



Pilot Knowledge Series

YAW IS NO YAWNING MATTER BY ROB KNIGHT

For nearly 45 years I have been teaching Effects of Controls, and for 20 years assessing other pilot's handling of aircraft. My observations over these periods leave me recognising clearly that too many pilots find flying in a straight line is a difficult manoeuvre. This trait is so broad across the pilot spectrum that it's a serious indictment on pilot training. While many would argue with this, the evidence is abundantly clear. So what's the problem?

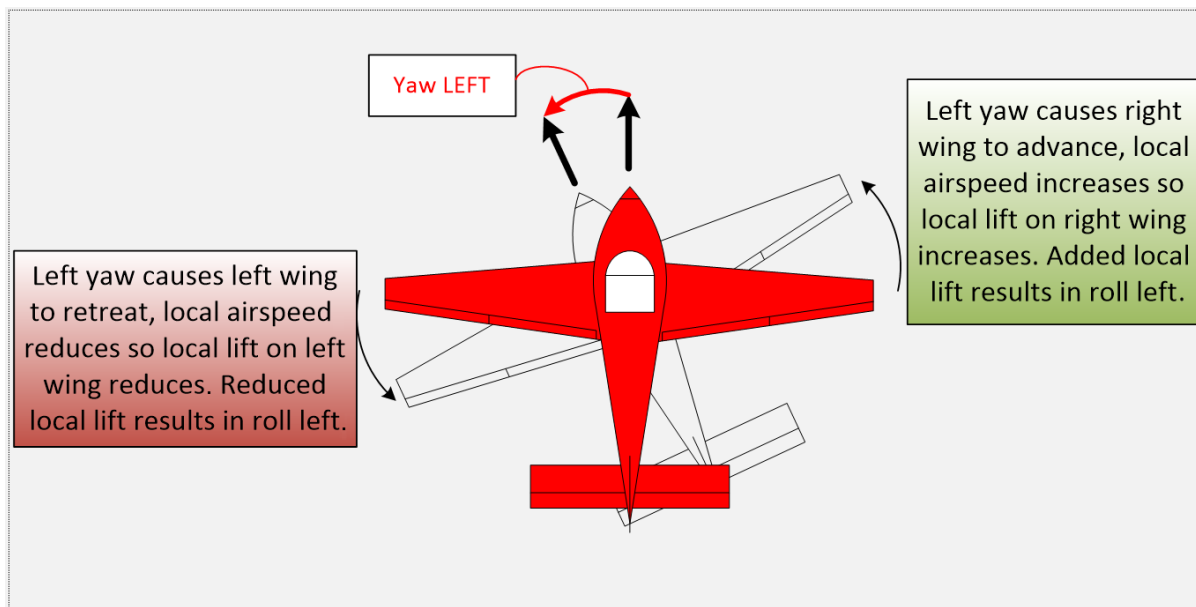
Essentially, it's one of human nature compounded by inadequate flight instruction. Humans naturally ignore yaw. In learning to walk we quickly found that leaning too far forward or backwards made us fall over and it hurt. We also learned that leaning excessively left or right caused a fall sideways and that hurt, too. However, we could stand and spin around and around and get dizzy: it was actually fun. Yaw was safe, but pitch and roll were punished with pain. This conditioning is life-long unless modified so, when pilots learn to fly, they MUST be taught to amend this conception. Too many pilots qualify whilst still lacking the necessary clear understanding of yaw and the true function of the aeroplane rudder because their instructors suffer the same conditioning shortcoming and are unable to see it themselves. Pilot's carrying this fundamental misconception naturally place an excessive priority on monitoring pitch and roll to the detriment of discerning and controlling yaw.

Over the years, asking flight test candidates what the rudder was for got me a virtually unanimous response, "To balance aileron drag". Further pressing may add, "Steering when taxiing". Both are correct but rudder function is much more than merely these.

Rudder controls yaw, either by causing it when input, or preventing it, stopping it, or correcting if it has already occurred. The *Effects of Controls* lesson provides details on further effects and these I will deal with in due course. Right now - understand that the rudder is the aeroplane's YAW control.

So what is YAW? YAW is movement about the aeroplane's vertical (or normal) axis or, from the pilot's perspective, lateral movement of the nose. Exactly as was taught in *Further Effects of Controls*, yawing the aeroplane will **SUBSEQUENTLY** promote roll. The reason is simple – if, for example, the aeroplane's nose is yawed left, whilst the yaw is occurring, the left wing will retreat compared to the right wing and the right wing will advance compared to the left wing. The airspeed difference thus created between the wings results in lift differential and the aeroplane will subsequently roll in the direction in which it yawed even though no ailerons was input.

