

EFFECTS OF CONTROLS (SECONDARY)

Aim: To learn about any secondary effects of flight control inputs.

We have seen the primary effect of controls... now let's explore any secondary effects... that is... does anything else happen when we pitch, roll or yaw... does one movement have more than the single effect we have seen so far?

Secondary Effects:

A secondary effect of control can be defined as any effect about one of the 3 main axis of motion which occurs as a result of an initial control input.

If we pitch the glider, will it roll or yaw? No... so there is no secondary effect of pitch.

How about if we apply aileron and roll the glider... it banks, slips towards the lower wing then yaws towards that lower wing... so yes, there is a secondary effect of roll and it is yaw.

And yawing... we apply some rudder... the glider yaws, skids sideways and rolls towards the direction of the yaw.

Your instructor will set the glider up in a normal gliding attitude at 45kts and demonstrate these secondary effects so you can see them. To summarise then:

Control	Axis	Primary Effect	Secondary Effect
Elevator	Lateral	Glider pitches nose up and down	there is no roll or yaw
Aileron	Longitudinal	glider rolls left / right	the glider slips towards the lower wing, then yaws towards the lower wing
Rudder	Vertical	glider yaws left / right	The glider skids then rolls towards the inner wing

So What?!

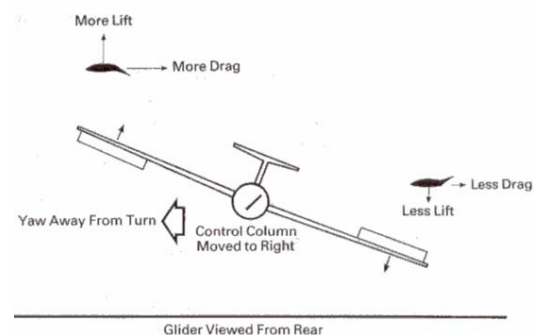
Applying elevator to pitch the nose up or down has no secondary effect to consider. But when we roll the glider to bank it to get it to turn, we get a secondary effect... slip. which is undesirable as it means the glider is no longer aligned with the relative airflow. This momentarily increases our drag and reduces our glide angle. To avoid this, we need to apply a little rudder in the same direction as the aileron to yaw the glider into the relative airflow rather than allow it to slip first.

How about the yaw leading to roll... how is this important? Well, it isn't in the air when flying normally but is useful if we lose roll effectiveness... when at or near the stall or when on the ground at slow speed. Applying rudder can yaw the glider and then cause it to roll sufficiently to pick a wing up or at least stop a wing dropping further. More on this in later exercises though.

But... there is something even more significant that happens when we roll a glider and we need to look at this.

Adverse Yaw Caused by Aileron Drag

The design of the glider with its long wings with ailerons out near the tips gives rise to this significant handling effect. When aileron is applied, the down going one increases its camber and angle of attack to the relative airflow, thereby generating lift to lift the wingtip and roll the glider while at the other wingtip the upgoing aileron is reducing camber and angle of attack, reducing the local lift and allowing roll towards it. As more lift is generated by the downgoing aileron, more drag accompanies it, while the opposite is happening on the upgoing aileron. This extra drag is called *Aileron Drag*. The difference in drag at the tips generates



yaw...*adverse yaw*, away from the desired direction of turn.

Air Exercise:

Your instructor will demonstrate this adverse yaw by setting the glider up in a wings level glide at 45 kts heading towards a prominent feature on the horizon. Holding the rudder neutral, they will apply a large amount of aileron to roll to the left. Look for the nose yawing to the right.

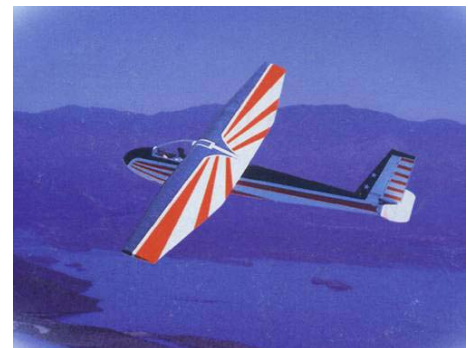
We see that if this occurs whenever we try to roll to bank the glider for a turn, we need to counter this. Applying rudder in the same direction as we apply aileron does the trick... left aileron, left rudder applied smoothly in a coordinated manner stops the adverse yaw. Right aileron and right rudder applied smoothly at the same time stops adverse yaw when we wish to roll and turn to the right.

Having demonstrated with you following through to feel the timing and amount of the control inputs to achieve smooth, balanced flight free of any slip or skid, it is your turn to try the coordinated application of aileron and rudder.

Airmanship:

Its time to introduce the term *airmanship* as an integral part of our flying training. It is used to describe a variety of considerations and actions pilots take to ensure they are safe in what they are doing. When busy learning, watching demonstrations, listening to the Instructor's words, taking control and concentrating on trying to do things as we have been shown, we can forget about some other responsibilities we have as pilots... the things that keep us safe. Airmanship considerations includes things like:

- Keeping an effective lookout and not running into anyone else
- Keeping orientated, knowing where the airfield is at all times
- Staying within safe gliding distance of a place to land
- Thinking ahead... staying ahead of the glider with respect to making decisions
- Being aware of the prevailing weather conditions
- Doing checks out loud and correctly
- Knowing and practicing the correct handover / take over of control



**We can be the world's best at control of our glider but if our airmanship skills are poor...
we are unacceptably dangerous to ourselves and others.**

From now on, we shall include a few airmanship tasks and skills with each exercise so we consciously get to practise them as we go about our learning exercises. Your instructor will gradually and progressively hand over more responsibility for performing appropriate airmanship tasks during each flight.

Tips:

Adverse yaw is significant in gliders and sets them apart from shorter wing powered aircraft where pilots can virtually forget about using the rudder when turning! Mastering this coordinated application of aileron and rudder is not hard... it just takes practice.

As you gain more experience, it will become instinctive and automatic.

Need To Know:

- How to counter adverse yaw when applying aileron.
- How to walk and chew gum..... just kidding!... that's harder than flying!!

Further Reading:

- The Glider Pilot's Manual; by Ken Stewart. Pg 36. All about effects of controls.