Introduction to Flight
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Lecture 05: Number 02.1
Aircraft Component Nomenclature: Wings and Its Component

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We now start with the presentation on aircraft component nomenclature so today, our task will be to familiarize you with some of the major components that go on the aircraft in general the aircraft can be divided into assemblies, sub-assemblies. parts and then you can go down to very very small parts. But a component in the aircraft actually means something like an assembly okay? so I will not be go in to revits and bolts and nuts but I will go to major parts like wing, fuselage, tail, etc.

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So let us see what are the components that we could cover in this presentation so we will of course cover the wing which is the main component we will proceed the fuselage of the body empennage or the tail and then we will go to miscellaneous now, this miscellaneous word is a very dangerous word okay? miscellaneous can mean anything .

So let us define, very soon what do mean by miscellaneous but before we start it is important for you to understand that we follow a particular axis when we talk about aircraft.

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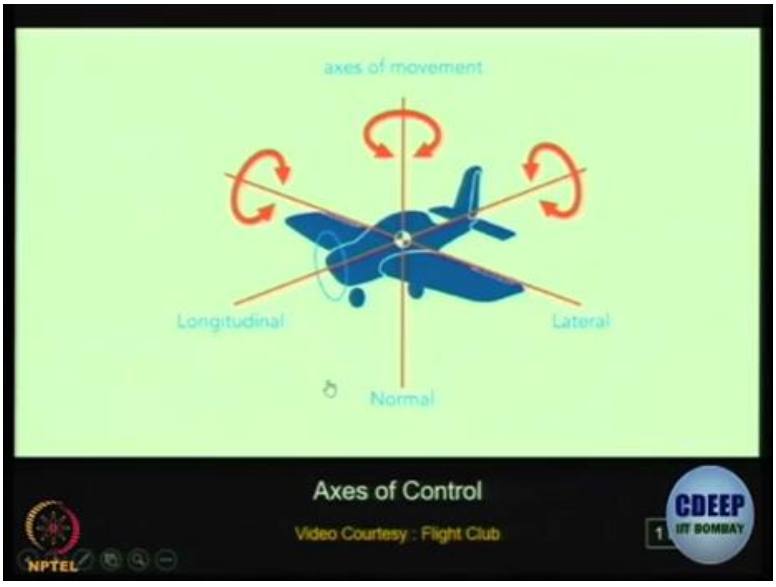

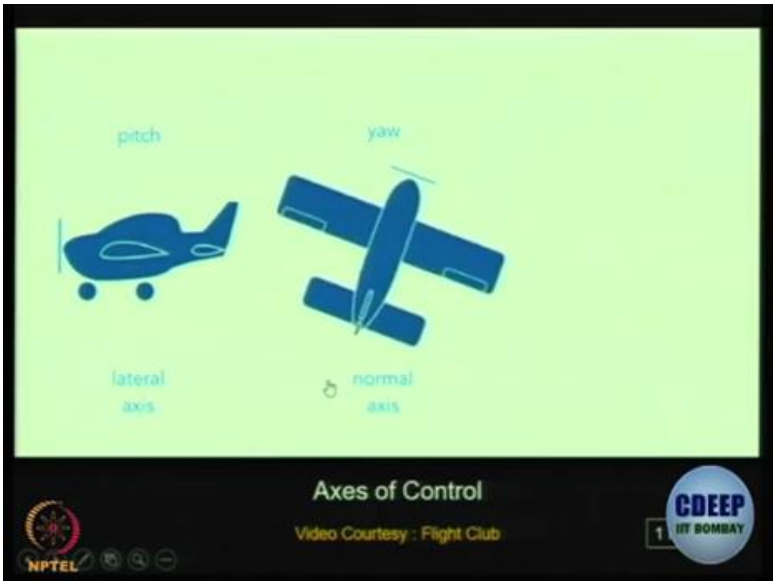
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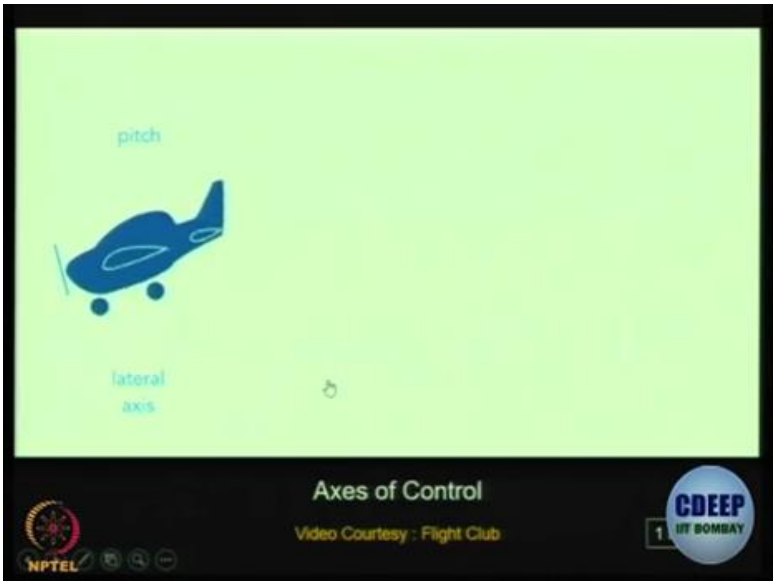
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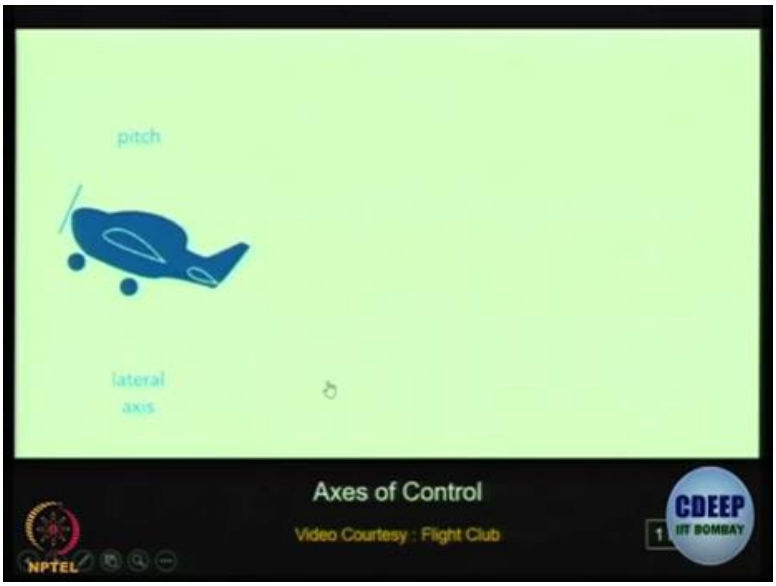
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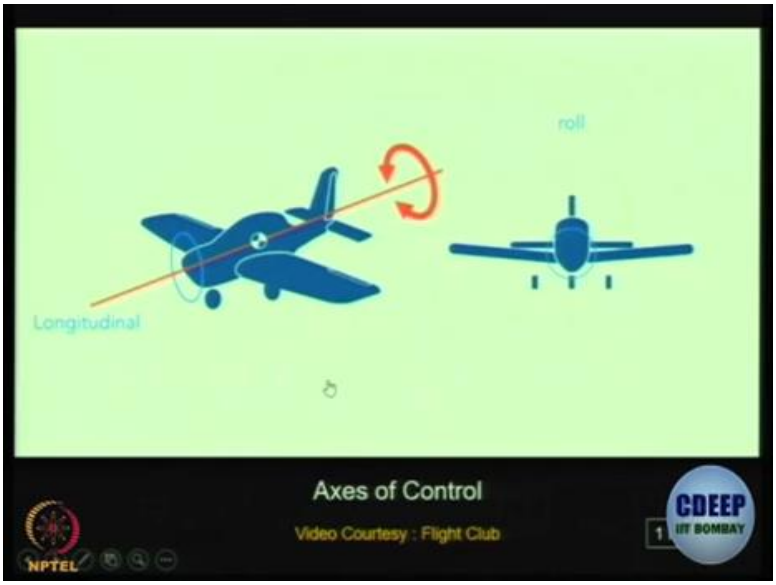
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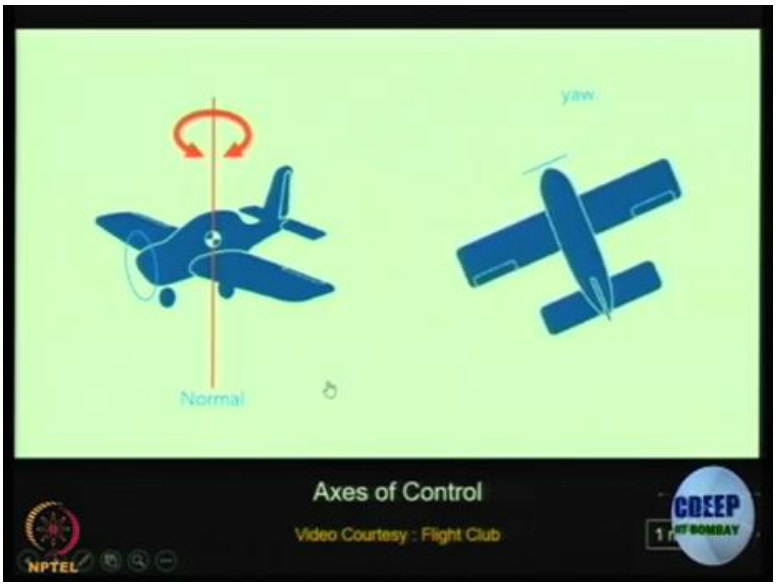
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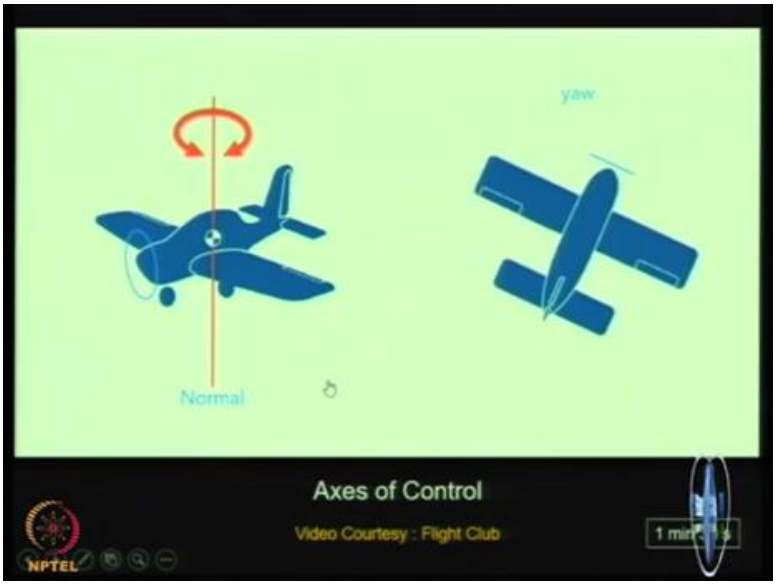
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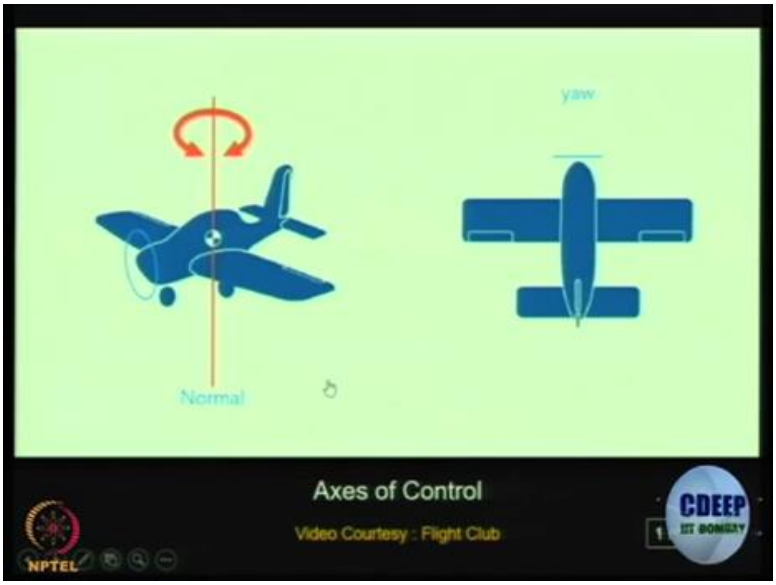
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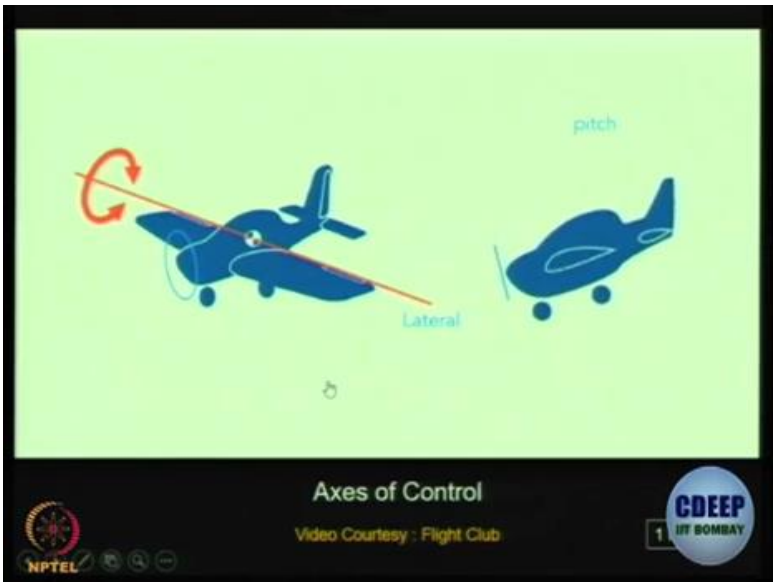
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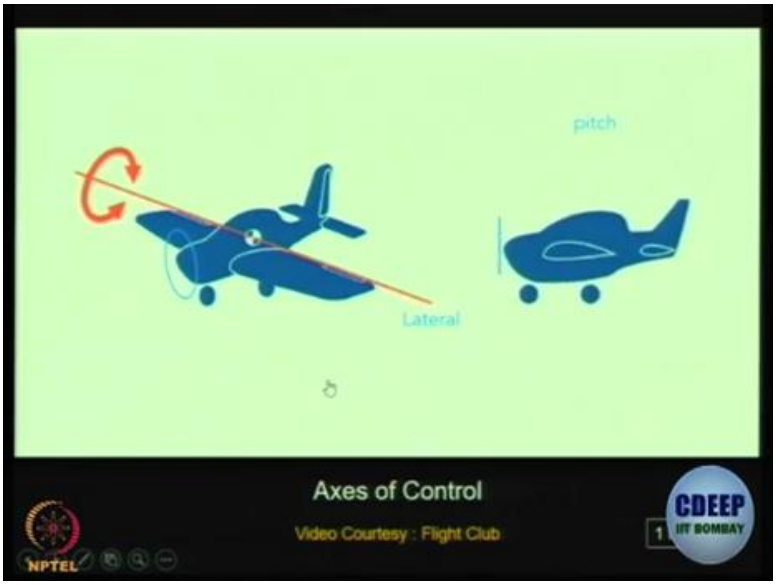

