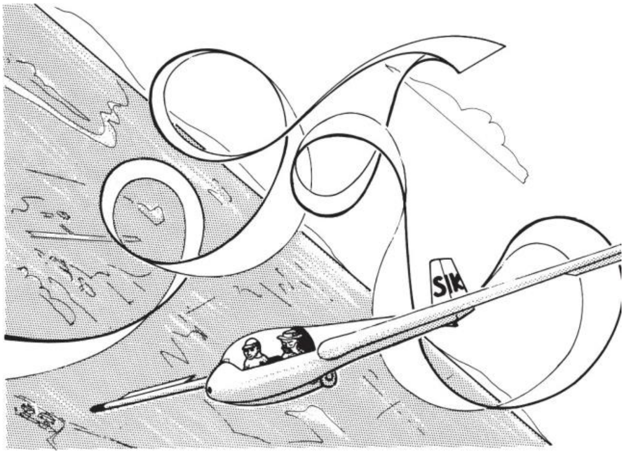
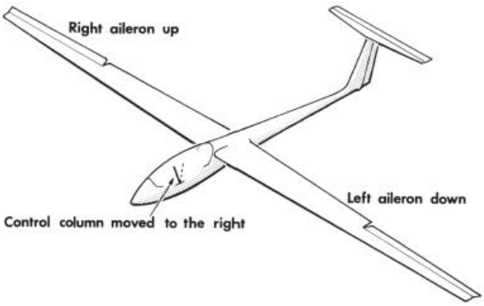
EFFECTS OF CONTROLS



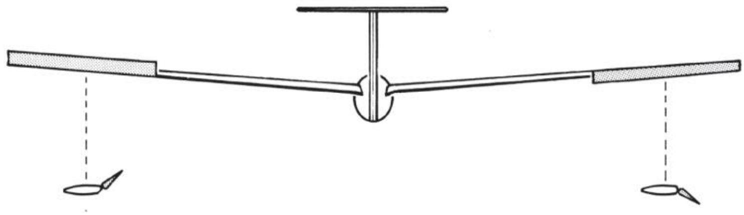
Before we go on to consider the effect of the controls, it essential to note that we will describe the action of the controls on the aircraft without any reference to the horizon, or any point on the earth. The controls always have the same primary effect relative to the aircraft (unless it is stalled) no matter what its position may be relative to the earth.

Primary Effects

The ailerons - These are parts of the wings and are connected as shown below. They are moved up and down by moving the control column (stick) from side to side, and are linked together so that one aileron moves down when the other moves up:



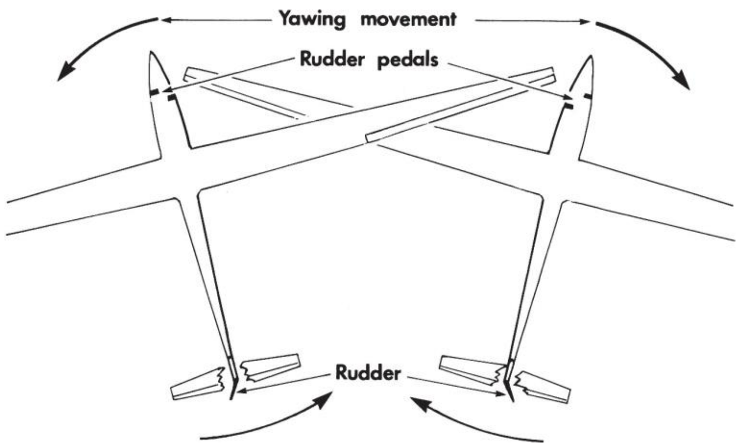
Movement of the stick to the left raises the left aileron and depresses the right aileron. Thus, the left aileron presents a reduced angle of attack to the airflow, and therefore gives less lift; the right aileron, having been lowered, presents an increased angle of attack and hence gives more lift.



The result is that the aircraft rolls or 'banks' to the left around a line drawn through the fuselage from nose to tail (the longitudinal axis). This is called a movement in the "rolling plane", ie, banking. If you hold the stick to the left you will continue to roll (or bank). If, therefore, you want to alter the angle of the aircraft in the rolling plane, you move the stick to one side, wait until the required attitude is reached, and then centralise the stick to maintain the attitude.

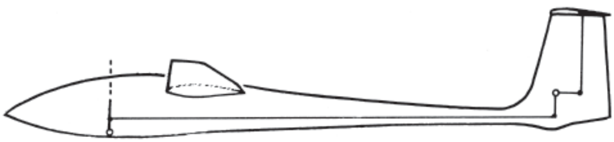
It will be seen later how bank in the appropriate direction enables the aircraft to turn.

