Introduction to Aircraft Design
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Lecture No – 02
Aircraft Design Process

We let us look now at the aircraft design process in which we will reinforce what we have discussed regarding the aircraft design phases, and will look at generally how the aircraft comes into being, so let us look at the process followed typically in conceiving a new civil aircraft.

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Here the whole activity is divided into three basic steps the steps of configuration development detailed design and after that, once the first prototype is fabricated you have the product support activity. So, is the same thing expressed in s different way and this particular image is credited to Dr. John McMasters who was a very distinguished research aerodynamicist and technical fellow in Boeing.

And according to him based on his huge experience in Boeing, you can notice that each of these steps involve some kind of back and forth, for example; once you complete the detailed design of the aircraft and once you do the flight testing and operations during the service of the aircraft there are some growth variations there are some improvements, for example that you know you have Boeing 737 which has come in dash 200, 300, 400, dash 500, 600.

And now they are probably running out of numbers because they already have dash 900, so all these are growth versions which involve a little bit of design effort, may be needed in incorporating these changes and then finally you have retirement from service and you have an archival process.

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For the military aircraft you know one normally looks only at mission focused aircraft design, I am going to qualify this statement very soon and that is the whole purpose of this particular slide, that typically the missions are the ones that are available the mission requirements are specified which tell the designer what this aircraft needs to do, and the design team then carries out a conceptual design.

To inform, the customer, what do we think it will look like and if the customer generally is okay with that, then we you know we carry out more detail analysis where we look at the sizing performance or optimization, weights, aerodynamics propulsion, etcetera and here we look at what the equations and the procedures are teaching us and then we go back and forth till we finalize.

And there is a very interesting observation that there is no uniqueness in the aircraft design there are as many designs which are possible to meet given mission requirements. And the regulatory

requirements as the number of designers are available okay, so some will be better than the other based on which criteria you follow the source of this information has come from, Dr. Bill Mason's notes from Virginia Tech where he teaches an Aircraft design course.

I am going to talk about Dr. Bill Mason's design data repository and there you will get a lot of sources which can be used by you to teach the students, however, one should keep in mind that today the main driver of the whole design process is cost. Cost is everything in today's environment because that is becoming the driving criteria for most of the activities that are taken place in the field of aircraft design.

So it is very, very important to have a Handle on the cost right in the beginning of the design process, this is something that we need to emphasize with the students, that you can do a very great aircraft design very good looking aircraft design but unless it is operating cost unless it is life cycle cost is less it is not going to eventually find favor.

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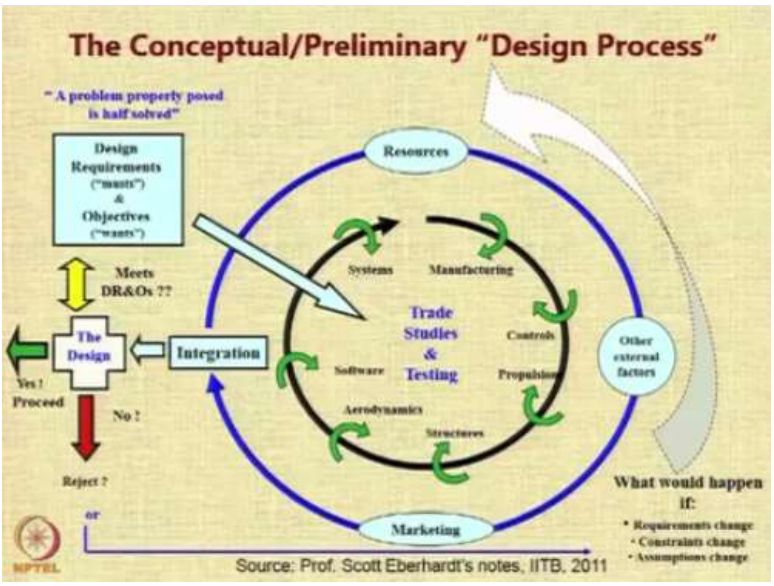

I will harp on this aspect in more detail in another clip professor Scott Eberhardt had spent some time at IIT Bombay as a visiting professor and during his discussions, he presented this particular slide where it shows that the whole process of the conceptual and preliminary design of the aircraft actually goes into a loop at various stages. You have an inner loop where we have trade

studies and testing where systems manufacturing, controls, propulsion, structures, aerodynamics software.