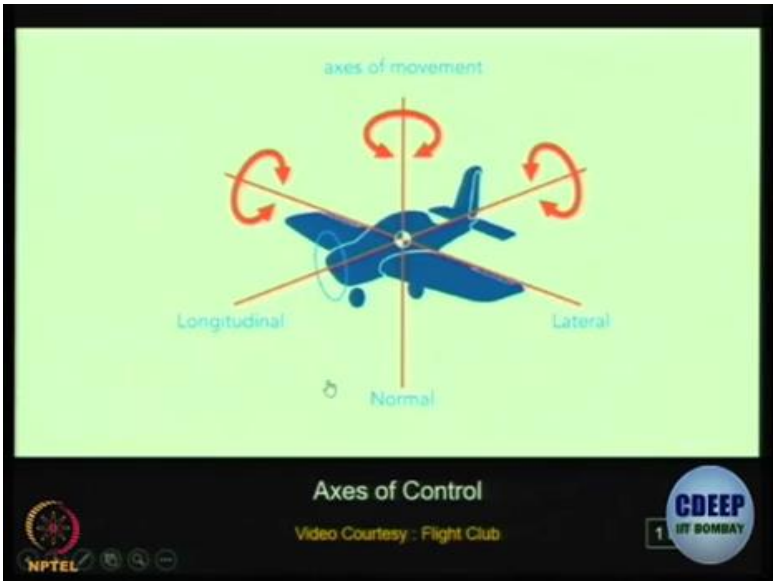

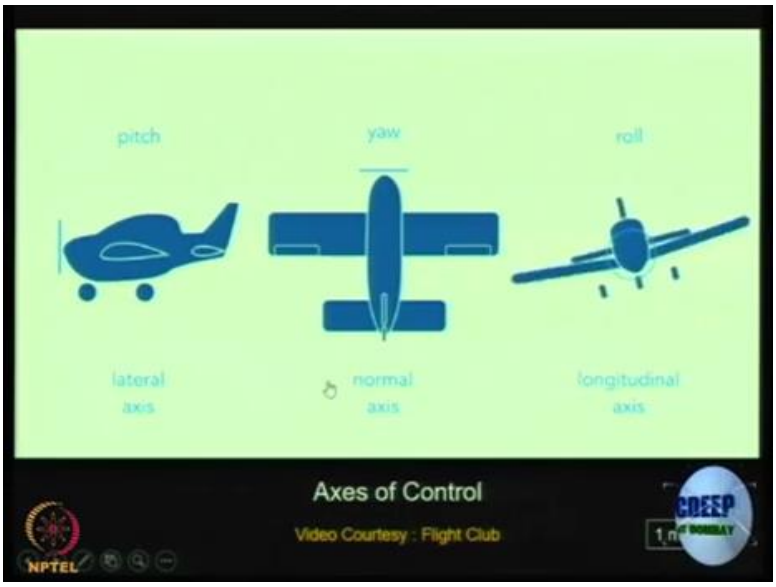

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Each of the three axis moves about the center of gravity, the aircraft principal axis are normal axis… that is a vertical axis… lateral axis… along the wing and longitudinal axis drawn from tale to nose, each axis is perpendicular to the other two axes. Let us look at it individually, the rotation path lateral axis is call pitch… nose up nose down we call pitch, so rotation about normal axis is called yaw, this is the movement of the nose of the aircraft from side to side… side to side movement of the nose is called as a yaw. The rotation about longitudinal axis is called roll, this is the movement of the aircraft wings, one wing goes up, the opposite wing goes down, so in summary these are the three principal axis of moment.