The rudder - This is hinged to the trailing edge of the fin. It can move to the right or the left, and is controlled by the rudder pedals:

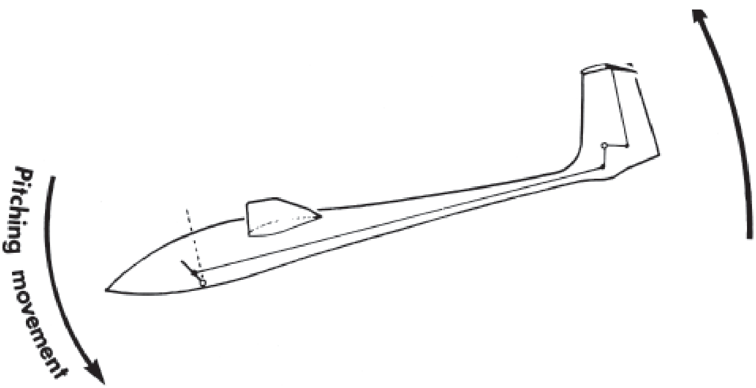


When the rudder pedal is pushed forward by the right foot, the rudder moves out to the right-hand side, and therefore is reacted on by the airflow. As a result, the tail of the aircraft moves round to the left, the aircraft pivoting on the centre of gravity; the nose thus moves to the right. When the rudder pedal is pushed to the left the reverse happens, the nose moves to left. These movements are in the "yawing plane". The rudder is normally regarded as a secondary control; it is used to assist the ailerons to perform a correct turn. However, use is made of the rudder in sideslips and in certain unusual conditions of flight.

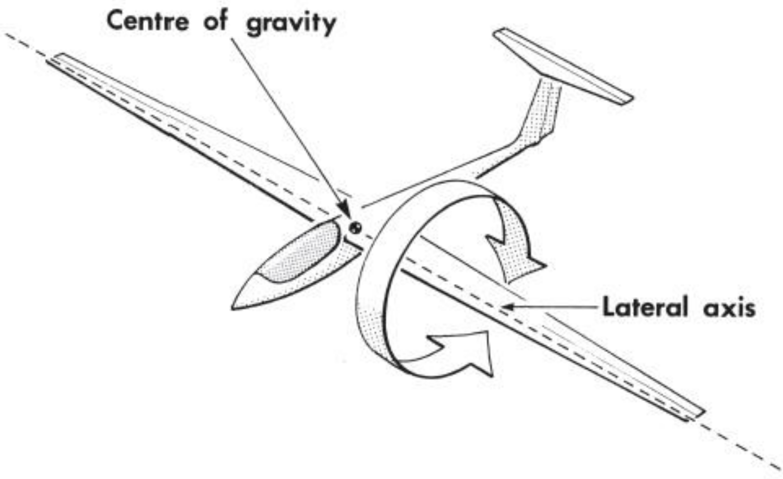
The elevator - This forms part of the tailplane, being hinged to it. It is raised or lowered by a backward and forward movement of the stick. Some gliders have no fixed part to the tailplane and this arrangement is known as an all-flying tailplane; however the principle of operation is the same.



When the stick is moved backwards, the elevator rises and the airflow past them applies a downward force to it. This results in the tail of the aircraft falling in relation to the nose, or as it is usually thought of and seen by the pilot, in the nose rising in relation to the tail. Similarly, when the stick is moved forward the elevator is depressed and the nose goes down. The elevator thus causes a movement in the "pitching plane", the aircraft pivoting about a lateral axis through its centre of gravity.



This pitching movement in flight alters the angle of attack of the wings to the airflow and the balance of forces is upset, causing the flight path to change.



Remember - No matter what the attitude of the aircraft is in relation to the ground, the controls always have the same primary effect on the aircraft (unless it is stalled). The ailerons give control in the rolling plane, the elevator in the pitching plane and the rudder in the yawing plane. These planes are referred to the aircraft and not to the earth.

The effect of a given control deflection depends upon the speed of the airflow over the control surfaces. At low speeds, larger control movements are necessary in order to produce the same effect on the aircraft.

The further effect of the controls and aileron drag

When the ailerons are moved, they have a secondary effect besides that of moving the aircraft in the rolling plane. This is due to the resistance that they offer to the airflow, i.e. to their drag. The aileron which is depressed obtains more lift due to its increased angle of attack, but this involves more drag. This extra drag tends to turn the aircraft in the yawing plane in the opposite direction to that in which the bank is applied, i.e. if the stick is moved to the left the aircraft yaws to the right. This effect is known as "aileron drag". It can be minimised by various design features but is still fairly pronounced on most gliders.

Another effect follows from the use of the ailerons. When the aircraft is banked it tends to slip in towards the lower wing. This produces a sideways pressure of air on the fuselage and fin; since there is more effective surface behind the centre of gravity than in front, the result is a yawing movement towards the lower wing. This "weathercock " effect is in the opposite direction to that produced by aileron drag.

