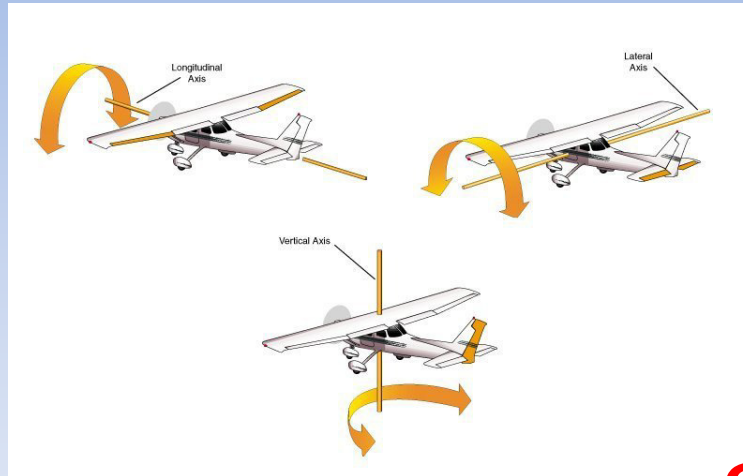


Flight Controls



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Primary Flight Controls

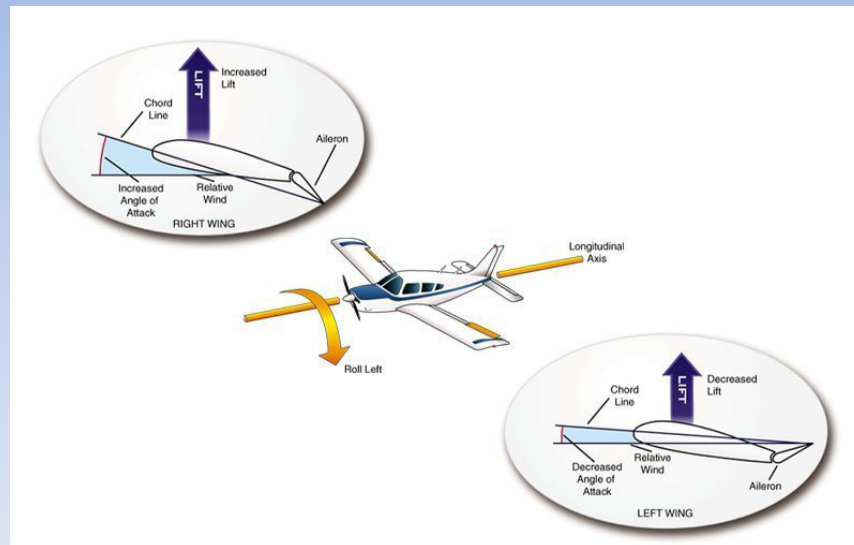
- Ailerons
- Elevators
- Rudders
- Spoilers (EASA 66 classified them as primary flight controls)

Ailerons

- Provide lateral roll control (longitudinal axis)
- Normally mounted wing trailing edge near wing tip
- Some large turbine aircraft employs 2 sets of ailerons (inboard / outboard ailerons)
- Low airspeed (inboard and outboard operating)
- High airspeed (only inboard operating)
- Outboard aileron may cause wing twist at high speed producing “aileron reversal effect”
- Too little bank may cause skid
- Too much bank may cause slip

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Roll Control



SPOILERS

- Reduce or spoil the lift
- Speed brakes
- Flight spoilers
 - Used in flight to assist rolling
 - Some aircraft use as primary flight controls (737)
 - Speed brakes (use for quick decent)
- Ground spoilers
 - Increase drag on landing to slow down aircraft
 - Spoil all lift
 - Reduce braking force