So in this presentation and also in the entire course we are going to use this three axis and this three moments pitching, rolling and yawing you have to appreciate what they are and remember this particular video right?

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So the first component of the aircraft that I want to talk about is the wing which is the major component okay? without wing it is very difficult have an aircraft so, here is a photograph of the wing as it looks from a particular window and you can see that the wing is just one single peace it contains several sub-assemblies few of these are visible in this photograph through the window, now there are two edges, so we will see which edge, we will see which parts of the wing moves and which parts remains stationary and we will see if we have missed something.

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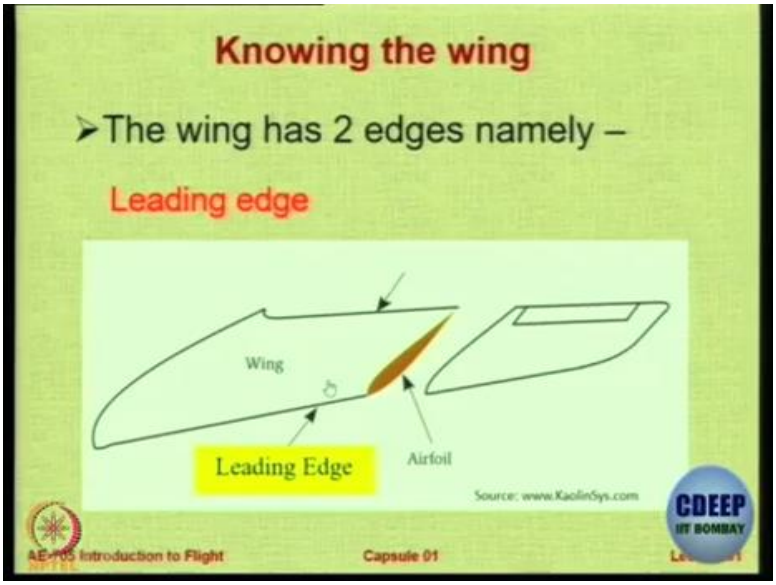

Okay? Let us see first the wing has two edges the leading edge and the trailing edge so the leading edge is the one that it is the air first it leads the trailing edge is the one that comes later okay? And if you cut the cross section of the wing the profile that you get is called as the airfoil if you are in the US it is airfoil if you are Europe it is aerofoil so it is the same thing actually.

whether it is airfoil or an airfoil, once again remember there is something not clear I would request you to please interrupt me.

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So let see that two wings in photographs we have the leading edge as seen from one of the windows why its leading it because it's in the front. how do I know because I can see the engine covering below and the one of trailing on the right is the trailing edge which is the rear portion and on the trailing edges there are certain things jacking out which we will very soon learn about.

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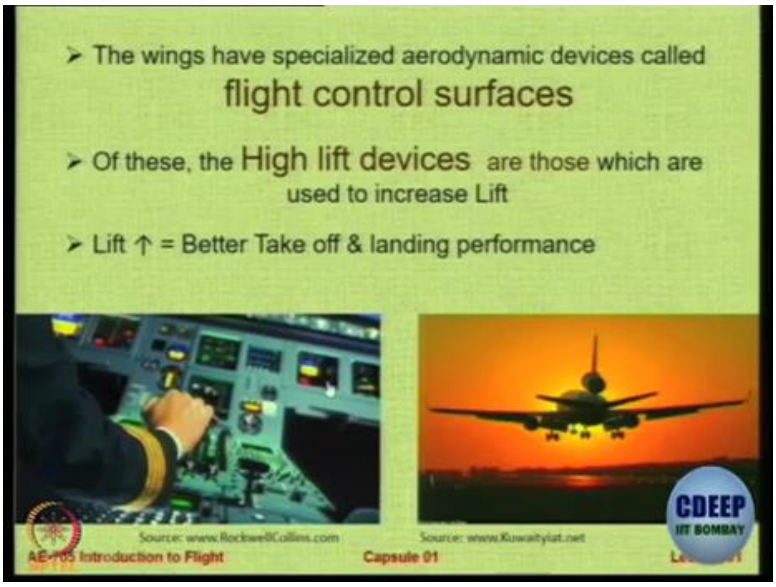

Okay,Now the wing is basically the device that produces the maximum lift and these devices are mounted or the wings are mounted on fuselage normally and there are some flight control surfaces mounted on the wing which help us in controlling the flight we also have some high lift devices which are basically meant to increase the lift so if you have better lift you have better takeoff and landing performance but there is also some other purpose of those.

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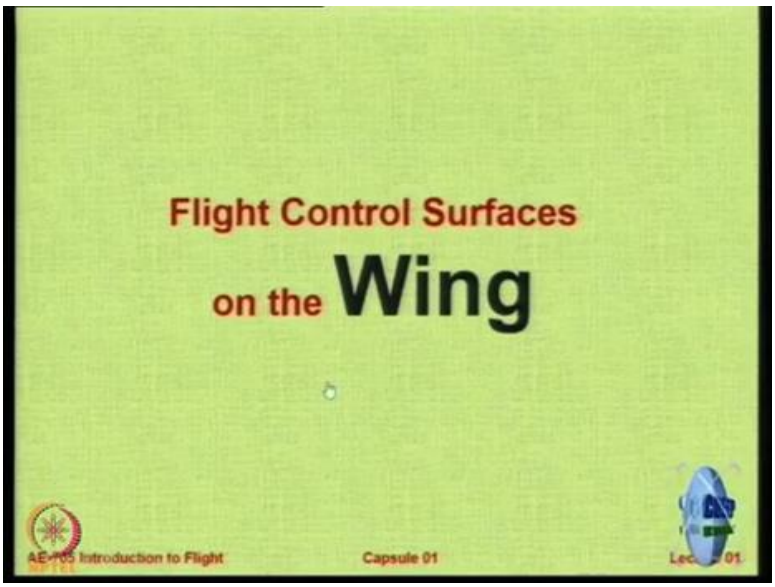
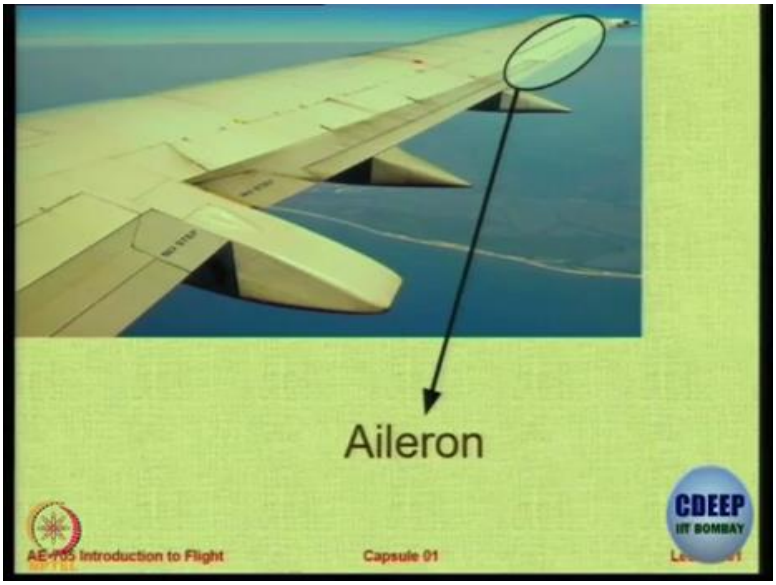
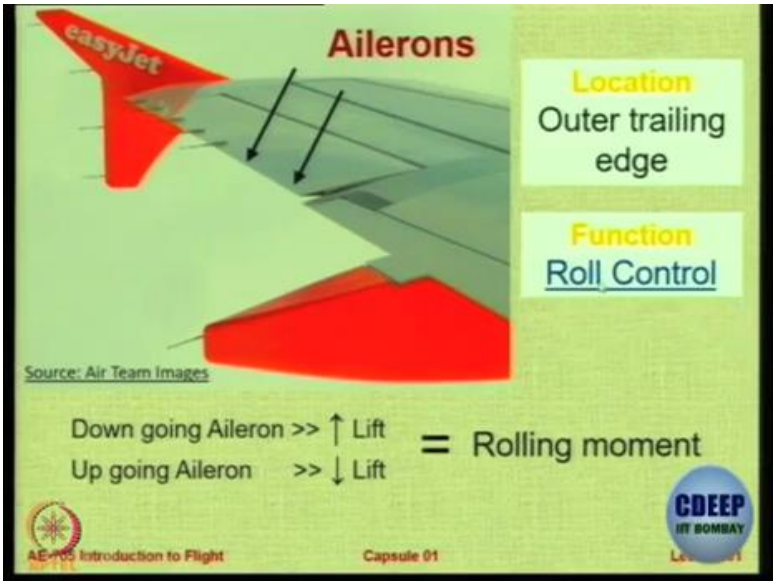


So first we will look at the wing and the control surfaces on the wing okay? so we look at this first the one which is extremely outboard is the aileron it has a specific function then if we just see what the aileron is we will see how it works.

