Gliding Australia Training Manual

Pilot Guide

Unit 5

Primary Effects of Controls

Unit 5 - Primary Effects of Controls

WHAT THIS UNIT IS ABOUT

To:

- develop effective reference to the horizon for controlling aircraft attitude;
- explain the primary effects of controls in both their aerodynamic effect and their effect on the airframe;
- demonstrate use of controls to vary pitch, bank angle and yaw.

WHAT ARE THE PRE-REQUISITES FOR THIS UNIT?

- GPC 1 – Lookout Awareness
- GPC 4 – Orientation and Sailplane Stability

COMPLEMENTARY UNITS

This unit should be read in conjunction with:

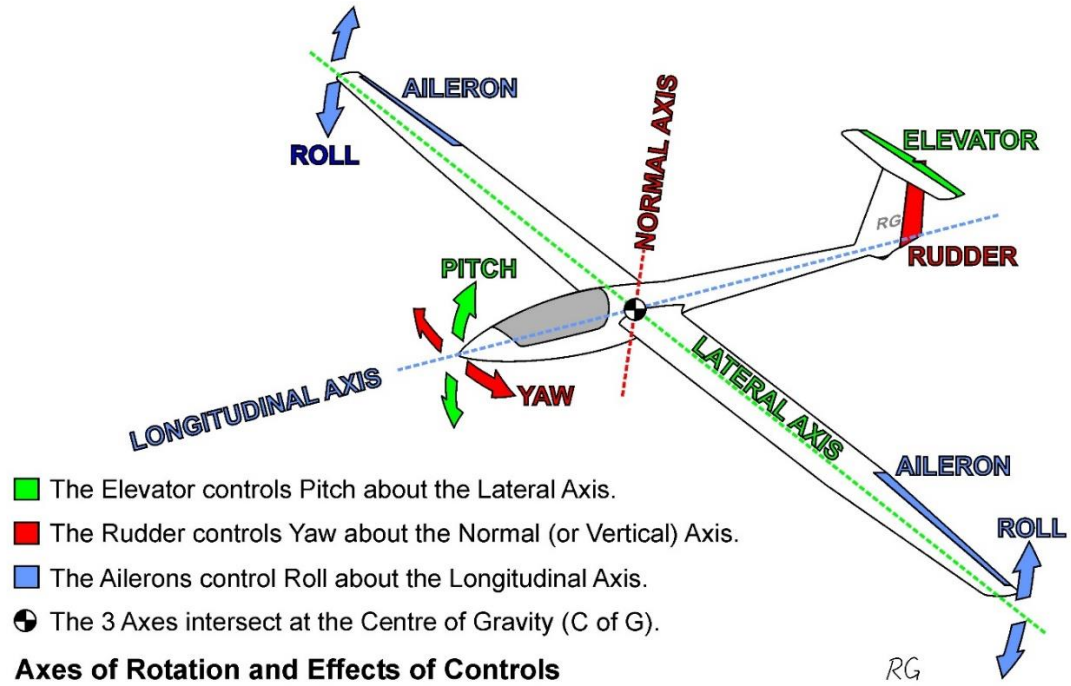
- Nil

KEY MESSAGES

- The aircraft is a stable platform with three axes around the Centre of Gravity – the flight controls provide rolling movements along each axis.
- Fly the aircraft by attitude, our primary attitude reference is the horizon.
- Different amounts of force on the controls will result in different rates of effect on the aircraft.
- Elevator is used to exert change in aircraft pitch - changing airspeed. Ailerons are used to exert change in aircraft bank – creating a roll. Rudder is used to exert change in aircraft yaw.

PILOT GUIDE FOR THIS UNIT

- As the glider flies it can rotate about any of three axes as shown in the following diagram.

