Introduction to Flight
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Non Pneumatic Instruments
Lecture No. 04.8

Right, moving on.

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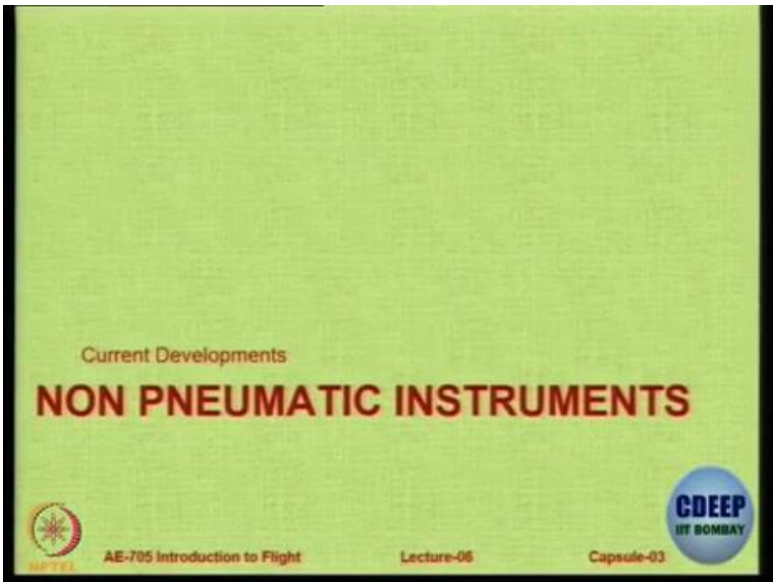

Now, look let us look at the current developments about which you may not find data in many textbooks, this information is not normally available. So, please pay attention, this is the present and the future, I would say that the pneumatic instrumentation was passed and it is going on in the present but very soon this is what you are going to see. First of all, tell me, what is the problem? What is the problem in using a pitot-static tube for speed measurement?

One answer is there can be blockages, there can be leakages. Suppose, I take care of blockages and leakages, do you still have a problem in using a pitot-static tube? What is the problem? I will give you a hint, look at a high performance aircraft, what could be the problem? Or let me ask you very specifically for which kind of aircraft this, the pitot-static tube is not something that you would like to see, anybody here? Yes.

Student: In the next movement, it maybe some, result which causes the velocity to decrease suddenly or increase suddenly, so in that case the pitot system will not be able to take into account the sudden change in the velocity.

Professor: That is an assumption but it is not true, that is not, that is not true. The pitot-static system is very well, because it works on pressure and pressure gets conveyed immediately, so there is no lag, there is no lag. Yes what can happen is, you are flying at a low speed and then you become supersonic and then subsonic the shock wave comes and goes but whatever happens the output is pressure and pressure is sensed beautifully by an instrument, I am assuming the instrument is leak-free and the instrument is block-free, if it is blocked or leaked then god help you.

Yes anybody else, there is one hand raised here, do you also have a comment? Ok just a minute this is, we will to go here, so please take a mic and tell me what could be the problem, my specific question is for which kind of aircraft is a pitot-static tube a serious problem?

Student: Hello, sir my name is Ganesh, actually in those aircraft which are manoeuvring to height so there will be a positional error means like if it is flying like this so there will be an air with different angle of attack in low speeds there could be a problem with that.

Professor: No, it does not matter sir, because whatever the aircraft does the repercussion of that is only pressure and pressure is sensed very quickly, almost instantaneously by a system. So, high manoeuvring, changing speeds, changing altitude, rate of climb, etcetera is not a problem. There is something more fundamental, some other fundamental application where you cannot accept this.

Yes, now we will come to you, yeah.

Student: Sir, it is requiring, this military aircraft that which are which required the stealth properties like that.

Professor: Stealth property that is the thing, see a pitot-static tube is a very small pointed device and it will give a very strong signature return, so yes, that is the answer. So, aircraft which are supposed to be stealthy they cannot, they cannot be relied to use on this instrument because it will be a giveaway, you spend hours of research and tons of money in making it with goods low signature and then you find the canopy is reflecting or you the one pitot tube is reflecting and it is giving away the position.

