Technical Arts 101
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Lecture - 20
Think and Analyze

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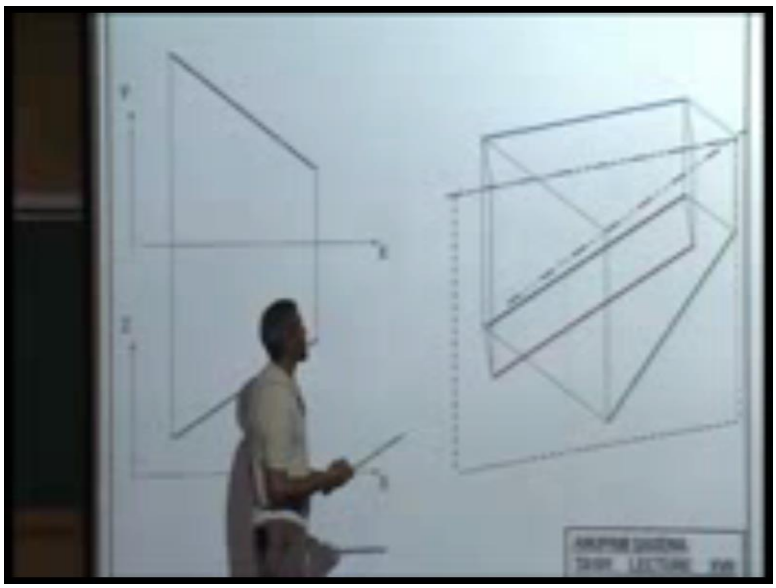

So, Ayush had raised his question last time that he was having a hard time visualizing the point view of a three dimensional line, with respect to this what I would call virtual bugs right. So, yesterday even I was having a hard time when I went back I was like how would I do that, but then I could figure a way out and maybe I will share that with you. So hopefully thinks will become clear in particular with regard to the distance at we were taking to get the point view. So, this figures clear to you right, is it is it yes or no?

Yes sir.

Perfectly clear.

Yes sir.

To whom is this figure not clear, wonderful.

So, projection in the horizontal plane, on the horizontal plane, projection on the vertical plane on the vertical plane these distances are essentially these distances, so pretty much

that right. And if you figure the intersection of the green and the blue line here, and the green and the blue line here. You have 2 vertices of a three dimensional line which is enclosed within a virtual bugs, right. Draw this plane that would contain this projection as well as this three dimensional line.

Now this step is critical project; this plane forward in a manner that you are actually getting this guy along with this plane. And this guy which is the image of this along with this plane get these 2 hinged lines. And when you are drawing this hinged line with respect to the horizontal plane So, this hinged line would be parallel over here So, you would be essentially flipping that plane over in such a way that all these 3 planes lie on the same plane that is what the basic idea is. Now, follow this carefully.

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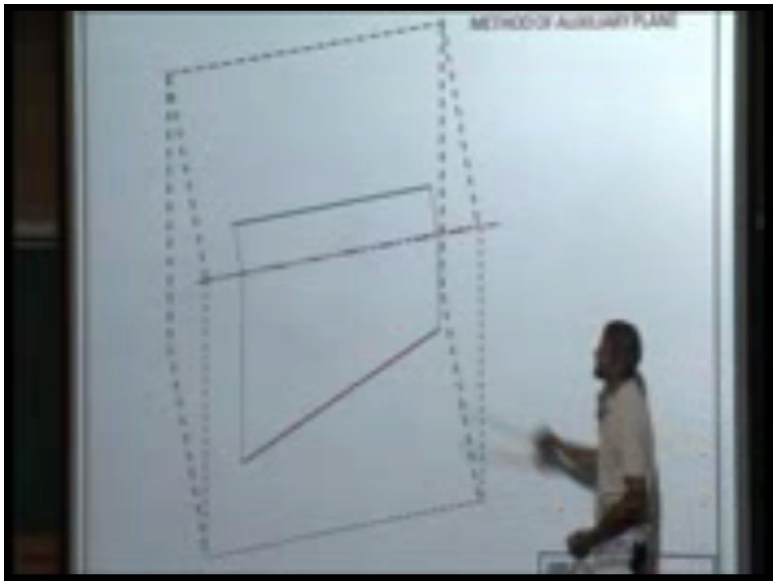

This is fine I have shifted this entire figure over there. Now, yesterday two of you came and I asked how you would be able to look at the plane that would contain the point view of this three dimensional line. And you know somebody was looking where they are like that alright. So let me try to get that plane on this picture So, the idea is that we are going to be looking on this line like so perpendicular possibly to this plane So, I draw 2 planes or rather I draw this plane parallel to this, this plane here parallel to this. And a back plane which is parallel to this plane which is containing the three dimensional line fine so far we me so far.

Yes sir.

