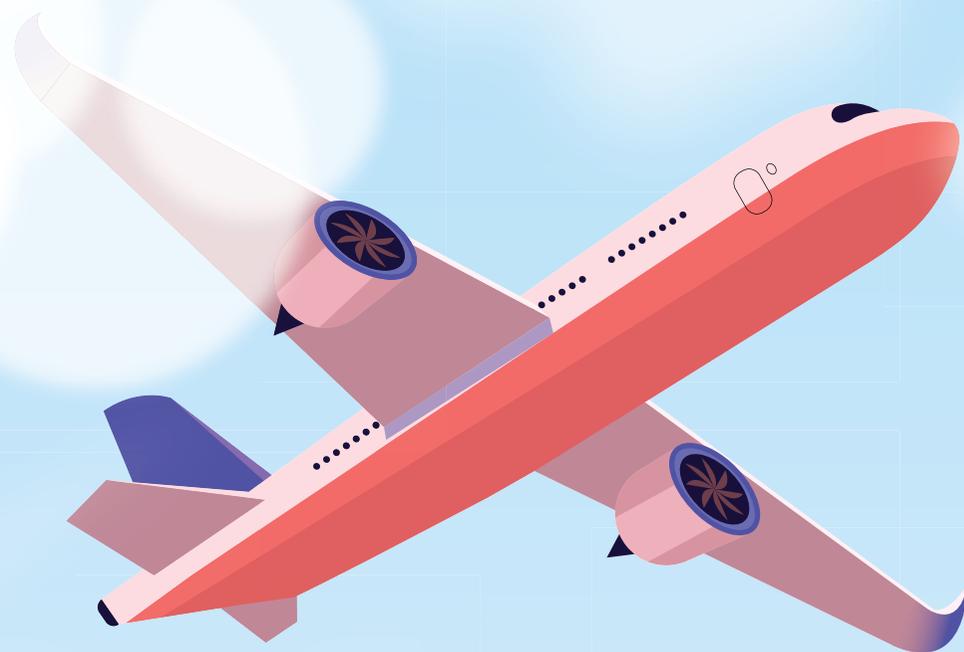


AIRBUS FOUNDATION

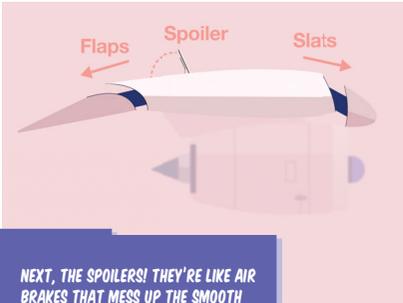
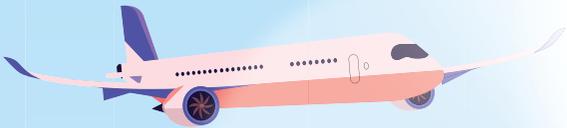
DISCOVERY  
SPACE

SCIENCE  
OF FLIGHT

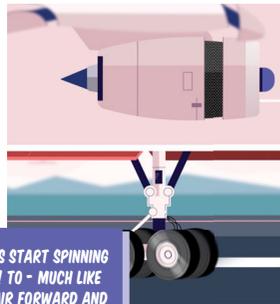
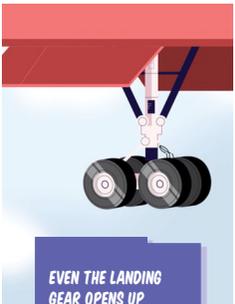


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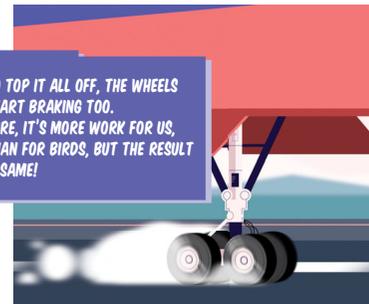


NEXT, THE SPOILERS! THEY'RE LIKE AIR BRAKES THAT MESS UP THE SMOOTH AIRFLOW OVER THE WINGS.



EVEN THE LANDING GEAR OPENS UP EARLY TO CATCH WIND.

AND THE ENGINES START SPINNING THE OTHER WAY! TO - MUCH LIKE A BIRD - PUSH AIR FORWARD AND SLOW DOWN EVEN MORE.



THE SPOILERS GET UP STRAIGHT. NOT ONLY FOR BRAKING, BUT ALSO TO LET THE AIR PUSH THE PLANE ON THE GROUND.

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!

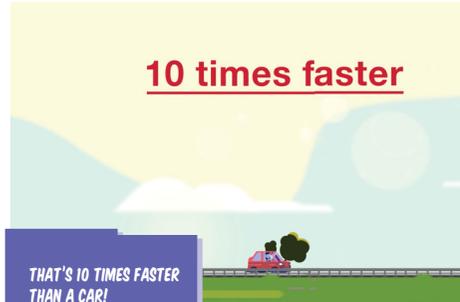
# Landing



**900 KM/H**

AN AVERAGE AIRPLANE FLIES ABOUT 900 KILOMETERS PER HOUR.

**10 times faster**



THAT'S 10 TIMES FASTER THAN A CAR!



AT SOME POINT YOU NEED TO SLOW DOWN TO LAND. BUT HOW DO YOU DO THAT IN THE AIR?



WELL, HAVE YOU EVER SEEN A BIRD LAND?



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 helicopters. Did you know they all fly in a different way? In this chapter, you find out how they reach the skies!

