Lighter-Than-Air Systems
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Lecture – 20
Biomimetic Airships

Now, the last thing I want to talk to you is a new activity that we have started very recently just last year. Any idea about what you mean by biomimetic? Bio is nature, mimetic is imitation, so this is yes this is imitation of nature. So we first look at some existing biomimetic system.

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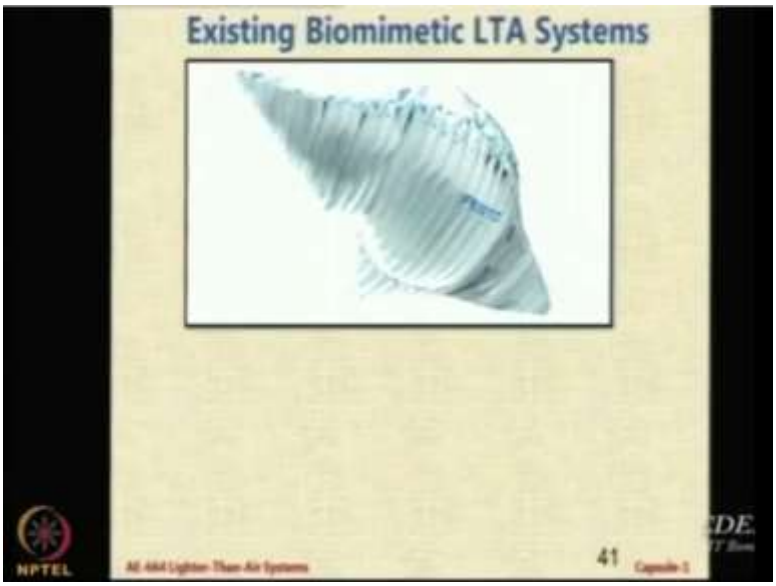

We are departing from the current trend, everything that you saw so far was our video. This will be the first video which is not my video.

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This is a video of a company called Festo which is outstanding in the implementation of biomimetic systems. There is a flying fish, there is a flying bird, all kinds of animals they make them fly in their foyer. This is an airship, a biomimetic airship.

So what we do here is propulsive force is generated not by an engine, but by the forward force created due to flapping of the tail. And this flapping of the tail is. We have some demonstrations of flying fish. We also have some very interesting systems such as this outdoor system. This is a multi-segment airship or segmented airship. So it has a front fixed balloon and everything else is flexible. the tail of the airship can align with the wind direction and distort itself.

So the load which comes because of sideload is just transferred in deflecting of the surface, some called as flying worm, flying snake, whatever. But you can see this is a very interesting concept and it is outdoor, it is not just indoor okay. You can skip, this will take some time okay. Then there is also a very interesting, now I will show you three more systems which are by Festo on biomimetic controls.

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Now, what have we done? We talk about all these, we have also done something.

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Interesting thing is that for a fish to fly or even to propel in water, the performance is affected a great deal by certain features like the fineness ratio that is the length or the diameter and the swimming style okay.

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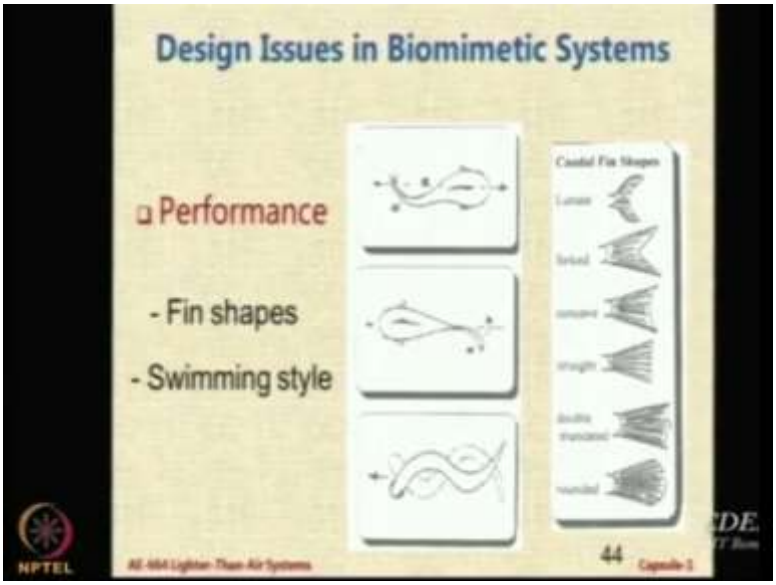

