NOC: Introduction to Airplane Performance
Prof. A. K. Ghosh
Department of Aerospace Engineering
Indian Institute of Technology, Kanpur

Lecture - 31
Revision

Good morning students, now you must be seeing a change, we are no more inside the classroom, we are free and free in open space, that is the beauty of aeronautical or aerospace engineering, that we have infinite liberty to conquer the atmosphere. You could see at present, we are all standing here on the tarmac and with me, Mr. Vipul Mathur who is the chief engineer here and with my team members help us in maintenance. They are the lifeline of flight laboratory IIT Kanpur and that is how, we could manage all this aircraft and impart training courses in terms of, academic enrichment to many, many colleges including IIT's and all government sponsored colleges private sponsored colleges.

If you recall, in the class I have discussed little bit about stall speed by the minimum speed of the aircraft, where you can maintain lift equal to weight. We, have also spoken about the importance of speed and in that connection we were very, very emphatic about it that, we need to understand, how a pilot get the feel about the airspeed, which is a air relative speed.

And hence, we will be giving lot weightage on instruments or the measuring instruments namely airspeed indicator and the altitude, which is altimeter, which gives the pressure altitude. Please understand, before a airplane goes for a takeoff, this tarmac is the most important place, where the engineer first checks the plane, he will be doing the runoff for the engine and after doing all checks, he will be releasing the aircraft to the pilot. Then, pilot does his own preliminary check and then goes for the preparation for a takeoff.

Today, I have requested Mr. Vipul Mathur with a chief engineer to explain, what are the procedures for preparing for a takeoff. So, this part you must try to understand, what are the methods, what are the procedures to be followed to ensure, that you are ready for a takeoff and at the same time I have requested him to explain you about the airspeed indicator, altimeter and other, other instruments. So, that you get a better feel and from here, we will go back to the classroom and again start writing equations, to see that yes a

designer has given enough bandwidth in the design, so that the pilot can fly very comfortably.

Thank you, very much.

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Good morning, I am Vipul Mathur chief engineer IIT Kanpur, at the moment we are inside the piper Saratoga aircraft. This is the cockpit area, where we are sitting, this is the instrument panel of this aircraft. You can see the two controls, this is the control stick, you can compare this control stick with the handle of your cycle. When you move the handle of your cycle on the left side like this, the cycle moves to left. Similarly, is in this aircraft also, when you move the handle to left, your aircraft banks to left, when you move the control stick to right, your aircraft banks to right.

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Then, we have the engine controls, this is the throttle control, the throttle the more the throttle you give the more the engine generates power. This is your propeller control with this, with the help of this control you can vary the blade angle of the propeller and this is your mixture control, with this control you can vary the mixture of fuel and air going inside the engine cylinders.

Now, this is your switch panel, you can see, we have different switches, this is your master switch and there are various other switches, here you can see all these white switches. These are the switches, these are all the circuit brakes, you can see this is the circuit braker panel, this is your radio sets, these are your radio sets, we have K x 1 6 5 band x king K x 1 6 5 radio set in this.

This is your altimeter, which indicates the altitude at which you are flying, this is your airspeed indicator, which gives you the indicated airspeed at which the aircraft is flying. This is your vertical speed indicator, which gives you the rate at, which you are ascending or descending. This is your R P M gauge, which gives you the R P M of the propeller, this particular aircraft the maximum R P M is 2700.

Then, this is your exhaust gas temperature gauge, which gives you the temperature of the exhaust gases coming in the cylinders. You can see this gauge, there are three gauges in one oil temperature, cylinder temperature and oil pressure. This is the fuel quantity gauge

one for the left tank, we have this left gauge for the right tank, we have the right gauge the two tanks are in the two wings.

We are going to start this aircraft, before starting this aircraft inside the cockpit and very first thing, we need to ensure is that your parking brakes are on. This is the parking brake and in order to ensure that your parking brake is on you have to brake, press your rudder pedals and then push this lever back and the parking brake is on now.

This is the ignition switch of the plane, this is the key of this plane, this is the ignition switch, I am putting this key inside the switch, a few seconds in this, this is the off position of the switch and this is the start position of the switch. So, now, apart from these two positions we have got both left and right, so this I will explain you while I will be doing the ground run the significance of these three positions both left and right.