So why the confusion with yaw? Because pilots don't perceive the yaw since they are not looking for it - they still prioritise roll and pitch. If an aircraft yaws and then rolls, but the pilot doesn't see the yaw, they inevitably use aileron to resolve the roll symptom and not the yaw cause.



What other causes are there for yaw that the non-discerning pilot can miss? The list is longer, even for single engined aircraft, than most people realise. It's not just the rudder that instigates yaw so let's look just at the two most predominant causes.

First, and the one actually taught, aileron drag causing adverse yaw when entering or exiting turns. Ailerons deflect in opposing directions – when one is UP the other is DOWN and each produces a different drag signature when deflected. The up aileron enjoys relatively lower drag whilst the down aileron suffers relatively higher drag. Thus, and again, as taught in *Further Effects of Controls*, ailerons promote roll and then, fractionally later in time, subsequent yaw. Its important to note that the drag differential between the wings will produce YAW **AWAY** from the direction of intended turn. Any time a pilot enters or exits a turn using aileron the aircraft will subsequently yaw (the wrong way) unless pilot corrected.

Second, and the one not regularly taught, the atmosphere. Turbulence and horizontal wind gusts both cause yaw. If turbulence lifts a wing the aeroplane slips away from the raised wing. The keel surface behind the centre of gravity causes weathercocking so the aeroplane will YAW and then roll. Even more insidious are horizontal wind gusts which are most prevalent on approach, especially as height diminishes. Horizontal wind gusts also cause weathercocking and result in --- YAW --- and then roll - and too many pilots don't recognise this. They tend to see only the resulting roll and remedy that leaving the yaw uncorrected. Turbulence and gusts are perfectly natural occurrences and what the pilot does about them is the element that, in my experience, differentiates between pilots and airplane drivers.

The driver will use aileron to level the wings. That is what they're there for, isn't it? Well, yes and no: it depends on what else is happening at the same time. Remember that roll follows yaw. If the pilot only sees the roll and misses the yaw he is behind the aeroplane and using aileron alone will only aggravate the situation. The driver will then, after the aileron



application, continue to try and get the nose back onto the reference point with his hand, tolerating the, hopefully, reducing swerves and wanderings of the nose. This can take from a few seconds or, on finals, take the entire leg and perhaps result in a go around because the aeroplane is too close to the runway edge for safety.

Pilots giving yaw recognition and yaw control a higher priority than roll or pitch will recognize the yaw before the roll occurs. They apply sufficient rudder to arrest any lateral nose movement and restore it to the original reference point. As roll is subsequent to yaw, if the pilot is quick and precise, the nose can be put back in place BEFORE roll has occurred. A pilot must FIRST keep the aircraft straight relative to the reference point ahead and only then use aileron, with appropriate rudder to balance, to level the wings. Otherwise they have overlooked/missed/not seen, the yaw that needed to be arrested by the rudder a just a few milliseconds before..... ergo THEY ARE BEHIND THE AIRCRAFT! They are controlling the symptoms, not eliminating the cause.

While entering and exiting turns is a subject for another time, a view heard from other experienced pilots is that they prefer to lead with rudder when applying, adjusting, or controlling bank. I do not subscribe to this. Personally, except for turns of just a few

degrees, I find this technique not to be universal, but more applicable to specific aeroplane types with particular aileron designs and longitudinal stability issues. This is especially so when using small aileron deflections necessary for gentle roll-ins. I use just sufficient rudder to counter any adverse yaw created. As I don't have adverse yaw before I use ailerons, there is no point in applying rudder before the aileron. It is really a case of recognizing the aeroplane characteristics of the machine that you are in.

However, when making an approach after setting the aeroplane up on finals on the extended centre-line, the situation requires a finer look. I have sat through an uncomfortably high number of qualified pilots making approaches that would do great justice to a ski slope slalom. The cause – they under used the rudder to stop yaw and keep straight, and over used the aileron trying **TO KEEP THE WINGS LEVEL. IF THEY KEPT THE AEROPLANE** straight with the rudder their wings would have stayed level without, or with only minor, aileron input.

On finals, keeping the highest priority on yaw will ease the pilot load because the aeroplane will be steadier and there will be no need to engage in combat with the controls. This will provide time to exercise better judgment so the approach will go easier and the flare and hold-off float will be easier to judge. This will make for better landings so confidence rises and so then will competence and expertise. All for the sake of applying a higher priority on yaw prevention and control.

Don't be an aircraft driver, be a pilot – it's much more comfortable.

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