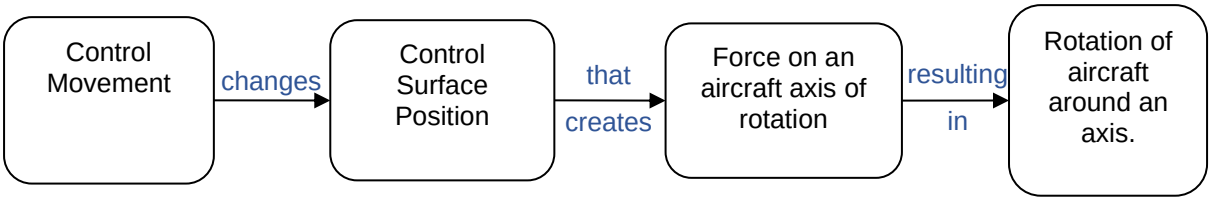


Axes of Rotation and Effects of Controls

- A glider in flight is a stable platform which can be readily controlled. The aircraft we use will fly in a stable manner. Without any external force applied in free flight the aircraft will continue to fly. This applies whether the aircraft is flying straight and level or in a banked turn.
- This stability means it requires a force to move the aircraft in any of these axes.
- The primary controls of a glider provide the ability to exert a force on the three axes. These controls and effects are the same as any other conventional aeroplane. The elevator and ailerons are controlled by the stick. The rudder is controlled by the rudder pedals. Whilst there are other controls in the cockpit, this unit concentrates on these three.
- Each of the primary flight controls in the aircraft link to an aircraft control surface.
    - The elevator is connected to the control column's forward and aft movement.
    - The ailerons are connected to the control column's side to side movement.

- The rudder is connected to the rudder pedals.

- Different amounts of force on the controls will result in different rates of effect on the aircraft. If we use a lot of force on the control we get a large control surface movement and therefore a large amount of rotation on the aircraft axis that it effects. Conversely a small amount of force results in a small effect.



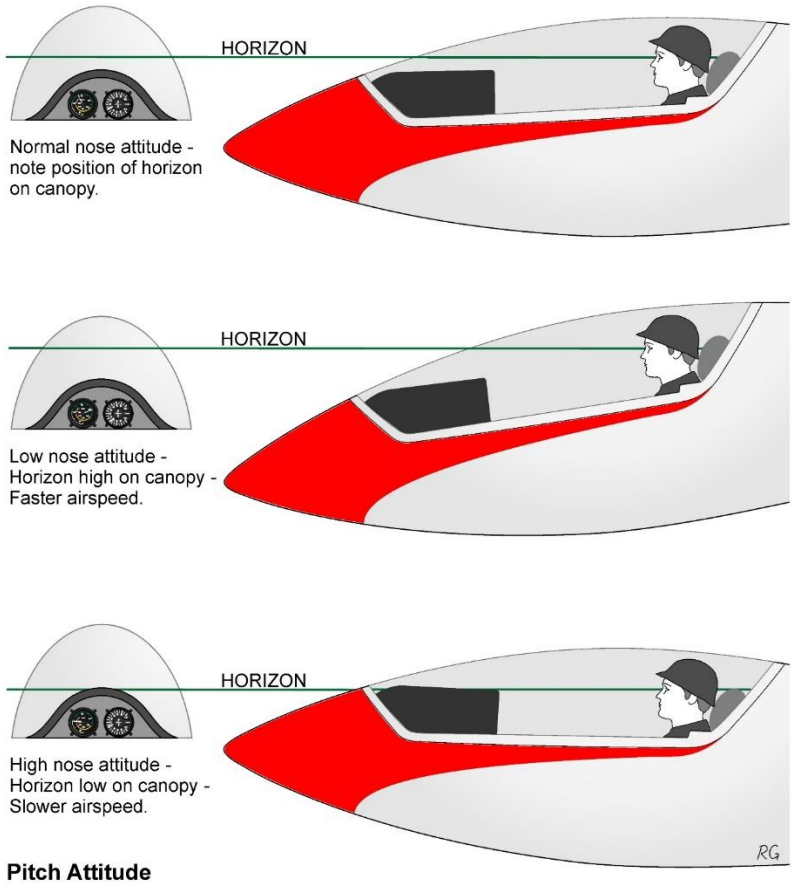
- The rotation of the aircraft in each axis is around the Centre of Gravity (C of G) of the aircraft.