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Ailerons
Location
Outer trailing edge
Function
Roll Control
Source: Air Team Images
Down going Aileron >> ↑ Lift
Up going Aileron >> ↓ Lift
= Rolling moment
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AE-105 Introduction to Flight
Capsule 01


Back
Ailerons and Roll control
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Rollers will be bank to turns the aircraft wings, turning the control right or left will cause the aircraft to bank in the same direction, this is accomplish with the ailerons, and surfaces out on the far end of each plane, they are similar in function to the elevator, however they work opposite each other, one goes up while the other goes down, the down will deflected the aileron ,mostly wings. while the upper deflected aileron drops the opposite way. This simultaneous lifting and dropping causes the aircraft to roll in the direction we desire thus turning the airplane. So do you understand ailerons always work together but in opposite direction, they are internally linked so when one aileron moves up the other aileron moves down. The one that moves down generates more lift, the one that moves up actually pushes that wing down so one wing is going down because of the air acting on it and you can also assume that the other wing is going up because of the air acting on it, so together they create a moment which overcomes the roll inertia and turns the aircraft or rolls the aircraft in the direction that is needed.

Now if in large aircraft we may have aileron split into many components usually we have an inboard aileron and the outboard aileron. So why do you think we need to have a breakup in the two ailerons. What could be the reason any one can try to answer this question. In case of failure then there is one aileron available but in case of failure you mean to say this is a backup, no no. We do not have inboard out board ailerons for a backup purpose. Please pass on the mic?Student: What is the different along the length of the…

No. my question is why do we break the aileron into two parts in board aileron and outboard aileron. Which is they are on each wing. Each wing has the inboard aileron coupled to the inboard of the other side, each wing has an outboard aileron coupled to the outboard coupled to the outboard of the other side.

So what is the reason, why we break it up? Yes, there is one person here.

So, what you are saying you want to add something to that you tried to what is your point of view?

Small and large changes in…?

In pitching.

Pitching? No.

Rolling.

In rolling okay. So basically the vision of aileron is two parts is driven by stress consideration, that if I actually deflect one peace aileron on a large aircraft the loads can become very high and may be term will be very sharp, which may lead to inconvenience to the passenger so therefore we have inboard ailerons which have a smaller moment arm, we have outboard aileron which have a larger moment arm.

When you want to have split roll you will deflect both of them. When you want a high speed roll you can deflect only outboard when you want to have a low speed board but then at very high speed it may be too much to deflect outboard aileron even by one small angle so you may like to deflect in board ailerons because the moment arm because the forces high because of high speed. So in supersonic flight you might turn using only the inboard aileron because the moment arm needed is less, sorry the moment distance needed is less. Force is coming from the aerodynamic force itself. So this not in every aircraft only in some aircraft. Location is in the outer trailing edge in the aircraft, function is roll control and the one that goes down give you more lift the one that goes up give you less lift and this gives you a rolling moment.

So let’s see one small clip of aileron in action and more so the effects of deflecting aileron.

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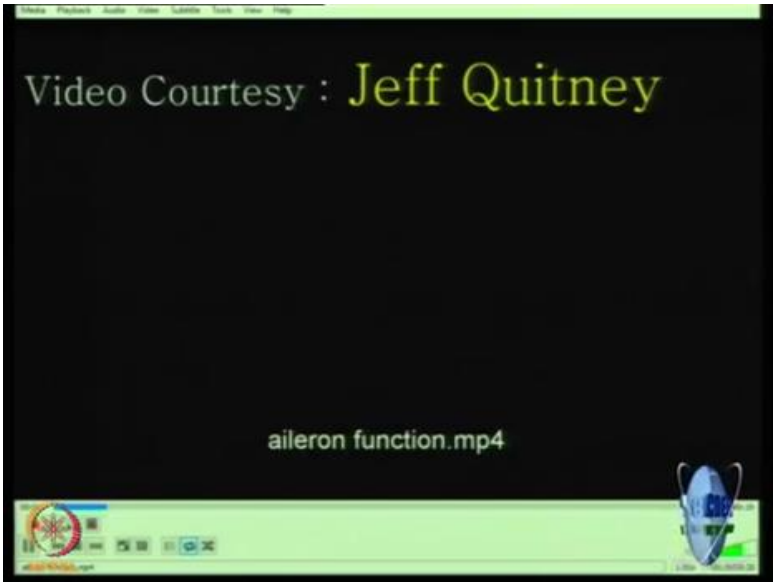

Very simple video, pilot deflects the aileron and that is the outcome of that in this case the pilot continues to hold the aileron so therefore you continue to get the moment go more than ninety degrees and then you will level up and after leveling off you are back, okay?

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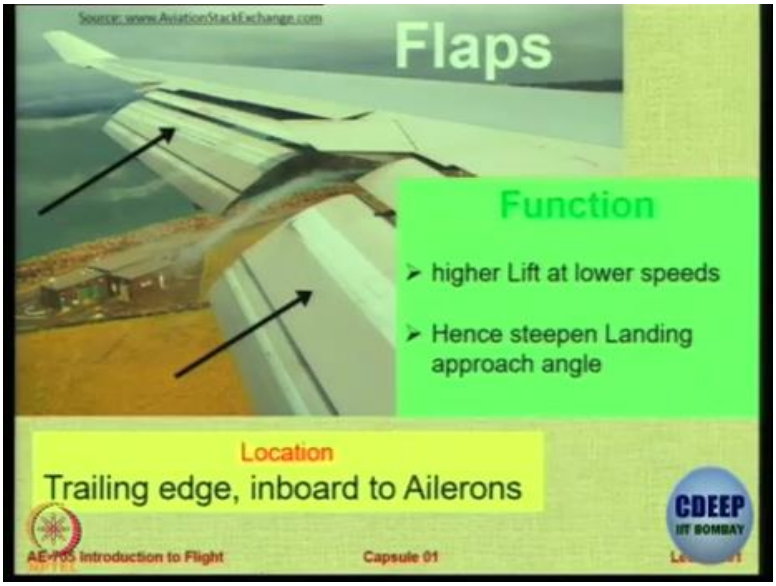

Alright let us see the next thing let us look at flaps, flaps are little bit complicated in some aircraft as you seen in this aircraft there are so many of them okay? so what is it? location is the trailing edge inboard to aileron, aileron are always more than outboard of the flaps so they are located inboard from the aileron but there could be many many of them. So what is the function of flaps? These are flaps on the trailing edge so their function is at lower speed I would like to provide higher lift we will study how we get more lift by the flaps at the moment I am not going to really start explaining the aerodynamic behind it because that comes later.

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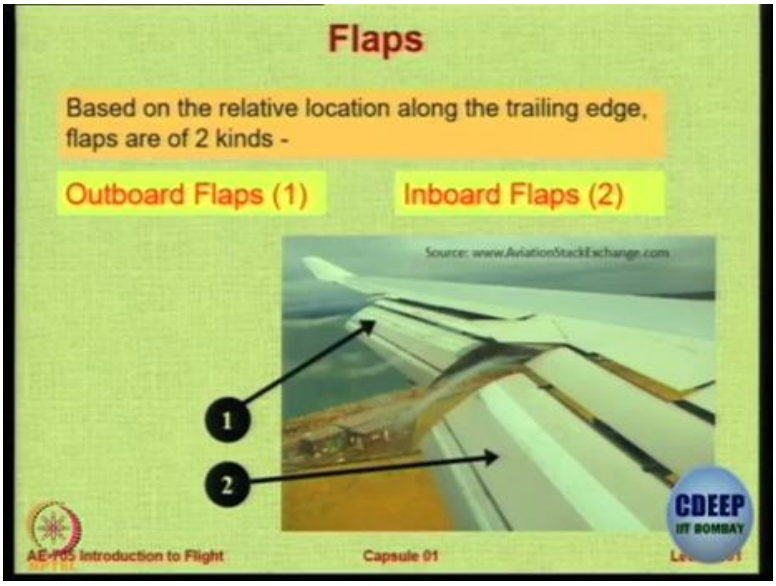

Today your task is where is a flap? What is a purpose? That is all. how is not important right now where. What? Where and, some points about its usage how it works let us not worry right now. Okay, flaps basically are of two kinds outboard flaps and inboard flaps okay? This division is done normally to elevate the load from it. you will never have a situation where you will deflect may be only outboard flap normally you will deflect both of them together but the load is distributed so that we do not have any large structure with loading acting on it because, the actuators which are going to deflected they are going to need lot of power and that will make the aircraft heavy.

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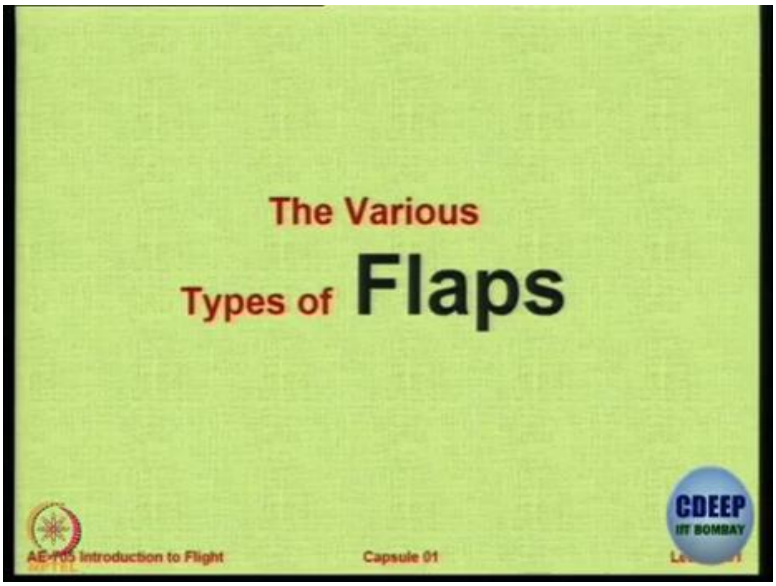