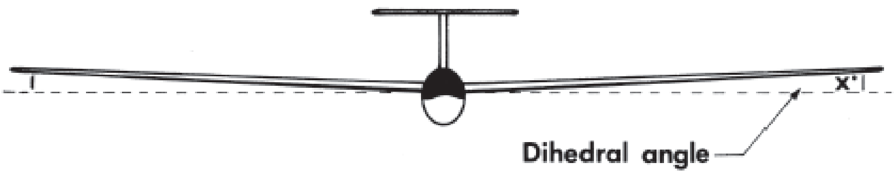
The rudder also has a secondary effect. When an aircraft is yawed by using rudder, the outer wing moves faster than the inner wing. The greater speed of the airflow past the outer wing gives it more lift, so that it rises, causing a movement in the rolling plane, i.e. banking. When the rudder is applied by itself, the outward skid also contributes to this effect, owing to the lateral stability of the aircraft.

The elevator has no secondary effects; the elevator pitches the glider. Of course, if the pitch is changed and the wing's angle of attack reaches the stalling angle, the glider will stall. More about stalling later.

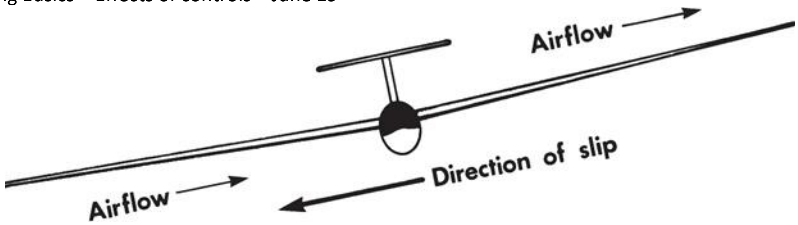
Stability

A glider is designed to be moderately stable in flight; this means that it should tend to keep the same attitude as that in which it is set, and to return to it if it is displaced by small air disturbances. This saves the pilot much effo rt, and tends to make the aircraft "fly itself".

Stability in the rolling plane - This is normally achieved by setting the wings to the fuselage at a slight upward "dihedral" angle:

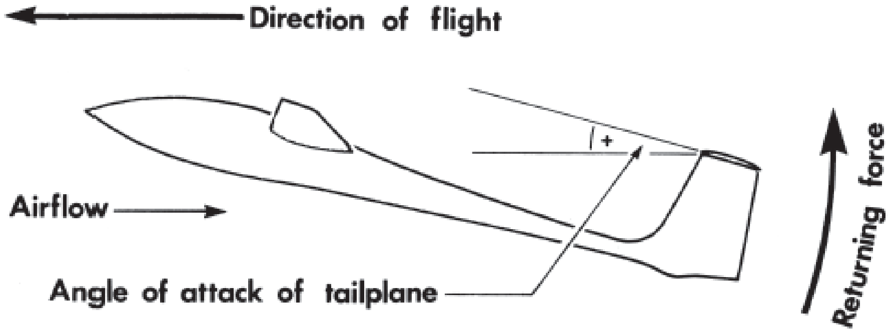


Should the aircraft, by reason of some air disturbance, become banked while flying straight, it will begin to slip towards the lower wing, like this:

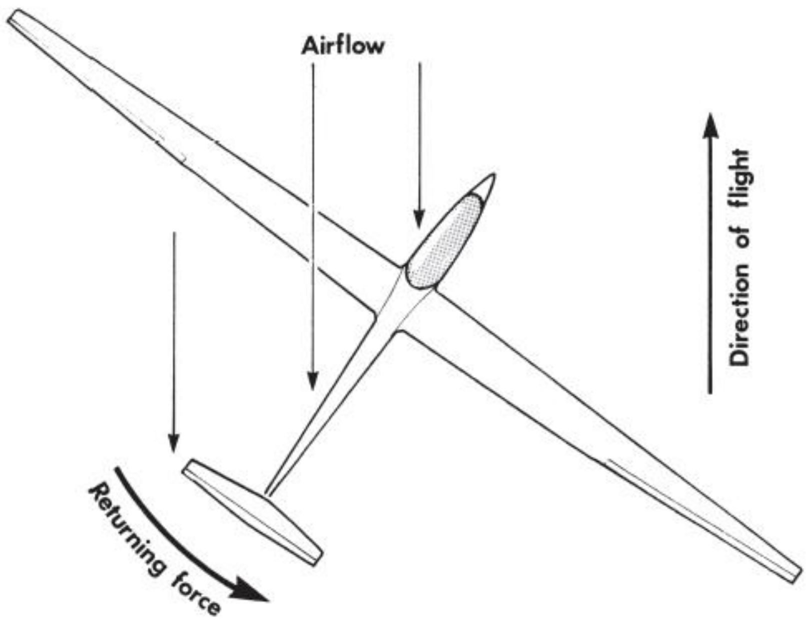


In consequence the lower wing meets the sideways component of the airflow at a greater angle of attack than the upper wing and will therefore have more lift. This greater lift restores the aircraft to the normal level position.