Chapter 2:

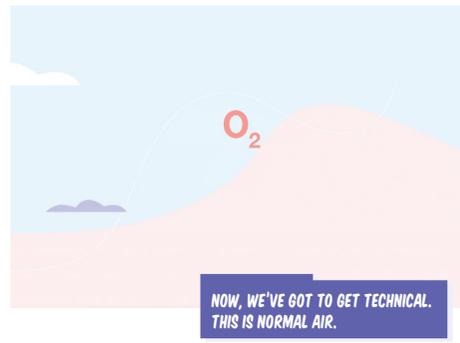
## 10.000 airplanes in the sky

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!

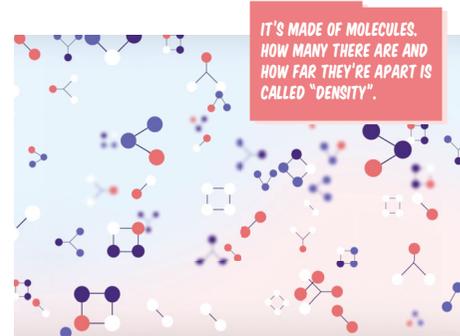




ON AN AIRPLANE YOU'LL HEAR, FEEL AND DO THINGS YOU'VE NEVER EXPERIENCED BEFORE!



FLYING IS A REAL ADVENTURE! SO, WHAT'S GOING ON?



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. THEN, THE DENSITY IS LOWER.

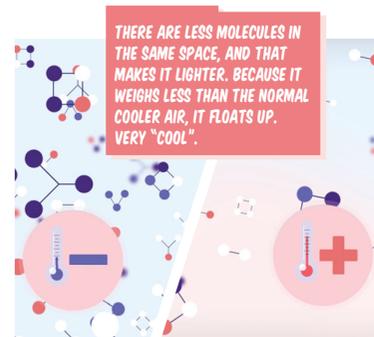


YOU'LL HEAR SOUNDS LIKE CLUNK PING AND THUMP!

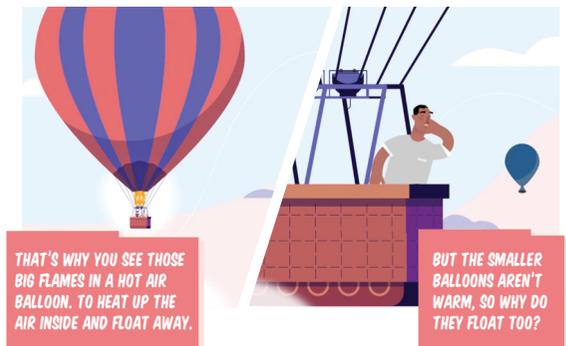
THIS MIGHT SEEM STRANGE, BUT REMEMBER, YOU'RE IN A BIG MACHINE. THINGS ARE CONSTANTLY MOVING, LIKE THE CARGO HOLD DOOR OR THE LANDING GEAR.



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!



THERE ARE LESS MOLECULES IN THE SAME SPACE, AND THAT MAKES IT LIGHTER. BECAUSE IT WEIGHS LESS THAN THE NORMAL COOLER AIR, IT FLOATS UP. VERY "COOL".

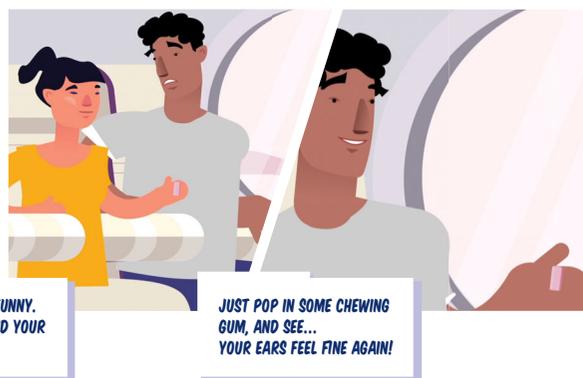


THAT'S WHY YOU SEE THOSE BIG FLAMES IN A HOT AIR BALLOON. TO HEAT UP THE AIR INSIDE AND FLOAT AWAY.

BUT THE SMALLER BALLOONS AREN'T WARM, SO WHY DO THEY FLOAT TOO?



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.

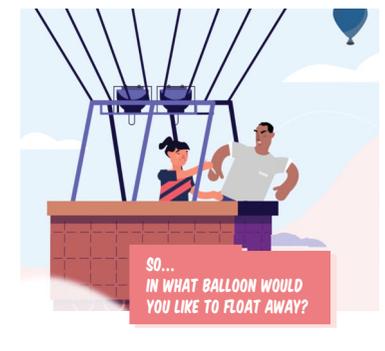


JUST POP IN SOME CHEWING GUM, AND SEE... YOUR EARS FEEL FINE AGAIN!



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?



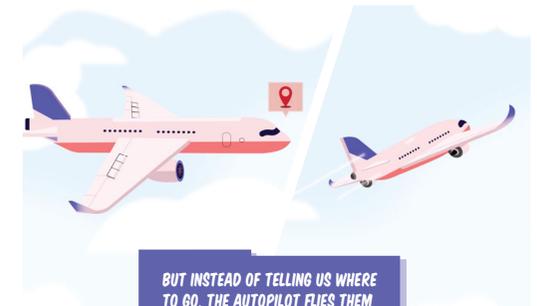
OK, LET'S TRY SOMETHING. SPREAD OUT YOUR ARMS... MOVE THEM UP AND DOWN...