All of them are playing a role to ensure that the musts which are the design requirements and objectives which are the wants are attacked and he says that if you properly pose a problem, then you have solved half the problem does it make the design requirement of objectives if not then you proceed if not then you reject, and also notice that this entire process is encompassed inside and outer ring which is limited by the constraints from resource from the other external factors like the regulatory environment and also the integration.

And every design that you do should be sensitive to changes what happens if the requirements change because requirements are not going to be sacrosanct and fixed for the entire period remember the aircraft design process is going to take time and the conceiving of the aircraft, I mean from the point time you conceive it till the time you actually make it maybe 10, 15 years time and during that time the scenario in the world will change.

The operating scenario will change if you have made some estimate but that may not remain, so requirements will change assumptions will change the constraints will change the design has to be sensitive enough to ensure that it can handle these change, okay?

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Let us look at the aircraft development process from another angle is the same thing, I am just trying to reiterate essentially this material you can present it to the students the way you feel is most appropriate the way you feel it will be able to clarify the concepts in the best fashion to the students, this is one more way of looking at the aircraft development process although this particular process is an evolutionary process.

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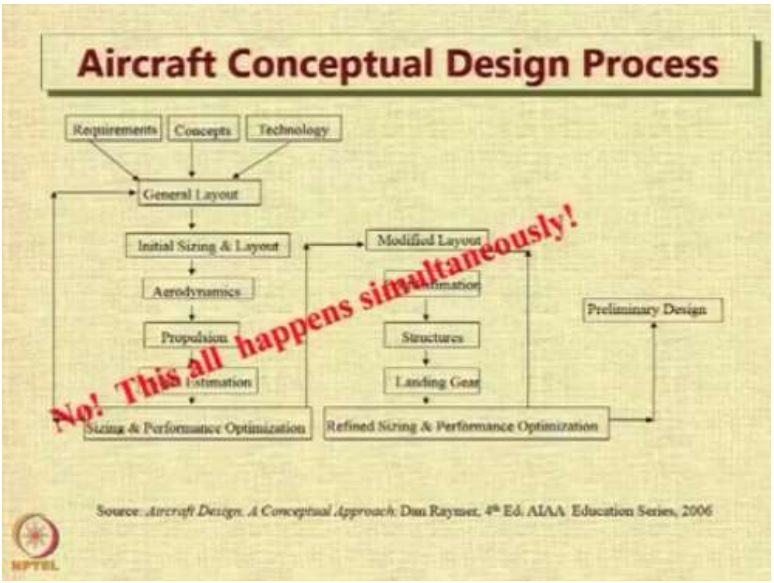

Now Daniel Raymer is a very celebrated author whose book on aircraft design is a very popular book on aircraft design. In his textbook he has given, this particular sequential procedure for aircraft design, he mentions that requirements specified by the customers or by the agencies that regulate the technological developments available and the concepts which can be investigated together come up result in the layout and then you do the initial sizing.

Then you look at aerodynamics propulsion mass sizing etcetera, etcetera, there is a whole process that he has laid out. However, in real life this whole process happens simultaneously, we have reached a stage here in analysis today when we do concurrent engineering and aircraft design is a very good example of concurrent engineering where all the disciplines that have a role to play they actually work or they are analyzed together.

Because if you do it sequentially then you will not lead to an optimal solution, okay, you have to go lot of back and forth instead, why not do it together and today we have tools like

Multidisciplinary design optimization, MDO for short which allow us to look the whole process at one shot, and that is a very important message to be conveyed to the students that do not look at aircraft design as a simple element working in isolation.

And also when you work as a team you should not say this is the aerodynamics group, this is the structural group this group will work something and then pass on the information to the next one no that is old story, the new story is that all of them work together and do it concurrently and that is why aircraft design is such a complicated and an exciting process because there is so much room for looking at the interactions and looking at how everything affects everything else, okay.

So, thank you for your attention we will now look at the next aspect and that as I mentioned in the previous clip is cost. So, we will look at the implication of cost. Thank you.