

Gliding Australia Training Manual

Trainer Guide



Unit 5

Primary Effects of Controls

Unit 5 - Primary Effects of Controls

AIM

The aim of this unit is for the student 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.

PREREQUISITE UNITS

- GPC Unit 1 Lookout Awareness
- GPC Unit 4 Orientation, Sailplane Stability

COMPLEMENTARY UNITS

This unit has no complementary GPC Units.

COMPETENCY ELEMENTS AND PERFORMANCE STANDARDS

ELEMENT	PERFORMANCE STANDARDS
1. Effects of controls – general	<ul style="list-style-type: none"> ● Describe: <ul style="list-style-type: none"> ○ The need for aircraft controls. ○ How to use aircraft attitude as a reference. ○ The primary aerodynamic effect of each flight control and the resultant force on the aircraft. ○ The type of stability encountered in the use of each control (positive, neutral, negative). ○ The result of varying air speed on control effectiveness. ○ How incorrect operation of each control could pose a threat to the safety of the flight. ● Demonstrate: <ul style="list-style-type: none"> ○ The correct way to hold the control column. ○ The correct application of force to use flight controls.
2. Effect of controls – elevator	<ul style="list-style-type: none"> ● Describe: <ul style="list-style-type: none"> ○ The use of elevator in controlling the aircraft's attitude. ● Demonstrate: <ul style="list-style-type: none"> ○ Use of elevator to control aircraft attitude through reference to the horizon. ○ The attitude required to achieve a nominated airspeed (between 50-70 knots). ○ The use of elevator to control aircraft pitch through a range of at least +/- 10 knots, changing pitch and holding, and returning to a stable platform.

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<p>3. Effect of controls – aileron.</p>	<ul style="list-style-type: none"> ● Describe: <ul style="list-style-type: none"> ○ The use of aileron in controlling the extent of roll and roll rate on the aircraft. ● Demonstrate: <ul style="list-style-type: none"> ○ The use of aileron to control aircraft roll from wings level to +/- 20 degrees of bank from horizontal in each direction and returning to wings level. ○ The use of aileron to maintain a desired angle of bank.
<p>4. Effect of controls – rudder.</p>	<ul style="list-style-type: none"> ● Describe: <ul style="list-style-type: none"> ○ The indications provided by the yaw-string. ● Demonstrate: <ul style="list-style-type: none"> ○ The use of rudder to control aircraft yaw to the left and right, returning to coordinated flight.

KEY MESSAGES

- The aircraft is a stable platform with three axes around the C of G – the flight controls provide rotational movements around 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. Rudder is used to exert change in aircraft yaw.
- We isolate the effect of each control so the student understands the relationship between the control input and aircraft response.

LESSON PLANNING AND CONDUCT

Classroom Briefing

It is recommended that you have a model glider available to demonstrate the Lateral, Longitudinal and Normal axis and resulting movement.

General

- Aircraft are stable.
- Controls act by exerting a rotation around each axis of the aircraft.
- Lookout is essential. Perform targeted scan prior to any control application.
- Flying by reference to aircraft attitude with reference to the horizon is essential.
- Only use enough force as needed to achieve the required outcome.
- As airspeed increases, the controls become more effective.
- Use of aileron and rudder together will be considered in the next unit.

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Use of Elevator

- Elevator controls rotation around the LATERAL axis causing the nose of the glider to pitch up or down with reference to the horizon.
- Moving the control column forward increases the lift on the tail plane causing the nose to lower on the horizon.
- Moving the control column aft decreases the lift on the tail plane causing the nose to rise on the horizon.
- The elevator operates in a natural sense to the pilot.
- Changes in pitch of the glider changes the aircraft's airspeed, resulting in changes to the airspeed indication, air noise and feel of controls.
- Elevator control has positive stability, returning to the trimmed attitude.

Use of Ailerons

- Ailerons control rotation around the LONGITUDINAL axis.
- Moving the control column sideways will deflect ailerons on each wingtip in opposite directions.
- Ailerons operate in a natural sense to the pilot.
- Ailerons departure from neutral results in a rolling force changing the aircraft's angle of bank.
- Larger aileron deflection results in increased rates of roll.
- The rolling force continues as long as the control column is held deflected from neutral, i.e. the duration of aileron input governs the angle of bank.
- Angle of bank will remain constant when the control column is in the neutral position.
- How to return the aircraft to wings-level position.

