight at the new AoA *by reducing the airspeed.* So the primary purpose of the "Elevator" is to control airspeed!

This new flight regime – i.e. the new AoA and the airspeed – may not be able to sustain level flight. After all, we have just increased the AoA and hence increased drag so, to regain level flight in this new regime, we may have to add power. As we increase power for a given AoA, we will increase the rate of climb. So the primary purpose of the throttle is to control the rate of climb. Put another way, energy from the power source is converted into potential energy (altitude).

Of course, throttle is intimately tied up with speed but is not how we *control* the speed. The throttle controls whether or not we are climbing, level, or descending at that speed. Similarly, the elevators are intimately tied up with the rate of climb but they are not how we *control* the rate of climb.

Watch a good pilot land and see how the aircraft is slowed by increasing the AoA and the throttle is set to achieve a nice sink rate. QED eh?

From WWI

The photo is of Ralph Biggar 1899-1987. He is standing beside a Sopwith Pup somewhere in Europe during WW1. His son Warren is a member of BRCM.

Warren says that his dad told him three things about his time in the service: 1. The only instrument he had in the aircraft was a compass he carried in his pocket. 2. He carried a very small caliber pistol for personal protection (which he gave to Warren after the war) 3. He NEVER saw the Red Baron!!

Warren's grandfather was the Mayor of the City of Hamilton 1905-06.