Massey; so I would take away certain information that I do not need at this time. So, what I am left with is just the horizontal projection over here the vertical projection over here and the respected planes alright. Now this view is probably not very comfortable for me to work with. So, what I will do is I will enclose this entire thing within a cube and rotate the cube a little are you with me or you are. So, what I will do is I will essentially transfer all these information on to a cube and rotate the cube.

So, what I will do is I will transfer this information; this information; this distance; this distance; this distance and this distance. Just carefully observe one more time this edge is now going to be one of the edges of the cube I am going to be measuring the red distances. And I am going to be placing this blue line on the horizontal surface I am going to be measuring these green distances on to the vertical plane. And then I am going to be having this red line at the end at the 2 ends of these green lines watch carefully.

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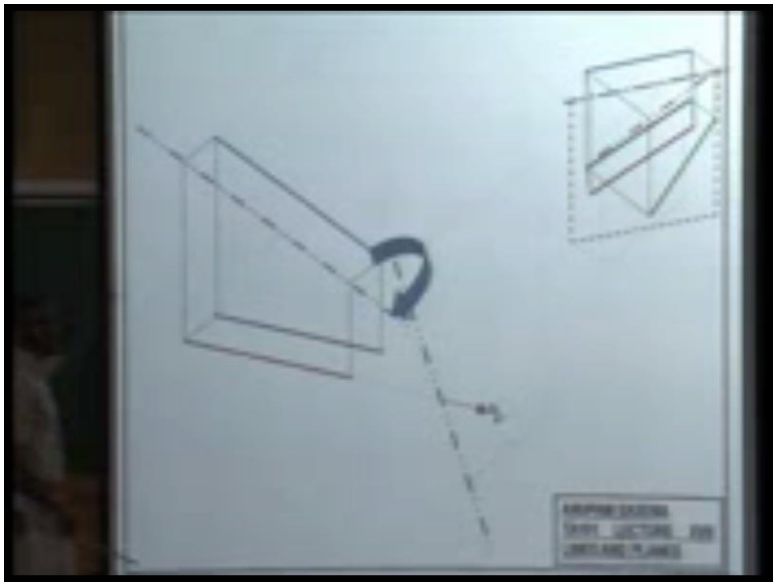

Now, it becomes a little easier for me to visualize the point view of this three dimensional line alright. Of course, for the point view I will have to be looking at this three dimensional line from here. So, I will have to draw a plane that would be that would be or I have to sketch a plane in such a manner that this guy over here is perpendicular to it right. Perhaps this is what my plane is, it will be an inclined plane, it would not be parallel to the vertical nor will it be parallel to horizontal it will be inclined plane. And let me assume that I am going to be having a hinged line here for now that

passes through one of the vertices of this red line So, the idea is for me to flip this plane above this hinged line like this. Let me try to capture the point view here follow this very carefully, but before I do that I will ask this question to you. Is this the actual three dimensional line, it is just the image of that right.

So, I should be considering the actual three dimensional line, look at that figure over there. The black line is something that I am impressive not the red line. Now, for that I am going to be using this distance I am going to be using this distance and this is where my black line is. So this plane black dash plane is going to be capturing the point view where over here is not it right not there. But here now your question was how do I correlate these distances with this one. Now, it is clear is it right now that plane need not be passing through this vertex of the red line it can be anywhere so long as its parallel to this plane.

So I can move this plane perpendicular to this line. Along this line once again it does not really matter whether location that plane is now what I would do is I would rotate the plane about that black hinged line like so. And when I do that this guy would be coming where here clear now is it for you to correlate this distance with this distance clear, anybody else? You are right for your constellation, this is not good team, it does not is to be good anyhow. So, having understood this let me move forward. So, visualization is only one aspect of it. So, with practice the more you practice the more it becomes easier for you to follow this mechanical.

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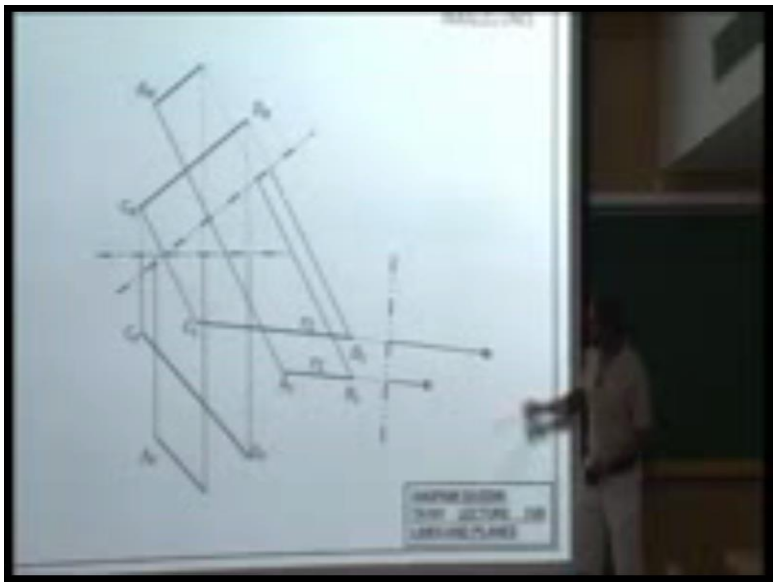

Anyhow, parallel lines given the projections of a three dimensional lines C D in the vertical and horizontal plane. And you also have the projections of a point A, the vertical plane projection here the horizontal plane projection over here. I am expected to draw a line that passes through a which is parallel to C d, how do I do this, how do I do this I will have to visualize this line.