Our Reference – the Horizon

- Before discussing the effects of controls, we need a reference point that can be used to consider their effects in flight.
- This reference point is the view of the horizon in front of the aircraft. As the aircraft moves the horizon will move as well.
- Glider pilots use the horizon as an important reference point for flying and your instructor will continually refer you to it.
- Using the horizon as a reference also focusses the pilot's attention outside of the cockpit which has benefits in maintaining overall situational awareness and collision avoidance.

Elevator

- The effect of the elevator is to control the pitch of the glider. Firstly, the glider is placed into its correct attitude with respect to the horizon. "Attitude" is the standard gliding term used to describe the position of the nose in relation to the horizon. When this is done, we have our "stable platform" referred to earlier. The illustration following shows how this appears from the cockpit of the glider.



Pitch Attitude

- First observe the effect of the elevator. Hold the stick lightly in the right hand and move it smoothly forward. Look ahead at the horizon while doing this and it will be observed that the nose will go down below the previous attitude. The sound level in the cockpit increases as the speed builds up, due to the increase in speed of the airflow past the cockpit. During training, this sound level is an important clue to changing speed in a glider. The increase in speed is confirmed by a glance at the Air Speed Indicator (ASI).
- Still looking ahead, the stick is brought smoothly back and the nose will come up (horizon falls). The airflow noise will decrease and a glance at the ASI shows that the speed is decreasing. See below.
- The elevator controls the attitude of the glider and therefore controls its speed. If the nose is low, the glider dives and the speed is high. If the nose is high, the glider flies slowly.
    - Stick forward, nose down, speed increases.
    - Stick back, nose up and speed decreases.
- This is the only effect of the elevator. In a glider the elevator changes the aircraft's attitude, and ATTITUDE = SPEED.

Ailerons

- The effect of the ailerons is to control the bank or roll of the glider. Starting at the stable platform again, the stick is held lightly in the right hand and moved smoothly to the left. The

left wing will go down and it will keep going down if the stick is kept over to the left. If the stick is brought back to the central position (this is called "centralizing" the stick) the glider will stay banked over to the left - it will not return to the wings-level position of its own accord. If the pilot wants to get the wings level, the stick has to be moved in the opposite direction, in this case to the right. When this is done, the glider will start rolling to the right until it reaches the level position. The stick is then once again centralized and the glider will remain steady with its wings level. The glider is back at the stable platform.

- It will be obvious that the same principles apply to banking to the right.
- To recap, stick to the left and the glider banks to the left. Stick to the right and the glider banks to the right. The glider does not return to the level position when the stick is centralized - it stays at the bank angle chosen by the pilot. The stick needs to be moved in the opposite direction if the pilot wants to return the glider to level flight.
- The primary effect of the ailerons is to bank or roll the aircraft.