Use of Rudder

- Rudder controls rotation around the NORMAL axis.
- Moving rudder controls the angle that the fuselage moves against airflow.
- Amount of yaw generated varies with the amount of movement applied to the rudder pedal - neutral rudder produces zero yaw.
- Yaw is indicated by the deflection of the yaw string on the canopy.
- An aircraft rotated in yaw will not be flying cleanly into the airflow and will experience some turbulence and reduced efficiency.

PRE-FLIGHT BRIEFING

- Emphasise lookout. Before we roll left or right, we look in that direction. Before we slow down and pull up, we look up.
- The elevator controls the pitch of the glider and thereby controls its speed. It operates in a sense that will be natural to the pilot - stick forward, nose down, stick back, nose up. Demonstrate the movement of the elevator while moving the stick.
 - Elevator - forward pressure, nose pitch down, more airspeed: back pressure, nose pitch up, less airspeed

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- The ailerons control the bank of the glider. The pilot's operation of the stick is again natural - stick left, glider banks left, stick right, glider banks right. Demonstrate the "one up, one down" movement of the ailerons when the stick is moved. Mention at this stage that banking turns the glider and that the ailerons should be regarded as the primary turning controls.
 - Aileron – large aileron movement - more rapid roll, less aileron, slower roll: Centralise - holds the bank angle or holds wings level.
- The rudder controls the yaw of the glider. Make sure you define the meaning of the word "yaw". Note that the pilot's operation of the rudder pedals is "push left to go left, push right to go right", which sounds natural enough to a pilot but can sometimes confuse a person. Demonstrate the movement of the rudder when the pedals are moved.
 - Rudder - yaws the glider left or right. Centralise to fly ahead or at desired bank angle. Does not turn the aircraft.

FLIGHT EXERCISES

Specific training advice for this unit is:

- Always commence and conclude each demonstration at the stable platform.
- Demonstrate the stable platform as aircraft trimmed to fly hands-off, wings level to horizon with no yaw. Note where the nose position is, in relation to the horizon.

Hand-over/take-over Procedure

- At this early stage 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.
- This formal hand-over/take-over procedure must NEVER be varied in instructional work.

Elevator

- During the teaching of elevator the trainer controls aileron and rudder, isolating the effect to be observed.
- Emphasis in the early stages of training should be primarily on attitude with indicated airspeed only mentioned as a cross-reference.
- Demonstrate attitude through reference to the horizon straight ahead.
- Demonstrate use of the elevator. You should let the student follow through on the stick.
- Return the nose to the original attitude and point out that the aircraft continues to fly at the trimmed attitude, this demonstrates the positive stability of the aircraft in pitch.

Suggested Patter:

- "Look ahead at the horizon. This is the correct attitude for normal flight in this glider. See the position of the nose in relation to the horizon and hear the air sound."
- "We're now going to have a look at the Primary Effect of the Elevator. Come lightly on the controls and feel what I am doing."

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- SEE the position of the nose below the horizon and SEE the nose go down as I ease the stick forward...
- HEAR the air noise increase...
- SEE the air speed indicator slowly increase...
- FEEL the pressure on the stick required to hold the nose down.
- Now SEE the nose go up as I ease the stick back ...
- HEAR the air noise decrease...
- SEE the air speed indicator slowly decrease...
- FEEL that the pressure on the stick is gone as we are back to the original attitude and we can fly hands-off.
- Now it's your turn... (repeat)

Student practice and feedback

- The elevator control is handed to the student and the appropriate response received.
- Remind the student to conduct a targeted scan.
- Direct the student to lower the nose; bring it back to the normal position; fly a little faster; now a little slower; and so forth.
- Request the student to fly at the normal glide attitude. Watch the horizon. If the nose is too high and the speed too slow, ease the stick forward a little until the nose is in the right place, and then check your movement to prevent the nose getting too low."
- Repeat demonstration as many times as needed for the student.
- Demonstrate different control feel and effectiveness at different airspeeds – use trim as needed to assist.