So, what kind of pitot-static tube or what kind of speed measurement systems would you like to have on such aircraft? Ones which are flush which are not projecting out, so you have something called as pitot plates. Pitot plates are very interesting, they basically are plates which

are attached to the side of the aircraft and as the air goes through them, we try to find out the difference between the two sides of the pressure on two sides of the plate.

So, what you do is you direct a plate, direct air through a plate which has a hole inside and now you measure the amount of air constricted by the obstruction, so this is used in aircraft like these, this aircraft is the Raptor F-22 and Stealth Bomber B-2, I have not shown because you cannot see it. So, it is supposed to be really stealthy, so it is usually these two aircraft, the question is how do they work, and the answer is not expected right now.

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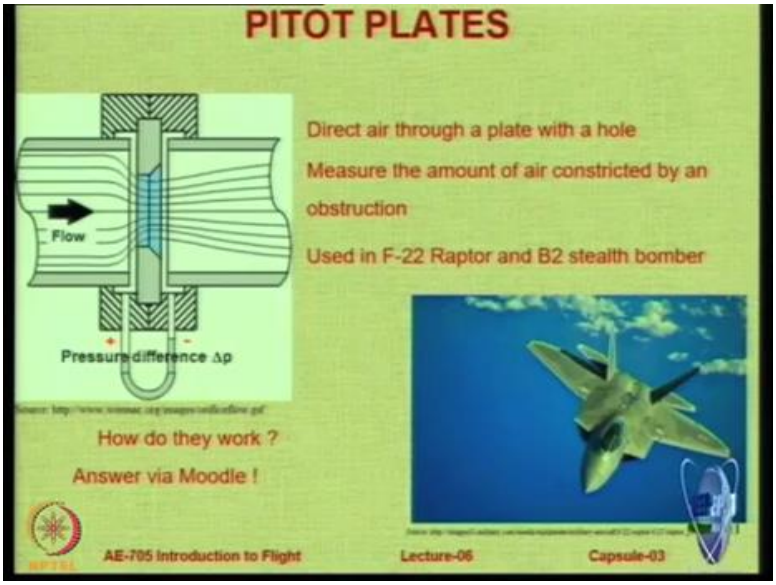

Let us study this and answer, this is something new, information about this is not easily available, a simple Google search on pitot plates will not show anything except pitot-static tubes because Google will think you have made a wrong entry. So this is a very interesting topic, I would like you to spend some time searching material for pitot plates and put it up on moodle.

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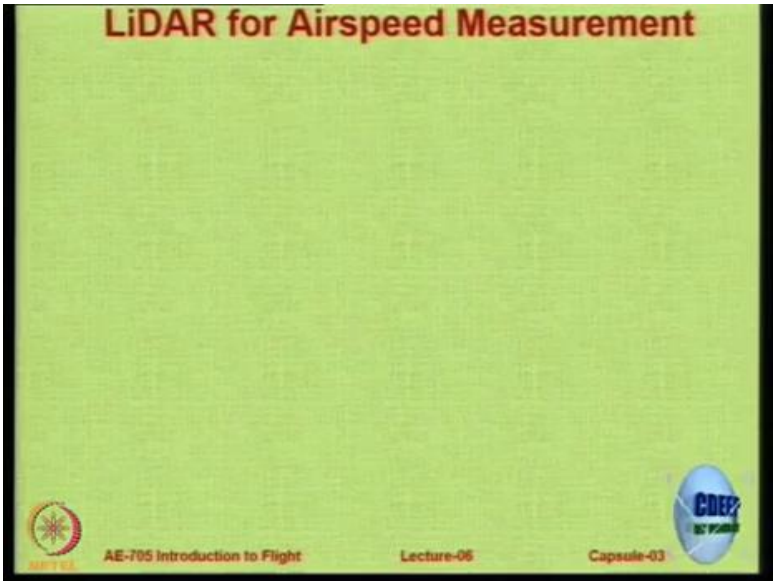

Moving on to the latest things, have you heard of radar? There is something called as LiDAR also in which you replace radio with light. So, light detection and?

