Task VIII.A: Straight and Level Flight

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Lesson Overview

Objective

The student should develop the ability to maintain straight-and-level flight primarily through the use of outside visual references. The student should be able to reference the instruments inside the airplane to ensure straight-and-level flight is continued. The ability to effectively trim the airplane for straight-and-level flight should also be developed.

Reference

- Aircraft Flight Manual / Pilot's Operating Handbook
- Airplane Flying Handbook (FAA-H-8083-3B, page(s) 3-16)

Key Elements

1. Control Pressures
2. Outside 90%, Inside 10%
3. Trim the airplane

Elements

1. Flight Controls
2. Control Pressures and Over-Controlling
3. Trim Technique

4. Integrated Flight Instruction
5. Straight and Level Flight
6. Level Flight
7. Straight Flight

Equipment

1. White board and markers
2. References
3. iPad

Instructor Actions

1. Discuss lesson objectives
2. Present Lecture
3. Ask and Answer Questions
4. Assign homework

Student Actions

1. Participate in discussion
2. Take notes
3. Ask and respond to questions

Schedule

1. Discuss Objectives
2. Review material
3. Development
4. Conclusion

Completion Standards

The student understands how to make adjustments to keep the aircraft in straight-and-level flight. He or she can also relieve the control pressures by trimming the aircraft and provides light, positive, proactive control pressures when aircraft attitude needs to be corrected.

Instructor Notes

Attention

Straight and level flight is the basis of everything dealing with flying. Every maneuver is based off a competent ability to maintain straight and level flight. It is the ground work for your flying abilities, and as simple and boring as it sounds, it is extremely important.

Overview

- Review Objectives and Elements/Key ideas

What

Straight and level flight is flight in which a constant heading and altitude are maintained. It is

accomplished by making immediate and measured corrections for deviations in direction and altitude from unintentional slight turns, descents, and climbs

Why

It is impossible to emphasize too strongly the necessity for forming correct habits in flying straight and level. All other flight maneuvers are in essence a deviation from this fundamental flight maneuver. It is not uncommon to find a pilot whose basic flying ability consistently falls just short of minimum expected standards, and upon analyzing the reasons for the shortcomings we discover that the cause is the inability to fly straight and level properly.

Lesson Details

Flight controls Axis of Rotation

To understand how to properly engage in straight and level flight it is important to first understand the primary flight controls, and the actions caused by use of these controls. The aircraft rotates around the center of gravity in three axis. These axis are pitch (around the lateral axis), roll (around the longitudinal axis), and yaw (around the vertical axis).

- Pitch - Lateral Axis
- Roll - Longitudinal Axis
- Yaw - Vertical Axis

Pitch

Pitch is controlled by the elevators. When back pressure is exerted upon the elevator control the trailing edge of the elevator is deflected up, and this decreases the camber of the elevator and creates a downward aerodynamic force. This causes the tail of the plane to move down and the nose to pitch up. This creates a pitching moment around the center of gravity (CG). The strength of this pitching moment depends upon the distance between the CG and the horizontal tail surface.

Forward pressure deflects the trailing edge of the elevator down, and this increases the camber creating more lift (i.e. less tail-down force). This causes the tail to move upward and the nose to move downward. This pitching moment also occurs around the CG.

- Controlled by the elevators - Stabalator
  - Back pressure
    - Deflects the trailing edge of the elevator surface up
  - Forward Pressure
    - Causes the tail of the airplane to move down and the nose to pitch up

Roll

Roll is controlled by the ailerons. When the aileron controls are deflected to the right this causes the right aileron to go up, and the left aileron to go down. This causes a decreased camber on the right

wing, and decreased lift on that wing. It also causes an increased camber on the left wing, resulting in increased lift on the left wing. These changes create a combined effect that rolls the aircraft to the right. Deflecting the aileron controls to the left does has the exact opposite effect. When the aircraft rolls it pivots around the CG.

- Controlled by the ailerons
  - Controlls to Left
    - Left aileron deflects up, decreasing the camber, resulting in decreased lift on the left wing
    - Right aileron deflects down, increasing the camber, resulting in increased lift on the right wing
  - Controlls to Right
    - Right aileron deflects up, decreasing the camber, resulting in decreased lift on the right wing
    - Left aileron deflects down, increasing the camber, resulting in increased lift on the left wing

Yaw

Yaw is controlled by the rudders. When the rudder is deflected into the airflow a horizontal force is exerted in the opposite direction. Pushing the left rudder pedal causes the rudder to deflect to the left, and pushing the right rudder pedal causes the rudder to deflect to the right. In each case this alters the airflow over the vertical surface causing a horizontal force that pushes the tail in the opposite direction thus yawing the aircraft around the CG.