Point view.

Point view or true length; I will have to figure out the plane in which this line is in true length hinged line this Q's going to be I am not sure which is one going to be common alright. So, this Q's going to be common, because I am using another hinged line I am going to be making an auxiliary plane draw projections perpendicular to this hinged line measure. What distances measure this distance transferred over there measure that distance transferred over there. And this is my line C 1 D 1 in auxiliary plane 1; remember I can use as many auxiliary planes as I can or as I would want. So this is the first auxiliary plane that is the reason why I am using the subscript C 1 D 1 and this would be in.

True length.

True length; great so it is really nice to get the feedback from you. So, this would be in true length now, that I have located the plane. I have to do the same exercise to get the

corresponding projection of A 1 that plane how do I do that I will draw a projector perpendicular to this hinged line. From that point I will measure this distance transferred over there that is where my point A 1 is. And then I know that this line is in true length so I can draw a line passing through A 1 which is parallel to C 1 D 1 of any length of any length right And this is let us say point B 1 I take B 1 back I am going to be using the same rules. Now I am going to be taking B 1 back where do I locate that B 1 over there. Now, would this be in true length A 1 B 1.

So, if one of if these lines are parallel and if one of the lines is in true length. The other one has to be in true length now, how do I locate B 1 in the horizontal plane over there? How do I do that? I do not know the distances right now I do not know the distance, but what I know is if this is in true length. Its corresponding projection in the other view has to be parallel to the hinged line, it has to be parallel to the hinged line which is what I am going to be using. So, I am going to be ensuring that this guy is in true length I am going to go up. And I am going to draw a line segment which is parallel to this hinged line. Once I get that now I can use the distances now, if I project this B H downward I can measure this distance. And transfer it back over here down and there is the projection of A B in the frontal plane on the vertical plane right.

So, I have not mentioned A H B H may be I will mention that that later, but if I want to see now the point views of these 2 lines, because both of these guys are in true lengths on this plane. So, if I look at these 2 lines from here I need to make a hinged line which is perpendicular to either one of these. Get the projections from there am I going to be getting the distances from there, because now this view is common between this guy and the view that I am going to be making. So, I will get that distance transferred over there I will get that distance transferred over here so far so good now what. So, my mistake what is so nice right you guys realize that. So, this guy should be here right. So, this distance should actually have been here and that distance should actually have been here. So, just flip this guys over and essentially you are going to be getting this point of view over here this point of view over here. So, point of view of C D sorry point of view of A B will be here point of view of C D will be there.

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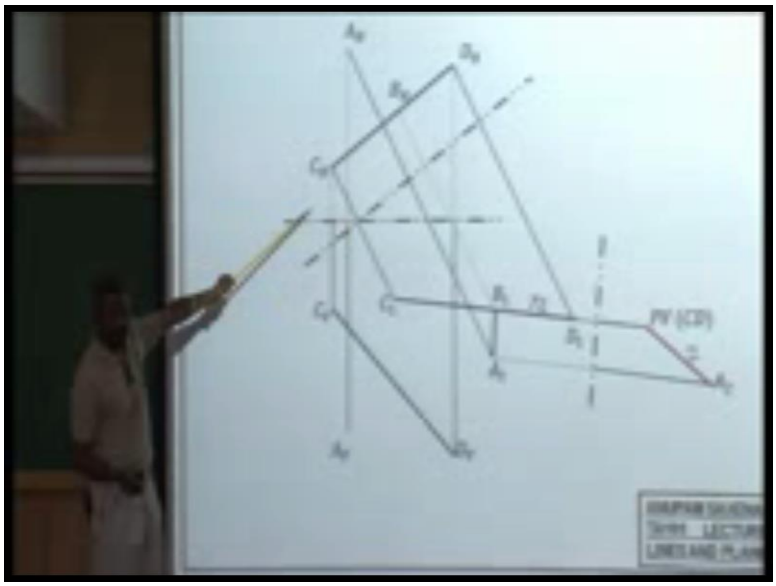

Next perpendicular to a line from a point, you got the projections C D in the horizontal plane and vertical plane. And we also got the projection A V and A H in both planes I am I am doing a here So, I am trying to make trans fats hinged line, it would be a good idea for you to sketch a long side, this lecture to view a nice practice and hopefully you will be. So, 2 things will happen number 1; your eyes will not get heavy number 2; you know it will be nice I mean you will get some practice so I will start with the hinged line. So, remember whatever exercise I am doing with respect to this view I can do exactly the same thing starting from here nothing stops me. So, I will draw a new hinged line parallel to C H D H here take the projections get this distance transferred over there get that distance transferred over there I get C 1 D 1 in.

