Lighter-Than-Air Systems
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Lecture - 72
Overview of Airship Design Methodology (ADM)

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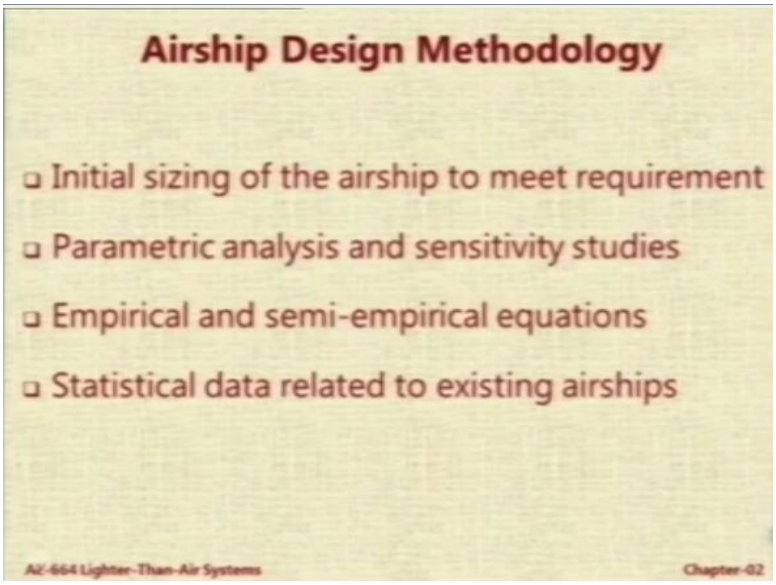

So, this is the crux or the main requirement. This methodology is supposed to carry out initial sizing to meet the requirements. So, what is initial sizing? Can someone help me in elaborating the meaning? Tell me what is meant by initial sizing when you talk in aerospace engineering or in design? Requirement. No that is requirements capture. Understanding the customer's requirements is requirements capture that has to be done before you do initial sizing.

But what exactly you do when you do initial sizing? Obtain an estimate of the empty weight fraction, yes that is very important part you need. When you say I have done initial sizing basically you mean I have tried to estimate the gross weight, a part of that will be empty weight, fuel weight, etc. because payload weight is given as a requirement. What else do you do? Yes, so when you get for let us say weight breakdown.

We try to obtain the gross weight and its breakdown. So, to meet these requirements the airship is going to weigh so much and this will be the weight breakup. This is one aspect. Anything else we do? Dimension. So there could be mass sizing and geometric sizing. By geometric

sizing we mean the length, width, etc. So, is the selection of the shape of the envelope inside this whole process? Yes, it is.

So, one could start off by saying okay shape was decided and we carried out the analysis to find the dimensions which will meet the requirement of that shape or one might say no we looked at 10 different shapes and came up with the best shape, both of them could be considered. In this particular analysis, we have not looked at many shapes. We took a conscious decision to make the envelope of a particular shape.

I will elaborate about that a little bit later. So, you understand that initial sizing will be completed when you are able to get the dimensions and the weight breakdown for a given shape. But more important than just estimating the weight or the size is the ability to carry out parametric analysis and sensitivity studies. So, what if some input parameter which is important like payload, what happens to the size if the payload is doubled or increased by 5%, 10%?

What happens if the purity of the lifting gas is compromised by a few percentage. So, effect of change in the key input parameters on the sizing both weight as well as dimension that is also a part of initial sizing and this is the main motivation. The third thing is that when you do initial sizing whether you like it or not, you cannot start from first principles always. In some cases you can. You can say okay let us assume something and then mathematically arrive at the method.

But in real life whenever you do conceptual design and initial sizing, it is very difficult to start from a fresh piece of paper and say that I will not look at any information about the past, I will not look at how people have done it, I will do it for the first time. This kind of approach becomes necessary when you are doing something which has never been done before. If you are taking up a project or design of a system for which there is absolutely no historical information, not even closely related to that.

Then you have no option but to start with a clean sheet of paper. But airships have been made for large number of years before we started. So it would have been stupid of us not to look at the information available over the experience of so many years. So that is why there are many empirical and semiempirical formulations which have to be used. At this point of time, I want

people to help me distinguish between what is meant by empirical and what is meant by semiempirical?

Some decisions or some conclusions which are made purely based on some experiments or observations with no logical or mathematical justification, they are called as empirical. So, for example let us just I will give you a very funny example, nothing to really quote somewhere. So you go to placement office, you collect the data for last 3 years or 10 years of how many people have got a job above a particular salary, let us say 10 lakhs a month per year and product plotted against the CPI and you will get some data.

I do not know how it will look like. But suppose it shows a trend that all the students who got the job worth more than 10 lakhs per month per year, they have a CPI of more than 6. So you can say empirical evidence indicates that a CPI of 6 or more is needed to get a job with salary of 12 lakhs per year. There could be 100 exceptions to this. There could be many muggles who will get CPI of 9.5, but they do not have a job or may be they did not apply for a job.

They wanted to go for something else. So if we limit ourselves to only those who applied that means those who wanted to apply for a job, even though you will get exceptions, but you will not get some kind of empirical data. You may also plot salary versus CPI and get a line, who knows it may be downward line. I do not know how it will be. But one of the studies that was published in Insight showed that their degrees in general are getting better jobs than B. Techs.

This is empirical, absolutely empirical, where is the mathematical proof of that? This is is an empirical data, but many people make a decision in life based on empirical information because there cannot be mathematical correlation for everything. So, I plot 20 aircraft. I plot empty weight fraction of the transport aircraft versus the gross weight of the aircraft and on the log-log plot I get a straight line.

And that straight line shows that empty weight fraction of a typical airliner is 62% of the total weight, this is empirical data. Then what is semiempirical? The semiempirical would be empirical with some amount of data processing or calculations or some amount of formulation that is semiempirical. So in our methodology like in almost every conceptual design methodology, we need to use either empirical or semiempirical information and that is what we have done in our methodology also.

And what we also did is we looked at the statistical data from existing airships, which were available at that time. It is not easy to collect data. Those of you who have attempted to collect data, there are many groups in aircraft design lab we are working on the AIAA design problem and you will realize it is not easy to collect data for aircraft even if they are similar to what you want it is not very easy. So getting the data is not easy, putting it together in the form that is meaningful is not easy. So this is a big contribution.