Training: Bob Juncosa

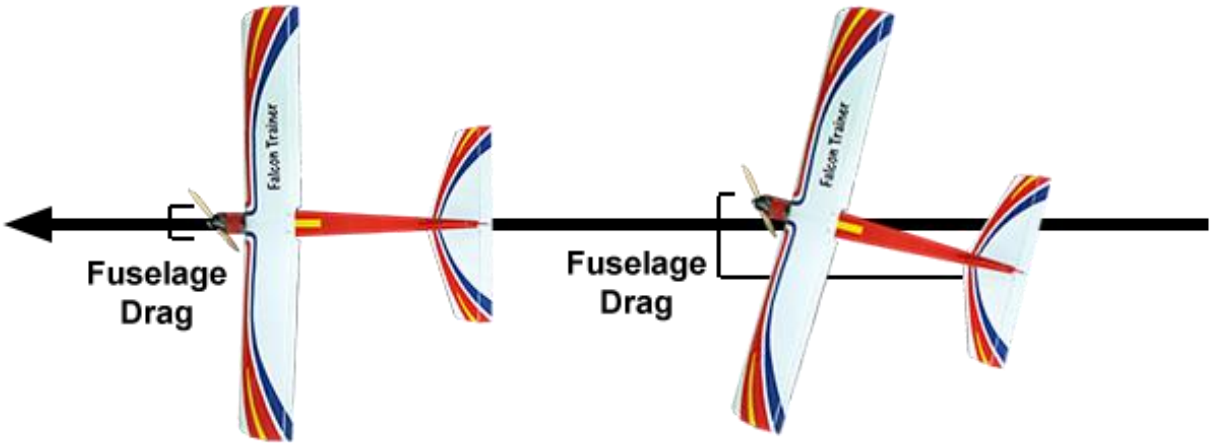
"The Forgotten Axis"

If you ask a large group of R/C pilots to raise their hands if they know how to control the throttle, rudder, elevator, and ailerons on a so-equipped airplane, it is a safe bet that they all would raise their hands. Now if ask them to keep their hands up if they use the rudder for anything other than ground maneuvers, some of those hands would probably be sheepishly withdrawn.

There are lots of times when the rudder can be used such as maintaining a heading down the runway in a cross wind, knife edge flying, and just about every aerobatic maneuver, but let's focus on the use of rudder in simple turns.

What follows is highly dependent on the particular airplane but let's see what happens when a simple level left turn is done completely without rudder (no mixing!) A left bank is first initiated with the ailerons. If the wing is symmetrical with no incidence, the plane will only roll left. If the wing is symmetrical but has incidence or is asymmetrical, the plane will roll left but the lift vector from the wing and/or incidence will be spilt into a vertical component that will keep the plane in the air and a horizontal component that will cause the plane to begin its turn. Unless you want a very wide turn, the next step will be to input some up elevator. That will push the tail down and the nose up to make the turn tighter.

Keep careful note of that last sentence. Unless the plane is banked 90°, the plane will turn but with a nose up, tail down attitude. Is that bad? Well any turn that ends successfully isn't "bad" but it could be better. In such a turn, the plane will now be presenting a very broad surface to the direction of flight. That generates more drag then necessary. That slows the plane down with causes it to lose lift and therefore lose altitude. The degree to which this happens depends greatly on the plane but in any case, it is all correctable my adjustments to throttle, elevator and ailerons. Your plane completes the turn. Maybe at the same altitude, maybe not.



Enter the rudder. Let's initiate the turn with the rudder instead of the ailerons. The inboard part of the wing will now be going slower than the outboard half which causes a differential in lift. The inboard wing will naturally dip. This effect will be minimized or even eliminated if the wing has dihedral because the inboard wing may be moving slower but it is "longer" in the horizontal plane compared to the outboard wing. This differential in lift now counteracts the lift differential caused by the difference in wing speeds.

At this point, your plane is in a relatively flat turn. Now centrifugal forces come into play. All the bits of your airplane want to move further out. These are the forces that makes control line flying possible by keeping the control line taught. Unlike control line flying where the end of the line is attached to the inboard most portion of the plane, your free flying plane's virtual attach point is the thrust axis through the center of the fuselage. This means that the inboard portions of your plane want to join the outboard portions on the other side of the thrust axis. (Think about what would happen to a control line plane if the attach point were at the CG and not at the inboard wingtip.) The tighter the turn, the stronger these forces are.

Your flat turning plane is now at the point that confounded early aviation pioneers. It was this point of instability that caused many crashes. In a turn, if that inboard wing decides to bank up, there is nothing preventing it from going all the way over. Try it (carefully). Try a wide rudder only turn. It should be OK. Now try a tighter turn. You will eventually find the point where the plane wants to roll out of the turn. That would be bad.

In the old days it was wing warping but thankfully we have the convenience of ailerons. Our old friend can easily correct for that undesirable roll and keep the inboard wing below the outboard.

To sum it all up, a turn can be initiated with either the rudder or ailerons. Use the bank and the elevator to determine the tightness of the turn. Use the rudder to keep the entire plane on the axis of flight. Congratulations. You have executed a "coordinated" turn.

Happy Landings

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