True length.

True length; one full and then I will do the same thing for a I will take projection which is perpendicular to this hinged line. I will measure this distance transferred over there and I will get my A 1 there alright. So the question is to figure out a perpendicular from point A in 3 D on to C 1 T 1 or C D, the three dimensional line C D, this is what the question is alright. So, at this time may be I will just move forward I will get the I will try to get the point view of C 1 D 1. Draw hinged line perpendicular to this projection I hope I am not making that mistake again get that distance measured over there this is my point view of C D.

And then likewise I will measure that distance draw a projector perpendicular that hinged line from A and transferred over there this is my A 2. So, this is my first auxiliary plane that contains the true length of C D; this is my second auxiliary plane that contains the point view of C D. Now, is it for me to draw a perpendicular from A 1 to C 1 D 1 and say that this would be perpendicular why not? Why not why not or why both questions? This would not be the actual length but this would be perpendicular, do you agree?

Yes sir.

The plane in which this line is in true length I draw a perpendicular, this will remain perpendicular. But this guy may not be in true length it is so on, this auxiliary plane it is only the projection of this line that you see to get the true length. I probably have to go over there would this be in true length, why is that, because this guy is parallel to this hinged line. If one of the projections is parallel to the hinged line the other projection will contain the true length quiet mechanical now. So, this would be in true length. So, you have the perpendicular over here you ensure that this guy is perpendicular. And you will find the true length of this perpendicular from here get back. You figure this point of intersection that is called as B 1 go back of course, B 1 has to lie on C D.

So, you get B H come down of course, B has to lie in C D so you get B V. So, this is your first or projection of your perpendicular in the horizontal plane. And this is the projection of the same perpendicular in the vertical plane with me. Now, better to understand lot easier to understand compare to previous lectures, last part from where? Till this is fine; till this fine that would be in true length; this is point B 1, B 1 has to lie on C 1 D 1 right come up and these projections they are going to be parallel to each other. So, the corresponding projection of B in the horizontal plane is going to be B h on C h D h come down the corresponding projection will be B v. And you join just A h B h over there and A B B v over here no rocket science how was your galaxy go in.

Very.

Tarring anyhow so this is clear, is this clear?

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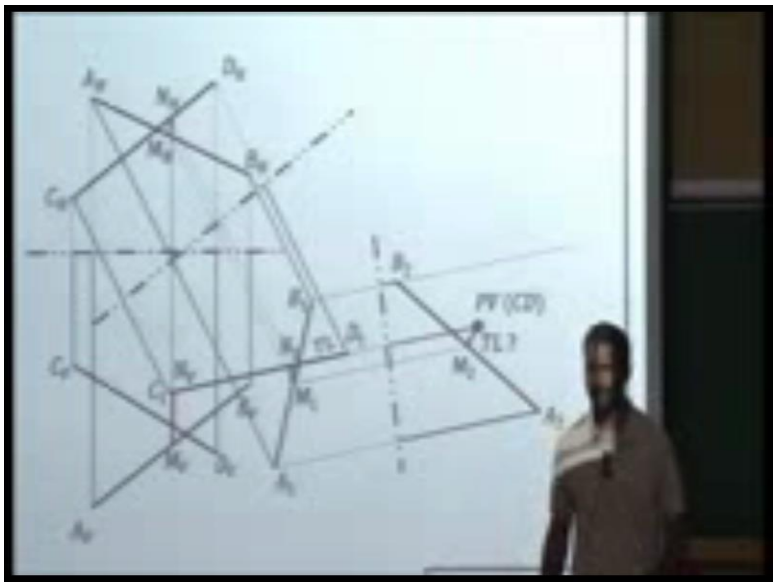

Shortest distances between lines is going to be a long day today so bear with me, but I i really want you to understand this, because if you do not then you will have difficulties studying Monday. So, it was important for us to have this class 1 look at this figure and you will realize that the points or the lines are intersecting or not. They are not intersecting the reason, why because you do not see the corresponding projection of the intersection in the horizontal plane over here. So, they cannot be intersecting they are skewed in space somewhere right alright. Same thing same thing a hinged line try to get the first auxiliary plane projectors perpendicular to that hinged line from everything A B C and D things might be a little messy. So, I want you guys to follow this carefully measure this distance transferred over there, measure that distance transferred on the projection from where on the on the projection emanating from D h over there.