WHAT HAPPENS? NOTHING MUCH, RIGHT? SO, WHY IS IT THAT WHEN BIRDS DO IT, THEY FLY?



THE PILOTS CAN SEE THE HIGHWAYS AND WAYPOINTS WITH A GPS SYSTEM. THEY EVEN HAVE GPS NAVIGATION!



BUT INSTEAD OF TELLING US WHERE TO GO, THE AUTOPILOT FLIES THEM THERE. MUCH COOLER.

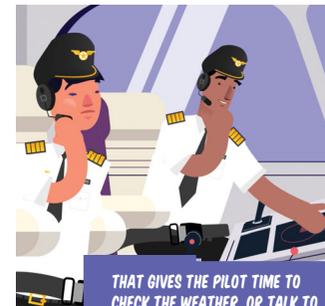


WELL... THEY'RE A BIT DIFFERENT THAN YOU AND I.

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!



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!



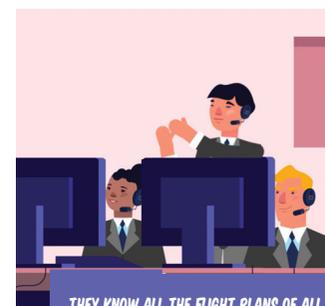
Human

Bird

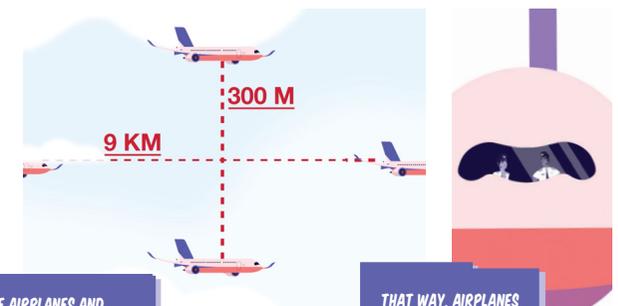
OUR BONES ARE SOLID. AND BIRD BONES ARE HOLLOW! IT MAKES THEM SUPER LIGHT. COOL HUH!



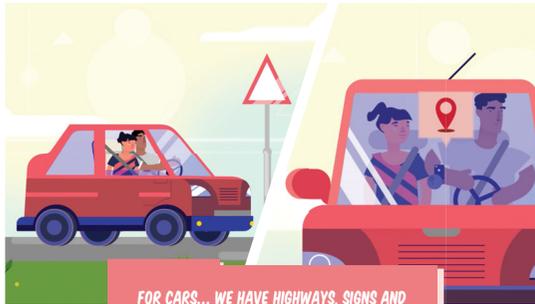
LASTLY, WE'RE NOT STRONG ENOUGH. NOW YOU MIGHT THINK...



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.



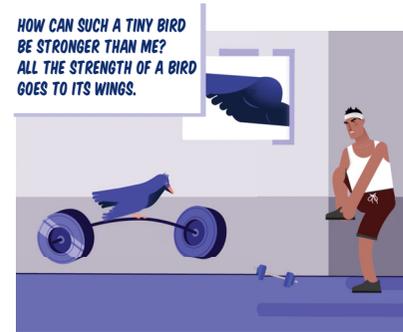
THAT WAY, AIRPLANES FLY SAFE AND ALWAYS FIND THEIR WAY!



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?



HOW CAN SUCH A TINY BIRD BE STRONGER THAN ME? ALL THE STRENGTH OF A BIRD GOES TO ITS WINGS.

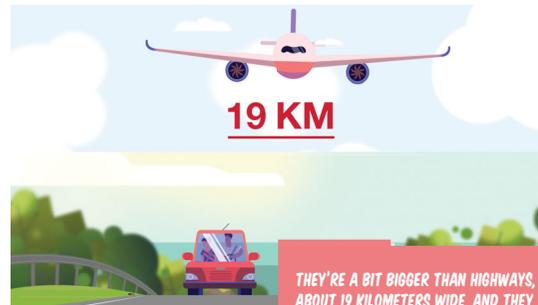


OUR "WINGMUSCLES" AKA, ARMS, ARE ONE HUNDRETH OF OUR TOTAL WEIGHT. BIRDS? ONE SIXTH!



WELL ACTUALLY, THERE ARE A KIND OF HIGHWAYS IN THE SKY TOO. THEY'RE CALLED AIRWAYS!

**Airways**

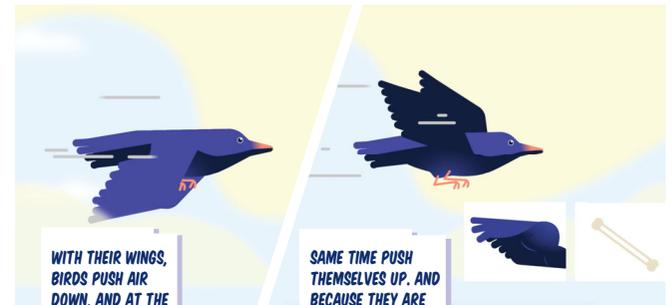


**19 KM**

THEY'RE A BIT BIGGER THAN HIGHWAYS, ABOUT 19 KILOMETERS WIDE, AND THEY CONNECT ALL THE AIRPORTS.



HAH... IMAGINE IF WE HAD ARMS LIKE THAT!



