**Introduction to Aircraft Design**
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**Lecture – 15**
**Design Considerations – Future Airlines**

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Let us have a look at what do we have in store for future? What exactly are going to be the key design considerations and what kind of shapes we might be able to see?

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What are the desired features of a transport aircraft of the future? Most aircraft designers are interested to reduce the drag acting on the aircraft by attacking the induced drag and for that

we need wings with large aspect ratio. Modern day transport aircraft certainly shows around 8 to 9. The aim is to take it to 12. Now, to meet this requirement, we are going to have now very slender wings, so are composites the answer.

But then with high aspect ratio you start entering the dangerous domain of aeroelasticity where you will start having problems with operations, so we do not know whether it really makes sense. There might be better ways of addressing the problem of slenderness of the aircraft or providing high aspect ratio and we will see a couple of attempts. The next big area where a lot of research is happening is the natural laminar flow.

Can you provide this kind of a flow? In India, we have had to transport aircraft, Saras and the new RTA, the regional transport aircraft RTA-70. Both of them are attempting to use natural laminar flow in their wings to address the problem of reduction in drag, but there are many tradeoffs to be considered. There are tradeoffs regarding the places where the flow can trip from laminar to turbulent. There are tradeoffs regarding manufacturing.

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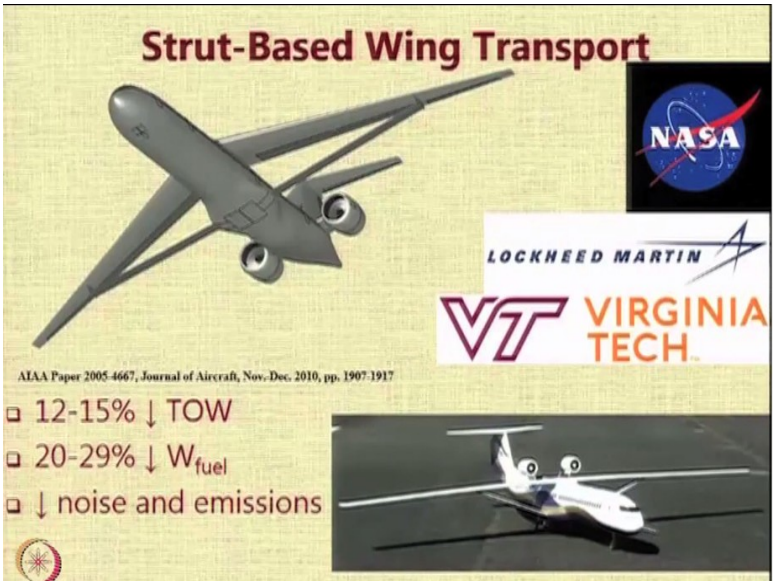


So let us look at 2 attempts to address this problem. One comes from the stable of Lockheed Martin supported by Virginia Tech and funded by NASA. This effort was initiated somewhere around 2005 and it is called as strut-based wing for transport aircraft. So studies have shown that if we use strut to support the wing of the aircraft, you can go for a very slender wing such as the one shown in this particular image or artist concept.

This aircraft has not yet flown with passengers, but there have been some small models made

as I will show you very soon. Studies indicate that using a strut-based wing, you can reduce the takeoff weight by up to 12 to 15% and the fuel consumption to around 20 to 30% and also much lower noises and emissions. So all of these are very, very desirable features for the transport aircraft of the future. In fact, these are meeting the goals specified by NASA for the aircraft of the future.

One experimental study of such an aircraft has also been done. Here is a video of the testing of a small UAV developed by the students of the University of Washington as part of their final year or Capstone Airplane design project. You can notice that this was a huge effort with several teams working together to create a strut-based wing. Obviously because it is a University they cannot make it more than just a model.

Some images about the modeling and the views of this particular aircraft. Notice that the engine also has a serrated rear, just like you see in a Boeing 787 engines, the so-called leap engine from GE. These are some studies on the structural dynamic and modeling of the aircraft. This is a code output which looks at the flexibility studies because the principal worry that the designers have is can this particular aircraft withstand the loads without flexing too much?

We will soon see a video of a trial of a UAV built by these students. So you can notice the wing of this aircraft appears to be very slender compared to the typical wings that you are used to seeing.