So, this is your C 1 D 1 and since this projection is parallel to this hinged line. This would be in true length do the same thing for the A's and B's take that distance transferred over here on the projections starting from h take that distance transferred over there and you would be getting A 1 D 1. This guy is in true length, how about this guy? Not in true length fine. Now let me try to visualize these 2 lines from a plane from where I can see C D as a point. Get the point view of C D make a line or make a hinge perpendicular to C D draw this projector measure that distance transferred over there. And this would give you the point view of C D, draw 2 other projectors from A 1 B 1

perpendicular to this guy this hinged line where are you going to be measuring the distances from here measure.

That distance transferred over here if you have not noticed let me emphasize that these distances are to be measured. They are to be measured from the hinged lines it is critical not to be measured form the points, but from the hinged lines every time alright. So, measure that distance this little one from this hinged line transferred over there and this is your A 2 B 2 so on. The second auxiliary plane you see C D as a point C D as a point and you see the projection of A B would A 2 B 2 be in true length. Good not a problem, how do we find the shortest distance between lines? I draw a perpendicular right there I draw a perpendicular alright is this going to be in true length.

Why do you say yes?

C D.

It is perpendicular to.

C D

But you do not know, do you as if now, but would this plane or would this projection of the perpendicular give you the give you the true length? Fine so you say yes; you say yes, but I will retrace my steps back and convince you that it is actually going to be in true length for those who believe great. But for those who do not believe that this is going to be in true length I will convince you that this is going to be in true length at this time. I just pose the question whether this is going to be in true length or not anyhow so I truck back I call this point M 2. I go back M 2 is going to be lying definitely on A 2 B 2 So, m will be part of a B in general everywhere on every plane.

So, this would be M 1 if that is the shortest distance if that is the shortest distance it has to be perpendicular somewhere right alright. Now since this guy is parallel to the hinged line why because this thing is perpendicular to C D. Shortest distance has to be perpendicular to to both lines right now to just see that it is perpendicular to C 1 D 1, but you can verify later whether it is perpendicular to a B or not in some auxiliary plane. Anyhow so once you verify that this is parallel to this that would be in true length. So, all need to do is name this intersection point as N 1 get both M and N back M lies on a B n

lies on C D on every plane So, this is M h N h M h N h and here this point would be what?

M v.

N v.

Sir.

Wait let me complete this, till here; till here. So, till here so ignore; ignore this part of the red line so it is going to be till here.

Sir.

Yeah.

Sir, while justifying that what the perpendicular do that in the second auxiliary plane. Sir using that the point M 1 lies in the series is that M 1 N 1 is perpendicular to C 1 D 1.

Yeah.

So, why is that sir?

Yeah.

Why did you take it is perpendicular to C 1 D 1?

The shortest distance is going to be perpendicular to both lines.

Do you agree the shortest distances is going to be perpendicular to both lines? Now, if you are seeing one of the lines in its true length that shortest distance will be perpendicular to it that is all.

Sir.

Yeah.

Sir; while drawing the first for the first time when you draw the perpendicular line then why did you draw it perpendicular to a line at the end of A 1 B 1 you got?

If I draw this line so you are asking as to why did I draw this perpendicular to A 2 B 2 I could have drawn it like this. But would that have been the shortest distance I could have drawn that like this, but would that have been the shortest distance this would be the shortest distance and that is the only possibility. You mean to say that if there is a line which is the shortest distance, if we take a solution along any plane it remain the shortest distance. It has to in reality in three dimensions if I have this line and if I have this line if I am going to be computing the shortest distance between these 2 guys that line would be unique that would not be changing. It is just that their projections will be different in different planes. Step up do we have another pointer turn around this is one of the lines in 3 D; this would be the other line 3 D figure out the shortest distance.

Perpendicular to both.

Both.

Yeah, show that now what is a question?

Sir, I am asking that suppose we have 2 lines.

Yeah.

One is a shortest one.

Yeah.

Somewhat lengthier than that.

Yeah.

If I take the projection of both the lines.

Around any plane is it always true that the projection of the short shortest line will always be shorter than the projection of the longer length. I mean in true length definitely not necessary, then how can we? What have a seat, but listen. So, this auxiliary plane is slightly different in this auxiliary plane you are seeing one line like this in the point view. And the other line or the projection of the other line somewhere how would you see the shortest distance. Absolutely which is what this is so that that plane is slightly different, but if you want to do this exercise try to get it A B in its true length. And figure out what

this projection is going to be alternatively, but just a moment before I alternatively. You know I started by finding the point view of C D do the same exercise instead of making this hinged line. Make a hinged line that is parallel to A h B h get the point view of A h B h, draw that shortest distance. And see really if the true lengths of the corresponding shortest distances are the same you could do that and you could verify.

Yes.

Sir if it C 1 D 1 and A 1 B 1.

Yeah.

So, of a C 1 D 1.

Can you be a little silent, because otherwise it becomes a little difficult for me to hear and can you be a little louder?

Sir in C 1 D 1 and A 1 B 1.