Stability in the pitching plane - This is provided by the tailplane. If the attitude of the aircraft is disturbed so that the tailplane is displaced downward from the line of flight, it will present a positive angle of attack to the airflow and have positive lift, consequently rising to the level position again. Similarly, if is it displaced upwards it will have negative lift, and again be restored to the level position.

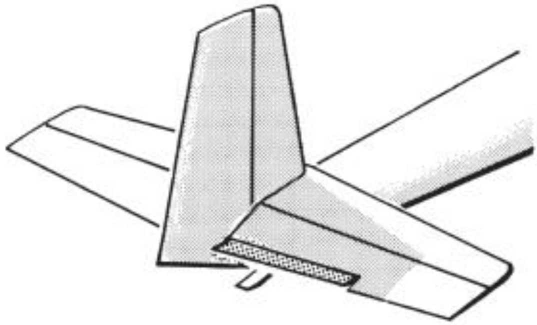


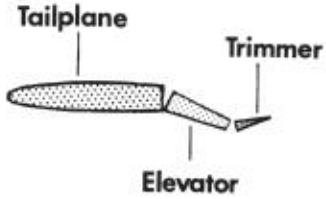
Stability in the yawing plane - This is provided by the fin and the sides of the fuselage. As the greater part of these surfaces is behind the centre of gravity, the aircraft possesses directional stability, and if it is displaced in the yawing plane will tend to "weathercock" back again.



Other controls

The trimmer - Most gliders are fitted with a subsidiary control on the elevators known as the "trimming tab" or "trimmer" which can be operated by the pilot. This may be a spring device in the control circuit, or an aerodynamic trimmer as shown; it is operated by a small lever which works in the same sense as the stick.





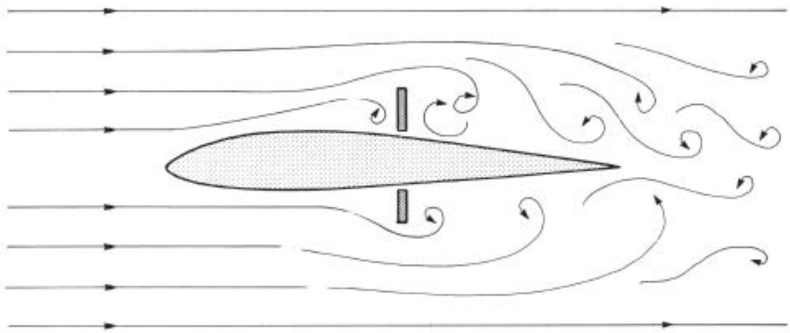
The trimmer is used to relieve the pilot of work in maintaining the required attitude in pitch. If, for instance, the pilot wishes to fly faster, she moves the stick to effect the necessary change of attitude and then, once the speed is steady, adjusts the trim until the aircraft maintains that attitude without any need for pressure on the stick. Remember set the *attitude*, check correct *speed* and then adjust the *trimmer*.

It should be noted that the tab and the control surface move in opposite directions, i.e., when the tab is moved up it will hold the elevator down, which in turn depresses the nose.

The airbrakes – Most gliders are fitted with airbrakes. Some usually older gliders have spoilers. Airbrakes and spoilers are used to control the angle of glide when approaching to land, thus making it easier to land safely in small spaces.

Airbrakes –

- Normally consist of surfaces which may be protruded both above and below the wing, but often only above.
- Are of robust construction and on some gliders may be used to limit the diving speed of a glider to a safe maximum.
- Produce a much greater increase in drag than do spoilers (see below), particularly at high speeds.
- May produce a change in attitude, either nose up or nose down, and possibly a change in trim.
- Reduce the lift over a part of the wing, necessitating an increased angle of attack and consequently both greater drag and higher stalling speed.



Spoilers -

- Are lightly constructed surfaces which can be projected from the wing into the airflow.
- They reduce the lift over a part of the wing. This means that the angle of attack must be increased in order to provide the lift needed to balance the weight. The increased angle of attack involves increased drag, and the angle of glide is again steepened. The fact that the angle of attack is increased without a change in speed means that the aircraft is nearer the stall without any indication from the airspeed, ie. the stalling speed is increased by opening the spoilers.
- Increase the drag, and hence steepen the angle of glide (ie, a steeper angle of glide is necessary in order to maintain the same airspeed).
- May produce a change in trim, eg, usually a nose-down movement of the glider.