HANDS-OFF FLIGHT CONTROL

A major purpose of initially learning hands-off flight control is to enable pilots to understand the techniques of fingertip control input. They will find properly trimmed flight allows satisfactory performance within the aircraft's design limits and is much easier and safer.

PHYSIOLOGY OF MANUAL CONTROL

Reference:

CFI Gene Hudson's article in the Mar/Apr 2014 FAA Safety-Brief, p-13.

The effect of mental physiology to manual control input is important to flight operations. It is helpful to consider the 19th century contributions of German anatomist and physiologist Ernst Heinrich Weber (1795-1878), and his student, physicist and philosopher Gustav Theodor Fechner (1801-1887).

Perception

These two scientists developed the theory of perception, defining the "just noticeable difference (JND)," or, in other words, the minimum change in a stimulus required to trigger perception.

With regard to pressure stimulus (such as force on the yoke), the JND is a change of approximately 14 percent of the pressure already present. Today, the relationships they defined are referred to as the Weber-Fechner law, or the W-F law. It is common knowledge in physiology but, unfortunately, not so well known in aviation.

Several features of the W-F law are important to flight operations. First, any stimulus (yoke pressure) which is constant will fade from perception over a very short time. A pilot who is flying in an out-of-trim condition will soon lose the ability to perceive applying any elevator pressure at all. The out-of-trim condition becomes the new zero; the pilot cannot trim it off, because they do not perceive that it is there.

Second, a constant stimulus (i.e., steady backpressure to compensate for being out-of-trim) will elevate the just-noticeable-difference. If the pilot is holding a constant 20 lbs. backpressure, the minimum pressure change he or she can feel on the yoke is now 2.8 lbs., in any direction.

Every attempt to make a "small" input will become a "small" input plus 2.8 lbs. of additional pressure that the pilot has no way to know is being applied. The result is over-controlling; small, precise inputs are impossible.

Also, the pilot will tend to make unintended inputs, in pitch and roll, across a 5.6 lb. "dead spot" in perception. This can be especially vexing when the pilot is attempting to accomplish non-flying tasks, such as reading a chart, or dialing a radio frequency; It becomes applying an unknown and unintended input up to the limits of the JND.

A pilot flying in this manner is much more at risk of inducing an unintentional stall. Too many pilots are in the habit of flying the aircraft with large control pressures, far away from the trimmed angle-of-attack.

The elevated JND makes it easy to accidentally apply the control forces necessary to overcome the stability of the aircraft and drive it to and past the critical angle of attack… "Stall"

Technique for establishing hands-off flight control is further outlined in Gene's article.

HANDS-OFF FLIGHT

To enable understanding how an aircraft is controlled consider that the aircraft was designed and built to fly. The pilot only inputs control, steering to specific headings and altitudes to accomplish a particular flight.

During ground operation, initial precise control input to the rudder can be done by wiggling the pedals back and forth while learning the input feel for maintaining the taxi lines.

A sample initial flight will be to begin flight from start of taxi to landing roundout only touching the control wheel when changing elevator trim. This is accomplished by using normal flight procedures of pre-flight, engine start, taxi, and engine run-up.

Prior to takeoff, the elevator will be set at an expected Vx indicated-airspeed. With clearance to takeoff, the power is set and brakes released. Steering is done normally with rudder input.

The aircraft will accelerate and upon reaching the indicated-airspeed as set with the trim, it lifts off, acceleration ceases, and climb begins at the trim-set indicated-airspeed.

Rudder input is continued for directional control toward a distant visually acquired target. Aileron input will not be used unless unusual conditions require more control than available with yawing by rudder.

When established in climb and clear of any obstacles, a slight push on the elevator control will allow acceleration and re-trim to Vy as a climb indicated-airspeed for this flight.

The flight will continue climbing until approaching a desired altitude at which the elevator is again gradually pushed to allow leveling at that altitude. The aircraft will now be accelerating to the desired cruise indicated-airspeed. Gradual power reduction will coordinate the thrust to this cruise indicated-airspeed. You are now cruising in level constant indicated-airspeed flight…still not touching the control wheel.

Additional understanding of flight control requires being aware that the aircraft flies at an angle-of-attack which means the direction of thrust is slightly above the

direction of motion. This results in a small thrust component-lift at the engine attachment…essentially, a fifth control which causes change with thrust change.

Throughout this flight, the elevator control is touched only to coordinate with thrust for changing indicated-airspeed. All level turn and climb maneuvering in this condition is by adding coordinated thrust.

Descent is different. When reducing thrust from level flight, the reduced thrust component-lift allows some acceleration. Now throughout all descent for constant indicated-airspeed flight, it requires coordinating the elevator trim with each thrust change.

Visual sighting of the runway end as relative to a spot on the windshield (like sighting a gun at a target) and maneuvered to be kept unmoving is a collision course to the landing area.

If using the control wheel for maintaining the approach course, again the technique of wiggling the control wheel with fingertips allows learning the feel for precise control.

SUMMARY

It should be noted when using minimum or no manual control wheel input when maneuvering, it is virtually impossible to stall the aircraft.

In the event of inadvertent IMC or any condition losing visual flight reference, turning loose the control wheel and with reference to a turn instrument, it is possible with rudder-only control to make a safe one-eighty turn and fly out of the conditions or with added thrust to climb to regain visual reference.

For precise idle-thrust and engine-out approaches use visual reference by sighting through a spot on the windshield aimed at the landing spot and keeping it unmoving.

A local Instructor using these techniques has found Students can be proficient for safe flight control to solo within five hours and completion of PPL requirements within thirty hours.

Robert Reser
2030 E. Cairo Dr.
Tempe, AZ 85282
602 430 5963
bob@safe-flight.net
http://safe-flight.net