And slow down so C 1 D 1 and A 1 B 1

Yes.

Draw the perpendicular to M 1 M 2 to M 1.

Yeah.

So, here you are saying that it was like C 1 D 1 in the true length.

Shortest distance should be perpendicular to C 1 D 1 the line connecting to 2 lines

Yeah.

The shortest distance line.

Yeah.

True lengths.

But in that line the second auxiliary plane.

Yeah.

A h; the T l the shortest distances that may be perpendicular to the point view of C D. But how do you now see that its possibly perpendicular to A 2. This one same let me try to understand what you are asking. So, you are saying step 1; I drew a perpendicular from here to here. Step 2; I drew a perpendicular from here to here now, let me counter ask a few questions. Are you convinced with this step?

Not very much.

If why is it that that ranges true length I can get. It is true length, because the shortest distance has to be perpendicular to both lines, agree?

Yes sir.

If I am seeing one of the lines in it is true length that means that I have been able to capture that line on that corresponding auxiliary plane. The shortest distance will be perpendicular to it agreed, do you agree with this? Then if you agree with this, then this guy is parallel to this hinged line, because both of these are perpendicular to C 1 D 1 right. Now if I go from here to here the projection of any line segment which is parallel to on the hinged lines. The corresponding projection in the other view has to be in true length it has to be right starts from point view of C D.

Do you agree with that?

Yes sir that.

So, if you agree with this and if you agree with this then your question is why point view of C D and line is perpendicular to A 2?

Sir if it starts from M 1 m 2 start from.

This is the point view of C D; this is my line here it could be anywhere. What is the shortest distance that you are going to be dropping from the point view of C D on to this? Correct alright coming forward.

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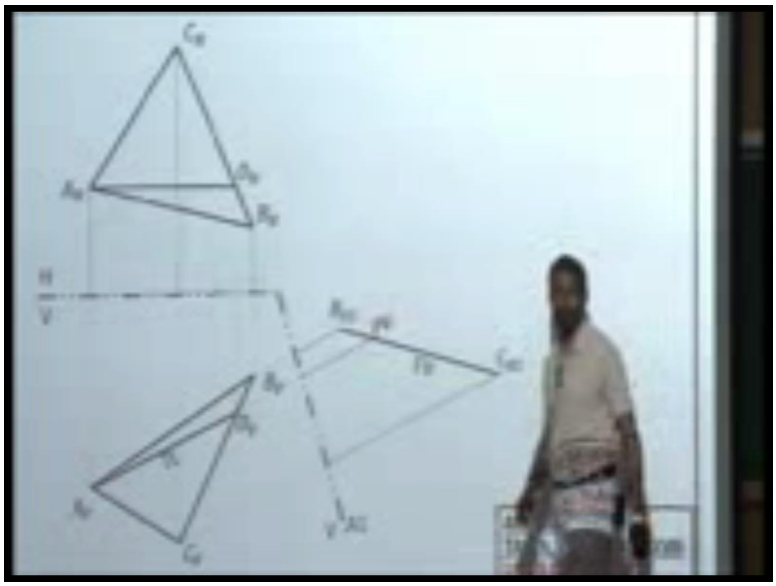

Rather going forward, enough of lines now into planes given the projection of a plane given the projection of a plane in the horizontal plane up there and the projection of the corresponding plane the vertical plane. So, these guys are the projections of plane of a plane A b B v C d down there A h B h C h up there. Look at the corresponding vertical projections they have to correlate so A with A, A with A B with B and C with C. The question is to find the h, view of the plane number 1 and to find the true shape of the plane if I can I have one of your. So, imagine that this guy is what you see over here on a triangle and imagine that this guy is what you see over there.

Now, the h view so this the this the true plane for example, the h view of the plane will be like this for you the h view of this plane will be like this. And if you flip if you flipped this plane over if you flip this plane over or rather if you rotate that plane about this h view you will be essentially getting the true shape right. Now, the question is how to find the h view of this plane? And then I know that if I flip this plane over by 90 degrees about that hinge I will be getting the true shape fine. Now, it might seem a little difficult, but it is not very difficult as it seems now be very careful be very attentive. And follow the following steps I start with the hinged line. Now, what I do is something smart what I do is something smart I locate a point D h; I locate a point D h on D h C h in such a way that a h D h is parallel to the hinged line that is this part of thing that I have done.

The second thing well not very difficult I project D h down and get that corresponding point here on B v C v. Now, this guy if we just feet this guy as a line segment it is parallel to the hinged line here this would be in true length. And if I look at this plane if I look at this plane in such a manner or rather let me let me go back. Next step I would do is I would draw a hinged line perpendicular to this line A v D v. So, in the process what I am trying to do? I am trying to find the point view of A v D v project this line and measure distances. So, that distance will be transferred over here this distance gets transferred over there this distance from this hinged line to C h gets transferred over there. And this distance gets transferred over there fine this is what I have done something very simple something very mechanical.