In order to start the aircraft, we have to put the master switch on, this is your master switch, now I have put this master switch on. As you have seen, when we put this switch on, the electrical power is on the aircraft. So, with this master switch on, now I need to prime the engine before starting, so you can see here there is a fuel pump switch here, which at the moment is in the off position.

Now, I will put this fuel pump switch in the on position, you can lesson the sound of the fuel pump and I am putting this mixture control in the rich position. Now, with this procedure I have primed the engine with the engine primed, now I am going to start the engine. Now, you can look at this ignition key at the moment it is in the off position, now I am going to put it in the start position and now, I will put the key to the start position that is I will engage try to engage the starter and the prop will start moving.

You can see, as you have seen I have engaged the starter and now, the ignition key is on the both positions, as soon as the engine fired I have put the mixture control to the rich position. In the mixture control there are two positions this is your leave position and this is your rich position rich position means, your maximum amount of fuel is going inside the engine cylinders. As soon as your engine starts, you can see the propellers moving in the front although, you will not be able to make out, because the R P M is quite high.

Now, when the engine has started, you can see the propeller moving outside although you will not be able to see the propellers at the moment, because the R P M is quite high

almost around 1200 R P M as I had told you earlier, this is your temperature gauge and this is oil pressure gauge the very first thing you need to observe, when starting just after starting, that your oil pressure should register within 30 seconds.

So, as soon as we started the oil pressure gauge needle has come to the green range it has registered in case if the oil pressure needle does not register, then you have to switch off the engine that indicates your oil pressure is nil, that is your oil has not started circulating in the system. So, with the oil pressure need le registered this indicates that your oil pressure, your oil is circulating in the system. So, with this as you have seen that oil pressure has already registered, now the aircraft is on 1200 R P M is you can see this is 1000 this is one graduation is one 100 and one another graduation this is 1200.

So, the propeller is moving at 1200 R P M I will run the engine for some time and see that the oil temperature has registered in the green range and a cylinder temperature is also in the green range. So, that the engine temperatures have come up to the operating levels. So, now, we will wait for some time for the temperatures to come to the green range.

Now, you can see your oil temperature is already on the green range your cylinder temperature that is the cylinder head temperature is also in the green range your oil pressure is also in the green range. Now, we will move the throttle this is the throttle lever, we will move the throttle lever and take it to 2000 R P M from this position, I am going to take the throttle to 2000 R P M, here you can see this is that 2000 R P M you can see 2020 written; that means, this is 2000 R P M.

After reaching 2000 R P M I will move this propeller control lever this propeller control lever, you can see there are two things two settings this is the top setting is the fine pitch, this is the coarse pitch. So, at the moment the propeller is on the fine pitch at 2000 R P M I will move this lever to the coarse pitch that is to the down position and check, whether there is a drop in R PM or not.

So, here we go now I am moving the propeller R P M to 2000 at the moment it is 1200, now we are moving to 2000. So, you can see gradually you can lessen the sound of the engine, the engine sound has started increasing, because we have started moving throttle up birds, now it is at 1500 R P M, we are gradually moving up. You can see now, we have come to 1600, we are now on 1700 it is 1800, now it is 1900, now just we are, just

100th shot of 2000 just see that the needle is gradually moving towards 2000, now you can see your propeller R P M is at 2000.

And as I have told you earlier with the prop R P Mat 2000 I will turn this lever to the coarse pitch this is the coarse pitch I will put this lever down you can listen the variation in the sound of the propeller. Because, the propeller is now moving from fine pitch to coarse pitch in addition to this difference in sound, you will see that drop in R P M, the check, what we have to do at the moment is, we need to observe that the drop should not be more than 500.

So, just now watch out I am moving this lever to the coarse pitch see this lever has gone to the coarse pitch. And you can see, you have lessened the variation in propeller, just see it again I will show it once more just observe the drop in R P M, this is 2000 at the moment it should be less than 500, just observe that it was something around 300,350, so this was all about the propeller check.

Now, with the propeller R P M at 2000 I will further move towards the full throttle that is as I have told you earlier the full throttle R P M is 2700 in this particular plane. When, we reach the full R P M the thing, which we have to observe is the manifold pressure you can see this is the manifold pressure, manifold pressure with full R P M should be something around 29 inches of mercury, which if the engine is able to generate that much of manifold pressure; that means, your engine is developing power up to its requirements, whatever engine is designed for the engine is generating that much of power.