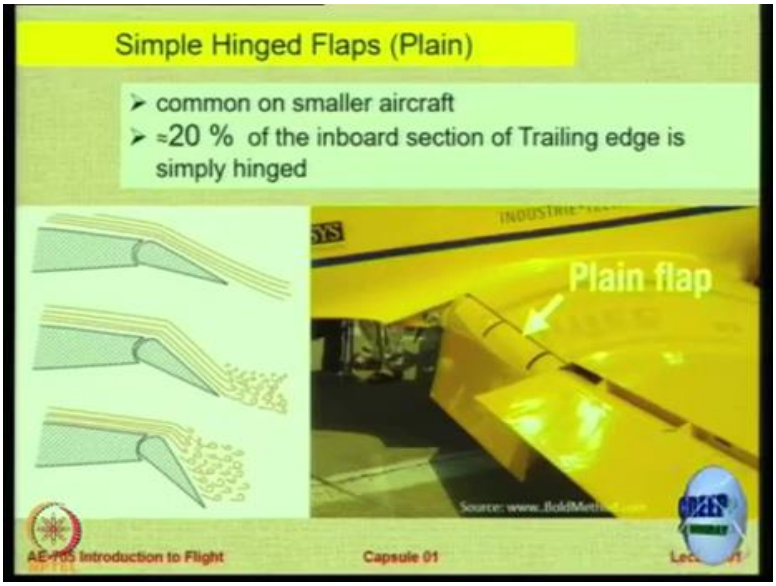

Now we have a special chapter on high lift devices where we will study the various types of flaps. Right now I want to show you some pictures okay? this is a simple hinged flaps. That it.

The whole thing moves down across a hinged okay, so it is also called as a plain flap, the most simplest flap where do you see this in the most simplest aircraft. Correct? Where, remember one thing in an aerospace in aircraft environment we always want to reduce three things. Cost, complexity, weight. We do not do more than needed complexity, cost and weight. So if you do not anything more complex than plain flap go for plain flap. If plain flaps are working for you never go for anything more than the plain flaps okay? so typically twenty percent of the wing is simply hinged. It could be slightly more twenty-five percent even thirty percent, but twenty percent is typically the order.

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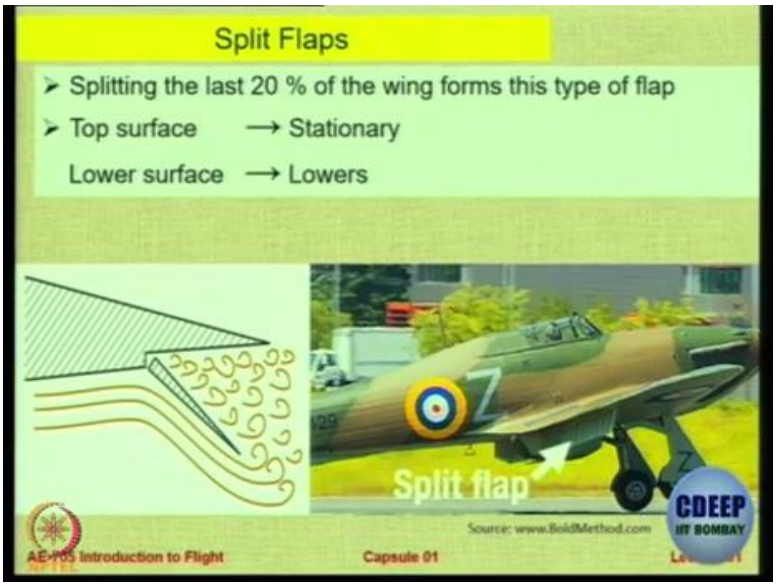

Split flaps are actually less effective because what we do here is only the bottom portion something comes down. The top portion remain as it is so you have a split so just last twenty percent of the wing forms it. top surface stationary lower surface most. Okay?

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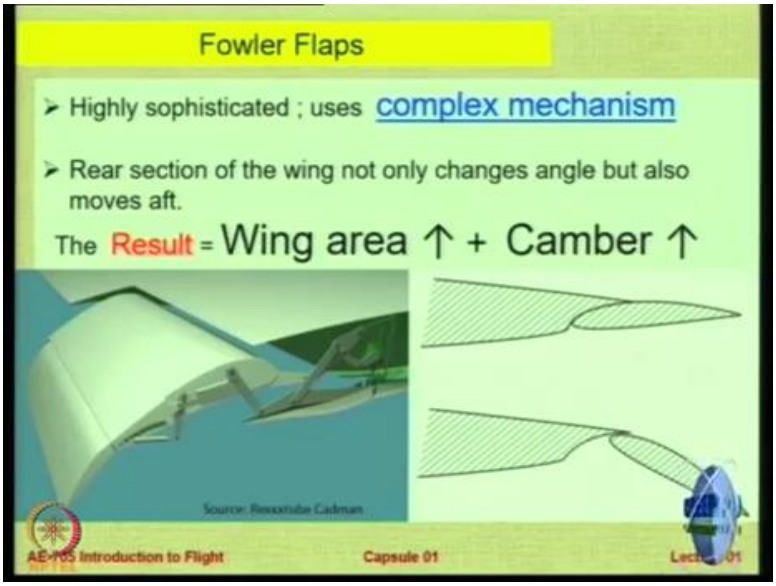

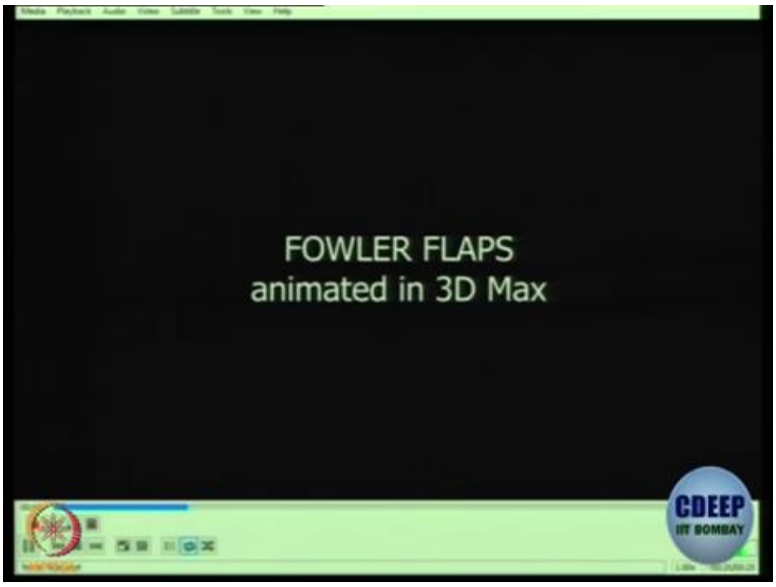

Then we have more complicated the many many types I am skipping. I want to come straight a way to one of the most complicated type these are the fowler flaps. So if you notice in this figure these flaps are not only moving down but they are also moving back, so they are increasing the area also. Apart from the angle of deflection, okay? These are the highly sophisticated their mechanism is really complex. So let us have a look at a small animation on the deflection and retraction of fowler flaps. It's only an animation give you a clear picture. So this flap is basically a single slotted fowler flap. That means there is a fowler flap and that to not one peace there is one small peace behind which moves independent.

You can have double slotted fowler flap you can have triple sotted fowler flaps but beyond that, the complexity becomes so large, that advantages are not so much, so I have never seen a quadruple slotted fowler flap, so for the moodle there is one small assignment for you, find out any aircraft that have got more than three slots okay? I would really like to hear from you. If there is some aircraft which have got quadruple or Penta slotted fowler flaps. I only know of three maximum three and also identify one aircraft which has got a triple slotted fowler flaps. And what you do is suppose we are playing faster finger first here. So the first person who say okay Boeing seven four seven the next person found yes yes I agree that is not the purpose, the next person to say this also, this also, this also so what will happen very soon we will have nice list.

So in my next presentation next year I want to just put a table saying these are the aircraft which have got a triple slotted fowler flaps. So one requirement is anything more than three slots in the trailing edge only, okay? I am looking at triple more than triple slotted fowler flaps and I am looking at also aircraft which are having the triple slotted or more than tripple slotted fowler flaps. So the wing also the area also goes up the curvature also goes up which is called as camber we will study this in the airfoil section. That is the outcome unfortunately it is very difficult to talk about the component and simply this is a component, we invariably end up telling something about the functioning but I am going to avoid it.