And then this is my first auxiliary plane I joined these 3 guys, these three points horizontal plane, vertical plane that is the vertical plane. And that is the first auxiliary plane A 1 D v comes now strangely this is the point view of A v D v. And this is my C A 1; this is my B A 1 and here I would have D A 1 and A A 1 once again. This is my C A 1; this is my B A 1 and here I would have D A 1 and A A 1 strangely I have got all the 4 points on a plane on to a single line. I have done nothing special all I have done is I have found a length I have found in h on the plane or a line segment on a plane in true length. I have just viewed that corresponding projection of the plane perpendicular to this that is all I have done nothing else. So strangely this entire plane is now represented in this auxiliary plane by this line segment is this the h view of the plane. This is what we wanted, did not we I could do the same thing starting from the vertical plane let me go over this real quick.

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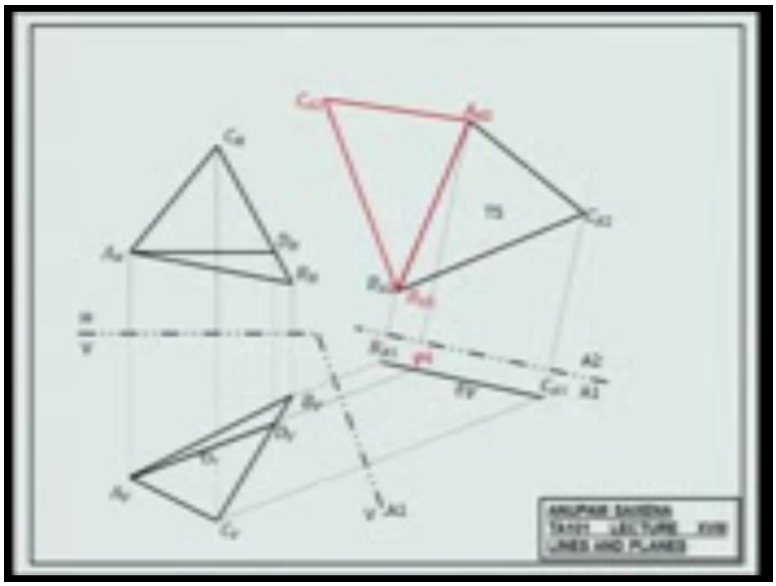

Parallel line project D v to D h, this would be in true length make a hinged line perpendicular to A h D h shoot the projectors out from these vertices. Measure this distance transferred over there; measure this distance transferred along C h; measure this one transferred along D h. Draw this line segment this is the h view of the plane that is the horizontal plane that is the auxiliary plane 1. And again you see that all these vertices lie on the line segment alright. Now if I draw a hinged line parallel to this h view of the plane and try to see how this guy looks perpendicular to this h view same thing. Shoot the projectors measure distances from where now from where from here this is between A 1 and A 2 hinged line.

Measure that distance transferred over there measure this distance transferred over here somewhere. Now, this distance is from here to A h measure this distance transferred over here this is the true shape of the plane. That you will be getting the beauty of this construction is nowhere am I using coordinate geometry nowhere I am using mathematics simple lines that is a beauty of them alright. Can I go back to the previous example and get the true shape of the thing real quick and can I try to compare these true shapes? No, hey half an hour more I have to finish this lecture. Just 2 minutes so I get this true shape from the previous example. I merge that true shape in such a way that when the vertices coincide then one of the edge is coincide.

And then I flip it so both will expectedly give you the same shape. Now, I have to finish this lecture number 1, but I will give you the freedom to, you know go back and do whatever you want. So, here are 2 proposals proposal 1; we take a break for 5 minutes you can wash your face drink water and then decide whether you want to come back or go to your hostel room. But I will have to stay here I will have to finish even if none of you are here. I think we are almost done let me see how much let me see how much I have.

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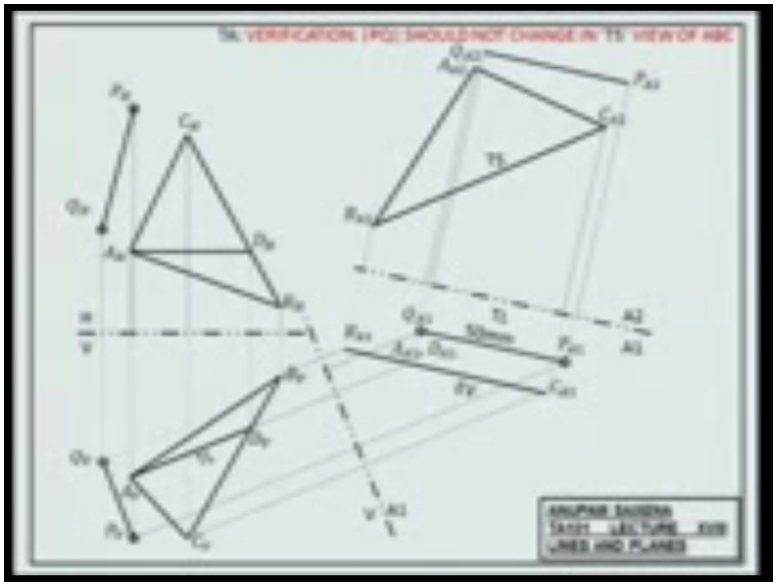