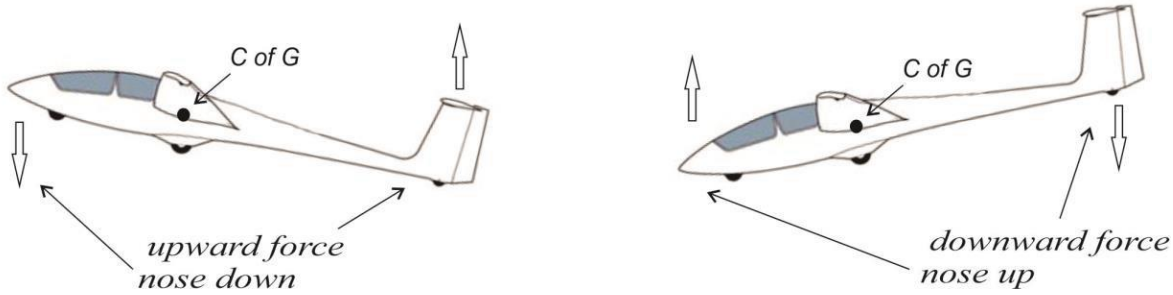
Rudder

- The effect of the rudder is to control the yaw of the glider. Once again we start at the stable platform. Moving the right rudder-pedal forward (which naturally causes the left one to move back) results in the nose of the glider yawing (swinging) to the right.
- One thing that is noticeable is that, when rudder is applied, the nose will only swing so far and then it will stop. This is because the rudder has only a limited ability to yaw the glider before it comes up against the yaw stability provided by the fin. Even though the rudder-pedals are kept deflected, the nose will only yaw so far and no further. This is the first clue that the rudder is not the control which turns the glider. The primary turning control is the aileron, not the rudder.
- There is usually not much need for a pilot to yaw the glider during flight, although there might be some need to use the rudder to PREVENT yaw, in rough air for example. The really useful purpose of the rudder is to act as a helping or "balancing" control to cancel out the adverse yaw caused by the aileron drag which will be shown in the next unit.
- This use of rudder in combination with the ailerons is known as "coordination". The coordination of your feet and hands is a very important part of learning to fly gliders.

Glider Stability and Control

- These two words “stability” and “control” are very important when talking about any aeroplane, and gliders are no exception. Stability means that the glider must be able to fly for short periods of time without the pilot touching the controls. If it can do this, it means it is a good safe design which will not be too difficult or demanding to fly. Control means the opposite of stability - it means that the glider should be manoeuvrable about all of its three axes of movement (pitch, roll and yaw), using its controls.
- If a glider is too stable, it is not very manoeuvrable and is tiring to fly. If it is not stable enough, it is difficult or even dangerous to fly. The designer has to produce a glider with just the right amount of each of these qualities so that it is stable enough to allow us to take our hand off the stick (to unfold a map, for example) without changing our flight path very much, yet still be very manoeuvrable when we want it to be.

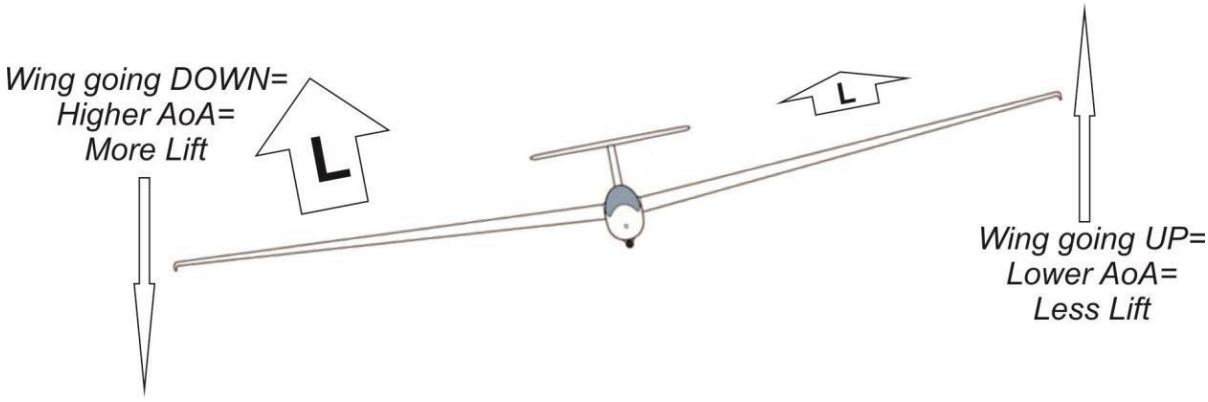
Longitudinal stability or stability in the pitching plane



- The diagram above shows that the tailplane (or horizontal stabilizer) is like a small wing placed at the rear of the glider. This is exactly what it is, and it will produce an upward or downward force to make the nose go back to where the pilot originally put it, if it should get moved from that position for any reason. If the nose tries to go up, the tailplane forces it back down again. If the nose tries to go down, the tailplane makes it go up again. Pitch positive stability in gliders is provided by the tailplane.