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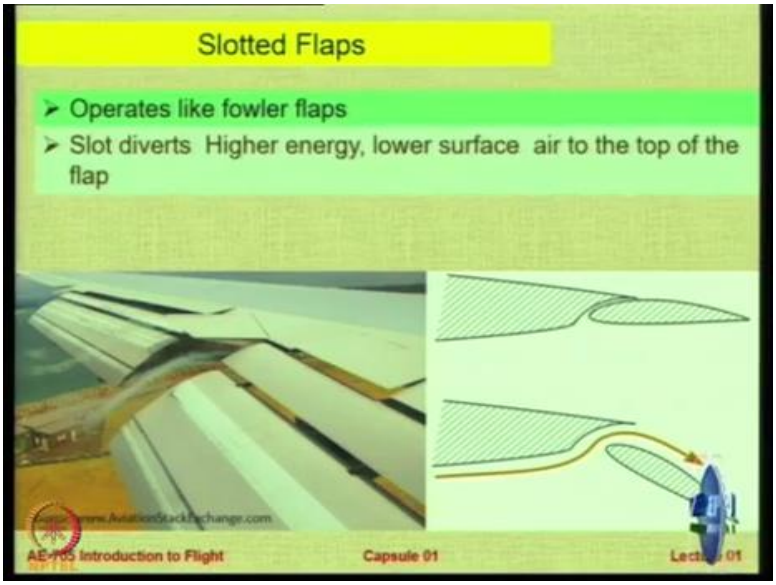

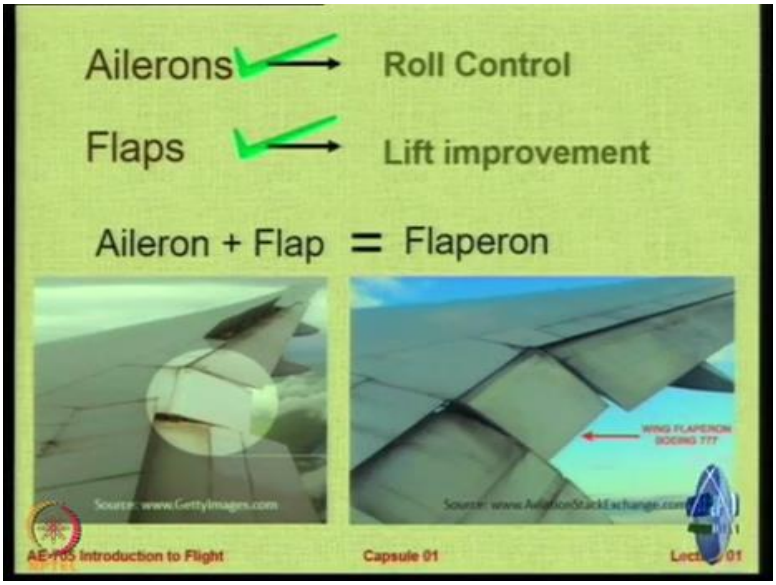

Okay slotted flaps are flaps where you create a air gap between the two moving parts or the three moving parts. This is an example of double slotted fowler flaps both inboard as well as outboard okay? so what we will do is create a small gap and we will see later on what happens there. Right.

Moving on so aileron give you roll control, flaps give you lift improvement, what about aileron plus flap? hat will we call it? flaperon so we have something called as flaperon which is aileron plus flap so when you want to move it like a flap both of them move down, when you want to move like an aileron one goes up one goes down so, ek pe ek free. That is the offer. okay? That is a flap aileron, so here is a flaperon , which you can see and this is the images taken from actual flight of some aircraft. It is a small peace between that inboard flaps and the outboard flaps and it can move up and down, as I will show in one video.

Okay? So let us see how this is going to help us?

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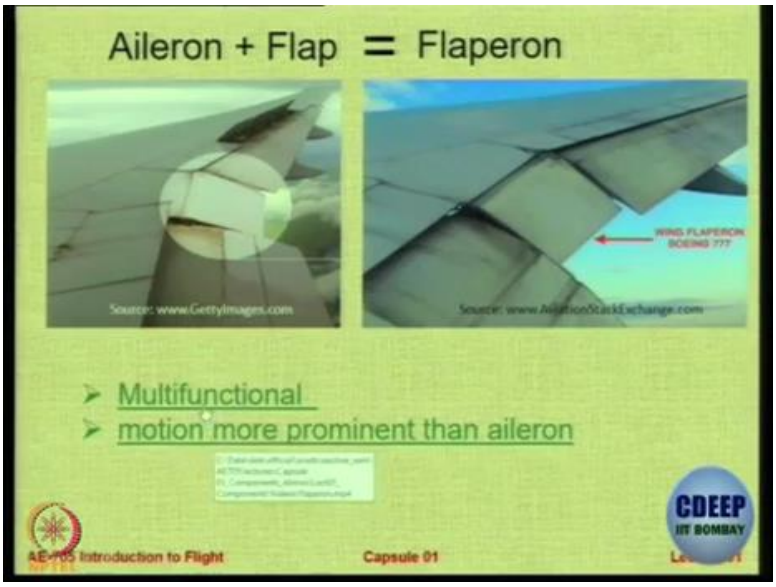

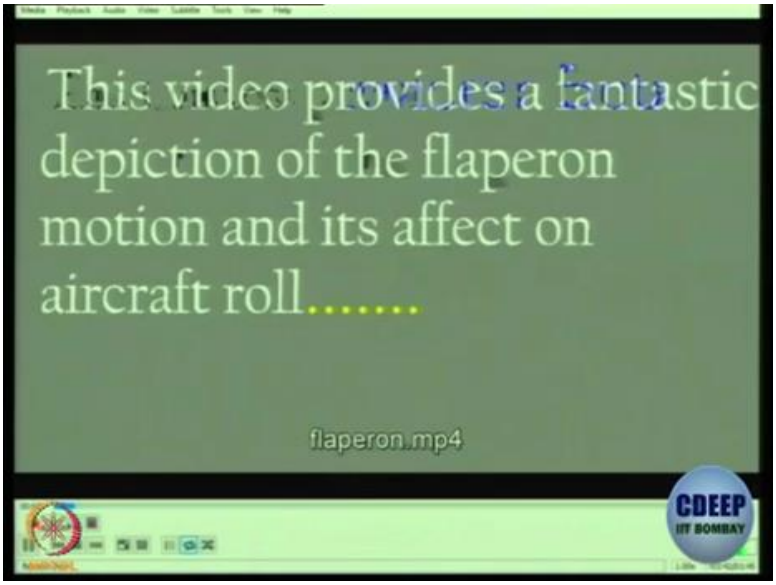


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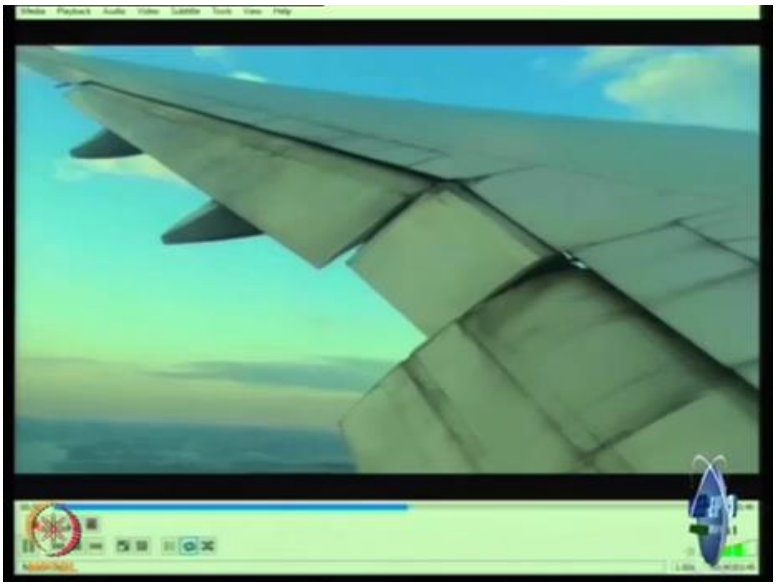

so this a video from start rolling to takeoff to some initial flight notice flaperon have already started moving is going up, because I do not want to create any deflection right now. So just come down completely that means it now working as a flap. Focus only on this part now please. Now you see it starts dancing because the pilot wants to create small correcting rolling moments to take care.

If you put aileron at this time may be you can see aileron also deflected little bit, difficult to see but he is trying to manage it just the dancing of the flaperon also to get the required moments. So now aircraft as gone into a climb that's it the job is over take them inside, so the flaps are now being retracted they are going to go down they are going to go up sorry and they are going to become flush, But the flaperon keeps moving because it spend for minor correction

okay? So this is the function of the flaps they are down during takeoff and they are giving you enhance lift. Okay.

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What are these? Anybody knows? Are the air break or spoilers? They are spoilers. So after landing you want to kill the lift, you want to spoil the lift. So what you do is you bring an obstacle in front. So you just put this flap plate up and give higher resistance. So it creates more drag which helps in reducing landing distance it kills the lift and allows you to descent very swiftly without speed increase. Otherwise you are landing distance may become very large and you are impact velocity of also may become very high. These are deployed on landing typically automatic as soon as landing gear touches down spoiler will go up we rarely deploy them in the flight. It's very dangerous interesting thing is they are not airbrakes, airbrake are different I will talk about airbrakes also, alright.

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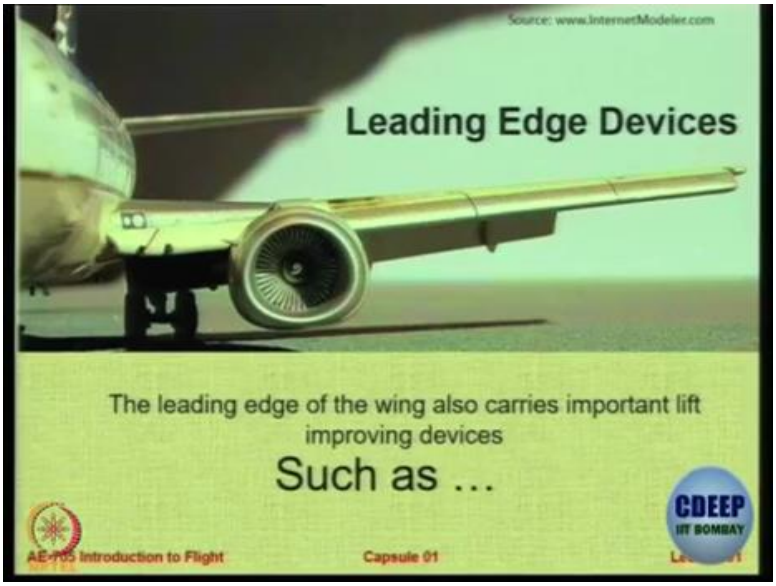

Leading edge devices now, here I also wand to show you discus with you some very interesting information. Do you observe that the engine intake has a very peculiar shape. Can you describe this particular shape? What you see, can you describe this shape? Anyone?

