Back to Basics:
Improving Rudder Skills

Featuring:
Wally Moran
Mark:   The focus of this workshop will be on proper use of the rudder. And this is a topic, Wally, that I know you’re very passionate about. As a designated pilot examiner and a flight instructor, what’s been your experience with regards to pilots using the rudder effectively during flight?

Wally:   The biggest problem I see in conducting checkrides and/or flying with people as their instructor, is a definite lack of understanding of the use of the rudder. I began to see this. And to confirm my beliefs, I decided to solicit some comments from some of the other instructors that I flew with, or that I knew. And here’s what they’ve told me, Mark.

One of the instructors -- a former national flight instructor of the year -- said, “Most of the pilots I fly with for the first time think the rudder is for steering on the ground and was a convenient place to put the brake pedals. Other than that, they use it for a foot rest.”

Another instructor told me, “The lack of understanding of the rudder has always been a problem with students. If a student is not taught the coordinated use of rudder and aileron early on, they will always have lazy feet.”

Yet another instructor said, “Just watch a pilot take off, and see them climb out with the right wing low to correct for the turning tendencies. That’s a case of improper use of the rudder.” Also, if you look at accident reports, you’ll see often they cite lack of directional control as one of the primary factors during takeoff or landing. Which control is it that helps us stay on the runway during takeoff and landing? It seems to me it’s that same rudder that the flight instructors are telling me that the pilots do not know how to use.

To better understand what pilots were being taught in this area, I began to ask the pilots and the flight instructors that I worked with if they could explain to me in eight words or less when it was I was supposed to move that rudder. And it turns out I wasn’t getting very good answers to that question.

So at this time, I’d like to challenge those of you who are taking this workshop to see if you can come up with eight words or less to tell me when it is I should move the rudder during normal flight operations in the air. It doesn’t count taxiing and those kinds of things. So if you’d like to write down an answer, we’ll give you the answer at the end of this presentation.

Mark:   So Wally, what is the down side of not using the rudder correctly?

Wally:   Well, Mark, just take a look at the accident statistics. How many do you see where the pilot failed to maintain aircraft control? That’s a big downside for us. The rudder is so important in every phase of flight for us. If we don’t develop and use proper rudder skills every day, they won’t be available to us on the day we really need them. An example of that could be a wind shear upset or a weather upset of some kind, and improper use of the rudder in a case like that could cause an inadvertent spin – not a
good result. Proper use of the rudder can save us from an unsafe situation. In addition, obviously, proper use of the rudder is important to make safe and smooth takeoffs and landings. And believe it or not, proper coordination during climb-out can actually improve your aircraft performance. Just think, if I could sell a product that could do all that for you in your airplane, I'd be a millionaire.

Mark: And it already exists!

Wally: It already exists. We can get it for just the cost of a little practice and perhaps some dual instruction.

Mark: It's obvious that we don't use the rudders enough, but I mean, we have rudders on every airplane that we fly, so there must be a reason that the rudders are there.

Wally: Absolutely, there is. Let's take it back to the beginning, Mark. Orville and Wilbur Wright did a lot of work for us in the beginning, and their earlier planes did not have movable rudders. They had fixed rudders, more like a boat. And in October 1902, Orville had had a terrible glider accident due to control problems, and lying awake in his bunk at night, he began to think about the problem. And it occurred to him that perhaps a movable rudder would solve that problem for them.

However, he said that Wilbur did not accept suggestions too readily, so he approached that subject very carefully with Wilbur the next day. He listened. He understood, but he was reluctant to add yet another control to the airplane because he was afraid it was going to, in his terms, “befuddle the pilot.” Well, the movable rudder was a fine idea. He said why not link it directly to the wing warping cradle so that the rudder would automatically move to counter warp-induced drag. You see, the Wright brothers had a problem with what we call adverse yaw. They connected the rudders and the ailerons together to eliminate that. Some other guy came along later and disconnected them, and that's what's given us all the problems.

Mark: Okay, so let's talk about adverse yaw then, Wally, and specifically the issues that it causes.

Wally: Sure. Adverse yaw occurs when we apply aileron to bank the airplane. The lowered aileron on the rising wing produces additional lift, which in turn produces additional drag, and causes the airplane to yaw in a direction opposite the turn. The rudder is on the airplane to correct for adverse yaw. And sure enough, Orville was correct -- that extra control has confounded pilots ever since.

Now that we have more powerful engines, and they're mounted on the front of the ship instead of the rear, as the Wright brothers did, we also need the rudder to counteract for the left-turning tendencies caused by the engine and the propeller.
Mark: How do I know how much to move the rudder, Wally, in that situation?