Lateral damping and Lateral stability, or stability in roll

- Stability in roll, known as lateral stability, is best considered in two parts.
- The first part is when the glider is rolling or banking, either because it has been tipped by a gust or because the pilot has made it roll. When the glider rolls, there is a difference in the amount of lift produced by each wing. The wing going down will produce more lift than the wing coming up, because of the difference in their angles of attack. This tends to reduce the rolling motion or “damp” the rolling of the glider and for this reason is known as lateral damping. Lateral damping is a very important factor in roll stability and it is always present as long as the wing is not stalled. If a stall occurs, lateral damping can be lost See unit 12 and Unit 18..
- The second part of lateral stability comes into effect when the glider has stopped rolling and is stuck at a particular bank angle. A combination of dihedral effect of the wings and pendulum effect of the fuselage will help restore the glider back to level flight. The diagram following illustrate both effects.



Directional stability or stability in yaw

- Stability in yaw, known as directional stability, is provided by the fin. When a glider yaws, the airflow blows against the side of the fin, producing a force which pushes the glider back into

straight flight. This is similar to the behaviour of a weathercock on a church steeple, and in fact this kind of stability is known as directional positive stability.

How Aircraft Controls are Used

- It was mentioned earlier that the rudder may be used to prevent yaw developing, as well as to actually produce yaw. This principle is in fact true of all the controls in their respective axes of operation:
- Elevator is used to change (or to STOP a change) the pitch of the aircraft, thus changing its airspeed.
- Ailerons, suitably coordinated with rudder, are used to change (or to STOP a change) to the aircraft's angle of bank that creates a turn.
- Rudder, as well as being used in coordination with ailerons, is used to change (or to STOP a change) to the yaw of the glider.

For example, rough air can cause changes in nose attitude or bank angle and the appropriate control can be used to resist this unwanted change.

FLIGHT EXERCISES FOR THIS UNIT

Hand-over/take-over Procedure

- It is essential to set the pattern for a formal hand-over/take-over procedure between trainer and student, to eliminate confusion over who has control at any one time.
- Whatever expression is used ("your aircraft/my aircraft" is quite satisfactory) a formal procedure must always be followed. Similarly, whatever expression is used it must receive a response. Your Trainer will demonstrate this essential procedure. This formal hand-over/take-over procedure must NEVER be varied.

Demonstration and Practice

- Your Trainer will demonstrate to you the aircraft stable platform, the use of the three flight controls of the aircraft and how they affect that stability in pitch, roll and yaw.
- You will have the opportunity to use the controls and feel the amount of force required to move them, and the subsequent effect on the aircraft. You will be asked to identify the effect that each control has on the aircraft in terms of pitch, roll and yaw.
- This unit may require several flights to exercise all controls to the point where you become competent in their use.

THINGS YOU MIGHT HAVE DIFFICULTY WITH

COMMON PROBLEMS	
Problem	**Solution**
• Looking at glider instruments for input.	You must lookout to the horizon and reference all instructions to aircraft attitude. It is more accurate and a faster response.

• Excessive force is used on controls	Hold the control column with just 2 or 3 fingers.
• Minimal control input used such that effect is difficult to see or there is tentative use of control inputs	The Trainer will demonstrate that smooth and positive control inputs give positive control over the aircraft.
• Failure to return control column to neutral resulting in continued rolling force and continued change to the aircraft's angle of bank.	Learn and practice centralising the controls.

HOW DO YOU DEMONSTRATE COMPETENCE?

- Describe the need for aircraft controls, and how they are activated from the cockpit and their effect on the aircraft.
- Demonstrate use of the three flight controls individually to control the aircraft in three axes.

RESOURCES & REFERENCES

- Video – Primary Effect of Flight Controls.
- Theory Lesson 2

SELF-CHECK QUESTIONS

Use these questions to test your knowledge of the unit.

- What are the three axes of rotation of an aircraft?
- What is the primary effect of the elevator?
- What is the primary effect of the ailerons?
- What is the primary effect of the rudder?
- Through which point do the axes of rotation act?
- How would you increase the airspeed of an aircraft?
- What is the use of the horizon?