Chapter 3 - Finding your way through the clouds!

The less smooth it is, the lower the plane goes.

Next, the spoilers! They’re like air brakes that mess up the smooth airflow over the wings.

Even the landing gear opens up early to catch wind.

Now, the plane flies slow enough to land! The wheels touch the ground.

And the engines start spinning the other way to – much like a bird – push air forward and slow down even more.

To top it all off, the wheels start braking too. Sure, it’s more work for us, than for birds, but the result is same!

The spoilers get up straight, not only for braking, but also to let the air push the plane on the ground.
How to brake with nothing but air!

Landing

An average airplane flies about 900 kilometers per hour. That's 10 times faster than a car!

Well, have you ever seen a bird land? At some point you need to slow down to land. But how do you do that in the air?

It makes its wings bigger and pushes air forward bit. A plane brakes quite the same way.

When the descent starts, the pilot opens up the flaps and slats. That makes the wings bigger, so they catch more wind.

Content

Chapter 1: How things fly
There are loads of things in the sky: balloons, birds, airplanes, and helicopters. Did you know they all fly in a different way? In this chapter, you find out how they reach the skies!

Chapter 2: 10,000 airplanes in the sky
There are tons of planes in the sky right now! But it took a lot of hard work to get them there. Discover how we invent, power and design those flying machines!

Chapter 3: Finding your way through the clouds!
Ever wondered how airplanes get from one place to another? You’ll need invisible highways, engines that spin the other way and chewing gum. This chapter will explain everything!
How do they float?

Balloons… you know them. In any color… in any size!

But do you know how they fly?

Well, balloons are actually one of the first things we’ve ever put in the sky!

More than 300 years ago, someone folded a paper balloon and put a flame underneath it. And… to his surprise… it went up!

But why does hot air go up?

Why does hot air go up?

Now, we’ve got to get technical. This is normal air.

See that tiny hole in the window? No, that’s not a mistake. That’s like the “chewing gum” for windows! It helps them get used to the different air as well.

Wow! Did you feel that? That’s turbulence. It happens because air moves all the time. The air is like a sea and the plane is like a boat.

But instead of riding waves, it rides winds!

Planes can handle the biggest bumps, so you’ve got nothing to worry about.

Just buckle up and enjoy the ride!

Chapter 3 - Finding your way through the clouds!
What can you expect on a flying adventure!

On an airplane you’ll hear, feel and do things you’ve never experienced before!

Flying is a real adventure! So, what’s going on?

And this [engine sound] is the engine during take-off. But once you’re in the air… the loudest noise you’ll hear is the air conditioning!

You’ll hear sounds like CLUNK PING and THUMP!

This might seem strange, but remember, you’re in a big machine. Things are constantly moving, like the cargo hold door or the landing gear.

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Up there, your ears might feel a bit funny. This is because the air is different and your ears have to get used to that.

Just pop in some chewing gum, and see… your ears feel fine again!

It’s made of molecules. How many there are and how far they’re apart is called “density”.

When you heat air up, the molecules go further apart. That makes it lighter. Because it weighs less than the normal cooler air, it floats up. Very “cool”.

That’s why you see those big flames in a hot air balloon. To heat up the air inside and float away.

But the smaller balloons aren’t warm, so why do they float too?

Well, they have a different kind of air in them. It’s a gas called helium.

And just like hot air, it’s lighter than normal air.

So… in what balloon would you like to float away?
Why birds are the perfect flying machines

Ok, let’s try something. Spread out your arms… move them up and down…

What happens? Nothing much, right? So, why is it that when birds do it, they fly?

First off, our arms have a different shape. But even if we had wings like that, we still couldn’t fly.

That’s because of difference number two: we are too heavy!

Lastly, we’re not strong enough. Now you might think…

Well… they’re a bit different than you and I.

Our bones are solid, and bird bones are hollow! It makes them super light. Cool huh!

The pilots can see the highways and waypoints with a GPS system. They even have GPS navigation!