Wally: That depends on how much you move the ailerons. The more you move the ailerons, the more adverse yaw you create -- therefore, the more rudder it takes to counteract that adverse yaw.

A common misconception, Mark, that I see among pilots is that they believe they need to hold rudder during the turn.

In a shallow and medium-banked turn you do not need to hold any rudder. You only need the rudder when you’re going into the turn and coming out of the turn. So if you think about it, when we turn an airplane, we start by applying aileron to establish the bank. That’s when you need the rudder. That’s when the adverse yaw is created.

As we establish the bank that we wish to hold, we release the aileron pressure. Similarly, we need to release the rudder pressure. Since we’re no longer making adverse yaw we don’t need to hold rudder to correct for it.

Mark: So once we’re established in the turn, when we release the ailerons, the plane will stay in the same bank.

Wally: It’ll stay in the same bank.

Mark: When we release the rudder it will also stay coordinated in flight in that turn.

Wally: Precisely. In a shallow and medium turn, it is not necessary to hold any rudder during the turn, only when you’re rolling in and rolling out.

Mark: In that case, Wally, how can I tell if I’m using or applying the right amount of rudder?

Wally: That’s a question we all ask. When I was a brand new pilot my instructor told me I would be able to feel the coordination and feel the right amount of rudder. I had two hours in the airplane, and all I could feel was a lot of noise and vibration and instructor hollering. So that wasn’t a very good thing for me. Of course I always said: “Yes, I can feel it,” when they would say, “Can’t you tell you’re uncoordinated?” And I would always answer: “Yes, of course.” But I really couldn’t tell a thing.

Another instructor would tell me, halfway around the turn, “Look at the ball. Check the ball.” And that helped me a little bit, but I really didn’t need to be checking the ball in the turn. I only needed to check it going into the turn and coming out of the turn. I don’t think I learned to feel coordination until late in my flying career. I sort of was faking it most of the time.

Mark: Do you have any tips for applying the right amount of rudder when we’re either rolling into or out of a turn?
Wally: Absolutely. Of course, all our instructors told us to watch the ball, and that’s okay, but we shouldn’t fly the airplane looking at the ball. We should fly the airplane looking out the window. So, the way you can tell a proper coordination by looking out the window is to watch the nose of the airplane. As you roll into the turn, the nose should stay in the same place that it was, and as the bank is established, the nose should begin to go in the direction of the turn. If it goes in the opposite direction as you roll in the aileron, you did not put in enough rudder. If it starts to move before the bank is established, you have put in too much rudder.

Same, rolling out of the turn -- as you pick a point to roll out of your turn, the nose should stop at that point, and as you roll out of the turn the nose should stay in that very same spot.

You can also use the same technique when correcting for gusts. Many pilots use only aileron when they pick up the wing. When they do this, the wing first drops, they apply aileron, the nose yaws in a direction, the wing comes up. When they release the aileron the nose now yaws back in the other direction, and so for each gust, they get a wing drop and two yaws. No wonder their passengers don’t enjoy flying with them on bumpy days.

Mark: So what should we do in that situation, then? What’s the proper technique to overcome that?

Wally: When a wing drops due to a gust, we should use both aileron and rudder coordinated to bring it back to level flight, thereby eliminating the two yaws, one left and one right.

Mark: What are some of the things that I can do to improve my rudder coordination, because the assumption is we’re not using enough rudder.

Wally: One of the exercises I use, Mark, is -- of course at a safe altitude and after we’ve cleared our area – I select a prominent landmark over the nose, and another one approximately 45 degrees to the left of the nose. Roll into a smooth, coordinated 30-degree bank towards the landmark that you’ve selected to the left. Continue the turn, and when you arrive at that landmark, roll from a 30-degree bank to the left, to a 30-degree bank to the right. And if you’ve done this correctly the nose should stay pointed directly at that point while you were rolling from one bank to the other.

If you’re not using proper rudder coordination, that nose will move around, and then you can work on your rudder until you get it to stay in one point. So if you roll from point to point, 30-degree bank to 30-degree bank, that will give you practice into and out of the turns. After you get good at doing this at cruise speed, slow the airplane down and put it in landing configuration, and with some flaps down, adverse yaw becomes even more pronounced. And this will become even more difficult, and get you to use even better rudder coordination.
Mark: We discussed adverse yaw. What about left-turning tendencies and using our rudder to counteract that?

