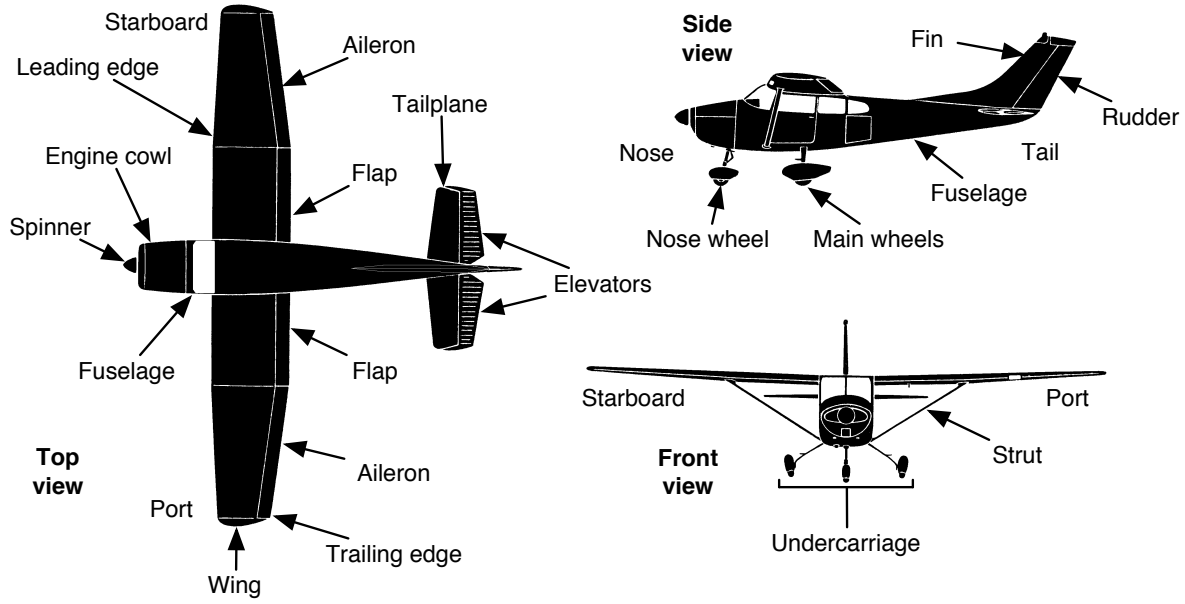
# Effects of Controls

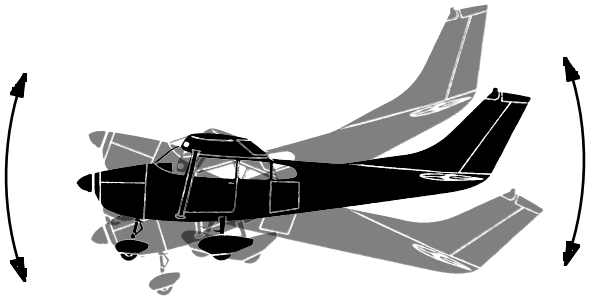
This diagram shows the main parts and control surfaces of a typical single-engine aircraft.




The primary flight controls on any powered aeroplane are: elevator (pitch), aileron (roll), rudder (yaw) & throttle. Gliders have no engine or throttle but their controls are otherwise the same.

The following descriptions give an explanation of the effect of each control in isolation, for a theoretical aircraft. In practical flight, controls are operated together, and there are also secondary effects of controls to consider.

## Elevator (pitch)

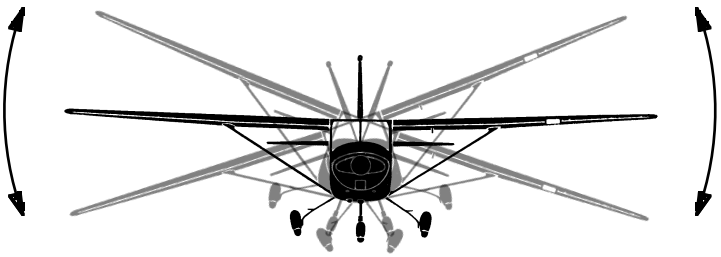


The elevators are controlled by the stick (or yoke). Stick forward, down elevator, nose pitches down. Stick back, up elevator, nose pitches up. If the elevator is raised, the force of the airflow pushes the tail down, rotating the aircraft about the balance point and raising the nose, described as pitch up. Similarly, down elevator causes a pitch down.