So, you can see the performance. Now, there are many fin shapes which are available. Each of these fins shapes is suitable for a particular application. You might like to have a fish which can remain at a particular place in a current of water that requires different fish. You might want a very fast flying fish in steady water. You may find a fish which can fly or swim fast in turbulent water. All of that will differ depending on what shape you use.

Plus we also have the various types of swimming styles in some like eel the whole body is moving like in a curled fashion. In some just the tail is vibrating. In some the tail and the middle part of the body is moving and there is a particular nondimensional parameter called as a Strouhal number. The Strouhal number is a ratio two forces like any other non-dimensional number and one important parameter is the frequency at which the tail vibrates with respect to the parameters of the fish.

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So we have attempted one small model of a biomimetic airship. So one of our students came for a 6-month internship funded by IRCC, the IRCC Research internship and he was interested in biomimetic airships. So we discovered in the market of very special material called as nanoclay coated polyester. So it is polyester, so very lightweight and nanoclay gives you ability to hold the helium gas.

So the shape that we chose after the several literature was a butterfly fish shape and this is the tail on the top. And we had this small machine in our lab, which can do heat sealing. So using heat sealing this airship was fabricated in our lab.

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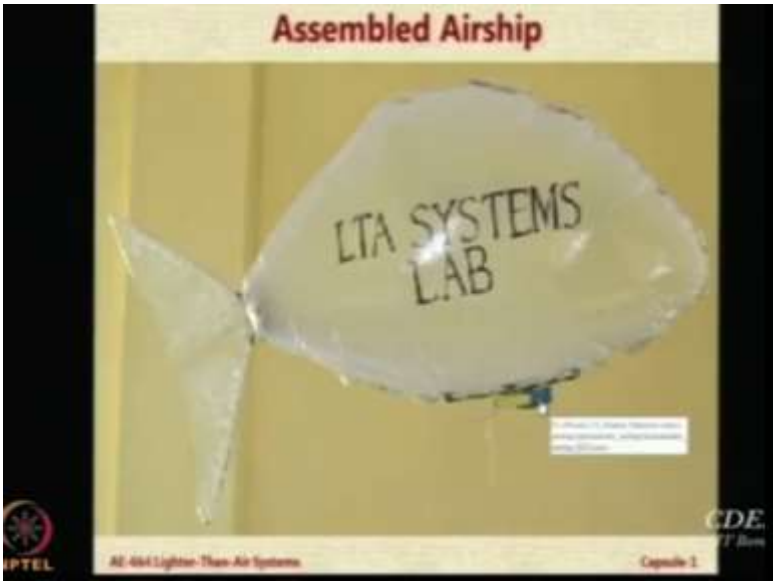

Here is a picture of the fabricated airship and this blue thing on the bottom is basically a center of gravity control. So I can move it forward, backward, and then I can pitch the nose up or down. Let us see how it flies.

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This is a small demo we did in Bangalore, sorry Hyderabad. This is our biomimetic airship. You can see it goes to the corner and then beautifully maneuvers itself without hitting the corner.

Such kind of maneuverability in tight corners is not possible for other airships or even smaller aircraft. So if you want to have a system which is just doing this kind of flying in an enclosed area or even outdoors if the winds are manageable, this is also a good alternative. The propulsive forces may be here very less.

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Now in this case, we have a servomotor for the flapping, but there are other ways of doing it.

You can use special elastomeric systems which stretch and shrink piezoelectric systems, you can use something like that. This is a very nice open area of research, and it would be nice if somebody can attempt to make something like this.