Student: it is round in shape and a flat bottom , So you are saying it is round in shape another flat bottom, I would not say it is a round in shape it is actually oval. if you look at the cross section the ring is actually oval so what is this part called? The one that is covering the engine is the nacelle it is the nacelle it is the engine nacelle anything that is provided for a shroud or a covering over a part which is suspended in the airstream is called as the nacelle. This is the engine nacelle the engine nacelle is not circular okay? What could be the reason? Why is it not circular?

Now let me tell you one thing I give you the background first, it was not like this earlier okay? It was made like this because we want to maintain some clearance from the ground, for any component of the aircraft there is a un written or a written rule that you should be 18 inches away from the ground under all condition of flight okay? except for something like tales skid which is going to rub on the ground unless required by function any component should never come less than 18 inches from the ground now if I make this particular intake perfectly circular it will probably become less than 18 inches clearance which can be dangerous.

So, this has been done to increase the clearance but why? was it not possible to go for a circular thing which can be 18 inches away okay? why this horrible looking shape? Believe me this shape is aerodynamically worse than a perfect circular intake. Okay? So on an I have aircraft

like this where even one percent higher drag it can be a real problem and the competition can actually whenever you because we have got one percent over drag why would a designer permit something like this?

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So this is the next question for the moodle, what is a reason for such awkward looking nacelle shape? Nacelle cross section in an aircraft? So the leading edge of the aircraft also contains certain devices such as slats, so basically a flap in the leading edge is called as a slat. just the name a similar function it goes down it has got the similar aerodynamic shape but it called as

a slat. So this is the fixed type slat, nothing moves here it's like this right from the beginning to the end. this is the aircraft configuration this red colour device is fixed the grey colour wing is fixed nothing moves this is called as a fixed type slat. this is also an example of a fixed type slat. where there are these members for structural rarity this is the fixed slats okay? There are member with supported. okay?

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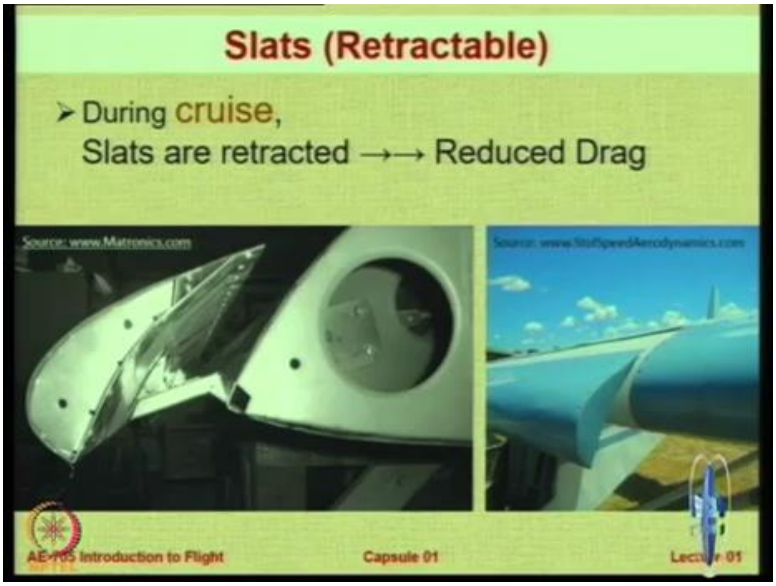

Why do you need this thing? we will come back later in some aircraft we have a retractable slats, that means we have slats which can be retracted ok, we do not have the file here of us, but this slate can be retracted so just like the fowler flap it can move back and close the gap between the two. When not here it, it can close the gap. These are the retractable type of slats okay? So obviously the purpose of this is to make the aircraft smooth during cruise. No gaps and no projecting parts in the fixed slat they will be more drag during cruise, but they are simpler.

And then you have something called as a Krueger flap, a Krueger flap is actually a very sharp curvature flap right at the leading at you can see here for example,

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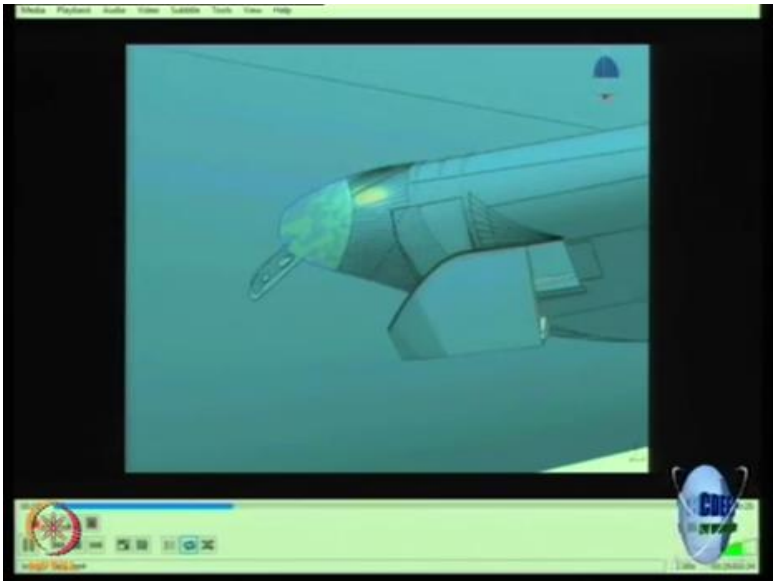
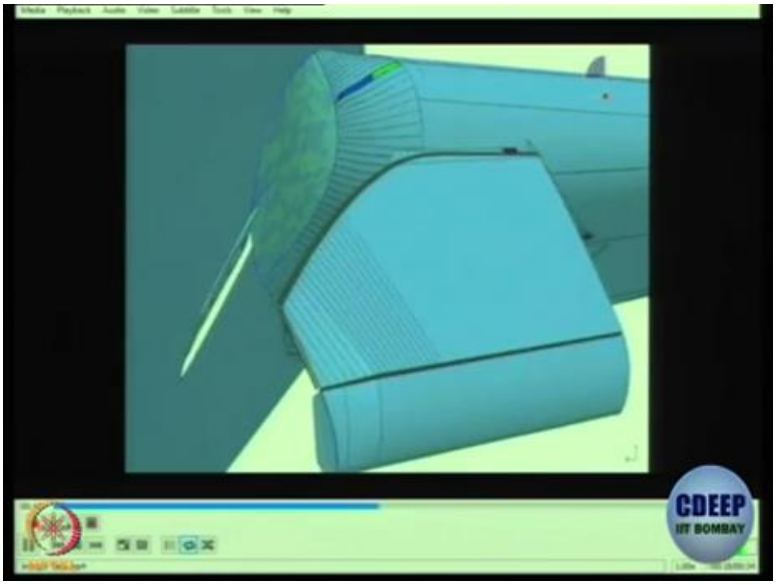
Krueger Flaps

- A portion of the lower wing is rotated out in front of the wing leading edge
- found between the fuselage and closest engine, where the wing is thickest