WITH THEIR WINGS, BIRDS PUSH AIR DOWN, AND AT THE

SAME TIME PUSH THEMSELVES UP. AND BECAUSE THEY ARE SO STRONG AND SO



**Waypoints**

THE AIRWAYS EVEN HAVE INTERSECTIONS AND MARKERS, CALLED WAYPOINTS. THEY ALL HAVE 5 LETTER NAME, LIKE DIDOS OR NEVIV. OR MORE FUN ONES LIKE LEAKY, BOATS, SINK IN AUSTRALIA. AND SPICY, BARBO, RIBBS IN AMERICA.



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?



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?



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 FLIES.



IT'S ALL GOT TO DO WITH LIFT. HAVE YOU EVER USED A KITE?



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!

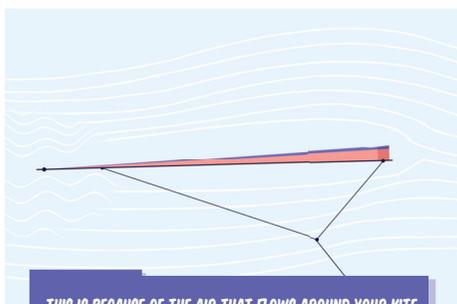


WIND IS MOSTLY AN ISSUE DURING TAKE-OFF AND LANDING.

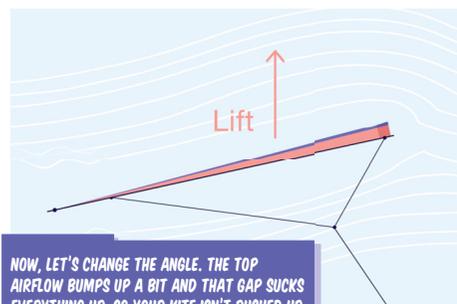
BUT IF IT'S TOO STORMY, PLANES SIMPLY WON'T FLY FOR A BIT. UNTIL THE STORM PASSES.



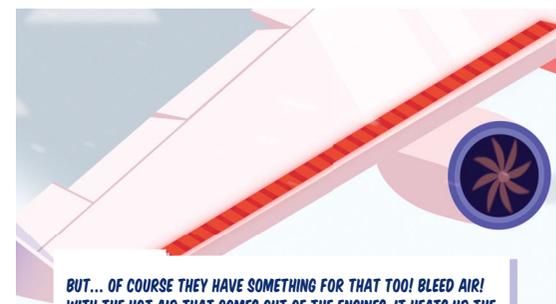
THE LAST WEATHER FORECAST IS ICE. IT GETS STUCK ON THE WINGS AND MAKES IT A BIT HARDER TO FLY AND STEER.



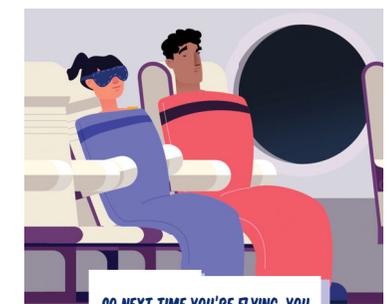
THIS IS BECAUSE OF THE AIR THAT FLOWS AROUND YOUR KITE. SEE WHAT HAPPENS WHEN THE KITE LAYS FLAT?



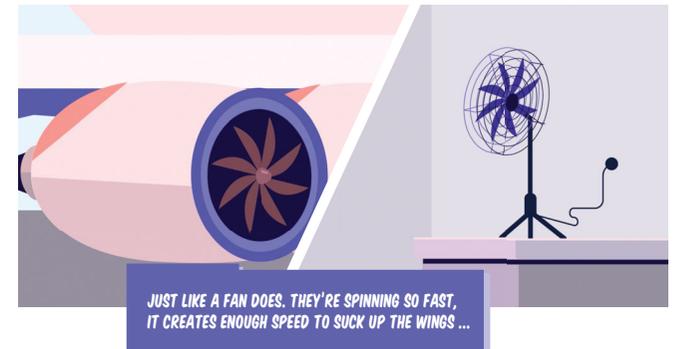
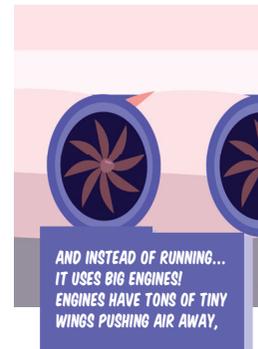
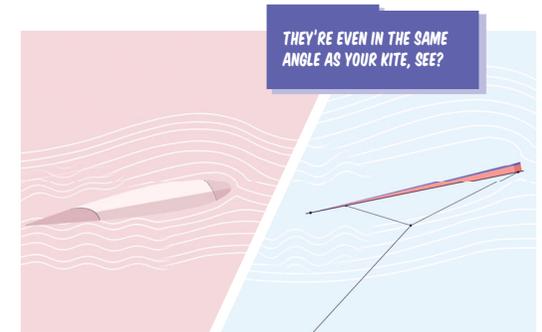
NOW, LET'S CHANGE THE ANGLE. THE TOP AIRFLOW BUMPS UP A BIT AND THAT GAP SUCKS EVERYTHING UP. SO YOUR KITE ISN'T PUSHED UP BY AIR... IT'S SUCKED UP! THIS IS CALLED LIFT.

