STALLS

STALLS - 1

- In order to fly, the wing must be able to produce enough lift to (at least) equal the load it must support – which makes sense…
- What is a stall, anyways? Basically, a “stall” occurs when the wing is no longer capable of producing enough lift to counteract the weight of the aircraft.

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- ***BUT!*** First things first – You need to have a basic idea of the aerodynamic formula for lift
- **Lift = ½ (Coefficient of Lift) x (Velocity)^2 x (Density of the air) x (Wing Area)**
- The speed of the airflow is, by far, the most important one – and the one you have most control over. If you double the speed – the lift increases FOUR TIMES!

STALLS - 3

- The Angle of Attack (AoA) is the angle between the chord line of the wing and the relative airflow.
- Increasing the angle of the wing to the relative airflow (the AoA) also increases the lift – up to a point – called the "Critical Angle of Attack".
- The CAoA for ~most~ normal airfoils is between about 15 – 20 degrees.

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- In a normal gliding attitude, the AoA is quite small. If the speed decreases, the Angle of Attack must increase (up to the CAoA), in order for the glider to keep flying normally.
- As the AoA increases, the "Center of Pressure" (CP) increases in size, and moves more towards the leading edge. Right before the stall, the lift is at a maximum value.

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- Beyond the CAoA, the CP rapidly moves rearward, and the nose drops earthward due to the loss of lift. As soon as the AoA is lower than the CAoA, the wing is unstalled. However, the other question that arises is: “Although the wing is unstalled, is the wing generating enough lift to support the weight of the glider?” Hmmmm……….

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- Well, now that the AoA is lower than the CAoA what sort of stuff may affect the stall, you ask? Let's go back to the formula for lift... The one thing you have most control over is the speed of the airflow. Remember, doubling the speed increases the lift FOUR times.
- Now that the speed is under control and you have recovered properly using the official SAC approved techniques, our thoughts turn to:

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WHAT FACTORS AFFECT THE STALL??

(In addition to AoA and speed of the airflow)

1) **WEIGHT** – The higher the glider's weight, the more lift the wing has to generate in order to fly.
2) **TURNS** – When the angle of bank increases, a portion of the original "level flight" vertical component of lift is displaced towards the inside of the turn – which means we're going to start descending (more than usual) if we don't increase the amount of lift.

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All of this now brings us to ***LOAD FACTOR***. The Load Factor is the ratio between:

The *"Effective Weight"* (the weight the glider feels), DIVIDED by the *"Actual Weight"* (of the glider.

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For example, in a 60 degree banked turn at a constant airspeed, the Load Factor is 2(also more commonly known as 2G's). You feel twice as heave as you do when sitting in the cockpit waiting to takeoff. The glider also ~feels~ like it's twice as heavy, and requires twice as much lift to keep from stalling. The level flight (1G) stall speed multiplied by the square root of the Load Factor equals the stall speed for that angle of bank.

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DEGREE OF BANK	**LOAD FACTOR**	**SQUARE ROOT**
15	**1.04**	**1.02**
30	**1.15**	**1.07**
45	**1.41**	**1.19**
60	**2.00**	**1.41**
75	**3.86**	**1.96**

The impact of the Load Factor on the stall speed can be quite dramatic at higher angles of bank. At 75 degrees of bank, the stall speed is almost DOUBLE (1.96) the 1G stall speed.

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3) Center of Gravity – As the CG moves forward, the download (lift in a downward direction – just like a weight) on the tail increases, to keep the nose up.

4) Surface Contamination – Snow, Ice, Dirt, Frost, Dew, **BUGS**… For example, surface contamination comparable to medium or coarse sandpaper can reduce lift by up to 30% and increase drag up to 40%. ***Clean your wings!***

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5) Heavy Rain - Impact craters and waves in the water film roughen the surface. They also decrease the airflow velocity. Huge degradation in glide performance and potentially large increase in the stall speed is the result.

6) Turbulence – Abrupt changes in wind speed or direction / wind shear can change the AoA.

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7) Flaps – Flaps can be both high lift and high drag devices. One will lower the stall speed, one will increase the stall speed. For example, “Thermalling” flap settings, “Landing” flap settings, “Negative” flap settings.

ACCELERATED (high speed) stalls are stalls which occur with a Load Factor higher than 1 (1G), such as steep turns or when pulling out of a dive.

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Recognizing the approach to a 1G stall

- The stick is further back than normal
- Low airspeed
- Low noise
- Mushy controls – ailerons not very responsive, and the elevator will not raise the nose further
- Buffeting / shuddering of the controls or airframe

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Any Questions?

- Why do we increase the speed on final approach?
- What do we do when entering a steep turn and why?
- What happens to the nose of the aircraft when we level out of a steep turn, and why?