Landing: The Ultimate Test of a Pilot

Landing is arguably the most complex maneuver in flying, and the most demanding of the pilot. Intuitively, our passengers know this; you can futz up everything else on a flight, but if you 'grease' the landing, they conclude you are an aviation god. Conversely, you can have a flawless flight, but end it with an inelegant landing, and they will never fly with you again. Rightly or wrongly, our landings are how others judge our position on the mythical pyramid of aviation expertise. It is for this, and other reasons, that smart pilots are always looking for ways to refine their landing technique.

The ideal landing should be many things: touchdown on the main wheels, at the desired spot on the runway, on and aligned with the runway centerline, with no lateral velocity, etc. Here we will discuss one aspect of good landing technique that is almost always overlooked: lateral stability during the landing and roll-out.

Many pilots are unaware that the lateral (yaw) stability of their aircraft on the ground is deeply dependent upon how the pilot handles the aircraft in the pitch axis, during both the landing and the subsequent rollout. The tricycle-type landing gear was designed to provide for a laterally stable rollout; however, a failure to handle the pitch of the aircraft correctly will *negate* the stable characteristics of the tricycle design, and re-create the *negative* lateral stability which is the dominant characteristic of the conventional or 'tail-dragger' design.

Tail-draggers are negatively stable in yaw because the main gears are in front of the center of gravity. Any yaw angle sets up turning moments which tend to pull the nose further away from the centerline in the direction of the initial yaw. Worse, the turning forces increase as the yaw angle increases. An engineer would say that the system is 'divergent' in yaw. It is the dynamic equivalent of shooting an arrow out of a bow with the feathered end in front. Left to its own devices, it will swap ends in an instant. This is the entry to the (in)famous 'ground loop' that is largely responsible for the hull insurance rates on tail-draggers being approximately double that of tricycle-equipped airplanes.

Tricycle gear airplanes are designed to be stable in yaw by virtue of putting the main gears *behind* the center of gravity. With most of the weight on the main gears, they act in a stabilizing fashion: any yaw angle sets up a turning moment which tends to bring the longitudinal axis back in line with the motion of the aircraft. The aircraft is positively stable in yaw; we have shot the arrow out of the bow with the feathers in back, and it goes straight.

Oh, but that it would always be so.

Unfortunately, tricycle-gear pilots have at their disposal a control which can, in the blink of an eye, convert the (yaw stable) physics of their airplane into the divergent (yaw unstable) dynamics that are the bane of every tail-dragger pilot. Contrary to common belief, it is entirely possible to ground-loop a tricycle-gear airplane.

The offending control is the elevator. Improper elevator control during the landing and/or roll-out will cause a tricycle-gear aircraft to become negatively stable in yaw. The endgame is a sudden and catastrophic loss of directional control, leading to an un-commanded turn and departure from the runway, or (worse) a ground loop.

A tricycle-gear aircraft which is landed at too high an airspeed, or in which the pilot relaxes the backpressure after the landing, or during the rollout, will transfer weight from the main gears up to the nose gear. Too much weight on the nose gear will cause the aircraft to go unstable in yaw, and from that point further it will behave like a tail-dragger (i.e. ground loop).

To prevent this undesirable chain of events, pilots need to get into the habit of preventing the aircraft from landing for as long as humanly possible: this means ‘holding it off’ in the float until all the airspeed bleeds off, the stall horn comes on, and the wing stalls. The aircraft will ‘plop’ onto the runway in a nose-high attitude, and (ideally) with full-aft elevator. The nose gear will remain clear of the runway.

Once on the ground, avoid the temptation to lower the nose. Hold the elevator full back, and keep it there through the rollout and braking. The nose gear will come down on its own when the decreasing airspeed reduces the down force on the elevator to a point where it can no longer hold the nose up. Continue to hold the elevator back until the aircraft slows to walking speed. The leverage from the down force on the tail keeps the weight biased onto the main gears, and reduces the weight on the nose gear. This condition maximizes the lateral stability during the rollout. The aircraft is laterally stable, it will not have a tendency to ‘dart’ left and right, but rather will exhibit a self-correcting tendency that helps the pilot keep the airplane pointed straight down the runway…where it should be.

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