That gives the pilot time to check the weather, or talk to Air Traffic Control.

Between airports, Area Control Centers support the pilots in the sky. There are about 400 around the world!

They know all the flight plans of all the airplanes and make sure they don’t fly at the same height or fly too close to each other.

That way, airplanes fly safe and always find their way!
The invisible highways in the sky

For cars… we have highways, signs and GPS navigation to tell us where to go. But you can’t see anything like that in the sky. So why don’t planes get lost?

Well actually, there are a kind of highways in the sky too. They’re called airways! The airways even have intersections and markers, called waypoints. They all have a five letter name, like DIDOS or NEVIV, or more fun ones like LEAKY, BOATS, and SINK in Australia. And SPICY, BARBQ, and RIBBS in America.

Our “wingmuscles” aka, arms, are one hundredth of our total weight, birds? One sixth! How can such a tiny bird be stronger than me? All the strength of a bird goes to its wings.

With their wings, birds push air down, and at the same time push themselves up. And because they are so strong and so light, they can fly. Light, they can fly. Don’t forget the tail! It helps the bird fly straight, and is a kind of steering wheel. By moving it left, the bird turns left, and the other way around.

That makes a bird the perfect flying machine! What would your flying machine look like?
How do airplanes reach the clouds?

It's pretty clear that planes are based on birds. The shape, the wings and the tail look very similar. But... birds flap their wings to fly... planes don't flap, but still fly. Why is that?

When there's no wind, you first have to run a bit before it goes up. If the kite stays flat, nothing happens. And if you change the angle a bit... it goes up!

Now, let's change the angle. The top airflow bumps up a bit and that gap sucks everything up. So your kite isn't pushed up by air... it's sucked up! This is called lift.

It's all about lift. Have you ever used a kite?

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This is because of the air that flows around your kite. See what happens when the kite lays flat?

Wind is mostly an issue during take-off and landing. But if it's too stormy, planes simply won't fly for a bit. Until the storm passes.

The last weather forecast is ice. It gets stuck on the wings and makes it a bit harder to fly and steer.

You might feel a little turbulence, but that's because thunder clouds are a bit bumpy.

Planes don't mind the rain as well. The drops just glide off when it freezes.

It's all got to do with lift. Have you ever used a kite?

But... of course they have something for that too! Bleed air! With the hot air that comes out of the engines, it heats up the wings... and melts the ice. No problem.

So next time you're flying, you know that a little thunder... is nothing to worry about!
Ahh… nice ‘n cozy. And that thunder…? That’s far away. Well, did you know, that you’re just as safe in that storm as under your covers?

Yep, airplanes sometimes fly through storms. Like that. And come out without a scratch. How do they do it?

An airplane does exactly the same with its wings…

An airplane is made of metal, like aluminum. It works like a lightning rod when lightning strikes. It guides the electricity off plane again, protecting the space where we sit.

And instead of running… it uses big engines! Engines have tons of tiny wings pushing air away, just like a fan does. They’re spinning so fast, it creates enough speed to suck up the wings...

And make that big plane fly! How would your plane look like?
Helicopters are the hardest thing to fly!

Have you ever been in a car and stuck your hand out of the window? But instead of hands, it has blades. But see, those blades are tilted just like your hand. While the blades are spinning... the helicopter pilot can change the tilt of the blades on one side! When you tilt your hand a little bit... wow! You feel your hand lift up! Now, tilt it the other way. You feel your hand go down.

Well, a helicopter does exactly that!

If the helicopter starts spinning its blades, it pushes the air down, and... you’ve guessed it... it goes up! Now, comes the really cool part.

When you tilt your hand a little bit... wow! You feel your hand lift up! Now, tilt it the other way. You feel your hand go down.

But instead of hands, it has blades. But see, those blades are tilted just like your hand.

That’s how a plane “rolls” to the left. Cool huh?

Chapter 3 - Finding your way through the clouds!

Chapter 3 - Finding your way through the clouds!