## Secondary effect of elevator

If the elevator is used to pitch the nose of the aircraft up, this has the secondary effect of increasing the angle-of-attack of the wing and so more lift is generated which will make the aircraft climb. However, at the same time the change of attitude will increase the drag of the aircraft which will tend to slow it down and cause it to descend. So, provided the engine output remains the same, the secondary effects of the elevator are to control the speed of the aircraft.

## Aileron (roll)



The ailerons are controlled by the stick (or yoke). Stick port (left), port aileron up, starboard aileron down, roll to port; stick starboard (right), starboard aileron up, port aileron down, roll to starboard. Roll is a rotation around the long axis of the fuselage. This effect is caused by

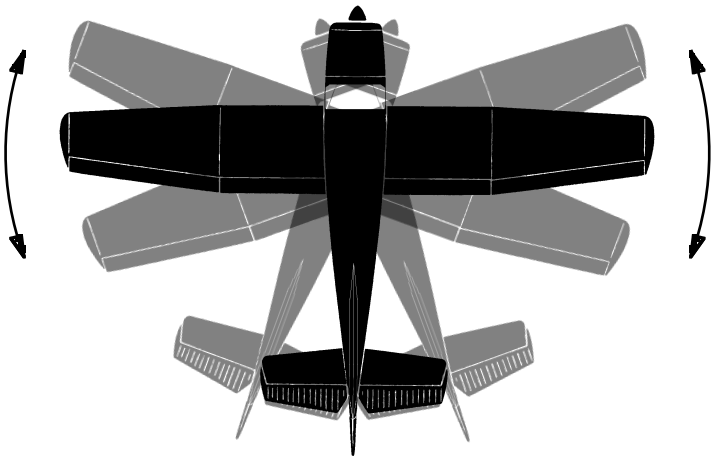
the operation of the ailerons. To roll left, the left aileron is raised and the right aileron lowered. The combined effects of the airflow on the controls lowers the left wing and lifts the right wing. The operation is reversed to roll right.

## Secondary effect of aileron

If the stick is moved to the left the aircraft will bank to the left. As the lift always acts at 90° to the wing, and weight always acts straight down, the resultant imbalance of forces causes the aircraft to sideslip to the left.

Also, this sideslip causes a flow of air towards the fuselage sides. As there will be more area behind the Centre of Gravity than in front of it, the resultant force will tend to rotate the aircraft causing it to yaw.

## Rudder (yaw)



The rudder is controlled by foot pedals. Starboard (right) pedal forward, rudder starboard, yaw to starboard. Port (left) pedal forward, rudder port, yaw to port. Yaw is a horizontal rotation around the vertical axis of the aircraft, and is initiated by the rudder. If the rudder is deflected left, the pressure from the airflow pushes the back around and the aircraft rotates around the vertical axis. Right rudder makes it rotate in the opposite direction. In the absence of any other control inputs, the aircraft will carry on the original direction of flight but with a sideways motion; it will only turn as a consequence of the secondary effects of controls.

## Secondary effect of rudder

Application of the rudder causes the aircraft to yaw from side to side. This yaw means that the wing on the outside of the turn is moving faster through the air, while the inside wing moves slower. This speed change generates more lift from the outside wing and less from the inner, causing the aircraft to roll in the direction of the turn. This effect is enhanced if the wings have dihedral (that is, they are angled upwards towards the tips). Dihedral increases the angle-of-attack for the wing on the outside of the turn (thus increasing its lift), and decreases the angle-of-attack for the wing on the inside of the turn (and decreasing its lift). The application of rudder then, causes first a yaw, followed by a roll. It is this secondary effect that allows aileron-less rudder-only models to be controlled.

## Throttle

Controls the amount of power the engine produces. Opening the throttle (more power) will cause the aircraft to speed up, thus creating more lift, resulting in a climb. Closing it (less power) will cause the aircraft to slow down, reducing the lift and hence making the aircraft descend. Depending on how high or low the engine and propeller are mounted, a change in engine power may also cause a change in attitude.

## Flaps

Flaps are used to increase the lift of the wing, and to add drag. Both of these effects allow the aeroplane to fly more slowly, which is useful when landing. Flaps are sometimes also used when taking-off. Flaps increase lift by changing the shape of the airfoil, and sometimes by increasing the area as well. Some simple aeroplanes do not have flaps.