Wally: Yes, typically, Mark, the book talks about four of them. Briefly, it is torque, which is the left-turning tendency caused by the rotational action of the propeller and the engine; P-factor, which is a left-turning tendency caused by the greater angle of attack of the down-swinging blade of the propeller; gyroscopic effect – that’s a reaction of the airplane due to the gyroscopic effect of the propeller itself. (It has very little effect on a nose wheel airplane. It comes into effect very big time in a tail wheel airplane.) And last, the spiral effect, and that is the slipstream of the propeller wash circling around the airplane, and providing a left-turning force against the vertical stabilizer and the rudder.

Let’s just take a look at how those factors work against us on a normal takeoff. Well, first of all, as we’re sitting on the end of the runway on the centerline, we have no left-turning tendencies. As we begin to apply the power, we begin to increase our torque, which is the first thing that causes the airplane to move toward the left. As the airplane begins to accelerate now, soon slipstream action becomes effective and also adds a left-turning tendency, which we have to correct for with right rudder.

We continue to accelerate and when we lift the nose, we pick up a big increase in P-factor. That’s when that down-swinging blade of the propeller creates a greater angle of attack, and we suddenly get a large increase in left-turning tendency when the nose wheel comes up. Not only have we increased the P-factor, but we’ve lost the steering ability of our nose wheel. It was helping us a bit in correcting for the first two left-turning tendencies we had. So in a nose wheel airplane, as we lift the nose we’re going to have to add some right rudder to compensate for that increased P factor. If we don’t, the airplane will begin to start moving toward the left side of the runway.

Now once we lift off we need to keep that right rudder in there to compensate for all of those tendencies. We have three factors pulling us to the left. We have to correct those with the right rudder. If we don’t, the airplane will either turn to the left, or we’ll have to correct it with some other means, usually the aileron.

Mark: As a flight instructor and an examiner, Wally, what do you typically see on a takeoff? How does this affect a pilot that’s taking off?

Wally: A common mistake I see, Mark, is the pilot will start the takeoff roll and properly correct for the first two left-turning tendencies -- that is, the torque and the slipstream.

As they roll down the runway and begin to lift the nose they fail to add the right rudder to solve the P-factor increase. The airplane begins to move to the left. Subconsciously they make a slight right aileron adjustment because that’s how we drive our cars every day and it tends to creep into our flying.
Now then, as they lift off, because they’re holding a bit of right aileron, the airplane is tracking a bit to the left. The right wing drops. They do a little zig, a little zag, and then they climb out, often with the right wing low. Take a watch next time you’re at the airport, and see how many airplanes have a minor right wing dip when they take off. Now, you say, is that a dangerous takeoff? Maybe not, but if you have a crosswind from the left, it’s not a very pleasant takeoff.

**Mark:** Does this tendency continue typically, Wally, during climb-out?

**Wally:** Absolutely. Most pilots climb out with the right wing low. They’re correcting for the left-turning tendencies with the aileron rather than the rudder. Therefore, they’re climbing in a side slip. If you’re climbing in a side slip, you’re not climbing as fast as if you’re in coordinated flight.

**Mark:** You talked earlier about proper use of the rudder can help us in preventing accidental spins. Can you talk more about that, and specifically why it’s important in this case to use the rudder?

**Wally:** Absolutely, Mark. When an aircraft stalls, typically our airplanes stall first at the root and then it moves out slowly toward the tip. So when we’re practicing stalls or we inadvertently get in a near-stall condition with a wind shear upset or something, and a wing drops, if the pilot uses a lot of aileron to try to pick up that wing, and not the proper amount of rudder with it, it’s very easy to induce a whole lot of adverse yaw, which will cause rotation in the direction of the down wing, which could ultimately result in a spin.

If the pilot uses proper rudder and aileron coordination they’ll get that wing up and they’ll avoid the spin. What I see on many checkrides during stall recovery is lots of aileron and almost no rudder. That’s how we get into a spin.

**Mark:** Any final thoughts, Wally, or anything else you’d like to share regarding the importance of using rudder in our everyday flying?

**Wally:** Well, Mark, we need to remember that it’s really important to practice good rudder skills all the time because we want that habit available to us when we really need it. So practice those exercises we talked about earlier. If you really want to get good at the rudder, see if you can get a couple hours in a tail wheel airplane, or better yet, go take a few lessons in a glider. They really show you the importance of proper rudder use.

Now, back to the question we asked you at the beginning of the program. That is, tell me in eight words or less, when it is I should move the rudder under normal flight operations. Since we’ve learned that the rudder is on the airplane to control adverse yaw and the left-turning tendencies of the engine, the eight words are: We need to move the rudder “every time we move the ailerons or throttle.”