So, let us observe that I am moving the throttle to full R P M that is 2700, now see R P M needle is gradually moving it is now at 2200, now when we are moving towards the higher R P M we need to ensure that are brakes are on, you can observe that in addition to the parking brakes our feet are on the brakes. Because, we need to ensure that our airplane shoed not move northward although the parking chokes are already on.

Now, just watch the propeller R P M the R P M gauge needle is moving to 2500, you can see the manifold pressure gauge is around 24 at the moment, thus watch out this is moving to 26, you can lessen the sound of the engine see that it is almost 2700, we are at full throttle and see the manifold is at 29, plus we need to ensure all your temperatures are in the green range oil temperature cylinder temperature and oil pressure.

Now, I am gradually moving backwards I am reducing power now you can see the needle is now, moving backwards, because I am reducing power, you can lessen the engine sound also gradually it is coming down. So, now, we are back to 2000, now from here from 2000, I will move the R P M to 1700 at 1700 R P M, I am going to check the ignition system, the ignition check. I have told you earlier that a ignition switch has got five positions of right left both and start at the moment the ignition switch is on the both position, you can see the ignition key is on the both position.

Now, at 1700 R P M I will move this key from both to right position and observe a drop in R P M after observing the drop it should not be more than 125 R P M, after observing the drop I will move the position key from right to both position. And similarly, we will check the ignition for the left, left position also and move the key on the both position to left position. Now, watch out I am moving a propeller R P M from 2000 to 1700, just watch out I am at 1800 at the moment it is now 1700 just look at the needle it as1700.

Now, watch out this ignition switch it is the key is at both position from both position I am moving to right position and you can observe the drop ((Refer Time: 18:29)) see it is from both to right see the drop you have seen from 1700 it came to 1600 and is back to1700, because the ignition key was switched to both position again.

So, what we observe we observed the drop of around 100 R P M which is satisfactory within the range, now I will put the ignition key from both to left position and we will again observe the drop, again the drop in R P M was around 100. So, we have checked a ignition system, now we will reduce the R P M again see gradually I am reducing power the needle is coming back and we are approaching 1000 R P M.

You can see the needle is at 1000 R P M, now with this 1000 R P M I will move the throttle lever to the ideal position, you can see this is the full throttle setting and this is your ideal position just the extreme. So, now the throttle is at ideal and this is your ideal R P M something around 800, 850 and I will check the mixture also.

Now, to check the mixture, I will put the mixture control from rich position to the lean position gradually and the increase in R P M should not be more than 20, 25. So, just see that I am gradually moving the mixture controlled lever from rich position to the lean position and you can see there is an increase in R P M of around 25, I have again moved

the lever mixture controlled lever back to rich position just in order to ensure that the engine does not cut off.

Now, with this we have checked the full power been generated by the engine, we have checked the ignition system, we have checked the propeller system, we have checked the mixture system. And now, we will taxi the aircraft, we will show how the aircraft is taxied and how do we turn the plane on the ground as we have put the parking brakes on earlier. Now, before going out for taxiing, we will ask the people outside to remove the ground chokes, so that we are cleared to move out I am indicating them to move out the chokes.

So, the people outside have removed the chokes I am taking the clearance from them they are indicating me thumbs up; that means, both the chokes have been moved out. Now, I am moving the parking brake out, you can see that, now the parking brake is also removed chokes are also out. Now, I will move the throttle over; that means, I will generate some more power and we will start taxiing in the process I have checked the brakes also, I am putting the brakes the aircraft is a stationary, now you can see I have checked the brakes also the functioning of the brakes.

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Now, I will turn the aircraft to left both the pedals are at the same level that is at the neutral position see the left pedal is moving inside the aircraft is moving is turning to left. The aircraft is turning to left, you can see that now the right rudder pedal is going

inside and a left is coming out, now both the pedals are again in the neutral position and the aircraft is moving straight. You, can see that both the pedals are there at the same position at the almost at the neutral position and you can see outside now you can see that the aircraft is moving straight with both pedals in the neutral position.

Now, I would like to show you how the aircraft is turning to right, just see that right rudder pedal has gone inside, you can see outside the plane just watch out the plane is turning right on the ground. Now, we are moving back to the tarmac position I am applying brakes, now I will put the parking brakes again now, still I will keep the brakes on and before shutting off, I will clear off the engine I will keep the propeller R P M to 1200 for a few minutes for the temperatures to stabilize.