Professor: Right, so here we use light for ranging and detection and a very interesting concept called as NESLIE, NESLIE is NEW STANDBY LiDAR instrument experiment, it was carried out and then when it was successful there was another project called as DANIELA demonstration of anemometry instrument based on laser.

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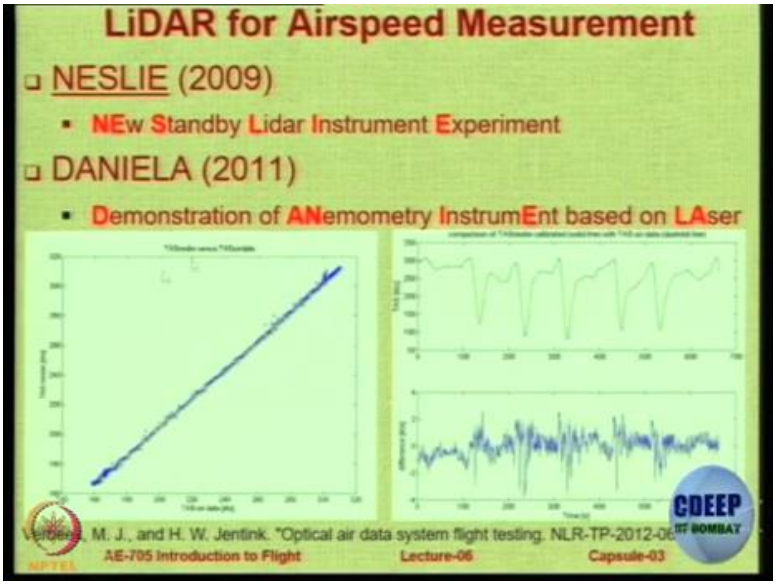

Now, no pressure only laser or LiDAR is used. So, let us see, let us see what this is and how it works. So, first I want to show you how good it is, so here you see a line which is inclined at almost 45 degrees and the dots there indicate, on the X-axis you have the true air speed which is altitude data and the true air speed which is measured by this this NESLIE experiment. You can notice they are perfectly aligned on the 45 degree line which means there is an error between the two but very, very marginal.

In fact, if you want to be more specific there is another figure which shows the error. So, on top there are actually two lines, we see only one line but there are two lines superimposed over each other, they are so perfectly matching that it looks like only one line and that is a comparison of the true air speed recorded by this NESLIE experiment and the actual by pitot-static instrumentation.

On the bottom, you have this error, difference in knots and the difference is only between plus minus, so plus 2 and minus 3 or let us say 4, in some cases, the difference is only between plus minus 4 knots and the speeds are 200 knots, 250 knots ,150 knots. So, in 150 knots the error is only about plus minus 4 knots, so that is a beauty. Let us see what this is, I have a nice video which plays, explains this particular experiment.

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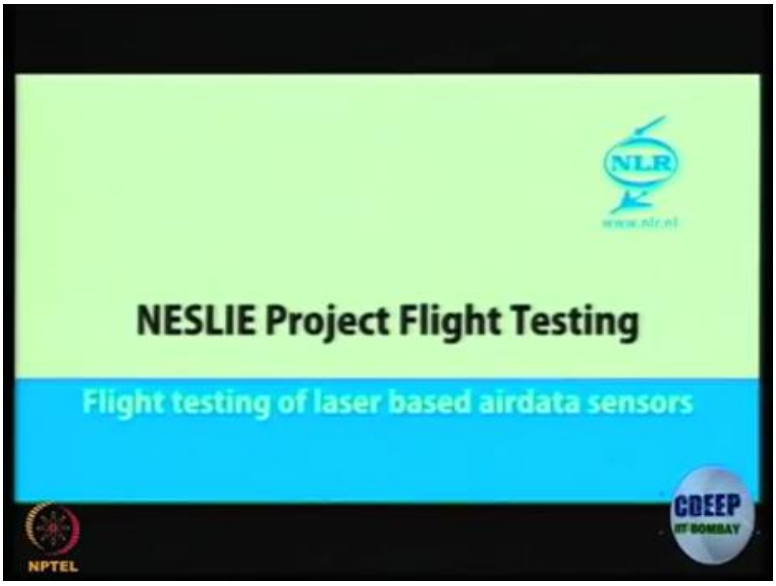

So, this is from NLR in Holland.