Aileron

- Once again it is important that all demonstrations should be given with the glider stabilised in straight flight so that the required effect may be clearly observed. The effect of aileron should be clearly isolated from the effects of the other controls.
- A single demonstration, and brief practice by the student, should be sufficient for them to appreciate the effect of aileron while watching the wingtip. In all future practice see that the student orientates themselves on the horizon directly ahead.
- Conduct full scan and targeted scan when ready to commence demonstration.
- Note the wings are level in relation to the horizon. Note the aircraft attitude with respect to the horizon.
- Note that the right wing goes down when you move the stick to the right and that the wing stops descending when the control column returns to the central position.
- Note that with the control column centred there is no rolling force. This demonstrates the neutral stability of the aircraft in roll.
- Observe the amount of bank by looking ahead, through the tilt of the horizon.
- Note that when you move the stick to the left that the wing comes back upwards towards level.

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- Centre the stick when the wings are again level with the horizon, observing that the aircraft remains stable in the wings-level position as the rolling force has been removed.
- The same principle of course applies to lowering and raising the left wing.

Suggested Patter:

- We're going to have a look at the Primary Effect of the Ailerons. Come lightly on the controls and feel what I am doing.
- Look ahead. Now Follow me though on the aileron.
- Look to the right-hand wing tip.
- SEE the wing go down as I move the stick to the right.
- SEE the wing stop moving as I put the stick in the centre.
- Pause to reinforce the lack of roll.
- SEE the wing come up as I move the stick back to the left.
- Now look ahead.
- SEE the wings held level as I centralise the aileron.
- Now let's repeat this while looking ahead over the nose.
- SEE the nose position relative to the horizon, note that the horizon is not tilted.
- SEE that right aileron makes us roll right, bank right SEE that the horizon is now tilted
- Centralise aileron – SEE that the bank angle remains constant.
- SEE that Left aileron makes us roll left, back to straight and level.
- Now it's your turn... (repeat).

Student practice and feedback

- Exactly the same as for the elevator.

Note:

1. Although controlling the glider laterally by using the ailerons is not difficult, confusion may result if it is not demonstrated to the student that the glider will stay at any bank angle it is taken to if the stick is centralised after the desired bank is obtained. Do not over-complicate matters - simply teach the truth.

- Demonstrate to the right and left as many times as needed for the student.
- Demonstrate a fast roll rate and slow roll rate by larger and small control movement.
- Demonstrate different control feel and effectiveness at different airspeeds.

Rudder

A demonstration is given which shows that the glider is yawed (not turned) by use of rudder.

All trainers must recognise the disadvantages that arise in future flying if the effects of rudder are incorrectly emphasised.

The student must be prevented from forming the impression that the rudder steers the glider in any way other than when the glider is on the ground. Therefore, there must be no undue repetition of demonstration or practice when teaching this control.

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The purpose of the exercise is to indicate the existence of the rudder as a third (or auxiliary) control and observe what the rudder does. The exercise should not go beyond this.

During the demonstration the trainer can eliminate the further effect of rudder with aileron. For this reason don't have the student on the stick because the trainer will 'cheat' by applying opposite aileron (crossed controls) to show the difference between heading and track.

The demonstration works best flown along a line feature such as road or long fence orientated into/down wind so that drift doesn't confuse the heading vs tracking).

- Invite the student to put their feet on the rudder pedals.
- Note the wings are level in relation to the horizon.
- Note that the yaw string is straight along the canopy.
- Press the right rudder pedal, feel both rudder pedals move.
- Note the aircraft swings its nose to the right. Note the yaw string on the canopy swings out to the right. Aircraft is now yawed to the right.
- May feel some buffeting of airflow over the fuselage.
- Let the student feel that you have to maintain pressure on the rudder pedal to hold the yaw.
- Point out that the nose is pointing to the right but the glider is still tracking in the original direction.
- Next demonstration is the effect of pushing the left rudder pedal.
- Press the left rudder pedal, feel both rudder pedals move.
- Note the aircraft swings its nose back to the centre. Note the yaw string returns to the canopy centreline. Aircraft is no longer experiencing a yawing force.
- May feel resumption of smooth airflow.
- Feel that there is no pressure needed on the rudder pedals when the aircraft is not yawed. This demonstrates the positive stability of the aircraft in yaw.