- Controlled with Rudders
  - When the rudder is deflected in one direction, a horizontal force is produced in the opposite direction

Control Pressures and Over-Controlling

It is important to maintain a light grip on the flight controls

- Only grip with the fingertips

The control forces desired should be exerted lightly and just enough to produce the desired result

> **Common Error - Application of control movements rather than pressures**
>
> - Use smooth, light pressure, not jerky movements
> - Large, jerky movements lead to large changes in pitch, bank, airspeed, etc., which leads to the pilot chasing the desired attitude
> - Next time you drive, pay attention to the steering wheel corrections you use to maintain your lane on the freeway
> - The student should follow along with the instructor during the maneuver to feel

> the control pressures being used to maintain straight-and-level flight

Overcoming Tenseness/Over-controlling

It can be easy to over-control the aircraft especially if having a death grip.Obviously, this is mitigated by maintaining a light grip on the flight controls. Try to only grip with the fingertips. This helps to exert only the control pressure needed which should be just enough to produce the desired result.

- Signs of over-controlling
  - Control movements rather than control pressures
    - Jolty, large movements of the flight controls
    - White knuckles (look for the death grip)
    - Overall nervousness
  - Prevention
    - Point out the over-controlling and demonstrate the correct light, fingertip grip and the pressures desired.

Trim Technique

Most airplanes are designed so that the primary flight controls (rudder, aileron, elevator) are streamlined with the non-movable airplane surfaces when the airplane is cruising straight and level at normal weight and loading.

- If the airplane is out of that balanced condition (faster, slower, heavier, lighter, etc.), one or more of the control surfaces is going to have to be held out of its streamlined position by continuous control input.
  - Trim tabs/control surfaces offset the constant flight control pressure inputs needed from the pilot
  - A properly trimmed aircraft is an indication of good piloting skills, and should allow the pilot to fly almost hands free
    - Any control forces the pilot feels should be a result of deliberate flight control inputs, not forces being applied by the airplane

Trimming the Airplane

1. Set the power
2. Set the pitch
3. Let the airspeed stabilize
4. Trim the airplane for the current airspeed
   a. Establish and hold the airplane in the desired attitude using the primary flight controls
      - Proper attitude should be established with reference to the horizon and then verified by reference to the flight instruments

b. Apply trim to relieve the control pressure
    - The airplane attitude must be established and held first, then control pressures trimmed
c. As previously discussed, if power changes, the pitch attitude to maintain level flight will change, and the aircraft will have to be re-trimmed
    - On a longer flight, as the CG changes with decreasing fuel, small adjustments may have to be made to maintain the proper trim

□□Common Error - Faulty trim technique□□

Trying to fly the airplane with trim is a common fault There is no such thing as the perfect trim — with changing air, gusts, turbulence, fuel burn, etc. the airplane will have to be trimmed often

Integrated Flight Instruction

Each flight maneuver is first learned by reference to outside references, then by instrument references only. This integrated approach will help develop the habit of monitoring the flight and engine instrumentation.

Straight and Level Flight

Straight and level flight is a matter of consciously fixing the relationship of a reference point on the airplane in relation to the natural horizon

- Vertical reference lines are best established on the ground.
- Horizontal reference lines are best established in flight.
- Ensure the pilot is properly seated to maintain and establish the reference points.

The objective is to detect small deviations from level flight as soon as they occur, necessitating only small corrections. It’s easy to chase the plane movements but I’ve found it helps to visualize the plane is like a leaf effortlessly floating down a small stream. There might be a little movement, but overall the plane wants to follow the air. Only make corrections when it looks like the plane is diverging from the intended altitude and flight path.