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This is the aircraft that was used for the experiments.

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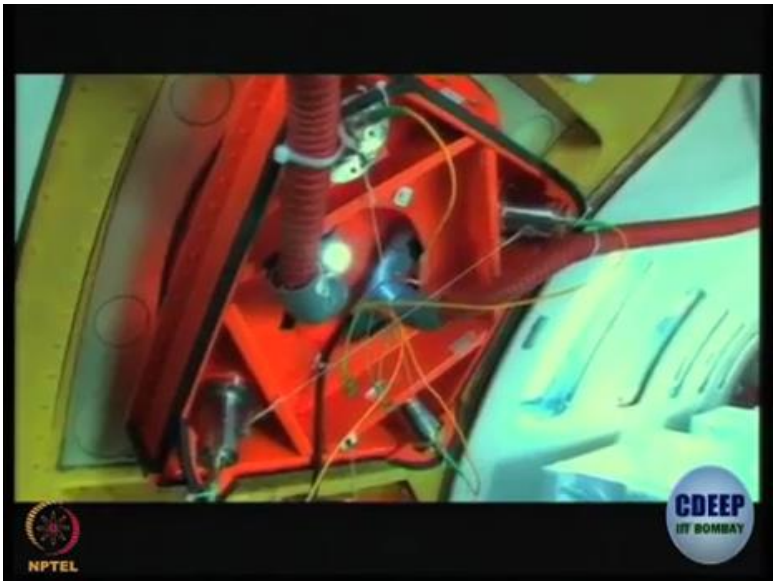

This red block is the LiDAR block.

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The airport is Schiphol in Amsterdam.

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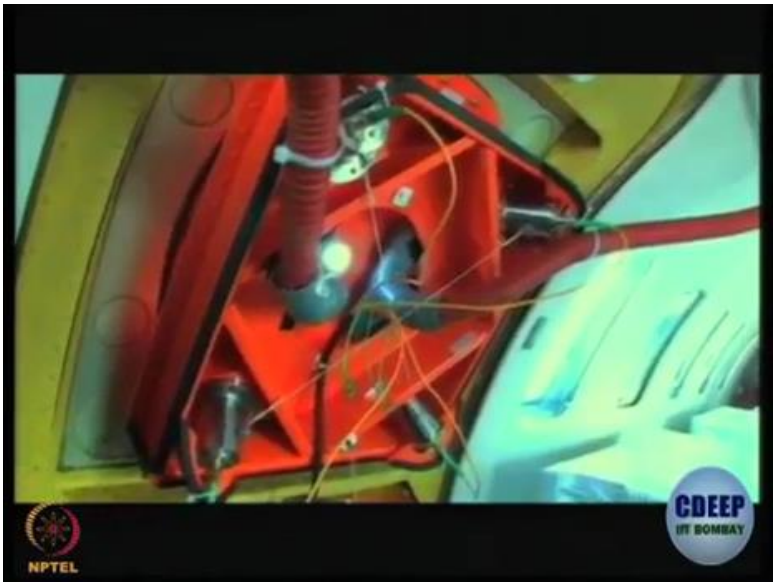