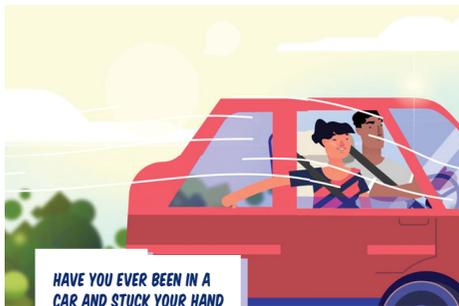


BUT... OF COURSE THEY HAVE SOMETHING FOR THAT TOO! BLEED AIR! WITH THE HOT AIR THAT COMES OUT OF THE ENGINES, IT HEATS UP THE WINGS... AND MELTS THE ICE. NO PROBLEM.



SO NEXT TIME YOU'RE FLYING, YOU KNOW THAT A LITTLE THUNDER... IS NOTHING TO WORRY ABOUT!





HAVE YOU EVER BEEN IN A CAR AND STUCK YOUR HAND OUT OF THE WINDOW?

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!

BUT INSTEAD OF HANDS, IT HAS BLADES. BUT SEE, THOSE BLADES ARE TILTED JUST LIKE YOUR HAND.



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.



WHILE THE BLADES ARE SPINNING... THE HELICOPTER PILOT CAN CHANGE THE TILT OF THE BLADES ON ONE SIDE!



AT THE SAME TIME, THE LEFTAILERON GOES UP, AND PUSHES THE WING DOWN.



THAT'S HOW A PLANE "ROLLS" TO THE LEFT. COOL HUH?

Roll



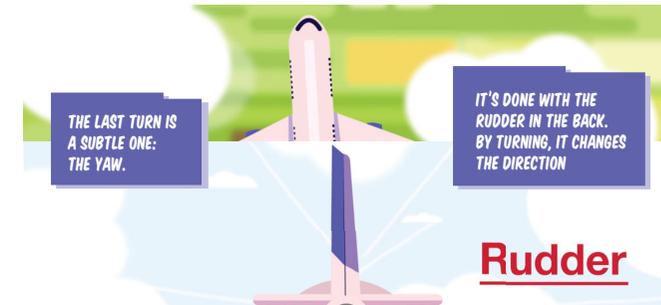
THE SECOND WAY A PLANE CAN TURN IS UP OR DOWN. THIS IS CALLED PITCHING.

Pitch



Elevators

IT USES THOSE LITTLE THINGS AT THE BACK FOR THAT, THE "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



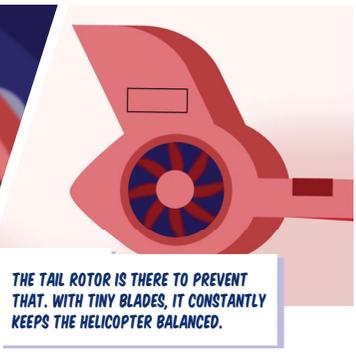
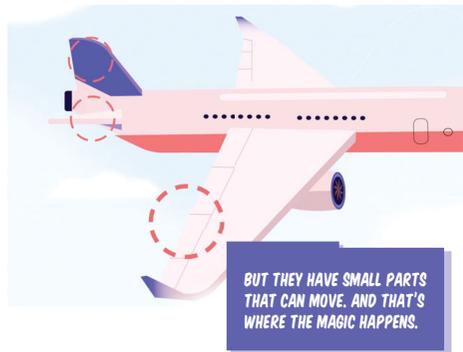
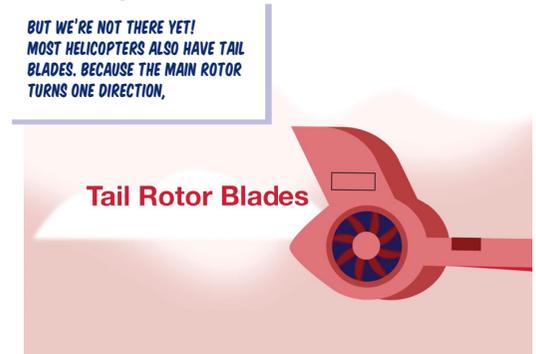
Yaw

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!





AS LONG AS WE CAN REMEMBER... BIRDS INSPIRED US TO REACH FOR THE SKIES.



AND THAT'S HOW OUR HISTORY OF FLYING STARTED. WELL...



### Taxiing

NEXT, THEY DRIVE TO THE RUNWAY. THAT'S CALLED "TAXIING".



SOMETIMES THAT TAKES A FEW MINUTES, SOMETIMES IT TAKES MORE THAN A HALF-HOUR!

MORE LIKE THE HISTORY OF FALLING. WE TRIED BEING



BIRDS. BUT SOMEHOW... WE KEPT FAILING AND... YEAH... FALLING.



1493

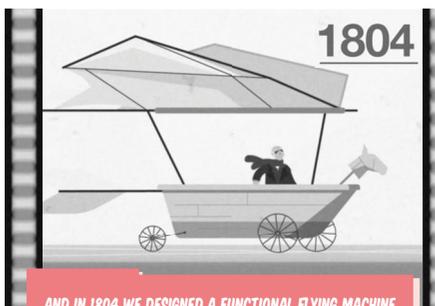
IN 1493, LEONARDO DA VINCI STARTED GETTING THE FIRST IDEAS OF HOW WE COULD FLY.



THERE, THEY HIT THE BRAKES AND...