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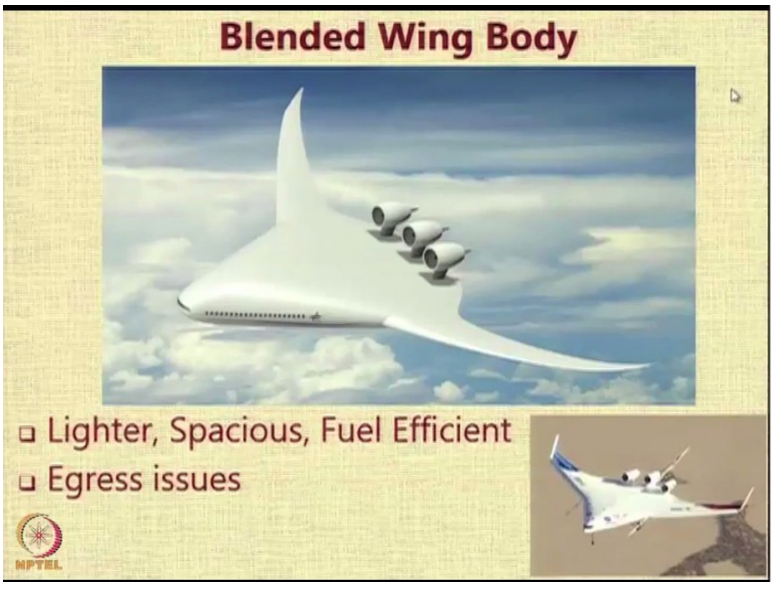

One more way of addressing this problem is to go for a blended wing body. This is a concept from DLR and a large amount of research has gone in DLR Germany to come up with this concept of an aircraft with a blended wing body configuration for transport. You notice it is very difficult to say where is the fuselage and where is the wing because they have both been blended. It is claimed by these studies that such an aircraft will be much lighter, more spacious for the passengers.

Today, the passengers fly essentially in the tube, which may be let us say 10 people abreast, but with this you may have a 50 abreast cabin and a large theatre like environment where you can sit. This configuration is supposed to be very, very fuel efficient as well as lighter. However, there is a serious problem. Remember we had seen that the requirements given by the airworthiness agencies are principally driven by safety.

And one of the requirements to ensure our safety as passengers is the ability to egress from the aircraft in a very short amount of time. The typical requirement is that all the passengers in the aircraft should be able to leave the cabin in about 180 seconds or 3 minutes with half the exit doors blocked and half the cabin crew noncooperative. And the major issue with the blended wing body aircraft apart from its very unconventional looks is that it will be difficult to show that the passengers can leave this aircraft in that stipulated 180 seconds window.

So when you think the body also has been tested in flight, we will see a clip of the Boeing X-48C remotely controlled aircraft scaled down model of this concept which has been tested.

So, these are the 2 approaches that we are going to see in the future.

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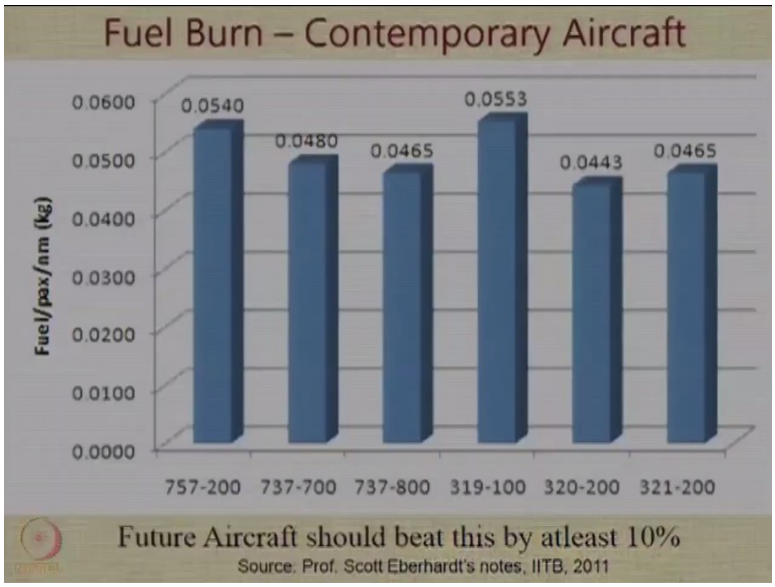


Another important consideration is the fuel burn. Contemporary aircraft have a fuel burn, which is approximately 0.045 kilograms of fuel per passenger per nautical mile and this bar chart shows the typical values of the fuel burn of some contemporary aircraft. Now, if you want to bring in a new aircraft in the market, you better beat this estimate by about 10% and that is when you will be able to really make the aircraft attractive to the customer. Thanks for your attention. We will now move to the next section.