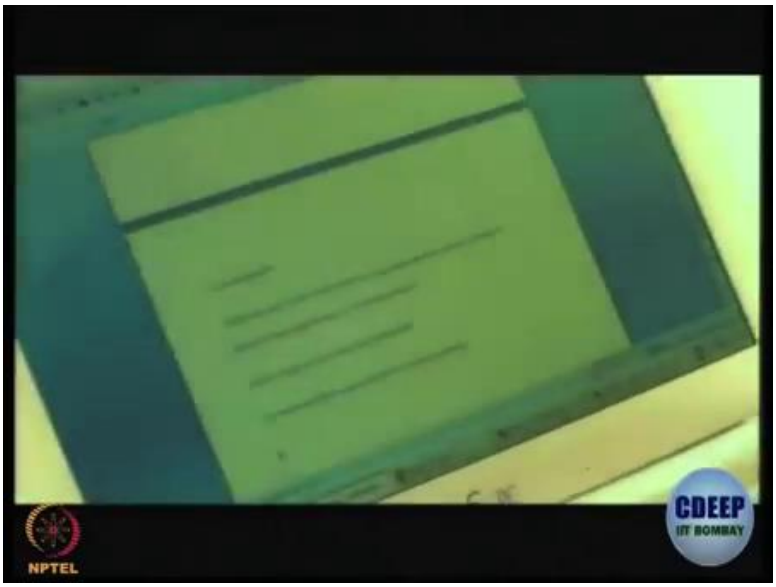

These are the optical heads which are measuring the speed using the LiDARs.

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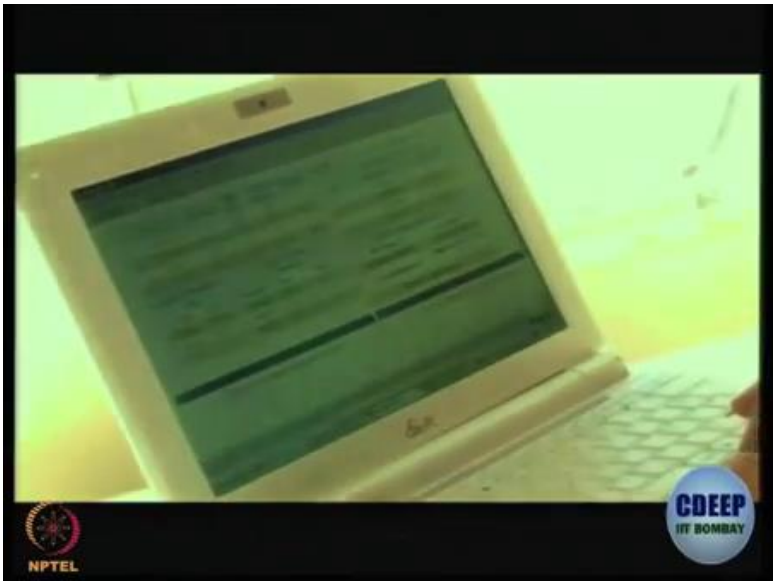

They tested the system in clouds, in bad weather, in rain, in disturbed winds.

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Coming into land.

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So, notice the partners basically this is a project under FP6, now FP7 has also been announced. You can see all of all the big names in aerospace instrumentation, as well as in aerospace engineering they are all there who are partners in this project, it is a research project therefore the implementation of this has not yet taken place in aircraft, this is a futuristic project where the aim is to remove the usage of pressure instruments on aircraft.

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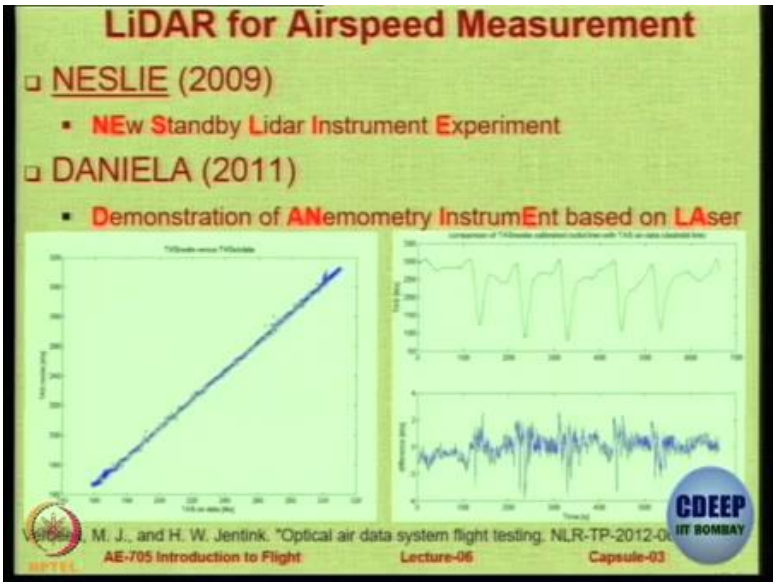