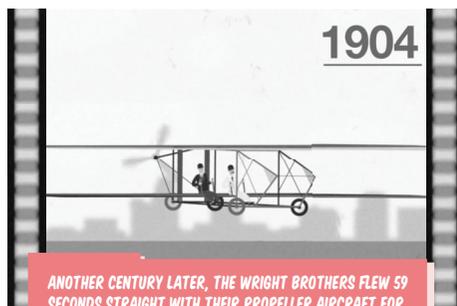


MAKE THEIR WINGS BIGGER. YEP, THEY CAN DO THAT! WITH FLAPS ON THE BACK, AND SLATS IN THE FRONT, IT'S EASIER TO LIFT UP!



1804

AND IN 1804 WE DESIGNED A FUNCTIONAL FLYING MACHINE. GEORGE CAYLEY'S DESIGN WAS INSPIRED BY A KITE!



1904

ANOTHER CENTURY LATER, THE WRIGHT BROTHERS FLEW 59 SECONDS STRAIGHT WITH THEIR PROPELLER AIRCRAFT FOR THE VERY FIRST TIME.



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!

**HOW DOES AN AIRPLANE GET IN THE SKY?**

WELL, THERE ARE BIG CATAPULTS AT EVERY AIRPORT... SHOOTING PLANES INTO THE- NAHH...

**1919**

NOW, FLYING REALLY TOOK HEH... FLIGHT! IN 1919 THE FIRST ALL-METAL AIRPLANE WAS BUILT, BUT IT COULD ONLY BRING 4 PASSENGERS.

**1931**

THE JUNKERS JU IN 1931 ALREADY CARRIED MORE. WITH ITS 3 ENGINES, IT COULD TRANSPORT 17 PEOPLE.

THEN FOLLOWED FIRST CHOPPERS, THE FIRST JET ENGINES.

THE PLANE HAS TO DO IT ALL BY ITSELF!

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.

**1952**

IN 1952 THE PASSENGER JET THE COMET STARTED FLYING, WHICH LOOKS A LOT LIKE THE PLANES TODAY.

**100 people**

3 hours

FIFTEEN YEARS LATER, THE SUPERSONIC CONCORDE FLEW 100 PEOPLE FROM PARIS TO NEW YORK IN THREE HOURS!

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!

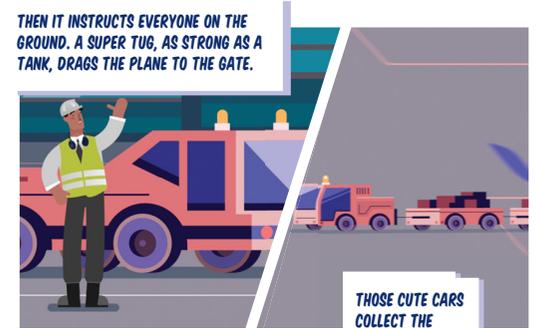
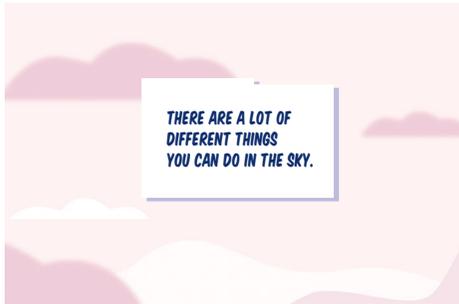
THEN THEY CHECK THE PLANE. THE PILOTS CHECK THE OUTSIDE,

AND THE SYSTEMS ON THE INSIDE. CHECK!

**800 people**

TODAY... THE AIRBUS A380, THE BIGGEST PASSENGER JET, CAN CARRY UP TO 800 PEOPLE.

I'D SAY WE'VE REACHED THE SKIES... AND BEAT THOSE BIRDS BIG TIME!





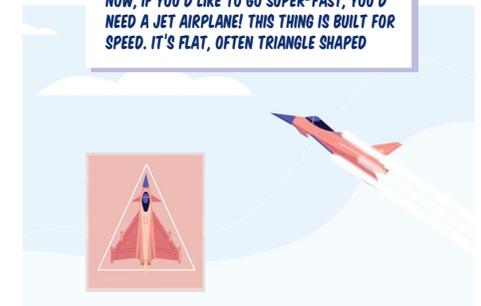
AS YOU MIGHT HAVE NOTICED... AIRPLANES ARE PRETTY BIG.



SO OBVIOUSLY, THEIR HOME NEEDS TO BE BIG TOO.



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.



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

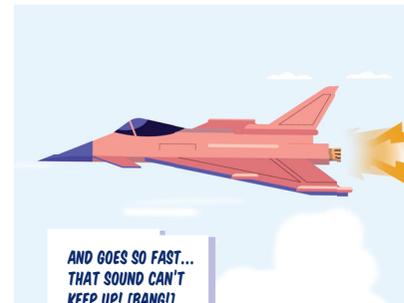


THAT'S WHY AIRPORTS ARE OFTEN JUST OUTSIDE THE CITY, WHERE THERE'S MORE SPACE.



### Air traffic Control tower

EVERY AIRPORT HAS AN AIR TRAFFIC CONTROL TOWER. THEY'RE LIKE THE TRAFFIC COPS YOU SOMETIMES SEE AT INTERSECTIONS.