Level Flight

Consciously fixing the relationship of the position of a portion of the airplane (toward the nose), used as a reference point, with the horizon. Want to learn to associate the movement of references with the forces which produce it

- Develops the ability to regulate the desired change in the airplane’s attitude
- Pitch (Constant Altitude)
    - Outside
        - Select a portion of the airplane’s nose or instrument glare shield as a reference point and keep that point in a fixed position relative to the horizon

    - Inside
    - To determine whether or not the pitch attitude is correct, the outside reference should be cross checked occasionally (90% outside, 10% inside) against the:
        - Altimeter
        - Attitude indicator
        - VSI
        - Airspeed indicator
            - ⬆ *Faster airspeed = Descending* ⬇
            - ⬇ *Slower airspeed = Climbing* ⬆

Corrections (Control Procedure)

If altitude is being lost or gained, the pitch attitude should be readjusted in relation to the horizon, then the altimeter should be checked to determine altitude is being maintained

- Elevators are the control
- Note the relationship between control pressure and the airplane's change in attitude
    - Use small, smooth controlled movements to maintain level flight

Straight Flight

As with level flight, straight flight is accomplished by maintaining a visual reference. Rather than using the nose, for straight flight we use the position of the wings relative to the horizon

Bank (Constant Heading)

Outside

- Both wingtips should be level and equally above or below the horizon (depending on if the airplane is high wing or low wing)
- The pilot can also select two or more outside visual reference points directly ahead of the airplane (e.g. roads, towns, lakes, buildings, anything really)

Inside

To determine whether or not the bank attitude is correct, the outside reference should be cross checked occasionally against:

1. The heading indicator
2. The attitude indicator
3. Turn Coordinator
4. Magnetic Compass

Bank Corrections (Control Procedure)

1. If the airplane is banking in one direction or the other, the bank should be readjusted to put both wings an equal distance from the horizon
2. Ailerons are the control
3. Right/Left aileron pressure results in the left wing raising and right wing lowering
    a. Note the relationship between control pressure and the airplane's change in attitude
    b. As mentioned in level flight, use small, smooth controlled movements

Power

The airplane's airspeed remains constant in straight and level flight if the power setting is also constant

(Power) Outside Aircraft

Changes in power settings, and/or airspeed will require changes in pitch attitude to maintain altitude

(Power) Inside Aircraft

- Cross check changes in airspeed with the Engine RPM and/or manifold pressure gauges
    - Increased power will result in a climb if no changes are made to the pitch attitude
    - Decreased power will result in a descent if no pitch changes are made to the pitch attitude

Power Corrections (Control Procedure)

As power is increased or decreased pitch attitude must be adjusted

- As power is increased, and airspeed increases, progressively decrease pitch in order to maintain altitude
    - Once acceleration ceases, and the aircraft is level, note the new visual reference in relation to the horizon and use it to maintain level flight
- If power is decreased, and airspeed decreases, progressively increase pitch in order to maintain altitude
    - Once deceleration ceases, and the aircraft is level, note the new visual reference in relation to the horizon and use it to maintain level flight

□□Common Errors□□

1. Failure to crosscheck and correctly interpret outside and instrument references
2. Application of control movements rather than pressures
3. Uncoordinated use of flight controls

4. Faulty trim technique

Conclusion

Level flight is maintained through pitch. We monitor pitch by keeping the reference point off the nose of the plane in the same place on the horizon and referencing the altimeter and attitude indicator. Level flight is controlled with elevator pressure. Straight flight is maintained through roll. We monitor bank by keeping an equal distance above each wing and the horizon as well as lining up two points in front of the airplane and keeping them in line. These visual references are cross checked with the heading indicator as well as the attitude indicator. Trim is essential in relieving the pilot of the control pressures necessary to maintain level flight. We should trim frequently and in small amounts in order to obtain and maintain straight and level flight.

ACS Requirements

To determine that the applicant

1. Exhibits instructional knowledge of the elements of straight-and-level flight by describing:
    a. Effect and use of flight controls.
    b. The integrated flight instruction method.
    c. Outside and instrument references used for pitch, bank, yaw, and power control; the crosscheck and interpretation of those references; and the control procedure used.
    d. Trim procedure.
    e. Methods that can be used to overcome tenseness and over controlling.
2. Exhibits instructional knowledge of common errors related to straight-and-level flight by describing:
    a. Failure to cross-check and correctly interpret outside and instrument references.
    b. Application of control movements rather than pressures.
    c. Uncoordinated use of flight controls.
    d. Faulty trim procedure.
3. Demonstrates and simultaneously explains straight-and-level flight from an instructional standpoint.
4. Analyzes and corrects simulated common errors related to straight-and-level flight.