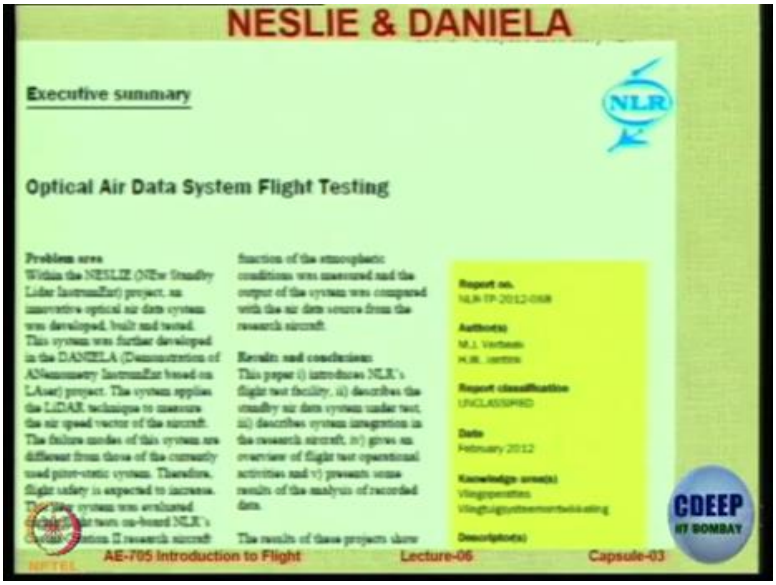

So, I just took some time to read the report. So, this is the photo of the executive summary.

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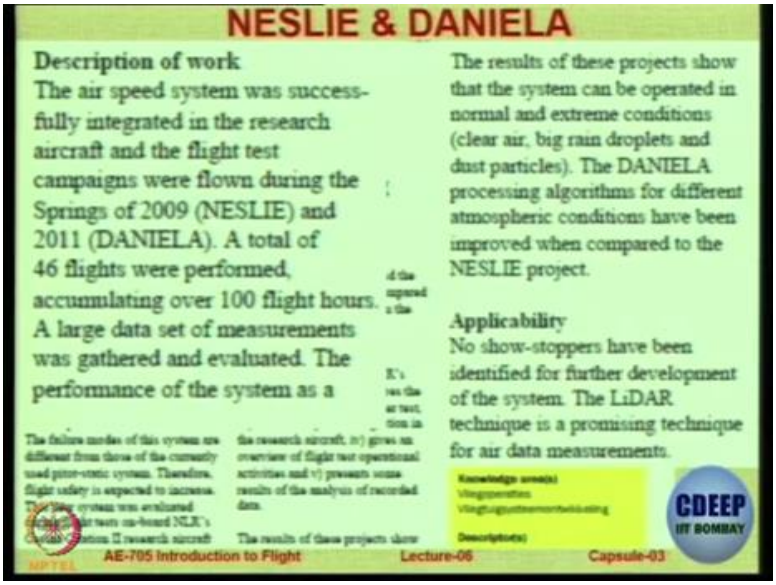

Important thing is that this airspeed system was successfully integrated in the research aircraft. There were 46 flights, about 100 hours of flying and what is the result? The system can be operated in normal and extreme conditions, clear air, big rain droplets and dust particles, and there are no show stoppers that means they do not think anything can go wrong, there is no obvious error or obvious problem in this particular system.

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So, this is the shape of things to come for the future.