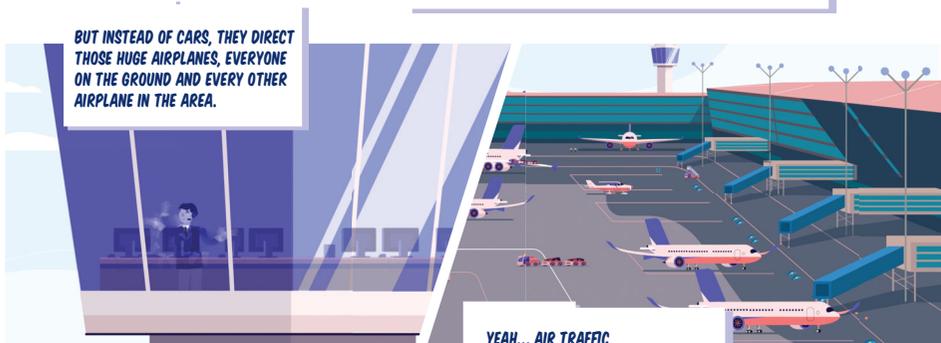


AND GOES SO FAST... THAT SOUND CAN'T KEEP UP! (BANG!)



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.

SAY, YOU'D LIKE TO HELP OTHERS, THEN GO FOR THE HELICOPTER.

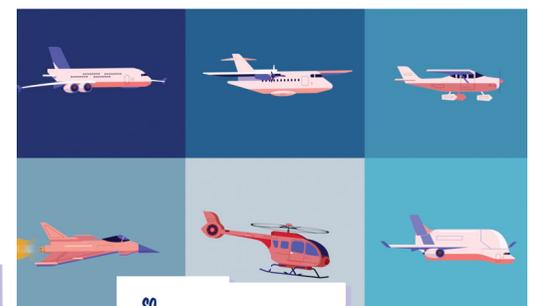


BUT INSTEAD OF CARS, THEY DIRECT THOSE HUGE AIRPLANES, EVERYONE ON THE GROUND AND EVERY OTHER AIRPLANE IN THE AREA.

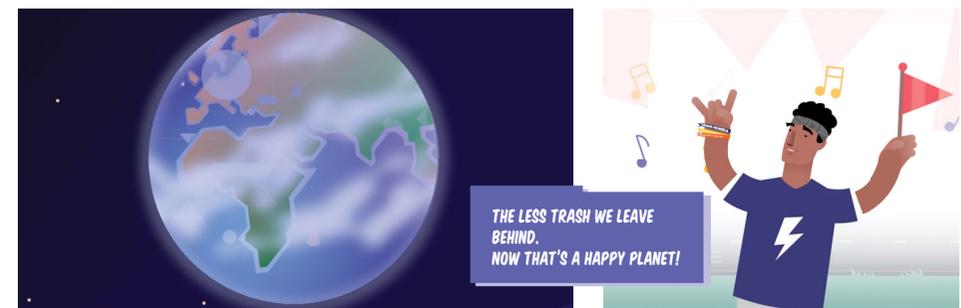
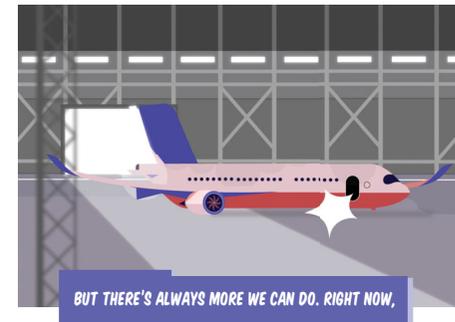
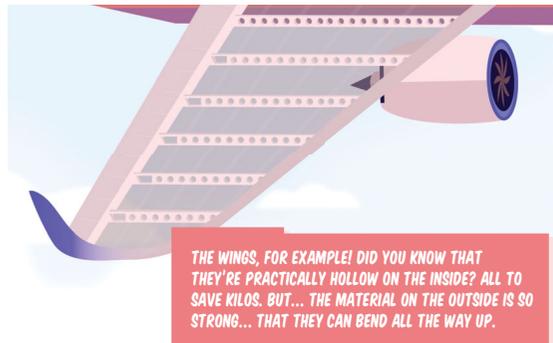
YEAH... AIR TRAFFIC CONTROL IS NO WALK IN THE PARK!

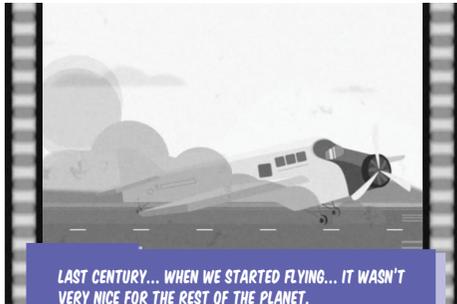


FEEL LIKE TAKING ON A BIGGER TASK? GO FOR THE AIRCRAFT... THAT CAN CARRY ANOTHER AIRCRAFT! SUPER COOL.



SO... WHAT'S YOUR NEXT MISSION?