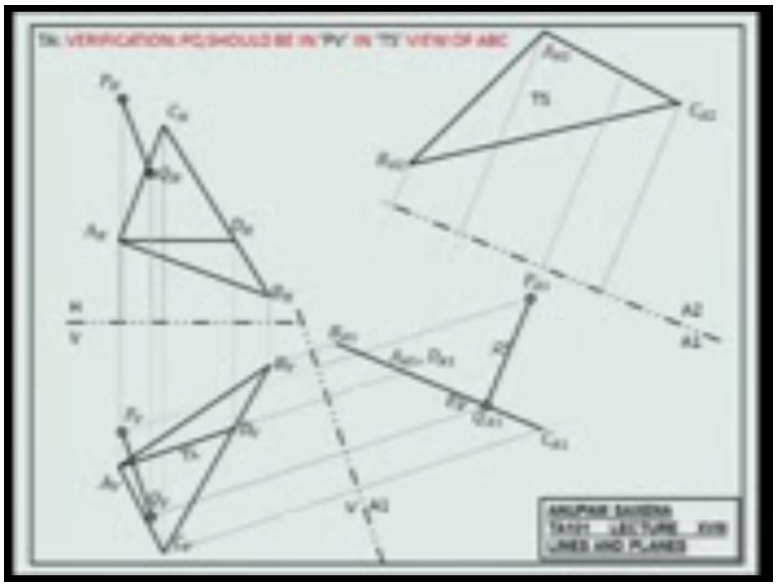
Line parallel to a plane is this straight forward get the plane in the h view get the plane at the h view. Draw a line parallel to it I will quickly go through that quickly go through that see listen otherwise see if I do not finish this. Then you guys are going to be having a problem in the next week I would not you guys will be facing problems bear with me for 5 or 10 more minutes and then you guys are free alright. Horizontal line A h D h stay with me guys you guys are what I mean you guys are so young. I mean full of energy come on you know I so much wish that many of you guys come back. And start teaching teach as I teach then you realize I mean what teaching is if not all at least at least 10 percent of you guys alright.

So, this is D v this is going to be in true length draw hinged line perpendicular to A v D v shoot the projections measure distances transfer distances straight forward. This is not very difficult this is the H v of the plane H v of the plane get the points not a problem do

the same thing for point P h. Shoot a projector perpendicular to this hinged line measure that distance transferred over there this is about T A 1 is draw a line parallel to the h v of the plane any given length let that point be Q A 1 trace it back. So, if you have seen that that is going to be in true length which is actually what is going to be true. Then this guy has to be parallel to that hinged line get this point Q v measure that distance shoot that projector transfer distance get Q h this what your line is?

So, if you just look at this picture and this picture it is not at all clear, if this line is parallel to the plane is it is it strange, but only this view gives a clear picture. How did if this is in true length this has to be parallel to the hinged line basic golden rule P Q should not change in T s view of A B C let us see what this is alright. So, if I make the 2 shape of the plane and what am I doing here measuring the distance transferring over there measuring the distance transferring over there alright. So, what am I saying? So, this length; this length would remain the same is it over here. And here and the only way this is going to be possible is if both these guys are parallel to the hinged line is it alright fine.

(Refer Slide Time: 51:56)



So, alright now same thing line perpendicular to a plane from a point. Stay with me just about getting done hinged line A h D h parallel to the hinged line I get the true length. And may be H v of the plane shoot the projectors get distances transfer distances get the H v of the plane stay with me mark these points. I do the same thing with the point measure that distance transferred over there I get that point as P A 1. And if I want to

draw a line perpendicular to a plane from a point this guy have to be perpendicular this point has to lie on the plane Q A 1, this should be in true length, should this be in true length?

Yes sir.

You guys want to go back. If this is in true length then this would be parallel to the hinged line and make sure or know this very well that Q the corresponding projection of Q over here has to be lying of this plane. So, this is Q v and measure that distance project Q v up there transfer this guy has to be lying within the plane this is Q h. And this is the line which is perpendicular to the plane in both horizontal and vertical planes alright forget about that. Verification P Q should be in point view wait this is important p q should be in point view in the 2 shape of a V C would that be the case alright. So, if you get the true shape of the plane and if you get the corresponding projection of P Q on to the true shape this would be the point which should be in the point view? You know so when you are doing this always verify always have those little thing is that you can use to verify whether you have done something correct or not?