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Speedbrake on BAE 146-300

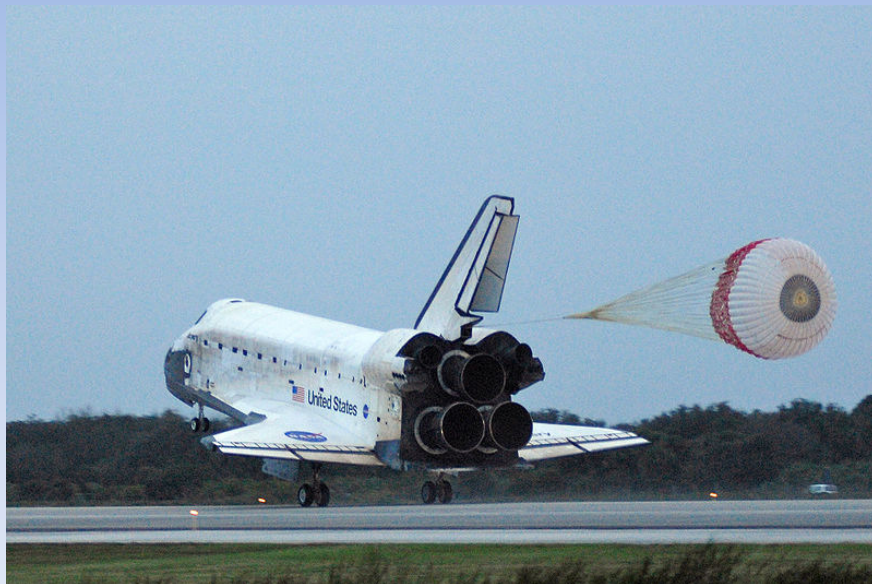


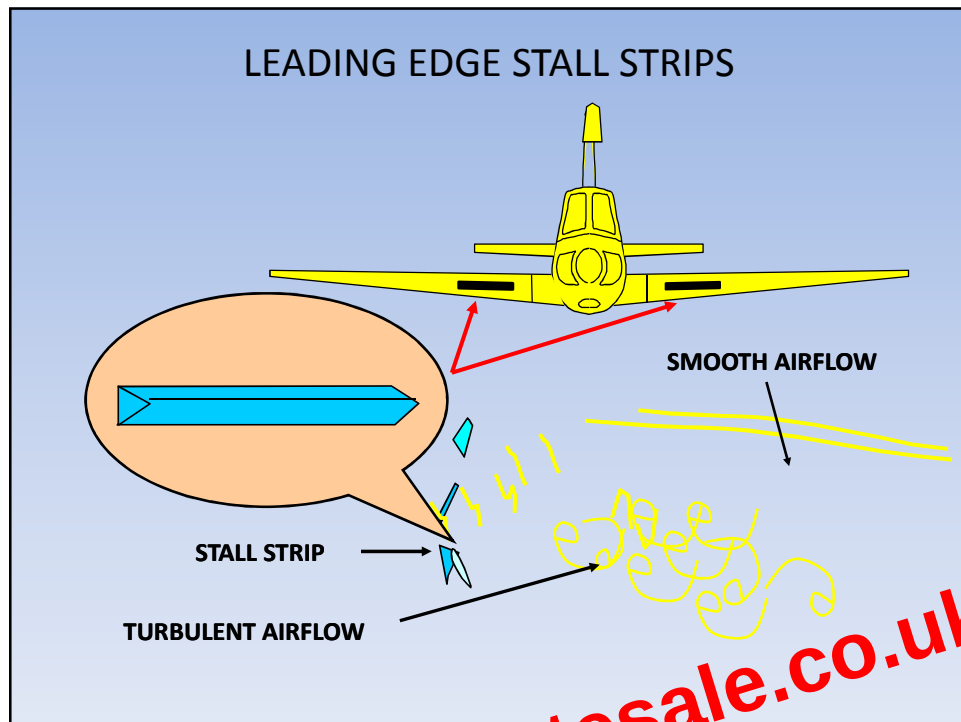
Parachute on Military Aircrafts



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Space Shuttle use Parachute and Split Rudder





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INDUCED DRAG

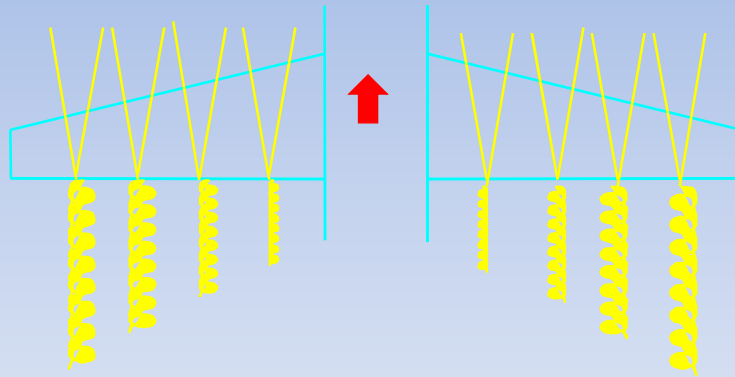
INDUCED DRAG IS A RESULT OF THE LIFT BEING GENERATED BY THE DIFFERING PRESSURE BETWEEN THE UPPER AND LOWER AEROFOIL SURFACES.

AIRFLOW OVER THE UPPER AEROFOIL SURFACE TENDS TO FLOW INWARDS TO THE WING ROOT AREA.

AIRFLOW OVER THE LOWER AEROFOIL SURFACE TENDS TO FLOW OUTWARDS TO THE WING TIPS.

WHEN THESE TWO FLOWS MEET AT THE TRAILING EDGES, VORTICES ARE GENERATED THAT FLOW TOWARDS THE WING TIPS.

