GROUND SCHOOL

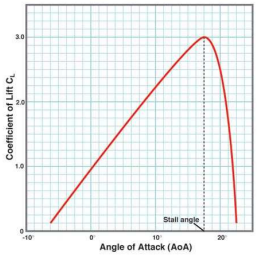
PRINCIPLES OF FLIGHT 3

GROUND SCHOOL

LECTURE THREE: STALLING

GROUND SCHOOL

STALLING



Stalling of the wing occurs above the stall angle or "critical angle" of attack

This can occur at high or low speeds – it has nothing to do with speed (although stalling speeds may be used for references purposes)

STALLING : AIRFLOW

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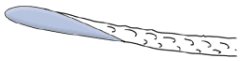
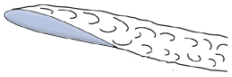
During “Normal” flight angles, the airflow separates towards the rear of the wing



At the critical angle, the separation point is much further forwards – the aerofoil is now struggling to produce lift with the turbulent airflow over it



As the aircraft stalls there is little or no laminar flow over the wing surface

STALLING : CENTRE OF PRESSURE

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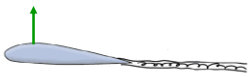
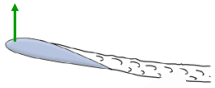


At “Normal” flight angles, the centre of pressure (the point where the lift operates) is about 1/3 chord



As the angle of attack is increased, the centre of pressure moves **forwards** (the lift is having to “pick up” more of the wing)

At the stall the centre of pressure moves rapidly **rearwards** causing a pitch **down** in most aircraft

STALLING : RECOGNITION

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APPROACHING A STALL You may get some or all of the following signs:

Sloppy controls – Less airflow over the surfaces makes them less effective because they are moving fewer air molecules

Yaw – becoming more obvious
Slipstream effect still occurring but less rudder authority to correct either through slower speed or because of turbulent airflow

Nose high attitude and associated reducing airspeed

Light Buffet as turbulent air reaches tailplane

Stall warning horn

STALLING : RECOGNITION

GROUND SCHOOL

THE STALL

At the stall the following usually happens:

- Aircraft pitches nose down

The aircraft is designed to do so – the centre of pressure moves rearwards and the angle of attack automatically reduces

- Heavy buffet

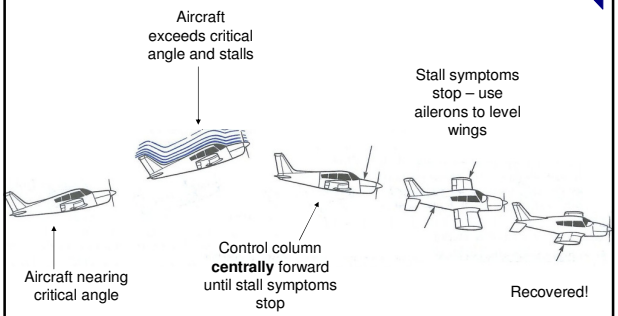
May be felt with large amount of turbulent airflow reaching the tailplane

- Stall warning

Will continue to sound until angle of attack is reduced below the stalling angle (usually about 16° for a light aircraft)

STALLING : RECOVERY

GROUND SCHOOL



STALLING : FACTORS AFFECTING

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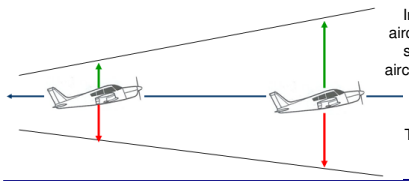
WEIGHT

A heavier aircraft will need to produce more lift to stay airborne

The stall will still occur at the same angle but the speed will change



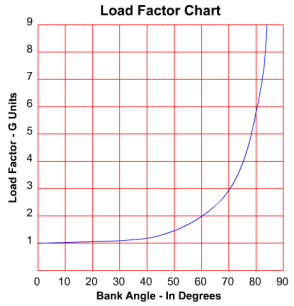
In this example the left aircraft is lighter and would stall at 40 kts, the right aircraft is heavier and would stall at 50 kts

The angle is the same

STALLING : FACTORS AFFECTING

GROUND SCHOOL

LOAD FACTOR



Load factor affects the "G" of the aircraft and its effective weight

The more weight, the harder the wing has to work to produce the lift

A higher angle of attack is needed and this brings the aircraft closer to the critical angle

For example, a 60° banked turn is a 2G turn – the aircraft's effective weight is doubled

STALLING : CHANGE OF STALLING SPEED

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If an aircraft usually stalls at 90 kts and is in a 60° banked turn, how do we work out what the new stalling speed will be?

New Stall Speed = Old Stall Speed x √(Load Factor)

The turn has a load factor of **2**

{ For the mathematicians: Load Factor = 1 / cos(bank angle) }

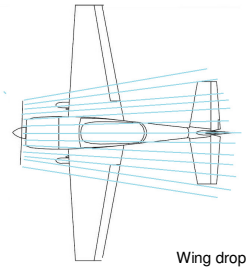
The square root of the load factor is **1.4**

90 kts x 1.4 = **127 kts**

STALLING : FACTORS AFFECTING

GROUND SCHOOL

POWER



Thrust from the propeller accelerates the airflow and adds kinetic energy to it

This delays the separation of the airflow from the wing surfaces

This means that the stall is delayed in terms of speed (still the same angle!)

Wing drop in the stall is more likely due to uneven amounts of stalling on the wings

STALLING : FACTORS AFFECTING

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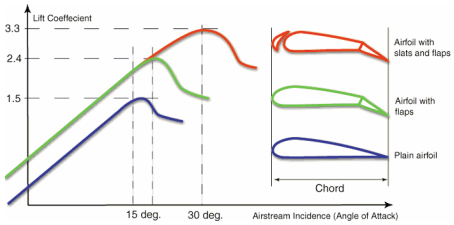
FLAPS Flaps are designed to reduce the stalling speed of an aircraft (despite the fact that the stalling angle of attack is reduced)



The effect depends upon the amount of flap selected and the type of flap being used

With slotted Fowler Flaps, the critical angle (stalling angle of attack) may also be increased to up to 30°

STALLING : FACTORS AFFECTING

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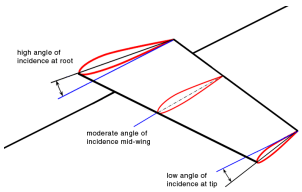
WASHOUT



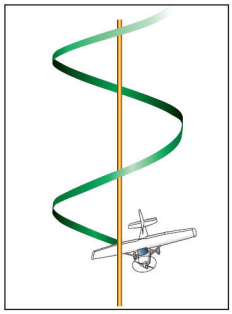
The "twist" of the wing ensures that the outer section of the wing has a lower angle of attack than the inner portion

This helps the wing stall at the root first

This is preferable because it means that ailerons are effective for much longer

STALLING : SPINNING

GROUND SCHOOL



Spinning occurs when one wing stalls more than the other and is uncorrected – autorotation follows

If the aircraft is not **stalled** it can't **spin** – this is why so much emphasis is placed on stall recognition in the PPL syllabus!

GROUND SCHOOL

PRACTICE QUESTION!

When is the co-efficient of lift at its maximum?

At the stalling angle of attack (C_{Lmax})

GROUND SCHOOL

Lecture 3 complete

Any Questions?