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Suggested Patter:

- We're going to have a look at the Primary Effect of the Rudder. Come lightly on the rudder pedals and feel what I am doing.
- SEE road/hill/cloud ahead of the nose.
- SEE the nose go to the right as I push the right pedal forward.
- (if you open the clear vision panel before the demo) HEAR the air coming through the vent.
- SEE the glider's nose is pointing to the right but the glider is still tracking along the road/towards the hill/cloud.
- SEE the yaw string - we're pointing right but still flying towards the yaw string.
- FEEL how we are still flying in that direction.
- SEE the nose point straight ahead as I centralise the pedals.
- Now it's your turn... (repeat).

Student practice and Feedback

- Exactly the same as for the elevator.

Student practice (under supervision) ALL CONTROLS

- Student practices primary effects of each control under direction of the trainer:
 - Conduct FULL SCAN and TARGETED SCAN.
 - Trainer nominates control to utilise and direction, with emphasis on primary effect through reference to aircraft attitude.
 - Emphasis on gentle effort on controls.
 - Student uses control and verbalises the primary effect on the aircraft.
- Student practices primary effects of control in own time.
 - Practice should include each control, each direction.
 - Return to stable platform between practices.
 - Practice at slow and fast airspeeds and observe differences in control responsiveness.

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COMMON PROBLEMS

Problem	Probable Cause
<ul style="list-style-type: none"> • Student fixation on cockpit instruments: 	<ul style="list-style-type: none"> • Student is nervous and wants to maintain focus inside cockpit. Give student additional time with Orientation & Stability to assist with familiarisation of flight. • Cockpit instruments present a distraction. Encourage lookout on horizon, reference all instructions to aircraft attitude. Consider covering instruments in student's view for this unit.
<ul style="list-style-type: none"> • Excessive grip force on controls: 	<ul style="list-style-type: none"> • Student is nervous or unsure how to hold the control column. Explain correct grip on control column. Ask student to hold column with just 2 or 3 fingers.
<ul style="list-style-type: none"> • Minimal control input used such that effect is difficult to see or tentative use of control inputs: 	<ul style="list-style-type: none"> • Student is unaccustomed to the degree of force required. Demonstrate required level of control input needed prior to student use of controls. Reinforce that smooth and positive control inputs give us positive control over the aircraft.
<ul style="list-style-type: none"> • Student fails to return aileron control to neutral resulting in continued rolling force and change to angle of bank: 	<ul style="list-style-type: none"> • Student does not recognise that the stick is not centred or does not understand that when off-centre aileron deflection is occurring.
<ul style="list-style-type: none"> • Student is left-handed and has difficulty controlling aircraft with non-dominant hand. 	<ul style="list-style-type: none"> • Operating with the non-dominant hand may not provide the same fine degree of motor skills. Give the student time to master both the training and the difficulty in operating the controls.
<ul style="list-style-type: none"> • Student may be experienced in flying a weight-shift aircraft such as a hang glider – in which case their reactions may be the opposite of what the trainer may expect (i.e. push forward in the expectation that this will raise the nose): 	<ul style="list-style-type: none"> • Primacy of original training will interfere with the student's actions. Give the student time to master both the training and overcoming the training primacy from their previous experience.

THREAT AND ERROR MANAGEMENT

THE THREATS THAT CAN APPLY TO THIS UNIT ARE:

- Anxious or Low G susceptible pilots.
- Turbulent atmosphere.
- High traffic level.

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- Poor horizon definition.
- Ineffective communication between student & trainer (including distractions, hearing difficulties or English as a second language).
- Use of aeronautical terms such as Port/Starboard instead of left/right may cause some confusion.

TRAINING MATERIALS AND REFERENCES

- GPC Pilot Guide Unit 5
- Theory Lesson 2