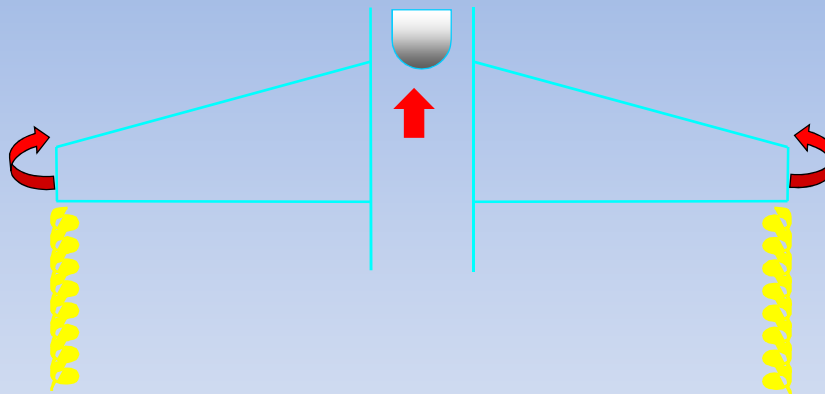
WING TIP VORTICES



TWO AIRFLOW'S MEET FORMING TRAILING EDGE VORTICES

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WING TIP VORTICES



THE HIGHER PRESSURE OF THE LOWER SURFACE WILL TEND TO FLOW OVER THE WING TIP TO THE LOWER PRESSURE ON TOP OF THE WING, CREATING WING TIP VORTICES.

INDUCED DRAG

THE VORTICES GENERATED BY THE AIRFLOW FROM THE LOWER SURFACE TO THE UPPER FORMS A SINGLE LARGE VORTEX FROM THE WING TIP.

THEY ARE VISIBLE WHEN MOISTURE IN THE AIR CONDENSES DUE TO THE DIFFERENTIAL PRESSURES.

THESE WING TIP VORTICES CAUSE THE WING TIP EFFECT RESULTING IN A NET DOWNWASH OF AIR WHENEVER LIFT IS PRODUCED.

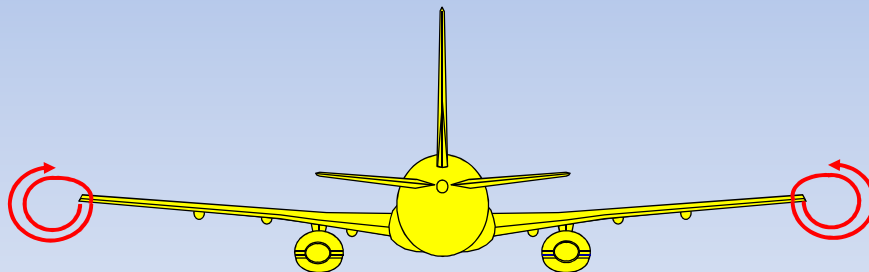
WHEN VIEWED FROM THE REAR OF THE AIRCRAFT THESE VORTICES ROTATE CLOCKWISE AROUND THE PORT WING AND ANTI CLOCKWISE AROUND THE STARBOARD WING.

THESE VORTICES GENERATE HIGH LEVELS OF INDUCED DRAG.

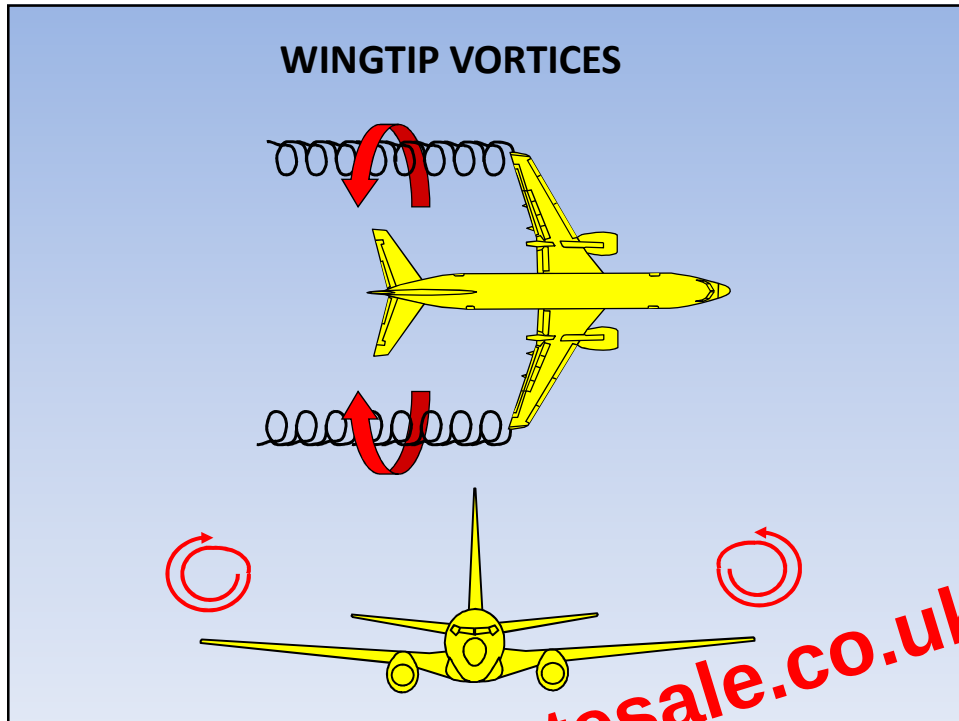
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WING TIP VORTICES