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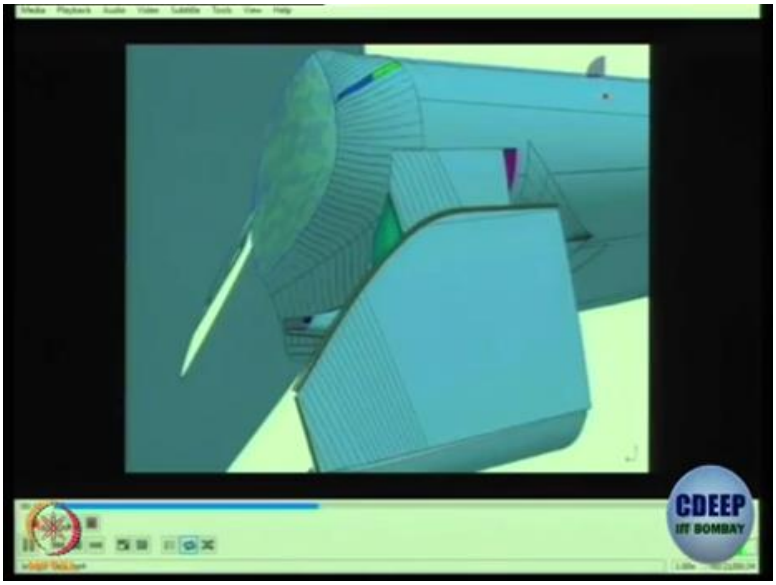
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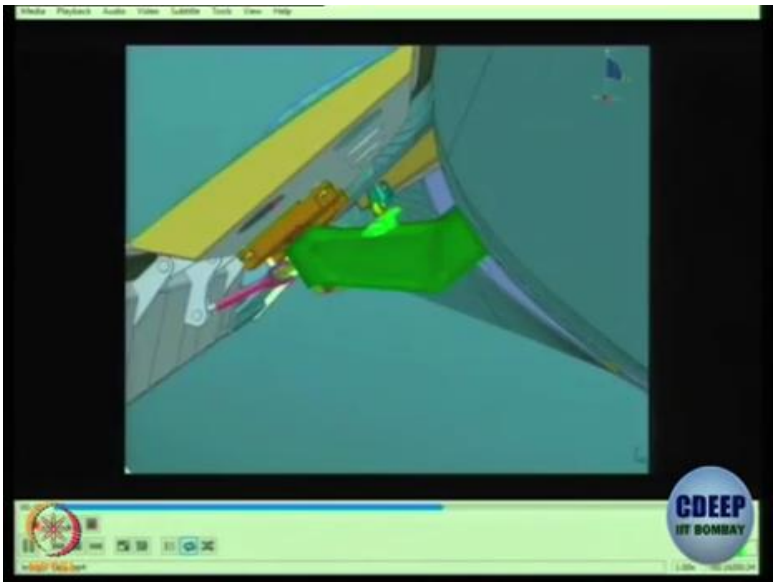
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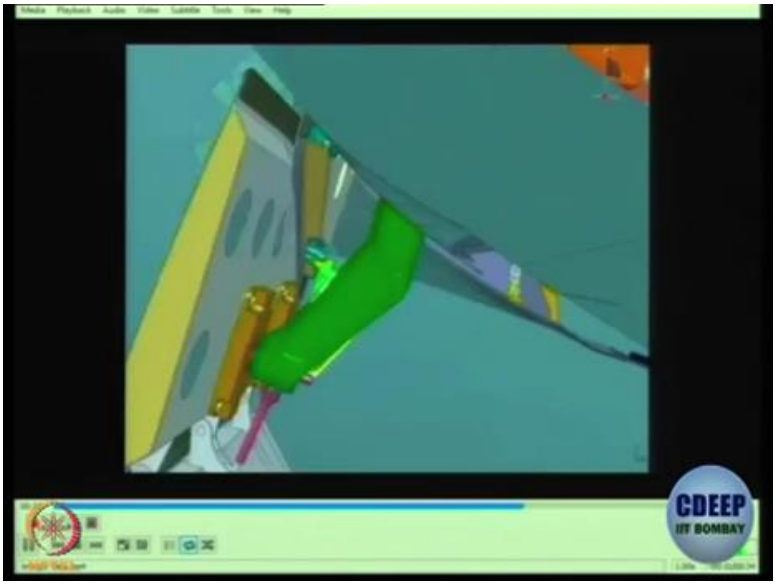

This particular thing is like a flap plate which came down but, it has a small curvature like this here. Okay? Let see so see how Krueger flaps operate this is the leading edge of the aircraft, so these flaps are actually going to come out and cover up. so these are the flaps which actually come down like this. in the leading edge, So they are called as a Krueger flap, all this video are easily available on YouTube okay? So there is no problem in finding it.

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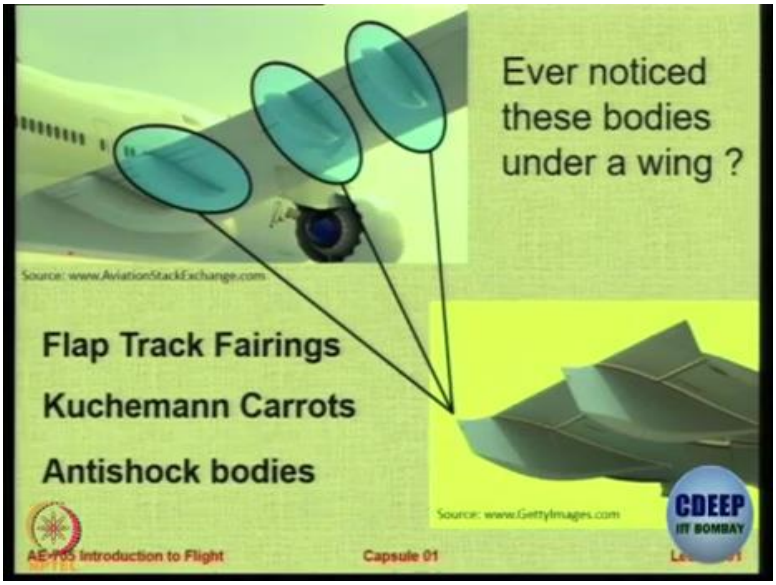

Okay, have you observe these wings? below the wing we observed it in so many of the wings that we saw so far so, what are these

Correct very well they contain the tracks on which they house the tracks so this is also like a covering actually there are flap tracks there, we will be horribly aerodynamic so you cover them with something like this so they are called as flap tracks ok? or flap tracks fairings now they come in different shapes some of them have very pointed thing on the back some are rounded, generally they are aerodynamically smooth bodies provided to reduce the drag of the flap track fairings. If you do not have them, it will be difficult to have flaps moving down ok? they are also called as Kuchemann carrots in respect of Kuchemann, who was the person who did the aerodynamic design of the concorde aircraft. that the purpose there is not just flap track the purpose there is to provide some saving in the drags people also called Anti shock bodies that can be used to manipulate the shock acting under high speed flight okay.

And this flap tacks of the ones that how, we already seen this. Okay let us put it all together now and see so, this the figure that I showed you in the beginning, the figure on the bottom left it shows a the working, now let us see the whole thing working together again.

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Houses flap deployment mechanism
Flap deployment mechanism
Video Courtesy : RexxTube
NPTEL
CDEEP


Houses flap deployment mechanism
Flap deployment mechanism
Video Courtesy : RexxTube
NPTEL
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Putting it together . . .
AE-105 Introduction to Flight
Capsule 01


CDEEP
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Take a close look …
Source : AviationStackExchange
CDEEP
IIT BOMBAY
AE-105 Introduction to Flight
Capsule 01


Nope !
➢ Air Brakes deployed on a
BAe 146
➢ Used to ↑ Drag
Source : www.Airliners.net
➢ Modern airliners have combined spoiler and airbrake controls
Source : Wikimedia
CDEEP
IIT BOMBAY
AE-105 Introduction to Flight
Capsule 01


BAe 146-300 Speed Brake Deployment
NEXT
BACK
NPTEL
CDEEP
IIT BOMBAY


BAe 146-300 Speed Brake Deployment
NEXT
BACK
NPTEL
CDEEP
IIT BOMBAY


BAe 146-300 Speed Brake Deployment
NEXT
BACK
NPTEL
CDEEP
IIT BOMBAY

So now this is on the ground notice what happen this is testing on the ground these are the flap track fairing. I think we will just proceed ahead I will try to show it some other time, these are your airbrake ok? these two on the back, these are the fuselage of the rear opens up like this and creates intentional drag.

So, these are load bearing member we can see there are two arms coming here which carry the load and they are going to give you the increase in the drag, so I will show you a small clip of BAe 146 landing from this the drag on the back they open up, there are no spoiler is here, okay? But they use a speed brake or an airbrake. Look at the run way it is not straight okay? It is up and down why is that so? because it's very difficult and very expensive to flatten a place of three, four kilometres so their certain runway wawiness permitted by regulatory bodies. So if you are within that, it is acceptable to have a runway which such kind of waviness.

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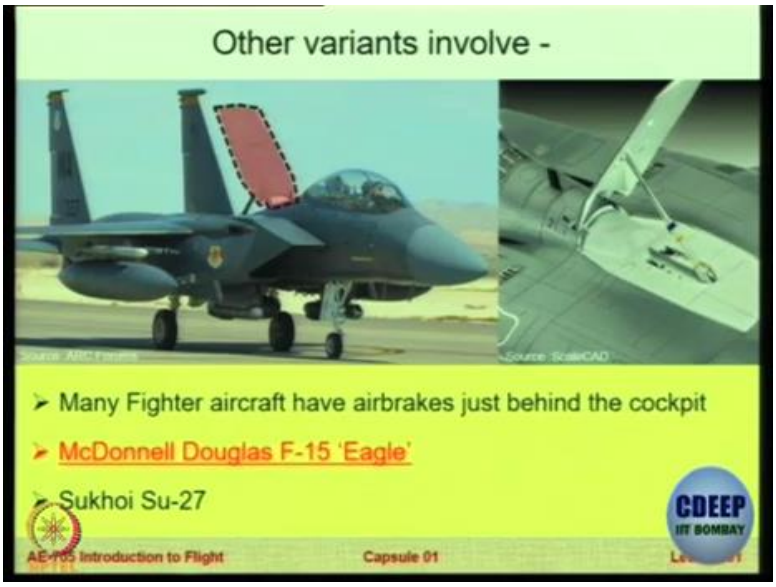

You can see an example of spoilers deflected, flaps deflected and this is the flaperon okay. Then you can also have them like this which come in a very large way so we can see here, for example, many fighter aircrafts just behind the cockpit. because that is the place you have the maximum drag, total frontal area is expose to this particular, so imagine the load which comes on this airbrake okay?

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Let us see a small clip, problem,

now, whatever like you to know is this is the component which is heavily loaded you will agree with that, so for your information when we had MiG-21 aircraft in this country now, it is almost obsolete there used to be metallic airbrake on MiG-21, and the composites laboratory of IIT Bombay aerospace department was given the task of creating composite airbrake okay?

So the first carbon fibre stress structure to fly on any military aircraft in India was a speed brake design by professor Lakkad and its team of our department. So when I was working in HAL I use to associate with professor Lakkad in installation and testing of this air speed brake, before that all composite materials used on aircraft were only some hash door some covers may be fin leading edge no stress parts only aerodynamic covering parts which were not heavily stressed. The first stressed component was the carbon fibre airbrake I do not remember how much weight was saved it was the massive weight saving just by one component after that the MiG-27 airbrakes was also converted into a composite airbrake.