

# APPI PPG

## LECTURE 1: THEORY OF FLIGHT



This is the most important lecture because on Day 1 the students need to understand that they make the wing fly and keep it flying. It is also the most complicated lecture and therefore needs to be simplified and related to Paragliding and Paramotoring.

### How does a wing fly?

- A glider is an aerofoil, this means that it is aerodynamic and therefore flies through the air. In order for it to fly, the aerofoil requires a Centre of Pressure, created by 4 forces acting upon the wing: Lift, Drag, Weight and Forward Speed.

#### 1. Lift

- As the wing moves through the air the leading edge disrupts the airflow, some air must go over the wing and some must go under.
- However, the aerofoil is designed in a way that makes the top surface (A), a further distance for the air to travel over than the bottom surface (B).
- This means that the air molecules traveling over the top surface move faster than the air traveling along the bottom surface.
- If one imagines 2 ping pong balls being split up as they reach the leading edge of the wing, the ping pong ball on the top surface will have to travel faster than the ping pong ball underneath in order for the two to meet at the trailing edge at the same time.
- This acceleration means that there are fewer molecules of air per m<sup>2</sup> on the top surface than there are on the bottom surface.
- This creates a low pressure on the top surface and high pressure on the bottom surface, resulting in the generation of Lift.
- 2/3 of lift is generated by the low pressure on the top surface, creating a vacuum and sucking the wing up. 1/3 of lift is created by the high pressure on the bottom surface, forcing the wing up.
- The more brake one applies, the more one increases the angle of attack and more lift is created. However, there comes a point where the air can no longer flow over or under the wing and this results in a stall.

- The angle of attack is the angle between the Chord line, an imaginary line running from the leading edge to the trailing edge, and the relative airflow.
- Another way to increase the angle of attack and therefore the lift is by applying power. As the Paramotor is 5/6 meters below the wing, by applying power the pilot is pushed ahead of the wing, thus increasing the angle of attack and allowing the wing to climb. At this point it is very dangerous to apply a lot of brake as the wing is close to the stall point.
- The key thing to remember about lift is the Need for Speed! To generate lift the pilot needs to run and keep running. To maintain lift the pilot needs to be gentle with the brakes and never apply an excessive amount of brake, normally no lower than the pilot's chest.
- The only time the pilot should apply both brakes below their chest is during landing when, at approximately 2m above the ground, they perform a flare.

## 2. Drag

- There are 2 main forms of drag, Parasitic Drag and Induced Drag. Form and Profile drag are part of Parasitic drag and used when referring to cars etc.
- Parasitic drag is anything that creates air resistance such as our clothes, the body, the paramotor, paraglider lines etc.
- As you double your airspeed you quadruple your Parasitic drag.
- Induced drag is created by the generation of lift. So every time you apply power to climb you are creating induced drag because you are increasing your angle of attack. Therefore when you decelerate the angle of attack decreases, the wing starts to fly faster, the Induced drag decreases and the Parasitic drag increases
- The best way to understand induced drag is to put your hand out of the window when in a car. With a flat hand, parallel with the ground there is very little resistance or drag. However, the more you tilt your hand up, the more resistance one feels.

## 3. Weight

- Paragliders are designed for certain weights in order to correctly balance out the other three forces and create a solid centre of pressure.
- If a pilot is heavy on a wing then the wing will fly and sink faster, it will also take off, fly and land a lot faster. It will cut through the turbulence more efficiently and be more dynamic to fly.
- If a pilot is light on a wing then it will fly and sink slower, it will also take off, fly and land a lot slower. However it will be more susceptible to tucks and collapses, as it will not be fully pressurized.
- All paragliders are designed to fly with a set glide angle. Most paragliders have a set glide ratio of 8:1. This means that they travel 8ft forward to every 1ft down.

- The glide angle is the angle between the pilot's actual flight line and the imaginary horizontal flight line.
- Due to the construction of the wing, if a 70kg pilot were to fly the same sized wing as a 100kg pilot from the same height they would both land in the same spot. However the heavier pilot would fly faster and arrive earlier but the glide ratio will remain the same.

#### **4. Forward Speed**

- This is a very simple concept to understand. If your wing is not flying at an airspeed of at least 12 –14mph then it will either not take off or it will stall.
- Therefore, in order to take off you need to give it that airspeed by running into wind and continuing to run. If you stop running it will stall and if you apply too much brake it will also stall!
- There are three different types of speed:
- Airspeed: The speed the wing moves through the air; normally around 25mph when flying without using the brakes, speed bar, trimmers or the reflex system.
- Wind Speed: The speed of the wind, this is variable however for this exercise let's say 10mph.
- Ground Speed: The speed of the wing over the ground, which varies due to the wind speed and the direction the wing is traveling relative to the wind.
- If the wing is flying into a 10mph head wind what will the ground speed be? Answer: 15mph.
- If the wing is flying down wind in a 10mph wind what will the ground speed be? Answer: 35mph.
- Which way should we take off and land? Into Wind, Into Wind, Into Wind!

#### **Key Points to Remember**

- Weight, helped by gravity, is the only force which acts upon the wing when there is no more Forward Speed. So the most important thing to remember is the Need for Speed! Keep Running, Never Jump, sit down or raise your legs. While flying don't brake below your chest until you come in to land.
- The Flare is a pull and push with the brakes as low as they go, starting at approximately 2m above the ground.
- Use the correct wing for your weight and always Take Off and Land into wind!

**ANY QUESTIONS?**

**END OF LECTURE 1**