The second way a plane can turn is up or down. This is called pitching.

Roll

Pitch

Elevators

The last turn is a subtle one: the yaw.

It’s done with the rudder in the back. By turning, it changes the direction.

Rudder

You use those little things at the back for that, the “elevators”.

Yaw

The plane is going a little to the left, or a little to the right.

Rudder

So... if you can use three steering wheels at once... you’re ready to fly an airplane!
Three ways a plane can turn

In a car, steering is pretty straight forward. You turn the steering wheel right...

The wheels turn, and you go right. Right. But how does a plane steer without wheels?

Well, wings can’t move, of course.

But they have small parts that can move, and that’s where the magic happens.

On the back of the wings, there are little parts called ailerons. Some have one.

Some even have three! They can move up and down. When the right one is down, the bottom part of the wing catches more air and is pushed up.

But we’re not there yet! Most helicopters also have tail blades. Because the main rotor turns one direction.

To fly, you need to use three different controls! Yeah... flying a helicopter is not easy...

But a lot of fun!

The tail rotor is there to prevent that. With tiny blades, it constantly keeps the helicopter balanced.

But you’d get terribly dizzy right?

By pushing air away harder on one side than the other... you can steer, in any direction!

The cabin automatically wants to go the other, pshaw...

Chapter 1 - How things fly
As long as we can remember... birds inspired us to reach for the skies.

And that's how our history of flying started. Well...

More like the history of falling. We tried being birds, but somehow... we kept falling and... yeah... falling.

In 1804 we designed a functional flying machine. George Cayley's design was inspired by a kite!

In 1493, Leonardo da Vinci started getting the first ideas of how we could fly.

And in 1904, the Wright brothers flew 59 seconds straight with their propeller aircraft for the very first time.

Another century later, the Wright brothers flew 59 seconds straight with their propeller aircraft for the very first time.

1493
1804
1904

Next, they drove to the runway. That's called "taxiing".

Then they power up the engines, let go of the brakes and... WOW!

Once they're going fast enough, the pilot lifts up the nose and off he goes. Bon voyage!

Then they power up the engines, let go of the brakes and... WOW!

Sometimes that takes a few minutes. Sometimes it takes more than a half-hour!

There, they hit the brakes and...

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Sometimes that takes a few minutes. Sometimes it takes more than a half-hour!

There, they hit the brakes and...

Flaps
Slats

Make their wings bigger. Yep, they can do that! With flaps on the back, and slats in the front, it's easier to lift up!
The plane has to do it all by itself! They also bring extra fuel in case there’s a lot of wind or they have to fly to a different airport nearby. Better safe than sorry!

How does an airplane get in the sky?

Well, there are big catapults at every airport... shooting planes into the- nahh...

First, the pilot and co-pilot plan the best route. They look at the weather, how many people and bags are on the flight and calculate how much fuel they need. At average, a plane needs about 12 liters per kilometer.

Then they check the plane. The pilots check the outside, AND THE SYSTEMS ON THE INSIDE, CHECK!

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What you need for speed in the skies!

15.000 in the sky!

Transporting ourselves. This is mostly done with passenger airplanes. Right now, there are about 15.000 in the sky!

14. They have big bodies to carry us and can only smoothly fly from big airport to big airport.

But... you'd need different aircrafts to do them. Let's start off with the most obvious mission.

There are a lot of different things you can do in the sky.

Then it instructs everyone on the ground. A super tug, as strong as a tank, drags the plane to the gate.

Then it's time to travel. Those cute cars collect the luggage.

And the stairs... well... they are stairs. Every car is especially made to help the plane!

Now, inside the airport new passengers are being prepped.

And the cabin crew helps everyone on board.

The tower welcomes the airplane and tells it when and where it can land.

And the cabin crew helps everyone on board.

In bigger airports, their bags are moved with a special kind of luggage-rollercoaster, hidden behind the walls and floors of the airport.

The airport also has hangars where airplanes can be maintained. So they're ready for a new trip!