VIEWED FROM THE REAR



WINGTIP VORTICES



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WINGLETS

THESE ARE SMALL FIN LIKE AEROFOILS THAT PROTRUDE UPWARDS FROM THE WING TIPS. THEIR ANGLE DEPENDS ON THEIR DESIGN.

SOME AIRCRAFT HAVE WINGLETS THAT ALSO PROJECT DOWNWARDS.

THEIR FUNCTION IS TO PREVENT THE UPPER AND LOWER AEROFOIL SURFACE VORTICES FROM MIXING AT THE WING TIPS.

BY PRODUCING TWO SMALLER VORTICES THEY SUBSTANTIALLY REDUCE INDUCED DRAG.

Fixed Trim Tab



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ADJUSTABLE TRIM TABS

THIS KIND OF TRIM TAB IS ADJUSTED FROM THE FLIGHT DECK WITH A FEEDBACK INDICATOR SHOWING ITS POSITION ON THE INSTRUMENTATION.

THEY ARE ADJUSTED BY EITHER A TRIM-WHEEL, TRIM LEVER OR SWITCH WITH THE TAB BEING ACTUATED BY MECHANICAL, ELECTRIC OR HYDRAULIC MEANS.

ADJUSTABLE TRIM TABS ARE NORMALLY ON ALL PRIMARY CONTROL SURFACES, AILERON, ELEVATOR AND RUDDER AND ALLOW TRIM ADJUSTMENTS IN ALL 3 AXIS.

BALANCE TABS

BALANCE TABS ASSIST THE CREW IN MOVING THE PRIMARY CONTROL SURFACES.

THE FLIGHT DECK CONTROLS ARE CONNECTED TO THE PRIMARY CONTROL SURFACES.

THE BALANCE TAB CONTROLS ARE CONNECTED TO THE FIXED AEROFOIL.

THE TAB WILL REMAIN IN THE SAME POSITION RELATIVE TO THE FIXED AEROFOIL.

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BALANCE TABS

AERODYNAMICALLY THE TAB IS MOVING IN THE OPPOSITE DIRECTION TO THE MOVEABLE CONTROL SURFACE AND THEREFORE ASSISTS THE CONTROL SURFACES TO MOVE.

THE FUNCTION OF A BALANCE TAB CAN BE COMBINED WITH THAT OF A TRIM TAB.

A LINEAR ACTUATOR WILL BE LOCATED IN THE TAB CONTROL MECHANISM AND WILL BE ACTUATED FROM THE FLIGHT DECK.

SPRING TABS

AT LOW AIRSPEEDS THE AERODYNAMIC LOADS ARE SMALL AND WILL INCREASE AS SPEED INCREASES.

AT LOW SPEED THE RIGIDITY OF THE TORQUE TUBE CAUSES THE PRIMARY CONTROL TO BE DEFLECTED WITH THE SPRING TAB.

THE TAB WILL REMAIN IN THE SAME RELATIVE POSITION TO THE PRIMARY CONTROL SURFACE AND WILL NOT PROVIDE ANY ADDITIONAL AERODYNAMIC ASSISTANCE IN MOVING THE CONTROL SURFACE.

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SPRING TABS

AS THE AIRCRAFTS SPEED INCREASES THE INCREASED AERODYNAMIC FORCES OPPOSE THE MOVEMENT OF THE PRIMARY CONTROL SURFACES.

MOVEMENT OF THE FLIGHT DECK CONTROLS CAUSES THE TORQUE TUBE TO TWIST (OR THE SPRING TO COMPRESS) RESULTING IN THE DEFLECTION OF THE SPRING TAB.

THE DEFLECTION OF THE SPRING TAB DECREASES THE FLIGHT DECK EFFORT AND ASSISTS THE PRIMARY CONTROL SURFACE TO MOVE.