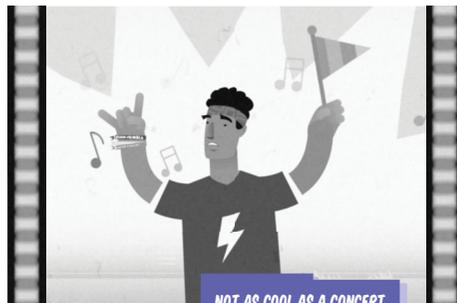
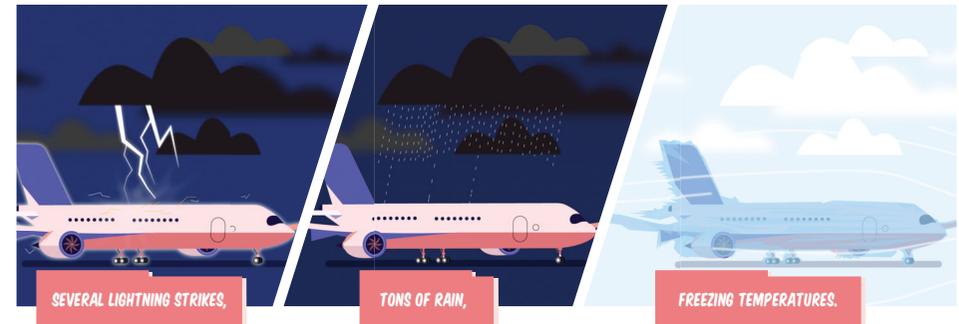
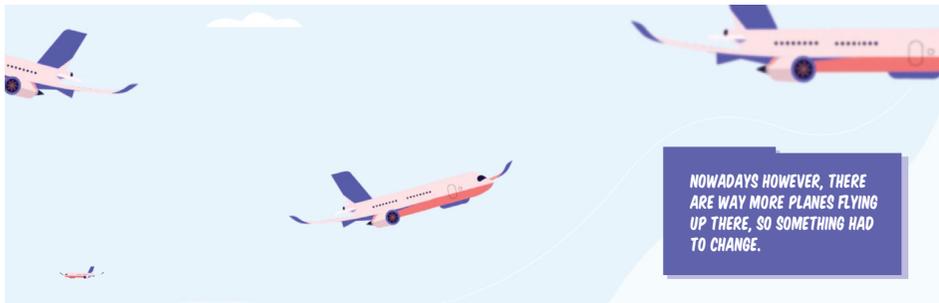




LAST CENTURY... WHEN WE STARTED FLYING... IT WASN'T VERY NICE FOR THE REST OF THE PLANET. THOSE ENGINES WEREN'T VERY EFFICIENT.



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!





IF YOU WANT TO FLY... YOU NEED POWER. CURRENTLY, THOSE BIG PLANES MOSTLY USE KEROSENE.



IT'S SIMILAR TO THE FUEL THAT GOES INTO A CAR, BUT TWEAKED AND FINE-TUNED FOR FLYING. SO...

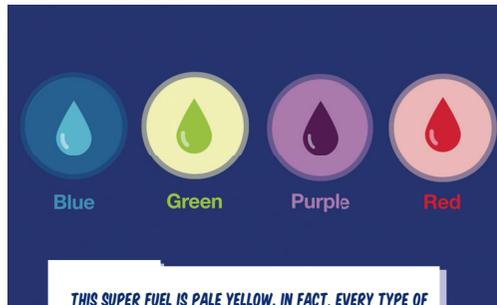
YOU CAN MAKE OIL FROM CERTAIN PLANTS. LIKE OLIVES OR COCONUTS.



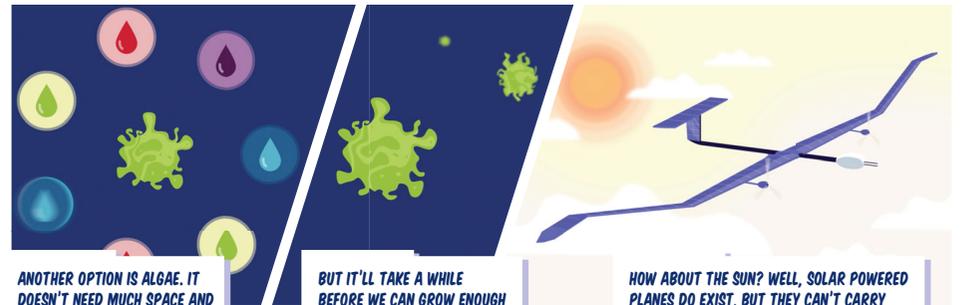
BUT THEN YOU'RE USING UP FOOD THAT WE ALSO NEED.



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?



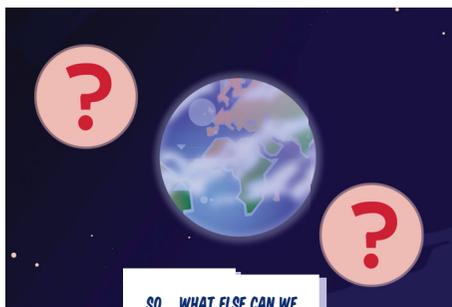
ANOTHER OPTION IS ALGAE. IT DOESN'T NEED MUCH SPACE AND MAKES QUITE A LOT OF OIL.

BUT IT'LL TAKE A WHILE BEFORE WE CAN GROW ENOUGH FOR EVERY AIRPLANE.

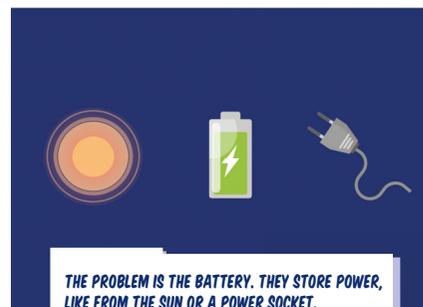
HOW ABOUT THE SUN? WELL, SOLAR POWERED PLANES DO EXIST, BUT THEY CAN'T CARRY MORE THAN A FEW PEOPLE.



BUT... 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.



BUT NOT ENOUGH TO POWER BIG PLANES. YET... SO WHAT WILL YOU USE TO POWER YOUR PLANE?