Introduction to Aircraft Design
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Lecture No – 05
The Design Spiral

Okay, There is a concept with we have to emphasize when we teach aircraft design to students and that is called as the design spiral.

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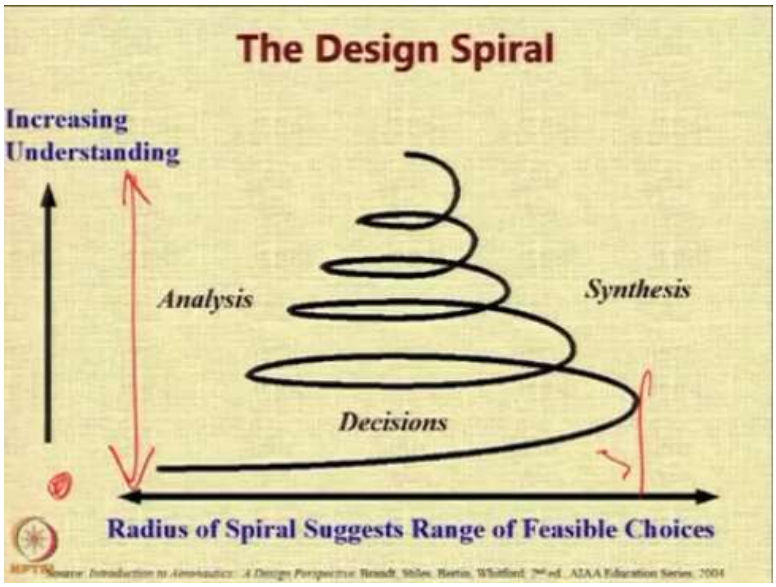

The design spiral is a very interesting concept, which is something that is really a dilemma that is faced by every aircraft designer and the spiral goes like this, this particular spiral has been explained very nicely in the textbook by Brandt, Stiles, Bertin and Whitford called as the Introduction to Aeronautics: A design perspective. This is the textbook which has appeared under the AIAA education series and it is a very good resource for aircraft design teachers.

Because, several concepts of aircraft designs are very beautifully illustrated and also we will revisit these particular textbooks later when we look at the Constraint Analysis and Performance Estimation. This particular Spiral tells us that as we continue are the journey of the aircraft design process, we have larger and larger information about the aircraft that we are designing, but the room available for us to make changes or amendments in the design become smaller and smaller.

Till you come to a stage where are you may know almost everything about the aircraft that you are designing but sorry, you will not be able to do anything about it now, because the room available to you is very limited. Let me illustrate to you with more information so, when you start the process you are somewhere hear your understanding is almost zero because you are at the beginning of the process okay?

And hence you can take virtually any decision so the range available to you to play for the radius of spiral suggested in the visible choices the range available to you here is very large. As you proceed further and further in the aircraft design process which is you go up so, you proceed like this and then when you come to a lot, when you come to the stages now you find that the room available to you to play is only so much, Okay?

This is the room available for you to play but your knowledge about the design is much more than what it was in the past, but when you go further and further on this process you will realise that when you come to this particular stage, where your knowledge and understanding is actually very high you are actually somewhere here in understanding, but the room available for you to play with is very small.

This is something which we need to sensitize the students because the decisions taken by them in the earlier stages of the aircraft design process. See the synthesis and the analysis and decision making they go together in this particular process. The decisions taken by them in the earlier stages are going to affect a lot the outcome and as they go further and further in the process, the room available to them will be less.

So, it is very important for us to emphasize that a lot of thought and lot of planning should go in the decision making right in the beginning otherwise, you will come to a stage where you know everything but you cannot do anything about it. Now another reality in aircraft design is the need for having a disciplinary balance.

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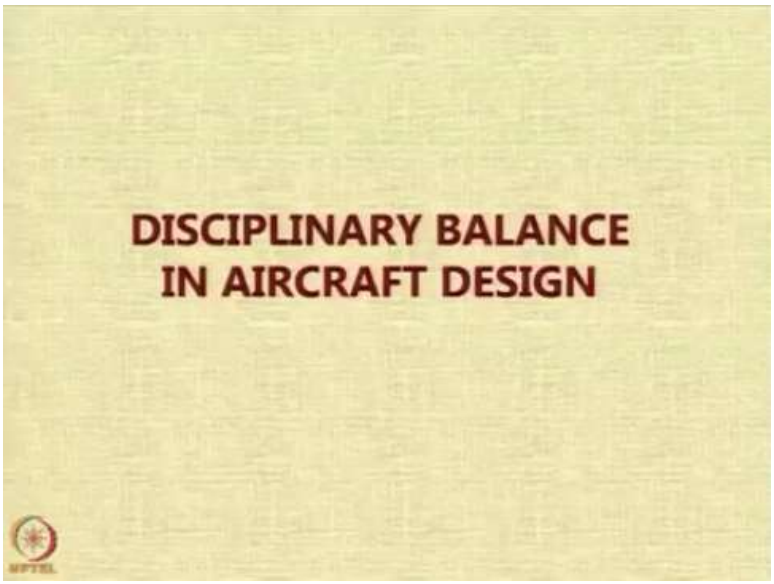

Aircraft design is conducted by a team of people, it could be team of specialist in the industry and in the classroom it will be a team of students. And normally different students have different interests, some of them like aerodynamics, some of them like structures, some are interested in control, some are interested in the drawing or in the CAD, some are in production. So what happens is that when you work in a group and what can happen in real life as well as in the classroom if that one or two people of a team, they will start dominating the whole process.

They will start leading the whole activity and they will become overpowering over the other disciplines. Now this tendency should be minimized, it is inevitable but it has to be minimized because the repercussions of this tendency both in real life as well as in the classroom are very, very drastic.

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Now on the later side, there is a very beautiful cartoon, which is called as Dream Airplanes this is attributed to C W Miller and I have borrowed it from the textbook by Nicolai called as a fundamentals of aircraft design. You can see here that what is the outcome of the design? If, one particular group dominates the procedure or the process, let look at for example the Power Plant Group, which is shown in the centre.

So if the Power Plant Group starts dominating the design exercise then the whole aircraft is going to be actually nothing but a power plant carrier by interestingly there is an aircraft which looks like this, but I do not think that was dominated by the Power Plant Group, I think there is a reason for that. So what you can do is you can give this as an exercise to the students and ask them to find out, which is the actual aircraft that looks very much like this particular cartoon and find out the reason for it?

Look at, For example, if the Electrical Group starts dominating the design process, what happens if the electrical group dominates? This is what happens, the whole aircraft is consisting of various kinds of electrical equipment and there will be an electrical cable with, you know connections if they have their way. Similarly, if the Stress Group dominates, then the structure will consist only your simple eye beams and elements which are riveted or bolted.

Because and you know change like this which is going to so this is just a conceptual sketch it is

an imaginary diagram. But the purpose of these diagrams or this cartoon is to illustrate in a joking fashion what can happen if a particular group starts dominating. So it is important for us to sensitize the students that when you work in the team do not allow one particular group or one particular team.

Do not allow one particular specialization to start dominating the design process otherwise you will end up with a skewed design like the one that you see here, thanks for your attention, we will now move to the next section.