

AIRCRAFT TRIMMING

Q: Why do airplanes need to trim?

A: Because the lift forces on the wings, horizontal stabilizer/elevator, and the vertical stabilizer/rudder vary with the plane's airspeed and the angle of attack (the angle at which that air strikes the leading edge of the affected airfoil) and its weight and balance (W&B).

If the airplane flew in a straight line at a constant altitude at a constant speed and constant weight all of the time we could attach all of the airfoils at the proper angles so that balanced forces are created and no trim devices would be needed. But since we want the airplane to climb, descend, speed up, slow down and carry different loads, the lift forces acting on the airfoils vary with each change in condition and any such change means we have to hold pressure on the flight controls to compensate. This can be very fatiguing unless we have a means of adjusting those controls so that they maintain their new positions.

Trim tabs and other trim devices provide the means by which we can adjust the flight controls.

Q: What exactly are trim devices?

A: They are any device or mechanism by which the flight loads can be trimmed out of the flight controls. Common ones include ground adjustable tabs (simple bent pieces of metal), adjustable tabs like on the Cessna single-engine airplanes, stabilators (there's no elevator....the whole horizontal tail moves) which require anti-servo trim tabs like on many Piper singles and twins, and all-flying tails which require servo or anti-servo tabs like on Mooney airplanes. All of them except the ground adjustable tab are connected to a crank handle or trim wheel or electrically operated button in the cockpit which when turned, pulled or pushed, or twisted causes the primary control surface to change pitch; i.e., move the trim control and the tab moves, and then the primary surface moves in response. See http://en.wikipedia.org/wiki/Trim_tab for more detail.

Q: So how then do we use these trim devices?

A: . Trim is not a substitute for the control wheel /joystick or rudders. The proper way to use trim is to relieve flight control forces, not as the primary means of changing the pitch, roll, or yaw of the airplane. See http://flighttraining.aopa.org/learntofly/project_pilot/articles/0209article_pf.html for further discussion.

By way of example, let's initiate a climb from cruising flight.

First, we pull back on the joystick to raise the nose, simultaneously adding climb power with the throttle(s). As the nose of the airplane pitches up, the airspeed starts bleeding off and we have to adjust the amount of back pressure we're holding on the joystick in order to keep the desired climb rate or angle. We also note that we have to press on a rudder pedal to stop the nose from drifting off the target heading while still keeping the ball in the center of the inclinometer; and we may even have to

hold a little aileron pressure to stop the airplane from rolling. If we're flying a U.S. built airplane we'll need to hold right rudder and right aileron pressure. On some European built airplanes we may need left rudder and aileron instead, because the propeller rotates to the left rather than to the right.

These control pressures increase as the speed continues to drop toward our target airspeed and it's becoming harder to hold the climb, hold the heading, and hold the wings level at the same time.

Now's the time to trim.

Elevator Trim Wheel and Indicator



We adjust the pitch trim first. Typically modern trim wheels, cranks, handles, or buttons are designed so their movement direction mirrors the direction we want the pressure applied to the control surface so we can relieve the pressure on the flight controls. We're holding aft pressure on the joystick to "hold the nose up" so we grab the vertically mounted elevator trim wheel at the top and pull it back and down, repeating this grab and pull movement until we no longer feel pressure against the fingers of the hand holding the joystick. If we've done it right we can release the stick and the airplane will continue climbing at the desired rate or angle. If not, we continue trimming until the pressure is gone.

Rudder Trim Wheel and Indicator



Next we adjust the rudder trim using the same technique.

The trim wheel is mounted horizontally and since we're holding right rudder pressure to keep the ball in the center and the airplane on heading we need to move it to the right to relieve the pressure on our right foot.

Note: In X-Plane, if we don't have rudder pedals, the program automatically coordinates the use of the rudder so we will only need to make minimal adjustments if any at all.

Aileron Trim Wheel and Indicator



Finally we adjust the aileron trim. The aileron trim wheel is also mounted horizontally and since we're holding pressure to the right, we need to adjust the trim to the right until the airplane doesn't "roll off" towards the heavy left wing.

Oftentimes, adjusting the aileron trim results in the rudder becoming out of trim. If this occurs, re-trim the rudder and then re-trim the aileron. It may take 3 or 4 repetitions before you get it fine tuned.

If we've done our job properly we can now release all of the flight controls and the airplane will continue climbing on course and at the proper rate or angle.

Q: I only have a short distance to climb. Do I have to trim?

A: Not as long as you can hold the pressures on the flight controls needed to maintain the desired pitch, roll, and yaw attitudes. In fact, it may save extra work if you don't trim. Why? Because if you return to the same attitude and power settings for which you'd previously trimmed, the airplane will return to trimmed flight once the airspeed reaches its previous value saving you the trouble of re-trimming.

Q: In X-Plane we can't physically move the trim. So how do we simulate it?

A: By clicking and dragging the mouse cursor, or by holding the mouse button down on the correct spots, on the trim wheel image. We can also use the appropriate keyboard key commands, as shown by the white keyboard characters in the above images.

That's about all there is to know about trimming an airplane. It's easy as long as you remember to use the trim to relieve pressures....not to fly the airplane.

Want to see a more technical discussion of trim? Start here: <http://www.grc.nasa.gov/WWW/K-12/airplane/trim.html>

Jim McNeill

[Shade Tree Micro Aviation](http://www.shadetremicro.com)

papamac@shadetremicro.com