Chapter 3 - Finding your way through the clouds!
Airports: the perfect home of the plane

As you might have noticed, airplanes are pretty big. So obviously, their home needs to be big too.

Air traffic Control tower

That’s why airports are often just outside the city, where there’s more space.

But instead of cars, they direct those huge airplanes, everyone on the ground and every other airplane in the area.

Yeah… Air traffic control is no walk in the park!

So obviously, their home needs to be big too.

Every airport has an air traffic control tower. They’re like the traffic cops you sometimes see at intersections.

But the smallest ones can land on the smallest airports and if you run into a little dust and rubble, your propeller can handle it.

Feel like taking on a bigger task? Go for the aircraft that can carry another aircraft! Super cool.

And goes so fast… that sound can’t keep up! [Bang!]

Now, if you’d like to go super-fast, you’d need a jet airplane! This thing is built for speed. It’s flat, often triangle-shaped.

But the smallest ones can land on the smallest airports and if you run into a little dust and rubble, your propeller can handle it.

Say, you’d like to help others, then go for the helicopter.

Because they can go everywhere, to rescue people who are in danger, or to pick up someone who’s hurt and needs help right away.

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That’s why airports are often just outside the city, where there’s more space.

So… what’s your next mission?
Why painting an airplane is a bad idea!

When building a plane, you have to keep two things in mind: weight and safety. The lighter a plane is, the further it can go... so every gram helps. But...

The wings, for example! Did you know that they’re practically hollow on the inside? All to save kilos. But... the material on the outside is so strong... that they can bend all the way up.

Swapping light bulbs for LED lights. Thinner cables, slimmer seats, even the plane itself is made of lighter, but stronger materials.

If you stripped everything away... it wouldn’t be very safe now would it? That’s why it’s about balancing weight and safety.

So when you see wings wobble a bit... don’t worry, they can take it! They’ve been saving weight everywhere.

The lighter a plane is, the further it can go... so every gram helps. But...

Every new model of airplane makes less noise and emits less gas. So better for the rest of the planet!

But there’s always more we can do, right now.

Parts of old aircrafts are being used to build new ones. And the more we can re-use, the less trash we leave behind. Now that’s a happy planet!
Airplanes: Evolving for the planet

Chapter 2 - 10,000 airplanes in the sky

Last century... when we started flying... it wasn't very nice for the rest of the planet. Those engines weren't very efficient.

And the noise they made was like a very loud concert!! But well, at the time, flying was so special, it was just as fun as a concert. We want more! We want more!

Nowadays however, there are way more planes flying up there, so something had to change.

Airplanes do still emit some gas, like CO₂, but a lot less than they used to. And the noise? That's more like a big truck passing by.

The last kilograms are saved by painting the plane one color. Every extra color can weigh up to 500 kilos! That's the same as 6 people!

Then they make sure that the plane is safe. They do thousands of tests for any situation.

So next time you're flying, you can be sure it's safe! How would you build your airplane?

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500 Kilos!

So next time you're flying, you can be sure it's safe! How would you build your airplane?
Where do you find the fuel to fly?

If you want to fly... you need power. Currently, those big planes mostly use kerosene.

Super fuel, which makes sense, as a plane’s engine is a bit different than the one of a car.

This super fuel is pale yellow. In fact, every type of airplane fuel has a different color. Cool right?

You can make oil from certain plants, like olives or coconuts.

But then you’re using up food that we also need.

Another option is algae. It doesn’t need much space and makes quite a lot of oil.

But it’ll take a while before we can grow enough for every airplane.

How about the sun? Well, solar powered planes do exist, but they can’t carry more than a few people.

But not enough to power big planes, yet... so what will you use to power your plane?

Chapter 2 - 10,000 airplanes in the sky

Fuel

Oil

But... as you might know, fuel is made of oil and our planet only has a limited amount of that.

So... what else can we use to fly?

The problem is the battery. They store power, like from the sun or a power socket.