And finally, I will switch off the engine, so how did we switch off the engine this is your mixture control I have told you earlier that this is your rich position, most forward position, is the rich position most backward position, is the lean position, when we put the mixture control to the most backward position; that means, we are cutting of the fuels applied to the engine cylinders, when the there is no fuel supply to the engine cylinders engine shuts off.

So, this is what I am going to do I am moving this mixture controlled lever from the rich position, to the ideal cut off position, that is to the most lean position and just see the engine has cut off, now you can observe, now the engine has stopped.

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Modern Cockpit

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Now, we are sitting in modern cockpit, which is called also called a glass cockpit, this aircraft is Cessna 206 H, newly inducted in flight regulatory I I T Kanpur this aircraft has got carbon 1000 avionics. As you can see, there are two screens in the front this is the first screen called the P F D that is the primary functional display, this is the second screen which is called the M F D which we call as multifunctional display.

So, whatever gauges we have seen in a conventional cockpit they were all analogue gauges in this cockpit, we have all digital gauges here, you can see that on the top left corner is the nav box we call the navigation box on the top right corner is the communication box. So, whatever navigation settings, were required in that conventional cockpit are given here, this on the left side and here communication on the right side, on the left side of the panel.

You can see, we have all the engine gauges, you can see all digital gauges on the left side these are all the engine gauges, right on the top is the manifold pressure you can see this

is the manifold pressure, second place this is the R P M the R P M of the propeller you can see the markings given green marketing, red marking, white marking.

Then, third is the fuel flow indicator, which gives the fuel flow in gallons per hour, you can see as we start the engine this bug here moves to the right and indicates the fuel flow. Next, is the oil pressure gauge here you can see in the red light this is blinking red light blinking because at the moment engine is not on, so that is why red light is blinking oil pressure is blinking, so here we can observe the oil pressure.

Next is the oil temperature gauge this is oil temperature again, you can see a bug here when the temperature increases this bug moves and goes to the green range, you can see the green range and at the end, you can see a red light also, which indicates the never exceed range. Then, next is the cylinder head temperature gauge this is the C H T gauge after that is the E D T gauge that is the exhaust gas temperature gauge. Next, we have the fuel quantity gauge, you can see here there are two bugs here one of the top, one on the right, one indicates the left tank, one indicates the right tank, on the top is on the top bug it is l written, you can see that l is written here on the yellow this indicates the left tank, on the bottom bug is R written, which indicates the fuel quantity in the right tank.

These are the electrical instruments this gives you the bus voltage and then the battery and the range. This was about the engine instruments here in the conventional cockpit you saw the altimeter the airspeed indicator in this cockpit, you can see this is the altimeter this indicates the altitude at which, you are flying and this gives you the specific altitude at which, you are flying and this is the scale.

This is the pressure that is to be set in the altimeter you saw in the conventional cockpit that it was to be set in the Kollsman window, here this is the place where the pressure has to be set then this is the airspeed indicator, we have already seen the conventional airspeed indicator in the conventional cockpit as a standby instrument in this cockpit also, you can observe conventional analogue airspeed indicator and altimeter, which are provided as stand by instruments in addition to the digital instruments.

So, on the left side you can see this is the airspeed indicator at the bottom, we can get a true airspeed also here, just next to the altimeter is the vertical speed indicator or the rate of climb indicator. Now, we have a few navigation instruments this is your attitude

indicator, this is your horizontal situation indicator, that is the we call it H S I, here in a small window, you can see the it gives you the outside air temperature the O A T.

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As you can see, the two screens are displaying the same data the P F D, as well as the M F D they are showing the same data. But, we can change the display on the M F D that is on the second screen on the multi functional display, we can change the display.

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And you can see here, we get we are getting the navigational maps, so while flying basic airspeed altimeter vertical speed your artificial horizon your H S I, this all these data

your nav data and your com data this, you are getting on the first screen that is on the P F D on the M F D, you are getting the engine instruments as well as the navigation maps.

So, lot of data has been distributed within these two screens, so you can see that the efficiency of the cockpit has increased, because of this glass cockpit as compared to the conventional cockpit. The space required is very less all the data has been squeezing these two screens and it is very reliable as compared to the other cockpits.

Thank you.